

CHAPTER 7

**Transport and Logistics Bureau
Highways Department
Transport Department**

**Reconstruction and improvement
of Tuen Mun Road**

**Audit Commission
Hong Kong
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This audit review was carried out under a set of guidelines tabled in the Provisional Legislative Council by the Chairman of the Public Accounts Committee on 11 February 1998. The guidelines were agreed between the Public Accounts Committee and the Director of Audit and accepted by the Government of the Hong Kong Special Administrative Region.

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RECONSTRUCTION AND IMPROVEMENT OF TUEN MUN ROAD

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RECONSTRUCTION AND IMPROVEMENT OF TUEN MUN ROAD

Executive Summary

1. Tuen Mun Road (TMR) is a 21.4-kilometre long high speed road connecting Tsuen Wan and Tuen Mun. As TMR was designed and built in the 1970s, as of 1990s, most at-grade sections reached the end of their service life and were in a state beyond economical repair, and some sections were dual two-lane carriageways and heavily used. To upgrade the sections of TMR to the then prevailing expressway standards, turn the entire strategic TMR to a dual three-lane carriageway, bring about an overall improvement to highway and serve the traffic needs of the Northwest New Territories (NWNT) better, the Transport and Logistics Bureau proposed 3 projects (Projects I to III) to the Legislative Council to reconstruct and improve TMR. The Highways Department (HyD) was the works agent responsible for implementing these 3 projects.

2. Between June 2001 and January 2013, the Finance Committee of the Legislative Council approved a total funding of \$8,942.2 million for Projects I to III. For Projects I to III: (a) between April 2002 and November 2005, 3 consultancies were awarded to the same consultant (Consultant X); and (b) between May 2008 and March 2012, 6 works contracts (Contracts A to F) were awarded to 4 contractors (Contracts A and B to Contractors A and B respectively, Contracts C, E and F to Contractor C, and Contract D to Contractor D). In the event, Projects I to III were completed between January 2010 and December 2014. As of June 2022, the Government had incurred \$8,629.3 million (97% of \$8,942.2 million) for Projects I to III.

3. HyD is responsible for the maintenance of public roads (including TMR), highway structures and ancillary facilities within its ambit. The Transport Department (TD) is responsible for monitoring the traffic conditions of various major roads (including TMR). In 2021, the annual average daily traffic volume of TMR was 127,800 vehicles. The Audit Commission (Audit) has recently conducted a review of HyD's work in implementing the projects for reconstruction and

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improvement of TMR and the work of HyD and TD in maintenance and traffic management of TMR.

Reconstruction and improvement works of Tuen Mun Road

4. Contracts A to F were completed between January 2010 and December 2014. Except Contract D which was completed on time, the other 5 contracts were completed 2.1 to 13.2 months later than their respective original completion dates, but within the extended contract completion dates with extensions of time (EOTs) granted. Except Contract E which was an in-house managed contract, for the other 5 contracts, Consultant X was the Engineer or Supervising Officer responsible for supervising the contract works. The total final contract sum of all 6 contracts was \$7,919.0 million (para. 2.3).

5. *Need to draw lessons from the events causing potential delays to Contracts A and C.* Under Contracts A and C, Contractors A and C were required to modify over 140 and 70 slopes in association with the road improvement along both sides of TMR respectively. According to Consultant X's assessment, due to the additional works to slopes under Contracts A and C and 3 other major delaying events under Contract C, Contracts A and C might suffer a potential delay of 3 years and 2.5 years respectively if no mitigation measures were implemented. Between July and August 2016, Consultant X issued 3 variation orders (VOs) (valued at \$140.5 million) under Contract A and 1 VO (valued at \$145.4 million) under Contract C to carry out measures to recover potential delays caused by the additional works to slopes and the 3 other delaying events. In the event, according to HyD, all potential delays were recovered and the related works under Contracts A and C were completed by the scheduled completion dates under the Contracts (paras. 2.4, 2.8 to 2.11). Audit noted that the following issues merit HyD's attention and drawing lessons therefrom in administering future reconstruction and improvement of road works projects:

- (a) *Significant additional works to slopes along TMR after award of Contracts A and C.* According to HyD, during the design stage of Contracts A and C: (i) ground investigations had been carried out to obtain subsoil information; and (ii) for cases due to existing site constraints, detailed design of geotechnical works was carried out based on the best available information such as the subsoil data at the nearby accessible locations. In the event, the actual ground conditions at some slopes were

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found different from those assumed during planning and design stage, and about 500 VOs (valued at \$174.0 million) and 160 VOs (valued at \$43.0 million) were issued under Contracts A and C respectively to carry out additional works for the slopes. Audit noted that there were guidelines related to site investigation (including ground conditions of slopes) before award of Contracts A and C, and further guidelines on good site investigation practice and geotechnical works of public works projects were subsequently promulgated after the award of Contracts A and C. In Audit's view, in implementing road works projects involving slope works in future, HyD needs to remind its staff and consultants to follow the related guidelines on site investigation (paras. 2.6 and 2.12);

- (b) ***Scope for improvement in local consultation.*** Under Contract C, Contractor C was responsible for the design and construction of a reinforced earth wall at a slope next to a residential development near Castle Peak Bay. According to HyD, notwithstanding previous consultations, after the commencement of site clearance works, residents of the residential development nearby expressed concern that the proposed reinforced earth wall was in close proximity to the residential development, and requested to shift the proposed wall further away from the premises. In the event, Consultant X issued a VO (valued at \$3.4 million) to shift the alignment of the earth retaining structure and change the proposed reinforced earth wall to a reinforced concrete wall. In Audit's view, there is scope for improvement in local consultation (para. 2.14); and
- (c) ***Scope for enhancing ground investigation for bridge works.*** Under Contract C, Contractor C was responsible for the widening of bridge structure of So Kwun Tan Bridge (i.e. Bridge A). According to HyD, ground investigations had been carried out during the design stage. However, an unexpected layer of marine mud was encountered during the piling works of Bridge A. In the event, Consultant X issued 2 VOs to change: (i) the foundation of Bridge A (valued at \$1.5 million); and (ii) the alignment of a section of reinforced earth wall (valued at \$3.6 million). In Audit's view, there is scope for enhancing ground investigation for bridge works (para. 2.15).
6. ***Some necessary slope works not included in contracts.*** Under Contracts A to C, Contractors A to C were required to carry out slope modification and/or stabilisation works along the TMR covered by the respective contracts. According to

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HyD, 23 slopes had been upgraded under 2 previous contracts and no upgrading or modification works would be required for these slopes based on the preliminary assessment results during design stage. In the event, after 2 rock fall incidents happened in March 2009, comprehensive site inspection, desktop study and additional investigation were conducted for these 23 slopes and upgrading and stabilisation works were carried out for 10 of the 23 slopes under Contracts A to C. In Audit's view, in implementing road works projects involving slope works in future, HyD needs to critically assess the conditions of slopes (including those previously upgraded) and include the related slope works in contracts (paras. 2.17, 2.18 and 2.20).

7. ***Construction works of some facilities not clearly specified in contract clauses.*** Project III involved permanent relocation or reprovision of facilities within the then existing boundary of On Ting Estate. However, the contract clauses of Contract F (a design-and-build lump sum contract) only required Contractor C to submit the design and construction programme for these facilities. According to Consultant X, the construction works of these facilities were not specified under the contract clauses of Contract F and they were deemed to be additional works and shall be separately measured. In the event, Consultant X issued a VO (valued at \$3.9 million) to instruct Contractor C to carry out the construction works of these facilities (paras. 2.27 and 2.28).

Other project management issues

8. ***Need to draw lessons from the installation of vertical greening panels along various sections of TMR.*** According to HyD: (a) vertical greening panels were installed at the noise barriers along TMR as trial with a view to maximising greening opportunities at highways structures; and (b) the vertical greening panels on noise barriers along TMR were constructed under Projects I and III with a total construction cost of \$75.6 million. HyD and the Leisure and Cultural Services Department are responsible for maintenance of vegetation on the vertical greening panels along sections of TMR under their purview. However, the growing conditions of vegetation on these panels were not satisfactory. HyD and the Leisure and Cultural Services Department concluded that the maintenance works of vegetation were difficult and the vertical greening panels were not sustainable in the long run. In the event, all the vertical greening panels on noise barriers along various sections of TMR were replaced with acoustic panels or under planning for replacement/removal. In Audit's view, HyD needs to draw lessons from the installation of vertical greening panels on noise barriers along TMR (paras. 3.2 to 3.4 and 3.13).

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9. ***Scope for enhancing construction site safety.*** According to HyD, from 2008 to 2016, there were 2 fatal accidents at construction sites of Contracts A and C (1 under each contract) and 43 non-fatal reportable accidents (i.e. accident resulting in an injury with incapacity for more than three days) at construction sites of Contracts A to C, E and F. Audit noted that there were late reporting of reportable accidents by Contractor C under Contracts C and F on 4 occasions, ranging from about 3 months to about 11 months late. In Audit's view, there is scope for enhancing construction site safety (paras. 3.19 to 3.21).

10. ***Scope for improvement in cost apportionment among project votes.*** Upon commencement of 4 TMR contracts (Contracts A to C and F) at various sections of TMR, HyD, together with Consultant X, had reviewed and identified the need to strengthen their communication with the general public through the establishment of a community liaison centre in Tuen Mun Town Centre. The total cost for provision and operation of the centre amounted to \$4.3 million. Based on the agreed cost apportionment arrangement, \$0.4 million and \$3.9 million should be charged under two project votes respectively. However, Audit noted that \$4.3 million were all charged under one of the two project votes. In Audit's view, HyD needs to take measures to ensure proper cost apportionment among project votes (paras. 3.24 to 3.26).

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11. ***Management of works orders.*** The maintenance works for TMR are covered under two term contracts (Contract G covering the period from 1 April 2016 to 31 March 2022 and Contract H covering the period from 1 April 2022 to 31 March 2028) let out by HyD in recent years. Of 635 works orders for non-routine maintenance and rehabilitation works relating to TMR issued by HyD to Contractor G from 2017-18 to 2021-22 and completed as of July 2022, 29 (5%) were completed later than their target completion dates (paras. 4.2, 4.3 and 4.7). Of the 29 works orders, Audit noted that:

- (a) ***Delays in completion of works orders.*** For 5 (17%) works orders, there were delays in completion of works orders by Contractor G, ranging from 10 to 144 days (or 4.7 months), averaging 2.2 months. According to HyD, such delays were mainly due to slow progress of contractor's works and it had notified Contractor G for the imposition of liquidated damages for the 5 overdue works orders (para. 4.7);

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- (b) ***Late notifications of EOT claims.*** For 13 (45%) works orders which were completed between November 2019 and September 2021, there were late notifications of EOT claims by Contractor G (notifications served on 30 September 2022, ranging from 370 to 1,060 days (or 2.9 years), averaging 2.5 years after completion of works orders) (para. 4.7); and
- (c) ***Delays in provision of information for claim assessments.*** For 11 (38%) works orders, Contractor G served notifications of EOT claims for 4 works orders in October 2018 and 7 works orders in February 2022. However, as of September 2022, assessments of EOT claims for these works orders were still in progress. According to HyD, this was mainly due to delays in provision of information by Contractor G for claim assessments (para. 4.7).
12. ***Need to improve the monitoring of defect rectification works.*** For 67 notification forms (NFs) relating to TMR issued during the period from April 2021 to March 2022 to instruct Contractor G to rectify defects, Audit noted that: (a) for 24 (36%) NFs, there were delays in completion of defect rectification works by Contractor G, ranging from 1 to 207 days (or 6.8 months), averaging 2.0 months; and (b) for 24 (36%) NFs, there were delays in submission of completion reports by Contractor G after the completion of defect rectification works, ranging from 1 to 356 days (or 11.7 months), averaging 5.0 months (paras. 4.9 and 4.10).
13. ***Scope for making better use of information technology for contract administration.*** According to HyD, inspection and maintenance records for roads and associated structures under its purview were stored in a computer system. Audit noted that HyD had not regularly compiled management information (e.g. based on the inspection and maintenance records in the computer system) for monitoring the conditions of high speed roads (including TMR) and associated structures, and determining their maintenance strategy (para. 4.17).
14. ***Need to keep under review the traffic conditions of TMR and the traffic demand arising from the development of NWNT.*** Audit noted that: (a) from 2015 to 2021, the volume-to-capacity ratios (an indicator of the traffic condition of a road) of TMR during the evening peak hour (Tuen Mun bound) had exceeded 1.0 since 2016 and generally increased to 1.12 in 2020 and 2021. This indicated that TMR had been at the onset of traffic congestion since 2016; (b) the Government planned to complete

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a series of road infrastructure projects in stages so as to enhance the internal and external connectivity of NWNT. Upon completion of these projects, the projected volume-to-capacity ratios of major roads (including TMR) connecting NWNT and the urban areas during the morning peak hour in 2036 would generally be lower to not more than 1.0 (i.e. has sufficient capacity to cope with the anticipated volume of vehicular traffic); and (c) the continuous growth in population and economic development of NWNT would generate additional traffic demand and put further pressure on TMR. Audit considers that there is a need to keep under review the traffic conditions of TMR and the traffic demand arising from the development of NWNT by TD, and the implementation progress of the road infrastructure projects in NWNT by HyD (the works agent for implementing these projects) (paras. 4.22, 4.23, 4.25 and 4.26).

15. ***Scope for further enhancing road safety of TMR.*** TMR was upgraded to the then prevailing expressway standards as far as practicable in order to improve the traffic flow and further enhance road safety. Audit noted that: (a) while the number of traffic accidents on TMR generally decreased from 231 in 2012 to 163 in 2015 (i.e. the first year after the substantial completion of reconstruction and improvement works of TMR in December 2014), it increased to 263 in 2019 and then decreased to 246 in 2021; and (b) while the accident rate per million vehicle-kilometre for TMR generally decreased from 0.38 in 2012 to 0.25 in 2016, it increased to 0.36 in 2018 and then decreased to 0.34 in 2021. In addition, from 2012 to 2021, the accident rates for TMR for each year (except for 2016) were higher than those of all major roads selected by TD. In Audit's view, TD needs to keep under review the safety performance of TMR and implement appropriate improvement measures with a view to further enhancing road safety of TMR (paras. 4.23, 4.27 and 4.28).

Audit recommendations

16. **Audit recommendations are made in the respective sections of this Audit Report. Only the key ones are highlighted in this Executive Summary. Audit has recommended that the Director of Highways should:**

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- (a) **in implementing road works projects involving slope works or bridge works in future, remind HyD staff and consultants to follow the related guidelines on site investigation, and critically assess the conditions of**

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slopes (including those previously upgraded) and include the related slope works in contracts (para. 2.25(a));

- (b) in implementing road works projects involving structures nearby property development in future, improve local consultation process and better address the concerns of relevant stakeholders (para. 2.25(b));
- (c) in preparing documents for a design-and-build lump sum works contract in future, take measures to critically vet contract documents to ensure completeness and accuracy (para. 2.38(a));

Other project management issues

- (d) draw lessons from the installation of vertical greening panels on noise barriers along TMR (para. 3.14);
- (e) in implementing works projects in future:
 - (i) make continued efforts to enhance construction site safety and take measures to ensure that HyD contractors timely report accidents at construction sites (para. 3.22(a) and (b)); and
 - (ii) take measures to ensure proper cost apportionment among project votes (para. 3.32(a));

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- (f) continue to closely monitor the implementation progress of works orders to ensure their timely completion by the contractors of high speed road maintenance term contracts (para. 4.19(a));
- (g) expedite the assessments of EOT claims and timely notify the contractors for the imposition of liquidated damages for overdue works orders under high speed road maintenance term contracts (para. 4.19(b));

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- (h) take measures to improve the monitoring of defect rectification works carried out by the contractors of high speed road maintenance term contracts (para. 4.19(c));
 - (i) compile regular management information for monitoring the conditions of high speed roads (including TMR) and associated structures, and determining their maintenance strategy (para. 4.19(g)); and
 - (j) keep under review the implementation progress of the road infrastructure projects in NWNT (para. 4.30).
17. Audit has *recommended* that the Commissioner for Transport should keep under review:

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- (a) the traffic conditions of TMR and the traffic demand arising from the development of NWNT, and take appropriate traffic management measures (para. 4.29(a)); and
- (b) the safety performance of TMR and implement appropriate improvement measures (para. 4.29(b)).

Response from the Government

18. The Director of Highways and the Commissioner for Transport agree with the audit recommendations.

PART 1: INTRODUCTION

1.1 This PART describes the background to the audit and outlines the audit objectives and scope.

Background

1.2 Tuen Mun Road (TMR) is a 21.4-kilometre (km) long high speed road (Note 1) connecting Tsuen Wan and Tuen Mun. As TMR was designed and built in the 1970s, as of 1990s, most at-grade sections reached the end of their service life (Note 2) and were in a state beyond economical repair, and some sections were dual two-lane carriageways and heavily used.

Reconstruction and improvement of TMR

1.3 The Transport and Logistics Bureau (TLB — Note 3) is responsible for the formulation of policies on matters relating to Hong Kong's transportation and logistics, including planning for and implementing the construction and improvement

Note 1: *According to the Highways Department, high speed roads are: (a) the expressways and the trunk roads connecting to these expressways; and (b) designated to carry large volumes of free flowing traffic and provide strategic links between major population centres.*

Note 2: *According to the Highways Department: (a) at the time of the design of TMR in 1970s, the design life of at-grade road pavements was 20 years while that for highway bridge structures was 120 years; and (b) with reference to its latest guidelines (September 2013 version), the at-grade road pavement is designed to service for 40 years. Within the life span, major maintenance to the pavement structure is not required under normal circumstances though minor repairs coupled with resurfacing at appropriate intervals are necessary to keep the pavement structure to serviceable condition.*

Note 3: *In July 2022, TLB was formed to take over the policy responsibility for the policy portfolio of transport matters. Before July 2022, the policy responsibility rested with the then Transport and Housing Bureau (July 2007 to June 2022), the then Environment, Transport and Works Bureau (July 2002 to June 2007), the then Transport Bureau (July 1997 to June 2002) and the then Transport Branch (before July 1997). For simplicity, all previous policy bureaux and branch responsible for the policy portfolio of transport matters are also referred to as TLB in this Audit Report.*

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of transport infrastructure. To upgrade the sections of TMR to the then prevailing expressway standards, turn the entire strategic TMR to a dual three-lane carriageway, bring about an overall improvement to highway and serve the traffic needs of the Northwest New Territories (NWNT) better, from May 2001 to May 2009, TLB proposed 3 projects to the Legislative Council (LegCo) to reconstruct and improve TMR (Note 4). The Highways Department (HyD) was the works agent responsible for implementing these 3 projects with works commencing between June 2008 and February 2010 (see Figure 1):

- (a) ***Reconstruction and improvement of TMR (Project I).*** The section of TMR between Tsuen Wan and Sam Shing Hui was a dual three-lane carriageway of about 15.5 km long, comprising about 13.4 km at-grade roads and 2.1 km bridge structures. As most at-grade sections of TMR reached the end of their service life, it was then considered necessary to upgrade them to the then prevailing expressway standards as far as practicable in order to improve the traffic flow and further enhance road safety. The reconstruction and improvement of the section of TMR from Tsuen Wan to Sam Shing Hui in Tuen Mun (hereinafter referred to as Project I) commenced in October 2008 and the works were substantially completed in December 2014. The scope of works under Project I included, among others, the following:
 - (i) reconstruction of about 13.4 km at-grade sections of TMR and resurfacing of about 2.1 km of TMR on highway structures between Tsuen Wan and Sam Shing Hui;
 - (ii) improvement of the road design of TMR to the then prevailing expressway standards as far as practicable;
 - (iii) upgrading works to roadside slopes;
 - (iv) installation of semi-enclosures and noise barriers along TMR; and

Note 4: *According to Highways Department, 2 sections of TMR (a section between Lam Tei Interchange and Tsing Tin Interchange, and another section between Tsing Tin Interchange and Pui To Road) had already been locally widened to dual three-lane before implementation of these 3 projects and hence the scope of these projects only involved widening and improvement of the remaining road sections of TMR.*

- (v) upgrading of the traffic control and surveillance system (TCSS);

- (b) ***Widening of TMR at Tsing Tin Interchange (Project II).*** Tsing Tin Interchange connects Tuen Mun Town Centre with TMR. To cope with the future traffic demand at Tsing Tin Interchange, a section of TMR of about 240 metres (m) long at Tsing Tin Interchange needed to be widened from a dual two-lane to a dual three-lane carriageway. The widening of TMR at Tsing Tin Interchange (hereinafter referred to as Project II) commenced in June 2008 and the works were substantially completed in January 2010. The scope of works under Project II included, among others, the following:
 - (i) widening of a TMR section of about 240 m long from a dual two-lane to a dual three-lane carriageway;

 - (ii) installation of noise barriers along the slow lanes of TMR; and

 - (iii) laying of low noise surfacing on each bound of TMR; and

- (c) ***Traffic improvements to TMR Town Centre Section (Project III).*** To meet the anticipated traffic growth making use of TMR as the major thoroughfare for the movement of people and goods to and from NWNT and cross-border, TMR Town Centre Section (about 1.8 km — Note 5) needed to be improved, mainly by widening a section between Yan Oi Town Square and Wong Chu Road from a dual two-lane to a dual three-lane carriageway. The traffic improvements to TMR Town Centre Section (hereinafter referred to as Project III) commenced in February 2010 and the works were substantially completed in February 2014. The scope of works under Project III included, among others, the following:
 - (i) widening of the TMR Town Centre Section between Yan Oi Town Square and Wong Chu Road of about 1.5 km long from a dual two-lane to a dual three-lane carriageway;

Note 5: *According to HyD, the length of the TMR Town Centre Section within the project boundary of Project III was about 1.8 km long, of which the section between Yan Oi Town Square and Wong Chu Road of about 1.5 km long needed to be widened to a dual three-lane carriageway.*

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- (ii) resurfacing of existing section of TMR;
- (iii) installation of noise barriers, semi-enclosures and full-enclosures along TMR; and
- (iv) provision of TCSS.

Figure 1

Projects for reconstruction and improvement of TMR



Legend:

	Section of TMR under Project I
	Section of TMR under Project II
	Section of TMR under Project III
	Sections of TMR already locally widened to dual three-lane before implementation of Projects I to III (see Note 4 to para. 1.3)

Source: HyD records

- 1.4 Projects I to III were implemented under the following project votes:
- (a) Project I: 3 project votes (hereinafter referred to as Project Votes I1, I2 and I3);
 - (b) Project II: 1 project vote (hereinafter referred to as Project Vote II); and
 - (c) Project III: 1 project vote (hereinafter referred to as Project Vote III).

The approved project estimate (APE) of Projects I to III totalled \$8,942.2 million and the funding was approved by the Finance Committee (FC) of LegCo between June 2001 and January 2013 (see Table 1).

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Table 1

**Funding approvals for Projects I to III
(June 2001 to January 2013)**

Date	Particulars	Approved amount (\$ million)
<i>Project I</i>		
Project Vote I1		
June 2001	Investigation and preliminary design	37.8
Project Vote I2		
June 2004	Detailed design and associated site investigations	71.6
Project Vote I3		
April 2008	Reconstruction and improvement of the section of TMR between Tsuen Wan to Sam Shing Hui	4,620.5
April 2009	Increase in APE to cover additional costs arising from higher-than-expected tender outturn price, higher estimate and increase in the provision for price adjustment	2,183.8
<i>Project II</i>		
Project Vote II		
April 2008	Widening of a section of TMR at Tsing Tin Interchange	60.6
<i>Project III</i>		
Project Vote III		
June 2009	Traffic improvements to TMR Town Centre Section	1,814.4
January 2013	Increase in APE to cover additional costs arising from higher-than-expected awarded tender price and increase in the provision for price adjustment	153.5
Total		8,942.2

Source: HyD records

1.5 Between April 2002 and November 2005, HyD awarded 3 consultancies for Projects I to III (see Table 2), as follows:

- (a) Consultancy X for the investigation and preliminary design for Project I;
- (b) Consultancy Y for the further study and investigation for Projects I to III;
and
- (c) Consultancy Z for the design and construction of Projects I and III (Note 6).

Note 6: *For Project II, it was an in-house managed project and HyD was the Engineer responsible for supervising the related contract works.*

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Table 2
Consultancies for TMR
(June 2022)

Consultancy	Consultant (Note 1)	Particulars	Consultancy fee (\$ million)
X (Awarded in April 2002)	X	Investigation and preliminary design for Project I	13.3
Y (Awarded in December 2003)	X	Further study and investigation for Projects I to III	3.1
Z (Awarded in November 2005)	X	Design and construction of Projects I and III	79.7 (Note 2)
Total			96.1 (Note 3)

Source: HyD records

Note 1: Consultancies X, Y and Z were awarded to the same consultant (i.e. Consultant X) through competitive tendering.

Note 2: For Consultancy Z, of the consultancy fee \$79.7 million, \$66.4 million was funded under Projects I and III, the remaining \$13.3 million was funded under the works project for improvement to Sham Tseng Interchange, works project for Bus-bus Interchanges on TMR and block vote of HyD. According to HyD, it is common to include various works in the vicinity under a consultancy to facilitate interface issues, and relevant works are funded by respective project votes.

Note 3: Of the total consultancy fees of Consultancies X, Y and Z (i.e. \$96.1 million), other than \$13.3 million of Consultancy Z which was funded under other works projects and block vote of HyD (see Note 2 above), the remaining \$82.8 million was funded under Projects I to III.

1.6 Between May 2008 and March 2012, for the implementation of Projects I to III, HyD awarded 6 works contracts (Contracts A to F) to 4 contractors (Contracts A and B to Contractors A and B respectively, Contracts C, E and F to Contractor C, and Contract D to Contractor D) through competitive tendering. The 6 contracts were completed between January 2010 and December 2014. Except Contract D which was completed on time, the other 5 contracts (Contracts A to C, E and F) were completed 2.1 to 13.2 months later than their respective original contract completion dates, but within the extended contract completion dates with extensions of time (EOTs — Note 7) granted (Note 8) (see Table 3).

Note 7: *According to the General Conditions of Contract for Civil Engineering Works, regarding contract works commencement, completion and delays: (a) the works and any section thereof shall be completed within the time or times stated in the contract calculated from and including the date for commencement notified by the Engineer or such extended time as may be determined; (b) if the Contractor fails to complete the works or any section of works within the time for completion or such extended time as may be granted, then the Employer shall be entitled to recover from the contractor liquidated damages for delay; and (c) if in the opinion of the Engineer, the cause of any delay to the progress of the works or any section of works is any of those stipulated in the General Conditions of Contract (e.g. inclement weather, a variation order issued by the Engineer, the contractor not being given possession of site, etc.), then the Engineer shall within a reasonable time consider whether the contractor is entitled to an EOT for completion of the works or any section thereof. According to the Project Administration Handbook for Civil Engineering Works issued by Civil Engineering and Development Department, an EOT for completion in effect deprives the Government of the right to liquidated damages for delay in completion of the works for the period of the extension and therefore has a financial implication.*

Note 8: *According to HyD, EOTs granted under Contracts A to C, E and F were mainly due to inclement weather.*

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Table 3

**Contracts awarded for Projects I to III
(May 2008 to December 2014)**

Contract	Section of TMR	Commencement date	Original contract completion date	Actual completion date	No. of months later than original contract completion date (Note)
Project I					
A (Awarded in October 2008)	Eastern Section of TMR (between Tsuen Wan and Tsing Lung Tau) (6.8 km)	30.10.2008	23.9.2013	29.10.2014	13.2
B (Awarded in February 2009)	Tai Lam Section of TMR (between Tsing Lung Tau and Siu Lam) (4.0 km)	18.2.2009	13.11.2013	23.7.2014	8.3
C (Awarded in June 2009)	Sam Shing Hui Section of TMR (between Siu Lam and Sam Shing Hui) (4.7 km)	30.6.2009	4.5.2014	30.12.2014	7.9
D (Awarded in March 2012)	TCSS upgrading works	10.4.2012	30.12.2014	30.12.2014	—
Project II					
E (Awarded in May 2008)	TMR section at Tsing Tin Interchange	6.6.2008	5.11.2009	9.1.2010	2.1
Project III					
F (Awarded in February 2010)	TMR Town Centre Section (mainly between Yan Oi Town Square and Wong Chu Road) (1.8 km)	26.2.2010	25.8.2013	19.2.2014	5.9

Source: HyD records

Note: According to HyD, EOTs for the whole period were granted under Contracts A to C, E and F, which were mainly due to inclement weather.

Project costs

1.7 The accounts of Contracts A to F (see Table 4) were finalised between March 2012 and September 2018. As of June 2022, \$8,629.3 million (97%) of APE totalling \$8,942.2 million (see para. 1.4) for Projects I to III had been incurred. Of this \$8,629.3 million:

- (a) \$7,576.7 million (88%) was related to expenditures for the Projects under Contracts A to F (see Note 5 to Table 4); and
- (b) the remaining \$1,052.6 million (12%) comprised resident site staff costs of \$831.0 million (Note 9), consultancy fees of \$82.8 million (see Note 3 to Table 2 in para. 1.5), and other costs of \$138.8 million (Note 10).

Note 9: *According to HyD, consultants are required to employ resident site staff of different grades (e.g. professional grade and technical grade) for supervising contractors' works. The Government reimburses consultants for the personal emoluments of resident site staff and pays an on-cost to consultants to cover their costs in managing the resident site staff.*

Note 10: *According to HyD, other costs mainly included miscellaneous costs for Project I (e.g. expenditures on laboratory testing, re-provision/removal of closed-circuit television cameras and speed enforcement cameras, and diversion/relocation/removal of public lightings, traffic signage and bollards).*

Introduction

Table 4
Contract expenditures of Contracts A to F
(June 2022)

Contract	Original contract sum (a) (\$ million)	Final contract sum (b) (\$ million)	Increase/ (decrease) (c) = (b) - (a) (\$ million)	Increase/(decrease) in provision for price fluctuation adjustment (Note 1) (d) (\$ million)	Increase/(decrease) after price fluctuation adjustment (e) = (c) - (d) (\$ million)
A	2,822.5	3,264.3 (Note 2)	441.8 (15.7%)	182.3 (6.5%)	259.5 (9.2%)
B	1,328.0	1,218.0 (Note 3)	(110.0) (-8.3%)	(147.3) (-11.1%)	37.3 (2.8%)
C	1,366.0	1,603.6 (Note 4)	237.6 (17.4%)	141.1 (10.3%)	96.5 (7.1%)
D	36.2	30.8	(5.4) (-14.9%)	— (—)	(5.4) (-14.9%)
E	55.9	57.3	1.4 (2.5%)	— (—)	1.4 (2.5%)
F	1,548.0	1,745.0	197.0 (12.7%)	184.1 (11.9%)	12.9 (0.8%)
Total	7,156.6	7,919.0 (Note 5)	762.4 (10.7%)	360.2 (5.0%)	402.2 (5.6%)

Source: HyD records

Note 1: The original contract sums of Contracts A to C and F included provisions for price fluctuation adjustments. According to HyD, due to shorter contract durations, a provision for price fluctuation adjustments was not included in Contracts D and E.

Note 2: For Contract A, of the final contract sum of \$3,264.3 million, \$69.8 million was funded under the works project of HyD for improvement to Sham Tseng Interchange, \$108.1 million was funded under HyD maintenance vote for maintenance works and \$10.1 million was funded under HyD block allocation vote for minor works, and not funded under Project I. According to HyD, it is common to include various works in the vicinity under a contract to facilitate interface issues, and relevant works are funded by respective project votes.

Note 3: For Contract B, of the final contract sum of \$1,218.0 million, \$0.4 million was funded under the works project of HyD for Route 8 between Cheung Sha Wan and Sha Tin, \$60.5 million was funded under HyD maintenance vote for maintenance works and \$27.7 million was funded under HyD block allocation vote for minor works, and not funded under Project I.

Note 4: For Contract C, of the final contract sum of \$1,603.6 million, \$58.0 million was funded under HyD maintenance vote for maintenance works and \$7.7 million was funded under HyD block allocation vote for minor works, and not funded under Project I.

Note 5: Of the \$7,919.0 million, \$7,576.7 million was related to Projects I to III, and \$342.3 million was related to works funded by other project votes, maintenance vote and block vote of HyD.

Maintenance of TMR

1.8 HyD is responsible for the maintenance of public roads (including TMR), highway structures and ancillary facilities (e.g. roadside barriers and traffic sign plates) within its ambit. It aims to maintain the integrity of the road facilities with particular emphasis on road safety and serviceability. Regular inspections are conducted, and repair and maintenance works are carried out timely to keep the roads in serviceable condition and to ensure the safety of road users.

1.9 HyD lets out term contracts through competitive tendering to carry out the road maintenance works. The maintenance works for TMR are covered under a 6-year term contract (Note 11) for the management and maintenance of high speed roads. In 2021-22, the expenditure for the relevant term contract amounted to \$168.3 million, including \$24.7 million relating to the management and maintenance of TMR.

Traffic management of TMR

1.10 TMR, with heavy daily traffic, is the trunk road (Note 12) connecting NWNT and the urban areas. The Transport Department (TD) is responsible for monitoring the traffic conditions of various major roads (including TMR), considering the need for road improvement projects and initiating necessary actions to obtain policy approval for the projects, and designing and implementing traffic management measures to ensure the efficient use of limited road space and to enhance road safety. In 2021, the annual average daily traffic volume of TMR was 127,800 vehicles.

Note 11: *The last contract for the management and maintenance of high speed roads in the New Territories West and Kowloon covered the period from 1 April 2016 to 31 March 2022, and the existing contract for the management and maintenance of high speed roads in the New Territories West and Kowloon West covers the period from 1 April 2022 to 31 March 2028.*

Note 12: *According to the Transport Department: (a) trunk roads are busy roads which link up areas and districts; (b) some trunk roads are designated as expressways by the Commissioner for Transport under the Road Traffic Ordinance (Cap. 374); and (c) all expressways and most of the trunk roads are high standard multi-lane dual carriageways with grade-separated interchanges and are designed to carry a high volume of traffic at a higher speed. Regarding TMR, the section from its junction with Tsuen Wan Road to its junction with Wong Chu Road is designated as an expressway under the Ordinance.*

Introduction

Audit review

1.11 In June 2022, the Audit Commission (Audit) commenced a review of HyD's work in implementing the projects for reconstruction and improvement of TMR and the work of HyD and TD in maintenance and traffic management of TMR. The audit review has focused on the following areas:

- (a) reconstruction and improvement works of TMR (PART 2);
- (b) other project management issues (PART 3); and
- (c) maintenance and traffic management of TMR (PART 4).

Audit has found room for improvement in the above areas and has made a number of recommendations to address the issues.

General response from the Government

1.12 The Secretary for Transport and Logistics has said that:

- (a) TLB attaches great importance to the timely delivery of transport infrastructure projects and good traffic management with a view to strengthening capacity of the local road network and enhancing connectivity, as well as providing a safe, reliable and efficient traffic and transport system. TLB welcomes the audit recommendations, and supports the proposed follow-up actions of HyD and TD; and
- (b) TLB will continue to oversee the work of HyD and TD to ensure that the departments will take appropriate follow-up actions as undertaken in their responses to the audit recommendations, including keeping under review the safety performance of TMR and the implementation progress of the road infrastructure projects in NWNT.

1.13 The Director of Highways and the Commissioner for Transport agree with the audit recommendations.

Acknowledgement

1.14 Audit would like to acknowledge with gratitude the full cooperation of the staff of HyD and TD during the course of the audit review.

PART 2: RECONSTRUCTION AND IMPROVEMENT WORKS OF TUEN MUN ROAD

2.1 This PART examines HyD's work in implementing the reconstruction and improvement works of TMR under Project I (paras. 2.4 to 2.26) and Project III (paras. 2.27 to 2.39) which accounted for nearly all the contract expenditures (see para. 2.2).

Background

2.2 The reconstruction and improvement of TMR was implemented under Projects I to III. Between May 2008 and March 2012, HyD awarded 6 works contracts for the implementation of these projects (see Table 3 in para. 1.6 and Table 4 in para. 1.7), as follows:

- (a) Contracts A to D (with a total final contract sum of \$ 6,116.7 million) under Project I;
- (b) Contract E (with final contract sum of \$57.3 million) under Project II; and
- (c) Contract F (with final contract sum of \$1,745.0 million) under Project III.

2.3 Contracts A to F were completed between January 2010 and December 2014. Except Contract D which was completed on time, the other 5 contracts were completed 2.1 to 13.2 months later than their respective original contract completion dates, but within the extended contract completion dates with EOTs granted (see para. 1.6). Except Contract E which was an in-house managed contract (for which HyD was the Engineer responsible for supervising the contract works), for all other 5 works contracts (i.e. Contracts A to D and F), Consultant X was the Engineer or Supervising Officer responsible for supervising the contract works. Table 5 shows the works and expenditures under Contracts A to F.

Reconstruction and improvement works of Tuen Mun Road

Table 5

Reconstruction and improvement works of TMR under Contracts A to F (June 2022)

Contract	Contract type	Works	Final contract sum (Note 1) (\$ million)
<i>Project I</i>			
A	Remeasurement contract (Note 2)	Reconstruction and Improvement of TMR — Eastern Section (between Tsuen Wan and Tsing Lung Tau) (6.8 km)	3,264.3
B		Reconstruction and Improvement of TMR — Tai Lam Section (between Tsing Lung Tau and Siu Lam) (4.0 km)	1,218.0
C		Reconstruction and Improvement of TMR — Sam Shing Hui Section (between Siu Lam and Sam Shing Hui) (4.7 km)	1,603.6
D	Design-and-build lump sum contract (Note 3)	Reconstruction and Improvement of TMR — TCSS	30.8
<i>Project II</i>			
E	Remeasurement contract (Note 2)	Widening of TMR at Tsing Tin Interchange	57.3
<i>Project III</i>			
F	Design-and-build lump sum contract (Note 3)	Design and Build of Traffic Improvements to TMR Town Centre Section (mainly between Yan Oi Town Square and Wong Chu Road) (1.8 km)	1,745.0
Total			7,919.0

Source: HyD records

Note 1: The accounts of Contracts A to F were finalised between March 2012 and September 2018.

Note 2: Under a remeasurement contract, the costs of works are based on the actual quantities of works done to be remeasured and the prices of different works items as priced by the contractor in the Bills of Quantities according to the contract.

Note 3: Under a design-and-build type contract, the contractor is required to design and construct the works in accordance with the Employer's Requirements. Under a lump sum contract, the quantities of various works items are substantially measured firm and the final price to be paid is ascertained by adding to/deducting from the contractor's accepted tender price the value of variations and other specified items (e.g. provisional quantities and contingency items).

Management of reconstruction and improvement works under Project I

Additional works to slopes along TMR under Contracts A and C after award of contracts

2.4 Under Contracts A and C, Contractors A and C were required to modify over 140 and 70 slopes in association with the road improvement along both sides of TMR Eastern Section and Sam Shing Hui Section respectively.

2.5 According to HyD:

- (a) ground investigations had been carried out during design stage under a ground investigation works contract to obtain as much subsoil information as practicable for design of the proposed geotechnical works;
- (b) for cases where ground investigations could not be conducted within the time allowed for the design period due to existing site constraints during design stage, detailed design of the respective geotechnical works was carried out based on the best available information, such as the subsoil data at the nearby accessible locations and base map supplemented with topographical survey; and
- (c) provisions had been included in Contracts A and C requiring contractors to carry out further ground investigations upon completion of site clearance at construction stage in order to verify the design assumptions made for the respective geotechnical works.

2.6 After the commencement of works, upon completion of site clearance on slopes and further ground investigations as required under Contracts A and C (see para. 2.5(c)), it was revealed that some of the ground conditions were different from those assumed during planning and design stage (e.g. rock layers were found in some soil cut slopes). As a result, the design of some slopes had been changed and additional works had to be carried out under Contracts A and C, as follows:

Reconstruction and improvement works of Tuen Mun Road

- (a) for Contract A, Consultant X issued about 500 variation orders (VOs — Note 13) (later valued at a total cost of \$174.0 million) to instruct Contractor A to carry out additional works for the slopes (Note 14); and
- (b) for Contract C, Consultant X issued about 160 VO's (later valued at a total cost of \$43.0 million) to instruct Contractor C to carry out additional works for the slopes (Note 15).

According to Consultant X, these additional slope works would cause potential delays to all sections of works under Contracts A and C, and hence consequently delaying the completion of the contracts.

Other major delaying events under Contract C after award of contract

2.7 After commencement of Contract C, according to HyD, apart from the additional works to slopes (see para. 2.6), there were 3 other major events which would cause potential delays under Contract C, as follows:

Note 13: *According to the General Conditions of Contract for Civil Engineering Works, the Engineer shall: (a) order any variation to any part of the works that is necessary for the completion of the works; (b) have the power to order any variation that for any other reason shall in his opinion be desirable for or to achieve the satisfactory completion and functioning of the works; and (c) determine the sum which in his opinion shall be added to or deducted from the contract sum as a result of issuing a VO.*

Note 14: *According to HyD, the major additional works for the slopes under Contract A included: (a) addition of a total of 190 m long reinforced earth walls (see Note 16 to para. 2.7(a)) and 111 m long concrete toe walls at slope toes; (b) addition of stabilisation works for rock slopes; and (c) addition of 903 soil nails, revision of slope profiles and associated drainage works.*

Note 15: *According to HyD, the major additional works for the slopes under Contract C included an addition of 1,262 soil nails.*

Reconstruction and improvement works of Tuen Mun Road

- (a) re-alignment of a reinforced earth wall (Note 16) involving additional works under VO A (later valued at a cost of \$3.4 million — see para. 2.14) to address the local residents' concern about the close proximity of the proposed retaining wall to their premises;
- (b) re-alignment of a reinforced earth wall to suit the change of foundation design of an abutment of So Kwun Tan Bridge (i.e. Bridge A) to cater for unexpected presence of marine mud layer identified during construction stage under VOs B and C (later valued at a total cost of \$5.1 million — see para. 2.15); and
- (c) diversion of newly laid water mains of 1,000 millimetres (mm) diameter at a slope feature to facilitate construction of a reinforced concrete wall (Note 17) (see para. 2.16).

According to Consultant X, these events would cause potential delays to road works under Contract C, and hence, delaying the completion of Contract C.

Delay recovery measures under Contracts A and C

2.8 According to Consultant X's assessment, due to the additional works to slopes under Contracts A and C (see para. 2.6) and 3 other major delaying events under Contract C (see para. 2.7), Contracts A and C might suffer a potential delay of 3 years and 2.5 years respectively if no mitigation measures were implemented. The Government might also suffer substantial potential financial exposure, including prolongation costs payable to Contractors A and C. Furthermore, there would be a knock-on effect to the completion of Contract D due to delay in provision of the TCSS related civil works in conjunction with the road works under Contracts A and C.

Note 16: *Reinforced earth wall is a structure with a vertical or near-vertical facing that is within 20 degrees from the vertical which comprises tensile reinforcing elements embedded in a compacted mass of fill, and shall include any connections, facings and granular filters and drainage material which may be necessary to ensure its stability.*

Note 17: *According to HyD, for retaining wall, its stability is provided by virtue of the strength and stiffness of the reinforced concrete and the weight of the retained fill (e.g. reinforced concrete L-shaped and inverted T-shaped cantilever, counterfort and buttressed retaining wall). Due to insufficient space for achieving stable slope geometry, reinforced concrete retaining wall is often adopted.*

Reconstruction and improvement works of Tuen Mun Road

2.9 Between July and August 2016, Consultant X issued 3 VOs (VOs D to F — later valued at a total cost of \$140.5 million) under Contract A and 1 VO (VO G — later valued at \$145.4 million) under Contract C to instruct Contractors A and C respectively to carry out measures to recover potential delays caused by the additional works to slopes and 3 other major delaying events (hereinafter referred to as delay recovery measures — see Table 6).

Table 6

**VOs D to G issued under Contracts A and C
for delay recovery measures**

VO	Delay recovery measures	Final value (\$ million)
<i>Mitigating the delays caused by additional slope works under Contract A</i>		
D	To construct a temporary steel vehicular bridge and provide additional site entrances at TMR to the central median area to expedite the construction of retaining wall at central median	41.0
E	To provide additional site entrances to the southern and northern slopes to allow concurrent construction of slope works	68.1
F	To change the construction method of the slopes so as to form the necessary space early for expediting commencement of westbound/eastbound road works	31.4
Total		140.5
<i>Mitigating the delays caused by additional slope works and 3 other major delaying events under Contract C</i>		
G	<ul style="list-style-type: none"> • To lay temporary pavements and revise method of construction to enable re-sequencing of roadworks • To form additional site entrances for carrying out the additional slope works • To deploy additional resources to allow the adoption of re-sequenced works schedule 	145.4 (Note)

Source: HyD records

Note: According to HyD, given that the delay recovery measures under VO G were adopted to expedite the overall construction progress of various sections of works under Contract C, the cost of \$145.4 million could not be broken down separately for mitigating respective delays caused by additional slope works and the other 3 major delaying events under Contract C.

Reconstruction and improvement works of Tuen Mun Road

2.10 According to Consultant X, by implementing the delay recovery measures via VOs D to G (see para. 2.9) under Contracts A and C, Contractors A and C managed to recover the potential delays caused by the additional works at slopes under Contracts A and C (see para. 2.6) and 3 other major delaying events under Contract C (see para. 2.7). In the event, according to HyD, all potential delays (i.e. 3 years and 2.5 years under Contracts A and C respectively — see para. 2.8) were recovered and the related works under Contracts A and C were completed by the scheduled completion dates under the Contracts.

Need to draw lessons from the events causing potential delays to Contracts A and C

2.11 Audit noted that the issues mentioned in paragraphs 2.12 to 2.16 below merit HyD's attention and drawing lessons therefrom in administering future reconstruction and improvement of road works projects.

2.12 ***Significant additional works to slopes along TMR after award of Contracts A and C.*** Audit noted that:

- (a) according to HyD, during the design stage of Contracts A and C, ground investigations had been carried out to obtain subsoil information for design of the proposed geotechnical works (see para. 2.5(a)). For cases where ground investigations could not be conducted within the time allowed for the design period due to existing site constraints during design stage, detailed design of the respective geotechnical works was carried out based on the best available information such as the subsoil data at the nearby accessible locations (see para. 2.5(b));
- (b) after commencement of Contracts A and C, further ground investigation and slope survey were carried out after site clearance. In the event, the actual ground conditions at some slopes were found different from those assumed during planning and design stage, and significant additional works to slopes were carried out under a considerable number of VOs, as follows:
 - (i) about 500 VOs were issued under Contract A to carry out additional works for the slopes (see para. 2.6(a)). Delay recovery measures under VOs D to F were carried out to recover the potential delays

Reconstruction and improvement works of Tuen Mun Road

at a total cost of \$140.5 million (see para. 2.9) (i.e. 4.3% of the final contract sum of \$3,264.3 million for Contract A); and

- (ii) about 160 VOs were issued under Contract C to carry out additional works for the slopes (see para. 2.6(b)). Delay recovery measures under VO G were carried out to recover the potential delays caused by additional works for slopes and 3 other major delaying events under Contract C at a cost of \$145.4 million (Note 18) (see para. 2.9) (i.e. 9.1% of the final contract sum of \$1,603.6 million for Contract C); and
- (c) the following guidelines were related to site investigation (including ground conditions of slopes):

Before award of Contracts A and C

- (i) Environment, Transport and Works Bureau Technical Circular (Works) No. 17/2004 on “Impossibility/Unforeseen Ground Conditions/Utility Interference” was issued in 2004 which stated that project officers should arrange to carry out all necessary site investigations and satisfy themselves that sufficient ground information has been made available prior to commencement and during the detailed design;

After award of Contracts A and C

- (ii) “Geoguide 2: Guide to Site Investigation” published by the Geotechnical Engineering Office of Civil Engineering and Development Department (CEDD) was updated in 2017 to provide:
 - guidance on good site investigation practice for works departments to plan and carry out investigation of works sites; and

Note 18: *According to HyD, given that the delay recovery measures under VO G were adopted to expedite the overall construction progress of various sections of works under Contract C, the cost of \$145.4 million could not be broken down separately for mitigating respective delays caused by additional slope works and the other 3 major delaying events under Contract C.*

Reconstruction and improvement works of Tuen Mun Road

- further guidelines in the application of new technologies and digital tools (such as geophysical survey methods and geographical information system) to enhance site investigation works; and
- (iii) further guidelines on geotechnical works of public works projects were promulgated in Development Bureau (DEVB) Technical Circular (Works) No. 3/2018 of March 2018 on “Enhancing Cost Effectiveness of Geotechnical Works of Capital Works Projects”. Under the Technical Circular, works departments are required to submit the ground investigation plan and the schematic design proposal with relevant information (e.g. ground investigation data) to the Geotechnical Engineering Office of CEDD for review and comment.

In Audit’s view, in implementing road works projects involving slope works in future, HyD needs to remind its staff and consultants to follow the related guidelines on site investigation (including application of new technologies and digital tools) in carrying out such investigation.

2.13 As mentioned in paragraph 2.7, there were 3 other major delaying events for which additional works were needed and they would cause potential delays to Contract C. In the event, delay recovery measures at \$145.4 million under VO G were implemented to recover the delays of these events and additional works for slopes (see Note 18 to para. 2.12(b)(ii)). There is scope for improvements relating to these other major delaying events (see paras. 2.14 to 2.16).

Reconstruction and improvement works of Tuen Mun Road

2.14 *Scope for improvement in local consultation.* Audit noted that:

- (a) ***Re-alignment of a reinforced earth wall.*** Under Contract C, Contractor C was responsible for the design and construction of a reinforced earth wall at a slope (i.e. Slope A) next to a residential development near Castle Peak Bay. According to HyD, notwithstanding previous consultations (Note 19), after the commencement of site clearance works for Slope A in June 2010, residents of the residential development nearby expressed concern about various aspects (e.g. visual, ventilation and security, etc.) in view of the fact that the proposed reinforced earth wall was in close proximity to the residential development, and requested to shift the proposed wall further away from the premises. In order to respond to the concern of the local residents, the retaining structure was re-designed so as to provide a larger clearance of about 3 m between the earth retaining structure and the boundary of the residential development; and

- (b) in the event, the wall re-alignment required a much steeper slope cut and extensive temporary slope stabilisation works during the excavation for the wall. Consultant X issued VO A (later valued at a cost of \$3.4 million) to instruct Contractor C to shift the alignment of the earth retaining structure and change the proposed reinforced earth wall to a reinforced concrete wall. Based on Consultant X's assessment, a potential delay of 603 days would be experienced in the slope works at Slope A if no delay recovery measures were implemented. In the event, delay recovery measures were implemented to recover the delay (see para. 2.9).

In Audit's view, in implementing road works projects involving structures (e.g. earth wall at slope) nearby property development in future, HyD needs to improve local consultation process and better address the concerns of relevant stakeholders (e.g. local residents).

Note 19: *According to HyD: (a) it had followed the procedures under Project Administration Handbook for Civil Engineering Works issued by CEDD in conducting the public consultation for Project I. Previous consultations during design stage for the project included District Council consultation and several public forums (to which stakeholders of the nearby residential premises were invited to express their views) convened before and during gazettal for Project I; and (b) during the gazettal period, none of the objections received were related to the concerned reinforced earth wall.*

Reconstruction and improvement works of Tuen Mun Road

2.15 *Scope for enhancing ground investigation for bridge works.* Audit noted that:

- (a) ***Re-alignment of a reinforced earth wall to suit the change of foundation design of Bridge A.*** Under Contract C, Contractor C was responsible for the widening of bridge structure of Bridge A (see para. 2.7(b)). According to HyD, ground investigations (including boreholes) had been carried out for the proposed bridge widening works during the design stage. Detailed design of the respective proposed works was carried out based on the borehole data at the nearby locations coupled with other existing information at that time, such as base map supplemented with topographical survey. Based on the subsoil data of the available borehole records, no marine deposit was revealed in the vicinity of Bridge A;
- (b) according to HyD, during the piling works of Bridge A, an unexpected layer of marine mud was encountered within the footprint of the east abutment of Bridge A. As verified in the subsequent ground investigation during construction stage, the extent of marine mud concerned was possibly localised and thus could not be revealed from available ground investigation data of nearby locations during design stage. As such, the design of the foundation of the east abutment was reviewed taking into account the updated ground investigation findings obtained; and
- (c) Consultant X issued:
 - (i) VO B (valued at \$1.5 million) to instruct Contractor C to change the original pad footing design (Note 20) of the east abutment of Bridge A to mini-pile foundation; and
 - (ii) VO C (valued at \$3.6 million) to instruct Contractor C to change the alignment of a section of reinforced earth wall at a slope nearby (i.e. Slope B) to avoid conflicting with those mini-piles of the east abutment of Bridge A.

Note 20: *Pad footings are commonly used in Hong Kong for shallow foundations in order to carry and spread concentrated loads, caused for example by columns or pillars. Pad foundations are rectangular or circular pads used to support localised loads such as columns.*

Reconstruction and improvement works of Tuen Mun Road

Based on Consultant X's assessment, a potential delay of 366 days would be experienced in the works at Bridge A and slope works at Slope B if no delay recovery measures were implemented. In the event, delay recovery measures were implemented to recover the delay (see para. 2.9).

In Audit's view, in implementing road works projects involving bridge works in future, HyD needs to remind its staff and consultants to follow the related guidelines on site investigation (see para. 2.12(c)) in carrying out such investigation.

2.16 *Scope for enhancing communication with government departments relating to their underground utilities.* Audit noted that:

- (a) *Diversion of newly laid water mains of diameter 1,000 mm at a slope feature.* Under Contract C, Contractor C was responsible for the construction of a reinforced concrete retaining wall at a slope (i.e. Slope C). After the completion of site clearance near Slope C, site investigation identified newly laid water mains of diameter 1,000 mm inside the footprint of the proposed reinforced concrete wall near Slope C. The water mains therefore had to be diverted before constructing the retaining wall. According to HyD, the water mains were to be laid by the responsible government department in a coordinated manner with HyD to minimise potential conflict with works under Contract C, as intended at the design stage; and
- (b) based on Consultant X's assessment, a potential delay of 235 days would be occurred from the diversion of the water mains if no delay recovery measures were implemented. In the event, delay recovery measures were implemented to recover the delay (see para. 2.9).

In Audit's view, in implementing road works projects in future, there is scope for HyD to enhance communication with related government departments about their underground utilities with a view to better coordinating the related works and minimising potential conflict of such works.

Reconstruction and improvement works of Tuen Mun Road

Some necessary slope works not included in contracts

2.17 Under Contracts A to C, Contractors A to C were required to carry out slope modification and/or stabilisation works along the TMR covered by the respective contracts. According to HyD:

- (a) 23 existing slopes (Note 21) had been upgraded under 2 HyD contracts commenced in 1994 and 1998 (i.e. about 11 to 14 years before the award of Contracts A to C from October 2008 to June 2009) respectively; and
- (b) Consultant X, under Consultancy Z (see Table 2 to para. 1.5), had conducted preliminary assessment of the conditions of all roadside slopes (including those previously upgraded) along TMR with available information (e.g. geology, slope information, as-built drawings and previous ground investigation, etc.) during design stage. Based on the preliminary assessment results of the roadside slopes, which had been circulated to relevant government departments for comment and agreement, no upgrading or modification works would be required for these 23 existing slopes under Contracts A to C.

2.18 On 6 and 24 March 2009, 2 rock fall incidents occurred at 2 of these 23 slopes along TMR under Contracts B and A respectively (Note 22). According to HyD, site inspections after these 2 incidents revealed that the falling of loose block or fragments might be due to:

- (a) the development of root system of the vegetation, which also contributed to the split action along the rock joints; and
- (b) the spalling of part of the shotcrete slope surface, coupled with adverse weather condition on the incident day.

Note 21: *For these 23 slopes, 7, 12 and 4 of them were located along the TMR sections under Contracts A to C respectively.*

Note 22: *According to HyD, the rock fall incident occurred on 6 March 2009 involved a rock slide of some 2 cubic metres, and the rock fall incident occurred on 24 March 2009 involved a falling fragment of the broken shotcrete. Fortunately, both incidents had not caused injuries or damage to properties.*

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According to HyD, in view of these 2 rock fall incidents, Consultant X recommended conducting a comprehensive review on the latest conditions of the 23 slopes which were originally not covered by Contracts A to C.

2.19 A comprehensive site inspection and desktop study on the 23 slopes found that additional investigation was required to ascertain the latest slope conditions. In this regard, Consultant X issued 10 VOs (later valued at a total cost of \$9.6 million) to instruct Contractors A, B and C under the respective contracts to conduct additional ground investigation and/or rock survey for the 23 slopes (7, 12 and 4 under Contracts A, B and C respectively). In the event, Consultant X issued another 60 VOs (later valued at a total cost of \$24.9 million) to carry out necessary upgrading and stabilisation works (Note 23) for 10 slopes (7, 1 and 2 under Contracts A, B and C respectively).

2.20 According to HyD, the 23 slopes had been upgraded under 2 previous contracts commenced in 1994 and 1998 (i.e. about 11 to 14 years before the award of Contracts A to C from October 2008 to June 2009 respectively) and Consultant X considered that no upgrading or modification works would be required for these slopes based on the preliminary assessment results during design stage (see para. 2.17). In the event, after the 2 rock fall incidents, comprehensive site inspection, desktop study and additional investigation were conducted for these 23 slopes and upgrading and stabilisation works were carried out for 10 of the 23 slopes (at a total cost of \$34.5 million (\$9.6 million + \$24.9 million) under Contracts A to C (see para. 2.19)). In Audit's view, in implementing road works projects involving slope works in future, HyD needs to critically assess the conditions of slopes (including those previously upgraded) and include the related slope works in contracts.

Need to strengthen checking of Bills of Quantities

2.21 Contracts A to C were remeasurement contracts. Under a remeasurement contract, the costs of works are based on the actual quantities of works done to be

Note 23: *Typical upgrading and stabilisation works include: (a) rock slope stabilisation works; (b) removal of loose block; (c) provision of maintenance access; and (d) provision of surface protection, reinstatement or wire mesh.*

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remeasured and the prices of different works items as priced by the contractor in the Bills of Quantities (BQ — Note 24) according to the contract.

2.22 According to HyD, BQ error refers to any error in description in BQ, and an omitted item refers to the omission of an appropriate item in BQ for the works which are shown/provided in the contract drawings or specifications (Note 25). Audit noted that, there were 36 items with BQ errors (later valued at \$86.1 million) under Contract A and 675 omitted items (later valued at \$222.1 million) under Contracts A to C.

2.23 According to Project Administration Handbook for Civil Engineering Works (hereinafter referred to as the Project Administration Handbook) issued by CEDD:

Before award of Contracts A to C

- (a) from the viewpoints of financial control, omitted items should be kept to an absolute minimum through proper preparation of a BQ and Particular Preambles;
- (b) all works items should be included in BQ and omitted items should be minimised as far as practicable. BQ should undergo a checking process to ensure the completeness and accuracy of BQ and elimination of major errors. This would facilitate competitive tendering, reduce resources for valuation of omitted items and minimise the disputes arising from the valuation of omitted items;

Note 24: *Under a remeasurement contract, a BQ, which forms part of the tender documents and subsequently the contract documents after the award of a contract, contains estimated quantities of various works items. A tenderer needs to provide a tender price for the relevant BQ items. For the successful tenderer, the BQ prices would be used for valuing the actual work performed.*

Note 25: *According to the General Conditions of Contract for Civil Engineering Works, for any BQ error or omitted item: (a) the contractor is required to carry out the works in accordance with the contract drawings and specification; and (b) the Engineer shall correct any such error or omission, and ascertain and certify the value of the works actually carried out.*

After award of Contracts A to C (promulgated in 2014)

- (c) a pre-tender cross-checking procedure should be introduced in the preparation of BQ;
- (d) if resources permit, project office should conduct spot-checking on the quantities of some selected cost significant items after the BQ has been prepared by the Consultants; and
- (e) an officer of the project office at a rank not lower than Directorate Grade 1 should chair a meeting to vet the BQ to ensure all the checking and cross-checking procedures have been duly completed and documented.

2.24 In Audit's view, HyD needs to remind its staff and consultants to follow the latest requirements in checking of BQ to ensure its completeness and accuracy.

Audit recommendations

2.25 **Audit has recommended that the Director of Highways should:**

- (a) **in implementing road works projects involving slope works or bridge works in future:**
 - (i) **remind HyD staff and consultants to follow the related guidelines on site investigation (including application of new technologies and digital tools) in carrying out such investigation; and**
 - (ii) **critically assess the conditions of slopes (including those previously upgraded) and include the related slope works in contracts;**
- (b) **in implementing road works projects involving structures (e.g. earth wall at slope) nearby property development in future, improve local consultation process and better address the concerns of relevant stakeholders (e.g. local residents);**

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- (c) **in implementing road works projects in future, enhance communication with related government departments about their underground utilities with a view to better coordinating the related works and minimising potential conflict of such works; and**
- (d) **remind HyD staff and consultants to follow the latest requirements in checking of BQ to ensure its completeness and accuracy.**

Response from the Government

2.26 The Director of Highways agrees with the audit recommendations. He has said that:

- (a) HyD will remind its staff and consultants to:
 - (i) follow the requirements in the latest guidelines on site investigation which cover the application of new technologies and digital tools (e.g. laser scanning technology);
 - (ii) critically assess the conditions of slopes (including those previously upgraded) in accordance with the latest guidelines of the Geotechnical Engineering Office of CEDD and include necessary slope works in the contracts when implementing road works projects involving slope works; and
 - (iii) maintain close liaison with relevant government departments about their underground utilities, particularly those involving project interface with the proposed works, with a view to better coordinating related works and minimising potential conflict of such works;
- (b) apart from the consultation procedures for public works projects as specified in the Project Administration Handbook, HyD would continue to strengthen communication with the public. HyD has recently been utilising new media and technologies (e.g. online platforms with computer animations) to facilitate stakeholders to have a better understanding and visualisation on its works; and

- (c) HyD will remind its consultants to continue to follow the latest requirements in the Project Administration Handbook (which has strengthened the quality assurance procedures in 2014 (such as in the checking of BQ — see para. 2.23(c) to (e))), and remind its staff to continue to conduct necessary checking on consultants' submissions in respect of BQ preparation work in future.

Management of reconstruction and improvement works under Project III

Construction works of some facilities not clearly specified in contract clauses

2.27 Under Project III, the traffic improvements to TMR Town Centre Section involved permanent relocation or reprovision of facilities (including bicycle parking spaces, new soft and hard landscape works and associated drainage works, and permanent lighting) within the then existing boundary of On Ting Estate. The relevant design and construction works were carried out by Contractor C under Contract F (a design-and-build lump sum contract — see Note 3 to Table 5 in para. 2.3). Contractor C contended that the construction works were additional works not covered by Contract F, and should be separately measured.

2.28 According to Consultant X:

- (a) the contract clauses of Contract F only required Contractor C to submit the design and construction programme for the permanent relocation or reprovision of facilities;
- (b) the construction works of these facilities were not specified under the contract clauses of Contract F and there was no item in the pricing schedule to allow Contractor C to price these works at the time of tendering; and
- (c) the construction works of these facilities were deemed to be additional works in respect of Contract F and shall be separately measured.

In the event, Consultant X issued VO H (later valued at a cost of \$3.9 million) to instruct Contractor C to carry out the construction works of these facilities.

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2.29 According to the Project Administration Handbook, it is essential that the contract documents for each contract are prepared with great care and by an experienced professional who has thorough knowledge of the works to be constructed, and the documents forming a contract must be scrutinised for comprehensive coverage, accuracy and consistency with one another before tenders are invited.

2.30 In Audit's view, in preparing documents for a design-and-build lump sum works contract in future, HyD needs to take measures to critically vet contract documents to ensure completeness and accuracy, including specifying clearly all the works required in contract clauses.

Scope for consulting the responsible parties of major institutional facilities about their underground facilities in the vicinity of works sites

2.31 Under Contract F, Contractor C was required to construct a vehicular bridge (i.e. Bridge B) and re-provision Chi Lok Bridge (i.e. Bridge C) and Siu On Bridge (i.e. Bridge D), which were lump sum, design and build items (Note 26). During the construction stage of Contract F, in November 2010, 2 existing cooling mains of diameters 450 mm and 600 mm were found in conflict with the foundation works of the proposed Bridge B and re-provision of Bridges C and D, as follows:

- (a) the 2 cooling mains were serving two institutional facilities as parts of their air-conditioning systems (to draw sea water for heat transfer forming integral parts of the air-conditioning systems);
- (b) the 2 cooling mains were not shown in any utilities record drawings obtained from other bureaux/departments or utility undertakers at planning stage;
- (c) in response to Contractor C's request for diversion of the 2 cooling mains, in December 2010, both the two institutional facilities replied that the

Note 26: *Under Contract F, Contractor C shall design and construct Bridges B to D in accordance with the Employer's Requirements at its lump sum prices specified in the tender documents.*

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diversion option was not preferred. One of them expressed that the diversion works might disrupt its daily operation; and

- (d) after due consideration on the cost and benefit of various options, changes of design to accommodate the 2 cooling mains at their original locations was considered the preferred option.

In the event, in August 2015, Consultant X issued 3 VOs (VOs I to K — later valued at a total cost of \$62.3 million) to instruct Contractor C to carry out additional design and construction works of Bridges B to D to accommodate the 2 cooling mains at their original place (Note 27).

2.32 According to Consultant X:

- (a) cooling mains were not one of the utilities as mentioned under Contract F; and
- (b) the 2 cooling mains exclusively served the two institutional facilities, which formed integral parts of their air-conditioning systems. The details of such facilities could only be obtained from their owners and maintenance agents, which were neither utility undertakers nor relevant parties commonly consulted when identifying existing underground utilities in public works projects.

2.33 In addition, in November 2015, Consultant X issued another VO (VO L — later valued at \$3.9 million) to instruct Contractor C to carry out additional design and construction works for foundations of 2 noise barriers/enclosures to accommodate the 2 cooling mains at their original place.

2.34 In Audit's view, in implementing works projects in future, there is merit for HyD to consult the responsible parties (e.g. maintenance agents) of major

Note 27: *According to HyD, as the valuations of VOs I to K had taken into account any costs of disruption and Contractor C had taken measures to mitigate the delay due to the cooling mains, no EOT or prolongation cost was granted separately.*

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institutional facilities in the vicinity of works sites about their underground facilities (e.g. cooling mains).

Scope for improvement in conducting in-situ investigation works for road works projects

2.35 Under Contract F, Contractor C was required to resurface the existing carriageway of the TMR Town Centre Section (see para. 1.3(c)(ii)). However, during the course of construction, more cracks at pavements were found at various locations. Upon detailed inspections, the depths of those cracks were found varying from about 120 mm to 300 mm measured from road surface. As the cracks were deep, the concerned road sections could not be effectively repaired by resurfacing as originally provided under Contract F. In the event, in March 2016, Consultant X issued VO M (later valued at \$12.6 million) to instruct Contractor C to carry out reconstruction of those deteriorating road areas (Note 28).

2.36 According to HyD and Consultant X:

- (a) TMR Town Centre Section was constructed in the 1980s and its road pavements had not been re-constructed since its commissioning;
- (b) although inspection on road condition had been conducted and surface cracks at various locations were observed in the planning stage, to minimise traffic impact possibly brought by in-situ investigation to the extremely busy TMR Town Centre Section, the exact extent of those cracks could not be fully determined to assess whether road reconstruction would be necessary. Based on the best available information in the planning stage, road resurfacing (Note 29) was considered the appropriate measures to repair the surface cracks observed; and

Note 28: *According to HyD, the extent of road reconstruction under VO M is 5,868 square metres, approximately 12% of the total area of carriageway to be resurfaced (50,796 square metres) as intended under Contract F.*

Note 29: *According to HyD, typical bituminous layers of flexible pavement include road base, base course, wearing course and friction course. Road resurfacing refers to the milling and relaying of the top layers (friction course and wearing course) of the bituminous layers while road reconstruction comprises removal and relaying of the whole depth of bituminous pavement structure of the existing carriageway.*

- (c) however, from the detailed inspection carried out during the construction stage, reconstruction (see Note 29 in (b) above) of the deteriorating road areas was found necessary for the completion of the works in order to effectively restore the structural condition of the deteriorating pavements. Furthermore, the timely reconstruction would also reduce the disturbance to the public in particular minimising nuisance to road users arising from repeated road openings and lane closure for frequent resurfacing works as the reconstruction would largely reduce the frequency of maintenance of the road pavements.

2.37 While noting HyD's view about the difficulties in conducting in-situ investigation of the conditions of a busy road section, in Audit's view, there is merit for HyD to explore measures to better ascertain the conditions of busy road sections for planning and design of future road works projects (e.g. making use of information from its maintenance term contractors during their regular inspection and maintenance of such sections — see paras. 1.8 and 1.9).

Audit recommendations

2.38 **Audit has *recommended* that the Director of Highways should:**

- (a) **in preparing documents for a design-and-build lump sum works contract in future, take measures to critically vet contract documents to ensure completeness and accuracy, including specifying clearly all the works required in contract clauses;**
- (b) **in implementing works projects in future, consult the responsible parties (e.g. maintenance agents) of major institutional facilities in the vicinity of works sites about their underground facilities (e.g. cooling mains); and**
- (c) **explore measures to better ascertain the conditions of busy road sections for planning and design of future road works projects (e.g. making use of information from HyD maintenance term contractors during their regular inspection and maintenance of such sections).**

Response from the Government

2.39 The Director of Highways agrees with the audit recommendations. He has said that, HyD will:

- (a) remind its consultants to follow the latest requirements in the relevant section of the Project Administration Handbook on checking tender documents (including contract clauses) to ensure that the works required are clearly specified, and remind its staff to conduct necessary checking on the related submissions from consultants to ensure completeness and accuracy;
- (b) consult the maintenance agents of major institutional facilities in the vicinity of works sites on their underground facilities as far as practicable in planning and design of future works projects; and
- (c) in the planning and design of future road works projects at busy road sections, review relevant information on pavement conditions (e.g. inspection reports and maintenance records) and carry out in-situ investigation as far as practicable taking into consideration the programme of routine maintenance works.

PART 3: OTHER PROJECT MANAGEMENT ISSUES

3.1 Apart from the issues relating to management of reconstruction and improvement works of TMR (see PART 2), there were other project management issues relating to TMR. This PART examines other project management issues, focusing on:

- (a) greening of noise barriers (paras. 3.2 to 3.15);
- (b) site safety (paras. 3.16 to 3.23); and
- (c) cost apportionment among project votes and project cost estimation (paras. 3.24 to 3.33).

Greening of noise barriers

3.2 According to HyD:

- (a) the Government is firmly committed to promoting greening as a means to enhance the quality of living environment in Hong Kong. Every practicable opportunity should be explored for provision of planters on highways structures including footbridges and flyovers; and
- (b) as such, vertical greening panels were installed at the noise barriers along TMR as trial with a view to maximising greening opportunities at highways structures.

Other project management issues

3.3 Under Projects I to III, noise barriers were installed along the respective sections of TMR to mitigate road traffic noise (see para. 1.3(a)(iv), (b)(ii) and (c)(iii)). According to HyD, vertical greening panels on noise barriers were incorporated into selected locations under Projects I and III as trial with a view to maximising greening opportunities (Note 30). In the event, vegetation was planted on small planting cups attached to the vertically placed panels at the lower part of noise barriers along the Eastern, Tai Lam and Town Centre Sections of TMR at a total construction cost of \$75.6 million to provide vertical greening panels for noise barriers (Note 31), as follows:

- (a) ***Eastern Section of TMR.*** A total of some 61,000 plants were planted on the vertical greening panels (1,700 m in length) on noise barriers along carriageway of the Eastern Section of TMR (see Photograph 1). The related construction works of vertical greening panels were carried out under Contract A at \$14.3 million;

Note 30: *According to HyD, vertical greening panel was adopted to the Eastern, Tai Lam and Town Centre Sections of TMR but not adopted to other sections of TMR because: (a) for the Sam Shing Hui Section of TMR, sunlight was not sufficient for vegetation inside the noise enclosures; and (b) for the TMR section at Tsing Tin Interchange, the related works were of smaller scale, which commenced earlier than the reconstruction and improvement works of other TMR sections.*

Note 31: *According to HyD: (a) the vertical greening panels along the Eastern and Tai Lam Sections of TMR were separated from the existing acoustic panels (for noise mitigation) at the back of the noise barriers; and (b) the vertical greening panels of the noise barriers along the Town Centre Section of TMR were integrated with a noise absorptive layer (for noise mitigation) at the back to form the vertical greening panels as a whole.*

Photograph 1

Vertical greening panels on noise barriers at Eastern Section of TMR



Source: HyD records

- (b) **Tai Lam Section of TMR.** A total of some 24,000 plants were planted on the vertical greening panels (600 m in length) on noise barriers along carriageway of the Tai Lam Section of TMR. The related construction works of vertical greening panels were carried out under Contract B at \$3.7 million; and
- (c) **Town Centre Section of TMR.** A total of some 83,000 and 102,000 plants were planted on the vertical greening panels on noise barriers along the carriageway (400 m in length) and along footpath (700 m in length) of the Town Centre Section of TMR respectively. The related construction works of vertical greening panels were carried out under Contract F at \$57.6 million (Note 32).

Note 32: According to HyD: (a) the vertical greening panels along the Town Centre Section of TMR served dual functions of both greening as well as noise mitigation; and (b) small planting cups with vegetation at front were integrated with a noise absorptive layer at the back to form the vertical greening panels as a whole (see Note 31 to para. 3.3). As such, there was no separate breakdown on the construction cost for the vertical greening layer only.

Other project management issues

3.4 According to DEVB Technical Circular (Works) No. 6/2015 and its superseded version No. 2/2004 “Maintenance of Vegetation and Hard Landscape Features”, the departmental responsibilities for maintenance of vegetation regarding TMR are as follows:

- (a) HyD is responsible for the horticultural maintenance works (Note 33) of vegetation on the vertical greening panels along the Eastern and Tai Lam Sections of TMR, which were within the boundary of expressways; and
- (b) the Leisure and Cultural Services Department (LCSD) is responsible for the horticultural maintenance works of vegetation on the vertical greening panels along the Town Centre Section of TMR, which were along non-expressway public roads outside country park.

Note 33: *According to HyD, horticultural maintenance works for the vegetation included weeding, thinning and pruning of vegetation, pest control, replacement of diseased and dead plants, and maintenance and repair of irrigation system.*

3.5 After the completion of Contracts A and B, the vegetation on the vertical greening panels along the Eastern and Tai Lam Sections of TMR were handed over by Contractors A and B to HyD in November 2017 and June 2016 respectively for horticultural maintenance (Note 34). The vegetation on the vertical greening panels along the Town Centre Section of TMR was handed over to LCSD in July 2017 (Note 35) for horticultural maintenance (Note 36).

Unsatisfactory growing conditions of vegetation on vertical greening panels

3.6 Audit noted that, from October 2017 to June 2022, HyD and LCSD received 15 and 23 complaints respectively from the public and LegCo Members regarding the withered vegetation on the vertical greening panels at various sections of TMR (see Photograph 2 for the withered vegetation on vertical greening panels at the Town Centre Section of TMR).

Note 34: *According to HyD: (a) the horticultural maintenance works of vegetation on vertical greening panels along TMR were covered under a 6-year term contract for the management and maintenance of expressways and high speed roads in the New Territories West and Kowloon. In 2021-22, the expenditure for the relevant term contract amounted to \$168.3 million (see para. 1.9); and (b) the maintenance term contract covered various road maintenance works including vegetation maintenance. Since the vegetation maintenance item cost covers various vegetated areas under the contract, a breakdown of the cost solely for maintenance of vegetation on vertical greening panels along TMR was not available.*

Note 35: *According to HyD, after the completion of Contract F, vegetation on vertical greening panels was handed over by Contractor C to HyD in June 2015 for establishment before handing over to LCSD in July 2017.*

Note 36: *According to LCSD: (a) the repair and horticultural maintenance works of vegetation (e.g. weeding, watering and regular inspection of vegetation) on vertical greening panels along the Town Centre Section of TMR were covered by LCSD's 5 horticultural maintenance term contracts from July 2017 to March 2022; and (b) the related expenditure for the vegetation on vertical greening panels during the period amounted to \$3.9 million.*

Photograph 2

**Withered vegetation on vertical greening panels
at the Town Centre Section of TMR
(June 2020)**



Source: HyD records

***Replacement of 400 m long vertical greening panels along carriageway
of the Town Centre Section***

3.7 From time to time, District Council Members of the Tuen Mun District Council (TMDC) had expressed concerns about the unsatisfactory growing conditions of the vegetation on the 400 m long vertical greening panels on noise barriers along carriageway of the Town Centre Section of TMR (see para. 3.3(c)). In this connection, Audit noted that:

- (a) at a meeting of TMDC in May 2020, in response to District Council Members' enquiries on the unsatisfactory conditions of vegetation on vertical greening panels, LCSD commented that:
 - (i) the vertical greening panels along the Town Centre Section of TMR were designed and constructed by HyD, including the selection and

planting of plants. The design of the vertical greening panels made it difficult for the soil below the plants to hold water;

- (ii) as the Town Centre Section of TMR was busy, LCSD's horticultural maintenance contractor encountered difficulties in obtaining approval for temporary road closure at the location concerned (i.e. 400 m long vertical greening panels on noise barriers along carriageway) to carry out the maintenance works; and
 - (iii) LCSD and HyD were studying alternatives or adjustment plans to improve the situation; and
- (b) at a meeting of TMDC in September 2020, HyD said that:
- (i) after reviewing the situation with LCSD, it was noted that the plants needed more frequent maintenance as they were easily affected by strong wind, dust and fungus. To safeguard the road users and workers, the road section concerned needed to be closed temporarily when carrying out the horticultural maintenance works. However, frequent temporary road closure for horticultural maintenance should be avoided as far as possible taking into consideration the increasingly busy traffic condition in the district and the need of minimising disturbance to the residents and the road users;
 - (ii) it was difficult for the plants on the vertical greening panels along TMR to grow sustainably considering the frequent maintenance needed, cost-effectiveness, greening effect and impact on the residents nearby during temporary road closure; and
 - (iii) the concerned 400 m long vertical greening panels would be replaced by acoustic panels similar to those at the adjacent location.

3.8 In the event, HyD engaged a contractor to replace the 400 m long vertical greening panels on noise barriers along carriageway of the Town Centre Section of TMR with acoustic panels without greening. The replacement works commenced in November 2021 and were substantially completed in January 2022 (incurring an expenditure of \$3.0 million, which was funded by Project Vote III).

Other project management issues

3.9 ***Planning to replace remaining vertical greening panels of the Town Centre Section.*** According to HyD, a coordination meeting with LCSD was held in May 2022 to discuss the way forward of the remaining 700 m long vertical greening panels along footpaths of the Town Centre Section of TMR. According to the evaluation report prepared after the meeting, HyD and LCSD concluded that vegetation on vertical greening panels along footpaths was neither sustainable nor cost-effective due to the following:

- (a) the small planting cups of the vertical greening panels hindered healthy plant growth in the long run;
- (b) the irrigation system deteriorated under the harsh environment in open space; and
- (c) in some locations, vertical greening panels were erected at higher level (e.g. 2 m or more above ground level) which made maintenance works difficult and time consuming.

In response to Audit's enquiry, in August 2022, HyD informed Audit that, it planned to replace the remaining 700 m long vertical greening panels along footpaths of the Town Centre Section of TMR with acoustic panels, and the tender for the related works contract would be invited in 2023.

3.10 ***Planning to remove vertical greening panels along the Eastern and Tai Lam Sections.*** Similar to the Town Centre Section, unsatisfactory growing conditions of vegetation on the vertical greening panels (2,300 m in length) were also noted along the Eastern and Tai Lam Sections of TMR.

3.11 In response to Audit's enquiry, in August 2022, HyD informed Audit that:

- (a) several maintenance constraints which led to the unsatisfactory growing conditions of vegetation on the vertical greening panels were identified:
 - (i) the plants were prone to disease and fungal attack under the harsh and dusty environment of TMR leading to rotting of plants;

- (ii) HyD encountered difficulties in obtaining approval for temporary road closure of the increasingly busy TMR for the horticultural maintenance works; and
 - (iii) condition of the irrigation system catering for the vertical greening deteriorated under the harsh environment in open space and it was difficult and labour intensive to conduct inspection and maintenance;
- (b) as of April 2022, the growing conditions of vegetation on the vertical greening panels along the Eastern and Tai Lam Sections of TMR remained unsatisfactory and it was considered that the vertical greening panels were not sustainable in the long run; and
- (c) HyD was considering the removal of vertical greening panels along the Eastern and Tai Lam Sections of TMR. The proposed removal works (Note 37) would require multi-stage temporary traffic arrangements as the vertical greening panels were situated adjacent to expressway and more extensive. HyD was formulating the detailed works plan and the removal works were targeted to be completed in 2024.

Need to draw lessons from the installation of vertical greening panels along various sections of TMR

3.12 In October 2022, HyD informed Audit that:

- (a) given that there was limited local experience of installation of vertical greening panels along highways of similar scale, HyD had conducted site trial on vertical greening panels proposed by the contractor at open area of the site office in the vicinity of the Town Centre Section of TMR prior to formal installation along TMR;

Note 37: *According to HyD, the proposed works will only involve removal of vertical greening panels which are separate from the existing acoustic panels at the back of the noise barriers along the Eastern and Tai Lam Sections of TMR (see Note 31 to para. 3.3).*

Other project management issues

- (b) as the site trial results were considered acceptable, the vertical greening panels were installed, followed by close monitoring by various parties over a substantial period of time; and
- (c) however, the conditions of the vertical greening panel were below expectation under the actual site conditions and constraints at TMR (see paras. 3.7, 3.9 and 3.11(a)).

3.13 According to HyD, the vertical greening panels on noise barriers along the Eastern, Tai Lam and Town Centre Sections of TMR were constructed (including the selection and planting of plants) under Projects I and III with a total construction cost of \$75.6 million (see para. 3.3). However, the growing conditions of vegetation on these panels were not satisfactory (see para. 3.6). HyD and LCSD concluded that the maintenance works of vegetation were difficult and the vertical greening panels were not sustainable in the long run (see paras. 3.9 and 3.11(b)). In the event, all the vertical greening panels on noise barriers along various sections of TMR were replaced with acoustic panels or under planning for replacement/removal. In Audit's view, HyD needs to draw lessons from the installation of vertical greening panels on noise barriers along TMR.

Audit recommendation

3.14 **Audit has recommended that the Director of Highways should draw lessons from the installation of vertical greening panels on noise barriers along various sections of TMR with a view to improving the design and implementation of greening works in future road works projects, including critically evaluating the technical feasibility, cost-effectiveness and sustainability in planting and maintenance of vegetation at high speed or busy road sections.**

Response from the Government

3.15 The Director of Highways agrees with the audit recommendation. He has said that:

- (a) HyD would draw lessons from the trial installation of vertical greening panels on noise barriers; and

- (b) HyD has been reviewing the “Guidelines on Design of Noise Barriers” taking into consideration the lesson learnt from TMR for other projects’ reference in future.

Site safety

3.16 According to Contracts A to F, contractors should:

- (a) throughout the progress of the works take full responsibility for the adequate stability and safety of all operations on the site and have full regard for the safety of all persons on the site; and
- (b) keep the site and the works in an orderly state appropriate to the avoidance of danger to all persons.

3.17 According to the Construction Site Safety Manual issued by DEVB, contractors are required to:

- (a) verbally report dangerous occurrences and accidents involving death, serious injury, serious damage or with worker admitted to the hospital to the Engineer’s site staff immediately, followed by preliminary accident report within 24 hours; and
- (b) promptly report all reportable accidents (i.e. accident resulting in death, serious injury and injury with incapacity for more than three days) to the Engineer’s Representative (Note 38).

3.18 Furthermore, according to DEVB Technical Circular (Works) No. 1/2020 and its superseded version No. 26/2000 “Score Card for Assessment of Site Safety Performance”, Score Card system (being a quantitative tool to assess the safety performance of contractors in a consistent approach) was implemented for assessing the contractor’s site safety performance (including the timeliness in reporting

Note 38: *According to the Manual, the contractor shall complete an injury report form within 7 days from the date of an accident.*

Other project management issues

accidents at construction sites) in quarterly performance reports for public works contracts.

Scope for enhancing construction site safety

3.19 According to HyD, from 2008 to 2016, at construction sites of Contracts A to C, E and F, there were 2 fatal accidents (see para. 3.20) and 43 non-fatal reportable accidents (i.e. accident resulting in an injury with incapacity for more than three days) (see para. 3.21).

3.20 ***Fatal accidents.*** The following 2 fatal accidents occurred at the construction sites under Contracts A and C:

- (a) on 7 April 2011, at the Yau Kom Tau Viaduct, a worker fell some 6 m from a steel working platform together with a piece of metal cover from the platform, resulting in serious bodily injuries. Two other workers working underneath the platform were struck by the falling metal cover, killing one and injuring the other (Note 39). According to HyD:
 - (i) for the accident, a steel cover was removed to facilitate the lifting of rebar onto lower working level, and the steel cover was subsequently restored. However, a telescopic crawler crane had tracked over the steel cover causing it to shift and eventually fall onto the lower level causing this fatal accident (Note 40); and
 - (ii) improvement measures had been taken, including revising working method, conducting specific risk assessment and providing specific training to workers; and

Note 39: *For this fatal accident, Contractor A and its subcontractors were prosecuted for violation of the Factories and Industrial Undertakings Ordinance (Cap. 59) and the Construction Sites (Safety) Regulations (Cap. 59I), and were convicted and fined for a total of \$480,000 in January 2016.*

Note 40: *An adverse performance was reflected in Contractor A's performance report for the second quarter of 2011 with very poor performance in site safety aspects to reflect the fatal accident on 7 April 2011 causing fatality and injuries.*

- (b) on 15 November 2014, at a section of TMR near Cafeteria Beach, a worker was struck by a rack of water pipes falling from a crane lorry truck during an unloading operation and being killed (Note 41). According to HyD:
- (i) a total of 15 water pipes were loaded on the lorry truck. It was believed that the procedures stated in the method statement (i.e. to transport the water pipes in a prefabricated cage which could hold only 12 water pipes) was not followed, causing this fatal accident (Note 42); and
 - (ii) improvement measures had been taken, including reviewing the method statement and risk assessment of the related works, and providing training for the safety enhancement measures, close supervision and monitoring of related operation.

3.21 *Non-fatal reportable accidents.* From 2008 to 2016, 43 non-fatal reportable accidents occurred at construction sites of Contracts A to C, E and F (14, 2, 18, 1 and 8 reportable accidents under respective contracts), involving sick leave ranging from 13 to 1,094 days. Contractors are required to promptly report all reportable accidents to Engineer's Representatives (see para. 3.17(b)). Audit noted that, according to the performance reports of contractors under Contracts A to F, there were late reporting of reportable accidents by the contractor (i.e. Contractor C) under Contracts C and F on 4 occasions (2 under each contract), ranging from about 3 months to about 11 months late. According to HyD, these 4 late reporting cases were reflected in Contractor C's performance reports with poor rating in site accident record aspects for the respective periods.

Note 41: *For this fatal accident, Contractor C and its subcontractors were prosecuted for violation of the Factories and Industrial Undertakings Ordinance and the Factories and Industrial Undertakings (Lifting Appliances and Lifting Gear) Regulations (Cap. 59J), and were found not guilty after considering all the evidence and the written closing submissions.*

Note 42: *Poor performance was reflected in site safety aspects in Contractor C's performance report for the period from September to November 2014 to reflect the fatal accident on 15 November 2014 causing fatality.*

Audit recommendations

3.22 Audit has *recommended* that the Director of Highways, in implementing works projects in future, should:

- (a) make continued efforts to enhance construction site safety with a view to safeguarding safety of all operations and all persons on sites; and
- (b) take measures to ensure that HyD contractors timely report accidents at construction sites in accordance with related requirements and appropriate follow-up actions are taken in a timely manner.

Response from the Government

3.23 The Director of Highways agrees with the audit recommendations. He has said that HyD will remind its staff and consultants to:

- (a) make continued efforts to enhance construction site safety; and
- (b) follow the latest requirements stipulated in the relevant DEVB Technical Circular (Works) for monitoring the timeliness of contractors' reporting of accidents occurred at construction sites.

Cost apportionment among project votes and project cost estimation

Scope for improvement in cost apportionment among project votes

3.24 Upon commencement of 4 TMR contracts (i.e. Contracts A to C and F) at the Eastern Section, Tai Lam Section, Sam Shing Hui Section and Town Centre Section, HyD, together with Consultant X, had reviewed and identified the need to strengthen their communication with the general public through the establishment of a community liaison centre (CLC) in Tuen Mun Town Centre. According to HyD, the proposed CLC would:

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- (a) be approximately 120 square meters and furnished with a range of facilities including an exhibition area with displays of information of Contracts A to C and F, together with physical models of the proposed works (Note 43);
- (b) act as the venue for close contact and communication with the community to address the local residents' queries in relation to the construction works which could better serve the public; and
- (c) provide visitors with access to the project background and the latest information for Contracts A to C and F. The centre would be stationed by resident site staff (public relation team) to serve the visitors.

3.25 In June 2010, Consultant X issued VO N (later valued at \$3.4 million) to Contractor C under Contract F (Note 44) for the provision and operation of CLC for a period of 3 years (i.e. from mid-July 2010 to mid-July 2013). According to the approval paper submitted to approving authority for VO N (i.e. HyD Officer at D2 rank or above — Note 45), the cost of the proposed CLC would be apportioned among Project Vote I3 and Project Vote III by reference to the road length of the respective works (i.e. 15.5 km (or 89.6%) under Project Vote I3 and 1.8 km (or 10.4%) under

Note 43: *According to HyD: (a) the prime function of CLC was to address questions related to Contracts A to C and F which had more interfaces with the public; (b) although there were less interfaces with the public for Contract D due to its nature, being an ancillary contract to provide TCSS works, CLC would also provide information upon receipt of relevant enquiries; and (c) Contract E was completed in January 2010 (prior to the establishment of CLC in July 2010). Hence, CLC did not serve to provide information and services to address questions related to Contract E.*

Note 44: *According to Consultant X, the provision of CLC was considered to be desirable to be carried out by Contractor C under Contract F so as to locate the centre in the closest proximity of Tuen Mun Town Centre.*

Note 45: *According to Consultancy X and the then prevailing Stores and Procurement Regulations, the approving authority for a proposed VO was determined based on the estimated cost for the proposed VO as follows:*

<i>Estimated cost for proposed VO</i>	<i>Approving authority</i>
<i>\$0.3 million or below</i>	<i>Consultant X</i>
<i>\$1.3 million or below</i>	<i>Officer at D1 rank</i>
<i>\$4 million or below</i>	<i>Officer at D2 rank or above</i>
<i>Exceeding \$4 million</i>	<i>Controlling Officer</i>

Other project management issues

Project Vote III). Furthermore, from July 2013 to July 2014, Consultant X issued another 4 VOs (i.e. VOs O to R — later valued at a total cost of \$0.9 million) for extending the operation of the CLC from mid-July 2013 to October 2014. As a result, the total cost for provision and operation of CLC amounted to \$4.3 million (\$3.4 million + \$0.9 million).

3.26 Based on the agreed cost apportionment arrangement, \$0.4 million ($\$4.3 \text{ million} \times 10.4\%$) should be charged under Project Vote III, and \$3.9 million ($\$4.3 \text{ million} \times 89.6\%$) should be charged under Project Vote I3. However, Audit noted that \$4.3 million were all charged under Project Vote III. In the event, the account of Contract F was finalised in November 2016. In Audit's view, in implementing works projects in future, HyD needs to take measures to ensure proper cost apportionment among project votes.

Scope for improving project cost estimation

3.27 According to the Project Administration Handbook, any estimate must be as accurate as possible as it affects the management of public funds and it has a direct effect on fund allocation.

3.28 The estimated overall project cost for the major works under Project I was \$4,620.5 million (i.e. Project Vote I3 — see Table 1 in para. 1.4) in February 2008. After obtaining funding approval of \$4,620.5 million for major works in April 2008, HyD invited tenders for the first works contract under Project I (i.e. Contract A) in May 2008. However, the returned tender prices of Contract A far exceeded its pre-tender estimate.

3.29 In view of the higher-than-expected tender outturn price for Contract A, in March 2009, in the submission to the Public Works Subcommittee, TLB said that following a review of the financial situation, the estimated overall project cost for the major works under Project I had increased to \$6,804.3 million due to reasons including the following:

- (a) higher-than-expected tender outturn price for the first civil works contract (i.e. Contract A);

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- (b) higher estimates of the remaining works contracts (i.e. Contracts B and C) and TCSS contract (i.e. Contract D);
- (c) upward adjustments in contingency sums for unforeseen works;
- (d) additional resident site staff costs due to the expansion of team size, and additional programming and coordination required; and
- (e) increase in the provision of price adjustment as a result of the increase in the total project estimate and the latest price adjustment factors.

In the event, funding approval was given by FC in April 2009 for increasing APE for the major works under Project I from \$4,620.5 million to \$6,804.3 million (see Table 1 in para. 1.4).

3.30 According to HyD:

- (a) relevant procedures including those under the Project Administration Handbook had been followed in preparation of the pre-tender estimates and the project estimate. The increase in APE was highly attributed to the accelerated increase in construction material prices from the third quarter in 2007 to May 2008 when the tenders of Contract A were returned. For example, the cost index for steel reinforcement as at May 2008 had risen by 72% compared to those in September 2007 when the project estimate was prepared; and
- (b) after award of Contract A, DEVB Technical Circular (Works) No. 6/2017 “Civil Engineering Works Tender Price Index” was issued in December 2017 to allow project officers to take into account the tender price trend in the project estimates and pre-tender estimates with a view to further enhancing the accuracy of project cost estimates.

3.31 In Audit’s view, in implementing works projects in future, HyD needs to remind its staff and consultants to follow the related guidelines to ensure that the project costs are estimated as accurately as possible.

Audit recommendations

3.32 Audit has *recommended* that, in implementing works projects in future, the Director of Highways should:

- (a) take measures to ensure proper cost apportionment among project votes; and
- (b) remind HyD staff and consultants to follow the related guidelines to ensure that the project costs are estimated as accurately as possible.

Response from the Government

3.33 The Director of Highways agrees with the audit recommendations. He has said that:

- (a) HyD has rectified the technical error by re-allocating the expenditure between Project Vote I3 and Project Vote III. HyD will remind its staff to take note of cost apportionment among project votes, if any, and thoroughly scrutinise the records on cost apportionment when processing project payments; and
- (b) HyD will remind its staff and consultants to continue to follow the latest guidelines, including the relevant section in the Project Administration Handbook and DEVB Technical Circular (Works), in the preparation of project estimation in future.

PART 4: MAINTENANCE AND TRAFFIC MANAGEMENT OF TUEN MUN ROAD

4.1 This PART examines the maintenance of TMR by HyD (paras. 4.2 to 4.20) and the traffic management of TMR by the relevant government departments (paras. 4.21 to 4.32).

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4.2 HyD is responsible for the maintenance of public roads (including TMR), highway structures and ancillary facilities (e.g. roadside barriers and traffic sign plates) within its ambit (see para. 1.8). HyD lets out term contracts through competitive tendering to carry out the road maintenance works. The maintenance works for TMR are covered under the following two term contracts in recent years:

- (a) 6-year term contract (Contract G) for the management and maintenance of high speed roads in the New Territories West and Kowloon, covering the period from 1 April 2016 to 31 March 2022. In January 2016, HyD awarded Contract G to Contractor G at a contract sum of \$493.6 million (Note 46) for 6 years. In 2021-22, the expenditure for Contract G amounted to \$168.3 million, including \$24.7 million relating to the management and maintenance of TMR. As of September 2022, the account of Contract G had not been finalised; and

Note 46: *The contract sum covered the management and maintenance works for various high speed roads (including TMR) within the geographical areas covered under Contract G. According to HyD, Contract G included a schedule of rates generally applicable to the works within the contract scope and there was no specific rate for the works solely relating to TMR.*

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- (b) 6-year term contract (Contract H) for the management and maintenance of high speed roads in the New Territories West and Kowloon West, covering the period from 1 April 2022 to 31 March 2028. In January 2022, HyD awarded Contract H to Contractor H at a contract sum of \$1,058.5 million (Note 47) for 6 years.

4.3 **Maintenance works.** According to HyD, the maintenance works conducted under Contracts G and H can be broadly classified into two types, as follows:

- (a) **Inspection and routine maintenance works.** The contractors are required to conduct inspection and carry out routine maintenance works (i.e. management and maintenance works — M&M works) for the road networks (including TMR) covered under the pertinent contracts. These M&M works include conducting inspections on roads, highway structures (e.g. road bridges, tunnels, subways, noise barriers and sign gantries) and roadside slopes to identify defects, and carrying out routine maintenance works (e.g. rectification of defects identified during inspections, scheduled cleansing of roads, highway structures and street furniture, and vegetation maintenance). The contractors are entitled to a monthly fee for each type of services provided under the contract provisions relating to M&M works. Payments to the contractors for M&M works are performance-linked. Payment deductions will be made if the performance standards are not achieved (see para. 4.4(a) and (b)). In 2021-22, the payment for M&M works under Contract G amounted to \$20.5 million, including an estimated amount of \$2.9 million relating to TMR (Note 48); and

Note 47: *The contract sum covered the management and maintenance works for various high speed roads (including TMR) within the geographical areas covered under Contract H. According to HyD, Contract H included a schedule of rates generally applicable to the works within the contract scope and there was no specific rate for the works solely relating to TMR.*

Note 48: *According to HyD: (a) the payment of \$20.5 million was for M&M works for various high speed roads (including TMR) within the geographical areas covered under Contract G; and (b) the estimated amount of \$2.9 million relating to TMR was calculated on a pro-rata basis according to the road length, structure area and number of slopes/verges involved as there was no specific rate for M&M works solely relating to TMR under Contract G.*

- (b) ***Non-routine maintenance and rehabilitation works.*** HyD may instruct the contractors to carry out non-routine maintenance and rehabilitation works not covered under the scope of M&M works (i.e. non-M&M works including, for example, cold milling and resurfacing of flexible pavements, replacement of bridge joints and bearings, application of protective coating to bridge structures, modification of existing directional sign plates and repair of damaged street furniture (e.g. crash cushion and steel vehicle parapet railing) outside the scope of M&M works). In such cases, HyD will separately issue works orders and pay the contractors for carrying out the related works. In 2021-22, the payment for non-M&M works orders under Contract G amounted to \$147.8 million, including \$21.8 million relating to TMR.

4.4 ***Monitoring of contractors' performance.*** The salient points of HyD's work in monitoring the performance of Contractors G and H in management and maintenance of high speed roads are as follows:

- (a) ***Engineer's audits (EAs).*** To measure the performance standards achieved by the contractors before making payments, HyD staff carries out EAs, on a sample basis, on M&M works performed by the contractors. An inspection (e.g. road inspection and highway structure inspection) conducted by a contractor is regarded as defective if an EA identifies defects not included in the inspection report of the contractor and the number of such defects identified exceeds the allowable limit as defined in the contract specifications. Monthly payments for M&M works will be progressively reduced if more defective inspections are found (Note 49);
- (b) ***Engineer's inspections (EIs).*** HyD staff also selects sites to conduct visits (i.e. EIs) during the execution of works to ascertain whether the contractors have carried out M&M works (i.e. inspection and routine maintenance works) in accordance with the contracts. For non-compliance observed

Note 49: *According to HyD, EAs were conducted on random samples selected from M&M works for various high speed roads (including TMR) within the geographical areas covered under Contract G. There was no payment deduction solely relating to TMR under Contract G.*

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during EIs, HyD will issue default notices (DNs — Note 50) to the contractors for deduction of contract payments (Note 51);

- (c) **Site supervision.** HyD staff carries out site supervision from time to time to monitor the works progress and the performance of contractors in non-M&M works; and
- (d) **Key performance indicators (KPIs).** KPIs, covering aspects including road safety, client satisfaction and contract compliance, are set out in the contracts as a tool for HyD to monitor the performance trends of contractors. Under the contract provisions, the contractors could also propose new KPI initiatives for HyD's agreement. After agreement of KPIs, the contractors are responsible for compiling KPI performance trends for reporting and monitoring at monthly progress meetings with HyD. When there is deterioration observed from KPI performance trends, the contractors are required to advise the likely causes for the deterioration of KPI performance trends. If this is due to poor management or performance of the contractors in any aspect, the contractors are required to propose improvement measures for HyD's consideration.

4.5 Audit noted that there was scope for improvement in the administration of term contracts relating to the maintenance of TMR (see paras. 4.6 to 4.19).

Note 50: *A DN refers to a notice given by HyD to the contractor for works undertaken by the contractor not in compliance with the contract specifications. It shows the type of non-compliance observed by HyD staff (e.g. inspection not carried out as programmed) and the amount to be deducted (e.g. ranging from \$650 to \$6,500 under Contract G) from payments to the contractor.*

Note 51: *During the three-year period from 2019-20 to 2021-22, the total number of DN's issued under Contract G for the road network (including TMR) was 4,432. According to HyD, as all DN's under Contract G were issued in paper form and kept in files (i.e. manual records), there was no readily available information on DN's relating to M&M works for TMR.*

Scope for improving the management of works orders

4.6 According to Contract G and the Maintenance Administration Handbook issued by HyD:

- (a) a time for completion shall be stated on a works order at the time of its issue and may be extended or revised according to the contract provisions. The works shall be completed within the time for completion as stated on the works order commencing on the date of issue of the works order or such extended time or such revised time. HyD shall have the right to claim liquidated damages (LD — Note 52) for the contractor's delay in completion of the works order; and
- (b) the progress of the works should be closely monitored throughout the whole duration of a works order.

4.7 During the five-year period from 2017-18 to 2021-22, HyD issued 635 non-M&M works orders (amounting to \$119 million as of March 2022) relating to TMR to Contractor G. As of July 2022, all of the 635 works orders had been completed. Of the 635 completed works orders, 29 (5%) were completed later than their target completion dates, ranging from 3 to 550 days (or 1.5 years), averaging 100 days (or 3.3 months). Audit noted that:

- (a) ***Delays in completion of works orders.*** For 5 (17%) of the 29 works orders, there were delays in completion of works orders by Contractor G, ranging from 10 to 144 days (or 4.7 months), averaging 68 days (or 2.2 months). According to HyD, such delays were mainly due to slow progress of contractor's works and it had notified Contractor G for the imposition of LD for the 5 overdue works orders;
- (b) ***Late notifications of EOT claims.*** For 13 (45%) of the 29 works orders, which were completed between November 2019 and September 2021, Contractor G only served notifications of EOT claims for these works orders on 30 September 2022 (i.e. 370 to 1,060 days (or 2.9 years),

Note 52: *According to HyD, LD shall be calculated by multiplying the number of days of delay by the rate per day prescribed in the contract.*

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averaging 917 days (or 2.5 years) after completion of works orders). According to HyD, the 13 EOT claims with late notifications (Note 53) were related to unexpected events out of Contractor G's control. Despite late notifications, HyD had written to Contractor G requesting it to give detailed explanation for the late submissions of the 13 EOT claims and submit full and detailed particulars of these claims to support its claims for EOT for completion. Upon receiving further information from Contractor G, HyD would consider assessing the 13 EOT claims with late notifications according to the contract provisions; and

- (c) *Delays in provision of information for claim assessments.* For 11 (38%) of the 29 works orders, Contractor G served notifications of EOT claims for 4 works orders in October 2018 and 7 works orders in February 2022. However, as of September 2022, assessments of EOT claims for these works orders were still in progress. According to HyD, the long time taken in assessing the EOT claims was mainly due to delays in provision of information by Contractor G for claim assessments. Upon completion of the assessments of EOT claims, LD would be imposed for works orders assessed to be overdue.

4.8 In Audit's view, HyD needs to:

- (a) continue to closely monitor the implementation progress of works orders to ensure their timely completion by the contractors of high speed road maintenance term contracts; and

Note 53: *According to the General Conditions of Contract for Term Contracts for Civil Engineering Works, regarding EOT for completion, as soon as practicable but in any event within 28 days after the cause of any delay to the progress of any works has arisen, the contractor shall give notice in writing to the Engineer of the cause and probable extent of the delay. According to the Project Administration Handbook, if the contractor has failed to comply with the abovementioned requirement, the Engineer is not bound under the contract to consider whether the contractor is fairly entitled to an EOT for completion. However, the Engineer may consider the contractor's claim for an EOT for completion if it is not unreasonable for him to do so.*

- (b) expedite the assessments of EOT claims (e.g. reminding the contractors to timely serve notifications of EOT claims and provide information for claim assessments) and timely notify the contractors for the imposition of LD for overdue works orders under high speed road maintenance term contracts.

Need to improve the monitoring of defect rectification works

4.9 Defects may be identified by HyD staff (e.g. during EIs) or referrals from other sources (e.g. complaints from the public). For defects falling within M&M works (see para. 4.3(a)), written notifications (i.e. notification forms — NFs) will be issued to instruct the contractor to rectify the defects within the time limits as stated on NFs. After the completion of defect rectification works, the contractor is required to submit completion reports on NFs within the stipulated time limits (e.g. 7 working days for highways structural maintenance works and 2 working days for roadside slope maintenance works) for HyD's checking. After receiving completion reports on NFs from the contractor, HyD staff will endorse and indicate on NFs the compliance of stipulated time limits or not. Should there be any non-compliance with the stipulated time limits, a DN will be issued.

4.10 For 67 NFs relating to TMR issued to Contractor G during the period from April 2021 to March 2022, Audit noted that:

- (a) for 24 (36%) NFs, there were delays in completion of defect rectification works by Contractor G (i.e. exceeding the time limits as stated on NFs), ranging from 1 to 207 days (or 6.8 months), averaging 60 days (or 2.0 months) (Note 54);
- (b) for 24 (36%) NFs, there were delays in submission of completion reports by Contractor G after the completion of defect rectification works (i.e. exceeding the stipulated time limits), ranging from 1 to 356 days (or 11.7 months), averaging 151 days (or 5.0 months); and

Note 54: *According to HyD, for the 24 NFs, DNs had been issued to Contractor G for 21 NFs with delays in completion of defect rectification works. For the remaining 3 NFs (all with delay of 1 day), no DN was issued to Contractor G as the delays in completion of defect rectification works were due to inclement weather beyond Contractor G's control and were considered justifiable under the contract provisions.*

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- (c) for 9 (13%) NFs, they were endorsed by HyD staff more than 30 days after the receipt of completion reports on NFs from Contractor G, ranging from 130 to 153 days (or 5.0 months), averaging 146 days (or 4.8 months). According to HyD, the completion reports on the 9 NFs were submitted by Contractor G during the period from late December 2021 to mid-February 2022. The endorsement process was affected by the special work arrangements for government employees in light of the outbreak of the fifth wave of the coronavirus disease (COVID-19) epidemic when priority was given to providing essential and emergency public road repair services.

4.11 In October 2022, HyD informed Audit that it had been closely monitoring the progress in implementation of defect rectification works and submission of completion reports on NFs, and had followed up with Contractor G in monthly progress meetings. The poor performance of Contractor G in aspects related to defect rectification works (e.g. identification of and responsiveness to problems, and attention to records) had been reflected in the relevant performance reports of Contractor G.

4.12 In Audit's view, HyD needs to:

- (a) take measures to improve the monitoring of defect rectification works carried out by the contractors of high speed road maintenance term contracts, including closely monitoring the implementation progress of defect rectification works and issuance of DNs to the contractors as needed; and
- (b) remind its staff to timely complete the endorsement process after receiving completion reports from the contractors of high speed road maintenance term contracts.

Need to take measures to ensure the timely submission of proposals for KPIs by the contractors

4.13 According to Contracts G and H:

- (a) KPIs shall cover at least road safety, client satisfaction and contract compliance aspects, and include but not limited to KPIs as defined in the contract specifications; and
- (b) within 14 days of the commencement of the contract period, the contractor shall propose KPIs with all related aspects such as reporting format, data attributes to be stored, etc. for the agreement of HyD.

4.14 Contractors G and H were required to submit proposals for KPIs to HyD by mid-April 2016 and mid-April 2022 respectively. However, Audit noted that there were delays in submission of proposals for KPIs, as follows:

- (a) ***Contract G.*** Contractor G submitted a proposal for KPIs to HyD in mid-June 2016 (i.e. a delay of about 2 months). According to HyD, after several rounds of comments, it agreed the final proposal for KPIs in late November 2016 and incorporated them under Contract G (Note 55); and
- (b) ***Contract H.*** Contractor H submitted a proposal for KPIs to HyD in August 2022 (i.e. a delay of about 4 months — Note 56). According to HyD, it agreed the final proposal for KPIs in September 2022 and incorporated them under Contract H (see Note 55 in (a) above).

Note 55: *According to HyD, the agreed final proposals were mainly related to the format for compiling KPI statistics in monthly progress reports of the contractors.*

Note 56: *According to HyD, the poor performance of Contractor H in submission of a proposal for KPIs had been reflected in the relevant performance report of Contractor H.*

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4.15 In October 2022, HyD informed Audit that:

- (a) Contractors G and H were required to submit proposals for KPIs (including but not limited to those specified in Contracts G and H) for HyD's monitoring of their performance trends. Prior to the contractors' submission, HyD had discussed with the contractors on their proposals for KPIs and invited them to incorporate new KPI initiatives in their proposals on top of those specified in the contracts; and
- (b) although Contractors G and H submitted their proposals for KPIs in mid-June 2016 and August 2022 respectively (i.e. delays of about 2 and 4 months respectively), upon HyD's agreement on their proposals, Contractors G and H then compiled their KPI statistics to include information since contract commencement for HyD's monitoring of their KPI performance trends.

4.16 In Audit's view, HyD needs to take measures to ensure the timely submission of proposals for KPIs by the contractors of high speed road maintenance term contracts.

Scope for making better use of information technology for contract administration

4.17 Audit noted that:

- (a) HyD kept paper records of site audit checklists (for EAs conducted by its staff), NFs and DNs under Contracts G and H in files (i.e. manual records). Retrieval of related information for a particular road network (e.g. TMR) could only be performed manually by searching the relevant files. According to HyD:
 - (i) with a view to more effectively managing the workflow of submissions and checking for supervising M&M works (including the workflow for EAs and EIs) and enhancing record-keeping (e.g. for site audit checklists, NFs and DNs), HyD had started developing a new digital management system to further digitalise the supervision of road maintenance works; and

- (ii) the system development commenced in April 2022 for completion in the fourth quarter of 2022 for trial under one of the existing local road maintenance term contracts. Upon completion of the system development, the digital management system would be adopted under other road maintenance term contracts, including high speed road maintenance term contracts; and
- (b) according to HyD, regular inspections were conducted, and repair and maintenance works were carried out for roads and associated structures under its purview. The inspection records (e.g. identification of potholes and cracks, and defects of movement joints) and maintenance records (e.g. road resurfacing, rectification of defects and damage, and replacement of bearings) were stored in the Electronic Maintenance Management System (EMMS — Note 57). Audit noted that HyD had not regularly compiled management information (e.g. based on the inspection and maintenance records in EMMS) for monitoring the conditions of high speed roads (including TMR) and associated structures, and determining their maintenance strategy.

4.18 In Audit's view, HyD needs to:

- (a) take measures to ensure that the development of the new digital management system for the supervision of road maintenance works is completed as scheduled and keep under review its performance after adoption (including under high speed road maintenance term contracts); and
- (b) compile regular management information (e.g. based on the inspection and maintenance records in EMMS) for monitoring the conditions of high speed roads (including TMR) and associated structures, and determining their maintenance strategy.

Note 57: *EMMS is established and maintained by the contractors to facilitate planning, programming, inventory data collection, maintenance history recording, data storage, complaint handling, preparing management reports and retrieval of all aspects of the maintenance, inspection, remedial and repair works. The contractors should allow HyD unrestricted 24-hour access to EMMS for monitoring purpose.*

Audit recommendations

- 4.19 **Audit has *recommended* that the Director of Highways should:**
- (a) **continue to closely monitor the implementation progress of works orders to ensure their timely completion by the contractors of high speed road maintenance term contracts;**
 - (b) **expedite the assessments of EOT claims (e.g. reminding the contractors to timely serve notifications of EOT claims and provide information for claim assessments) and timely notify the contractors for the imposition of LD for overdue works orders under high speed road maintenance term contracts;**
 - (c) **take measures to improve the monitoring of defect rectification works carried out by the contractors of high speed road maintenance term contracts, including closely monitoring the implementation progress of defect rectification works and issuance of DNs to the contractors as needed;**
 - (d) **remind HyD staff to timely complete the endorsement process after receiving completion reports from the contractors of high speed road maintenance term contracts;**
 - (e) **take measures to ensure the timely submission of proposals for KPIs by the contractors of high speed road maintenance term contracts;**
 - (f) **take measures to ensure that the development of the new digital management system for the supervision of road maintenance works is completed as scheduled and keep under review its performance after adoption (including under high speed road maintenance term contracts); and**
 - (g) **compile regular management information (e.g. based on the inspection and maintenance records in EMMS) for monitoring the conditions of high speed roads (including TMR) and associated structures, and determining their maintenance strategy.**

Response from the Government

4.20 The Director of Highways agrees with the audit recommendations. He has said that:

- (a) HyD will continue to closely monitor the implementation progress of works orders under high speed road maintenance term contracts for their timely completion. It has requested the contractors of high speed road maintenance term contracts to include the latest status of works orders in monthly progress reports for monitoring;
- (b) HyD has reminded the contractors of high speed road maintenance term contracts to timely serve notifications of EOT claims and provide information for claim assessments. It has also reminded its staff to expedite the assessments of EOT claims and timely notify the contractors for the imposition of LD for overdue works orders under high speed road maintenance term contracts;
- (c) HyD will continue to closely monitor the implementation progress of defect rectification works by the contractors of high speed road maintenance term contracts. It has requested the contractors of high speed road maintenance term contracts to compile reports showing the latest progress of defect rectification works for monitoring in monthly progress meetings. It has also reminded its staff to issue DNs to the contractors as needed;
- (d) HyD has reminded its staff to timely complete the endorsement process after receiving completion reports from the contractors of high speed road maintenance term contracts;
- (e) HyD will update the relevant checklist to remind its staff to draw the contractors' attention, prior to the commencement of contracts, to the requirement of timely submission of proposals for KPIs under high speed road maintenance term contracts;
- (f) HyD has been closely monitoring the development progress of the new digital management system for the supervision of road maintenance works with a view to ensuring its completion by the fourth quarter of 2022 as scheduled for trial and will keep its performance under review; and

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- (g) HyD will compile regular management information (e.g. based on the inspection and maintenance records in EMMS) for monitoring the conditions of high speed roads (including TMR) and associated structures, and determining their maintenance strategy.

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4.21 TMR, with heavy daily traffic, is the trunk road connecting NWNT and the urban areas. TD is responsible for monitoring the traffic conditions of various major roads (including TMR), considering the need for road improvement projects and initiating necessary actions to obtain policy approval for the projects, and designing and implementing traffic management measures to ensure the efficient use of limited road space and to enhance road safety (see para. 1.10). Table 7 shows the annual average daily traffic volume of TMR (Note 58) from 2012 to 2021.

Table 7

**Annual average daily traffic volume of TMR
(2012 to 2021)**

Year	No. of vehicles
2012	102,240
2013	92,580
2014	94,530
2015	102,660
2016	123,250
2017	129,590
2018	129,160
2019	133,340
2020	127,640
2021	127,800

Source: TD records

Note 58: *This refers to the section of TMR from Sham Tseng to Tsing Long Highway. According to TD, this road section provides a broad understanding of the traffic conditions of TMR as it carries the highest annual average daily traffic volume and peak-hour traffic flow data for this road section is available in TD's Annual Traffic Census. Unless otherwise specified, all traffic volume and volume-to-capacity ratio of TMR mentioned in this Audit Report refer to the information for this section of TMR.*

Need to keep under review the traffic conditions of TMR and the traffic demand arising from the development of NWNT

4.22 According to TD, a volume-to-capacity ratio (v/c ratio) is an indicator of the traffic condition of a road:

- (a) a v/c ratio equal to or less than 1.0 means that a road has sufficient capacity to cope with the anticipated volume of vehicular traffic;
- (b) a v/c ratio above 1.0 indicates the onset of traffic congestion; and
- (c) a v/c ratio above 1.2 indicates more serious congestion with traffic speeds deteriorating progressively when there is further increase in traffic.

4.23 TMR was upgraded to the then prevailing expressway standards as far as practicable in order to improve the traffic flow and further enhance road safety (see para. 1.3(a)). Audit noted that:

- (a) from 2015 to 2021 (i.e. after the substantial completion of reconstruction and improvement works of TMR in December 2014), while the v/c ratios of TMR during the morning peak hour (both Kowloon and Tuen Mun bounds) and evening peak hour (Kowloon bound) were equal to or less than 1.03, the v/c ratios during the evening peak hour (Tuen Mun bound) had exceeded 1.0 since 2016 and generally increased to 1.12 in 2020 and 2021 (see Table 8). This indicated that TMR had been at the onset of traffic congestion (see para. 4.22(b)) since 2016;

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Table 8

v/c ratios of TMR
(2012 to 2021)

Year	Morning peak hour (Note 1)		Evening peak hour (Note 2)	
	Kowloon bound	Tuen Mun bound	Kowloon bound	Tuen Mun bound
2012	0.85	0.68	0.63	1.06
2013	0.74	0.58	0.59	0.97
2014	0.75	0.59	0.55	0.93
<i>After substantial completion of reconstruction and improvement works of TMR in December 2014</i>				
2015	0.82	0.65	0.58	0.90
2016	0.90	0.77	0.65	1.03
2017	0.94	0.83	0.70	1.11
2018	0.96	0.83	0.60	1.13
2019	1.03	0.85	0.70	1.09
2020	0.91	0.79	0.69	1.12
2021	0.92	0.92	0.58	1.12

Source: TD records

Note 1: Morning peak hour refers to the busiest one hour from 7 a.m. to 10 a.m. on weekdays (i.e. Mondays to Fridays, except public holidays).

Note 2: Evening peak hour refers to the busiest one hour from 4 p.m. to 7 p.m. on weekdays (i.e. Mondays to Fridays, except public holidays).

Remarks: The v/c ratios in this Table are derived from the data of the section of TMR from Sham Tseng to Tsing Long Highway in TD's Annual Traffic Census (see Note 58 to para. 4.21). At this road section, there are 4 traffic lanes on Kowloon bound and 3 traffic lanes on Tuen Mun bound.

- (b) according to TD, in the absence of new road infrastructure projects, the projected v/c ratio of TMR (between Tsing Lung Tau and Sham Tseng) during the morning peak hour in 2036 (Note 59) would reach 1.2 (i.e. more

Note 59: The projected v/c ratio of TMR (between Tsing Lung Tau and Sham Tseng) during the morning peak hour in 2036 was based on the forecast of the traffic impact assessment conducted under the feasibility study on Route 11, which was completed in late 2020. According to TD, the projected v/c ratio of TMR (between Tsing Lung Tau and Sham Tseng) during the evening peak hour in 2036 was less than 1.0 under the abovementioned traffic impact assessment.

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serious congestion with traffic speeds deteriorating progressively when there is further increase in traffic — see para. 4.22(c));

- (c) a traffic survey was conducted by HyD's consultant under the Tuen Mun-Chek Lap Kok Link (TM-CLKL — Note 60) project in 2021 after the commissioning of the northern connection of TM-CLKL in December 2020. The traffic survey showed that the traffic flows at the relevant major road sections in Tuen Mun (including TMR Town Centre Section and the slip road connecting to Wong Chu Road) had increased. According to TD, the increased traffic flows were due to the fact that these major road sections in Tuen Mun provided a more convenient access via TM-CLKL to North Lantau and the Hong Kong International Airport;
- (d) the Government planned to complete a series of road infrastructure projects (Note 61) in stages so as to enhance the internal and external connectivity of NWNT. Upon completion of these road infrastructure projects, the projected v/c ratios of major roads (including TMR) connecting NWNT and the urban areas during the morning peak hour in 2036 would generally be lower to not more than 1.0. For TMR (between Tsing Lung Tau and Sham Tseng), the projected v/c ratio during the morning peak hour in 2036 would be reduced from 1.2 to 1.1;

Note 60: *TM-CLKL provides a road connecting NWNT, the Hong Kong-Zhuhai-Macao Bridge, North Lantau and the Hong Kong International Airport. It comprises: (a) the southern connection, which connects the Hong Kong-Zhuhai-Macao Bridge Hong Kong Port and North Lantau via viaducts and was opened to the public in 2018 (urban bound in October 2018 and Tung Chung bound in November 2018); and (b) the northern connection, which connects Tuen Mun Area 40 and the Hong Kong-Zhuhai-Macao Bridge Hong Kong Port via a sub-sea tunnel and was opened to the public in December 2020.*

Note 61: *Examples of the road infrastructure projects are: (a) Route 11 (section between Yuen Long and North Lantau). The investigation study for this project commenced in September 2021 and was in progress as of August 2022; (b) Tuen Mun Bypass, which links up Lam Tei and Tuen Mun Area 40 as well as Tuen Mun-Chek Lap Kok Tunnel. The investigation study for this project commenced in March 2022 and was in progress as of August 2022; and (c) extension works to major roads in Tuen Mun (e.g. construction of the slip roads connecting Lung Fu Road to Tsing Wun Road and a slip road connecting TMR northbound to Hoi Wing Road westbound). The investigation study for this project commenced in September 2021 and was in progress as of August 2022.*

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- (e) according to the 2020 annual report of the Transport Complaints Unit (Note 62), complaints were received from some members of the public about frequent traffic congestion at TMR over the past years. In addition, in recent years (from 2019 to 2021), the traffic conditions (e.g. traffic congestion problem) of TMR were also discussed at the meetings of TMDC and its Traffic and Transport Committee from time to time;
- (f) TMR was a major road connecting NWNT and the urban areas. According to the 2019-based Territorial Population and Employment Data Matrix (Note 63) compiled by the Planning Department in 2021, the population in NWNT would increase by 22% from 1.15 million in 2019 to 1.40 million in 2031 while the employment in NWNT would increase by 34% from 0.29 million in 2019 to 0.39 million in 2031. The continuous growth in population and economic development of NWNT (e.g. Hung Shui Kiu New Development Area (Note 64) and public housing developments in Tuen Mun (Note 65)) would generate additional traffic demand and put further pressure on TMR; and

Note 62: *The Transport Complaints Unit was set up under the Transport Advisory Committee to receive and handle complaints and suggestions from the public on transport matters. The Transport Advisory Committee advises the Chief Executive-in-Council on broad issues of transport policy and major transport-related proposals to facilitate the continuous development of Hong Kong. As of September 2022, the Committee comprised a chairman and 17 members, including 3 government officials (i.e. representatives from TLB, TD and the Hong Kong Police Force).*

Note 63: *According to the Planning Department, the Territorial Population and Employment Data Matrix is updated regularly in about every two to three years to tie in with the updated population projections. It provides estimated data on territorial distributions of population and employment in the future years for use as reference materials by government departments and stakeholders involved in the planning of developments and services. It also serves as a basis for strategic transport modelling.*

Note 64: *According to the Government's website on the Hung Shui Kiu New Development Area: (a) upon full development, the development area will provide accommodation for a population of about 218,000 (including 176,000 new population) with the first population intake expected in 2024; and (b) the development area will also provide about 150,000 new employment opportunities.*

Note 65: *Examples of public housing developments in Tuen Mun are 4 projects (i.e. Sites 1 and 1A, Sites 3 and 4 (East), Site 4A (South) and Site 5) in Tuen Mun Area 54 and 1 project in Tuen Mun Area 29 West.*

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- (g) in this connection, in December 2020, TD engaged a consultant to conduct a “Strategic Study on Major Roads beyond 2030 — Feasibility Study” (hereinafter referred to as the strategic study). The strategic study (Note 66) commenced in December 2020 for completion in March 2023. According to TD:
- (i) the strategic study would take into account the traffic demand of NWNT and the Northern Metropolis, and TMR was one of the major roads covered in the strategic study; and
 - (ii) it planned to consolidate the preliminary findings of the strategic study and commence consultation in the second half of 2022.

4.24 In October 2022, TD informed Audit that:

- (a) it had proactively adopted multifaceted approaches to handle traffic and transport issues at TMR and had been closely monitoring the traffic conditions of TMR so as to provide continuous enhancements to the road markings/traffic signs and take forward local traffic improvements timely in response to local demand and changes in traffic patterns since the commissioning of major road infrastructures (Note 67). TD had also

Note 66: *The strategic study would explore the layout of territory-wide major road infrastructure and conduct preliminary engineering and technical assessments for the alignments and supporting facilities, so as to ensure that the related planning would complement or even have reserve capacity to meet the overall long-term development needs of Hong Kong, including the Northern Metropolis Development Strategy, etc. The strategic study would also review the impacts of the related transport infrastructure on the existing transport network and formulate the corresponding strategies.*

Note 67: *According to TD: (a) given that the traffic flows at TMR Town Centre Section had increased since the commissioning of the northern connection of TM-CLKL (see para. 4.23(c)), it installed additional directional signs at appropriate locations and arranged junction widening works to encourage motorists to use alternative driving routes to gain access to the northern connection of TM-CLKL. Extension works to major roads in Tuen Mun would be carried out to facilitate smoother traffic to the northern connection of TM-CLKL; and (b) widening of Castle Peak Road — Castle Peak Bay project was in progress for tentative completion in 2024. The project would enhance the effectiveness of Castle Peak Road in easing traffic (including that of TMR) and cope with the future traffic demand in Tuen Mun.*

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completed enhancements of various traffic facilities and implemented smart mobility initiatives (Note 68); and

- (b) for all development projects where traffic impact on TMR was anticipated, project proponents should submit traffic impact assessments to assess the traffic impact arising from development traffic with due consideration to other projects under planning, and implement the necessary road improvement measures to mitigate the traffic impact.

4.25 In Audit's view, TD needs to keep under review the traffic conditions of TMR and the traffic demand arising from the development of NWNT (including findings from related studies), and take appropriate traffic management measures (e.g. road improvement works and road infrastructure projects) with a view to improving the traffic conditions of TMR.

4.26 As HyD is the works agent responsible for implementing the road infrastructure projects in NWNT mentioned in paragraph 4.23(d), Audit considers that HyD needs to keep under review the implementation progress of these projects with a view to enhancing the internal and external connectivity (via major roads including TMR) of NWNT.

Note 68: *According to TD, examples of these enhancements and initiatives are as follows: (a) it had developed a Traffic and Incident Management System in end-2017 to enhance the efficiency and effectiveness in handling traffic incidents (e.g. emergency repair works, fallen trees, traffic accidents, vehicle breakdown and watermain burst) in major roads. The system was operated round-the-clock for monitoring traffic situation in the territory (including TMR), liaising with relevant parties for incident handling and disseminating real-time traffic and public transport news to the public; and (b) it completed the installation of a total of 1,200 traffic detectors on all strategic routes and major roads (of which 80 were located at TMR) in end-2020 to collect real-time traffic information so as to strengthen its capability in handling traffic incidents as well as traffic management. The traffic data collected were being disseminated through the journey time indication system, speed map panels (one of them was installed at TMR), mobile application "HKeMobility" and the Public Sector Information Portal for the convenience of pre-trip planning.*

Scope for further enhancing road safety of TMR

4.27 As mentioned in paragraph 4.23, TMR was upgraded to improve the traffic flow and further enhance road safety. Audit noted that:

- (a) as shown in Table 9, while the number of traffic accidents on TMR generally decreased from 231 in 2012 to 163 in 2015 (i.e. the first year after the substantial completion of reconstruction and improvement works of TMR in December 2014), it increased to 263 in 2019 and then decreased to 246 in 2021. In addition, while the number of casualties on TMR decreased from 398 in 2012 to 282 in 2016 (i.e. the second year after the substantial completion of reconstruction and improvement works of TMR), it increased to 402 in 2019 and then decreased to 369 in 2021. The percentage of killed and seriously injured casualties (Note 69) decreased from 12.8% in 2012 to 9.4% in 2015 (i.e. the first year after the substantial completion of reconstruction and improvement works of TMR) and then fluctuated during the period from 2016 to 2021, ranging from 8.1% (in 2021) to 15.7% (in 2020);

Note 69: *According to TD's terminology in traffic accident statistics: (a) "killed" refers to sustained injury causing death within 30 days of the accident; (b) "seriously injured" refers to an injury for which a person is detained in hospital as an "in-patient" for more than 12 hours. Injuries causing death more than 30 days after the accident are also included in this category; and (c) "slightly injured" refers to an injury of a minor character such as a sprain, bruise or cut not judged to be severe, or slight shock requiring roadside attention and detention in hospital is less than 12 hours, or not required.*

Table 9

Traffic accidents and casualties on TMR
(2012 to 2021)

Year	No. of traffic accidents (a)	No. of casualties by degree of injury				Percentage of killed and seriously injured casualties (f) = $\frac{(b) + (c)}{(e)} \times 100\%$
		Killed (b)	Seriously injured (c)	Slightly injured (d)	Total (e) = (b) + (c) + (d)	
2012	231	2	49	347	398	12.8%
2013	235	3	42	331	376	12.0%
2014	187	–	40	301	341	11.7%
<i>After substantial completion of reconstruction and improvement works of TMR in December 2014</i>						
2015	163	–	28	269	297	9.4%
2016	181	1	42	239	282	15.2%
2017	225	1	34	345	380	9.2%
2018	256	1	34	355	390	9.0%
2019	263	1	42	359	402	10.7%
2020	250	2	57	317	376	15.7%
2021	246	1	29	339	369	8.1%

Source: TD records

- (b) as shown in Table 10, while the accident rate per million vehicle-km (Note 70) for TMR generally decreased from 0.38 in 2012 to 0.25 in 2016 (i.e. the second year after the substantial completion of reconstruction and improvement works of TMR), it increased to 0.36 in 2018 and then decreased to 0.34 in 2021. In addition, from 2012 to 2021, the accident rates for TMR for each year (except for 2016) were higher than those of all major roads selected by TD. The accident rates for TMR were much

Note 70: According to TD, the accident rate per million vehicle-km normalises the accident figures against the traffic flow and distance travelled, and is calculated as follows:

$$\frac{\text{No. of personal injury accidents over the latest 12-month period}}{\text{Annual traffic flow} \times \text{Length of road in km} \div 1,000,000}$$

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lower than the territory-wide figures for all roads from 2012 to 2021 (ranging from 1.14 to 1.28) and remained steady around 0.34 to 0.36 between 2018 and 2021; and

Table 10

**Accident rates per million vehicle-km
(2012 to 2021)**

Year	TMR	All selected major roads (Note)	All roads
2012	0.38	0.27	1.28
2013	0.38	0.27	1.25
2014	0.30	0.24	1.23
2015	0.25	0.23	1.22
2016	0.25	0.27	1.18
2017	0.32	0.28	1.15
2018	0.36	0.25	1.14
2019	0.35	0.27	1.15
2020	0.35	0.24	1.14
2021	0.34	0.27	1.26

Source: TD records

Note: TD disseminated the accident rates per million vehicle-km for the selected 17 major roads in Hong Kong from 2012 to 2014. Examples of these major roads were TMR, Yuen Long Highway, San Tin Highway, Island Eastern Corridor, Tolo Highway, Kwun Tong Bypass, West Kowloon Highway, Tsing Sha Highway, Cheung Tsing Highway, and North Lantau Highway and Lantau Link (with accident rate presented together). Since 2015, the accident rates for North Lantau Highway and Lantau Link have been presented separately and thus the number of selected major roads has increased to 18.

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- (c) according to TD:
- (i) the occurrence of traffic accidents on TMR during the period from 2016 to 2021 was mainly attributed to driver contributory factors (e.g. driving inattentively, driving too close to vehicle in front and careless lane changing) (Note 71);
 - (ii) it conducted routine accident blacksites investigation and identified accident clusters at a section of TMR (Tuen Mun bound) near a residential development. Accordingly, it proposed and implemented additional traffic signs “bend ahead and reduce speed” to remind motorists to pay attention to the road environment and slow down with a view to improving road safety; and
 - (iii) it carried out speed limit reviews at TMR (Note 72) to ensure that the prevailing speed limit of TMR was optimum having regard to safety and engineering considerations.

4.28 In Audit’s view, TD needs to keep under review the safety performance of TMR and implement appropriate improvement measures (e.g. additional traffic signs and road markings) with a view to further enhancing road safety of TMR.

Note 71: *According to TD, its traffic accident statistics database has data fields related to different contributory factors of traffic accidents, namely driver contributory factors, casualty contributory factors, vehicle contributory factors and environment contributory factors. According to TD’s database, of the total 1,421 traffic accidents on TMR occurred during the period from 2016 to 2021: (a) 1,298 (91.3%) were caused by driver contributory factors (206 (15.9%) of 1,298 were also caused by other contributory factors); (b) 41 (2.9%) were caused by casualty contributory factors (2 (4.9%) of 41 were also caused by other contributory factors); (c) 6 (0.4%) were caused solely by vehicle contributory factors; (d) 9 (0.7%) were caused solely by environment contributory factors; and (e) 67 (4.7%) did not involve any of the above four contributory factors.*

Note 72: *Since 2014, TD conducted speed limit reviews for three road sections of TMR and recommended to retain the existing speed limits of those respective road sections under review taking into account of various factors, including traffic accident rates, prevailing travelling speed of vehicles and road characteristics.*

Audit recommendations

4.29 **Audit has *recommended* that the Commissioner for Transport should keep under review:**

- (a) **the traffic conditions of TMR and the traffic demand arising from the development of NWNT (including findings from related studies), and take appropriate traffic management measures (e.g. road improvement works and road infrastructure projects) with a view to improving the traffic conditions of TMR; and**
- (b) **the safety performance of TMR and implement appropriate improvement measures (e.g. additional traffic signs and road markings) with a view to further enhancing road safety of TMR.**

4.30 **Audit has *recommended* that the Director of Highways should keep under review the implementation progress of the road infrastructure projects in NWNT mentioned in paragraph 4.23(d) with a view to enhancing the internal and external connectivity (via major roads including TMR) of NWNT.**

Response from the Government

4.31 **The Commissioner for Transport agrees with the audit recommendations in paragraph 4.29.**

4.32 **The Director of Highways agrees with the audit recommendation in paragraph 4.30. He has said that HyD will keep under review the implementation progress of the road infrastructure projects in NWNT mentioned in paragraph 4.23(d).**

Acronyms and abbreviations

APE	Approved project estimate
Audit	Audit Commission
BQ	Bills of Quantities
CEDD	Civil Engineering and Development Department
CLC	Community liaison centre
DEVB	Development Bureau
DNs	Default notices
EAs	Engineer's audits
EIs	Engineer's inspections
EMMS	Electronic Maintenance Management System
EOTs	Extensions of time
FC	Finance Committee
HyD	Highways Department
km	kilometre
KPIs	Key performance indicators
LCSD	Leisure and Cultural Services Department
LD	Liquidated damages
LegCo	Legislative Council
m	metre
mm	millimetre
M&M works	Management and maintenance works
NFs	Notification forms
NWNT	Northwest New Territories
TCSS	Traffic control and surveillance system
TD	Transport Department
TLB	Transport and Logistics Bureau
TMDC	Tuen Mun District Council
TMR	Tuen Mun Road
TM-CLKL	Tuen Mun-Chek Lap Kok Link
VOs	Variation orders
v/c ratio	Volume-to-capacity ratio