

CHAPTER 10

Highways Department

Road improvement works

**Audit Commission
Hong Kong
23 October 2004**

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.

Report No. 43 of the Director of Audit contains 11 Chapters which are available on our website at <http://www.info.gov.hk/aud/>

Audit Commission
26th floor, Immigration Tower
7 Gloucester Road
Wan Chai
Hong Kong

Tel : (852) 2829 4210
Fax : (852) 2824 2087
E-mail : enquiry@aud.gov.hk

ROAD IMPROVEMENT WORKS

Contents

	Paragraph
PART 1: INTRODUCTION	1.1
Background	1.2 – 1.3
Audit review	1.4 – 1.5
Acknowledgement	1.6
PART 2: MANAGEMENT OF ROAD IMPROVEMENT CONTRACTS	2.1
Completion of road improvement contracts	2.2 – 2.3
<i>Audit observations</i>	2.4 – 2.7
<i>Audit recommendation</i>	2.8
Response from the Administration	2.9 – 2.10
Accuracy of approved project estimates	2.11 – 2.14
<i>Audit observations</i>	2.15 – 2.16
<i>Audit recommendations</i>	2.17
Response from the Administration	2.18 – 2.19
PART 3: WIDENING OF TOLO HIGHWAY	3.1
Contract A works	3.2 – 3.4
Difficulties encountered during piling works	3.5 – 3.11
<i>Audit observations</i>	3.12 – 3.14
<i>Audit recommendation</i>	3.15
Response from the Administration	3.16 – 3.17

	Paragraph
Road reconstruction works	3.18 – 3.25
<i>Audit observations</i>	3.26 – 3.27
<i>Audit recommendations</i>	3.28
Response from the Administration	3.29
Management of variation orders	3.30
<i>Audit observations</i>	3.31 – 3.34
<i>Audit recommendations</i>	3.35 – 3.36
Response from the Administration	3.37 – 3.38
 PART 4: IMPROVEMENT TO TUEN MUN ROAD	 4.1
Contract B works	4.2 – 4.3
Additional slope stabilisation works	4.4 – 4.7
Additional works for reinforced earth walls	4.8 – 4.11
<i>Audit observations</i>	4.12 – 4.14
<i>Audit recommendation</i>	4.15
Response from the Administration	4.16 – 4.17
 PART 5: ENTRUSTED WATER MAINS WORKS	 5.1
Contract C works	5.2 – 5.3
Removal of asbestos cement water mains	5.4 – 5.7
<i>Audit observations</i>	5.8 – 5.11
<i>Audit recommendations</i>	5.12 – 5.13
Response from the Administration	5.14 – 5.15

	Paragraph
PART 6: ADDITIONAL UTILITY WORKS	6.1
Contract D works	6.2
Problems encountered during construction of Contract D works	6.3 – 6.7
<i>Audit observations</i>	6.8 – 6.11
<i>Audit recommendations</i>	6.12 – 6.13
Response from the Administration	6.14 – 6.16

	Page
Appendices	
A: Road improvement contracts with extended contract periods	47
B: Analysis of total EOT granted to contractors	48
C: Comparison of estimated contract sum in APE with contract sum of accepted tender of recent major contracts	49
D: Chronology of key events	50 – 53
E: Acronyms and abbreviations	54

PART 1: INTRODUCTION

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

Background

1.2 Hong Kong's roads are among the most heavily used in the world with over 520,000 vehicles on 1,928 kilometres of roads. Dense urban development, growth of new towns and sustainable activity continue to place heavy demands on Hong Kong's road network. The Government has to continue reviewing and developing the road network to support future development needs. This involves improving the existing road network, such as widening and/or realigning the roads (hereinafter referred to as road improvement works) in addition to building new roads.

1.3 *Administrative framework.* The Environment, Transport and Works Bureau (ETWB) is responsible for, among others, the overall policy formulation, direction and coordination of land transport. The Transport Department is responsible for considering the need for road improvement projects and initiating necessary action to obtain policy approval for the projects. The Highways Department (HyD) is responsible for the planning, design, and construction of the road improvement works. The design and/or works supervision are either undertaken by in-house staff or consultants.

Audit review

1.4 The Audit Commission (Audit) recently carried out a review of the road improvement works administered by the HyD. The review focused on road improvement works with individual contract value of over \$100 million completed within the three-year period 1 January 2001 to 31 December 2003. There were eight such contracts, with a total value of \$2,750 million (see Table 2 in para. 2.4). The review did not cover contracts for building new roads.

1.5 The audit has found that there is scope for improvement in contract administration and project implementation of road improvement works.

Acknowledgement

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

PART 2: MANAGEMENT OF ROAD IMPROVEMENT CONTRACTS

2.1 This PART examines road improvement works with individual contract value exceeding \$100 million completed by the HyD from 1 January 2001 to 31 December 2003.

Completion of road improvement contracts

2.2 From 1 January 2001 to 31 December 2003, the HyD certified the completion of eight major road improvement contracts. Table 1 shows the number of road improvement contracts with extended contract periods. The details of the extension from the original contract completion date to the certified completion date are given in Appendix A.

Table 1

Road improvement contracts with extended contract periods

Extension of contract period (Note)	No. of contract(s)	Percentage
> 12 months	2	25.0%
> 6 to $\leq$ 12 months	3	37.5%
> 3 to $\leq$ 6 months	1	12.5%
$\leq$ 3 months	1	12.5%
None	1	12.5%
Total	8	100.0%

Source: HyD records

Note: Extension of contract periods due to inclement weather was not taken into account.

2.3 In August 2004, in response to Audit's enquiry about the monitoring of timely completion of contracts, the HyD informed Audit that:

- (a) there were inherent risks associated with civil engineering works, especially for the road improvement works where substantial foundation works, slope works and underground works were involved;
- (b) detailed risk assessments were carried out for major projects and contingencies were allowed for such risks. The current form of works contract also allowed the issue of variation orders which were necessary and desirable for the completion of the works;
- (c) extension of time (EOT) to the original contract completion date had to be allowed for due to inclement weather, third party interferences such as those caused by utility companies, and unforeseen circumstances necessitating the issue of variation orders; and
- (d) the HyD held Highways Department Programme Management Meetings to discuss key issues of all major projects with a view to ensuring that all major projects were well planned and progressed according to their latest programmes.

Audit observations

2.4 Road improvement works usually require temporary closure of traffic lanes, which would cause inconvenience to road users and the public. Therefore, any prolonged completion of road improvement works is undesirable. According to Table 1, the contract periods of five contracts were extended for more than six months. Audit has found that the HyD granted EOT to contractors of seven contracts and paid and/or assessed prolongation cost in six contracts, as shown in Table 2. **Audit considers that the HyD should make continued efforts to improve its project management to achieve, as far as possible, the timely completion of works.**

Table 2
Extension of time and prolongation cost

Extension of contract period	Original contract sum	Original contract period	EOT granted (Note 1)	Prolongation cost paid/ assessed
	(\$ million)	(days)	(days)	(\$ million)
> 12 months				
Tolo Highway Contract (hereinafter referred to as Contract A)	860.0	980	613.0	84.3 (Note 2)
Victoria Road Contract (hereinafter referred to as Contract D)	119.4	912	318.5	8.5 (Note 2)
> 6 to ≤ 12 months				
Hiram's Highway Contract	138.9	970	272.5	9.4 (Note 2)
Tuen Mun Road Contract (hereinafter referred to as Contract B)	268.0	700	217.0	18.7 (Note 3)
Pok Fu Lam Road Contract (hereinafter referred to as Contract C)	258.0	850	242.0	16.3 (Note 2)
> 3 to ≤ 6 months				
Fo Tan Road Contract	303.0	945	171.5	10.5 (Note 2)
≤ 3 months				
Eastern Corridor Contract	688.0	960	20.0	(Note 2)
None				
Shap Pat Heung Contract	114.7	792	Nil	(Note 2)
Total	2,750.0		1,854.5	147.7

Source: HyD records

Note 1: The EOT granted did not include those days granted due to inclement weather (see Appendix B for total EOT granted).

Note 2: As at 31 July 2004, the final payment certificate was not yet issued.

Note 3: In addition to the prolongation cost, the HyD also paid a disruption cost of \$13.4 million to the contractor.

2.5 Audit noted that the major factors affecting progress of the works were variations, adverse weather conditions, existence of uncharted underground utilities, unforeseen ground conditions, and other factors such as restrictions on temporary traffic arrangements. Table 3 is an analysis of the total EOT granted under the eight contracts due to the above factors (see Appendix B for details).

Table 3
Analysis of extension of time granted

EOT granted (Note 1) due to	No. of contract(s) (out of the 8 contracts)	Total EOT granted (days)
Variations of works	7	1,531.0 (Note 2)
Inclement weather	8	930.0
Underground utility	3	162.0
Ground conditions	1	95.0
Others	5	66.5

Source: HyD records

Note 1: The HyD granted EOT only for dominant events. Many overlapping events were not separately assessed for EOT.

Note 2: The figure included 440 days of EOT assessed under a supplemental agreement for overall settlement of claims.

2.6 During construction, amendments to the planned works might be necessary in order to cater for changes in requirements. These amendments were effected through variations of works ordered under the terms of the contracts or supplemental agreements to the contracts. **Audit considers that substantial contract variations are undesirable as such variations would invariably have both cost and time implications, such as EOT and prolongation costs that would have to be granted or paid.**

2.7 Audit selected four contracts (i.e. Contracts A, B, C and D — see Table 2 in para. 2.4) for in-depth examination. Audit has found that there is room for improvement in project implementation and contract administration. The details are given in PART 3 to PART 6 of this Report.

Audit recommendation

2.8 **Audit** has *recommended* that the **Director of Highways** should make continued efforts in the project planning, contract preparation and management of road improvement works to minimise the need for issuing substantial contract variation orders and, as a consequence, granting of extension of time during the construction stage.

Response from the Administration

2.9 The **Director of Highways** generally agrees with the audit recommendation mentioned in paragraph 2.8. He has said that:

- (a) substantial variations that have time and financial consequences should be avoided as far as possible;
- (b) the HyD accepts that there is room for improvement in project implementation and contract administration. In fact, in recent major road works contracts, the HyD has taken proactive action in identifying asbestos cement pipes, making allowance in the contracts for risks in connection with foundation works and catering for non-availability of site for survey in expressways;
- (c) in general, before tendering of any road works contract, the HyD will undertake extensive surveys and site investigation works. However, there are practical limitations brought about by the need to avoid disruption to traffic, difficulties of access, non-availability of land and delay to commencement of the contracts. Therefore, engineering judgment must be used to strike the right balance. In these circumstances, contract variations may be inevitable; and
- (d) in some circumstances, contract variations are also necessary as a consequence of equitable sharing of risks in civil engineering contracts and for improving the design or modifying requirements for the overall benefit of the projects.

2.10 The **Secretary for the Environment, Transport and Works** has said that:

- (a) it is recognised as a widely accepted international practice that an equitable allocation of risks between the employer and the contractor is critical to successful project implementation. Putting all the risks onto the contractor will only result in hidden cost elements driving the tender prices upward;

- (b) on this basis, there are provisions in virtually all standard conditions of the contract, adopted by major national and international jurisdictions, compensating the contractors for contract variations in the form of EOT and/or additional payment when risk elements not allocated to them materialise during the construction period. As a result, it is not uncommon that construction contracts end up having longer construction periods and costing more than the awarded tender prices;
- (c) whilst a comparison of the original contract period and awarded tender price with the actual time for completion and additional payment in the form of prolongation costs could provide some indications of the quality of project management, it is more important to ensure that there is no failure in complying with administrative procedures resulting in additional time and cost;
- (d) the ETWB has recently reviewed the risk allocation policy, the procurement approaches and cost reduction initiatives. The following technical circulars have been issued, which are relevant to this subject:
 - (i) ETWB Technical Circular (Works) No. 17/2004 of June 2004 “Impossibility/Unforeseen Ground Conditions/Utility Interference” (Note 1); and
 - (ii) ETWB Technical Circular (Works) No. 23/2004 of July 2004 “Right of Employer to terminate for convenience and risk allocation with respect to changes in law”; and
- (e) to better control changes originated from client departments, in October 2003, the ETWB promulgated ETWB Technical Circular (Works) No. 30/2003 “Control of Client-Initiated Changes for Capital Works Projects” requiring that all changes in policy, user requirements or timing of the project, etc. should be submitted via a senior official in the Client Policy Bureau.

Accuracy of approved project estimates

2.11 Upon the approval of funding by the Finance Committee, the approved project estimate (APE) of a works project becomes the project’s expenditure ceiling. The APE of a works project usually comprises an estimated sum for the works contract (i.e. the estimated contract sum), an estimated sum for other costs (if any), and a reserve for contingency

Note 1: *This circular provides guidelines on risk management with respect to physical and legal impossibilities, unforeseen ground conditions and interference of utility works.*

(usually 5% to 10% of the APE). After tendering, the price of the successful tender becomes the awarded contract sum, which can be different from the estimated contract sum included in the APE. Hence, project proponents should estimate the project cost accurately to avoid over-estimation of the APE.

2.12 In January 2000, the then Secretary for Works (Note 2) expressed concern about the persistent over-estimation of the APEs in works projects against the tenders awarded and the magnitude of the over-estimation. The Secretary for Works requested the works departments:

- (a) to take measures to improve the accuracy of the project estimates before preparing the Public Works Subcommittee papers for funding approval; and
- (b) to suitably adjust the APE and the cashflow projections of a project, if necessary, when the tender price was much lower than the approved estimate.

In January 2001, in order to improve the accuracy of the project estimates, the HyD issued HyD Technical Circular (HyDTC) No. 2/2001 “Vetting Committee on Project Estimates and Consultants’ Performance Appraisal” (Note 3). The circular announced the establishment of a committee to vet project and pre-tender estimates and set out additional monitoring and control measures for improving the accuracy of project and pre-tender estimates.

2.13 In the Director of Audit’s Report No. 42 of March 2004, Audit reported on the need to improve the accuracy of the APEs for works contracts of the Drainage Services Department and made recommendations for improvement. The Administration generally agreed with the audit recommendations. The Financial Services and the Treasury Bureau (FSTB) said that, apart from reducing the APE, the FSTB had put in place measures to ensure proper control and use of funding under the APE. The measures were as follows:

Note 2: *With the introduction of the accountability system in July 2002, the responsibility of the Secretary for Works was taken up by the Secretary for the Environment, Transport and Works.*

Note 3: *HyDTC No. 2/2001 was superseded by HyDTC No. 4/2003, which is still in force, issued in June 2003 on the same subject.*

- (a) if the outturn tender price was lower than the approved estimate, the FSTB would administratively adjust downward the capital resources allocated to the project. The lower spending limit would become the administrative cap on the project expenditure. Works departments should not expend beyond the administrative cap unless with full justifications and approval by the FSTB (Note 4); and
- (b) as part of the annual resource allocation exercise, works departments would update the cashflow requirement for works projects in the light of planning development and actual works progress and put forward realistic estimates on the funding required so as not to lock up valuable resources unnecessarily. Any savings from lower outturn expenditure would be reflected in the annual updating of project estimates.

2.14 After considering the Director of Audit's Report No. 42, the Public Accounts Committee, in its Report No. 42 of June 2004, considered that the heads of works departments were given too much discretionary power to decide whether or not to adjust the APE even when the accepted tender price was much lower than the estimated contract sum in the APE, especially when the APE might be used to cover huge sums of highly uncertain dispute settlements and contract variations. The Public Accounts Committee has recommended that the works departments should, under the following circumstances, inform the Legislative Council with full justifications:

- (a) when the difference between the accepted tender price and the estimated contract sum in the APE of a works project is \$15 million or more, irrespective of whether or not there will be any substantial variations in the contract cost that may warrant an adjustment of the APE and/or require the Finance Committee's approval of an increase in the APE to cover the ultimate outturn price; and
- (b) when the expenditure relating to dispute settlement under a works contract amounts to \$15 million or more.

Audit observations

2.15 Instances of over-estimating the APEs were also found in the HyD. The contract sums of the accepted tenders for seven out of the eight road improvement contracts were substantially lower than the estimated contract sums in the APEs, as shown in Table 4.

Note 4: *The administrative capping procedures have been adopted by the FSTB since mid-2002.*

Table 4

Over-estimation of contract sum in approved project estimate

Contract (Note 1)	Estimated contract sum in APE	Contract sum of accepted tender	Over-estimation/ (Under-estimation) of contract sum in APE	
	(a)	(b)	(c) = (a) - (b)	(d) = (c) / (a) × 100%
	(\$ million)	(\$ million)	(\$ million)	(%)
Tolo Highway Contract (i.e. Contract A)	2,206	860	1,346 (Note 2)	61 %
Shap Pat Heung Contract	195	115	80	41 %
Pok Fu Lam Road Contract (i.e. Contract C)	365	258	107	29 %
Fo Tan Road Contract	424	303	121	29 %
Hiram's Highway Contract	190	139	51	27 %
Tuen Mun Road Contract (i.e. Contract B)	350	268	82	23 %
Victoria Road Contract (i.e. Contract D)	147	119	28	19 %
Eastern Corridor Contract	640	688	(48)	(8 %)

Source: HyD records

Note 1: These contracts were awarded before the issue of HyDTC No. 2/2001 in January 2001.

Note 2: This was due to savings in a number of areas after completion of design review and refinements in January 1999 subsequent to the preparation of the estimate in mid-1998, and savings as a result of competitive tendering environment in early 1999. The Public Works Subcommittee of the Finance Committee was informed of the details in January 2003 in Information Paper PWSCI(2002-2003)38.

2.16 To improve the accuracy of the project estimates, in January 2001, following the issue of HyDTC No. 2/2001, the HyD set up a Vetting Committee on Project Estimates and Consultants' Performance Appraisal. In August 2004, the HyD provided Audit with a comparison of the estimated contract sum included in the APE with the contract sum of accepted tender of recent major contracts awarded after the setting up of the Vetting Committee. Audit noted that there were still cases of over-estimation ranging from 4.9% to 30.6% (see Appendix C for details). **Audit considers that continued efforts by the HyD are needed to improve the accuracy of the estimated contract sum included in the APE, and to comply with the promulgated guidelines of the FSTB and the ETWB on preparing project estimates.**

Audit recommendations

2.17 **Audit has recommended that the Director of Highways should make continued efforts:**

- (a) **to improve the accuracy of project estimates when seeking Finance Committee's funding approval; and**
- (b) **to comply with the promulgated guidelines of the FSTB and the ETWB on preparing project estimates.**

Response from the Administration

2.18 The **Director of Highways** generally agrees with the audit recommendations mentioned in paragraph 2.17. He has said that:

- (a) since the setting up of the Vetting Committee on Project Estimates, the accuracy of pre-tender contract estimates has been improved to generally within 5% to 20% of the tender sum and there are also significant improvement in the contract estimates of APEs; and
- (b) the APE is the sum of all the estimates for any number of contracts in a project, usually including design and supervision costs. The contracts may be implemented in stages throughout a number of years. In some cases, applications for APE are made long before the detailed design and contract documentation is finalised for the last contract in the project. The estimates for such contracts made at an early stage cannot be as robust as intended, whilst the actual lowest tender sum will depend on factors like prevailing market conditions as well as subsequent design development.

2.19 The **Secretary for the Environment, Transport and Works** agrees, in principle, to the need for accurate project estimates. She has said that:

- (a) market conditions are dynamic and change rapidly with time and economic situation. It is not realistic to expect individual project officers to be able to identify the tendering strategy of potential bidders, and prepare an estimate falling within a narrow margin of the awarded tender price; and
- (b) the most important issue is to ensure that no tangible resources are unnecessarily tied up as a result of the project estimates being higher than the awarded tender prices. The ETWB considers that the existing measures (see para. 2.13) taken by the Administration to ensure that this situation will not happen are effective.

PART 3: WIDENING OF TOLO HIGHWAY

3.1 This PART examines the extension of contract period for completion of Contract A.

Contract A works

3.2 In March 1999, the HyD awarded Contract A, in the sum of \$860 million (which included a contingency sum of \$120 million), for widening the section of Tolo Highway between Island House Interchange and Ma Liu Shui Interchange. The scope of works included, among others:

- (a) the widening of Tolo Highway from a dual 3-lane to a dual 4-lane carriageway; and
- (b) the widening of a vehicular bridge at Pak Shek Kok (hereinafter referred to as Bridge A – Note 5).

The contractor of Contract A (hereinafter referred to as Contractor A) commenced the works on 29 March 1999. The original contract completion date was 2 December 2001. A consultant (hereinafter referred to as Consultant A) carried out the design work. Consultant A was also the Engineer for Contract A (hereinafter referred to as Engineer A).

3.3 During construction, Contractor A lodged a number of claims. In May 2003, the HyD sought the FSTB's approval to formally enter into a supplemental agreement to settle all claims. In July 2003, after obtaining the approval, the HyD entered into a supplemental agreement with Contractor A. The supplemental agreement provided for:

- (a) an extension of the completion date to 30 June 2003 (i.e. a difference of 575 days compared to the original contract completion date) for completing the major works of Contract A together with the variations to noise barriers and other additional works; and

Note 5: *Contract A works also included the widening of another vehicular bridge, construction of the Northern Access to Pak Shek Kok development area which comprised an elevated slip road over Tolo Highway, drainage works, slope works, landscaping works, erection of noise barriers, reclamation works, etc.*

- (b) the settlement of claims and other outstanding issues at the final contract sum of \$717.5 million (Note 6).

In the event, Engineer A granted an additional 53 days of EOT (there was no prolongation cost for this additional EOT) to Contractor A to extend the completion date from 30 June 2003 to 22 August 2003, and certified the major works of Contract A as substantially completed on the extended date (i.e. a difference of 628 days compared to the original contract completion date).

3.4 According to the HyD, the major causes of granting of the EOT were as follows:

- (a) difficulties encountered during the piling works of Bridge A;
- (b) increases in road reconstruction works and modifications to drainage works; and
- (c) variations to noise barriers.

This PART focuses on the issues relating to items (a) and (b). The details are given in paragraphs 3.5 to 3.14 and paragraphs 3.18 to 3.27 respectively. (The issue relating to item (c), the noise barriers, was reported in the Director of Audit's Report No. 41 of October 2003).

Difficulties encountered during piling works

Investigation to assess ground conditions

3.5 In August 1997, Consultant A submitted to the HyD a ground investigation proposal for the detailed design of Contract A works. For the design of Bridge A piling works, Consultant A originally proposed to make four land drillholes, one at each of the four corners of the existing bridge. Subsequently, Consultant A made a judgment to sink one marine drillhole on the seaward side of Bridge A to replace the four land drillholes. In August 2004, upon Audit's enquiry, the HyD advised that:

- (a) the replacement marine drillhole was to minimise disturbance to the public. Owing to the accessibility problem along the expressway, a temporary traffic arrangement involving lane closure would be required for sinking the originally intended four land drillholes. However, for sinking of the marine drillhole, the

Note 6: *According to the HyD's submission to the FSTB in May 2003, this amount included an estimated sum of \$84.3 million for 562 days of potentially payable prolongation.*

access via the expressway could be avoided. Thus the traffic would not be affected; and

- (b) the purpose of the site investigation at the design stage was to obtain data for the foundation design. Having considered the design programme, the time required for the temporary traffic arrangement for carrying out the land drillholes, and the data obtained from the marine drillhole, Consultant A considered that sufficient data had been obtained for design purposes.

3.6 Consultant A completed the ground investigation for Contract A works in March 1998 and issued a final ground investigation report in October 1998. For Bridge A, the result of the marine drillhole indicated that the rockhead level (i.e. the possible founding level of the piles) on the seaward side of the bridge was at about 40 metres below the existing seabed surface.

Piling works of Bridge A

3.7 Under Contract A, bored piles were required to support Bridge A. Major works for constructing the bored piles of the bridge as provided for in Contract A were as follows:

- (a) installation of bored pile shafts;
- (b) breaking out obstructions (Note 7) during pile installation; and
- (c) drilling the bored piles each at least 0.5 metre into the bed rock to form a rock socket or to such a length as not to affect or be affected by adjacent piles (Note 8).

3.8 For the piling works, Contractor A was required under Contract A:

Note 7: *According to the Geotechnical Engineering Office Publication No. 1/96 on “Pile Design and Construction”, obstructions below ground in the form of man-made features or boulders and corestones are commonly encountered in old reclamations. According to the HyD, the extent of obstruction encountered during the excavation of piles was largely dependent on the spread of boulders or isolated layers of scattered rock at the site.*

Note 8: *A measurement item of socket length not exceeding 0.5 metre and another measurement item of socket length exceeding 0.5 metre, but not exceeding 1 metre, were included in the Bills of Quantities of Contract A.*

- (a) to carry out ground investigation by drilling boreholes at the location of each pile to identify the extent of possible obstruction and to determine the founding levels; and
- (b) based on the results of the ground investigation (hereinafter referred to as the pre-drilling results), to propose the tentative founding levels.

A note in a contract drawing for the piling works stated that “whenever obstruction is encountered, heavy chisel shall be used for breaking up to facilitate removal”.

3.9 Contractor A carried out the ground investigation as required. After assessing the pre-drilling results, Contractor A considered that the quantities of rock sockets and obstructions had increased significantly compared to the contract quantities (i.e. quantities stated in the Bills of Quantities). Contractor A considered it difficult and slow to use chisel to break rock and obstructions below the ground surface. In order to mitigate delay to the piling works, Contractor A proposed to adopt a modified method of construction, using reverse circulation drilling machines together with the conventional chisel/grab to excavate the obstructions.

3.10 Table 5 shows a comparison of the contract quantity and the final quantity for the obstructions and the rock sockets at Bridge A.

Table 5

Comparison of contract quantity and final quantity

Description	Contract quantity	Final quantity	Percentage increase
	(a)	(b)	$(c) = \frac{(b) - (a)}{(a)} \times 100\%$
	(metre)	(metre)	
Obstructions	115	322	180%
Rock sockets	17	107 (Note)	529%

Source: HyD records

Note: The increase was due to the significant increases in the actual lengths of the rock sockets (ranging from 0.5 metre to 12.5 metres) when compared to those stated in the Bills of Quantities (ranging from 0.5 metre to 1 metre).

3.11 Since July 2000, Contractor A lodged claims for EOT in respect of the substantial increase in the quantities. In December 2002, Engineer A issued a variation order to reimburse Contractor A for the cost of the additional works on rock sockets. Engineer A considered that the increased quantities of the obstructions and the rock sockets had caused an overall delay to Contract A. The HyD considered that Contractor A was entitled to EOT and prolongation cost. In July 2003, the HyD entered into a supplemental agreement with Contractor A (see para. 3.3). The supplemental agreement included, among others, settlement of the claim for EOT, prolongation cost and cost of using the reverse circulation drilling machines.

Audit observations

3.12 A thorough understanding of the ground conditions is a pre-requisite for the design of the piling works, including the determining of the lengths of piles into the bedrock, i.e. rock sockets. It is also important for ascertaining the extent of obstructions to piling works, particularly for piling works carried out on reclaimed land. This was because the obstructions could affect the works progress and the method of construction. According to the Geotechnical Engineering Office Publication No. 1/96, for piling works on reclaimed land, problems caused by obstructions are common.

3.13 There were significant increases in the quantities of the obstructions and the rock sockets, more than those allowed for in Contract A. The increases had caused an overall delay to the contract. The HyD had to grant EOT and pay prolongation cost to Contractor A.

3.14 In August 2004, upon Audit's enquiry about the extent of site investigation carried out during the design stage, the HyD advised that:

- (a) the purpose of the site investigation at the design stage was to obtain data for the foundation design. Based on the information about the rockhead levels from the marine drillhole, end-bearing type of bored piles founded on bedrock was adopted. It was expected that there would be variations in the obstructions, rockhead levels and rock socket lengths, but it was reasonably certain that variations would not affect the choice of pile type and the designed integrity of the foundation;
- (b) the actual amount of obstructions to the piling works could not be predicted accurately even with a drillhole at each and every pile because of the substantial difference in the size of the drillholes and the size of the piles. As such, the

quantity of the obstructions as included in the Bills of Quantities was a nominal quantity set at about 10% of the total length of the piles to be constructed; and

- (c) before the award of contract, it was expected that rock sockets longer than one metre would be required, given the requirement that a pile should not be founded at a level affecting or be affected by adjacent piles. Unless a drillhole was sunk at each pile location, the large local variation of rockhead levels at some individual pile groups resulting in longer rock sockets was an inherent risk that could not be predicted accurately. Nevertheless, a contingency sum totalling \$120 million had been allowed to cater for expected variations in obstructions and rock socket lengths, and other risks.

Audit recommendation

3.15 **Audit has recommended that, in order to minimise variations of works and the risk of delays in the construction stage, the Director of Highways should strengthen the site investigation measures in order to obtain, as far as possible, comprehensive and accurate information on the ground conditions before tendering. This is particularly important for the design and planning of:**

- (a) **foundation works, especially piling works carried out on reclaimed land; and**
- (b) **geotechnical works, including slope stabilisation works and excavation works.**

Response from the Administration

3.16 The **Director of Highways** agrees with the audit recommendation mentioned in paragraph 3.15 and will pay particular attention to the newly promulgated ETWB Technical Circular (Works) No. 17/2004 of June 2004 which gives guidelines on dealing with unforeseen ground conditions. He also agrees that variations during contract period would have time and financial consequences. He has said that, in Contract A:

- (a) to minimise the risk of variations, extensive site investigation works had been planned and carried out before the finalisation of the foundation design;
- (b) to avoid unnecessary disruption to traffic along Tolo Highway and to minimise delay to the commencement of contract, it was decided that some site investigation works had to be carried out after occupation of the site by the contractor; and

- (c) good engineering judgment was exercised to strike a balance as to the extent of site investigation works to be carried out before and after the award of a contract, and contingencies were allowed for in the contract sum to cover any unforeseen conditions.

3.17 The **Secretary for the Environment, Transport and Works** agrees that a comprehensive site investigation will generate more useful subsoil information for design purposes. This general principle has been elaborated in ETWB Technical Circular (Works) No. 17/2004 of June 2004 in the context of risk allocation between the employer and the contractor. She has said that:

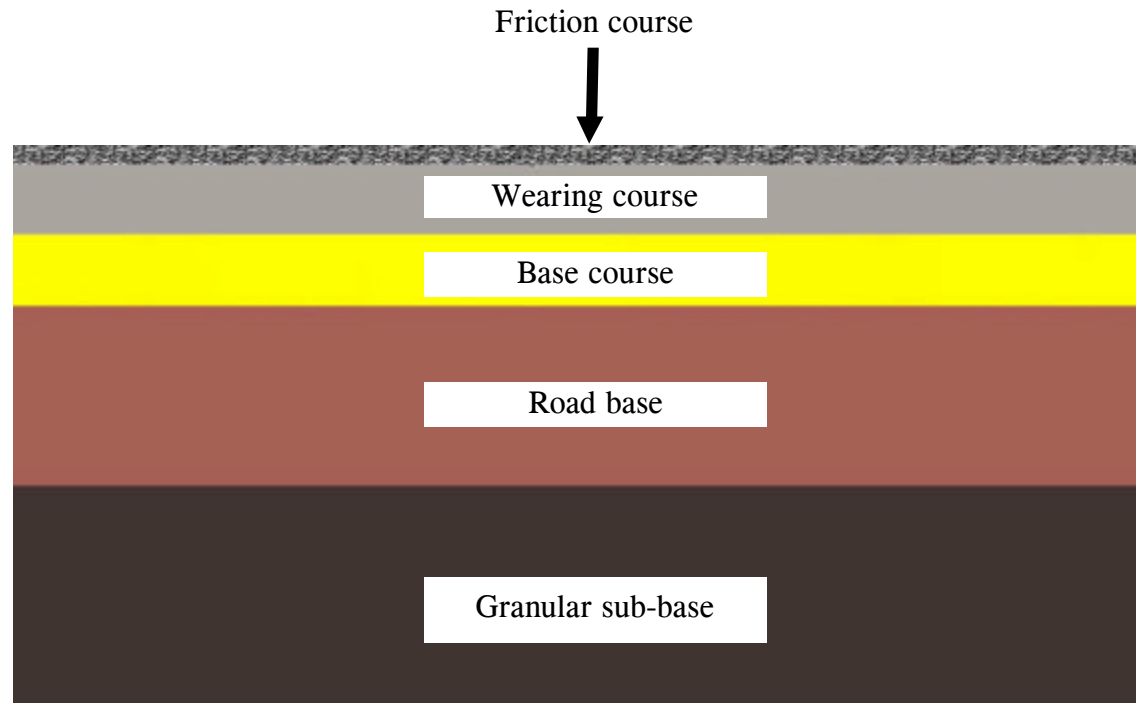
- (a) there is, however, a practical limit on the extent of site investigation works for a particular project, which is essentially a professional judgment exercised by the respective project team at the design stage. Unless a disproportionate amount of effort is spent on site investigation, changes made after the award of contract are almost inevitable given the general characteristic of the Hong Kong geological conditions; and
- (b) there is also a need to balance the time spent on site investigation before the award of a contract and contract extension due to subsoil variation in relation to the overall implementation time of the project. Design changes before the award of a contract to accommodate variations in subsoil conditions as revealed in the site investigation are normally translated into a longer contract period and higher costs. The overall implementation time may not be significantly different from the alternative of dealing with those subsoil variations not identified in the site investigation by extending the construction period.

Road reconstruction works

Typical layers of Tolo Highway pavement

3.18 The pavement of Tolo Highway is typically made up of five layers, namely a granular sub-base, a road base, a base course, a wearing course and a friction course. The sub-base, usually made up of granular material, is laid under the road base to strengthen it and to improve drainage. The road base and base course form the underlying layers for distributing the traffic loads to the sub-base. The wearing course provides a safe skid resistance surface, and is intended to withstand the effect of abrasion and stresses from traffic. As Tolo Highway is a high-speed road, a friction course is laid as the uppermost layer to reduce tyre noise and to improve skid resistance and surface drainage. Figure 1 shows the typical layers of Tolo Highway pavement.

Figure 1
Typical layers of Tolo Highway pavement



Source: HyD records

Road works requirements of Contract A

3.19 For the road works of Contract A, two major types of road works were required, as follows:

- (a) new pavement construction works: constructing pavement layers from granular sub-base to friction course; and
- (b) resurfacing works: milling of the existing carriageway surface and laying of new wearing and friction courses.

New pavement construction works were to be carried out on the widened part of Tolo Highway and resurfacing works were to be carried out on the existing carriageway. Contract A also specified pavement reinstatement works on those areas of the existing carriageway, which were excavated for underground works, such as drainage works, ducts, noise barriers foundations, etc.

Design profiles of the widened road

3.20 According to the Final Design Manual for Contract A works, the levels and alignment of the widened road were to follow those of the existing Tolo Highway. In August 2004, in response to Audit's enquiry, the HyD said that:

- (a) before the commencement of the detailed design, the HyD provided Consultant A with information on the as-built levels of Tolo Highway;
- (b) during the design stage, the Survey Section of the HyD carried out surveys along the kerbs of Tolo Highway (Note 9) to ascertain whether there were any discrepancies between the as-built information and the actual road profiles;
- (c) based on the available information, including the results of the additional kerbside surveys, the existing road profiles of the carriageway were deduced by Consultant A; and
- (d) Consultant A designed the road profiles of the widened road based on the deduced road profiles.

Revisions of pavement construction

3.21 ***Pavement reconstruction to replace reinstatement.*** In July 2000, Engineer A issued a variation order to revise some of the road works. The changes included carrying out full lane reconstruction (i.e. carrying out new pavement construction works — see para. 3.19(a)), instead of local trench reinstatement over drainage trenches and noise barriers foundations (Note 10). In August 2000, Contractor A lodged a claim for EOT and prolongation cost.

Note 9: *The HyD advised that only limited site surveys could be carried out during the design stage to avoid serious traffic disruption to Tolo Highway which was an operating expressway. As such, the Survey Section of the HyD carried out surveys along the kerbs of Tolo Highway. The surveys were carried out from February 1997 to July 1997.*

Note 10: *In August 2004, upon Audit's enquiry, the HyD said that the change of requirement was a design improvement. Local trench reinstatement of the existing carriageway might result in irregular road surfaces affecting road safety and the road pavements might require frequent maintenance. It was therefore preferable to carry out full lane reconstruction, instead of local trench reinstatement.*

3.22 ***Pavement reconstruction due to road level problems.*** In September 2000, Engineer A informed the HyD that site surveys of the existing road levels of Tolo Highway had been completed (Note 11). The site surveys found that the existing road levels at some locations were below the design road levels of the widened road. The HyD considered that the differences were most likely due to settlement of the existing carriageway after the as-built drawings were prepared. The HyD noted that in some sections of the road, the existing pavements had to be reconstructed (i.e. carrying out new pavement construction works —see para. 3.19(a)) instead of resurfaced due to the need to match with the adjacent new pavements.

3.23 In November 2000, Engineer A issued a variation order to Contractor A requiring him to reconstruct some of the existing pavements instead of resurfacing them. In the same month, Contractor A informed Engineer A that:

- (a) it would take more time to reconstruct the pavement than to resurface the pavement of the same area; and
- (b) the changes of the road works would cause delay to the works.

In January 2002, Engineer A issued a variation order (Note 12) revising the works instructed under the variation order issued in November 2000. A significant portion of the pavement reconstruction works previously ordered was reverted back to resurfacing works. Contractor A carried out the pavement works as ordered.

3.24 ***Quantities of new pavement construction.*** Table 6 shows the quantities of the new pavement construction carried out and the quantities of the works stated in Contract A. There was a net increase of nearly 20%.

Note 11: *According to the HyD, the site surveys were jointly carried out by Engineer A and Contractor A intermittently between June 1999 and June 2000. The joint surveys were required for record and measurement purposes.*

Note 12: *In this variation order, the original type of resurfacing works (see para. 3.19(b)) was revised and differentiated into different types of resurfacing works with different thickness of base course and road base.*

Table 6
Quantities of new pavement construction

New pavement construction	Final quantity	Contract quantity	Increase/ (Decrease)
	(a)	(b)	(c) = (a) - (b)
	(square metre)	(square metre)	(square metre)
1. New pavement for road widening	84,628	86,732	(2,104)
2. Pavement reconstruction to replace reinstatement (see para. 3.21 —Note)	16,640	—	16,640
3. Pavement reconstruction due to road level problems (see para. 3.22)	2,625	—	2,625
Total	103,893	86,732	17,161

Source: HyD records

Note: According to the Bills of Quantities for Contract A, there should have been about 5,400 square metres of existing carriageway which required trench reinstatement.

3.25 **Extension of time and prolongation cost.** In December 2002, Contractor A submitted to Engineer A details of the delay to the works. The delay was mainly caused by the increase in quantity of pavement reconstruction works (see Table 6) arising from the variations ordered. In July 2003, the HyD entered into a supplemental agreement with Contractor A. The supplemental agreement included, among others, settlement of the above claim for EOT and prolongation cost.

Audit observations

3.26 **Pavement reconstruction to replace reinstatement.** In July 2000, Engineer A instructed Contractor A to carry out full lane reconstruction instead of local trench reinstatement over drainage trenches and noise barriers foundations to reduce future maintenance problem. This instruction resulted in an increase of about 16,600 square metres of pavement construction works (see item no. 2 of Table 6) and affected the progress

of the road works. According to the HyD, the change of requirement was a design improvement. **Audit considers that the HyD should have critically reviewed the design requirements of the works before tendering. This would help minimise the issue of variation orders arising from changes of major design requirements after the commencement of the works.**

3.27 ***Pavement reconstruction due to road level problems.*** During construction, the joint site surveys found that the existing road levels at some locations were below the designed road levels. The HyD considered that the differences were most likely due to the settlement of the existing carriageway after the as-built drawings were prepared. In order to match the difference in the road levels, variation orders were issued. As a result, there was another increase of about 2,600 square metres of new pavement construction works (see item no. 3 of Table 6) which had also affected the progress of the works. Audit noted that Tolo Highway was built on reclaimed land where settlement might have occurred, rendering the actual levels of the existing road being different from those indicated on the as-built drawings. **It seemed that the data on the as-built drawings of Tolo Highway and the result of the HyD's limited verification surveys were unable to provide sufficient information for the design of the widened road.**

Audit recommendations

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

- (a) **critically review the control procedures of the HyD to ensure that major design requirements are identified before tendering; and**
- (b) **for the design of a widened road (one which has to match with the levels of the existing road, and especially if the existing road is built on reclaimed land susceptible to settlement), strengthen the site survey measures to verify, as far as possible, the levels of the existing road as indicated on the as-built drawings, before using the data on these drawings for the design of the widened road.**

Response from the Administration

3.29 The **Director of Highways** has said that the HyD will pay particular attention to the newly promulgated ETWB Technical Circular (Works) No. 17/2004 which gives guidelines on dealing with situations where the site is not available for investigation during design stage. He has also said that:

- (a) the audit recommendation mentioned in paragraph 3.28(a) came about owing to the need to replace a planned trench reinstatement to produce a more durable pavement with reduced long term maintenance costs. The planned trench reinstatement totalling 5,400 square metres (2.4% of total carriageway area in the Bills of Quantities) was replaced by the reconstruction of these trenches and the area between them totalling 16,640 square metres (7.1% of the total final carriageway area). It would have been difficult to foresee at the design stage the need for such small scale reconstruction (rather than trench reinstatement) without opening up of the pavement for investigation of its conditions. The closure of Tolo Highway for investigation and detailed survey was impracticable because of the serious traffic disruption and hence the economic losses to society, not to mention the delay to implementation of the project;
- (b) the audit recommendation mentioned in paragraph 3.28(b) came about owing to the need to replace the planned simple resurfacing by reconstruction to cater for the road level difference. The area totalled 2,600 square metres (1.1% of the total final carriageway area). To avoid closure of the expressway, the HyD had already carried out kerbside surveys to determine the road levels at the design stage to verify, as far as practicable but without seriously disrupting traffic, the levels of the existing carriageway for the design; and
- (c) to cater for the non-availability of a site survey at the design stage, the HyD, in a recent road improvement contract along an expressway, has allowed for some increases in the quantity of road reconstruction works.

Management of variation orders

3.30 It is not uncommon to issue variation orders during the course of a construction contract, such as that of the road improvement works. However, even a variation order of relatively small value can have a significant disruptive effect on a part of the whole of the works, which may entitle the contractor to EOT as well as other costs. For this reason, the overall financial implications as well as programme implications of a variation order must be considered before it is issued. According to the Project Administration Handbook, the Engineer should refer to and seek the prior approval of the Employer before ordering variations estimated to be exceeding \$300,000 in value. The value of the variation should include any likely prolongation/disruption costs and their effect on Resident Site Staff cost or other commitments to expenditure.

Audit observations

3.31 As mentioned in paragraph 3.23, a variation order for the pavement reconstruction works was issued in November 2000. This variation order involved an estimated additional cost of \$2.2 million. Audit noted that Engineer A had sought the prior approval of the HyD before issuing the variation order, the estimated value of which had exceeded \$300,000. However, Audit noted that the submission for approval of the variation order did not indicate whether the estimated value included the likely prolongation/disruption costs and other possible commitments to expenditure, if any. The submission also did not specify the likely impact the variation order would have on the overall programme of the contract. As it transpired, the pavement reconstruction works ordered affected the progress of the works and the HyD had to grant EOT and pay prolongation cost (in addition to the cost of the works) to Contractor A.

3.32 In August 2004, upon Audit's enquiry, the HyD advised that Engineer A, in preparing the estimated values of all variations for submissions for approval, had considered and separately stated the likely prolongation/disruption costs and their effect on Resident Site Staff cost or other commitments to expenditure, where applicable. As for that particular variation order issued in November 2000, Engineer A had at that time assessed that there would not be any costs other than the cost of the works. As such, the estimated value in the submission included the cost of the works only. However, the HyD has agreed that, in future submissions for approval of variation orders, it should clearly be spelt out whether there would be any likely prolongation/disruption costs and other commitments to expenditure for management's information and decision.

3.33 As a variation ordered may have significant programme implications for a works contract, it is important that its impact on the overall programme of the works should be assessed before a decision to issue the variation order is made. Audit scrutinised 18 variation orders issued under Contract A with estimated values over \$300,000. The result indicated that for 16 (89%) of these 18 variation orders, the submissions for approval did not provide the implications the changed works might have on the works programme.

3.34 **Audit considers that, as a good project management practice, in any approval granted for major variations to the works of a contract, in addition to the financial implications (i.e. both the cost of the variations and the likely cost of prolongation), the implications of the variations on the overall programme of the works should also be taken into account.**

Audit recommendations

3.35 Audit has *recommended* that the Director of Highways should strengthen the internal control procedures to ensure that:

- (a) in the submissions for approval of variation orders, it should clearly be spelt out whether there would be any likely prolongation/disruption costs and other commitments to expenditure for management's information and decision; and
- (b) the issuing of variation orders is justified having regard to:
 - (i) the need for the variations;
 - (ii) the implications of the variation orders on the overall programme of the works; and
 - (iii) the overall financial impact (including any likely prolongation/disruption costs and/or other commitments to expenditure, where applicable) of the variation orders.

3.36 Audit has *recommended* that the Secretary for the Environment, Transport and Works should consider notifying all works departments (e.g. by promulgating Environment, Transport and Works Bureau Technical Circulars (Works)) of the audit recommendations mentioned in paragraph 3.35, so that they may also be aware of possible areas of improvement in their project implementation and contract administration.

Response from the Administration

3.37 The Director for Highways has said that the HyD will pay particular attention to Works Bureau Technical Circular No. 13/92 of April 1992 "Independence of the Engineer and Referral of Variations and Other Commitments", the Engineering and Associated Consultants Selection Board Handbook, and the General Conditions of Employment for Consultants, and especially to the need to estimate and include likely prolongation/disruption costs for the purpose of seeking approval wherever such costs can be reasonably estimated. He has also said that:

- (a) the assessment of claims prolongation/disruption costs actually depends on the submission made by the contractor, which is most often not available at the time of issuing the variation order. Though the Engineer can make an estimate, the accuracy is inevitably questionable because of the lack of an agreed programme, the arguments about float times, and the presence of other concurrent delaying events. Usually, reasonable estimates of prolongation/disruption costs can only be made towards the later part of the contract period when the critical works can be identified more easily; and
- (b) the HyD has already exercised good control on the issue of variation orders through monthly progress reports and regular meetings with consultant/contractor to ensure that the Engineer complies with the requirements in the issue of variation orders. In any case, variation orders are necessary for the completion of the works and must be issued in a timely manner whenever justified.

3.38 **The Secretary for the Environment, Transport and Works** has said that:

- (a) there are existing guidelines (Works Bureau Technical Circular No. 13/92, the Engineering and Associated Consultants Selection Board Handbook and the General Conditions of Employment for Consultants) requiring the Engineer to advise the Employer on the reasons and estimated values (including any likely prolongation/disruption costs and other commitments to expenditure) of the variations when seeking the Employer's approval. The Engineer is also required to report all delays to the Employer within, normally, 14 days once the delay is identified. As such, it is considered that there are adequate guidelines covering the areas of concern mentioned in paragraphs 3.35 and 3.36. Nevertheless, she will remind works departments to keep strict observance of the above requirements, and refine the relevant procedures where necessary; and
- (b) essential cost and programme information will be captured in the new Public Works Programme Information System to be rolled out by the end of 2004. The ETWB will be able to monitor more closely the scope and extent of contract variations.

PART 4: IMPROVEMENT TO TUEN MUN ROAD

4.1 This PART examines the extension of contract period for completion of Contract B.

Contract B works

4.2 In September 1998, the HyD awarded Contract B, in the sum of \$268 million, for completing road improvement works of Tuen Mun Road near Tai Lam (Note 13). The scope of the works included:

- (a) realigning and widening the Kowloon bound carriageway of the Tuen Mun Road near Tai Lam;
- (b) slope cutting and slope stabilisation works; and
- (c) retaining wall works at the central median (Note 14) near Tai Lam to allow for the construction of an additional lane.

The contractor of Contract B (hereinafter referred to a Contractor B) commenced the works on 16 September 1998. The original contract completion date was 15 August 2000. In the event, the works were certified substantially completed on 31 May 2001 (i.e. a difference of 289 days between these two dates). The Engineer for Contract B (hereinafter referred to as Engineer B) granted Contractor B 289 days of EOT (of which 72 days were due to inclement weather). The HyD paid \$32.1 million (a prolongation cost of \$18.7 million and a disruption cost of \$13.4 million) to Contractor B.

4.3 According to the HyD, the EOT granted was mainly due to variations of works (see Appendix B for details). Audit examined some of the variation orders and found that a substantial portion of the EOT granted was related to additional slope stabilisation works and additional works for reinforced earth walls. The details are given in paragraphs 4.4 to 4.14.

Note 13: *In May 1994, the HyD awarded a contract for improvement to Tuen Mun Road. The original contract completion date was July 1996. Owing to site difficulties encountered, the contractor could not complete the works near Tai Lam.*

Note 14: *The central median was an existing slope separating the Kowloon bound carriageway and the Tuen Mun bound carriageway. This slope would be excavated to enable the construction of reinforced earth walls and an additional traffic lane.*

Additional slope stabilisation works

4.4 During the design stage for Contract B works, the HyD appointed a consultant (Note 15) to carry out site investigations. The site investigations found that the ground generally comprised competent granite. Based on the results of the site investigations, the scope of works for the permanent stabilisation measures required was indicated in the tender drawings of Contract B.

4.5 In mid-1999, Contractor B commenced the excavation works to construct the additional lane. Photograph 1 shows the excavation works of slopes in Tuen Mun Road.

Photograph 1

Excavation works of slopes in Tuen Mun Road



Source: HyD records

Note 15: *The consultant was also the Engineer for Contract B, i.e. Engineer B.*

During the course of the excavation works, Contractor B encountered unexpected ground conditions of extensive completely decomposed granite. To enable the excavation works to proceed safely, the following measures were taken:

- (a) implementing additional slope stabilisation measures, such as soil nails, mass buttress walls and structural skin walls, which were not included in the original design;
- (b) revising the rock excavation profile; and
- (c) adding permanent protection measures to newly formed slopes.

Between October 1999 and March 2001, Engineer B issued a number of variation orders to Contractor B for carrying out the additional slope stabilisation works. Contractor B lodged claims for EOT.

4.6 In general, Contractor B considered that the additional works instructed under the variation orders:

- (a) substantially changed the scope of works and increased the quantum of stabilisation works not contemplated at the time of tender; and
- (b) caused delay to the progress of excavation works.

4.7 Engineer B considered that the claims were valid in principle as Contractor B's progress of works was affected by the additional slope stabilisation works ordered. In the event, Engineer B granted a total of 105 days of EOT to Contractor B, and the HyD paid prolongation and disruption costs to Contractor B.

Additional works for reinforced earth walls

4.8 The works of Contract B also included the construction of a reinforced earth wall structure in the central median of the existing road for providing the additional traffic lane. The construction of the reinforced earth wall structure was originally programmed for the period April 1999 to September 1999. There were different types of reinforced earth wall. The most suitable one would be adopted depending on the ground conditions and topography of the slope over the length of the proposed reinforced earth wall structure. According to the contract, Engineer B was responsible for determining the foundation level

of each type of wall at any given location of the central median, and Contractor B was responsible for the construction details of the reinforced earth walls.

4.9 In early June 1999, during the construction of the reinforced earth walls in the central median, Contractor B's excavation works were approaching the foundation level as indicated in Engineer B's design. However, the expected rockhead (i.e. the level of the bedrock on which the reinforced earth walls were to be founded) was still not noticeable. In mid-June 1999, Engineer B issued a variation order to Contractor B for digging two trial holes to determine the new foundation level. The trial pits showed that there was still no evidence of the rockhead 2 metres to 2.5 metres deep below the excavated ground level. In July 1999, as a result of the unexpected ground conditions, Engineer B issued another variation order to Contractor B:

- (a) to increase the height of the reinforced earth walls in the area concerned;
- (b) to increase the depth of excavation for the revised wall type (Note 16); and
- (c) to construct an additional temporary support to the eastbound Tuen Mun Road.

4.10 In July 1999, Contractor B lodged a claim for EOT. Contractor B considered that the progress of the works was affected by the additional works instructed under the variation orders, which could not have been anticipated or identified by him at the time of tender. In April 2000, Contractor B completed the reinforced earth wall structure. Photograph 2 shows the completed reinforced earth wall structure at the central median of Tuen Mun Road.

Note 16: *According to the HyD, the depth of excavation for the originally designed wall types was 6 metres. Under the variation order issued in July 1999, the depth of excavation for the revised wall type was 10 metres. Hence, the increase in the depth of excavation was 4 metres.*

Photograph 2**Completed reinforced earth wall structure at the central median of Tuen Mun Road**

Source: HyD records

4.11 Engineer B considered that the claim was valid in principle, as any delay to the construction of the reinforced earth walls in the central median of Tuen Mun Road would have a corresponding knock-on effect on other works. In the event, Engineer B granted a total of 75 days of EOT to Contractor B, and the HyD paid prolongation and disruption costs to Contractor B.

Audit observations

4.12 Contract B mainly involved the remaining works of an earlier contract which could not be completed due to site difficulties (see Note 13). Although Contract B works had been redesigned to minimise the cutting back of steep slopes, the works still required a large amount of geotechnical works, such as excavation works and slope stabilisation works. The types of reinforced earth wall constructed also depended on the ground conditions. Therefore, it was important to obtain accurate information on the ground conditions from the site investigations at the design stage. However, after the

commencement of the excavation works, significant discrepancies between the anticipated and the actual ground conditions (on the type of granite and the depth of rockhead level) were noted. The discrepancies led subsequently to the issue of a number of variation orders for the additional slope stabilisation and the reinforced earth wall works. In the event, the HyD had to grant EOT and pay prolongation and disruption costs to Contractor B.

4.13 In May 2004, Audit asked why there was a significant discrepancy between the anticipated ground conditions ascertained from the site investigations and the actual ground conditions encountered. In July 2004, in reply to Audit's enquiry, the HyD said that:

- (a) in any civil engineering projects, ground investigations at the design stage could only practically be carried out at isolated locations. The area covered would necessarily be very small compared with the size of the site. The ground conditions could only be predicted by interpolation or extrapolation based on the information obtained in adjacent boreholes. The accuracy of the predicted outcome would depend a lot on the uniformity of the ground. Where there was an abrupt change in the ground conditions between the boreholes, the accuracy of the prediction would necessarily be affected;
- (b) more site investigations carried out at the design stage could increase the chance of picking up the variable ground conditions. However, this should not be the sole criterion of judging whether or not adequate/representative site investigations had been done. Other factors, such as engineering judgment, budgetary constraints, allowable time and resources, and site conditions, had to be taken into consideration; and
- (c) in this case, accessibility to the slope and the central median was seriously restricted by the busy traffic on Tuen Mun Road. In some locations, site investigations could only be carried out during the construction stage after the traffic lanes had been shifted away from the slope.

4.14 **Audit considers that, given the difficult site conditions at Tai Lam encountered by the preceding contractor (see Note 13), more site investigations should have been carried out to ascertain, as accurately as possible, the actual ground conditions of the site before letting Contract B.**

Audit recommendation

4.15 **Audit has recommended that the Director of Highways should, similar to the recommendation in paragraph 3.15, strengthen the site investigation measures in order to obtain, as far as possible, comprehensive and accurate information on the ground conditions before tendering.**

Response from the Administration

4.16 The **Director of Highways** generally agrees with the audit recommendation mentioned in paragraph 4.15. He will pay particular attention to the newly promulgated ETWB Technical Circular (Works) No. 17/2004 (see para. 3.16). He has also said that:

- (a) in general, the HyD has followed Works Bureau Technical Circular No. 13/90, “Geoguide 2: Guide to Site Investigation”, and “Highway Slope Manual” in its planning and formulation of site investigation, and the HyD’s consultants have exercised their professional skills to devise site investigation requirements;
- (b) it should be noted that the soil conditions in Hong Kong are highly variable and local variation could not be predicted accurately even with well planned site investigation; and
- (c) for Contract B, in addition to the boreholes data available at the time, the HyD’s consultant had made 34 more site investigation boreholes prior to finalising the design. With a total of 79 numbers of borehole data available for the project, the HyD was satisfied that adequate and representative site investigations had been carried out to predict the actual ground conditions of the site before letting the contract.

4.17 The **Secretary for the Environment, Transport and Works** agrees that a comprehensive site investigation will generate more useful subsoil information for design purposes. This general principle has been elaborated in ETWB Technical Circular (Works) No. 17/2004 of June 2004 in the context of risk allocation between the employer and the contractor. Other comments on site investigations are as stated in paragraph 3.17(a) and (b).

PART 5: ENTRUSTED WATER MAINS WORKS

5.1 This PART examines the extension of contract period for completion of Contract C.

Contract C works

5.2 In December 1998, the HyD awarded Contract C, in the sum of \$258 million, for constructing road improvement works at the junction of Pok Fu Lam Road and Sassoon Road. The scope of works included:

- (a) realignment of existing carriageways; and
- (b) entrusted water mains works of the Water Supplies Department (WSD).

The contractor of Contract C (hereinafter referred to as Contractor C) commenced the works on 16 December 1998. The original contract completion date was 13 April 2001. In the event, the works were certified as substantially completed on 9 April 2002 (i.e. a difference of 361 days between these two dates). The Engineer for Contract C (hereinafter referred to as Engineer C) granted Contractor C 361 days of EOT (of which 119 days were due to inclement weather). For the EOT granted, Engineer C assessed a prolongation cost of \$16.3 million. As at 31 July 2004, the final account of Contract C had not yet been agreed upon.

5.3 According to the HyD, the EOT granted was mainly due to variations of works (see Appendix B for details). Audit examined some of the variation orders and found that a portion of the EOT granted was related to the removal of asbestos cement water mains. The details are given in paragraphs 5.4 to 5.11.

Removal of asbestos cement water mains

5.4 According to Contract C, several existing water mains along Pok Fu Lam Road and Sassoon Road were to be replaced by new water mains. At the time of tender in August 1998, the water mains to be replaced were shown in the tender drawings based on the record plans provided by the WSD, which did not indicate that the water mains were made of asbestos cement.

5.5 In May 2000, during construction of a retaining wall, an asbestos cement water main supplying water to the Queen Mary Hospital burst. In June 2000, the WSD informed Contractor C that:

- (a) there were other water mains in the site made of asbestos cement; and
- (b) asbestos cement water mains were vulnerable to breakage when exposed.

5.6 The WSD and Engineer C subsequently advised Contractor C not to attempt to expose the asbestos cement water mains for the time being. The construction works of the retaining wall and the new water mains could not be proceeded until the asbestos cement water mains were removed (Note 17). This affected Contractor C's progress of works.

5.7 In order to ensure an uninterrupted water supply to the Queen Mary Hospital, a substantial temporary diversion of the water main network was required, before the removal of the asbestos cement water mains. In August 2000, the WSD started the temporary water main diversion works. The diversion works were completed in February 2001. In March 2001, the asbestos removal contractor (Note 18) engaged by Contractor C completed the removal and disposal works for the asbestos cement water mains. Contractor C considered that the progress of the works during the period August 2000 to March 2001 was affected. In June 2001, Engineer C granted 83 days of EOT to Contractor C. In the event, the HyD had to pay prolongation cost to Contractor C.

Audit observations

5.8 In old urban areas, many of the water mains were laid a long time ago, some of which might have been made of asbestos cement. In the case of Contract C, as substantial temporary diversion works were required for the removal of the asbestos cement water mains, the progress of Contract C works was affected. In the event, the HyD had to pay prolongation cost to Contractor C.

Note 17: *According to the WSD, normally, it is not necessary to remove existing water mains before constructing new water mains.*

Note 18: *The Air Pollution Control Ordinance (Cap. 311) and the Waste Disposal Ordinance (Cap. 354) strictly control the activities of handling, removal and disposal of materials containing asbestos. Such activities require the employment of a registered asbestos removal contractor, supervised by a registered specialist asbestos consultant.*

5.9 In May 2004, Audit asked the HyD whether it had sought clarification from the WSD on the material type of the water mains before tendering Contract C. In July 2004, the HyD replied that:

- (a) the information about the water mains as shown in the tender drawings was based on the WSD's record plans, which did not indicate that they were made of asbestos cement;
- (b) during the design stage, the WSD attended a number of coordination meetings with the HyD but did not mention the existence of asbestos cement water mains, nor any temporary diversion requirements before the water mains were exposed. Hence, the HyD was not aware of the existence of the asbestos cement water mains; and
- (c) if the material type of the water mains was ascertained before tendering, there was still a need to divert the concerned water mains. A longer construction period would have been required to allow for such diversions and the contract price would have also been higher.

5.10 In July 2004, Audit also asked the WSD whether it was aware at the design stage that the water mains concerned were made of asbestos cement, and why the WSD did not inform the HyD of the material type of the water mains in the coordination meetings. In September 2004, the WSD informed Audit that:

- (a) the water mains concerned were a pipeline of 150 millimetres in diameter (i.e. the 150mm water main) and a pipeline of 300 millimetres in diameter (i.e. the 300mm water main). The record plans provided to the HyD did not indicate the material type of the 150mm water main, but indicated that the material for some sections of the 300mm water main was made of mild steel;
- (b) the 150mm water main was probably installed before the 1980s at which time it was not the WSD's standard practice to record the pipe material nor the year of laying on the record plans;
- (c) the 150mm water main burst in May and June 2000 during the construction of Contract C works. In the course of repairing, the WSD noted that this water main was made of asbestos cement; and

- (d) after the incidents, Contractor C asked if there were other water mains in the site also made of asbestos cement. After site investigations carried out to obtain the necessary information, it was revealed that the 300mm water main was also made of asbestos cement at some locations.

5.11 **Audit considers that, if the material type (asbestos cement) of the old water mains had been ascertained before tendering Contract C, better planning and programming of the works could have been achieved. This would help minimise the delay and thereby the prolongation cost.**

Audit recommendations

5.12 **Audit has *recommended* that the Director of Highways should, for road improvement projects with entrusted works, strengthen consultation with the relevant departments to ascertain, before tendering, if specific requirements are needed for constructing the entrusted works. This is particularly important for works to be carried out in old urban areas, where:**

- (a) **old type of materials (such as asbestos cement), which may require special handling, removal and disposal, were often used in underground utilities;**
- (b) **the working space for road works is limited; and**
- (c) **substantial traffic diversions are often required.**

5.13 **Audit has *recommended* that the Director of Water Supplies should, for water mains works entrusted to other works departments for implementation in old urban areas, remind the relevant departments, before tendering, of any potential areas of concern (such as the presence of water mains possibly made of asbestos cement), so that better planning and programming of the works can be achieved by the works departments.**

Response from the Administration

5.14 **The Director of Highways generally agrees with the audit recommendation mentioned in paragraph 5.12. He has said that:**

- (a) the HyD will continue to have close consultation with the relevant departments regarding entrusted works to ensure that their requirements are incorporated into the design and contracts. In recent contracts, the HyD had paid specific attention to asbestos cement pipes and catered for their removal; and
- (b) in urban roads, especially those with congested underground utilities, the exact requirements needed for water main laying and connection works cannot be accurately ascertained until the roads are opened up. Some variations are inevitable.

5.15 The **Director of Water Supplies** agrees with the audit recommendation mentioned in paragraph 5.13. He has said that:

- (a) the requirements needed for constructing the entrusted water main works under Contract C were provided to the HyD at the design stage based on information available at that time;
- (b) while asbestos cement water mains are vulnerable to damage when exposed, it is not always feasible, due to site constraints, to provide adequate protection to exposed pipes of any material due to the dead weight of the pipes and fittings and any associated thrust blocks. Under the circumstances, the alternative would be to provide temporary/permanent pipe diversion instead of temporary protection to the pipelines;
- (c) it is up to the contractors to devise, based on their experience and the project requirements, the most suitable way to execute the work. It is not uncommon to carry out temporary diversion of water mains to suit the works schedule; and
- (d) as with any civil engineering projects, some changes to the original programme and design are not uncommon to suit the actual site conditions and progress of the works.

PART 6: ADDITIONAL UTILITY WORKS

6.1 This PART examines the extension of contract period for completion of Contract D.

Contract D works

6.2 In December 1998, the HyD awarded Contract D, in the sum of \$119.4 million, for Phase 2 of the Victoria Road Improvements Stage II project (Note 19). The scope of works included:

- (a) widening and realigning the 1.8-kilometre long two-lane carriageway of Victoria Road between Sassoon Road and Pok Fu Lam Road; and
- (b) associated slope, water mains and drainage works.

The contractor of Contract D (hereinafter referred to as Contractor D) commenced the works on 11 December 1998. The original contract completion date was 9 June 2001. In the event, the works were certified substantially completed on 30 October 2002 (i.e. a difference of 508 days between these two dates). The Engineer for Contract D (hereinafter referred to as Engineer D) granted Contractor D 394 days of EOT (of which 75.5 days were due to inclement weather). Engineer D also assessed that Contractor D would be entitled to a prolongation cost of \$8.5 million. As at 31 July 2004, further EOT to be granted was under assessment.

Problems encountered during construction of Contract D works

6.3 Since the commencement of Contract D, various unforeseen conditions such as adverse ground conditions, unknown underground utilities, and additional utility installations for the Cyberport development had affected the progress of the works.

Acceleration measures to mitigate delay

6.4 The prolonged period of works for the whole Victoria Road Improvements Stage II project since 1995 resulted in public complaints. The Southern District Council repeatedly voiced concerns over the delay in the completion of Contract D. Since late 2000,

Note 19: *The works of the Victoria Road Improvements Stage II project were implemented in two phases. The works of Phase I commenced in 1995 and were completed in 1998.*

the HyD started discussions with Engineer D, the Hong Kong Police Force and the Transport Department to address the delay and to draw up possible measures to bring forward the completion of the works under Contract D. In September 2001, the then Information Technology and Broadcasting Bureau (Note 20) also expressed concern as to whether the road improvement works could be completed in time to tie in with the intake of Cyberport Phase I tenants by March 2002.

6.5 In October 2001, after discussions with the relevant parties, the HyD drew up measures to increase Contractor D's output by relaxing the lane closure requirements (such as allowing a longer length of the road to be closed and extending the duration of lane closure), and extending the working hours for the works.

6.6 At that time the HyD estimated that, with the proposed acceleration measures in place:

- (a) the permanent carriageway works could be completed and the carriageway could be open to public traffic by end of March 2002; and
- (b) the completion of the remaining works under Contract D would be brought forward by six weeks from mid-August 2002 to early July 2002.

In mid-November 2001, the HyD sought approval from the then Finance Bureau (Note 21) for entering into a supplemental agreement with Contractor D (Note 22).

Additional fixed telecommunication network service works

6.7 According to the HyD, between mid-November 2001 and early December 2001, new requirements were introduced to squeeze in the fixed telecommunication network service (FTNS) works for the commissioning of the Cyberport. It was necessary to

Note 20: *With the introduction of the accountability system in July 2002, the responsibility of the Information Technology and Broadcasting Bureau was taken up by the Information Technology and Broadcasting Branch of the Commerce, Industry and Technology Bureau. With effect from 1 July 2003, the Information Technology and Broadcasting Branch was retitled the Communications and Technology Branch.*

Note 21: *With the introduction of the accountability system in July 2002, the responsibility of the Finance Bureau was taken up by the Financial Services and the Treasury Bureau.*

Note 22: *In mid-December 2001, the Finance Bureau gave approval to the HyD for entering into the supplemental agreement in the sum of \$4 million to implement the acceleration measures.*

determine the alignment of the FTNS common trench to avoid conflict with other utilities. As priority had to be given to the FTNS works, the progress of the accelerated works (see para. 6.6) was seriously affected. The road works were further delayed due to the late handing back of the sites by the telecommunication operators. In the event, the carriageway was completed in July 2002 and the remaining works were completed in October 2002.

Audit observations

6.8 Unforeseen site conditions, conflicts of underground utilities and traffic restrictions are typical reasons for delays of road improvement works in old urban areas. Audit noted that the HyD had taken proactive action to discuss with various parties concerned in order to draw up acceleration measures to mitigate the delay. The acceleration measures (drawn up in October 2001) were implemented in December 2001. However, the situation was subsequently aggravated by the additional FTNS works required for the commissioning of the Cyberport. As a result, the accelerated road works could not be completed by end of March 2002.

6.9 In July 2004, in response to Audit's enquiry, the HyD said that:

- (a) the HyD's consultant for Contract D had exercised his judgment reasonably in formulating site investigation proposals to ascertain the site conditions before tendering the contract;
- (b) as regards the delay caused by the utility works, most of the delay had originated from the additional utility works of the Cyberport development. As no information about the Cyberport development had been given to the HyD before tendering, there was no way that the requirements of the Cyberport development could be incorporated into the contract;
- (c) the new requirements for the Cyberport's FTNS works at Victoria Road were not known to the HyD until the Cyberport Developer and the Information Technology and Broadcasting Bureau raised such requirements in mid-November 2001. Without sufficient details of the works, the HyD was unable to incorporate the FTNS works into the supplemental agreement approved by the Finance Bureau in mid-December 2001; and
- (d) as the requirements for the FTNS works were introduced at a very late stage, the delay and disruption of the road works caused by such late additional works was inevitable.

6.10 In July 2004, Audit also asked the Commerce, Industry and Technology Bureau (which has taken up the responsibility of the Information Technology and Broadcasting Bureau —see Note 20 to para. 6.4) about the implementation programme of the Cyberport development to ascertain if the utility installations and the FTNS works could have been better planned and coordinated with the road works under Contract D. In August 2004, the Commerce, Industry and Technology Bureau replied that:

- (a) in February 1999, the Government reached an agreement on the broad framework of the Cyberport development;
- (b) according to the agreement, the Cyberport project would be completed in eight phases. The first phase was scheduled for completion in early 2002. The actual commissioning date of the first phase of Cyberport was April 2002;
- (c) infrastructure works undertaken by the Government for the Cyberport project started in the third quarter of 1999;
- (d) the Government was not responsible for undertaking the utility installations (mainly gas mains laying works) and the FTNS works. The Cyberport Developer was responsible for ensuring that the Cyberport was provided with the town gas services and the FTNS. The utility installations and the FTNS works were undertaken by the utility and telecommunication operators. The relevant operators should have communicated directly with the HyD regarding the requirement of the utility works and their schedules;
- (e) according to the Bureau's records, the commencement/completion dates of the utility works concerned might have been pushed back due to the delay in the completion of the Victoria Road Improvements Stage II project, which was originally scheduled to be completed in June 2001; and
- (f) if the utility works were to be carried out after the actual completion of Contract D (i.e. after October 2002), the opening of Cyberport would have been delayed by more than six months. Such delay would not be acceptable to the Bureau, as the aim of the Government in undertaking the Cyberport project was to create a cluster of leading information technology and services companies and a critical mass of professional talents in Hong Kong in the shortest possible time.

6.11 **Audit considers that better planning and coordination among utility companies and government departments/bureaux (such as those required between the HyD and the then Information Technology and Broadcasting Bureau) could have minimised the likelihood of delay to the completion of Contract D.**

Audit recommendations

6.12 **Audit has recommended that the Director of Highways should, for future road improvement contracts:**

- (a) **carry out adequate investigations to ascertain the underground utilities before tendering; and**
- (b) **take proactive action to liaise with utility companies and government departments/bureaux to ascertain, as far as possible, their particular requirements before tendering.**

6.13 **Audit has recommended that the Secretary for the Environment, Transport and Works should remind all works departments/bureaux to monitor closely the planning of works to ensure that there are adequate consultations among the parties concerned so that late additional works outside the scope of the original contract (such as late additional utility installations), which may have significant time and cost implications for the works, are minimised as far as possible.**

Response from the Administration

6.14 **The Director of Highways generally agrees with the audit recommendations mentioned in paragraph 6.12. He has said that:**

- (a) **the HyD will follow the newly promulgated ETWB Technical Circular (Works) No. 17/2004 of June 2004 which gives guidelines on dealing with unforeseen ground conditions and utilities interference;**
- (b) **from the HyD's records, there are an average of 35 kilometres of underground utilities and pipes for every kilometre of road and even more in urban areas. Under the congested underground conditions, no detection technology is available to locate the exact positions of these utilities and pipes except by opening the road. To minimise disruption to existing traffic, site investigations after the letting of contracts are inevitable; and**
- (c) **in the case of Contract D, as no information about the Cyberport development had been given to the HyD before tendering, there was no way that the requirements could be incorporated into the contract. The HyD had taken proactive action to draw up acceleration measures to mitigate the delay caused by the additional utility works of the Cyberport development.**

6.15 **The Secretary for Commerce, Industry and Technology** has said that:

- (a) it is true that the HyD was not aware of the utility works requirements of the Cyberport development and could not have incorporated them in Contract D, since the contract was awarded in December 1998 and the agreement on the broad framework of the Cyberport development was not reached until February 1999;
- (b) there is indication that both the HyD and its contractor had knowledge of the FTNS requirements in, if not before, October 2001;
- (c) in mid-November 2001, the Information Technology and Broadcasting Bureau only raised concerns about the delay in the road works and the possible implications for the Cyberport development, and did not introduce new requirements for the FTNS works (Note 23); and
- (d) he does not see why the HyD did not have sufficient details of the FTNS works to incorporate them into the supplemental agreement approved in mid-December 2001.

6.16 **The Secretary for the Environment, Transport and Works** generally agrees to the audit recommendation mentioned in paragraph 6.13. She has said that:

- (a) various aspects of risk management with respect to unforeseen ground conditions and interference by utility works are covered in the ETWB Technical Circular (Works) No. 17/2004 of June 2004 on the subject of risk allocation between the employer and the contractor;
- (b) furthermore, it has been a long established practice for departments to circulate the project layout plans at the design stage to all utility undertakings for the purpose of obtaining utility record and any future improvement plans in the works areas, so that the utility works could be carried out in conjunction with the road works; and
- (c) the ETWB will remind the works departments of these requirements.

Note 23: *In September 2004, the HyD informed Audit that as far as the HyD was concerned, these were new programme requirements for completing the FTNS works by early April 2002.*

Appendix A
(para. 2.2 refers)

Road improvement contracts with extended contract periods

Extension of contract period	Original contract completion date	Certified completion date	Total extension of contract period	Extension of contract period due to	
				Inclement weather	Other reasons (Note 1)
	(a)	(b)	(c) = (b) - (a) (days)	(d) (days)	(e) = (c) - (d) (days)
> 12 months (Note 2)					
Tolo Highway Contract (i.e. Contract A)	2.12.2001	22.8.2003	628	15	613
Victoria Road Contract (i.e. Contract D)	9.6.2001	30.10.2002	508 (Note 3)	75.5	432.5
> 6 to ≤ 12 months (Note 2)					
Hiram's Highway Contract	23.11.2001	14.12.2002	385.5	113	272.5
Tuen Mun Road Contract (i.e. Contract B)	15.8.2000	31.5.2001	289	72	217
Pok Fu Lam Road Contract (i.e. Contract C)	13.4.2001	9.4.2002	361	119	242
> 3 to ≤ 6 months (Note 2)					
Fo Tan Road Contract	2.7.2002	28.8.2003	422	250.5	171.5
≤ 3 months (Note 2)					
Eastern Corridor Contract	10.3.2003	18.7.2003	130	110	20
None (Note 2)					
Shap Pat Heung Contract	31.12.2001	24.6.2002	175	175	—

Source: HyD records

Note 1: Other reasons were mainly uncharted underground utilities, unforeseen ground conditions and variations of works (see Appendix B for details).

Note 2: In this classification, extension of contract period due to inclement weather was not taken into account.

Note 3: Out of the 508 days of extension, 394 days of EOT had been granted. As at 31 July 2004, further EOT to be granted was still under assessment.

Appendix B
(paras. 2.5, 4.3
and 5.3 refer)

Analysis of total EOT granted to contractors

Contract	EOT granted due to					Total EOT granted
	Inclement weather	Underground utility	Unforeseen ground conditions	Variations ordered	Other factors	
	(days)	(days)	(days)	(days)	(days)	
Tolo Highway Contract (i.e. Contract A)	15.0	—	—	579.0 (Note 1)	34.0	628.0
Fo Tan Road Contract	250.5	—	—	159.5 (Note 2)	12.0	422.0
Victoria Road Contract (i.e. Contract D)	75.5	51.75	95.0	170.75	1.0	394.0
Hiram's Highway Contract	113.0	102.0	—	170.5	—	385.5
Pok Fu Lam Road Contract (i.e. Contract C)	119.0	8.5	—	221.0	12.5	361.0
Tuen Mun Road Contract (i.e. Contract B)	72.0	—	—	210.0	7.0	289.0
Shap Pat Heung Contract	175.0	—	—	—	—	175.0
Eastern Corridor Contract	110.0	—	—	20.0	—	130.0
Total	930.0	162.25	95.0	1,530.75	66.5	2,784.5

Source: HyD records

Note 1: The figure included 440 days of EOT assessed under a supplemental agreement for overall settlement of various claims.

Note 2: The figure included 15 days of EOT claimed. As at 31 July 2004, the claim was still under assessment.

**Comparison of estimated contract sum in APE with
contract sum of accepted tender of recent major contracts**

Contract	Estimated contract sum in APE	Pre-tender estimate (Note)	Contract sum of accepted tender	Over-estimation/ (Under-estimation) of contract sum in APE	
	(a)	(b)	(c)	(d) = (a) - (c)	(e) = (d) / (a) × 100%
	(\$ million)	(\$ million)	(\$ million)	(\$ million)	(%)
Contract 1	2,472.00	2,000.62	1,716.11	755.89	30.6%
Contract 2	186.00	181.40	138.30	47.70	25.6%
Contract 3	1,555.00	1,468.31	1,213.00	342.00	22.0%
Contract 4	3,261.00	3,071.48	2,760.00	501.00	15.4%
Contract 5	666.30	666.30	608.14	58.16	8.7%
Contract 6	1,525.00	1,485.00	1,449.60	75.40	4.9%
Contract 7	562.00	541.90	562.00	—	—
Contract 8	648.00	676.12	678.00	(30.00)	(4.6%)

Source: HyD records

Note: These were the revised/approved pre-tender estimates after vetting by the Vetting Committee on Project Estimates and Consultants' Performance Appraisal.

Chronology of key events

Accuracy of approved project estimates

January 2000	The then Secretary for Works expressed concern about the persistent over-estimation of the approved project estimates in works projects.
January 2001	The HyD issued HyDTC No. 2/2001 “Vetting Committee on Project Estimates and Consultants’ Performance Appraisal” to, among others, improve the accuracy of the estimates.
May 2002	The then Finance Bureau adopted the administrative capping procedures to adjust downward the capital resources allocated to a works project if the outturn tender price was lower than the approved project estimate.
March 2004	In the Director of Audit’s Report No. 42, Audit reported on the need to improve the accuracy of the approved project estimates for works contracts of the Drainage Services Department.
June 2004	The Public Accounts Committee made a number of recommendations to address the issue of over-estimation.

Contract A

August 1997	Consultant A submitted a ground investigation proposal for the detailed design of Contract A works. Consultant A proposed to make four land drillholes for the design of Bridge A piling works.
March 1998	Consultant A completed the ground investigation for Contract A works. One marine drillhole was sunk for the design of Bridge A piling works.
October 1998	Consultant A issued the final ground investigation report.
March 1999	Contractor A commenced the works.
July 2000	Contractor A lodged claims for EOT and prolongation cost due to the increase in the quantities of rock sockets and obstructions for the piling works at Bridge A. Engineer A issued a variation order to Contractor A to revise some of the road works (i.e. full lane reconstruction instead of local trench reinstatement) to reduce maintenance problem.

Appendix D
(Cont' d)

August 2000	Contractor A lodged a claim for EOT and prolongation cost due to the revision of the trench reinstatement to pavement reconstruction.
November 2000	Engineer A issued a variation order to Contractor A to reconstruct some of the existing pavements (i.e. new pavement construction works instead of resurfacing works) to match their level with that of adjacent new pavements.
December 2001	This was the original contract completion date of Contract A.
January 2002	Engineer A revised the works instructed under the variation order issued in November 2000 to revert a significant portion of the instructed works back to resurfacing works.
December 2002	Engineer A issued a variation order to reimburse Contractor A for the cost of the additional works arising from the piling works at Bridge A.
July 2003	The HyD entered into a supplemental agreement with Contractor A for the settlement of claims for EOT and prolongation cost.
August 2003	The works were certified substantially completed.

Contract B

September 1998	Contractor B commenced the works.
June 1999	During the construction of the reinforced earth walls in the central median of Tuen Mun Road, Contractor B's excavation works were approaching the foundation level but the expected rockhead level was still not noticeable. Engineer B issued a variation order to Contractor B for digging two trial holes to determine the new foundation level.
Mid-1999	During the excavation works of slopes, Contractor B encountered unexpected ground conditions of extensive completely decomposed granite.
July 1999	Engineer B issued another variation order to Contractor B for constructing the revised reinforced earth walls.

Appendix D
(Cont' d)

October 1999 to March 2001	Engineer B issued a number of variation orders to Contractor B for carrying out additional slope stabilisation works.
August 2000	This was the original contract completion date of Contract B.
May 2001	The works were certified substantially completed.

Contract C

December 1998	Contractor C commenced the works.
May 2000	During construction of a retaining wall, an existing asbestos cement water main supplying water to the Queen Mary Hospital burst.
June 2000	The WSD informed Contractor C that there were other water mains in the site made of asbestos cement and asbestos cement water mains were vulnerable to breakage when exposed.
August 2000	The WSD started the temporary diversion works (which were completed in February 2001) before the asbestos cement water mains could be removed.
March 2001	The asbestos removal contractor engaged by Contractor C completed the removal and disposal works for the asbestos cement water mains.
April 2001	This was the original contract completion date of Contract C.
June 2001	Engineer C granted 83 days of extension of time to Contractor C due to the removal of the asbestos cement water mains.
April 2002	The works were certified substantially completed.

Contract D

December 1998	Contractor D commenced the works. Since the commencement, various unforeseen conditions, such as additional utility installations for the Cyberport development, had affected the progress of the works.
Late 2000	The HyD started discussions with various parties concerned to address the delay and to draw up possible measures to bring forward the completion of the works.

Appendix D
(Cont' d)

June 2001	This was the original contract completion date of Contract D.
September 2001	The then Information Technology and Broadcasting Bureau expressed concern as to whether the works could be completed in time to tie in with the intake of Cyberport Phase I tenants by March 2002.
October 2001	The HyD drew up acceleration measures to increase Contractor D' s output so that the permanent carriageway works could be completed by March 2002 and the remaining works by July 2002.
November 2001	The HyD sought approval from the then Finance Bureau for entering into a supplemental agreement with Contractor D.
Mid-November to early December 2001	New requirements were introduced to squeeze in the FTNS works for the commissioning of the Cyberport.
December 2001	The Finance Bureau gave the approval to the HyD for entering into the supplemental agreement in the sum of \$4 million to implement the acceleration measures.
July 2002	The carriageway was completed.
October 2002	The remaining works under Contract D were completed. The works were certified substantially completed.

Acronyms and abbreviations

APE	Approved project estimate
Audit	Audit Commission
EOT	Extension of time
ETWB	Environment, Transport and Works Bureau
FSTB	Financial Services and the Treasury Bureau
FTNS	Fixed telecommunication network service
HyD	Highways Department
HyDTC	Highways Department Technical Circular
WSD	Water Supplies Department