CHAPTER 3

Drainage Services Department

Harbour Area Treatment Scheme Stage I

Audit Commission
Hong Kong
31 March 2004

This audit review has been 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 have been accepted by the Government of the Hong Kong Special Administrative Region.

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HARBOUR AREA TREATMENT SCHEME STAGE I

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PART 1: INTRODUCTION

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

Sewage strategy for Victoria Harbour

1.2 The Harbour Area Treatment Scheme (HATS), previously known as the Strategic Sewage Disposal Scheme (SSDS — Note 1), is a major government initiative to deal with water pollution of Victoria Harbour. Originally conceived in the 1980s, HATS is an overall sewage collection, treatment and disposal strategy for replacing the unacceptable discharge of sewage into the harbour without proper treatment. The implementation of HATS was divided into four stages. After the full commissioning of HATS Stage I, the sewage from the urban areas in Kowloon and Northeast Hong Kong Island is treated by HATS. This accounts for about 75% of the sewage discharging into the harbour. The remaining 25% of the sewage flow (from the north and south-western parts of Hong Kong Island) is to be dealt with by the further stages of HATS, which are currently under planning. The catchment area of HATS Stage I is shown at Figure 1 on the centre pages.

Project implementation

Core components of HATS Stage I

1.3 HATS Stage I is a mega capital works programme comprising 19 individual works projects for designing and constructing four core components. The four core components are as follows:

(a) ***Sewage tunnel system.*** This is a sewage tunnel system for collecting sewage:

— from the urban areas in Kowloon between Tsuen Wan and Tseung Kwan O; and

— from Chai Wan and Shau Kei Wan on Hong Kong Island;

(b) ***Stonecutters Island Sewage Treatment Works (STW).*** This is a new centralised sewage treatment works at Stonecutters Island for treating the sewage by a chemically enhanced primary treatment process;

(c) ***Submarine outfall.*** This is an outfall extended from the Stonecutters Island STW for disposing of the treated effluent in the western harbour area; and

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Note 1: *The SSDS has been renamed as HATS since March 2001.*

(d) ***Upgrading of existing preliminary treatment works.*** This involves the upgrading of seven existing preliminary treatment works and the construction of sewage pumping stations along the tunnel alignment.

Sewage tunnel system

1.4 The sewage tunnel system of HATS Stage I comprises six tunnels (23.6 kilometres long) built at a depth of 80 metres to 150 metres below ground or sea level. Sewage is conveyed through a number of shafts and tunnels from the preliminary treatment works in the catchment area to the Stonecutters Island STW for treatment. HATS Stage I adopted a deep tunnel conveyance system to achieve the shortest route and to minimise disturbance and nuisance to the public, the environment, traffic, existing utilities, transport systems and buildings during construction. Table 1 shows the details of the six sewage collection tunnels.

Table 1

Details of the six sewage collection tunnels

Tunnel	From	To	Length (metres)
Eastern tunnels			
AB	Chai Wan (via Shau Kei Wan)	Kwun Tong	4,830
C	Tseung Kwan O	Kwun Tong	5,332
D	Kwun Tong	To Kwa Wan	3,572
E	To Kwa Wan	Stonecutters Island	5,495
Western tunnels			
F	Tsing Yi	Stonecutters Island	3,580
G	Kwai Chung	Tsing Yi	779
		Total	**23,588**

Source: DSD records

1.5 According to their position relative to the Stonecutters Island STW, Tunnels AB, C, D and E are known as the eastern tunnels. Tunnels F and G are known as the western tunnels. The alignment of the six tunnels is shown at Figure 1 on the centre pages.

Concerns over delay in completion and budget overrun

1.6 In February 1994, the Finance Committee (FC) of the Legislative Council (LegCo) approved the funding for HATS Stage I. The target completion date was June 1997. In the event, there were contractual and technical problems in implementing the works projects, resulting in delay and budget overrun. There were also LegCo and public concerns over the implementation of HATS Stage I.

Administrative framework

1.7 The Environmental Protection Department (EPD) is responsible for planning the overall sewerage and sewage treatment infrastructure in Hong Kong and for monitoring the marine water quality. The Drainage Services Department (DSD) is responsible for the design, construction and operation of sewerage and sewage treatment infrastructure. The Environment, Transport and Works Bureau (ETWB) is responsible for policy matters on environmental protection and conservation, and for overseeing the operation of the EPD and the DSD on the provision of sewerage and sewage treatment services. The ETWB is also responsible for ensuring the effective planning, management and implementation of public sector infrastructure development and works programmes in a safe, timely and cost-effective manner.

Audit review

1.8 In the Director of Audit's Report No. 30 of June 1998, the Audit Commission (Audit) reported on the acceleration of works in the SSDS Stage I and made recommendations for improvement in a number of areas. After considering the Director of Audit's Report No. 30, the Public Accounts Committee of LegCo, in its Report No. 32 of July 1999, suggested the Director of Audit to conduct, upon the conclusion of the SSDS Stage I, similar investigations to ascertain the full cost of the project and the factors leading to the budget overrun.

1.9 Audit recently conducted a review on the implementation of HATS Stage I. The review focused on the following areas:

(a) delay in works and increase in cost (see PART 2);

(b) forfeiture of original tunnel contracts (see PART 3);

(c) problems encountered in tunnel completion contracts (see PART 4); and

(d) impact on water quality of Victoria Harbour (see PART 5).

PART 2: DELAY IN WORKS AND INCREASE IN COST

2.1 This PART examines the implementation of HATS Stage I.

Project funding

2.2 Planning for HATS Stage I commenced in the early 1990s. The DSD was tasked to design and construct HATS Stage I. In February 1992 and May 1993, the FC approved $130 million for the creation of a capital project (Project 142DS) in the Public Works Programme funded by the Capital Works Reserve Fund (CWRF) for the detailed design and investigation of HATS Stage I.

2.3 ***Sewage Services Trading Fund.*** In February 1994, the FC approved a capital injection of $6,800 million from the Capital Investment Fund to establish the Sewage Services Trading Fund (SSTF) to finance the capital cost of sewage projects, of which $5,174 million was earmarked for HATS Stage I. In March 1994, the Government established the SSTF. The Director of Drainage Services managed the SSTF and accounted for the operations of the Government's sewage services. The DSD created 17 works projects under the SSTF to implement HATS Stage I.

2.4 In November 1997, the then Provisional LegCo approved the closure of the SSTF with effect from 31 March 1998 because the SSTF was no longer able to fulfil the statutory obligation of meeting expenses from revenue. At the time of closure of the SSTF, the total expenditure of the 17 works projects was $4,408.9 million. The outstanding works were transferred to the CWRF by creating 17 works projects (for the eastern tunnels, see para. 2.6) with approved project estimates (APEs) totalling $1,672.4 million. Including the CWRF project (Project 142DS) for detailed design and investigation, the total approved funding for HATS Stage I was $6,211.3 million (see Table 2 for details).

Table 2

Approved funding

	($ million)
APE for detailed design and investigation	130.0
Expenditure up to 31 March 1998 for the 17 works projects funded under the SSTF	4,408.9
APEs of the 17 works projects created under the CWRF in April 1998 (Note)	1,672.4
Total approved funding	6,211.3

Source: *DSD records*

Note: *The APEs of these 17 works projects were the estimated costs for completing the works projects, including allowances for estimated changes in the price level during the construction period. Additional funding for completing the eastern tunnels was separately sought in a new project (see para. 2.6).*

Increases in funding

2.5 Owing to problems encountered in implementing HATS Stage I, the DSD sought additional funding on five occasions. The total funding for HATS Stage I increased to $8,498.7 million. Table 3 shows the increase in funding.

Table 3

Increase in funding

Date	Works project	($ million)
Dec. 1997	Sewage tunnel system – eastern tunnels (Note 1)	2,000.0
Aug. 1998	Environmental Impact Assessment study (Note 2)	13.6
Jun. 1999	Supervision of main works	98.8
Dec. 2000	Sewage tunnel system – western tunnels	115.0
Mar. 2001	Stonecutters Island STW	60.0
	Total additional funding	**2,287.4**
Original approved funding (see Table 2)		6,211.3
	Final approved funding	**8,498.7**
Forecast final expenditure as at February 2004		8,202.1

Source: *DSD records*

Note 1: *This was a new project created for funding the completion works of the eastern tunnels due to insufficient funding in the SSTF (see para. 2.6).*

Note 2: *This item was approved by the then Secretary for the Treasury under delegated authority since the amount was not more than $15 million. For the other four items, approval of the FC was sought.*

2.6 In November 1997, when the then Provisional LegCo approved the closure of the SSTF, there was insufficient funding in the SSTF to finance the re-tendering of the completion works of the sewage tunnel system arising from forfeiture of the tunnel contracts (see para. 2.9). In December 1997, the FC approved $2,000 million for the creation of a new project (Project 286DS) under the CWRF for the completion of the eastern tunnels. This works project was the nineteenth works project created for HATS Stage I.

2.7 Table 4 shows an analysis of the increase in funding according to the works category.

Table 4

Analysis of increase in funding for Harbour Area Treatment Scheme Stage I

Works category	Original approved funding ($ million)	Increase in funding ($ million)	Final approved funding ($ million)
(A) Advance works	562.4	0	562.4
(B) Works for the core components:			
(a) Sewage tunnel system (Note)	1,310.5	2,115.0	3,425.5
(b) Stonecutters Island STW	2,078.8	60.0	2,138.8
(c) Submarine outfall	562.7	0	562.7
(d) Upgrading of preliminary treatment works	841.7	0	841.7
(C) Fees, investigation and supervision	855.2	112.4	967.6
Total	**6,211.3**	**2,287.4**	**8,498.7**

Source: *DSD records*

Note: *The increase of $2,115 million comprised $2,000 million for the eastern tunnels and $115 million for the western tunnels (see Table 3).*

Appendix A shows the financial position of the works projects under HATS Stage I.

Delay in completing the works

2.8 When funding was approved for HATS Stage I, the target completion date was June 1997. As a result of the problems encountered in the works projects, the final completion date was deferred to December 2001, i.e. a delay of 4.5 years. Most of the works projects could not be completed on schedule. For the four core components, only the Stonecutters Island STW could be partially commissioned in May 1997. From May 1997 to December 2001, the Stonecutters Island STW was operated at 25% of the designed flow to treat sewage collected from North West Kowloon through the existing sewerage network. Its full commissioning was deferred to December 2001.

2.9 For the sewage tunnel system, the works for the six sewage collection tunnels were originally grouped under two contracts and were scheduled for completion by May 1997. Owing to unsatisfactory progress and the contractor's failure to proceed with the tunnelling works with due diligence (see paras. 3.3 to 3.5), the Government re-entered the two contracts in December 1996. The outstanding works were re-tendered under *three* tunnel completion contracts. In July 1997, the DSD awarded a contract for completing the two western tunnels (i.e. Tunnels F and G) using the balance of funds in the SSTF. As funds were insufficient under the SSTF for completing the four eastern tunnels, in December 1997, the FC approved $2,000 million for the creation of a new works project (Project 286DS) under the CWRF for completing the eastern tunnels. In January 1998, the DSD awarded two contracts for completing the four eastern tunnels. In the event, there was significant delay in the three tunnel completion contracts because of contractual and technical problems.

2.10 The delay in completing the sewage tunnel system had knock-on effects on the progress of the other projects. Appendix B is a chart showing the progress of the works of HATS Stage I. Appendix C shows the date of completion of works projects of HATS Stage I.

Audit observations

Significant delay and substantial cost increases

2.11 The original approved funding for HATS Stage I was $6,211.3 million. However, there were substantial cost increases for the works projects. Additional funding totalling $2,287.4 million was sought on five occasions to meet the funding requirements of the works projects. There was also a delay of 4.5 years in completing HATS Stage I.

2.12 According to the DSD, the main cause of delay and cost increase in HATS Stage I was the forfeiture of the original tunnel contracts. The funding increase of $2,115 million for the sewage tunnel system accounted for 92% of the total funding increase of $2,287.4 million (see Table 4 in para. 2.7). As the sewage tunnel system was one of the core components of HATS Stage I and was on the critical path of the whole programme, its delay in completion also affected the progress of other projects. Audit examined the problems in constructing the sewage tunnel system. The audit findings are reported as follows:

(a) forfeiture of original tunnel contracts (see PART 3); and

(b) problems encountered in tunnel completion contracts (see PART 4).

Need to improve project management and budgetary control

2.13 The delay in completing HATS Stage I deferred the environmental benefits to be derived from improving the water quality of Victoria Harbour. The increase in funding for HATS Stage I also resulted in significant financial implications to the Government. **Audit considers that there is room for improvement in DSD's project management and budgetary control to ensure that large-scale works projects are delivered on time and within budget.**

2.14 To supplement the guidelines and procedures in force, in August 2000, the DSD issued specific guidelines for the management of time-critical projects under DSD Technical Circular No. 9/2000 "The Assessment of Risk and Cost of Time-critical Projects". The technical circular said that for time-critical projects, additional efforts and resources were required for project management to ensure that they were completed on time and within budget. This technical circular requires DSD officers to:

(a) carry out comprehensive risk assessment in the early planning stage to identify critical and high risk factors involved in delivering the projects on time and within budget;

(b) work out solutions and strategies to eliminate or contain the risks, and devise contingency plans to cope with the uncertainties; and

(c) conduct risk management workshops at critical stages during the implementation of the projects to cope with changing circumstances.

2.15 DSD Technical Circular No. 9/2000 promulgated useful guidelines for improving project management and budgetary control for large-scale time-critical projects. **The DSD needs to ensure that the guidelines are followed by DSD officers and are updated regularly.**

Post-implementation review

2.16 In February 2001, the then Secretary for Works informed the Public Works Subcommittee (PWSC) of the FC that it was the government's practice to conduct a comprehensive review upon the completion of a large-scale project. As for HATS Stage I, it would be appropriate to conduct a review after completing the projects and finalising the claims. The PWSC urged the Administration to conduct the review as soon as possible and requested that the review findings should be discussed by the relevant LegCo panels.

2.17 In February 2004, in response to Audit's enquiry, the ETWB confirmed that a post-implementation review of HATS Stage I with a view to making improvements for future similar projects had been substantially completed. The ETWB would report the findings to LegCo during the current LegCo session.

Audit recommendations

2.18 **Audit has *recommended* that the Director of Drainage Services should:**

(a) **implement effective measures to ensure that large–scale works projects, such as the further stages of HATS, are delivered on time and within budget; and**

(b) **take action to ensure that DSD officers follow the guidelines promulgated in DSD Technical Circular No. 9/2000 for improving project management and budgetary control of time-critical projects, and that the guidelines are updated regularly.**

Response from the Administration

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

(a) the total funding of HATS Stage I should have been $6,850 million in money-of-the-day prices (i.e. taking into account changes in price level). However, at the time of closure of the SSTF, the DSD only obtained a total approved funding of $6,211.3 million; and

(b) the estimated final expenditure for HATS Stage I is $8,202 million (see Table 3 of para. 2.5). Taking into account the settlement sum of $750 million recovered from Contractor A (see paras. 3.9 and 3.12), the net increase in cost would have been $602 million ($8,202 million – $6,850 million – $750 million) instead of $2,287.4 million (Note 2).

Note 2: *Audit noted that the total funding of $6,850 million mentioned by the DSD was a notional figure based on a projection prepared in June 1995. At the time of closure of the SSTF in March 1998, the total approved funding was $6,211.3 million (see para. 2.4). Subsequently, supplementary provisions totalling $2,287.4 million were approved (see para. 2.5). The final approved funding was $8,498.7 million and the forecast final expenditure was $8,202.1 million. As for the settlement sum of $750 million recovered from Contractor A, it is relevant to note that the Government incurred legal costs of $129 million (see para. 3.12).*

PART 3: FORFEITURE OF ORIGINAL TUNNEL CONTRACTS

3.1 This PART examines the forfeiture of the original tunnel contracts, and the implementation of improvement measures in the tunnel completion contracts to reduce the risk of contract forfeiture.

Original tunnel contracts

3.2 The six sewage collection tunnels were originally grouped under two contracts (hereinafter referred to as Contracts A and B). In December 1994, both Contracts A and B were awarded to the same contractor (hereinafter referred to as Contractor A). Table 5 shows the particulars of Contracts A and B.

Table 5

Particulars of Contracts A and B

	Contract A	**Contract B**
Contractor	A	A
Tunnel	AB, C	D, E, F, G
Contract sum:		
Original	$490.0 million	$693.6 million
Revised (up to forfeiture)	$548.0 million	$733.6 million
Contract period:	28 months	29 months
Commencement date	January 1995	January 1995
Scheduled completion date	April 1997	May 1997
Date of forfeiture	**December 1996**	**December 1996**

Source: DSD records

Forfeiture of original tunnel contracts

3.3 Contractor A commenced the works in January 1995. In early 1996, the DSD observed that the works progress was slow. The situation deteriorated significantly in the following months despite extensive discussion between the DSD and Contractor A. In June 1996, Contractor A unilaterally suspended the works in Tunnels C and F. In July 1996, Contractor A also ceased the works in the other four tunnels.

3.4 Contractor A claimed that the inflow of water into the tunnels was unexpected and the works were impossible to complete in accordance with the terms of the contracts. Contractor A put forward proposals to change the engineering design, the construction method and the payment terms. The DSD did not accept the proposals. Although only two tunnels (i.e. Tunnels C and F) encountered the water inflow problem, Contractor A ceased the works in all the six tunnels.

3.5 The DSD appointed external legal advisors and independent tunnelling experts to provide expert advice. After an investigation, the DSD instructed technical changes to facilitate the resumption of the works. The DSD also discussed with Contractor A the technical changes and difficulties in resuming the works. However, Contractor A refused to resume the works, but continued to negotiate with the DSD. As Contractor A failed to proceed with the works with due diligence, the DSD considered that Contractor A had forfeited Contracts A and B. In December 1996, the DSD re-entered the sites of Contracts A and B.

Progress of tunnel excavation works up to forfeiture

3.6 In July 1996, i.e. about 19 months from the commencement of the works, Contractor A ceased the works in all the six tunnels. According to DSD records, Contractor A only completed 7.7% of the total tunnel excavation works (see Appendix D for details).

Settlement of contractual disputes

3.7 After the forfeiture of Contracts A and B in December 1996, in May 1997, Contractor A served an arbitration notice to the Government, claiming that the Government's re-entry of the sites was wrong. The Government objected to Contractor A's claim and counter-claimed that the re-entry was valid. In May 1998, an arbitrator was appointed to deal with the dispute.

3.8 In 2000, three arbitration hearings were held. The arbitration awards were substantially favourable to the Government in all of the most significant issues under dispute. In August 2000 and January 2001, Contractor A filed two appeals against the arbitration awards. Following the issue of the arbitration awards, Contractor A and the Government agreed to appoint a mediator to settle the remaining issues based on the arbitrator's findings on liability. A mediation hearing commenced in June 2001 in parallel with the preparation for the appeal hearings under the arbitration proceedings.

3.9 Following extensive negotiations between the Government and Contractor A, on 20 September 2001, a Settlement Agreement was signed by both parties. According to the Settlement Agreement, Contractor A agreed to pay $750 million to the Government by three equal instalments due in October of 2001, 2002 and 2003. As part of the Settlement Agreement, the Government and Contractor A agreed to terminate and withdraw all further arbitration and appeal proceedings. By October 2003, Contractor A had duly paid $750 million to the Government.

Measures to reduce the risk of contract forfeiture

3.10 After the forfeiture of Contracts A and B, the DSD re-packaged the outstanding works under three separate tunnel completion contracts (hereinafter referred to as Contracts C, D and E — see Table 7 in para. 4.2). The DSD also limited the award of no more than two of the three contracts to one tenderer. Such an arrangement would spread the risks among more contractors. The purpose was to avoid the unsatisfactory situation of the forfeited contracts in which Contractor A was awarded both contracts for all the six tunnels.

Additional safeguards

3.11 To reduce the chance of default, the DSD also introduced the following improvement measures in the tunnel completion contracts as additional safeguards:

(a) ***Parent company guarantee.*** The tenderers were required to provide parent company guarantees on their performance. This would increase the commitment of both the successful contractor and his corporate group to reduce the chance of default; and

(b) ***Performance bond.*** The tenderers were required to provide performance bonds amounting to 10% of the tendered sums. (By comparison, in the forfeited contracts, the requirement was 1%.) By increasing the performance bond, the contractors were motivated to complete the works and attempts to default would be discouraged.

Audit observations

Need to reduce the risk of contract forfeiture

3.12 The Government incurred an additional works expenditure of $1,293 million due to the forfeiture of Contracts A and B. Appendix E shows a breakdown of the additional works expenditure. In addition, the Government also incurred legal costs of $129 million. Despite the settlement sum of $750 million received from Contractor A, the Government still suffered a substantial loss of $672 million ($1,293 million + $129 million – $750 million). The Government also encountered significant delays to the tunnelling works and other works of HATS Stage I.

3.13 **In view of the significant consequences of contract forfeiture, Audit considers that the DSD needs to implement effective measures to minimise the risk of contract forfeiture. Audit considers that the measures mentioned in paragraphs 3.10 to 3.11 are effective in minimising the risks of contract forfeiture. The DSD should continue to adopt such measures in the tunnel contracts in the further stages of HATS.**

Improvement measures not strictly enforced

3.14 For the two improvement measures mentioned in paragraph 3.11, the DSD had stipulated the following time limits in the letters of acceptance of tender issued to the successful tenderers:

(a) ***Parent company guarantee.*** The duly executed guarantee had to be submitted to the DSD within 14 days from the date of the letter of acceptance of tender; and

(b) ***Performance bond.*** The bond, duly executed under seal, had to be submitted to the DSD three working days prior to the date of signing the contract.

3.15 The timely submission of the contract instruments was essential to ensure that the improvement measures were put into effect at the commencement dates of the contracts to protect the Government's interests. However, the DSD did not strictly enforce the requirements mentioned in paragraph 3.14. The duly executed contract instruments were submitted 11.4 months (Contract C), 6.9 months (Contract D) and 11.4 months (Contract E) after the stipulated time limits. The delay was quite long. This meant that a substantial part of the contract period (from 25 months to 27 months) had elapsed before the duly executed contract instruments were submitted. Appendix F shows the details of the delay in the submission of the duly executed contract instruments.

3.16 The DSD had made progress payments to Contractors C, D and E while the required contract instruments were still outstanding. **Audit noted that there was a specific provision in Contracts C, D and E stipulating that the proper execution and submission of the parent company guarantee was a "condition precedent to the contractor's entitlement to any payment" under the contract. Audit considers that the DSD should have taken action to ensure that the contractors complied with the requirement of submitting the duly executed contract instruments within the stipulated time limits.**

Front-loading of contract payments in the forfeited contracts

3.17 The DSD also introduced another improvement measure in the tunnel completion contracts for preventing front-loading of contract payments (Note 3), an unsatisfactory situation encountered in the forfeited contracts. In January 1997, the DSD informed the then Works Branch (Note 4) of the contract strategies to be adopted for the tunnel completion contracts. The DSD said that in the standard form of works contracts, contractors had the opportunity to front-load the contract payment by inserting a high rate for certain items (such as contractor's accommodation) in the Preliminaries Section in the Bills of Quantities (Note 5). In the forfeited Contracts A and B, these preliminary items represented 15.4% and 16.3% of the contract sums respectively. The DSD considered that such percentages for the preliminary items did not properly represent the relationship between the interim payments and the progress of the works.

3.18 In April 1997, at a pre-tender meeting, the DSD informed the prospective tenderers that in the forfeited contracts, with more than 40% of the contract sum paid, only about 15% of the works had been completed up to the date of forfeiture. For the completion contracts, the DSD did not wish to have heavily front-loaded payment. Therefore, the DSD revised the payment pattern, and set a ceiling on the preliminary items at 10% of the contract sum. The DSD considered that this would represent a suitable balance in risk sharing between the contractor and the Government, and would reduce the risk of the contractor defaulting after securing a large up-front payment.

Note 3: *The front-loading of contract payments refers to pricing the tender in such a way that a high proportion of the total contract payments (in the form of progress payments or interim payments) is paid out in the early stage of a contract.*

Note 4: *With effect from 1 July 1997, the title of Works Branch has been changed to Works Bureau. With effect from 1 July 2002, the duties and responsibilities of the Works Bureau have been subsumed into the ETWB.*

Note 5: *The Bills of Quantities are items giving brief descriptions of the works to be performed and the quantities estimated. Tenderers are required to price the items in the Bills of Quantities.*

3.19 Audit noted that substantial progress payments (on average 43.4% of the contract sum) had been made to Contractor A up to the time of forfeiture of Contracts A and B in December 1996. The results are shown in Table 6.

Table 6

Progress payments made to Contractor A

		Contract A ($ million)	Contract B ($ million)	Total ($ million)
(A)	Contract sum	548.0	733.6	1,281.6
(B)	Progress payments (up to forfeiture in December 1996)	236.2	319.8	556.0
(C)	**Payments as a percentage of contract sum ((B) ¸ (A) ´ 100%)**	**43.1%**	**43.6%**	**43.4%**

Source: DSD records

As for the progress of works, the DSD mentioned that only 15% of the works were completed up to the date of forfeiture (see para. 3.18). In terms of the progress of tunnel excavation works, Audit noted that Contractor A completed only 7.7% (see Appendix D) of the total length of the tunnels.

3.20 Heavy front-loading in the contract payments is not conducive to securing the contractor's commitment in completing the contracts, and would add to the losses suffered by the Government in the event of forfeiture. The DSD made good efforts to revise the contract terms in the tunnel completion contracts to prevent heavy front-loading. **Audit considers that, for large-scale high-risk works projects, such as the tunnelling works in the further stages of HATS, the contract terms should be critically devised so that progress payments are made, as far as possible, in line with the actual progress of works.**

Audit recommendations

3.21 **Audit has *recommended* that the Director of Drainage Services should:**

(a) **continue to implement measures to minimise the risk of contract forfeiture in future similar projects (e.g. the further stages of HATS);**

(b) **strictly implement the contract conditions for the provision of parent company guarantee and performance bond to ensure that the required instruments are submitted by contractors within the stipulated time limits; and**

(c) **for large-scale works projects, critically devise the contract payment schedules to ensure that progress payments are made, as far as possible, in line with the actual progress of works.**

3.22 **Audit has also *recommended* that the Secretary for the Environment, Transport and Works should notify all works departments of the audit recommendations in paragraph 3.21.**

Response from the Administration

3.23 The **Director of Drainage Services** generally agrees with the audit recommendations mentioned in paragraph 3.21. He has said that the process of submission and acceptance for some of the documents was prolonged mainly because the DSD did not possess the required information to attest the documents submitted by overseas companies operating under legal systems different from the English jurisdiction. The DSD needed to obtain certification by overseas lawyers on the validity of the documents as executed by the overseas parent companies and bondsman, and the authentication of the qualification of the certifying lawyers by overseas government authorities. The procedures were extremely complicated and time consuming.

3.24 The **Secretary for Financial Services and the Treasury** generally agrees with the audit recommendations mentioned in paragraph 3.21. He has said that:

(a) he supports the audit recommendation mentioned in paragraph 3.21(c) that contract payment schedules should be designed to ensure that progress payments are made, as far as possible, in line with the actual progress of works. This arrangement would provide better protection of the Government's interest;

(b) he has no objection to adopting measures to minimise the risk of contract forfeiture as long as the government procurement principles of fairness, openness and value for money, and the relevant obligations under the World Trade Organisation Agreement on Government Procurement, are complied with;

(c) once the time limit for the provision of contract instruments is stipulated (whether in a letter of acceptance or in the tender document), it is reasonable that the time limit should be adhered to. Otherwise, the stipulation of the time limit would be meaningless and the Government's interest may not be adequately protected; and

(d) overseas contractors (because of different jurisdictions) may require a longer time to sort out their legal instruments in the execution of performance bonds.

3.25 The **Secretary for the Environment, Transport and Works** welcomes the audit recommendations and will notify all works departments to take on board the audit recommendations mentioned in paragraph 3.21 for general application in future projects in the Public Works Programme.

PART 4: PROBLEMS ENCOUNTERED IN TUNNEL COMPLETION CONTRACTS

4.1 This PART examines the problems encountered in the three tunnel completion contracts.

Tunnel completion contracts

4.2 After the forfeiture of the two original tunnel contracts (i.e. Contracts A and B) in December 1996, the works for completing the tunnels were subsequently re-tendered under three separate contracts, i.e. Contracts C, D and E. Table 7 shows the particulars of the three completion contracts.

Table 7

Particulars of the three tunnel completion contracts

	Contract C	**Contract D**	**Contract E**
Contractor	C	D	E
Tunnel	AB, C	D, E	F, G
Contract sum:			
Original	$773.0 million	$574.8 million	$356.8 million
Final (Position as at February 2004)	$821.7 million	$714.7 million	$605.2 million
Increase in cost	$48.7 million	$139.9 million	$248.4 million
Contract period:	27 months	26 months	25 months
Commencement date	January 1998	January 1998	July 1997
Scheduled completion date	April 2000	February 2000	August 1999
Actual completion date	November 2001	September 2001	December 2001
Delay in completion	19 months	19 months	28 months

Source: DSD records

4.3 There were significant delay and substantial increase in cost in implementing the tunnel completion contracts. Details are provided in paragraphs 4.4 to 4.34.

Claim arising from use of forfeited plant

4.4 Upon the forfeiture of Contracts A and B, the construction plant left on site was forfeited and became government property. The items of the forfeited plant included the mucking systems used for hoisting up spoil excavated from the tunnel to the surface for disposal. The proper operation of the mucking systems was vital to tunnel excavation. Photograph 1 on the centre pages is an example of a mucking system.

Use of forfeited plant

4.5 To make better use of the forfeited plant and to mitigate the losses arising from the forfeiture, the DSD considered that the successful tenderers for the tunnel completion contracts should be given the opportunity to use as many items of the forfeited plant as possible. Therefore, the DSD allowed the tenderers to choose between using the forfeited mucking systems or bringing in their own systems.

4.6 As the Government was not responsible for the purchase, operation and maintenance of the forfeited plant, the DSD intention was not to accept any liability arising from the use of the forfeited plant. The risk should be borne by the contractor who was allowed to inspect the plant before tendering. **The decision whether or not to use such plant was to be taken by the contractor voluntarily for his own benefit and at his own risk. No claim should be allowed on the grounds that the contractor did not or could not foresee any matter in connection with the use of the plant.**

4.7 With this in mind, exclusion clauses were provided in the tunnel completion contracts to protect the interest of the Government and to allocate the risk to the contractors. A tenderer who wanted to use the forfeited plant was required to sign a "No Claim Statement" to the effect that he had assessed the conditions and suitability of the forfeited plant, and that he would not instigate any claim against the Government resulting from the use of the forfeited plant. In the event, all the successful tenderers, i.e. Contractors C, D and E, chose to use the forfeited mucking systems, among other forfeited plant, and signed the No Claim Statements.

Replacement of the defective mucking system

4.8 In July 1997, Contractor E commenced the works. In October and November 1997, Contractor E started excavating Tunnels G and F respectively.

Contractor E found that the mucking system could not operate effectively at full load. In December 1997, Contractor E employed an expert to inspect the mucking system. The expert concluded that the system could not be safely used for the tunnel works. The mechanical hoisting and the electronic control had problems, which affected the safe operation of the system. Contractor E decided to completely replace the system. In January 1998, Contractor E submitted the expert's findings to the DSD and submitted a claim for monetary compensation for the cost of replacement and extension of time.

Advice of an independent specialist

4.9 In February 1998, the consulting engineer (hereinafter referred to as the Consultant) employed by the DSD to supervise the contracts commissioned a specialist in winch machines to carry out an independent review of the defects of the mucking system. The specialist considered that the serious latent defects of the mucking system could not have reasonably been foreseen by a civil engineering contractor. Such defects could only be identified after the system was put to repeated use under full load conditions.

Advice of the Consultant

4.10 In March 1998, the Consultant considered that Contractor E's claim was not a clear case, and cast doubt on the applicability of the exclusion clauses. Regarding the specialist's view that a civil engineering contractor would not have the necessary expertise to identify the latent defects, the Consultant considered that it was not unreasonable to have expected that Contractor E would hire an expert to examine the suitability of the mucking system, given the importance of the system and the clear intention of the contract that the contractor was to accept the risk on the use of the system.

4.11 The Consultant concluded that, on a balance of probability, Contractor E was unlikely to succeed in arguing that the exclusion clauses were ineffective. On the other hand, if Contractor E attacked the applicability of the exclusion clauses, this would be an arguable case although the Contractor was unlikely to be successful. However, the Government would have to incur significant legal costs and the project would be delayed.

4.12 From a dispute resolution point of view, the Consultant said that it was desirable to take into account the Government's overall cost. If the dispute was escalated, considerable legal expenses would be incurred and the outcome could not be predicted with certainty, as an arbitrator or judge might be sympathetic to a contractor when the risk allocation was unfavourable to the contractor. The Consultant recommended that Contractor E should be given the benefit of doubt and the claim should be resolved under the terms of the contract in favour of Contractor E.

Legal advice

4.13 In March 1998, the DSD requested the Department of Justice (DOJ) to peruse the Consultant's assessment and give advice. The DSD informed the DOJ that it was beyond dispute that Contractor E had not foreseen the problem with the mucking system when the tender was submitted, and was therefore suffering from very significant financial consequences. As such, Contractor E would rigorously pursue the claim. Bearing in mind the general works policy that disputes should be resolved at their initiation to avoid unnecessary dispute escalation or festering of working relationship, and the importance of completing the tunnel works, the DSD considered that the Consultant's recommendation should be endorsed. In response, the DOJ said that it agreed with the DSD's assessment.

Settlement of the claim

4.14 On 25 March 1998, the DSD accepted Contractor E's claim after considering the views given by the independent expert, the Consultant and the DOJ. The Consultant then assessed the replacement cost. As the mucking systems of Contracts C and D were similar to the one used by Contractor E and were likely to have the same problems, the DSD also instructed Contractors C and D to replace their systems. The Consultant also assessed the claims from Contractors C and D for replacing their systems.

Additional cost and delay to tunnel completion contracts

4.15 Replacing the mucking systems of the three tunnel completion contracts resulted in substantial additional cost and significant delay. The details are shown in Table 8.

Table 8

Additional cost and delay due to replacing the mucking systems

	Contract C	**Contract D**	**Contract E**
Additional cost (Note)	$33.9 million	$59.7 million	$42.1 million
Delay	3.4 months	4.5 months	5.7 months

Source: *DSD records*

Note: *The additional cost of replacing the mucking systems formed part of the claim filed by the Government on the defaulted contractor (see para. 3.12 and Item (C) of Appendix E).*

Audit observations

Use of the forfeited plant

4.16 According to DSD records, except the mucking systems, other items of forfeited plant used by the contractors generally functioned properly. The use of forfeited plant would result in lower tender prices. The DSD intention was that the contractors should be allowed to elect to use the forfeited plant for their own benefit and at their own risk.

4.17 **According to the exclusion clauses and the No Claim Statement, the contractors were to bear the risks arising from the use of the forfeited plant. However, in the event, the Government incurred substantial additional costs due to the need to replace the defective mucking systems. The completion of the tunnelling works was also delayed. Audit considers that the Government needs to review the arrangement for the use of forfeited plant in completion contracts and, in particular, the applicability of the exclusion clauses and the No Claim Statement, with a view to formulating guidelines to protect the Government's interests.**

Need to conduct risk-benefit analysis

4.18 The total cost incurred for replacing the defective mucking systems included the direct cost of the new mucking systems and the prolongation cost. Based on the claims settled with the contractors, the cost of replacing the mucking systems is shown in Table 9.

Table 9

Cost of replacing the mucking systems

	Contract C ($ million)	Contract D ($ million)	Contract E ($ million)	Total ($ million)
(A) Direct cost	13.5	17.1	12.2	42.8
(B) Prolongation cost	20.4	42.6	29.9	92.9
(C) Total cost	33.9	59.7	42.1	135.7
(D) **Prolongation cost as a percentage of the total cost ((B) ¸ (C) ´ 100%)**	**60.2%**	**71.4%**	**71.0%**	**68.5%**

Source: DSD records and Audit analysis

4.19 As shown in Table 9, the total prolongation cost was $92.9 million, or 68.5% of the total cost for replacing the mucking systems. In this context, Audit noted that the cost of bringing in new plant at the beginning of the contracts, which mainly involved the direct cost, was lower than the total cost of replacement. **The use of forfeited plant may have the benefit of a lower tender price. However, it may involve the risk of accepting subsequent claims for replacing the defective plant at a total cost much higher than the direct cost.**

4.20 As happened in Contracts C, D and E, the risk that the Government might in the end have to replace the defective forfeited plant materialised. **Audit considers that, prior to making forfeited plant available for use in a completion contract, the DSD needs to conduct a risk-benefit analysis on the use of those items of forfeited plant that are critical to the completion of the works.**

Audit recommendations

4.21 **Audit has *recommended* that the Director of Drainage Services, in collaboration with the Secretary for the Environment, Transport and Works, should:**

(a) **review the arrangement for the use of forfeited plant in completion contracts, in particular, the applicability of the exclusion clauses and No Claim Statement, with a view to formulating guidelines to protect the Government's interests; and**

(b) **if there is intention to allow a contractor to use forfeited plant in a completion contract, conduct a risk-benefit analysis on the use of those items of forfeited plant that are critical to the completion of the works.**

Response from the Administration

4.22 The **Director of Drainage Services** generally agrees with the audit recommendations mentioned in paragraph 4.21.

4.23 The **Secretary for the Environment, Transport and Works** welcomes the audit recommendations mentioned in paragraph 4.21 and will take into account the audit recommendations in considering the revision of the contract re-entry procedures.

Difficult ground conditions

Site investigation to assess ground conditions

4.24 The six sewage tunnels were built 80 metres to 150 metres below ground or sea level to ensure a minimum rock cover of 30 metres. The tunnels were excavated by tunnel boring machines, except for Tunnel G (from Kwai Chung to Tsing Yi) where the drill and blast method was used. According to the DSD, tunnelling works were difficult engineering works, particularly when they were carried out deep underground. There was not much experience in the world in excavating tunnels at such depths and under high water pressure.

4.25 Prior to tendering of the tunnelling works, the DSD had made use of the geological information of the Geotechnical Engineering Office and had conducted extensive geological investigations to assess the ground conditions. These site investigations included seismic surveys and borehole investigations along the tunnel alignment. The DSD also carried out laboratory testing on the soil and rock samples obtained to assess the ground conditions. A total of 150 boreholes were drilled for HATS Stage I. The expenditure for the site investigations was $220 million. Similar to other tunnel projects, the boreholes were widely spaced and could only provide an indication of the ground conditions. This reflected the inherent uncertainties of ground conditions for deep tunnel projects. Precise information on the actual ground conditions at each location could only be ascertained during tunnel excavation.

Actual ground conditions worse than anticipated

4.26 During the tunnel excavation works, the actual ground conditions (except Tunnel G which had better ground conditions than expected) were found to be much worse than those indicated by the site investigations. There were several difficult geological regions. The major fault zones were more extensive than expected. The fractured rocks in the fault zones were extremely difficult to drill through. There were instances where weak rocks were encountered and some earth materials fell into the tunnels. To enable the excavation to proceed safely, the contractors carried out additional ground strengthening and stabilisation measures, which included grouting ahead of the excavation to control excessive ground water inflow, and the installation of reinforcement bars, steel casing tubes and steel support frames.

Audit observations

Delay and additional cost

4.27 The additional works to deal with the difficult ground conditions were very time-consuming and could not have been foreseen when the tenders were called for. The contractors claimed for the direct and prolongation costs incurred. The DSD had to bear

additional costs totalling $346 million. The additional works for tackling the difficult ground conditions also seriously disrupted the progress of the works. Table 10 shows the additional cost and the delay involved.

Table 10

Additional cost and delay due to difficult ground conditions

	Contract C	Contract D	Contract E
Additional cost	$46.7 million	$103.9 million	$195.4 million
Delay	5.5 months	5 months	16.6 months

Source: DSD records

Need to conduct more comprehensive site investigations

4.28 In October 2000, the DSD informed the LegCo Panel on Environmental Affairs that the cost of the site investigations (conducted in the early 1990s) was fairly substantial. However, with the benefit of hindsight, the DSD considered that the site investigations were not sufficient to reveal the actual ground conditions. In future, for projects involving substantial underground works, the DSD would conduct more comprehensive site investigations to reduce as far as possible uncertainties due to the variability of ground conditions even though it was not possible to wholly eliminate the uncertainties.

4.29 In conducting site investigations, the DSD applied various hi-tech methods. As new technology was developed, the DSD would examine the cost-effectiveness of applying the new technology in conducting site investigations. For tunnelling works such as those for the further stages of HATS, the DSD would set up working groups with the participation of the Geotechnical Engineering Office and tunnelling experts to plan the site investigations.

4.30 In December 2003, in response to Audit's enquiry, the ETWB and the DSD said that a review had been conducted on the adequacy of the site investigations for HATS Stage I. They would promulgate guidelines to improve site investigation of future tunnel projects.

Figure 1

Harbour Area Treatment Scheme Stage I
catchment area and alignment of the sewage tunnels
(paras. 1.2 and 1.5 refer)

Legend: HATS Stage I catchment area

Source: EPD records

Figure 2

Locations of the water quality monitoring stations in Victoria Harbour
(para. 5.6 refers)

Legend: Water quality monitoring station

Source: EPD records

Figure 3

Locations of the beaches in the Tsuen Wan District
(para. 5.12 refers)

Legend: ○ Beach

Source: EPD records

Photograph 1

An example of a mucking system
(para. 4.4 refers)

Source: DSD records

Audit recommendations

4.31 **Audit has *recommended* that the Director of Drainage Services should:**

(a) **improve the methodology for conducting site investigations by adopting new technology; and**

(b) **for major works projects involving substantial underground works (e.g. the further stages of HATS), conduct comprehensive site investigations with the assistance of geotechnical and tunnelling experts to provide more accurate information about the ground conditions.**

4.32 **Audit has also *recommended* that the Secretary for the Environment, Transport and Works should promulgate guidelines for improving site investigations, particularly for tunnel projects.**

Response from the Administration

4.33 The **Director of Drainage Services** generally agrees with the audit recommendations mentioned in paragraph 4.31.

4.34 The **Secretary for the Environment, Transport and Works** welcomes the audit recommendations mentioned in paragraphs 4.31 and 4.32. She has said that actions are being taken to promulgate guidelines for improving site investigations of future tunnel projects.

Substantial cost increase in tunnel completion contracts

Additional funding for cost increase

4.35 There was substantial cost increase in the three tunnel completion contracts due to:

(a) replacement of the defective mucking systems (see paras. 4.4 to 4.20); and

(b) additional works relating to difficult ground conditions (see paras. 4.24 to 4.30).

Table 11 summarises the cost increase of the three contracts and the supplementary provision approved.

Table 11

Cost increase and supplementary provision

Reason for cost increase	Contract C ($ million)	Contract D ($ million)	Contract E ($ million)
Replacement of the mucking system	33.9	59.7	42.1
Additional works due to difficult ground conditions	46.7	103.9	195.4
Others (Note)	(31.9)	(23.7)	10.9
Total	**48.7**	**139.9**	**248.4**
Supplementary provision	**Nil**	**Nil**	**115.0**

Source: *DSD records*

Note: *For Contracts C and D, there were offsetting savings from other works items.*

4.36 Table 11 shows that despite the substantial cost increases, Contracts C and D did not require any supplementary provision. While supplementary provision was sought for Contract E, the amount of $115 million was much less than the cost increase of $248.4 million. Audit analysed the approved project estimates (APEs) and the cost increases of Contracts C, D and E and found that there is room for improvement in budgetary control.

Budgetary control over public works projects

4.37 Upon the approval of funding by the FC, the APE of a works project becomes the expenditure ceiling under the project. Project proponents should estimate the cost accurately to avoid the over-estimation of the APE. The Secretary for Financial Services and the Treasury has the delegated authority for approving an increase in the APE of up to $15 million. Application for supplementary provision for increasing the APE by more than $15 million has to be submitted to the FC for approval.

4.38 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 (usually 5% to 10% of the APE). After tendering, the successful tender is accepted and the tender price becomes the awarded contract sum. The awarded contract sum can be quite different from the estimated contract sum included in the APE. During the course of the works, the head of a works department has the authority to approve an increase in the contract sum provided that there is no change in the scope of the contract and the APE is not exceeded.

Audit observations

Over-estimation of the contract sum

4.39 For the three tunnel completion contracts, Audit noted that the contract sums of the accepted tenders were substantially lower than those estimated in the APEs. Table 12 shows the over-estimation of the contract sum in the APE.

Table 12

Over-estimation of the contract sum in the approved project estimate

		Contract C ($ million)	Contract D ($ million)	Contract E ($ million)
(A)	APE (Note 1)	941.0	880.0	539.0
(B)	Less: sum reserved for contingency	52.0	48.0	39.0
(C)	Estimated contract sum in the APE	889.0	832.0	500.0
(D)	Less: contract sum of the accepted tender (Note 2)	773.0	574.8	356.8
(E)	**Over-estimation of the contract sum in the APE**	**116.0**	**257.2**	**143.2**
(F)	**Percentage of over-estimation ((E) ¸ (C) ´ 100%)**	**13.0%**	**30.9%**	**28.6%**

Source: *DSD records and Audit analysis*

Note 1: *Contract E was funded under Project 320DS with an APE of $539 million. Contracts C and D were funded under Project 286DS with an APE of $2,000 million, comprising:*

	($ million)
Contract C	*941*
Contract D	*880*
Consultancy fees for construction supervision	*179*
Total APE	*2,000*

Note 2: *For each contract, the DSD assessed and concluded that the price of the accepted tender was reasonable. The DSD considered that the tender price was not unreasonably low to pose a high risk regarding the contractor's ability to complete the works.*

4.40 **Table 12 shows that the over-estimations of the contract sums amounted to $116 million (Contract C), $257.2 million (Contract D) and $143.2 million (Contract E). In view of the substantial over-estimations, Audit considers that the DSD needs to improve the accuracy of the estimated contract sum included in the APE.**

4.41 In January 2000, the then Secretary for Works 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 requested the works departments:

— to take measures to improve the accuracy of the project estimates before preparing the PWSC papers for funding approval;

— to review their system of collecting, updating and sharing out of the centralised database of unit costs; and

— **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.**

4.42 In response, in January 2001, the DSD issued DSD Technical Circular No. 2/2001 "Project Estimates and Pre-Tender Estimates". This circular sets out additional monitoring and control measures for improving the accuracy of project estimates and pre-tender estimates. **Audit considers that the DSD should continue to introduce necessary measures to improve the accuracy of project estimates and ensure that the promulgated guidelines for preparing project estimates are complied with.**

Approved project estimate not adjusted to reflect the lower tender price

4.43 There is a mechanism in place to reduce the APE when the awarded contract sum is lower than that estimated in the APE. According to an information paper prepared in March 1996, the Administration informed the FC that:

> ***"Where the tender sum is below the estimate approved by the Finance Committee, we will consider reducing the approved estimate to reflect the lower forecast outturn price."***

4.44 The FC has delegated the authority to reduce the APE to the Secretary for Financial Services and the Treasury. Requests for reduction in the APE by any amount may be made to the Secretary for Financial Services and the Treasury by memorandum, without involving the FC, provided that the scope of the project remains unchanged.

4.45 DSD Technical Circular No. 5/93 "Public Works Subcommittee Submissions" issued in April 1993 stipulates that **DSD Division Heads are required to periodically review the APEs for works projects. If they are satisfied that the APE of a project can be reduced, they should seek the approval of the Secretary for Financial Services and the Treasury.**

4.46 Despite the guidelines, Audit noted that the DSD did not reduce the APEs of the tunnel completion contracts even though the accepted tender prices were much lower than the estimated contract sums included in the APEs. Audit could not find any documentation of the reasons for the DSD not to do so. **Audit considers that the DSD should follow the guidelines for reducing the APE, and document the reasons for cases where reducing the APE is considered not warranted.**

Surplus funds used for cost increase

4.47 As the DSD had not reduced the APEs to reflect the lower tender prices, the surplus funds (representing the over-estimation of the contract sums) in the APEs were eventually used to meet the increases in the contract sums (see Table 13).

Table 13

Surplus funds from over-estimation and increase in contract sum

		Contract C	Contract D	Contract E
		($ million)	**($ million)**	**($ million)**
(A)	Surplus funds from over-estimation (see Table 12 in para. 4.39)	116.0	257.2	143.2
(B)	Final contract sum	821.7	714.7	605.2
(C)	Original contract sum	773.0	574.8	356.8
(D)	**Cost increase (i.e. (B) - (C), see Table 11 in para. 4.35)**	**48.7**	**139.9**	**248.4**
(E)	**Cost increase as a percentage of original contract sum ((D) ¸ (C) ´ 100%)**	**6.3%**	**24.3%**	**69.6%**

Source: DSD records and Audit analysis

4.48 Table 13 shows that for Contracts C and D, the DSD did not have to seek additional funding from the FC because the cost increase was covered by the surplus fund in the APE. As for Contract E, the DSD had to seek supplementary provision from the FC because the surplus fund of $143.2 million was insufficient to meet the cost increase of $248.4 million. Appendix G is a summary of the changes in the contract sums and the changes in the APEs of the tunnel completion contracts.

4.49 For Contracts C and D, the FC was not informed of the over-provision in the APE of $373.2 million (i.e. $116.0 million + $257.2 million) since no supplementary provision was sought. The FC was also not informed of the cost increase of $188.6 million (i.e. $48.7 million + $139.9 million) and of the fact that the increase was covered by the over-provision in the APE.

4.50 **For Contract E, the Administration sought from the FC supplementary provision of $115 million, which was less than the actual increase of $248.4 million. In the submission to the FC, Audit noted that the Administration did not mention the cost increase of $248.4 million. The submission only provided justifications for the additional funding of $115 million. The FC was not informed that a substantial part of the cost increase of $133.4 million (i.e. $248.4 million - $115 million) was covered by the over-provision in the APE. Audit considers that the FC should have been so informed.**

Audit recommendations

4.51 **Audit has *recommended* that the Director of Drainage Services should:**

(a) **take action to improve the accuracy of project estimates and ensure that the promulgated guidelines for preparing project estimates are complied with; and**

(b) **take action to reduce the APE of a project when the tender price is significantly lower than the estimated contract sum in the APE, and document the reasons where a reduction in the APE is considered not warranted.**

4.52 **Audit has also *recommended* that the Secretary for the Environment, Transport and Works should:**

(a) **remind all works departments to follow the guidelines to adjust the APE when the tender price is significantly lower than the estimated contract sum in the APE; and**

(b) **remind all works departments and relevant policy bureaux to state clearly in their submissions to the FC seeking an increase in the APE for works projects:**

(i) **the total cost increase and the reasons for the increase; and**

(ii) **whether any surplus funds in the APE have been used to meet the cost increase.**

Response from the Administration

4.53 The **Director of Drainage Services** generally agrees with the audit recommendations mentioned in paragraph 4.51. He agrees to document the reasons for cases where a reduction in the APE is considered not warranted. He has said that:

(a) the awarded contract sum, which is heavily affected by the prevailing market conditions, the pricing strategies and the perception of risks of individual contractors, does not necessarily give an accurate indication of the final cost of the works. The final cost is influenced by the nature of the works and necessary variations for completion;

(b) the prices of the tenders received for the three tunnel completion contracts varied widely. For each contract, the average price of the tenders received was very close to or even higher than the estimated contract sum in the APE. There was no clear indication that the contract sums were grossly over-estimated (Note 6); and

(c) shortly after Contract E commenced in July 1997, problems with the mucking system started to surface in early November 1997. By early February 1998, difficult ground conditions were encountered and tunnel excavation had to be suspended. Contracts C and D were awarded in January 1998. It was not considered prudent to adjust the APEs downwards in view of these problems and the likely financial implications even though the contracts were awarded at relatively lower tender prices. The subsequent development and the final contract sums showed that the consideration at the time was appropriate.

Note 6: *In assessing the accuracy of the estimated contract sum, Audit considers that it is more appropriate to compare it with the price of the accepted tender (see para. 4.39), rather than the average price of tenders received. Indeed, in January 2000, the then Secretary for Works expressed concern about the persistent over-estimation of the APEs in works projects against the tenders awarded (see para. 4.41).*

4.54 The **Secretary for Financial Services and the Treasury** generally agrees with the audit recommendations. He has said that:

(a) apart from reducing the APE, the Financial Services and the Treasury Bureau has put in place measures to ensure proper control and use of funding under the APE. If the outturn tender price is lower than the approved estimate, the Financial Services and the Treasury Bureau would administratively adjust downward the capital resources allocated to the project. The lower spending limit would become an administrative cap on the project expenditure. Works departments should not expend beyond the administrative cap unless with full justifications and approval by the Financial Services and the Treasury Bureau. Under existing arrangements, information on the outturn tender prices for contracts each exceeding $30 million is submitted to LegCo for reference; 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. In that context, works departments have been urged to 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.

4.55 The **Secretary for the Environment, Transport and Works** generally agrees with the audit recommendations mentioned in paragraph 4.52. She has said that as the estimates of projects may fluctuate from time to time, it is not desirable to reduce the APE each time when the latest estimate is lower than the APE (due to lower tender prices or other reasons) except where the Controlling Officer is certain that there will ultimately be significant surplus funds under the project. To have done otherwise would involve the FC and the Financial Services and the Treasury Bureau in the micro-management of contracts and detract them from the deliberation of other more important financial issues.

PART 5: IMPACT ON WATER QUALITY OF VICTORIA HARBOUR

5.1 This PART examines the effectiveness of HATS Stage I in improving the water quality of Victoria Harbour.

Project commissioning

5.2 Before December 2001, sewage from the urban areas on both sides of Victoria Harbour was discharged directly into the harbour after simple screening and degritting at local preliminary treatment works. After the full commissioning of HATS Stage I in December 2001, about 75% of the sewage from the harbour area is conveyed from the local preliminary treatment works through the sewage tunnels to the Stonecutters Island STW for treatment. The treated effluent is discharged to the western harbour area via a submarine outfall 1.7 kilometres southwest of Stonecutters Island.

Stonecutters Island Sewage Treatment Works

5.3 The Stonecutters Island STW is the largest sewage treatment plant in the world employing the chemically enhanced primary treatment process. It was built on 10.6 hectares of reclaimed land at the cost of $2,100 million. It has a design capacity for treating 1.7 million cubic metres of sewage a day. In 2002, the sewage flow was 1.4 million cubic metres a day on average. A brief description of different sewage treatment processes is provided at Appendix H.

5.4 At present, the DSD is operating 24 preliminary treatment works, 2 primary treatment works, and 6 secondary treatment works (3 of which with disinfection facility). There are no tertiary treatment works. The Stonecutters Island STW is one of the two chemically enhanced primary treatment works and is not provided with disinfection facility. The ETWB is currently considering, in the context of the development of the further stages of HATS, upgrading the treatment level at the Stonecutters Island STW and installing a disinfection facility. The DSD has conducted trials on the use of Biological Aerated Filter technology, an advanced sewage treatment process characterised by its compact size, for application in Hong Kong. At present, there are no firm plans for implementing the further stages of HATS.

Operating performance of the Stonecutters Island Sewage Treatment Works

5.5 The operating efficiency of a sewage treatment plant is usually measured by its efficiency in removing pollutants from the sewage. In the design of the Stonecutters Island STW, target rates were set on its pollutant removal efficiency. The actual performance of

the Stonecutters Island STW indicated that it had achieved and exceeded the target pollutant removal rates. According to the DSD, the Stonecutters Island STW's performance has been excellent. It is recognised as one of the world's most efficient facilities adopting the chemically enhanced primary treatment process.

Monitoring of marine water quality

5.6 The EPD monitors the marine water quality in Hong Kong by periodically collecting samples from various locations for testing. The EPD positions 17 water quality monitoring stations in the harbour as shown in Figure 2 on the centre pages.

5.7 The EPD uses the following four key water quality parameters to assess the marine water quality:

(a) ***Dissolved oxygen.*** It indicates the total amount of oxygen dissolved in water. Most marine organisms need oxygen for respiration and maintenance of life. An increase in dissolved oxygen represents an improvement in water quality whereas a decrease represents a deterioration;

(b) ***Ammonia.*** It is found at quite high levels in sewage. A high concentration of ammonia is toxic to marine life. An increase in ammonia represents a deterioration in water quality whereas a decrease represents an improvement;

(c) ***Total inorganic nitrogen.*** It is a measure of the amount of nutrients in water. A large amount of total inorganic nitrogen may stimulate excess algal growth in water. An increase in total inorganic nitrogen represents a deterioration in water quality whereas a decrease represents an improvement; and

(d) ***E. coli.*** It is a kind of bacteria found in human faeces, often used as an indicator of sewage pollution. The level of E. coli is a measure of the sewage bacteria in the water. A high E. coli count indicates greater faecal contamination and higher health risk. A decrease in E. coli count represents an improvement in water quality. E. coli is a key parameter for bathing beaches.

5.8 To evaluate the effectiveness of HATS Stage I in improving the water quality of Victoria Harbour, it is relevant to compare the changes in the four key water quality parameters before (in 2001) and after (in 2002) the commissioning of HATS Stage I. Appendix I shows the comparison of water quality of Victoria Harbour between 2001 and 2002.

Water quality after project commissioning

Significant improvement in water quality in Victoria Harbour

5.9 Since the full commissioning of HATS Stage I in December 2001, there has been a significant improvement in the water quality in Victoria Harbour. The improvement has extended to the beaches on the eastern side of Hong Kong Island, such as Shek O and Big Wave Bay. An analysis of the 2001 and 2002 water quality monitoring data in Appendix I shows that:

(a) ***Dissolved oxygen.*** The level of dissolved oxygen in the harbour increased. The level increased by around 20% to 30% in most parts of the harbour, even though the increase was lower (around 10%) in the western harbour area;

(b) ***Ammonia.*** From Lei Yue Mun in the east to Rambler Channel in the west (except at one location near Green Island), the ammonia level in most of the locations declined by about 20% to 50%;

(c) ***Total inorganic nitrogen.*** The total inorganic nitrogen declined by around 30% to 40% in the central and eastern harbour areas, and by 2% to 13% in the western harbour area; and

(d) ***E. coli.*** The level of E. coli declined by nearly 90% at Lei Yue Mun to around 60% in the north Rambler Channel. **However, in the western harbour area, the bacteria level showed quite a substantial increase.**

Adverse impact on water quality in the western harbour area

5.10 Notwithstanding the general improvements in terms of the increased level of dissolved oxygen and the reduction in pollutants, in 2002 the level of E. coli in four water quality monitoring stations in the western harbour area increased substantially after the full commissioning of HATS Stage I, as shown in Table 14:

Table 14

Bacteria level in the western harbour area
2001 and 2002

Water quality monitoring station		Level of E. coli		% increase
Station	**Location**	**2001**	**2002**	
		(a)	**(b)**	$(c) = \frac{(b)-(a)}{(a)} \times 100\%$
		(count/100 ml)	**(count/100 ml)**	
VM8	Near Green Island	2,200	4,900	122.7%
WM3	Near South Tsing Yi	1,400	3,300	135.7%
WM4	Between Tsing Yi and Ma Wan	660	1,400	112.1%
WM2	Between Green Island and Kau Yi Chau	490	760	55.1%

Source: EPD records

5.11 According to the EPD, the rise in bacteria level in the western harbour area in 2002 was due to the large volume of treated effluent discharged from the Stonecutters Island STW via the submarine outfall. As the level of sewage treatment at the Stonecutters Island STW was only up to the chemically enhanced primary treatment level without disinfection, it could only remove 50% of the bacteria in the sewage. The large volume (1.4 million cubic metres a day) of effluent discharge from it had brought about the rise in the bacteria level.

Closure of Tsuen Wan beaches

5.12 The increased bacteria level in the western harbour area has affected the Tsuen Wan beaches. There are eight gazetted beaches in the Tsuen Wan District. Seven of them are situated along the Tsuen Wan coast, and one is in Ma Wan. Three of the beaches have been closed to the public since the mid-1990s because of the poor water quality due to local pollution. Figure 3 on the centre pages shows the locations of the eight beaches in the Tsuen Wan District.

5.13 After the full commissioning of HATS Stage I, the water quality at the Tsuen Wan beaches has deteriorated. A comparison of the bacteria level of the Tsuen Wan beaches between 2001 and 2002 is summarised in Table 15.

Table 15

Bacteria level of the beaches in Tsuen Wan District
2001 and 2002

	E. coli level		
Beach	**2001**	**2002**	**% increase**
	(a)	**(b)**	**(c) = $\frac{(b)-(a)}{(a)} \times 100\%$**
	(count/100 ml)	**(count/100 ml)**	
Gemini	323	1,155	257.6%
Casam	233	741	218.0%
Hoi Mei Wan	199	547	174.9%
Lido	269	683	153.9%
Anglers (Note)	621	1,169	88.2%
Approach (Note)	411	696	69.3%
Tung Wan (in Ma Wan)	133	201	51.1%
Ting Kau (Note)	739	742	0.4%

Source: *EPD records*

Note: *These three beaches have been closed since the mid-1990s.*

5.14 In determining the beach water quality, an E. coli level exceeding 610 count per 100 ml (corresponding to a swimming-associated illness rate of more than 15 cases per 1,000 swimmers) is considered not suitable for swimming (Note 7). **In 2002, the E. coli level of most of the beaches in Tsuen Wan exceeded the threshold level of 610 count per 100 ml. According to the EPD, the increase in the E. coli level was due to the effluent discharge from the Stonecutters Island STW.**

Note 7: *The EPD classifies beaches into the following four ranks based on the E. coli level:*

Rank	***E. coli level (count/100 ml)***	***Minor illness rate (cases per 1,000 swimmers)***
Good	*24 and below*	*Undetectable*
Fair	*25 to 180*	*10 and below*
Poor	*181 to 610*	*11 to 15*
Very Poor	*Over 610*	*Over 15*

5.15 In early 2003, in order to safeguard the health of swimmers, the EPD recommended the Leisure and Cultural Services Department (Note 8) to close the four Tsuen Wan beaches (i.e. Gemini, Casam, Hoi Mei Wan and Lido) for the 2003 bathing season in addition to the three closed beaches. Consequently, all the seven beaches along the Tsuen Wan coast were closed for the 2003 bathing season. Tung Wan in Ma Wan was the only beach in the Tsuen Wan District that remained open.

Audit observations

Need to closely monitor water quality

5.16 **After the commissioning of HATS Stage I, there has been a significant improvement of water quality in Victoria Harbour and at beaches on the eastern side of Hong Kong Island. However, there has been a rise in the bacteria level in the western harbour area. Audit considers that the EPD needs to continue to monitor closely the impact of HATS Stage I on the water quality of Victoria Harbour, particularly the bacteria level in the western harbour area and the Tsuen Wan beaches. The EPD should also take into account the high bacteria level of the treated effluent from the Stonecutters Island STW in planning the further stages of HATS, and in evaluating options for providing a permanent disinfection facility in the long term.**

Need to consider interim measures

5.17 According to the EPD, the Tsuen Wan beaches are affected by both the local sources of pollution and the discharge from the Stonecutters Island STW. When the local sewerage system is completed in 2006 and properties are subsequently connected to it, the local pollution should decrease. There will be some improvement in the water quality. However, in the longer term, as the population and sewage flows in the HATS catchment increase, deterioration in water quality will likely occur. There will only be long-term improvements when the further stages of HATS are completed.

5.18 The further stages of HATS, however, are still in the planning stage. It may take many years before the treatment level at the Stonecutters Island STW is upgraded together with the installation of a *permanent* disinfection facility. **Audit considers that the Administration needs to consider providing *interim* measures (such as installing a *temporary* disinfection facility) to reduce the bacteria level in the western harbour area.**

Note 8: *The Leisure and Cultural Services Department manages the opening and closing of gazetted beaches.*

Audit recommendations

5.19 **Audit has *recommended* that the Director of Environmental Protection should:**

(a) **continue to closely monitor the impact of HATS Stage I on the water quality of Victoria Harbour, particularly the bacteria level in the western harbour area and the Tsuen Wan beaches; and**

(b) **take into account the high bacteria level of the effluent discharged from the Stonecutters Island STW in planning the further stages of HATS, and in evaluating the options for providing a permanent disinfection facility in the long term.**

5.20 **Audit has also *recommended* that the Secretary for the Environment, Transport and Works, in collaboration with the Director of Environmental Protection and the Director of Drainage Services, should consider the need for providing some *interim* measures, such as installing a *temporary* disinfection facility at the Stonecutters Island STW, in order to reduce the bacteria level in the western harbour area, having regard to the fact that the further stages of HATS may take many years to complete.**

Response from the Administration

5.21 The **Secretary for the Environment, Transport and Works,** the **Director of Environmental Protection** and the **Director of Drainage Services** generally agree with the audit recommendations mentioned in paragraphs 5.19 and 5.20.

Appendix A
(para. 2.7 refers)

Financial position of works projects

Project	Approved project estimates			Reasons for increase	Latest forecast expenditure
	Original (a)	Revised (b)	Increase (c) = (b) - (a)		
	($ million)	($ million)	($ million)		($ million)
(A) Advance works					
287DS — Advance works	562.4	562.4	—	—	558.9
Sub-total	562.4	562.4	—		558.9
(B) Sewage tunnel system					
304DS — Tunnels from Chai Wan and Tseung Kwan O to Kwun Tong	342.4	342.4	—	—	306.4
311DS — Tunnels from Kwun Tong and Kwai Chung to Stonecutters Island	429.1	429.1	—	—	390.0
286DS — Tunnels from Chai Wan and Tseung Kwan O to Kwun Tong and from Kwun Tong to Stonecutters Island	—	2,000.0	**2,000.0**	Due to forfeiture of the original tunnel contracts, the completion works for the tunnels were re-tendered.	2,000.0
320DS — Tunnels from Kwai Chung to Stonecutters Island	539.0	654.0	**115.0**	Mainly due to the replacement of defective mucking systems, and additional works for dealing with unforeseen ground conditions.	599.0
Sub-total	1,310.5	3,425.5	**2,115.0**		3,295.4
(C) Stonecutters Island Sewage Treatment Works					
288DS — Chemical dosing facilities	143.3	143.3	—	—	135.0
305DS — Sludge treatment facilities	275.0	275.0	—	—	268.0

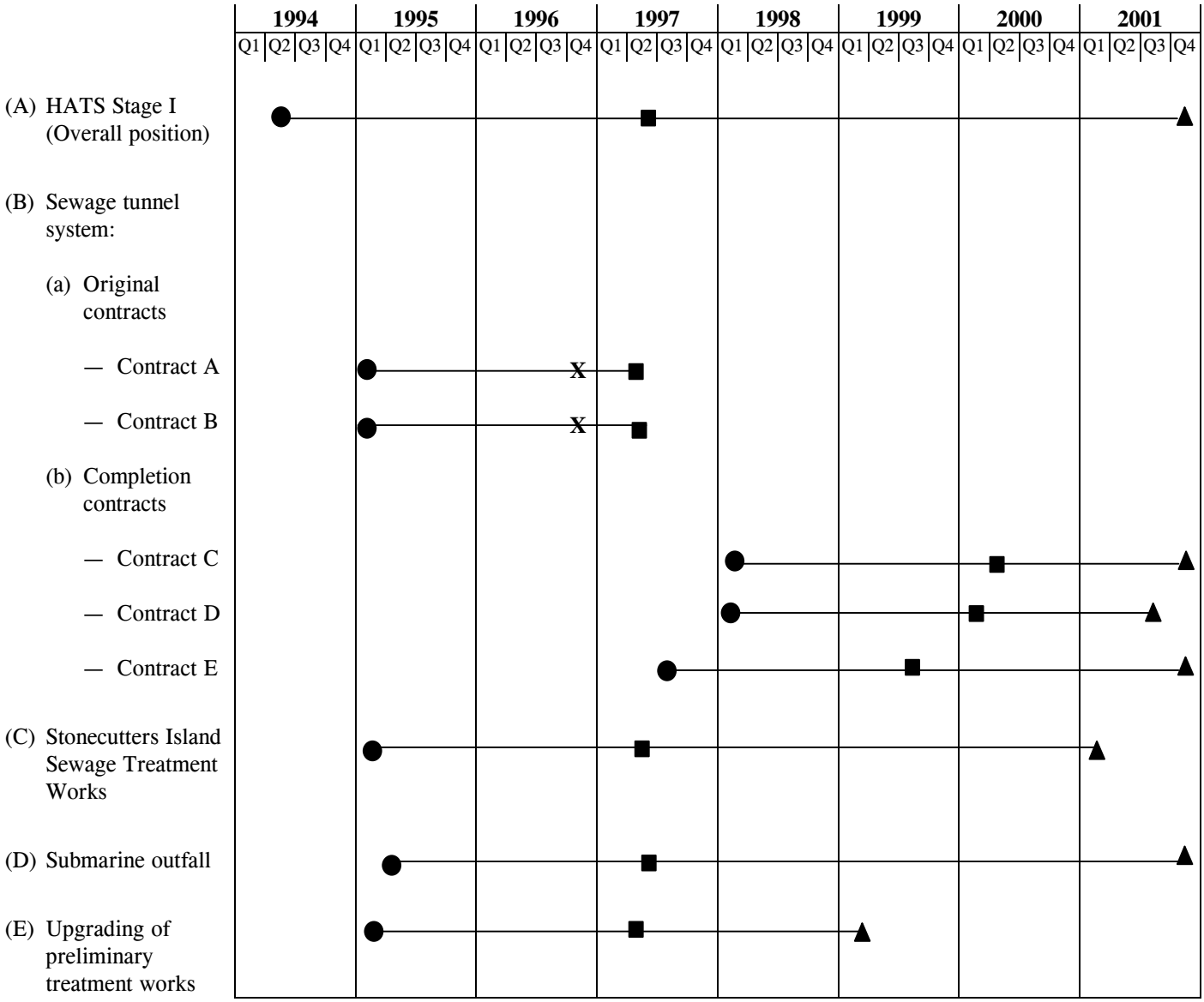
Project	Approved project estimates			Reasons for increase	Latest forecast expenditure
	Original (a)	Revised (b)	Increase (c) = (b) - (a)		
	($ million)	($ million)	($ million)		($ million)
306DS — Sedimentation tank civil works	372.1	372.1	—	—	365.3
307DS — Pumping station electrical and mechanical equipment	437.4	437.4	—	—	420.9
308DS — Pumping station, buildings and site development	397.1	457.1	**60.0**	Mainly due to forfeiture of the tunnel contracts, interfacing problem with Project 307DS and design changes.	446.1
310DS — Sedimentation tank electrical and mechanical equipment	401.5	401.5	—	—	384.0
316DS — Construction of sludge facilities and supply of sludge containers	52.4	52.4	—	—	39.9
Sub-total	2,078.8	2,138.8	**60.0**		2,059.2
(D) Submarine outfall					
315DS — Submarine outfall	562.7	562.7	—	—	545.1
Sub-total	562.7	562.7	**—**		545.1
(E) Upgrading of preliminary treatment works					
309DS — Upgrading existing preliminary treatment works	841.7	841.7	—	—	812.8
Sub-total	841.7	841.7	**—**		812.8

Project	Approved project estimates			Reasons for increase	Latest forecast expenditure
	Original (a)	Revised (b)	Increase (c) = (b) - (a)		
	($ million)	($ million)	($ million)		($ million)
(F) Fees, investigation and supervision					
142DS — Consultant fees and investigation	130.0	130.0	—	—	97.0
312DS — Construction supervision of main works	620.2	719.0	**98.8**	Mainly due to the extension of the construction period for HATS Stage I.	719.0
A09DS — Pilot plant study	13.5	13.5	—	—	11.5
317DS — Baseline monitoring and performance monitoring	36.8	36.8	—	—	35.0
318DS — Environmental impact assessment study	54.7	68.3	**13.6**	Mainly due to the delay in completing the mathematical modelling to incorporate the latest population projection.	68.2
Sub-total	855.2	967.6	112.4		930.7
Total	**6,211.3**	**8,498.7**	**2,287.4**		**8,202.1**

Source: DSD records

Appendix B
(para. 2.10 refers)

Progress of the works



Legend: ● Commencement of works

■ Scheduled completion date

▲ Actual completion date

X Date of forfeiture

Q1, Q2, Q3, Q4: First, second, third and fourth quarter of the year respectively.

Source: DSD records

Appendix C
(para. 2.10 refers)

Completion of works projects

Project	Date of completion: Scheduled (a)	Actual (b)	Delay (c) = (b) - (a) (day)	Reasons for delay
(A) Sewage tunnel system				
304DS — Tunnels from Chai Wan and Tseung Kwan O to Kwun Tong (Contract A)	29-Apr-1997	Forfeited	N/A	Slow progress. Contract later forfeited.
311DS — Tunnels from Kwun Tong and Kwai Chung to Stonecutters Island (Contract B)	29-May-1997	Forfeited	N/A	Slow progress. Contract later forfeited.
286DS — Tunnels from Chai Wan and Tseung Kwan O to Kwun Tong and from Kwun Tong to Stonecutters Island				
— (Contract C)	24-Apr-2000	28-Nov-2001	583	Replacement of the mucking system and additional ground stabilisation due to unforeseen ground conditions.
— (Contract D)	29-Feb-2000	24-Sep-2001	573	Replacement of the mucking system, machinery breakdown, additional ground stabilisation due to unforeseen ground conditions, and additional works.
320DS — Tunnels from Kwai Chung to Stonecutters Island (Contract E)	25-Aug-1999	11-Dec-2001	840	Replacement of the mucking system, machinery breakdown, additional ground stabilisation due to unforeseen ground conditions, and additional works to facilitate commissioning of HATS Stage I.

Project	Date of completion			Reasons for delay
	Scheduled (a)	Actual (b)	Delay (c) = (b) - (a) (day)	
(B) Stonecutters Island Sewage Treatment Works				
288DS — Chemical dosing facilities	14-Jun-1997	27-Sep-1999	835	Inclement weather and the additional works for modification of the prototype chemical systems due to the delay in the tunnel contracts.
305DS — Sludge treatment facilities	27-May-1997	1-Sep-1997	97	Inclement weather and longer-than-expected time for commissioning due to delay in completion of the sewage tunnels.
306DS — Sedimentation tank civil works	15-Jun-1997	15-Jun-1997	0	N/A
307DS — Pumping station electrical and mechanical equipment	29-Jun-1997	20-Apr-2000	1,026	Interfacing problem with Project 308DS, forfeiture of tunnel contract and modification and disruption due to design changes.
308DS — Pumping station, buildings and site development	26-May-1997	19-Mar-2001	1,393	Interfacing problem with Project 307DS, forfeiture of tunnel contract and modification and disruption due to design changes.
310DS — Sedimentation tank electrical and mechanical equipment	15-Jun-1997	30-Sep-1999	837	Delay in access to the sedimentation tanks due to interfacing problem with Project 306DS.
316DS — Construction of sludge facilities and supply of sludge containers	10-Mar-1997	4-May-2000	1,151	Extended period for carrying out the works due to delay in the tunnel contracts.

Project	Date of completion: Scheduled (a)	Date of completion: Actual (b)	Delay (c) = (b) - (a) (day)	Reasons for delay
(C) Submarine outfall				
315DS — Submarine outfall	28-May-1997	13-Dec-2001	1,660	Commissioning deferred due to delay caused by forfeiture of the original tunnel contracts.
(D) Upgrading of preliminary treatment works				
309DS — Upgrading existing preliminary treatment works	18-Apr-1997	31-Mar-1999	712	Site possession deferred due to delay in tunnel contracts, damage of sewer at To Kwa Wan Preliminary Treatment Works and additional works for water supply to the fire hydrants.

Source: DSD records

Appendix D
(para. 3.6 refers)

Tunnel excavation up to forfeiture of contracts in December 1996

Tunnel	From	To	Length to be excavated	Actual length excavated	Percentage excavated
			(a)	**(b)**	**(c) = (b)/(a) × 100%**
			(metres)	**(metres)**	
AB	Chai Wan (via Shau Kei Wan)	Kwun Tong	4,830	625.0	12.9%
C	Tseung Kwan O	Kwun Tong	5,332	188.0	3.5%
D	Kwun Tong	To Kwa Wan	3,572	283.0	7.9%
E	To Kwa Wan	Stonecutters Island	5,495	123.6	2.2%
F	Tsing Yi	Stonecutters Island	3,580	481.2	13.4%
G	Kwai Chung	Tsing Yi	779	112.5	14.4%
		Total	**23,588**	**1,813.3**	**7.7%** (Note)

Source: *DSD records*

Note: *The scope of works of Contracts A and B also included works other than tunnel excavation. On the whole, about 15% of the works was completed up to the date of forfeiture (see para. 3.18).*

Appendix E
(para. 3.12 refers)

Additional expenditure due to forfeiture of the two original tunnel contracts

		($ million)
(A)	Interim maintenance and security of tunnel sites after forfeiture	109
(B)	Consultant fees and resident site staff costs incurred due to forfeiture	169
(C)	Additional costs for completing the works, including:	951
	— increased tender prices due to perceived higher risks of re-entered contract works	
	— re-mobilisation of site resources, refurbishment and re-provision of tunnelling equipment	
	— cost of replacement of defective mucking systems	
(D)	Variations and claims under other contracts due to the forfeiture of the two original tunnel contracts	64
	Total	**1,293**

Source: DSD records

Appendix F
(para. 3.15 refers)

Delay in submission of duly executed contract instruments

		Tunnel completion contract		
		Contract C	**Contract D**	**Contract E**
(A)	**Parent company guarantee:**			
(a)	Date of letter of acceptance of tender	2 Jan 1998	2 Jan 1998	17 Jul 1997
(b)	Required date of submission i.e. 14 days from (a)	16 Jan 1998	16 Jan 1998	31 Jul 1997
(c)	Actual date of submission (Note)	15 Jan 1998	13 Aug 1998	7 Jul 1998
	Delay in submission	Nil	**6.9 months**	**11.4 months**
(B)	**Performance bond:**			
(d)	Date of signing the contract	12 Jan 1998	12 Jan 1998	24 Jul 1997
(e)	Required date of submission i.e. three days prior to (d)	9 Jan 1998	9 Jan 1998	21 Jul 1997
(f)	Actual date of submission (Note)	16 Dec 1998	2 Apr 1998	2 Sep 1997
	Delay in submission	**11.4 months**	2.8 months	1.4 months
(C)	**Delay in submission (for both contract instruments)**	**11.4 months**	**6.9 months**	**11.4 months**
(D)	**Contract period of the tunnel completion contracts**	**27 months**	**26 months**	**25 months**

Source: *DSD records*

Note: *This was the date when the **duly executed** contract instrument was submitted. In some cases, the contract instruments were first submitted at an earlier date. However, the instruments could not give the Government the desired protection as they were either in draft form or not properly executed, and had to be revised and re-submitted.*

Appendix G
(para. 4.48 refers)

Changes in the contract sums and the approved project estimates

	Tunnel completion contract		
	Contract C	**Contract D**	**Contract E**
	($ million)	**($ million)**	**($ million)**
APE for tunnelling works	941.0	880.0	539.0
Less: sum reserved for contingency	52.0	48.0	39.0
Estimated contract sum in the APE	889.0	832.0	500.0
Less: over-estimation	116.0	257.2	143.2
Original contract sum	773.0	574.8	356.8
Add: cost increase	48.7	139.9	248.4
Final contract sum	**821.7**	**714.7**	**605.2**
Original APE	941.0	880.0	539.0
Add: supplementary provision	0.0	0.0	115.0
Final APE	**941.0**	**880.0**	**654.0**
			(Note)

Source: *DSD records and Audit analysis*

Note: *The supplementary provision of $115 million for Contract E was approved on the basis of the estimated requirement as at December 2000. The final contract sum of $605.2 million was the latest forecast expenditure as at February 2004.*

Appendix H
(para. 5.3 refers)

Brief description of different sewage treatment processes

(a) ***Preliminary treatment.*** This process involves the screening of solids and the removal of grit.

(b) ***Primary treatment.*** This process provides solid separation by sedimentation, in addition to screening.

(c) ***Chemically enhanced primary treatment.*** This process enhances the primary treatment process through the addition of flocculating agents to enable quicker and better settlement of solids in the sewage. In the Stonecutters Island STW, ferric chloride is used as the flocculating agent.

(d) ***Secondary treatment.*** This process involves screening, sedimentation, and biological treatment. The core biological treatment process utilises aeration to facilitate the growth of micro-organisms to decompose organic matters.

(e) ***Tertiary treatment.*** This is the treatment of sewage that goes beyond the secondary treatment and includes the removal of nutrients (such as phosphorus and nitrogen) and a high percentage of suspended solids.

(f) ***Disinfection.*** This involves destruction of harmful bacteria in sewage via chemicals (e.g. chlorine, ozone) or physical process (e.g. ultraviolet light). This is a separate process applied to the treated effluent from a prior sewage treatment process.

Source: DSD records

Appendix I
(paras. 5.8 and 5.9 refer)

Comparison of water quality of Victoria Harbour between 2001 and 2002

	Station reference (Note 1)	Year/ % Change (Note 2)	Dissolved oxygen (mg/l)	Ammonia (mg/l)	Total inorganic nitrogen (mg/l)	E. coli (count/100 ml)
1	WM2	2001	5.6	0.09	0.27	490
		2002	6.1	0.09	0.23	760
		% Increase/(Decrease)	8.9%	0.0%	(14.8%)	55.1%
2	WM3	2001	5.3	0.11	0.27	1,400
		2002	5.8	0.11	0.27	3,300
		% Increase/(Decrease)	9.4%	0.0%	0.0%	135.7%
3	WM4	2001	5.3	0.10	0.29	660
		2002	5.9	0.10	0.28	1,400
		% Increase/(Decrease)	11.3%	0.0%	(3.4%)	112.1%
4	VM1	2001	4.7	0.20	0.32	5,200
		2002	5.7	0.11	0.20	600
		% Increase/(Decrease)	21.3%	(45.0%)	(37.5%)	(88.5%)
5	VM2	2001	4.5	0.25	0.39	9,700
		2002	5.8	0.14	0.26	1,300
		% Increase/(Decrease)	28.9%	(44.0%)	(33.3%)	(86.6%)
6	VM4	2001	4.5	0.26	0.41	6,500
		2002	5.6	0.16	0.28	3,300
		% Increase/(Decrease)	24.4%	(38.5%)	(31.7%)	(49.2%)
7	VM5	2001	4.4	0.28	0.44	8,100
		2002	5.7	0.18	0.31	4,000
		% Increase/(Decrease)	29.5%	(35.7%)	(29.5%)	(50.6%)
8	VM6	2001	4.3	0.27	0.43	4,800
		2002	5.4	0.20	0.34	4,900
		% Increase/(Decrease)	25.6%	(25.9%)	(20.9%)	2.1%
9	VM7	2001	4.6	0.25	0.44	4,400
		2002	5.6	0.21	0.35	4,400
		% Increase/(Decrease)	21.7%	(16.0%)	(20.5%)	0.0%

Appendix I
(Cont'd)
(paras. 5.8 and 5.9 refer)

	Station reference (Note 1)	Year/ % Change (Note 2)	Dissolved oxygen (mg/l)	Ammonia (mg/l)	Total inorganic nitrogen (mg/l)	E. coli (count/100 ml)
10	VM8	2001	5.5	0.12	0.32	2,200
		2002	5.9	0.15	0.31	4,900
		% Increase/(Decrease)	7.3%	25.0%	(3.1%)	122.7%
11	VM12	2001	4.8	0.19	0.38	5,300
		2002	5.4	0.18	0.37	4,100
		% Increase/(Decrease)	12.5%	(5.3%)	(2.6%)	(22.6%)
12	VM14	2001	5.0	0.16	0.43	3,900
		2002	6.0	0.13	0.40	1,600
		% Increase/(Decrease)	20.0%	(18.8%)	(7.0%)	(59.0%)
13	VM15	2001	4.5	0.27	0.45	2,700
		2002	5.5	0.21	0.38	1,700
		% Increase/(Decrease)	22.2%	(22.2%)	(15.6%)	(37.0%)
14	JM3	2001	5.7	0.14	0.22	280
		2002	6.6	0.10	0.21	130
		% Increase/(Decrease)	15.8%	(28.6%)	(4.5%)	(53.6%)
15	JM4	2001	5.5	0.13	0.20	740
		2002	6.3	0.06	0.13	120
		% Increase/(Decrease)	14.5%	(53.8%)	(35.0%)	(83.8%)
16	EM1	2001	5.4	0.13	0.21	1,300
		2002	6.2	0.07	0.15	140
		% Increase/(Decrease)	14.8%	(46.2%)	(28.6%)	(89.2%)
17	EM2	2001	5.8	0.10	0.16	450
		2002	6.4	0.06	0.12	70
		% Increase/(Decrease)	10.3%	(40.0%)	(25.0%)	(84.4%)

Source: *EPD records*

Note 1: *See Figure 2 on the centre pages for the location of the water quality monitoring stations.*

Note 2: *Figures in a shaded box denote deterioration in the water quality.*

Appendix J

Chronology of key events

Early 1990	Planning for constructing HATS Stage I commenced.
February 1992	The FC approved $130 million for the creation of a project under the CWRF for the detailed design and investigation of HATS Stage I.
February 1994	The FC approved the funding for implementing HATS Stage I. The target completion date was June 1997.
December 1994	Contracts A and B were awarded to Contractor A for commencing the works in January 1995.
June 1996	Contractor A unilaterally suspended the works in Tunnels C and F.
July 1996	The works in the other four tunnels also ceased.
December 1996	The DSD re-entered the sites of Contracts A and B.
May 1997	Contractor A served an arbitration notice to the Government, claiming that the Government's re-entry of the sites of Contracts A and B was wrong.
July 1997	The DSD awarded Contract E to Contractor E for completion of Tunnels F and G by August 1999.
October 1997	Contractor E started excavating Tunnels F and G and found that the mucking system could not operate effectively at full load.
November 1997	The then Provisional LegCo approved the closure of the SSTF with effect from 31 March 1998.
December 1997	The FC approved the creation of a new project under the CWRF for the completion works of Tunnels AB, C, D and E with an APE of $2,000 million.
January 1998	The DSD awarded Contract C to Contractor C for completing Tunnels AB and C by April 2000, and awarded Contract D to Contractor D for completing Tunnels D and E by February 2000.

January 1998	Contractor E submitted a claim to the DSD for monetary compensation for replacing the mucking system and for extension of time.
March 1998	The Consultant advised the DSD regarding Contractor E's claim. The DSD requested the DOJ to peruse the Consultant's assessment and give advice.
March 1998	The DSD accepted Contractor E's claim for the costs related to the replacement of the mucking system.
May 1998	An arbitrator was appointed to deal with the contractual dispute between the Government and Contractor A.
August 2000	The DSD issued specific guidelines on the management of time-critical projects under DSD Technical Circular No. 9/2000 "The Assessment of Risk and Cost of Time-critical Projects".
October 2000	The DSD informed the LegCo Panel on Environmental Affairs that the cost involved in the site investigations was fairly substantial.
December 2000	The Administration sought supplementary provision of $115 million from the FC for Contract E.
February 2001	The then Secretary for Works informed the PWSC that it was a government practice to conduct a comprehensive review upon the completion of a large-scale project.
September 2001	A Settlement Agreement was signed by Contractor A and the Government whereby Contractor A agreed to pay $750 million to the Government and terminate all arbitration and appeal proceedings.
December 2001	HATS Stage I was completed and fully commissioned.
Early 2003	The EPD recommended closing the four Tsuen Wan beaches (i.e. Gemini, Casam, Hoi Mei Wan and Lido) for the 2003 bathing season in addition to the three closed beaches.

Appendix K

Acronyms and abbreviations

Audit	Audit Commission
APE	Approved Project Estimate
CWRF	Capital Works Reserve Fund
DOJ	Department of Justice
DSD	Drainage Services Department
EPD	Environmental Protection Department
ETWB	Environment, Transport and Works Bureau
FC	Finance Committee
HATS	Harbour Area Treatment Scheme
LegCo	Legislative Council
PWSC	Public Works Subcommittee
STW	Sewage Treatment Works
SSDS	Strategic Sewage Disposal Scheme
SSTF	Sewage Services Trading Fund