CHAPTER 7

Environment Bureau
Drainage Services Department

Upgrading and operation of Pillar Point Sewage Treatment Works

Audit Commission
Hong Kong
31 March 2021

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

Report No. 76 of the Director of Audit contains 7 Chapters which are available on our website at https://www.aud.gov.hk

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

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

UPGRADING AND OPERATION OF PILLAR POINT SEWAGE TREATMENT WORKS

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UPGRADING AND OPERATION OF PILLAR POINT SEWAGE TREATMENT WORKS

Executive Summary

1. The Pillar Point Sewage Treatment Works (PPSTW) in Tuen Mun was built in 1982. It was designed for providing preliminary treatment of sewage from the Tuen Mun district before discharging to the marine waters at the Urmston Road channel to the south west of Tuen Mun. It also provides septic waste reception and treatment facilities to handle septic waste delivered to it. In 2001, to cater for the increase in population and planned new developments in Tuen Mun district and to improve the quality of the effluent discharged from PPSTW, the Environmental Protection Department (EPD) considered that there was a need to upgrade the capacity and treatment level of PPSTW. The Drainage Services Department (DSD) is responsible for the design and construction of the upgrading works and operation of the upgraded PPSTW. The Environment Bureau is responsible for policy matters on environmental protection and for overseeing the operation of DSD and EPD on the provision of sewerage and sewage treatment services.

2. DSD adopted a design-build-operate (DBO) arrangement for implementing the upgrading and operation of PPSTW, and it was DSD's first pilot use of DBO arrangement for a sewage treatment project. In July 2009, the Finance Committee (FC) of the Legislative Council approved the upgrading works of PPSTW at an approved project estimate (APE) of $1,360.9 million. In July 2010, FC approved an increase in APE by $559.6 million to $1,920.5 million. In June 2005, DSD awarded a consultancy agreement (Consultancy X) to a consultant (Consultant X) for the upgrading works. In July 2010, DSD awarded a DBO contract (Contract A) to a contractor (Contractor A) for the design and construction of the upgrading works of PPSTW and operation and maintenance of the upgraded PPSTW. The design and construction of the upgrading works of PPSTW commenced in July 2010 and were substantially completed on 17 May 2014. As of October 2020, the total project expenditure was $1,858.9 million. The operation of the upgraded PPSTW commenced on 18 May 2014. Contractor A would operate the plant for 10 years and DSD has an option to extend the operation period for a further five years. The total operation payment to Contractor A since commissioning of the upgraded PPSTW and up to 31 March 2020 was about

$412 million. The Audit Commission (Audit) has recently conducted a review of the upgrading and operation of PPSTW.

Upgrading works of Pillar Point Sewage Treatment Works

3. ***Early deterioration of concrete protective coating.*** According to Contract A, all concrete structures that may be in contact with sewage shall be protected by liquid applied membrane system, which shall give a minimum of 10-year protection to the concrete. According to DSD, a polyurea-based coating was adopted by Contractor A to the concrete surfaces of the newly constructed structures. However, since December 2013, deterioration of the protective coating had been found by Consultant X. In March 2015, about 15% of the membrane was found peeling off. In July 2016, significant portions of the membrane were found peeling off from some structures (e.g. coarse screen channels and manholes) which became exposed and corroded. According to DSD: (a) Contractor A had carried out small-scale trial tests to identify more durable protective coatings than the polyurea-based coating used. As of February 2021, two types of coatings had been used for repairing the peeled-off concrete coating and the works were completed in March 2020; and (b) in November 2020, DSD appointed a local university to carry out an investigation on the failure of concrete protective coating to identify the root cause of the matter (expected to be completed by November 2021). In Audit's view, DSD needs to continue to monitor the performance of the new types of protective coatings and complete the investigation as early as practicable (paras. 2.7 to 2.10).

4. ***Automatic cleaning system of ultraviolet (UV) disinfection facilities not fully functioning.*** After chemically enhanced primary treatment (CEPT) process at the upgraded PPSTW, sewage is fed into the UV disinfection facilities for disinfection by the UV lamps. The UV lamps were fitted with a mechanical/chemical cleaning system to reduce fouling of the lamps, thereby maximising the disinfection performance. According to Consultant X, in April 2014 (i.e. one month before the commissioning of upgraded PPSTW in May 2014), it found that the automatic cleaning system of the UV disinfection facilities could not perform well in keeping the sleeves of the UV lamps clean, thus causing high *Escherichia coli* (*E. coli*) counts in the treated effluent. According to Contractor A, one of the factors leading to the failure of the automatic cleaning system was the formation of ferric sulphide on the sleeves of the UV lamps during CEPT process, which affected the functioning of hydraulic cylinders of the system. Contractor A set up a cleaning team in July 2014 to clean the UV sleeves manually in order to

restore the performance of the UV disinfection system until a permanent solution was in place, and replacement of hydraulic cylinders were carried out from July to October 2014 as immediate mitigation. In Audit's view, DSD needs to keep under review the operation of the automatic cleaning system and explore further measures for enhancing its effectiveness (paras. 2.11 to 2.13 and 2.16).

5. ***Need to ensure compliance with contract requirements relating to materials for equipment/facilities.*** Contract A specified the requirements for the material used in fine screens. In November 2014, it was found that the materials of chain in the fine screens at the upgraded PPSTW included one grade of stainless steel which was at variance with the grade specified under the contract requirements and there was a durability issue as the main difference between the two grades was corrosion resistance. In the event, all the chains were replaced by Contractor A at its sole cost in August 2015. In March 2021, DSD informed Audit that additional measures for ensuring the contractor's compliance with contract requirements relating to materials for equipment/facilities had been taken by DSD in the upgrading works project of the San Wai Sewage Treatment Works (which was under a DBO contract awarded in May 2016 (after the award of Contract A) and commenced operation in March 2021). In Audit's view, DSD needs to keep under review the effectiveness of such measures (paras. 2.17 to 2.20 and 4.4).

6. ***Need to ensure timely completion of defects correction.*** According to Contract A, Contractor A should carry out the outstanding works and the relevant works to repair, rectify or make good any defect, imperfection or other fault in the construction works at its own cost within the one-year defects correction period which commenced after the substantial completion of construction works in May 2014 (i.e. defects correction period expired in May 2015). Audit noted that Contractor A completed its obligation in respect of defects correction in November 2015 (i.e. 6 months after the expiry of the defects correction period) (paras. 2.28 and 2.29).

7. ***Need to ensure timely finalisation of contract accounts.*** According to Financial Circular No. 7/2017, for a DBO contract, accounts of the design and build portions of the contract should be finalised as soon as possible and in any event not later than three years after the completion of the design and build portions. Audit noted that the account of Contract A in respect of the design and build portions was finalised in November 2017 (i.e. 3.5 years after the substantial completion of the upgrading works of PPSTW in May 2014), exceeding the 3-year time limit specified in the Financial Circular (paras. 2.32 and 2.33).

Monitoring of operation of upgraded Pillar Point Sewage Treatment Works

8. ***Non-compliances with some Key Performance Indicators (KPIs).*** According to Contract A, there are 13 KPIs (covering effluent quality, environmental monitoring, and administration and reporting) for measuring the performance of Contractor A in operating the upgraded PPSTW. The monthly operation payment to Contractor A is adjusted to reflect the level of performance achieved, which is assessed based on monitoring results on KPIs in the reporting month. Since commissioning of the upgraded PPSTW in May 2014 and up to October 2020, DSD had deducted a total of $565,920 from payment to Contractor A on 8 occasions involving non-compliances with 5 of the 13 KPIs. The non-compliance involving the highest amount ($460,980) of payment deduction (accounting for 81% of the total of $565,920) was related to an unauthorised emergency bypass incident in August 2014. The incident lasted for about 11 hours with about 95,000 cubic metres untreated sewage discharged and, as a result, 14 beaches were closed for about two days. According to DSD: (a) the direct cause leading to the bypass incident was mechanical failure of all the four fine screens; (b) the main contributing factors included inadequate experience of Contractor A's operation staff and lack of adequate awareness of risks by Contractor A; and (c) follow-up actions had been implemented to prevent recurrence of the incident. In Audit's view, the payment deductions relating to non-compliances with five KPIs on various occasions indicate scope for improvement in Contractor A's performance (paras. 3.4, 3.5, 3.8, 3.9 and 3.11).

9. ***Scope for improving demerit point mechanism.*** According to Contract A, demerit points are assigned for non-compliances with KPIs, which provide the basis for payment deduction from Contractor A. Audit noted that: (a) the total payment deduction for non-compliances with KPIs is capped at 32% of the monthly operation payment under Contract A. For the DBO contract of the San Wai Sewage Treatment Works awarded in May 2016 (after the award of Contract A), the maximum payment deduction is 40% (i.e. 8 percentage points higher); and (b) for unauthorised emergency bypass, deduction can only be made for one event in each month at the maximum under Contract A (without taking into account the gravity of the event). For the San Wai Sewage Treatment Works contract, the assignment of demerit points to unauthorised emergency bypass in a month is linked to the duration of the bypass. In March 2021, DSD informed Audit that it aimed to start reviewing the demerit point mechanism of Contract A in mid-2022 (when reviewing

the further five-year extension of Contract A from May 2024 to May 2029 — see para. 2). In Audit's view, DSD needs to conduct the review as scheduled and complete it timely (paras. 3.12 to 3.15).

10. ***High E. coli concentration found in some effluent samples of DSD's surprise checks.*** According to DSD, it has developed a surprise checking mechanism for better monitoring of Contractor A's performance, and its surprise checks serve as quality assurance and aim to provide additional checking on effluent quality at different time slots. DSD conducted surprise checks for *E. coli* concentration in effluent of PPSTW on 161 days from April 2019 to October 2020. It considered that there were 23 (14%) days with high *E. coli* concentration (i.e. exceeding 300,000 counts per 100 millilitres) in effluent and requested Contractor A to investigate the reasons. Audit noted that: (a) for the 23 days, the time taken for completion of the investigations by Contractor A (counting from DSD's surprise checking dates) ranged from 9 days to about 20 months (averaging about 3.5 months). In particular, for 3 days, the investigation results were only available after one year; and (b) while there was an established practice for the surprise checking mechanism, DSD had not promulgated guidelines in this regard (paras. 3.16 to 3.18).

11. ***Scope for enhancing occupational safety at PPSTW.*** According to Contract A, Contractor A is required to ensure that all operations are conducted in such a manner so as to eliminate the risks to persons, property and equipment. Audit noted the following instances involving occupational safety at PPSTW: (a) a fatal accident occurred in October 2014, with a worker of Contractor A suspected to have fallen into a terminal manhole and his body was found one month later. The Labour Department (LD) prosecuted Contractor A for violation of the Occupational Safety and Health Ordinance (Cap. 509) for the fatal accident and Contractor A was convicted and fined a total of $145,000 in September 2015. However, Audit noted that DSD had not taken adequate and timely follow-up actions on Contractor A with regard to the fatal accident. It was only in March 2021 that DSD sent a written request to LD asking for information on the cause of the accident and issued an under-performance notice to Contractor A for poor provision of safety measures during work; (b) two incidents involving injuries occurred in October 2015 and April 2018 respectively. DSD had issued under-performance notices to Contractor A for the two incidents; and (c) there were unauthorised entries of workers of Contractor A into confined space without proper certificates in September 2017, January 2018 and September 2020 respectively. DSD had issued warning letters to Contractor A for the incidents (paras. 3.20 to 3.22 and 3.24).

12. ***Scope for enhancing the monitoring of preventive maintenance.*** Contractor A is required under Contract A to maintain a Computerised Maintenance Management System (CMM System) to facilitate management of corrective and preventive maintenance of PPSTW, and carry out preventive maintenance according to the schedules as specified in the contract as a minimum. According to CMM System records, there were 16,952 preventive maintenance tasks (involving 432 equipment items) completed during the period of some 5.5 years from January 2015 to October 2020. Audit selected 20 equipment items for which preventive maintenance was carried out once during the period, and noted that their maintenance frequency fell short of the required minimum frequency of once every six months or every year under Contract A. According to DSD: (a) Contractor A had fine-tuned the preventive maintenance schedules to meet the operational needs of the plant; and (b) some maintenance records were not included in CMM System and were maintained in manual records. Audit noted that there was no readily available information on the revisions made to the preventive maintenance schedules in Contract A (paras. 3.30, 3.34 to 3.38).

13. ***Need to ensure the timely completion of maintenance tasks and compile regular management information on maintenance.*** According to CMM System records, there were 7,572 maintenance tasks (7,313 for preventive maintenance and 259 for corrective maintenance) completed between January 2019 and October 2020. Audit noted that: (a) there was delay in completion for 2,108 (29%) of the 7,313 preventive maintenance tasks, ranging from 1 day to 1 year (averaging 12 days) after target completion dates. For the 259 corrective maintenance tasks, there was delay in completion for one task for about 5 months; and (b) DSD had not regularly compiled management information (e.g. highlights or summaries) on maintenance carried out at PPSTW (para. 3.40).

Administration of design-build-operate contract arrangement

14. After the award of the first DBO contract (i.e. Contract A) in July 2010, two more DBO contracts were awarded by DSD for other sewage treatment works in June 2013 and May 2016 respectively. According to DSD, the experience gained during the implementation of Contract A would be a valuable reference for future contract arrangement of projects of sewage treatment works (paras. 4.4 and 4.5).

15. ***Need to keep under review the cost-effectiveness of adopting DBO contract arrangement.*** In July 2010, FC approved an increase of the APE by $559.6 million (41%) to $1,920.5 million for meeting the required expenditure of the upgrading works. The justifications for the cost increase provided by the Environment Bureau included: (a) additional capital cost of $403.1 million was required for developing a sewage treatment plant design that fulfilled specified performance requirements and for achieving higher cost-effectiveness in subsequent operations; and (b) it was expected that the estimated annual recurrent expenditure arising from the upgrading works for the operation stage would be decreased by $30 million and overall savings of $450 million would be yielded over the 15-year life cycle (see para. 2) of the upgraded PPSTW. As of January 2021, the upgraded PPSTW had been operated for about 6.5 years. According to DSD, the actual operation expenditure in general reflected that the estimated annual saving of $30 million had been achieved. In Audit's view, DSD needs to keep under review the savings achieved in operating the upgraded PPSTW (paras. 4.8 and 4.9).

16. ***Need to timely conduct post-completion review.*** According to the Project Administration Handbook for Civil Engineering Works, a post-completion review: (a) is a useful project management tool; (b) is generally not warranted for consultancy agreements and works contracts of a project which has a total cost less than $500 million; and (c) should be carried out within a reasonable period, say six months, after the substantial completion of a consultancy agreement or a works contract. Audit noted that the design and construction portions of Contract A were already substantially completed in May 2014 and the total contract expenditure ($1,774.7 million) was much higher than $500 million. However, as of January 2021 (more than six years thereafter), DSD had not conducted a post-completion review for the design and construction portions of Contract A (paras. 4.10 and 4.11).

17. ***Scope for making better use of Knowledge Management Portal in sharing experience gained.*** According to DSD, the experience gained during the implementation of Contract A would be a valuable reference for future procurement of sewage treatment works projects and should be properly included in the Knowledge Management Portal of DSD. Audit noted that, regarding the information for DBO contracts, as of January 2021: (a) the Portal only contained a PowerPoint presentation on DBO contract procurement dated November 2016 (i.e. more than 4 years ago); and (b) DSD's experience gained in monitoring the operation of the upgraded PPSTW was not posted onto the Portal (para. 4.14).

Audit recommendations

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

Upgrading works of Pillar Point Sewage Treatment Works

(a) **continue to monitor the performance of the new types of protective coatings for repairing the peeled-off concrete coating at PPSTW and complete the investigation on the failure of the concrete protective coating at PPSTW as early as practicable (para. 2.21(a));**

(b) **keep under review the operation of the automatic cleaning system of UV disinfection facilities at PPSTW and explore further measures for enhancing its effectiveness (para. 2.21(b)(i));**

(c) **keep under review the effectiveness of the additional measures implemented at other sewage treatment works for ensuring the contractor's compliance with contract requirements relating to materials for equipment/facilities (para. 2.21(c));**

(d) **take measures to ensure the timely completion of defects correction by the contractor of a works project and the timely finalisation of accounts of the design and build portions of a DBO contract (para. 2.35(c) and (d));**

Monitoring of operation of upgraded Pillar Point Sewage Treatment Works

(e) **continue to closely monitor the performance of the contractor in operating PPSTW including compliances with KPIs, and review the demerit point mechanism of the contract as scheduled and complete it timely (para. 3.27(a) and (b));**

(f) **take timely actions to investigate the reasons for high *E. coli* concentration in effluent found by DSD's surprise checks at PPSTW and address the issues identified (para. 3.27(c));**

(g) **formalise the existing practice and promulgate guidelines on DSD's surprise checks conducted on effluent quality of PPSTW (para. 3.27(d));**

(h) **take adequate and timely follow-up actions on incidents relating to occupational safety at PPSTW and make continued efforts to enhance the occupational safety at PPSTW (para. 3.27(f) and (g));**

(i) **enhance the documentation of the revisions made to the preventive maintenance schedules in the PPSTW contract (para. 3.45(b)(i));**

(j) **strengthen measures to ensure that the maintenance for equipment and facilities at PPSTW is timely completed, and regularly compile management information on maintenance carried out at PPSTW for monitoring purpose (para. 3.45(c) and (e));**

Administration of design-build-operate contract arrangement

(k) **keep under review the savings achieved in operating the upgraded PPSTW under the DBO contract arrangement (para. 4.16(a));**

(l) **conduct a post-completion review for the design and construction portions of Contract A (para. 4.16(b)); and**

(m) **make better use of the Knowledge Management Portal in sharing experience gained from DBO contract arrangement (para. 4.16(c)).**

Response from the Government

19. The Director of Drainage Services agrees with the audit recommendations.

PART 1: INTRODUCTION

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

Background

1.2 The Pillar Point Sewage Treatment Works (PPSTW) in Tuen Mun was built in 1982. It was designed for providing preliminary treatment (Note 1) of sewage from the Tuen Mun district before discharging to the marine waters at the Urmston Road channel to the south west of Tuen Mun. PPSTW also provides septic waste reception and treatment facilities to handle septic waste delivered to it by septic waste collection contractors.

1.3 The Environmental Protection Department (EPD) is responsible for planning the infrastructure required for collecting and treating sewage and monitoring the marine water quality. In 2001, to cater for the increase in population and planned new developments in Tuen Mun district and to improve the quality of the effluent discharged from PPSTW, EPD considered that there was a need to upgrade the capacity and treatment level of PPSTW. The Drainage Services Department (DSD) is responsible for the design and construction of the upgrading works and operation of the upgraded PPSTW. The Environment Bureau (Note 2) is responsible for policy matters on environmental protection and for overseeing the operation of DSD and EPD on the provision of sewerage and sewage treatment services.

Note 1: *Preliminary treatment includes screening and removal of grits (e.g. sands and bone pieces) from the sewage.*

Note 2: *In July 2007, the Environment Bureau was formed to take over the policy responsibility for environmental matters. Before July 2007, the policy responsibility rested with the then Environment, Transport and Works Bureau (July 2002 to June 2007), the then Environment and Food Bureau (January 2000 to June 2002), the then Planning, Environment and Lands Bureau (July 1997 to December 1999) and the then Planning, Environment and Lands Branch (before July 1997).*

1.4 DSD adopted a design-build-operate (DBO — Note 3) arrangement for implementing the upgrading and operation of PPSTW, and it was DSD's first pilot use of DBO arrangement for a sewage treatment project. The design and construction works commenced in July 2010 and were substantially completed in May 2014. The upgraded PPSTW commenced operation in May 2014.

Upgrading works of PPSTW

1.5 The scope of the upgrading works of PPSTW was as follows:

(a) upgrading of the sewage treatment level from preliminary treatment to chemically enhanced primary treatment (CEPT — Note 4) with ultraviolet (UV) disinfection treatment process;

(b) expansion of the treatment capacity from 215,000 cubic metres (m^3) per day to 241,000 m^3 per day;

(c) provision of new septic waste reception and treatment facilities to cater for septic waste of 1,200 m^3 per day; and

(d) provision of ancillary works (e.g. roadwork and landscaping work).

Photograph 1 shows the upgraded PPSTW.

Note 3: *DBO is a form of contract procurement whereby the contractor is required to design and construct a proposed facility in accordance with all requirements set forth in the contract by the Government. Upon completion, the contractor will be required under the contract to operate and maintain the completed facility for a specified period of time. The ownership of the facility will remain with the Government throughout the contract duration. Upon expiry of the operation phase specified in the contract, the facility will be handed back to the Government free of any charges in a specified condition.*

Note 4: *Primary treatment includes preliminary treatment process (i.e. screening and removal of grits) and a primary sedimentation process for removal of settleable suspended solids from the sewage. For CEPT, chemicals are added during the primary sedimentation process to enhance the removal of suspended solids.*

Photograph 1

Upgraded PPSTW

Source: DSD records

1.6 In July 2009, the Finance Committee (FC) of the Legislative Council (LegCo) approved the upgrading works of PPSTW at an approved project estimate (APE) of $1,360.9 million. In July 2010, FC approved an increase in APE by $559.6 million to $1,920.5 million (see Table 1).

Table 1

Funding approvals for the upgrading works of PPSTW (July 2009 to July 2010)

Date	Particulars	Approved amount ($ million)
July 2009	Design and construction of the upgrading works	1,360.9
July 2010	Increase in APE to cover the higher design and construction cost (Note) and increase in the provision for price adjustment	559.6
	Total	1,920.5

Source: *DSD records*

Note: *According to DSD, the proposed design with higher design and construction cost would yield significant reduction in subsequent operation cost for 15 years (see para. 1.8(b)) resulting in a net saving of the whole life-cycle cost (see para. 4.8).*

1.7 In June 2005, DSD awarded a consultancy agreement (Consultancy X) to a consultant (Consultant X) for the upgrading works, which involved a DBO contract (Contract A — see para. 1.8). Being the Supervising Officer for the DBO contract, Consultant X's services included supervising the design and construction of the upgrading works and the first-year operation of the upgraded PPSTW. The consultancy was completed in March 2018. As of October 2020, consultancy fees of $17.9 million had been paid to Consultant X (Note 5).

Note 5: *The consultancy fees for planning work before Contract A was awarded (e.g. environmental impact assessment, reference design, contract strategy development, contract documentation and tender) of $12.2 million in total were funded under the block allocation Subhead 4100DX of the Capital Works Reserve Fund Head 704 under the control of DSD. The consultancy fees incurred after Contract A was awarded (i.e. during design, build, commissioning and initial operation stage) of $5.7 million were funded under the project vote (see para. 1.6).*

1.8 In July 2010, DSD awarded Contract A to a contractor (Contractor A) for the design and construction of the upgrading works of PPSTW and operation and maintenance of the upgraded PPSTW at a contract sum of $2,673.7 million (Note 6), which comprised:

(a) $1,664.5 million (62%) for the design and construction of the upgrading works and interim operation (Note 7) of the existing treatment plant during the design and construction period; and

(b) $1,009.2 million (38%) for the operation stage (covering the contractual operation period of 15 years, viz. the 10 years after completion of the construction works and the option to extend the operation period for a further five years — see para. 1.12).

1.9 The design and construction of the upgrading works of PPSTW commenced in July 2010 and were substantially completed on 17 May 2014. The operation stage commenced on 18 May 2014.

1.10 The account of Contract A relating to design and construction portions (including interim operation of the existing treatment plant during the design and construction period — see para. 1.8(a)) was finalised in November 2017. The final contract sum was $1,774.7 million (see Table 2).

Note 6: *In January 2010, the Central Tender Board advised DSD to conduct contract price negotiation with the recommended tenderer. After tender negotiation, the contract sum (reduced to $2,673.7 million) was approved by the Financial Services and the Treasury Bureau in April 2010.*

Note 7: *Interim operation referred to the period between the date of handover of the existing plant from DSD to the contractor and the completion date of design and construction of the upgrading works. During the interim operation period, the contractor would take over the existing facilities from DSD and continue the operation and maintenance of the existing facilities in accordance with the DBO contract.*

Table 2

Expenditure of Contract A relating to design and construction portions (October 2020)

Original contract sum (a)	Final contract sum (b)	Increase (c) = (b) – (a)	Increase in provision for price fluctuation adjustment (d)	Decrease after price fluctuation adjustment (e) = (c) – (d)
($ million)				
1,664.5	1,774.7 (Note 1)	110.2 (6.6%)	192.9 (11.6%) (Note 2)	(82.7)

Source: *DSD records*

Note 1: *The funding for the expenditure of $1,774.7 million was as follows:*

(a) *expenditure of $1,754.1 million under Contract A was funded under the project vote (see para. 1.6);*

(b) *expenditure of $5.7 million for inspection and desilting works for submarine outfall pipes carried out by Contractor A as instructed by Consultant X in March 2015 was charged to an item under block allocation Subhead 4100DX of the Capital Works Reserve Fund Head 704; and*

(c) *the operating costs for interim operation of $14.9 million was provided from one DSD Subhead of the General Revenue Account.*

Note 2: *The original contract sum already included provision for price fluctuation adjustment. These were additional sums to cover excessive price fluctuation adjustment.*

1.11 As of October 2020, the total project expenditure was $1,858.9 million ($61.6 million below the final APE of $1,920.5 million — see para. 1.6). Of the $1,858.9 million, $1,754.1 million (94%) was related to expenditure under Contract A (see Note 1 to Table 2 in para. 1.10). The remaining $104.8 million

(6%) comprised resident site staff costs ($96.1 million — Note 8), consultancy fees ($5.7 million — see Note 5 to para. 1.7) and other miscellaneous costs ($3 million).

Operation of upgraded PPSTW

1.12 The operation of the upgraded PPSTW commenced on 18 May 2014. Contractor A would operate the plant for 10 years and DSD has an option to extend the operation period for a further five years. For the first-year operation of the upgraded PPSTW, Consultant X was the Supervising Officer for Contract A and responsible for supervising Contractor A's operation and reporting Contractor A's performance to DSD. After the first-year operation (i.e. since 18 May 2015), DSD has fully taken up the work for monitoring (including supervising) Contractor A's operation.

1.13 Under Contract A, there is a set of Key Performance Indicators (KPIs) for measuring the performance of Contractor A. The monthly payment to Contractor A for operation of the upgraded PPSTW consists of:

(a) a fixed fee, which covers maintenance, overhauling and operation of the facilities; and

(b) a variable fee, which is based on the actual volume of treated effluent.

The monthly payment to Contractor A is adjusted to reflect the level of performance achieved, which is assessed based on monitoring results on KPIs in the reporting month.

Note 8: *Resident site staff are employed by the consultant to carry out the duties stipulated in the consultancy agreement for supervising the contractors' works. The Government reimburses the consultant for the salaries and remuneration (e.g. mandatory provident fund and medical benefits) it paid for the employment of resident site staff.*

1.14 According to DSD, from January to October 2020, the average volume of sewage treated by PPSTW was about 185,000 m^3 per day (i.e. about 77% of the design capacity of 241,000 m^3 per day) and that of septic waste received was about 1,050 m^3 per day (i.e. about 88% of the design capacity of 1,200 m^3 per day). In 2019-20, the payment to Contractor A for operation of PPSTW was about $84 million. The total operation payment to Contractor A since commissioning of the upgraded PPSTW (i.e. 18 May 2014) and up to 31 March 2020 was about $412 million.

Responsible divisions of DSD

1.15 The Harbour Area Treatment Scheme Division under DSD's Sewage Services Branch was responsible for monitoring the design and construction of the upgrading works of PPSTW and the first-year operation of the upgraded PPSTW. After the first-year operation (i.e. since 18 May 2015), the Sewage Treatment Division 1 under DSD's Electrical and Mechanical Branch has taken over the monitoring of the operation of PPSTW. An extract of DSD's organisation chart as at 31 October 2020 is at Appendix A. As of October 2020, 7 staff in the Sewage Treatment Division 1 were involved in monitoring the operation of PPSTW (Note 9). According to DSD, the related staff expenditure incurred solely for monitoring the operation of PPSTW for 2019-20 was about $1.7 million.

Note 9: *According to DSD, the 7 staff were also involved in monitoring the operation of other sewage treatment works and flood control facilities in North West New Territories, Sham Tseng and Tuen Mun Region.*

Audit review

1.16 In November 2020, the Audit Commission (Audit) commenced a review of the upgrading and operation of PPSTW. The audit review has focused on the following areas:

(a) upgrading works of PPSTW (PART 2);

(b) monitoring of operation of upgraded PPSTW (PART 3); and

(c) administration of DBO contract arrangement (PART 4).

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

Acknowledgement

1.17 During the audit review, in light of the outbreak of coronavirus disease (COVID-19), the Government had implemented various special work arrangements and targeted measures for government employees, including working from home. Audit would like to acknowledge with gratitude the full cooperation of the staff of DSD during the course of the audit review amid the COVID-19 epidemic.

PART 2: UPGRADING WORKS OF PILLAR POINT SEWAGE TREATMENT WORKS

2.1 This PART examines DSD's work in managing the upgrading works of PPSTW, focusing on:

(a) design and construction of upgrading works (paras. 2.6 to 2.22); and

(b) other contract management issues (paras. 2.23 to 2.36).

Contract A

2.2 In July 2010, DSD awarded Contract A to Contractor A for the upgrading works of PPSTW and the operation of the upgraded PPSTW at a contract sum of $2,673.7 million, comprising $1,664.5 million for the design and construction portions (including interim operation of the existing treatment plant during the design and construction period) and $1,009.2 million for the operation stage (Note 10).

2.3 The design and construction works commenced in July 2010 and were originally scheduled for completion on 25 November 2013. Consultant X was the Supervising Officer responsible for supervising the design and construction of the upgrading works. Due to inclement weather, Contractor A was granted extensions of time totalling 5.7 months (173 days) in accordance with Contract A, and the contract works (i.e. the design and construction portions) were substantially completed on 17 May 2014. The operation stage (i.e. 10 years plus an optional extension of 5 years) commenced on 18 May 2014. Consultant X was responsible for supervising the first-year operation of the upgraded PPSTW and the role of Supervising Officer was handed over to DSD in May 2015.

Note 10: *Contract A sets out, among others, the Employer's Requirements which specify the requirements for design, construction and operation of the upgraded PPSTW. Under Contract A, payment to Contractor A would be made on a lump sum basis (for the design and construction elements) or monthly basis (for the operation and maintenance of PPSTW during the design and construction period and the operation stage), subject to price fluctuation adjustment.*

Cost increase under Contract A

2.4 The account of Contract A relating to design and construction portions (including interim operation of the existing treatment plant during the design and construction period) was finalised in November 2017 and the total contract expenditure was $1,774.7 million (see Table 3).

Table 3

Total contract expenditure of Contract A relating to design and construction portions (November 2017)

Particulars	Amount ($ million)
Contract works completed	1,481.8
Payment for contract price fluctuation (Note)	292.9
Total contract expenditure	1,774.7

Source: *DSD records*

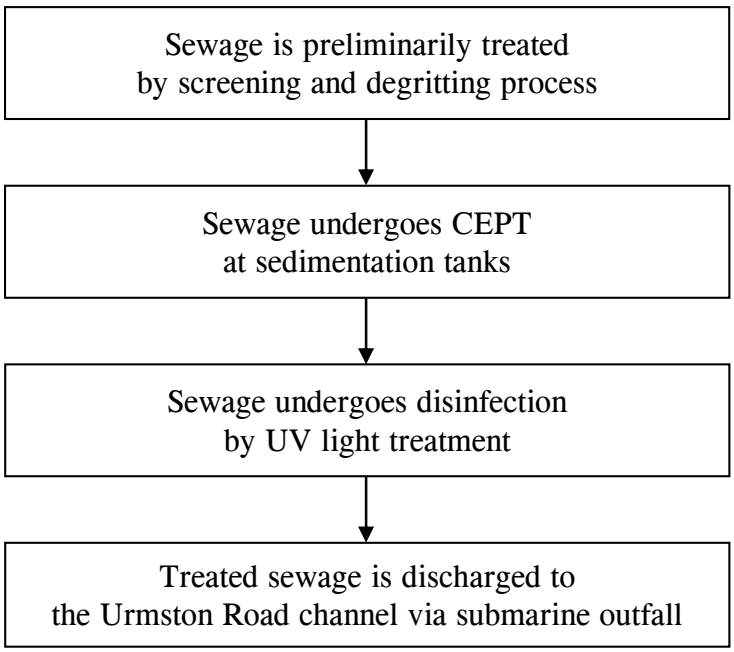
Note: *Of the $292.9 million payment for contract price fluctuation, $100 million was provision for price fluctuation adjustment included in the original contract sum.*

Sewage treatment process of upgraded PPSTW

2.5 At the upgraded PPSTW, the sewage (including septic waste collected — Note 11) is treated to the effluent standards specified in Contract A. Figure 1 shows the sewage treatment process of the upgraded PPSTW.

Figure 1

Sewage treatment process of the upgraded PPSTW



Source: DSD records

Note 11: *Septic waste collected is unloaded at septic waste reception station.*

Design and construction of upgrading works

2.6 Under Contract A, Contractor A was required to design and construct the upgrading works for PPSTW in accordance with the contract requirements. Contractor A was required to submit design submissions (Note 12) to Consultant X (Note 13) for comment and consent. Consultant X would seek advice from DSD on major aspects (e.g. process design and deviations from the contract requirements), before granting consent to Contractor A's design submissions (Note 14).

Early deterioration of concrete protective coating

2.7 According to Contract A, all concrete structures that may be in contact with sewage shall be protected by liquid applied membrane system (Note 15), which shall give a minimum of 10-year protection to the concrete.

2.8 According to DSD, a polyurea-based coating (Note 16) was adopted by Contractor A to the concrete surfaces of the newly constructed structures. However, since December 2013 (i.e. 5 months before the commissioning of upgraded PPSTW in May 2014), deterioration of the protective coating had been found by Consultant X, as follows:

Note 12: *According to Consultant X, an independent design checker of Contractor A had checked and certified that Contractor A's design complied with the relevant contract requirements.*

Note 13: *Being the Supervising Officer, Consultant X would ensure that Contractor A and independent design checker of Contractor A discharged their duties satisfactorily and the designs were in compliance with Contract A.*

Note 14: *After Consultant X's granting of approval-in-principle to Contractor A's preliminary design (with general arrangement drawings), Contractor A submitted the detailed design to Consultant X for approval.*

Note 15: *According to DSD: (a) liquid applied membrane system is a monolithic, fully-bonded and liquid-based coating system suitable for concrete protection; (b) there are different types of liquid applied membrane system; and (c) Contract A sets out that epoxy-based system should not be used.*

Note 16: *Polyurea-based coating is a type of liquid applied membrane system. According to DSD, this protective coating had also been successfully applied in other sewage treatment works of DSD.*

(a) in early December 2013, the membrane at the fine screen channels and grit channels was found peeling off;

(b) in November 2014 and January 2015, some peeled-off membrane was found blocking the feed tube of centrifuges in the sludge dewatering building and the intake of drainage delivery pump at CEPT area;

(c) in March 2015 (i.e. about 10 months after the commissioning of upgraded PPSTW), about 15% of the membrane was found peeling off; and

(d) in July 2016, significant portions of the membrane were found peeling off from some structures (e.g. coarse screen channels and manholes) which became exposed and corroded, and any delay on rectifying the problem would affect the durability of the concrete structures.

2.9 In June 2017, DSD said that if the deteriorated protective coating could not be timely repaired, this might lead to concrete spalling, failure of structure and major disruption to the treatment process. According to DSD, the following actions had been taken to address the problem:

(a) Contractor A appointed two experts to carry out investigation. According to the investigation reports in March and July 2017, multiple potential causes (e.g. build-up of acidic vapours, chemical attack on the coating and inter-coat delamination (Note 17)) had been identified;

Note 17: *According to the investigation report, inter-coat delamination occurred in some areas where it appeared that a second coating had been applied over the first coating.*

(b) Contractor A had carried out small-scale trial tests to identify more durable protective coatings than the polyurea-based coating used and to apply the selected coatings at critical locations (Note 18). As of February 2021, two types of coatings (i.e. a new epoxy-based coating and a calcium-aluminate-based coating) had been used for repairing the peeled-off concrete coating and the works were completed in March 2020. The new types of protective coatings applied were in good condition and their performance had been closely monitored on site; and

(c) in November 2020, DSD appointed a local university to carry out an investigation on the failure of concrete protective coating to identify the root cause of the matter. As of January 2021, the investigation was still in progress. It was expected that the investigation would be completed by November 2021.

2.10 In Audit's view, regarding the concrete protective coating at PPSTW, DSD needs to:

(a) continue to monitor the performance of the new types of protective coatings for repairing the peeled-off concrete coating; and

(b) complete the investigation on the failure of the concrete protective coating (see para. 2.9(c)) as early as practicable with a view to identifying the root cause of the matter and taking necessary follow-up actions.

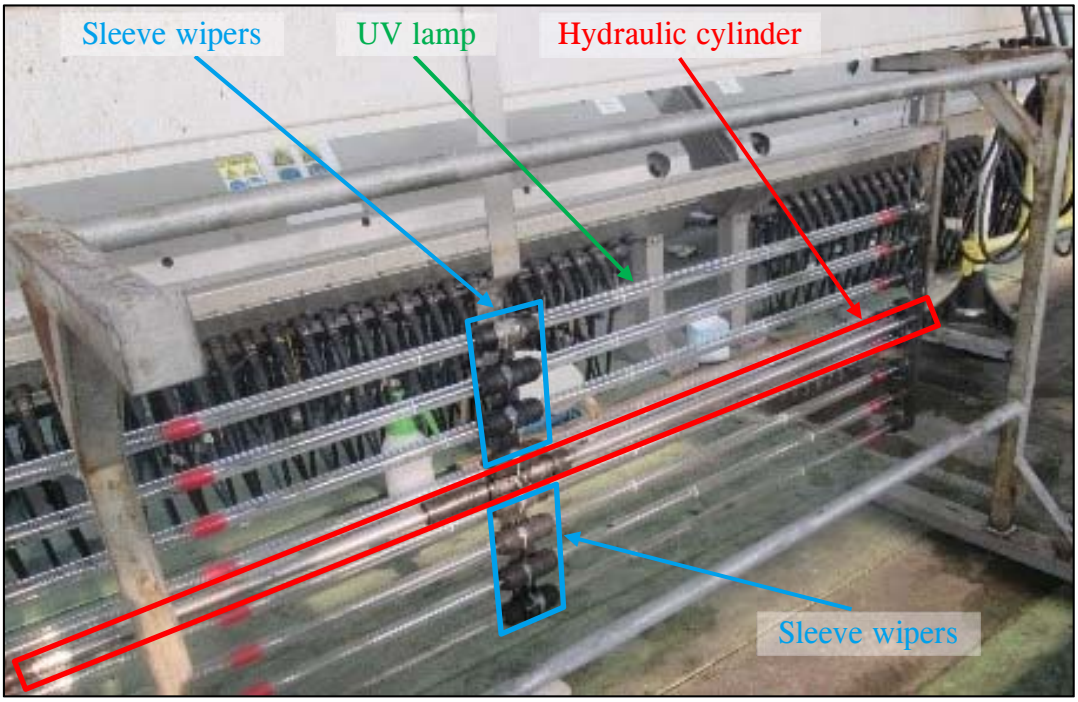
Note 18: *According to DSD, trial tests had been conducted on six brands/types of epoxy-based coatings and one calcium-aluminate-based coating. Based on the preliminary trial results, the out-performing coatings were considered suitable for application at three critical locations, namely: (a) the septic waste equalisation tank; (b) the common inlet chamber of the preliminary treatment works; and (c) the two wet wells of the preliminary treatment works. The trial and application of such coatings were covered by an Employer's Change (issued in July 2017) at an estimated cost of $3.1 million. As of October 2020, $1.7 million had been charged to the project vote (see para. 1.6).*

Automatic cleaning system of UV disinfection facilities not fully functioning

2.11 During CEPT process at the upgraded PPSTW, ferric chloride (being a chemical coagulant for destabilising colloidal particles) is added to the sewage to facilitate faster settlement of suspended solids. After CEPT process, sewage is fed into the UV disinfection facilities for disinfection (Note 19) by the UV lamps. The UV lamps were fitted with a mechanical/chemical cleaning system (comprising mainly sleeve wipers and hydraulic cylinders for moving the wipers) to reduce fouling of the lamps (see Photograph 2), thereby maximising the disinfection performance.

Photograph 2

UV module of disinfection facilities at upgraded PPSTW



Source: *DSD records*

Note 19: *UV irradiation disinfection method was adopted in the upgraded PPSTW in accordance with the policy direction of EPD in April 2007.*

2.12 According to Consultant X, in April 2014 (i.e. one month before the commissioning of upgraded PPSTW in May 2014), it found that the automatic cleaning system of the UV disinfection facilities could not perform well in keeping the sleeves of the UV lamps clean, thus causing high *Escherichia coli* (*E. coli*) counts in the treated effluent.

2.13 According to Contractor A:

(a) the automatic cleaning system of the UV lamps was found blocked by some black oily substances in July 2014;

(b) the failure of the automatic cleaning system was due to various factors. One of them was the formation of ferric sulphide during CEPT process as ferric chloride was used as the coagulant. Ferric sulphide deposited on the sleeves of the UV lamps affected the functioning of the hydraulic cylinders of automatic cleaning system;

(c) other factors leading to the failure of the automatic cleaning system were mainly related to the hydraulic cylinders (Note 20);

(d) in July 2014, it set up a cleaning team (Note 21) to clean the UV sleeves manually in order to restore the performance of the UV disinfection system until a permanent solution was in place. Replacement of hydraulic cylinders were carried out from July to October 2014 as immediate mitigation;

(e) in order to avoid the formation of ferric sulphide, it was pursuing the use of alum instead of ferric chloride in CEPT process. However, trial use of

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Note 20: *The factors included the grease used being too thick and easily contaminated, low hydraulic output from the defective pumps of hydraulic system, insufficient greasing frequency, the cylinder internals being very tight and vulnerable in "tough" conditions, the wiping frequency and duration being too low, and no detection of cylinders failure.*

Note 21: *According to DSD, the cost of the cleaning team was borne by Contractor A (i.e. covered by the fixed fee paid to Contractor A by DSD — see para. 1.13(a)).*

alum was suspended in April 2015 after having been used for two weeks due to the generation of high level of hydrogen sulphide (Note 22); and

(f) it had carried out various measures by June 2015 for long-term mitigation of the automatic cleaning problem (Note 23).

2.14 In June 2019, DSD commented that intensive manual cleaning of UV sleeves was required and the automatic cleaning system should be enhanced urgently.

2.15 Between January and March 2021, DSD informed Audit that:

(a) despite the fact that the automatic cleaning system was functioning, in order to maintain the performance of the UV disinfection system, Contractor A continued to carry out additional manual cleaning of the UV sleeves (see para. 2.13(d));

(b) CEPT process at PPSTW could cater for adoption of both alum and ferric chloride. In view of the influent sewage characteristics, ferric chloride was proposed by Contractor A as the most appropriate chemical coagulant for the process;

(c) the design and performance of the UV disinfection system, including the automatic cleaning system, had been assessed and tested by Contractor A. The automatic sleeve wiper cleaning system as a supporting system helped reduce the frequency of manual operation and maintenance activities;

Note 22: *Hydrogen sulphide is a toxic gas and can be a health hazard especially in confined space.*

Note 23: *The measures included: (a) cylinders of lighter grease type were selected; (b) maintenance manual was revised and staff training was provided; (c) overall plant process was stabilised; (d) indicator system was implemented to monitor the condition of the automatic cleaning system; and (e) cylinder upgrade kits were developed and tested to reduce the sensitivity of the cylinders to foulant material build-up.*

(d) a plant-specific preventive maintenance schedule (e.g. manual cleaning of UV sleeves) had been adopted by Contractor A in mitigating potential issues with the automatic cleaning system of UV disinfection facilities; and

(e) a more advanced inclined UV disinfection system (Note 24) had been adopted in the upgraded San Wai Sewage Treatment Works (see para. 4.4(b)). The performance of the cleaning system of the inclined UV disinfection system had been satisfactory since the testing and commissioning of the upgraded San Wai Sewage Treatment Works in September 2020.

2.16 In Audit's view, regarding the automatic cleaning system of UV disinfection facilities, DSD needs to:

(a) keep under review the operation of the system at PPSTW and explore further measures for enhancing its effectiveness; and

(b) continue to monitor the performance of the system at other sewage treatment works.

Note 24: *According to DSD, an inclined UV disinfection system had been used in the upgraded San Wai Sewage Treatment Works in its testing and commissioning stage since September 2020. Its cleaning system is an automatic "chemical-mechanical" cleaning system, with the wipers parked out of the sewage flow in between wiping cycles (resulting in minimal exposure of components in the flow and thus lower level of maintenance). In comparison, the wipers of the horizontal system used at PPSTW are always submerged in and exposed to sewage flow. Besides, at the upgraded San Wai Sewage Treatment Works, the size of the sleeves of the UV lamps is bigger and the power of the wiper system is relatively higher than those of PPSTW's system.*

Need to ensure compliance with contract requirements relating to materials for equipment/facilities

2.17 According to Contract A, the material used in fine screens (Note 25) should follow the requirements stipulated in the General Specification for Electrical and Mechanical Sewerage Facility Installations 2007 Edition (Note 26) of DSD, as follows:

(a) the screen structure, chain, sprocket wheel, shaft, screenings grid, rake, scraper, chain link plate, all connection/mounting bolts and nuts, roller track, guard, discharge chute should be made of stainless steel or better approved material; and

(b) material grades should conform to the respective British Standards or equivalent/better national or international standards. Unless otherwise specified, stainless steel of Grade 316 should be regarded as the minimum grades of different materials in terms of corrosion resistance.

Any deviations from the requirements shall be substantiated and submitted for Consultant X's approval.

2.18 Arising from the emergency sewage bypass incident caused by the mechanical failure of all the four fine screens in August 2014 (see para. 3.8(a)), Consultant X conducted an investigation of the incident to ascertain the causes of failure of the fine screens. According to the incident investigation report of Consultant X in November 2014, among others:

Note 25: *Fine screens are used under preliminary treatment to remove particles between 4 millimetres and 25 millimetres from entering the sedimentation system.*

Note 26: *The General Specification for Electrical and Mechanical Sewerage Facility Installations aims to specify the basic requirements of design of electrical and mechanical installations which are essential for application in the sewage and drainage projects including sewage treatment works, sewage and floodwater pumping stations and associated works and facilities managed by DSD. All electrical and mechanical sewerage facility installations shall be carried out to conform to the General Specification unless otherwise amended by the Particular Specification of the works contract.*

(a) the materials of chain in the fine screens included stainless steel of Grade 304, which was at variance with the contract requirements (i.e. stainless steel of Grade 316 — see para. 2.17(b)). Samples of the chain were sent to an accredited laboratory by Consultant X in September 2014 for testing of material type. The results showed that apart from the lock nuts in the chain, none of the other materials were of stainless steel of Grade 316;

(b) based on a factory test report from the manufacturer of fine screens submitted by Contractor A to Consultant X during the construction period in September 2012, the entire fine screens (except the motor/gear box, bearings, liners, covers and windows) were made out of stainless steel of Grade 316;

(c) the manufacturer of the fine screens explained that it did not have relevant design information of the chains, as the chains were not manufactured by it but provided by its chain suppliers;

(d) there was a durability issue as the main difference between Grade 304 and Grade 316 was corrosion resistance (Note 27); and

(e) all the chains of the fine screens would be replaced with new ones of materials complying with the contract requirements. In the event, all the chains had been replaced by Contractor A in August 2015 (Note 28).

2.19 In March 2021, DSD informed Audit that in order to ensure that the contractor complied with the contract requirements relating to materials for equipment/facilities, additional measures had been taken by DSD in the upgrading works project of the San Wai Sewage Treatment Works (see para. 4.4(b)). The contractor was required to produce a list showing compliance with respect to the

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Note 27: *According to Consultant X, the non-compliance of material for the fine screens was not the cause of failure of fine screens in the sewage bypass incident in August 2014 (see para. 3.9(a) for the causes).*

Note 28: *Contractor A replaced the chains at its sole cost in accordance with contract requirements. According to Consultant X, the new chains were tested on site by a positive material identification tool as an additional reference to ascertain compliance with the specification.*

Employer's Requirements and the requirements specified in the General Specification for Electrical and Mechanical Sewerage Facility Installations relating to equipment/materials.

2.20 In Audit's view, DSD needs to keep under review the effectiveness of the additional measures implemented at other sewage treatment works for ensuring the contractor's compliance with contract requirements relating to materials for equipment/facilities.

Audit recommendations

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

(a) **regarding the concrete protective coating at PPSTW:**

(i) **continue to monitor the performance of the new types of protective coatings for repairing the peeled-off concrete coating; and**

(ii) **complete the investigation on the failure of the concrete protective coating as early as practicable with a view to identifying the root cause of the matter and taking necessary follow-up actions;**

(b) **regarding the automatic cleaning system of UV disinfection facilities:**

(i) **keep under review the operation of the system at PPSTW and explore further measures for enhancing its effectiveness; and**

(ii) **continue to monitor the performance of the system at other sewage treatment works; and**

(c) **keep under review the effectiveness of the additional measures implemented at other sewage treatment works for ensuring the contractor's compliance with contract requirements relating to materials for equipment/facilities.**

Response from the Government

2.22 The Director of Drainage Services agrees with the audit recommendations.

Other contract management issues

2.23 Apart from the design and construction of the upgrading works, Audit noted that there was scope for DSD to enhance contract management work in other areas (see paras. 2.24 to 2.34).

Scope for incorporating more reference information into condition survey report for upgrading works

2.24 According to Consultancy X:

(a) the conditions of facilities at PPSTW before the upgrading works, including the outfall and emergency bypass, should be ascertained in a condition survey conducted by an independent surveyor before issuing tender of Contract A; and

(b) the survey results should serve as reference information for the tenderers of Contract A to evaluate the operation and necessary modifications or refurbishment costs required.

2.25 Regarding the conditions of the submarine outfall before the upgrading works, it was stipulated in the proposal of condition survey submitted by Consultant X to DSD in May 2007 that:

(a) water level measurement (Note 29) at the outfall terminal manhole would be carried out by an independent surveyor for testing and monitoring the hydraulic performance of the outfall; and

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Note 29: *In general, during the water level measurement, maximum flow would be generated by the outfall pumping station. The incurred water level inside the*

(b) relevant test results of dye test (Note 30) (for identification of any leakage from the outfall) and underwater inspection (for inspecting the hydraulic performance of the outfall) conducted by DSD around the end of 2006 would be obtained from DSD (Note 31) and incorporated into the condition survey report.

In June 2007, DSD expressed that it had no comment on the proposal of condition survey.

2.26 Audit noted that the condition survey report submitted by Consultant X in June 2008 did not include the results of DSD's dye test and underwater inspection for assessing the conditions of the outfall as stated in Consultant X's proposal (see para. 2.25(b)). In December 2020 and March 2021, DSD informed Audit that:

(a) it had conducted dye tests for submarine outfall pipes of PPSTW on an annual basis and the records since 2003 were available. For underwater inspections, only the records of inspections conducted since 2011 (in 2011, 2016 and 2020) for submarine outfall pipes of PPSTW were available;

(b) in view of the availability of technology at the time of condition survey and to avoid disruption to the operation of existing PPSTW, the conditions of the submarine outfall pipes were deduced from the water level measurement conducted at the outfall manhole by the independent surveyor (see para. 2.25(a)); and

(c) as the management and maintenance of the submarine outfall pipes had always been the responsibility of DSD (instead of Contractor A), and

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outfall terminal manhole would be measured to indicate any blockage inside the outfall.

Note 30: *According to DSD, for dye test, coloured dye is introduced at the upstream end of the outfall. Any dye found at locations other than the outlet of the outfall indicates that the outfall may be damaged and needs to be repaired.*

Note 31: *According to Consultant X, dye test results would be obtained from the Sewage Treatment Division 1 of DSD and the underwater inspection results would be obtained from the Buildings/Civil Maintenance Team under the Operations and Maintenance Branch of DSD.*

water level measurement conducted at the outfall manhole (see para. 2.25(a)) could deduce the condition of submarine outfall pipes, the records of dye tests and underwater inspections were not essential design information for the tendering and design of Contract A.

2.27 Given that condition survey results serve as reference information for tenderers to evaluate the operation and necessary modifications required (see para. 2.24(b)), in Audit's view, in administering an upgrading works project in future, there is merit for DSD to consider incorporating more reference information (e.g. underwater inspection results) as proposed by the consultant into the condition survey report. In this connection, as only the records of underwater inspections conducted since 2011 for submarine outfall pipes of PPSTW were available (see para. 2.26(a)), DSD needs to take measures to enhance its record keeping relating to the conditions of facilities of sewage treatment works.

Need to ensure timely completion of defects correction

2.28 According to Contract A, Contractor A should carry out the outstanding works and the relevant works to repair, rectify or make good any defect, imperfection or other fault (for simplicity, the two types of works are hereinafter referred to as defect works) in the construction works at its own cost within the one-year defects correction period which commenced after the substantial completion of construction works in May 2014. Upon the expiry of the defects correction period (i.e. 17 May 2015), all defect works should have been completed to the satisfaction of the Supervising Officer (Note 32).

2.29 Audit noted that, as of mid-September 2015 (i.e. 4 months after the expiry of the defects correction period in May 2015), there were 944 items of defect works not yet completed/rectified by Contractor A. According to DSD, Consultant X had reminded Contractor A to complete the works in the monthly operation meetings (Note 33) since July 2014. In the event, Contractor A completed its

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Note 32: *Supervising Officer shall issue a Defects Correction Certificate stating the date on which Contractor A completed its obligation in respect of defects correction.*

Note 33: *Operation meetings were held between DSD, Consultant X (up to August 2016) and Contractor A on a monthly basis.*

obligation in respect of defects correction on 17 November 2015 (i.e. 6 months after the expiry of the defects correction period).

2.30 According to Consultant X, the reasons leading to the slow progress of completing the defects correction by Contractor A included:

(a) inadequate resources deployed by Contractor A to achieve the defects correction programme; and

(b) protracted and ineffective coordination between the construction team and operation team of Contractor A.

2.31 In Audit's view, in implementing a works project in future, DSD needs to take measures to ensure the timely completion of defects correction by the contractor (e.g. closely monitoring of resources deployed by the contractor to the defects correction programme).

Need to ensure timely finalisation of contract accounts

2.32 According to Financial Circular No. 7/2017, for a DBO contract, accounts of the design and build portions of the contract should be finalised as soon as possible and in any event not later than three years after the completion of the design and build portions.

2.33 Audit noted that the account of Contract A in respect of the design and build portions was finalised in November 2017 (i.e. 3.5 years after the substantial completion of the upgrading works of PPSTW in May 2014), exceeding the 3-year time limit specified in the Financial Circular.

2.34 In Audit's view, DSD needs to take measures to ensure the timely finalisation of accounts of the design and build portions of a DBO contract in future.

Audit recommendations

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

(a) **in administering an upgrading works project in future, consider incorporating more reference information (e.g. underwater inspection results) as proposed by the consultant into the condition survey report;**

(b) **take measures to enhance the record keeping of relevant test results (e.g. underwater inspection) relating to the conditions of facilities of sewage treatment works;**

(c) **in implementing a works project in future, take measures to ensure the timely completion of defects correction by the contractor (e.g. closely monitoring of resources deployed by the contractor to the defects correction programme); and**

(d) **take measures to ensure the timely finalisation of accounts of the design and build portions of a DBO contract in future.**

Response from the Government

2.36 The Director of Drainage Services agrees with the audit recommendations.

PART 3: MONITORING OF OPERATION OF UPGRADED PILLAR POINT SEWAGE TREATMENT WORKS

3.1 This PART examines DSD's work in monitoring the operation of upgraded PPSTW, focusing on:

(a) monitoring of contractor's performance (paras. 3.4 to 3.28); and

(b) monitoring of operation and maintenance of facilities (paras. 3.29 to 3.46).

3.2 ***Operation of upgraded PPSTW.*** The influent to PPSTW includes sewage collected through public sewerage and septic waste received at the plant. The sewage treatment process of the upgraded PPSTW comprises coarse screening, fine screening, grit removal, CEPT and UV disinfection. After going through the treatment process, the effluent will be discharged through submarine outfall pipes to the Urmston Road watercourse where water is deep and current is strong to facilitate rapid dilution and dispersion of the effluent.

3.3 Under the Water Pollution Control Ordinance (Cap. 358), EPD has issued to DSD a licence for the discharge of effluent from PPSTW (Note 34). According to Contract A, the objectives for operation of the upgraded PPSTW include the following:

Note 34: *According to the Water Pollution Control Ordinance, in application of the Ordinance to the Government, if it appears to the Director of Environmental Protection that any discharge is being, or has been, made in contravention of the Ordinance by any person in the course of carrying out his duties in the service of the Government, the Director will report the matter to the Chief Secretary for Administration if the contravention is not forthwith terminated to the Director's satisfaction. On receipt of the Director of Environmental Protection's report, the Chief Secretary for Administration will enquire into the circumstances and, if the enquiry shows that a contravention is continuing or likely to recur, the Chief Secretary for Administration will ensure that the best practicable steps are taken to terminate the contravention or avoid the recurrence.*

(a) as the discharge of effluent from the upgraded PPSTW is subject to the conditions stipulated in the discharge licence issued by EPD, a key objective of operation is to achieve full compliance with the discharge licence; and

(b) it is also the objective of operation to operate and maintain the upgraded PPSTW to upkeep the facilities in the optimum conditions in order to maximise the service life of the facilities.

Monitoring of contractor's performance

3.4 According to Contract A, there are 13 KPIs for measuring the performance of Contractor A in operating the upgraded PPSTW, as follows:

(a) 7 KPIs on effluent quality (i.e. concentration of total suspended solids, 5-day biochemical oxygen demand (Note 35) and *E. coli* — Note 36), which are related to the discharge standards stipulated in the discharge licence issued by EPD;

(b) 2 KPIs on environmental monitoring (e.g. unauthorised emergency bypass); and

(c) 4 KPIs on administration and reporting (e.g. data integrity and incident reporting).

3.5 The monthly payment to Contractor A for operation of the upgraded PPSTW consists of a fixed fee (which covers maintenance, overhauling and operation of the facilities) and a variable fee (which is based on the actual volume of treated effluent) (see para. 1.13). The monthly operation payment to Contractor A

Note 35: *The 5-day biochemical oxygen demand is a measure of the amount of oxygen consumed by microorganisms in the process of decomposing organic matter in 5 days. A high value of the parameter indicates that a water body has been polluted by a large quantity of organic matter.*

Note 36: *Of the 7 KPIs, 3 KPIs are related to total suspended solids, 2 KPIs are related to 5-day biochemical oxygen demand and 2 KPIs are related to E. coli.*

is adjusted to reflect the level of performance achieved, which is assessed based on monitoring results on KPIs in the reporting month.

3.6 According to DSD, it may issue warning letters and adverse performance reports (Note 37) to Contractor A for unsatisfactory performance. If Contractor A continually fails to comply with the requirements after warnings, DSD may also take further contractual and legal actions, including taking over the operation of PPSTW and terminating Contractor A's employment.

3.7 Contractor A is required to submit to DSD monthly reports for operation of the upgraded PPSTW. According to DSD, its staff regularly conduct site inspections on plant condition of PPSTW, including conducting joint site walks with Contractor A for identification of under-performance events and inspection of site safety on a monthly basis.

Non-compliances with some KPIs

3.8 Since commissioning of the upgraded PPSTW in May 2014 and up to October 2020, DSD had deducted a total of $565,920 from payment to Contractor A on 8 occasions involving non-compliances with 5 of the 13 KPIs (see Table 4), as follows:

(a) ***Unauthorised emergency bypass.*** Unauthorised emergency bypass involved the highest amount ($460,980) of payment deduction (accounting for 81% of the total of $565,920). On 25 August 2014 (three months after the completion of the upgrading works in May 2014), an emergency sewage bypass incident occurred at PPSTW during which untreated sewage was discharged to the Urmston Road watercourse. The incident lasted for about 11 hours with about 95,000 m^3 untreated sewage discharged. As a result, 14 beaches in Tuen Mun and Tsuen Wan were closed for about two days. DSD had deducted $460,980 from the payment to Contractor A for the unauthorised emergency bypass ($9,220 was also deducted for late reporting of the incident for 51 minutes — see (c) below). DSD had also issued an adverse performance report to

Note 37: *During the contract period, DSD issues quarterly performance reports to Contractor A.*

Contractor A for the unauthorised emergency bypass (see also paras. 3.9 and 3.10 for the causes of and DSD's follow-up actions on the incident);

(b) ***Consistent minor breaches.*** According to Contract A, Contractor A is required to comply with the general requirements in the contract, such as matters relating to site cleanliness, provision of safety measures during work, and equipment availability and serviceability. DSD will issue an under-performance notice if Contractor A fails to comply with any of the general obligations under the contract, and four or more under-performance notices of non-repeated events issued in the same reporting month will result in payment deduction (Note 38). Audit noted that four to six under-performance notices were issued in September 2014, March 2017 and March 2020 (Note 39), resulting in a total payment deduction of $57,412;

(c) ***Incident reporting.*** According to Contract A, Contractor A is required to report serious and emergency incidents (Note 40) to DSD within 15 minutes of the occurrence of the incidents. There was late reporting of the emergency sewage bypass in August 2014 for 51 minutes and the malfunction of outlet penstocks at terminal manhole in March 2017 for about 5 hours, resulting in a total payment deduction of $17,998;

Note 38: *For a non-repeated event (i.e. a single incident), each under-performance notice will count as 20 under-performance points. For a repeated event (i.e. a repeated failure to comply with the same obligation within a rolling two-month period), each under-performance notice will count as 40 under-performance points. Under-performance points reaching 61 or above will result in payment deduction. Therefore, four or more under-performance notices of non-repeated events issued in the same reporting month will result in payment deduction.*

Note 39: *The details were as follows: (a) in September 2014, there were undue down-time of various equipment items and foam overflow. As a result, four under-performance notices were issued; (b) in March 2017, there was malfunction of outlet penstocks at terminal manhole. As a result, six under-performance notices were issued; and (c) in March 2020, there was septic waste overflow. As a result, four under-performance notices were issued.*

Note 40: *Reportable incidents are serious and emergency incidents that may lead to death, serious injury or damage to properties, or may arouse widespread media attention or public concern.*

(d) ***High E. coli concentration in effluent.*** In September 2014, there was an occasion (on 11 September 2014) where *E. coli* concentration in effluent exceeded 300,000 counts per 100 millilitres (Note 41), resulting in payment deduction of $22,675; and

(e) ***Data integrity.*** There were data entry errors in a monthly report submitted by Contractor A, resulting in deduction of $6,855 from May 2019 payment. The errors were related to entering test results for effluent quality on the wrong dates, resulting in 111 material inconsistencies (Note 42).

Table 4

Non-compliances with KPIs resulting in payment deduction (May 2014 to October 2020)

No.	KPI	Date of non-compliance	Payment deducted ($)	
1	Unauthorised emergency bypass	August 2014	460,980 (81%)	
2	Consistent minor breaches	September 2014	6,802 (1%)	57,412 (10%)
		March 2017	43,888 (8%)	
		March 2020	6,722 (1%)	
3	Incident reporting	August 2014	9,220 (2%)	17,998 (4%)
		March 2017	8,778 (2%)	
4	High *E. coli* concentration in effluent	September 2014	22,675 (4%)	

Note 41: *According to DSD: (a) under Contract A and the discharge licence, there are two discharge standards for E. coli concentration in effluent (see Note 48 to para. 3.17), and their compliances are based on data collected on a monthly or a rolling 12-month basis; (b) the high E. coli concentration in effluent (exceeding 300,000 counts per 100 millilitres) on one occasion in September 2014 had not violated the discharge standards; and (c) payment was deducted as a higher standard of supervision on discharge quality was set at the beginning stage of operation.*

Note 42: *According to Contract A, a material inconsistency refers to: (a) a gross error in a reported result for a parameter set out in the discharge licence; (b) reporting a result referred to in the discharge licence where the work, measurement or sample was not done or taken; or (c) a materially false entry.*

5	Data integrity	May 2019	6,855 (1%)
		Total	565,920 (100%)

Source: DSD records

3.9 ***Unauthorised emergency bypass.*** For the unauthorised emergency bypass which occurred at PPSTW on 25 August 2014 (see para. 3.8(a)), DSD informed LegCo Panel on Environmental Affairs in November 2014 that:

(a) the direct cause leading to the bypass incident was mechanical failure of all the four fine screens (Note 43) for filtering solid matters. The main contributing factors included:

(i) inadequate experience of Contractor A's operation staff. It was of paramount importance to maintain the protection level setting of the electronic overload protection mechanism at a normal level and to carry out regular inspections to ensure its proper operation. However, the staff of Contractor A unduly set the protection level setting of the electronic overload protection mechanism above the normal level; and

(ii) lack of adequate awareness of risks by Contractor A. Before the bypass incident on 25 August 2014, there had already been two occasions of fine screen failure on 12 and 21 August 2014 respectively. However, Contractor A had failed to conduct a proper investigation. Besides, the fine screen which failed on 21 August 2014 had not been promptly repaired and, as a result, only three fine screens were available with no standby unit for emergency use when the bypass incident occurred; and

(b) to prevent recurrence of the incident, a series of follow-up actions had been implemented, including stepping up inspection of fine screens,

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Note 43: *There are four fine screens installed at PPSTW, with one serving as a standby unit and the other three as duty units. The rakes of each fine screen run on two guiding chains respectively located at the two sides of each screen. The chains consist of a series of rollers, link plates and pins which are all held together by connecting clips at the sides of the chains. An electronic overload protection mechanism is also installed at each fine screen to protect it from damage due to overloading. On 25 August 2014, one fine screen was under repair, and the connecting clips of the remaining three fine screens were dislodged, which eventually led to the falling apart of the chains and failure of the fine screens.*

replacing the chains of all four fine screens, reinforcing the connecting clips of the chains and the chain tensioning devices, and enhancing training of operation staff.

3.10 Audit noted that, according to DSD's monthly site inspections of PPSTW during December 2019 to June 2020, DSD found that the protection level of the electronic overload protection mechanism for one fine screen was set above the normal level in four months (i.e. December 2019 and February, May and June 2020). In March 2021, DSD informed Audit that:

(a) on each occasion, DSD verbally requested Contractor A to resume the setting to the normal level and Contractor A then resumed the setting to the normal level; and

(b) standby unit was available during the above-mentioned period and the condition was kept under monitoring.

3.11 According to DSD, Contractor A's overall performance was considered satisfactory in general. In Audit's view, the payment deductions relating to non-compliances with five KPIs on various occasions (see para. 3.8) indicate scope for improvement in Contractor A's performance. DSD needs to continue to closely monitor the performance of the contractor in operating PPSTW including compliances with KPIs.

Scope for improving demerit point mechanism

3.12 According to Contract A, demerit points are assigned for non-compliances with KPIs, which provide the basis for payment deduction from Contractor A. The number of demerit points assigned to each KPI is capped in each month. For all the 13 KPIs, the total number of points allocated is 10,000 points and the total number of demerit points for non-compliances is capped at 3,200 points. The maximum payment adjustment is a deduction of 32% of the monthly payment for the operation.

3.13 Audit noted scope for improving the demerit point mechanism of Contract A, as follows:

(a) ***Maximum payment deduction.*** For Contract A, the total payment deduction for non-compliances with KPIs is capped at 32% of the monthly operation payment. Audit noted that subsequent to the award of Contract A in July 2010, another DSD's DBO contract of the San Wai Sewage Treatment Works was awarded in May 2016 (see para. 4.4(b)), with the maximum payment deduction being 40% of the monthly operation payment, which is 8 percentage points higher than that for PPSTW;

(b) ***Unauthorised emergency bypass.*** For unauthorised emergency bypass, the demerit points are based on the number of events. The number of demerit points for each event is 1,000 points and the total number of demerit points is capped at 1,000 points in each month. Hence, deduction can only be made for one event in each month at the maximum. Also, the mechanism does not take account of the gravity of the event (i.e. the volume or the time duration of untreated sewage discharged and seriousness of the impact). In August 2014, there was an unauthorised emergency bypass event which lasted for about 11 hours with about 95,000 m^3 untreated sewage discharged. As a result, 14 beaches were closed for about two days. In accordance with the mechanism, 1,000 demerit points were assigned (i.e. 10% of monthly operation payment was deducted). Audit noted that subsequent to the unauthorised emergency bypass event in August 2014, DBO contract of the San Wai Sewage Treatment Works was awarded in May 2016, under which the assignment of demerit points to unauthorised emergency bypass in a month is linked to the duration of the bypass (Note 44); and

(c) ***Incident reporting.*** For incident reporting, the number of demerit points for late reporting of serious and emergency incidents are 3 points per five minutes late, subject to a maximum of 20 points in each month. Therefore, late reporting for 35 minutes or more is assigned 20 demerit points, regardless of the actual period of delay. In August 2014 and March 2017, there were two late incident reporting events for 51 minutes and about 5 hours respectively. Notwithstanding the long delays in

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Note 44: *The number of demerit points assigned to unauthorised emergency bypass in a month are as follows: (a) 1,000 points if the duration is less than 1 hour; (b) 1,500 points for 1 to less than 3 hours; (c) 2,000 points for 3 to less than 6 hours; and (d) 3,000 points for 6 hours or more.*

incident reporting, only 20 demerit points were assigned on each occasion.

In this connection, according to a review of Consultant X in 2017 concerning Contract A (Note 45), while operation mechanism of KPI was considered effective, the potential adjustment in monthly operation payment could be reinforced to provide adequate driving force on the contractor to fulfil the more important KPIs which included compliance with the discharge licence and unauthorised sewage bypass.

3.14 In response to Audit's enquiry about the scope for reviewing the demerit point mechanism of Contract A, in March 2021, DSD informed Audit that:

(a) any change in the demerit point mechanism would be subject to negotiation and agreement with Contractor A, and might need to be executed under supplementary agreement with additional financial implications. DSD considered it not advisable to conduct the review at this stage; and

(b) the review could be conducted at a later stage, such as when reviewing the further five-year extension (i.e. from May 2024 to May 2029) under Contract A (see para. 1.12). According to Contract A, DSD would be required to give Contractor A at least a 12-month notice (i.e. before May 2023) in writing to exercise the right to extend the operation period. Therefore, DSD aimed to start reviewing the demerit point mechanism in mid-2022.

3.15 In Audit's view, DSD needs to review the demerit point mechanism (including the maximum payment deduction level for non-compliances with KPIs and the assignment of demerit points for unauthorised emergency bypass and incident reporting) of the PPSTW contract as scheduled and complete it timely.

Note 45: *In 2017, as required under Consultancy X, Consultant X submitted to DSD a review report on performance measurement and control mechanism under Contract A relating to operation and maintenance of PPSTW.*

High E. coli concentration found in some effluent samples of DSD's surprise checks

3.16 According to Contract A, there are 7 KPIs on effluent quality requirements, and their compliances are based on monthly data collected at the sampling frequencies specified in the contract (Note 46). For example, Contractor A is required to conduct sampling of the effluent to check concentration of *E. coli* seven times a week (Note 47). According to DSD:

(a) making reference to EPD's surprise checks to other sewage treatment works, DSD has developed a surprise checking mechanism for better monitoring of Contractor A's performance. The surprise checking mechanism for effluent quality is an established practice, and there have been follow-up actions and regular reporting at monthly meetings with Contractor A on high *E. coli* concentration found in effluent;

(b) DSD's surprise checks serve as quality assurance and aim to provide additional checking on effluent quality at different time slots; and

(c) samples collected by Contractor A and DSD are sent to accredited laboratories for testing of effluent quality.

3.17 DSD conducted surprise checks for *E. coli* concentration (Note 48) in effluent of PPSTW on 161 days from April 2019 to October 2020. Of DSD's

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Note 46: *According to DSD, since commissioning of the upgraded PPSTW in May 2014 and up to October 2020: (a) there had been no non-compliance with the discharge standards under the discharge licence and Contract A; and (b) DSD had not received any notice from EPD on non-compliances with the discharge standards.*

Note 47: *According to DSD, Contractor A conducts sampling between 9 am and 9:30 am every day.*

Note 48: *According to Contract A and the discharge licence, there are two discharge standards for concentration of E. coli in effluent, as follows: (a) the monthly geometric mean concentration should not exceed 20,000 counts per 100 millilitres; and (b) the 95 percentile concentration (based on a rolling 12-month data) should not exceed 300,000 counts per 100 millilitres. According to Contractor A's test results on samples for effluent quality from April 2019 to October 2020, the concentration of E. coli in effluent met both discharge standards.*

161 days' surprise checks, DSD considered that there were 23 (14%) days with high *E. coli* concentration (i.e. exceeding 300,000 counts per 100 millilitres — Note 49) in effluent and requested Contractor A to investigate the reasons for high *E. coli* concentration. According to Contractor A's investigation:

(a) for 11 days, the unsatisfactory level of *E. coli* concentration was due to equipment failure or poor disinfection efficiency of UV disinfection facilities during DSD's sampling;

(b) for 10 days, the reasons were unknown as the UV disinfection system was operating normally during DSD's sampling; and

(c) for 2 days, the unsatisfactory level of *E. coli* concentration might be due to sampling contamination.

3.18 Regarding DSD's surprise checks for effluent quality at PPSTW, Audit noted that:

(a) for the 23 days with high *E. coli* concentration in effluent found by DSD's surprise checks from April 2019 to October 2020 (see para. 3.17), the time taken for completion of the investigations by Contractor A (counting from DSD's surprise checking dates) ranged from 9 days to about 20 months (averaging about 3.5 months). In particular, for 3 days, the investigation results were only available after one year;

(b) the number of surprise checks conducted for concentration of *E. coli* in effluent ranged from 6 to 12 days (averaging 9 days) in each month from April 2019 to October 2020 excluding April and May 2020 (Note 50);

Note 49: *For the 23 days, the E. coli concentration in effluent ranged from 370,000 to 13,000,000 counts per 100 millilitres (averaging about 1,488,000 counts per 100 millilitres).*

Note 50: *According to DSD, no surprise check was conducted in April and May 2020 due to the outbreak of COVID-19 and implementation of special work arrangements. Besides, during the same 19-month period from April 2019 to October 2020, surprise checks on concentration of total suspended solids and that of 5-day biochemical oxygen demand in effluent had been conducted once in each of 13 months and no surprise check had been conducted in the remaining 6 months.*

(c) while there was an established practice for the surprise checking mechanism for effluent quality (see para. 3.16(a)), DSD had not promulgated guidelines (covering frequency and timing of surprise checks, and follow-up actions needed) in this regard; and

(d) DSD had not regularly compiled management information (e.g. highlights or summaries) on results of surprise checks for effluent quality for monitoring by its senior management.

3.19 In Audit's view, DSD needs to:

(a) take timely actions to investigate the reasons for high *E. coli* concentration in effluent found by its surprise checks at PPSTW and address the issues identified (e.g. equipment failure or poor disinfection efficiency of UV disinfection facilities and possible sample contamination — see para. 3.17);

(b) formalise the existing practice and promulgate guidelines on its surprise checks conducted on effluent quality of PPSTW (covering frequency and timing of surprise checks, and follow-up actions needed); and

(c) regularly compile management information (e.g. highlights or summaries) on test results of its surprise checks at PPSTW for monitoring by its senior management.

Scope for enhancing occupational safety at PPSTW

3.20 According to Contract A, Contractor A is required to ensure that all operations are conducted in such a manner so as to eliminate the risks to persons, property and equipment. Contractor A should submit to DSD a safety plan which includes details such as safety policy, safety and health training and personal protective equipment.

3.21 Audit noted that since the commencement of the operation of the upgraded PPSTW in May 2014, there had been various instances involving occupational safety at PPSTW, including a fatal accident (see paras. 3.22 and 3.23) and other incidents related to occupational safety (see para. 3.24).

3.22 ***Fatal accident.*** A fatal accident occurred on 10 October 2014, with a worker of Contractor A suspected to have fallen into a terminal manhole when he shut down a penstock and his body was found one month later. Subsequent to the fatal accident, DSD had engaged a consultant to review the safety and health system of the works. According to DSD, improvement measures had been taken, including erection of guard-rails along the edge of the terminal manhole, installing safety harness system at the terminal manhole and remote closed-circuit television (CCTV) cameras for surveillance, and restructuring and updating the content and order of the safety plan. The Labour Department (LD) prosecuted Contractor A for violation of the Occupational Safety and Health Ordinance (Cap. 509) for the fatal accident and Contractor A was convicted and fined a total of $145,000 in September 2015 (Note 51). However, Audit noted that DSD had not taken adequate and timely follow-up actions on Contractor A with regard to the fatal accident. It was only in March 2021 that DSD sent a written request to LD asking for information on the cause of the accident and issued an under-performance notice to Contractor A for poor provision of safety measures during work.

3.23 In March 2021, LD and DSD informed Audit that:

(a) ***LD.*** LD received a written request from DSD on 1 March 2021 asking for information on the cause of the fatal accident. LD provided the information to DSD (Note 52) on 12 March 2021 with due consideration

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Note 51: *According to DSD, it requested a case update from the Hong Kong Police Force in August 2017 and noted the Coroner's decision that no death inquest would be required.*

Note 52: *According to LD, the direct cause of the accident was believed to be that the worker had somehow fallen into the terminal manhole through an unfenced opening where the metal cover had been removed. The indirect causes included the following: (a) no risk assessment had been done before the accident; (b) there was deficiency in the system of work, particularly its failure in ensuring that employees (including the worker who had fallen into the manhole) working on the top of the terminal manhole could work safely without falling hazard; (c) the permit-to-work system in place could not cater for different situations of work on the top of the manhole; and (d) the metal covers of the openings of the manhole were not securely key-locked at all times.*

of the restrictions under the Occupational Safety and Health Ordinance and the Personal Data (Privacy) Ordinance (Cap. 486) (Note 53); and

(b) ***DSD.*** Based on the conviction under the Occupational Safety and Health Ordinance, DSD issued an under-performance notice to Contractor A on 9 March 2021 for poor provision of safety measures during work with regard to the fatal accident (see para. 3.22). Following receipt of further information about the cause of accident from LD on 12 March 2021, DSD would also reflect the issue in the corresponding performance report of Contractor A based on the conviction for failing to provide and maintain a system of work to ensure safety and health at work.

3.24 ***Other incidents related to occupational safety.*** Since the commencement of the operation of the upgraded PPSTW in May 2014, there had been other incidents related to occupational safety at PPSTW, including the following:

(a) ***Incidents involving injuries.*** DSD had issued under-performance notices to Contractor A for two incidents involving injuries, as follows:

(i) in October 2015, a worker of Contractor A lost balance and dropped a metal cover to his co-worker's finger and caused minor injury. Contractor A informed DSD of the incident one month later. DSD issued two under-performance notices to Contractor A for inadequate provision of safety measures and late reporting of the incident; and

(ii) in April 2018, a worker of Contractor A slipped and fell down from a concrete block of 60 centimetres height and received a minor surgery. Contractor A informed DSD of the incident 50

Note 53: *According to LD: (a) as the accident investigation reports compiled by LD officers contain information relating to working processes and personal data, LD is precluded from releasing the reports to third parties (including other government departments) under the Occupational Safety and Health Ordinance and the Personal Data (Privacy) Ordinance; and (b) LD will from time to time issue press releases containing conviction results related to fatal work accidents on the respective dates of judgements. For the fatal accident in 2014 (see para. 3.22), a press release was issued in September 2015 providing a brief account of the case and the conviction results.*

hours later. DSD had issued an under-performance notice to Contractor A for inadequate safety awareness and/or working environment and late reporting of the incident;

(b) ***Occupational safety at confined space.*** According to DSD guidelines, working in confined space is an extremely high-risk activity and safety supervision of confined space work is necessary in order to prevent gassing and drowning accidents. A contractor is required to ensure that no worker enters a confined space unless a certificate has been issued (Note 54). Audit noted the following instances involving occupational safety at confined space at PPSTW:

(i) in September 2015, a worker of Contractor A was found smoking inside a confined space. DSD had issued an under-performance notice to Contractor A; and

(ii) in September 2017, January 2018 and September 2020, there were unauthorised entries of workers of Contractor A into confined space without proper certificates. DSD had issued warning letters to Contractor A for the incidents (Note 55); and

(c) ***Site safety inspections.*** According to DSD, its staff conduct joint site walks with Contractor A for site safety inspections of PPSTW on a monthly basis. According to the inspection records for September 2020, DSD identified 7 irregularities. Audit noted that 3 (43%) of the 7 irregularities had already been identified by DSD more than one year and up to two years (averaging 21 months) ago but were still not yet fully

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Note 54: *According to Factories and Industrial Undertakings (Confined Spaces) Regulation (Cap. 59AE), a contractor shall ensure that no worker enters a confined space for the first time until the contractor has issued a certificate stating that all necessary safety precautions in relation to the hazards identified in the risk assessment report have been taken and the period during which workers may remain safely in the confined space. When work is being carried out in a confined space, a contractor shall ensure that the risk assessment report and the related certificate are displayed in a conspicuous place at the entrance of the confined space, and the safety precautions undertaken continue to be effective.*

Note 55: *According to DSD, for the case in September 2020, the performance was also reflected in the quarterly performance report of Contractor A for the period from September to November 2020 (e.g. safety aspect was rated as "poor").*

rectified, including faulty signals in a fire services panel and water seepage at a pump inlet.

3.25 Regarding occupational safety at PPSTW, DSD informed Audit in March 2021 that:

(a) DSD monitored the performance of Contractor A in occupational safety through regular and ad-hoc site inspections. The performance of Contractor A was regulated through advice, warning and performance reports; and

(b) DSD had issued three Employer's Changes (at a total estimated cost of $2.1 million) to Contractor A for enhancing the safety of working environment (e.g. provision of additional CCTV systems at confined space) at PPSTW in 2016, 2019 and 2020.

3.26 In Audit's view, DSD needs to take adequate and timely follow-up actions on incidents relating to occupational safety at PPSTW. DSD also needs to make continued efforts to enhance the occupational safety at PPSTW, including:

(a) keeping under review and improving the safety of facilities as needed;

(b) closely monitoring the contractor's measures in safeguarding occupational safety and promoting safety awareness; and

(c) stepping up actions to ensure that the irregularities identified in site safety inspections are timely rectified.

Audit recommendations

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

(a) **continue to closely monitor the performance of the contractor in operating PPSTW including compliances with KPIs;**

(b) **review the demerit point mechanism (including the maximum payment deduction level for non-compliances with KPIs and the**

assignment of demerit points for unauthorised emergency bypass and incident reporting) of the PPSTW contract as scheduled and complete it timely;

(c) **take timely actions to investigate the reasons for high *E. coli* concentration in effluent found by DSD's surprise checks at PPSTW and address the issues identified (e.g. equipment failure or poor disinfection efficiency of UV disinfection facilities and possible sample contamination);**

(d) **formalise the existing practice and promulgate guidelines on DSD's surprise checks conducted on effluent quality of PPSTW (covering frequency and timing of surprise checks, and follow-up actions needed);**

(e) **regularly compile management information (e.g. highlights or summaries) on test results of DSD's surprise checks at PPSTW for monitoring by DSD's senior management;**

(f) **take adequate and timely follow-up actions on incidents relating to occupational safety at PPSTW; and**

(g) **make continued efforts to enhance the occupational safety at PPSTW, including:**

(i) **keeping under review and improving the safety of facilities as needed;**

(ii) **closely monitoring the contractor's measures in safeguarding occupational safety and promoting safety awareness; and**

(iii) **stepping up actions to ensure that the irregularities identified in site safety inspections are timely rectified.**

Response from the Government

3.28 The Director of Drainage Services agrees with the audit recommendations.

Monitoring of operation and maintenance of facilities

3.29 According to Contract A, one of the objectives of operation of PPSTW is to operate and maintain the works to upkeep the facilities in the optimum conditions in order to maximise the service life of the facilities (see para. 3.3(b)). Hence it is necessary to devise a comprehensive maintenance schedule over the life of the asset. Preventive maintenance should be carried out to avoid inducing undue wear and tear to the equipment.

3.30 Contractor A is required under Contract A to maintain the following computer systems for managing the operation and maintenance of facilities at PPSTW:

(a) ***Supervisory Control and Data Acquisition System (SCADA System).*** SCADA System is for on-line monitoring and controlling of various electrical and mechanical equipment and systems of PPSTW; and

(b) ***Computerised Maintenance Management System (CMM System).*** CMM System is to facilitate management of systems and equipment, daily operation work, corrective and preventive maintenance of PPSTW. All maintenance and asset related information is recorded, analysed and stored in the System.

3.31 According to DSD:

(a) SCADA System and CMM System are managing tools used by Contractor A and DSD is not involved in running the systems;

(b) for DSD's information and regular monitoring purposes, Contractor A submits the maintenance records generated from CMM System via monthly operation reports, with major preventive maintenance activities shortlisted in the reports. Besides, any critical/sensitive activities will be highlighted for discussion or review in the monthly operation meetings and recorded in minutes of the meetings;

(c) for CMM System, DSD can make use of the records to trace the maintenance history of particular equipment in order to have analysis or

further investigation/discussion/evaluation via ad-hoc communication, weekly inspection, monthly operation meeting or quarterly contractor performance reporting; and

(d) for SCADA System, DSD can monitor the real-time operation data and retrieve historical data from time to time if necessary. As routine checking during weekly inspection, DSD can retrieve and review the plant performance information via SCADA System data.

Inconsistencies and loss of data in SCADA System

3.32 SCADA System is a real-time system used for remote control and monitoring of the operation of PPSTW by Contractor A, which is linked to the field equipment. According to DSD, there were inconsistencies and loss of data in SCADA System, as follows:

(a) ***Inconsistencies in some on-site readings and SCADA System.*** DSD noted that there were inconsistencies in some readings taken on site and those shown in SCADA System. For example:

(i) the readings of hydrogen sulphide (see Note 22 to para. 2.13(e)) at the outlets of deodorisation units of PPSTW were shown as "zero" all the time in SCADA System, which differed from the on-site values shown in the local control panel. DSD's checking found that hydrogen sulphide reading had been overwritten as "zero" in SCADA System; and

(ii) the alarm settings (e.g. high and low alarm levels) for the sensors measuring the hydrogen sulphide outlet concentration level were overridden in SCADA System.

According to DSD, the problem of data inconsistencies had been rectified in September 2020 (i.e. about 1.5 years after identification of the problem in June 2019); and

(b) ***Loss of data among terminals of SCADA System.*** The master control terminal of SCADA System is located in the control room at PPSTW, and two terminals receiving the same signals are located in DSD's two offices

at PPSTW and the Sham Tseng Sewage Treatment Works (Note 56) respectively. Since commencement of operation of PPSTW in May 2014, there had been loss of data in the terminals in the two DSD's offices. For example, some signals (such as signals for UV system) were lost in the two terminals in DSD's two offices and some historical data could not be extracted from DSD's terminals. As of February 2021, the problem was not yet fully resolved.

3.33 In September 2020, DSD issued a warning letter to Contractor A stating that it had already issued at least six letters about data inconsistencies and data loss in SCADA System since October 2018 but there was still no significant improvement, and inaccurate data in SCADA System would directly tamper DSD's monitoring of site operation. Audit noted that it took about 1.5 years to resolve the problem of data inconsistencies (see para. 3.32(a)) and the data loss problem was not yet fully resolved as of February 2021 (see para. 3.32(b)). In Audit's view, DSD needs to continue to monitor SCADA System and take timely follow-up actions in addressing the problems identified (e.g. data loss problem in the terminals of the two DSD's offices).

Scope for enhancing the monitoring of preventive maintenance

3.34 According to Contract A, Contractor A should uphold the condition of the facilities of PPSTW and carry out routine inspection and maintenance (i.e. preventive maintenance) according to the schedules as specified in the contract as a minimum. In general, the minimum maintenance frequency required for most of the equipment ranges from weekly to annually.

3.35 CMM System maintains the maintenance records for facilities at PPSTW. According to Contract A, CMM System should provide planned preventive maintenance function, trigger preventive maintenance tasks based on user defined frequency criterion and collect statistics for each equipment in the database for analytical use. According to CMM System records, there were 16,952 preventive maintenance tasks (involving 432 equipment items) completed during the period of some 5.5 years from January 2015 to October 2020.

Note 56: *According to DSD, its regional control centre for Sham Tseng and Tuen Mun region is located at the Sham Tseng Sewage Treatment Works.*

3.36 Based on CMM System records (Note 57), Audit selected 20 equipment items for which preventive maintenance was carried out once during the period from January 2015 to October 2020. Audit noted that their maintenance frequency fell short of the required minimum frequency of once every six months or every year under Contract A.

3.37 In March 2021, DSD informed Audit that:

(a) preventive maintenance for equipment and facilities at PPSTW was not carried out according to the specified schedules in Contract A. From the experience gained in the operation phase and for effective resources allocation, Contractor A had fine-tuned the preventive maintenance schedules to meet the operational needs of the plant; and

(b) some maintenance records were not included in CMM System and were maintained in other systems (e.g. monthly reports, weekly reports and logbook).

3.38 According to Contract A, it is necessary to devise a comprehensive maintenance schedule over the life of the asset, and preventive maintenance should be carried out to avoid inducing undue wear and tear to the equipment (see para. 3.29). Audit noted that:

(a) the frequency of preventive maintenance for equipment and facilities at PPSTW deviated from the specified schedules in Contract A as Contractor A had fine-tuned the schedules (see para. 3.37(a)). As far as could be ascertained, there was no readily available information on the revisions made to the preventive maintenance schedules in Contract A; and

(b) some maintenance records were not included in CMM System and were maintained in manual records (see para. 3.37(b)).

Note 57: *CMM System had not recorded the minimum maintenance frequency required for each equipment. Therefore, Audit could not readily ascertain whether the preventive maintenance had been carried out according to the required frequency for each equipment.*

3.39 In Audit's view, DSD needs to enhance the monitoring of the contractor's preventive maintenance of equipment and facilities at PPSTW, including:

(a) enhancing the documentation of the revisions made to the preventive maintenance schedules in the PPSTW contract;

(b) taking measures to ensure that preventive maintenance is carried out according to the required frequency; and

(c) exploring the feasibility of using CMM System to capture all maintenance records (see para. 3.38(b)).

Need to ensure the timely completion and recording of maintenance tasks and compile regular management information on maintenance

3.40 According to DSD, the details of maintenance are required to be recorded in CMM System, including the progress (e.g. task creation date, task priority (Note 58), planned start date, target and actual completion dates). According to CMM System records, there were 7,572 maintenance tasks completed between January 2019 and October 2020 (Note 59). Based on available information in CMM System (see para. 3.37(b)), Audit noted the following issues:

(a) ***Some maintenance tasks completed later than the target time.*** Of the 7,572 maintenance tasks completed between January 2019 and October 2020, 7,313 (97%) were preventive maintenance and 259 (3%) were corrective maintenance. The target time for completion of the maintenance ranged from immediately to one month. Audit noted that:

Note 58: *According to CMM System records, there are four task priorities, i.e. tasks to be completed immediately, within 8 hours, 7 days or 1 month from the planned start date of the tasks.*

Note 59: *According to DSD, based on CMM System records, there were 67 maintenance tasks not yet completed as of October 2020. In February 2021, DSD informed Audit that all these maintenance tasks had been completed between January 2019 and October 2020 but the related CMM System records had not been updated (see also para. 3.40(b) for Audit's findings on recording of maintenance information in CMM System).*

(i) of the 7,313 preventive maintenance tasks completed, there was delay in completion for 2,108 (29%) tasks, ranging from 1 day to 1 year (averaging 12 days) after target completion dates; and

(ii) of the 259 corrective maintenance tasks completed, there was delay in completion for one task for about 5 months.

In Audit's view, DSD needs to strengthen measures to ensure that the maintenance for equipment and facilities at PPSTW is timely completed;

(b) ***Some maintenance tasks not timely recorded in CMM System.*** Of the 7,572 maintenance tasks completed between January 2019 and October 2020, the completion dates of 1,559 (21%) tasks were earlier than the task creation dates in CMM System (i.e. they were recorded in CMM System after the tasks had been completed for 1 day to 4.5 months, averaging 12 days). In Audit's view, DSD needs to take measures to ensure that maintenance information for equipment and facilities at PPSTW is timely recorded in CMM System; and

(c) ***Need to regularly compile management information on maintenance.*** Audit noted that DSD had not regularly compiled management information (e.g. highlights or summaries) on maintenance carried out at PPSTW, including:

(i) frequency of preventive maintenance carried out and compliance with the prevailing maintenance schedules; and

(ii) equipment requiring frequent corrective maintenance.

In Audit's view, DSD needs to regularly compile management information (e.g. highlights or summaries) on maintenance carried out at PPSTW for monitoring purpose.

Need to ensure timely rectification of defects identified in plant performance audit and structural condition survey

3.41 According to Contract A, Contractor A is required to, in the 5th, 9th and 14th years after commencement of operation of the upgraded PPSTW, appoint:

(a) an independent professional engineer to carry out a plant performance audit, including assessment on the general operation and maintenance condition of the plant and equipment; and

(b) an independent structural engineer to carry out a structural condition survey of the buildings and structures, including assessment on the physical condition of the key structural components at the plant.

3.42 A plant performance audit was completed in May 2019 (i.e. the 5th year after commencement of operation of the upgraded PPSTW in May 2014), which identified a total of 25 items requiring rectification works to be completed within one month to six months, as follows:

(a) 4 items requiring urgent rectification to be completed within one month. Examples included replacing malfunctioned fire equipment and repairing the weight-bridge cum car-plate recognition system;

(b) 15 items requiring moderate rectification to be completed within three months. Examples included rectifying inconsistencies in the hydrogen sulphide readings between SCADA System and local control panel (see para. 3.32(a)(i)), and checking equipment with abnormal noise or vibration; and

(c) 6 items requiring minor rectification to be completed within six months. Examples included repairing CCTV system and damaged penstock.

3.43 A structural condition survey commenced in May 2019 and was completed in April 2020 (with the report submitted to DSD in May 2020). According to the structural condition survey, while there were no serious defects or signs of structural distress or instability, 1,290 defects were observed along both internal and external structural elements of the buildings and structures. According to Contract A, for defects identified in a structural condition survey, all the

rectification works should be completed within 60 days after issue of the report or other period as agreed by DSD (Note 60).

3.44 Audit noted that there was scope for improvement in the rectification works, as follows:

(a) ***Defects not timely rectified.*** According to DSD, Contractor A reported that the rectification works for all defects identified in the structural condition survey had been completed by January 2021, i.e. about eight months after issue of the report in May 2020 and exceeding the 60-day time limit specified in Contract A (see para. 3.43). In March 2021, DSD informed Audit that the progress of implementing the rectification works was monitored and recorded in monthly operation meetings with Contractor A. In Audit's view, DSD needs to strengthen actions to ensure that defects identified in a structural condition survey of PPSTW are timely rectified; and

(b) ***Need to keep track of progress of rectification works.*** According to DSD:

(i) Contractor A reported that the rectification works for the items identified in the plant performance audit and the defects identified in the structural condition survey had been completed by October 2019 and January 2021 respectively; and

(ii) the progress of implementing the rectification works was monitored and recorded in monthly operation meetings with Contractor A.

Audit noted that the time limits for completing the rectification works for different items/defects varied (e.g. ranging from one month to six months for those identified in the plant performance audit — see para. 3.42). However, there was no documentary evidence showing that DSD had kept track of the progress of rectification works against the time limits for these items/defects. In Audit's view, there is merit for DSD to keep track

Note 60: *There was no documentation showing that DSD had agreed to extend the rectification period.*

of the progress of rectification works against the time limits for different items/defects (e.g. requesting Contractor A to provide regular reports).

Audit recommendations

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

(a) **continue to monitor SCADA System and take timely follow-up actions in addressing the problems identified (e.g. data loss problem in the terminals of the two DSD's offices);**

(b) **enhance the monitoring of the contractor's preventive maintenance of equipment and facilities at PPSTW, including:**

(i) **enhancing the documentation of the revisions made to the preventive maintenance schedules in the PPSTW contract;**

(ii) **taking measures to ensure that preventive maintenance is carried out according to the required frequency; and**

(iii) **exploring the feasibility of using CMM System to capture all maintenance records;**

(c) **strengthen measures to ensure that the maintenance for equipment and facilities at PPSTW is timely completed;**

(d) **take measures to ensure that maintenance information for equipment and facilities at PPSTW is timely recorded in CMM System;**

(e) **regularly compile management information (e.g. highlights or summaries) on maintenance carried out at PPSTW for monitoring purpose;**

(f) **strengthen actions to ensure that defects identified in a structural condition survey of PPSTW are timely rectified; and**

(g) **regarding items/defects identified in a plant performance audit and a structural condition survey of PPSTW, keep track of the progress of rectification works against the time limits for different items/defects.**

Response from the Government

3.46 The Director of Drainage Services agrees with the audit recommendations.

PART 4: ADMINISTRATION OF DESIGN-BUILD-OPERATE CONTRACT ARRANGEMENT

4.1 This PART examines DSD's administration of DBO contract arrangement for upgrading and operation of PPSTW and the experience gained (paras. 4.2 to 4.17).

Adopting the design-build-operate contract arrangement

4.2 According to Environment, Transport and Works Bureau Technical Circular (Works) No. 32/2004 (Note 61), DBO approach is one of the procurement approaches (Note 62) that:

(a) bundles the design, construction and operation responsibilities in one contract;

(b) addresses the risk that the contractor may be tempted to "design down" (Note 63) to suit the tender price. In areas where advanced technology is required, it is essential for the technology chosen for the design to provide best value in procurement terms, and for this to be demonstrated by its life-cycle costs;

(c) any under-estimation of operating costs would be a contractor's risk; and

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Note 61: *The Circular aims to facilitate user departments in adopting a more rational and systematic approach in selecting the procurement approach and associated project delivery techniques for public works projects.*

Note 62: *Procurement approaches are broadly classified into four generic categories in accordance with the contractor's involvement in the key stages of the overall development process, namely: (a) Designer Led; (b) Design and Construct; (c) Design Construct and Operate; and (d) Finance Design Construct and Operate. DBO approach is one of the sub-categories of the Design Construct and Operate category.*

Note 63: *For example, the contractor may compromise on the quality of design to save costs.*

(d) operator cannot attribute any problem that it encounters to the previously carried out design and construction.

4.3 The upgrading and operation of PPSTW was the first sewage treatment works project of DSD adopting the DBO contract arrangement. According to DSD, it brought in DBO arrangement for procuring sewage treatment facilities in view of its potential merits, as follows:

(a) encouraging the introduction of overseas innovative technologies, experience and management techniques;

(b) larger scope for optimisation resulting in lower life-cycle cost;

(c) minimisation in government staff resources; and

(d) clearer accountability of responsibilities among design, construction and operation phases as only one party is responsible for the whole DBO process.

4.4 After the award of the first DBO contract (i.e. Contract A) in July 2010, two more DBO contracts had been awarded by DSD for other sewage treatment works, as follows:

(a) under the upgrading of the Stonecutters Island Sewage Treatment Works, a DBO contract for the sludge handling and disposal facilities was awarded in June 2013 at a contract sum of $2,081 million (Note 64). The sludge handling and disposal facilities commenced operation in March 2015; and

(b) a DBO contract for the upgrading and operation of the San Wai Sewage Treatment Works was awarded in May 2016 at a contract sum of $3,142 million. The upgraded sewage treatment works commenced operation in March 2021.

Note 64: *According to DSD, the design and construction portions commenced in July 2013 and were completed in March 2015. As of January 2021, it was under the operation stage.*

Drawing on the experience gained

4.5 According to DSD, the experience gained during the implementation of Contract A (being the first DBO contract of DSD for upgrading PPSTW) would be a valuable reference for future contract arrangement of projects of sewage treatment works.

4.6 Audit noted that, apart from the issues identified in PARTs 2 and 3 above, there were various issues related to the implementation of the first DBO contract for upgrading and operation of PPSTW, which merit DSD's attention and follow-up actions, and DSD could draw on the experience gained in implementing future DBO contracts (see paras. 4.7 to 4.15).

Need to keep under review the cost-effectiveness of adopting DBO contract arrangement

4.7 In July 2009, FC approved the funding for the upgrading works at an estimated cost of $1,360.9 million (see para. 1.6). However, the APE was not sufficient to cover the tender price for the design and construction portions of the recommended tender.

4.8 In July 2010, FC approved an increase of the APE by $559.6 million (41% — Note 65) to $1,920.5 million for meeting the required expenditure of the upgrading works. The justifications for the cost increase provided by the Environment Bureau were as follows:

(a) ***Higher capital cost.*** The DBO contract arrangement helped optimise the interfaces among design, construction and operation of PPSTW at early stages of the project and contractor would apply innovative technologies in wastewater treatments. Increase of APE for the upgrading works was required for additional capital cost for developing a sewage treatment

Note 65: *The increase of APE by $559.6 million comprised an increase in design and construction cost for the upgrading works of $403.1 million and an increase in provision for price adjustment of $156.5 million.*

plant design that fulfilled specified performance requirements and for achieving higher cost-effectiveness in subsequent operations; and

(b) ***Savings in operating cost.*** In return, as significant savings would be yielded in subsequent operation of the plant, the benefits of enhanced operational efficiency should outweigh the need for additional capital cost of $403.1 million. It was expected that the estimated annual recurrent expenditure arising from the upgrading works for the operation stage would be decreased by $30 million (33%) from $90 million to $60 million. As a result, overall savings of $450 million would be yielded over the 15-year life cycle of the upgraded PPSTW.

4.9 As of January 2021, the upgraded PPSTW had been operated for more than 6.5 years. According to DSD, it had exercised tight control on the operating cost of the upgraded plant and the actual operation expenditure in general reflected that the estimated annual saving of $30 million had been achieved. To assess the cost-effectiveness of the higher capital cost incurred under the DBO contract arrangement and facilitate drawing on the experience gained in future, in Audit's view, DSD needs to keep under review the savings achieved in operating the upgraded PPSTW.

Need to timely conduct post-completion review

4.10 According to the Project Administration Handbook for Civil Engineering Works issued by the Civil Engineering and Development Department:

(a) a post-completion review is a useful project management tool and shall be conducted upon the substantial completion of a major consultancy agreement or a major works contract on projects under the Public Works Programme. The emphasis and objective of the review are to gain maximum benefit from the experience accrued, rather than to apportion blame;

(b) there is no rigid definition for major projects or the minimum number of reviews to be undertaken by departments. As a broad guideline, post-completion reviews are generally not warranted for consultancy agreements and works contracts of a project which has a total cost less than $500 million or of a project which does not involve complicated

technical and management issues. Based on the above guidelines, departments could select agreements/contracts to be reviewed at their discretion;

(c) indicators that a project involves complicated issues may include project involving:

(i) a claim of a substantial sum, say over $1 million; and

(ii) incidents that attract public attention;

(d) a post-completion review should be carried out within a reasonable period, say six months, after the substantial completion of a consultancy agreement or a works contract. However, in case there are on-going disputes with the service providers, it may be more appropriate to defer the review until the disputes are settled; and

(e) a post-completion review should be led by the officer in charge of the project and he or she should solicit input from the client and other project participants (such as the consultants, contractors and subcontractors) as appropriate. Upon the completion of a post-completion review, the department shall prepare a report documenting all concerned issues, findings, conclusions and recommendations for future reference by the department.

4.11 The design and construction portions of Contract A were already substantially completed in May 2014 and the total contract expenditure ($1,774.7 million — see para. 1.10) was much higher than $500 million (see para. 4.10(b)). However, Audit noted that, as of January 2021 (more than six years thereafter), DSD had not conducted a post-completion review for the design and construction portions of Contract A.

4.12 As a post-completion review is a useful project management tool and to facilitate drawing on the experience gained in future DBO contracts, in Audit's view, DSD needs to conduct a post-completion review for the design and construction portions of Contract A.

Scope for making better use of Knowledge Management Portal in sharing experience gained

4.13 Upon the request of DSD, Consultant X commissioned a review of the effectiveness and efficiency of the implementation of Contract A in April 2016 and submitted the review report in April 2017. The report aimed to share the experience gained from the upgrading and operation of PPSTW and make recommendations for improving future DBO contracts. Consultant X's recommendations included:

(a) ***Deeper involvement of DSD during design stage.*** Under the DBO contract arrangement of PPSTW, with a view to shortening the design checking procedures and enhancing cost-effectiveness and efficiency, DSD was only involved in major issues (e.g. proposed changes of Employer's Requirements — see Note 10 to para. 2.2) and less DSD resources were committed to the project during the design stage. On the other hand, DSD's expertise in sewage treatment works, which was unique in Hong Kong, was not fully utilised. Deeper involvement of DSD during the design stage would be beneficial to the project; and

(b) ***Setting of lower bound Employer's Requirements.*** For a DBO contract, the Employer's Requirements were necessarily performance specifications, which allowed room for innovation, introduction of proprietary designs and new technologies and utilisation of expertise from around the world. It also allowed room for the contractor to develop its operation and maintenance strategy and the modes of operation that would suit its design. On the other hand, flexibility in Employer's Requirements could be exploited by the contractor. Additional lower bound requirements should thus be stipulated in the Employer's Requirements.

According to DSD, Consultant X's recommendations had been adopted in the upgrading works project of the San Wai Sewage Treatment Works (see para. 4.4(b)).

4.14 According to DSD, the experience gained during the implementation of Contract A would be a valuable reference for future procurement of sewage treatment works projects and should be properly included in the Knowledge

Management Portal of DSD (Note 66). Audit noted that, regarding the information for DBO contracts, as of January 2021:

(a) the Knowledge Management Portal only contained a PowerPoint presentation on DBO contract procurement (Note 67) dated November 2016 (i.e. more than 4 years ago); and

(b) in particular, the results in the review report of Contract A (see para. 4.13) and DSD's experience gained in monitoring the operation of the upgraded PPSTW were not posted onto the Portal.

4.15 In Audit's view, there is scope for DSD to make better use of the Knowledge Management Portal in sharing experience gained from DBO contract arrangement (e.g. regular updating of experience gained in implementing DBO contracts).

Audit recommendations

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

(a) **keep under review the savings achieved in operating the upgraded PPSTW under the DBO contract arrangement;**

(b) **conduct a post-completion review for the design and construction portions of Contract A to facilitate drawing on the experience gained in future DBO contracts; and**

Note 66: *According to DSD Technical Circular No. 1/2005, Knowledge Management Portal is a departmental centralised knowledge database to capture valuable experience and enhance effective sharing of information. It is a platform to facilitate storage, retrieval and sharing of useful knowledge and information within DSD.*

Note 67: *The presentation covered the upgrading works projects of PPSTW, the Stonecutters Island Sewage Treatment Works and the San Wai Sewage Treatment Works.*

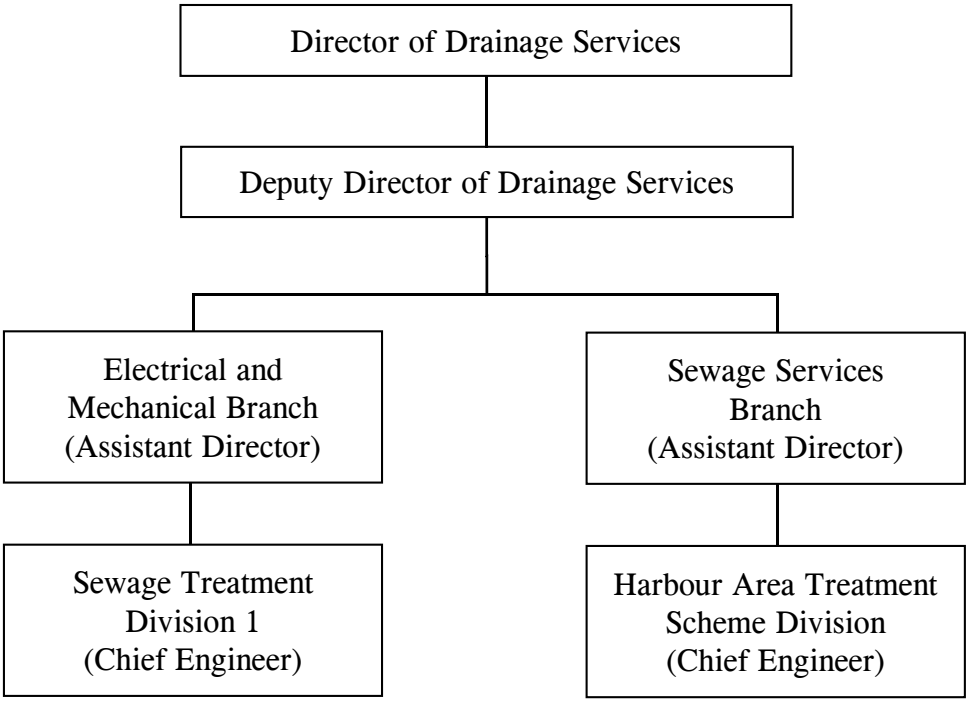
(c) **make better use of the Knowledge Management Portal in sharing experience gained from DBO contract arrangement (e.g. regular updating of experience gained in implementing DBO contracts).**

Response from the Government

4.17 The Director of Drainage Services agrees with the audit recommendations.

Appendix A
(para. 1.15 refers)

Drainage Services Department: Organisation chart (extract) (31 October 2020)



Source: DSD records

Appendix B

Acronyms and abbreviations

APE	Approved project estimate
Audit	Audit Commission
CCTV	Closed-circuit television
CEPT	Chemically enhanced primary treatment
CMM System	Computerised Maintenance Management System
DBO	Design-build-operate
DSD	Drainage Services Department
E. coli	*Escherichia coli*
EPD	Environmental Protection Department
FC	Finance Committee
KPI	Key Performance Indicator
LD	Labour Department
LegCo	Legislative Council
m^3	Cubic metres
PPSTW	Pillar Point Sewage Treatment Works
SCADA System	Supervisory Control and Data Acquisition System
UV	Ultraviolet