For Information

Subcommittee on
Sewage Services (Sewage Charge) (Amendment) Regulation 2007,
Sewage Services (Trade Effluent Surcharge) (Amendment) Regulation 2007 and
Technical Memorandum on Procedures and Methods for Sampling and Analysis of Trade Effluents

Information on Issues raised by Members at the Meetings on 19 April 2007 and 24 April 2007

Purpose

In response to requests made by Members at the Subcommittee meetings on 19 April 2007 and 24 April 2007, this paper provides further information on the following topics:

(a) The need for and the effects of chlorination/dechlorination when the Government proceeds with HATS Stage 2B;

(b) Harbour Area Treatment Scheme (HATS) – a breakdown of unit treatment costs relating to different stages;

(c) Stonecutters Island Sewage Treatment Works (SCISTW) – sewage quality (average values) relating to different stages of HATS; and

(d) Rough comparison of the recurrent costs for the biological treatment plant under Stage 2B if it is constructed underground or above ground.

The need for and the effects of chlorination/dechlorination when the Government proceeds with HATS Stage 2B

2. The completion of HATS Stage 1 brought about a general improvement in harbour water quality, with significant improvements particularly in the eastern part of the harbour. However, the western waters deteriorated due to the lack of disinfection facilities in HATS Stage 1. A large

volume of undisinfected effluent is discharged through a single outfall, thereby affecting the water quality of the waters around the outfall and beyond. This discharge of undisinfected effluent coupled with the existing local discharges of untreated sewage resulted in the closure of four more beaches in the Tsuen Wan area following the full commissioning of the HATS Stage 1 in December 2001.

3. The results of water quality modeling conducted under the on-going Environmental Impact Assessment (EIA) Study for the provision of disinfection facilities for HATS Stage 2 have shown that bacteria levels in the western harbour and the Tsuen Wan beaches would further deteriorate as a result of the projected increase in sewage flows in the harbour area and the commissioning of Stage 2A if disinfection is not provided. The need for disinfection has been clearly demonstrated.

4. Regarding the second phase of Stage 2, the advance disinfection facilities (ADF) EIA water quality modeling results show that with the implementation of Stage 2B, compliance with the relevant WQO at most of the beaches without the provision of disinfection should be achievable. However, it is important to note that modeling cannot fully predict the high variability of some factors (e.g. salinity, natural ultra violet radiation and wind) that affect the density of *E. coli* in the receiving waters. Therefore, planning for disinfection is necessary in order to ensure consistent compliance with the WQO. In fact, the Report of the Public Accounts Committee (PAC) of the Legislative Council on the Director of Audit's Report No. 42 (2004), requested the Administration to "*take into account the high bacteria level of the effluent discharged from the Stonecutters Island Sewage Treatment Works in planning the further stages of HATS, and in evaluating the options for providing a permanent disinfection facility in the long term*".

5. Following up on the PAC report the Drainage Services Department commissioned consultants to examine the different options for provision of a disinfection facility for HATS and to conduct an EIA. Various disinfection technologies have been considered but the only one that can be installed reasonably quickly (within two to three years) so as to allow early improvements in water quality and hence early reopening of the Tsuen Wan beaches, is chlorination followed by dechlorination. While the environmental impact assessment for this technique has yet to be concluded, all the indications are that the impacts on water quality should be acceptable. <u>Annex A</u>

summarizes the tests conducted under the EIA study, the results obtained and the conclusions that could be drawn.

6. While the results of the studies conducted to date are encouraging, whether chlorination/dechlorination will indeed be adopted as the disinfection technology will ultimately depend on the outcome of the Environmental Impact Assessment Ordinance (EIAO) process when the final report of the ADF EIA study is submitted to the EIAO Authority for approval later this year. A period for public comment is part of the EIAO process and the advice of the Advisory Council on the Environment (ACE) will be sought on the acceptability of the proposed disinfection technology before the Authority makes a final decision.

Harbour Area Treatment Scheme – Breakdown of unit treatment costs
Stonecutters Island Sewage Treatment Works – sewage quality

7. As requested by a Member at the Subcommittee on 24 April 2007, a breakdown of the unit treatment costs of different stages of HATS; and the sewage quality relating to HATS Stage 1, Stage 2A and Stage 2B, are at Annex B and Annex C respectively for Members' reference.

Rough comparison of the recurrent costs for the biological treatment plant under Stage 2B if it is constructed underground or above ground

8. As requested by Members on 24 April 2007, we have roughly estimated a comparison of the recurrent costs to be incurred by HATS Stage 2B if the biological plant is built underground (as currently proposed) and built at-grade level. (Annex D) Our current plan is that the future biological plant under Stage 2B should be constructed underground to allow other "container-related" infrastructure to be built above it to maximize use of the site. It should also be noted that the recurrent costs of Stage 2B are not factored into the SC increment projection.

Environmental Protection Department
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Annex A

Environmental Assessment of Chlorination/Dechlorination for HATS

A detailed impact assessment on the discharge of chlorinated/dechlorinated effluent from SCISTW has been conducted under the Adavnce Disinfection Facilities (ADF) Environmental Impact Assessment (EIA) study. The risk assessment covers various phases of HATS Stage 2, i.e. the ADF phase, Stage 2A and Stage 2B and has taken a very prudent approach by making very conservative assumptions. Potential risks to human health and aquatic life, as well as the potential acute and chronic toxicity to aquatic life have been assessed based on the methodology and assessment criteria established by U.S. Environmental Protection Agency (USEPA) and the test results obtained from a series of whole effluent toxicity tests and chlorination by-products tests performed on raw and chlorinated/dechlorinated (C/D) effluent from HATS.

Assessment Criteria

2. The assessment criteria are presented in Table 1.

Table 1 - Established Assessment Criteria

Parameter	Endpoint	Criteria	Source
Total residual chlorine (TRC)	Water Quality Criteria	0.013mg/L at the edge of ZID	ADF EIA
		0.008mg/L edge of mixing zone[6]	EEFS[7]
Risk to human health	Incremental lifetime cancer risk[1]	10^{-4} to 10^{-6}	USEPA
	Non-carcinogenic health effect (total hazard index)[2]	1	
Risk to aquatic life	Total hazard index[3]	1	
Acute toxicity to aquatic life	Acute toxicity unit	0.3 at the edge of ZID[4]	USEPA
Chronic toxicity to aquatic life	Chronic toxicity unit	1.0 at the edge of mixing zone[5]	

[1] The incremental lifetime cancer risk due to exposure to identified Contaminants of Concern (COCs) via incidental ingestion and dermal contact of contaminated seawater, and consumption of contaminated seafood.

[2] The total hazard index due to exposure to identified COCs imposing non-carcinogenic effect via incidental ingestion and dermal contact of contaminated seawater, and consumption of contaminated seafood.

[3] The total hazard index due to exposure to identified COCs.

[4] ZID – Zone of initial dilution based on one-hour average condition

[5] Four-day average condition
[6] Daily maximum
[7] Environmental and Engineering Feasibility Studies (EEFS) Report on Community Consultation for the Proposed Water Quality Criteria

Results of Whole Effluent Toxicity Tests

3. The whole effluent toxicity tests (WETT) for raw and C/D effluents from SCISTW and Tolo Harbour Effluent Export Scheme (THEES), i.e. effluents from Sha Tin STW and Tai Po STW (to represent the secondary effluent to be generated from HATS Stage 2B), were carried out following the protocol established by the Agriculture, Fisheries and Conservation Department (AFCD) through a study undertaken by the City University in 2001 for the Hong Kong marine environment. Four species, including fish, amphipod, barnacle larvae and shrimp, were chosen for the acute toxicity tests, while diatom was used for the chronic toxicity tests. These five species represent the important species of different communities in the marine environment of Hong Kong and are of great ecological and fisheries significance.

4. The WETT results showed no acute toxicity on fish, amphipod and shrimp for the raw and C/D effluents of SCISTW, but the 48-hr LC50[1] for barnacle larvae did indicate some toxicity for both effluents. Similarly a No-Observable-Effect-Concentration (NOEC)[2] for diatom could be determined for both the raw and C/D SCISTW effluents, indicating the presence of some toxicity. Further statistical analysis was conducted on the toxicity test data of barnacle larvae and diatom to determine whether the C/D process has induced additional toxicity in the chemically enhanced primary treated (CEPT) effluent in SCISTW. The analysis showed that the C/D process did not induce any statistically significant differences to the toxicity effect in the CEPT effluent on barnacle larvae and diatom.

5. The WETT results for the secondary effluents from THEES showed that the raw and C/D secondary effluents did not exert acute and chronic toxicity effect on the species used in the WETT. No 48-hr LC50 for animal species and no NOEC for diatom could be determined

Results of Chlorination By-products (CBPs) Testing

6. A series of chemical analyses were conducted to determine the chemical concentrations in raw and C/D effluents. All CBPs that are included in the USEPA National Primary Drinking Water Standards and the US National Pollutant Discharge Elimination System were selected for testing. A total of 34

[1] 48-hr LC_{50} is the lethal concentration of effluent to 50% of test animals after 48 hours of exposure.
[2] NOEC – No-Observable-Effect-Concentration is the highest concentration of effluent producing effects not significantly different from responses to controls.

chemicals, including total residual chlorine (TRC), Trihalomethanes (THMs) & Haloacetic Acids (HAAs), were tested.

7. Based on the CBPs test results for the CEPT effluent from SCISTW, nine chemicals were detected in the C/D CEPT effluent whilst six chemicals were detected in the raw CEPT effluent. The concentration of TRC detected in the C/D CEPT effluent was in the range of 0.03-0.1 mg/L as compared with 0.03-0.05 mg/L TRC detected in raw CEPT effluent. For six chemicals detected in the C/D CEPT effluent, the concentrations were less than 10μg/L. The remaining two chemicals had concentrations within the range of 10-50μg/L.

8. The test results for the secondary effluent from THEES showed that six chemicals were detected in the C/D secondary effluent whilst one chemical was detected in raw secondary effluent. Three chemicals had concentrations less than 10μg/L and two chemicals had concentrations ranging from 10-50μg/L. The TRC concentration detected in the C/D secondary effluent was less than 0.02 mg/L as compared with the 0.04-0.05 mg/L detected in raw effluent.

9. The log Kow values of the chemical species detected in the C/D effluent are less than 4.0, which indicate that these detected chemical species do not have significant potential to bioaccumulate in the marine organisms.

Risk Assessment Results

10. The potential risks to human health and ecological resources due to chronic exposure to chlorination by-products in CEPT effluent and secondary effluent, as well as the potential acute and chronic toxicity to aquatic life due to the effluent discharge from SCISTW, were estimated and the results are summarized below.

11. Based on the chlorination by-products tests on the CEPT effluent, the incremental lifetime cancer risk was in the range of 10^{-6} to 10^{-7}. The health hazard indexes calculated were around 0.003 for both adult and child. The hazard index for risk to aquatic life was within the range of 0.28 to 0.69.

12. The results of the chlorination by-products tests on the secondary effluent showed that the incremental lifetime cancer risk was in the range of 10^{-6} to 10^{-7}. The health hazard indexes calculated were around 0.002 for both adult and child. The hazard index for risk to aquatic life was within the range of 0.28 to 0.47.

13. By applying the WETT data to the water quality modeling, the acute toxicity unit and the chronic toxicity unit for C/D CEPT effluent were within the ranges of 0.052-0.069 and 0.06-0.07 respectively. No toxicity to marine organisms, as shown in the WETT results, was expected from the C/D

secondary effluent. The model results also indicated that the TRC levels at the edge of the ZID and mixing zone complied with the criteria set out in Table 1.

Conclusion

14. The above assessments show that all results were well within the USEPA's assessment criteria as listed in Table 1. This indicates that the potential risks to human health and ecological resources and the potential water quality impacts in terms of acute and chronic toxicity due to the discharge of chlorinated/dechlorinated effluent from different phases of HATS Stage 2 are low. This confirms that the chlorination/dechlorination process is an environmentally acceptable option for HATS.

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Annex B

Harbour Area Treatment Scheme
Breakdown of Unit Treatment Costs

	Stage 1 ($/m^3$)	Stage 1 plus Stage 2A - ADF ($/m^3$)	Stage 1 plus Stage 2A – Whole ($/m^3$)	Stage 1 plus Stage 2A plus Stage 2B ($/m^3$)
Staff	0.08	0.08	0.05	0.07
Light & Power	0.15	0.15	0.17	0.54
Chemical	0.05	0.19	0.23	0.18
Sludge Disposal	0.04	0.04	0.04	0.09
Maintenance	0.20	0.20	0.24	0.53
Total	0.52	0.66	0.73	1.41

<u>**Annex C 附件 C**</u>

Stonecutters Island Sewage Treatment Works - Sewage Quality (average values)
昂船洲污水處理廠 – 污水水質(平均數值)

Parameters 參數	**Influent** 流入水 **(Note 1)**	**Effluent** 經處理的污水			
		<u>**HATS Stage 1**</u> **CEPT** 經化學強化一級處理 **(Note 1)**	<u>**HATS Stage 1**</u> **CEPT + Disinfection** 經化學強化一級處理 + 消毒 **(Note 1)**	<u>**HATS Stage 2A**</u> **CEPT + Disinfection** 經化學強化一級處理 + 消毒 **(Note 1)**	<u>**HATS Stage 2B**</u> **CEPT +Biological + Disinfection** 經化學強化一級處理 + 生物處理 + 消毒 **(Note 2)**
5-day Biochemical Oxygen Demand (mg/l) 5 天生化需氧量 （毫克/公升）	190	55	55	55	20
Suspended Solids (mg/l) 懸浮固體（毫克/公升）	220	45	45	45	25
Nitrogen (mainly organic N) (mg/l) 氮(有機氮為主) （毫克/公升）	35	25	25	25	7
Total Phosphorus (mg/l) 總磷 （毫克/公升）	5	2.5	2.5	2.5	2
E.coli (no. per 100 ml) 大腸桿菌 （每 100 毫升數量）	20,000,000	10,000,000	200,000	20,000	20,000

Note 1 : The data shown in the column are based on measured effluent quality, except for the *E coli* figures with disinfection applied which are based on projected values.
註 1 : 除了經消毒處理的大腸桿菌含量為預期的數據外，下列數值均基於量度的污水水質。

Note 2 : The data shown below are based on projected values.

註 2 : 下列數值均基於預期的數據。

Annex D

Harbour Area Treatment Scheme Stage 2B Comparison of Recurrent Costs under Different Construction Configurations (underground vs at-grade)

	Biological Plant built underground ($M)	Biological Plant built at-grade ($M) (Rough Estimate)
Additional Recurrent Cost		
Staff	20	20
Light & Power	380	355
Chemical	-40	-48
Sludge Disposal	50	50
Maintenance	290	232
Total	**700**	**605**