Harbourfront Commission

For information
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Water Quality of Victoria Harbour and its Typhoon Shelters

PURPOSE

This paper updates Members on the water quality of Victoria Harbour and its typhoon shelters, with highlights on the water quality at the Kai Tak Approach Channel (KTAC) and Kwun Tong Typhoon Shelter (KTTS). It also reports progress of the Harbour Area Treatment Scheme (HATS).

WATER QUALITY OF VICTORIA HARBOUR AND ITS TYPHOON SHELTERS

Water Quality Objectives (WQO)

2. The Environmental Protection Department (EPD) regularly collects marine water samples from three depths, namely near the sea surface (Surface), in the middle layer of the sea (Middle) and near the sea bed (Bottom) for water quality monitoring. Based on the monitoring results, we check the status of compliance with the Water Quality Objectives (WQOs) laid down under the Water Pollution Control Ordinance. The WQOs for the 4 key parameters : 1) depth-averaged dissolved oxygen (DO) concentration; 2) bottom DO concentration; 3) Total inorganic nitrogen (TIN) and 4) Ammoniacal nitrogen (as unionised form) (NH_3-N), are set out below :

Parameter	WQO
Dissolved Oxygen (Bottom)	Not less than 2 mg/L for 90% of samples
Dissolved Oxygen (Depth-averaged)	Not less than 4 mg/L for 90% of samples
Nutrients (Total inorganic nitrogen, TIN)	Annual mean depth-averaged not to exceed 0.4 mg/L
Ammoniacal nitrogen (as unionised form, NH_3-N)	Annual mean depth-averaged not to exceed 0.021 mg/L

3. We also monitor the bacterial level by measuring the *E. coli* counts. However, there is no bacteriological WQO laid down for the Victoria Harbour Water Control Zone, since its beneficial uses are mainly associated with navigation and provision of typhoon shelters and buoys. If certain part of Victoria Harbour, such as the KTAC, is to be used for conducting water sports activities (rowing, canoeing, etc.), the water quality should be able to comply with the existing bacteriological WQO of 610 *E. coli* counts/100 ml

(annual geometric mean value) established for secondary contact recreational subzone under the WPCO.

4. EPD publishes the water quality monitoring results in the annual report "Marine Water Quality in Hong Kong", which can be downloaded from the EPD's website. The following paragraphs summarise the compliance status with the WQOs in 2011 for the 4 key parameters of Victoria Harbour and its typhoon shelters, namely Chai Wan Cargo Handling Basin, Shau Kei Wan Typhoon Shelter, Sam Ka Tsuen Typhoon Shelter, Kwun Tong Typhoon Shelter, To Kwa Wan Typhoon Shelter, Causeway Bay Typhoon Shelter, New Yau Ma Tei Typhoon Shelter and Rambler Channel Typhoon Shelter, the location of which is depicted in Figure 1, and the bacterial level in terms of *E. coli* counts.

Victoria Harbour

5. EPD's long-term monitoring data show that the water quality of Victoria Harbour has improved during the last decade after implementation of HATS Stage 1 in end 2001 (See Figures 2 and 3). However, in 2011, the compliance rate with the key WQOs of the Victoria Harbour Water Control Zone was only 50%, mainly due to the low compliance rates with the DO and TIN objectives at several stations in the harbour.

6. The DO levels in a water body can be affected by organic pollution as well as natural factors such as temperature and stratification of the water column. Since the monitoring data, on the basis of parameters such as organic nitrogen and 5-day Biochemical Oxygen Demand (BOD_5), did not show any obvious sign of an increase in organic pollution in the harbour's waters, the lower compliance rate with the DO objective in 2011 was likely related to the hot weather experienced during the summer months of that year. The correlation of low DO level with high temperature was also supported by the statistical analyses of marine water quality data collected between 2002 and 2011 (Figure 4). We observe that the decreasing DO levels were statistically and significantly correlated with increasing water and/or air temperature of various marine water bodies in Hong Kong during the last decade.

7. Regarding nutrient levels, the lower compliance rate with the TIN objective in 2011 could be due to a higher background TIN level under the influence of Pearl River discharge, as reflected in the increase in TIN levels in many stations in the Northwestern and Southern waters, the year-to-year normal range of fluctuation of the discharge from surface run-off, as well as the effluent discharged from the four remaining preliminary treatment plants (PTWs) located between North Point and Central during the period. After the commissioning of HATS Stage 2A in 2014, we anticipate that the pollution load into Victoria Harbour will be

significantly reduced when the effluent from the four PTWs are intercepted from direct discharge and collected for treatment at the Stonecutters Island Sewage Treatment Works (SCISTW).

Typhoon Shelters

8. Typhoon shelters are used by small to medium vessels for protection against strong winds and rough sea conditions particularly during the typhoon season. For this reason, typhoon shelters are often located in sheltered water bodies. Since typhoon shelters are designed with breakwaters, the water circulation between the typhoon shelters and Victoria Harbour is restricted, and hence more vulnerable to pollution impact from both land-based sources through the storm drain outlets, and discharge from vessels moored at the typhoon shelters. Some common pollution sources to near-shore waters and typhoon shelters include misconnections of sewers from buildings, defective or aging sewers resulting in leakage from broken sewers and cross connection between sewers and storm water drains, illegal discharges, non-point source pollution (e.g. street cleaning and littering), wastewater from moored vessels, etc.

9. Regarding the various WQO parameters in 2011, as shown in Table 1, the ammoniacal nitrogen WQO could be fully complied with. However, seven typhoon shelters (excluding Chai Wan Cargo Basin) failed to meet with the DO objective, largely because of the hot summer months which led to lower DO levels as explained earlier in paragraph 6. Four typhoon shelters, namely New Yau Ma Tei, Causeway Bay, Kwun Tong and Rambler Channel typhoon shelters, also failed to comply with the TIN objective.

10. Though we observe long term improvement trends in terms of *E. coli* levels (a reduction of bacterial levels ranging from 60 to 95%) as depicted in Figure 5, which is brought about by the implementation of sewerage improvement schemes, the *E. coli* levels in several typhoon shelters such as New Yau Ma Tei and Causeway Bay typhoon shelters remain relatively high as shown in Table 2.

WATER QUALITY AT KTAC

11. The KTAC receives discharges from Kai Tak River (KTR) as well as storm water and surface runoff from the Kwun Tong, Kowloon Bay, Jordan Valley, San Po Kong and Kowloon City areas. Since the KTAC is embayed by the former Kai Tak airport runway and the existing breakwaters of the KTTS with poor water circulation and flushing capacity, pollution from land based sources such as illegal discharge, and non-point sources such as polluted storm water and surface runoff, cannot be effectively dispersed or assimilated after discharge into the KTAC.

12. To improve the water quality and odour problem at KTR, KTAC and KTTS to tie in with the Kai Tak development, the Government has initiated a series of improvement measures since 2009. These measures include continuous rectification of expedient connections at the upstream of KTR, constructing a new dry weather flow interceptor (DWFI) at Jordan Valley, upgrading some existing DWFIs upstream, and bioremediation works at KTAC and KTTS.

13. According to the water quality results gathered by the Civil Engineering and Development Department (CEDD) in 2011 and 2012 (as shown in Table 3 with the location of the sampling stations shown in Figure 6), the geometric mean levels of *E. coli* from the discharge point of KTR to the KTAC were all above 3,000 cfu/100ml. The *E. coli* levels at the KTTS (2,237 cfu/100ml at Station KT1 in 2011) were lower than those at the KTAC. The data so far indicate that the water quality at the KTAC does not meet the bacteriological WQO of 610 *E. coli* cfu/100 ml (annual geometric mean value) laid down for secondary contact recreational uses.

14. CEDD will continue collecting water samples and monitoring the water quality at the KTAC and KTTS. After completion of all drainage rectification works by the Drainage Services Department (DSD) and the bioremediation works by CEDD, CEDD will review the justifications for a proposed opening at the former runway to improve water circulation at the KTAC and KTTS, and will consult the Harbourfront Commission in 2014.

PROGRESS UPDATE OF HATS STAGE 2A

15. HATS Stage 1 was commissioned in December 2001, and has since been providing chemically enhanced primary treatment at the SCISTW of some 1.4 million cubic metres of sewage collected daily from urban Kowloon, Tseung Kwan O, Kwai Tsing and the northeastern part of Hong Kong Island. HATS Stage 1 currently serves a population of about 3.5 million, and since its commissioning, the water quality of Victoria Harbour has improved significantly. For example, the dissolved oxygen in the harbour waters has increased by about 10% and the levels of key pollutants in the harbour area waters have generally decreased.

16. In March 2010, DSD commissioned the advance disinfection facilities (ADF) at the SCISTW under HATS Stage 2A to remove at least 99% of the *E.coli* in the treated effluent. Upon commissioning of the ADF, the *E. coli* level in marine water on the western side of Victoria Harbour fell by 60%, and the water quality of the Tsuen Wan beaches has also shown substantial improvement and is able to comply with the WQO for bathing beaches since

2010. Four previously closed beaches in Tsuen Wan were re-opened in June 2011, to be followed by the remaining three in 2013.

17. DSD is now working on HATS Stage 2A, which aims to collect and treat the remaining 450 000 cubic metres of sewage generated from the northern and southwestern shores of Hong Kong Island. Construction works are now in progress and are targeted for completion in end 2014. When Stage 2A is commissioned, it is expected that the water quality of Victoria Harbour would be further improved.

18. Regarding odour abatement at the SCISTW, DSD awarded a contract under the HATS 2A works package in October 2009 to install covers for all the previously uncovered sedimentation facilities and flow chambers, and to provide air extraction systems so as to collect the air generated from these facilities for purification by deodorization units before discharging to the atmosphere. After the works are completed in September 2012, the odour generated from these previously uncovered facilities has been mitigated. In addition, works are in progress to provide deodorizing devices in all pumping stations and sludge treatment facilities so as to further reduce the odour. Upon completion of various odour control and mitigation measures, the efficiency of odour abatement would be further enhanced.

19. As part of the HATS 2A works package, upgrading works are currently being carried out at three PTWs at North Point, Wan Chai East and Central, while the Wanchai West PTW will be decommissioned in early 2013. During the construction stage, some temporary improvement measures to the PTWs have been implemented, for instance, the screenings and grit handling area inside the Central PTW has been provided with a full enclosure for odour treatment by temporary deodorizers. Weekly odour patrol is being carried out by an environmental team to measure the odour intensity along the boundary of each PTW, in order to ensure proper implementation of the odour mitigation measures. Since the commencement of the PTW upgrading contract in January 2011, no excess odour intensity has been recorded. Upon completion of the PTW upgrading works, the efficiency of odour abatement at these PTWs will be further enhanced, since all the sewage treatment facilities will be covered/enclosed and the foul air contained will be extracted via odour ducts to deodorizers for treatment.

20. EPD commissioned a consultancy study in June 2010 on the secondary sewage treatment works under HATS Stage 2B, including a review on the water quality, population projection, sewage flow and load. Upon completion, the Government will consider the findings of the study and propose the measures required to further improve the water quality of the harbour.

CONCLUSION

21. Members are requested to note the content of this paper.

Environmental Protection Department
Civil Engineering and Development Department
Drainage Services Department

December 2012

Figure 1. Location of marine water quality monitoring stations and typhoon shelters in Victoria Harbour

Figure 2. Marine water quality trends of Victoria Harbour, 1997 to 2011

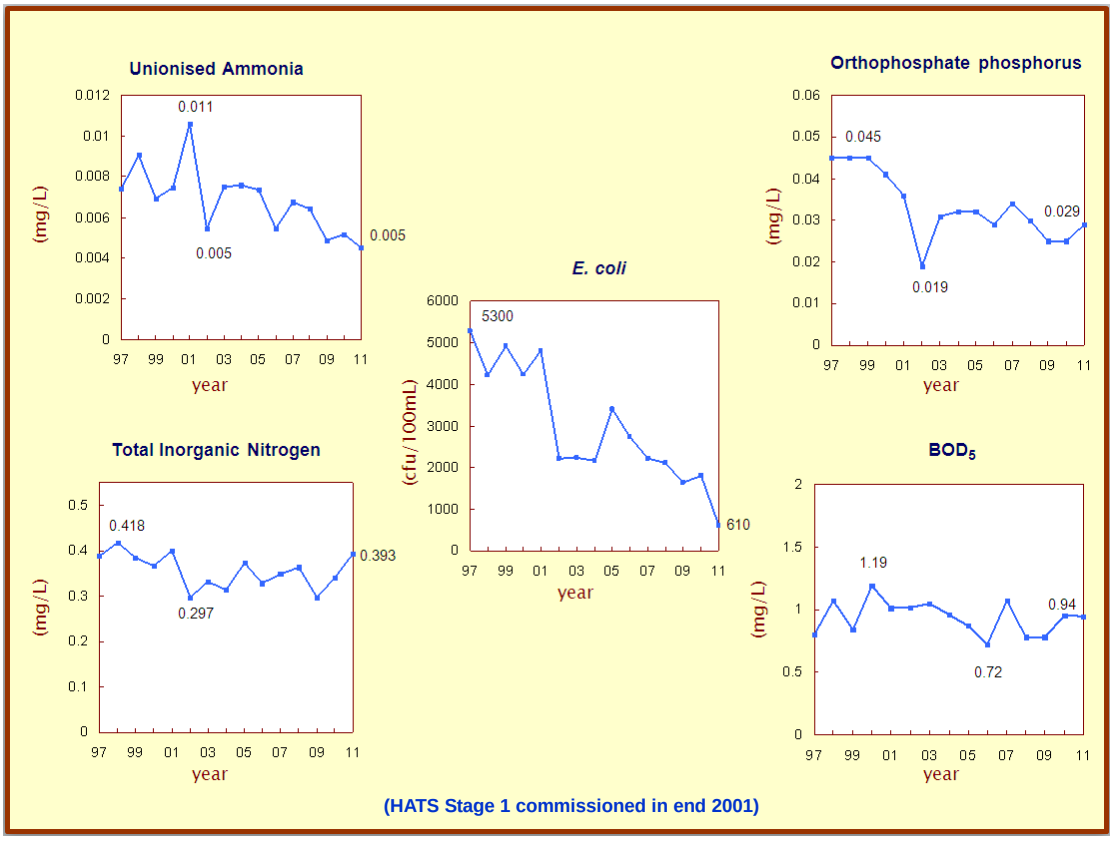

Figure 3. Annual Mean Dissolved Oxygen Levels in Victoria Harbour, 1997 to 2011

Figure 4. Correlation between Dissolved Oxygen and Sea Water Temperature in Tolo Harbour (TM6), Victoria Harbour (VM5) and Western Buffer (WM3) Water Control Zones in 2002-2011

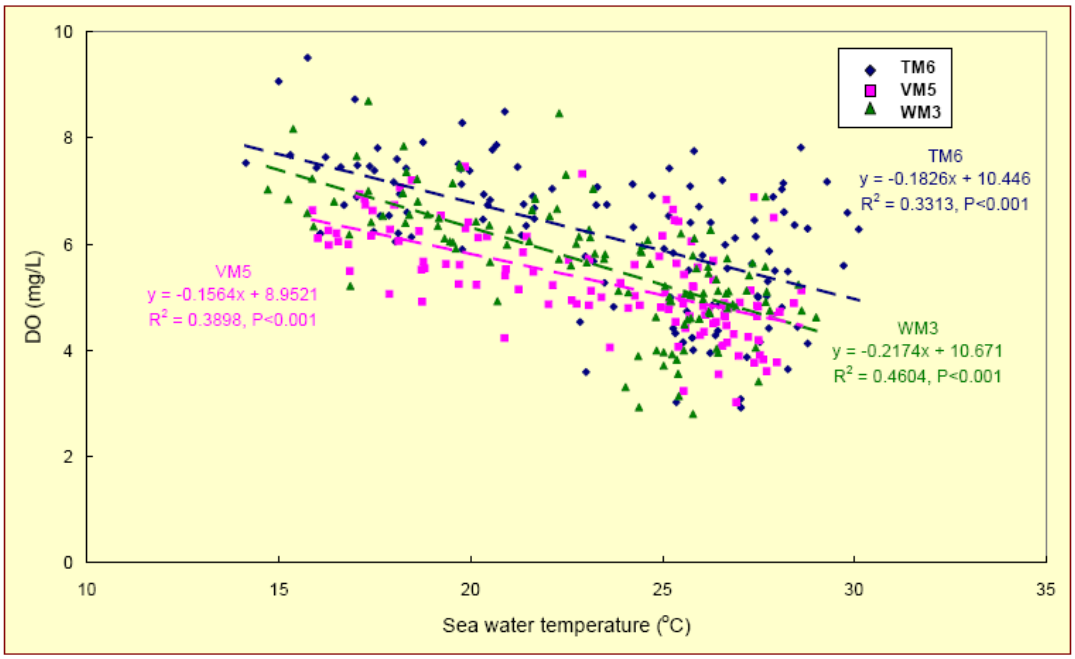

Table 1. Annual mean levels of dissolved oxygen (DO), total inorganic nitrogen (TIN) and ammoniacal nitrogen (NH_3-N) in typhoon shelters/cargo basin in Victoria Harbour in 2011

Typhoon Shelters /Cargo Basin	Annual mean level in 2011(mg/L)			
	DO (bottom)	DO (depth-average)	TIN	NH_3-N
Water Quality Objective (WQO)	90% samples ≥		annual mean ≤	
	2 mg/L	4 mg/L	0.4 mg/L	0.021 mg/L
Chai Wan Cargo Basin	5.6	5.7	0.21	0.003
Shau Kei Wan Typhoon Shelter	4.6	4.7	0.29	0.004
New Yau Ma Tei Typhoon Shelter	3.5	3.5	0.57	0.006
To Kwa Wan Typhoon Shelter	4.7	4.6	0.37	0.004
Causeway Bay Typhoon Shelter	4.0	4.0	0.45	0.005
Sam Ka Tsuen Typhoon Shelter	5.0	4.8	0.32	0.004
Kwun Tong Typhoon Shelter	3.6	3.9	1.09	0.007
Rambler Channel Typhoon Shelter	5.0	4.8	0.45	0.004

Remark : red figures represent non-compliance with the WQO

Figure 5. Mean *E. coli* levels at the typhoon shelters/cargo basin in Victoria Harbour from 1997 to 2011

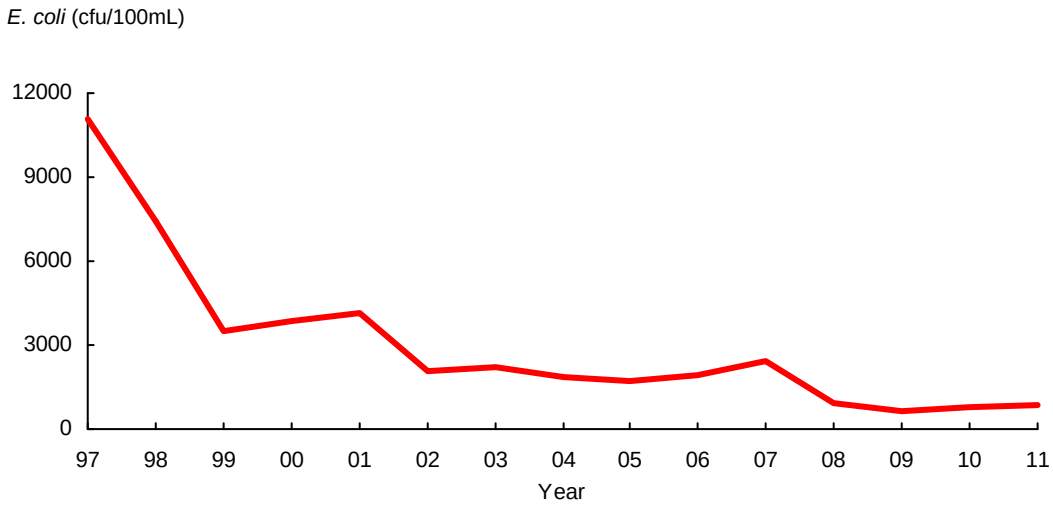

Table 2. Annual Geometric Mean *E. coli* level (counts per 100 mL) at the typhoon shelters/cargo basin in Victoria Harbour from 2008 to 2011

Typhoon Shelters /Cargo Basin	Annual Geometric Mean *E. coli* level (counts/100 mL)			
	2008	2009	2010	2011
Chai Wan Cargo Basin	240	420	190	300
Shau Kei Wan Typhoon Shelter	720	570	310	540
New Yau Ma Tei Typhoon Shelter	1,700	930	2,800	1,700
To Kwa Wan Typhoon Shelter	510	290	510	800
Causeway Bay Typhoon Shelter	3,500	2,000	2,700	2,000
Sam Ka Tsuen Typhoon Shelter	780	610	560	1,100
Kwun Tong Typhoon Shelter	2,300	1,200	820	1,200
Rambler Channel Typhoon Shelter	730	680	1,000	500

Figure 6 Sampling stations in KTR, KTAC and KTTS

Table 3 Geometric mean levels of *E. coli* in KTR, KTAC and KTTS in 2011 and 2012

CEDD's data (Geometric mean (GM) *E. Coli* levels in counts/100mL)

Year	KN1	AC1	AC2	AC3	AC4	AC5	AC6	AC7	KTTS (KT1)
2011	35,623	17,788	18,705	22,317	9,013	18,383	10,177	8,621	2,237
2012	3,039	6,698	7,753	8,127	10,212	7,185	10,276	6,908	310

(Note : The GM values are based on the results of the samples collected in February, May, August and November of 2011, and February, May and August of 2012)