Marine Water Quality at Typhoon Shelters within Victoria Harbour

This Note summarises the water quality of the typhoon shelters located in Victoria Harbour, namely Chai Wan Cargo Handling Basin, Shaukeiwan 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, as depicted in the map at Annex 1.

Background

Typhoon shelters are used by small to medium vessels for protection against strong winds and rough sea conditions particularly during 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 shelter 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 shelter. Some common pollution sources to the typhoon shelters include misconnections of sewers from buildings, illegal discharges; leakage from broken sewers, non-point source pollution (e.g.street cleaning and littering) and wastewater from moored vessels etc.

Water Quality Objectives (WQO)

The marine water quality monitoring programme of the Environmental Protection Department (EPD) covers the monitoring of water quality in typhoon shelters. 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) Ammonia 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
Ammonia nitrogen (as unionised form) (NH_3-N)	Annual mean depth-averaged not to exceed 0.021 mg/L

We also monitor the bacterial level by measuring the *E. coli* counts. However, there is no bacterial WQO laid down for the typhoon shelters, since bacterial WQO is only laid down for bathing beaches, fish culture sub-zone, and secondary contact recreational sub-zone such as those areas intended for water sport activities (rowing, canoeing).

Water Quality condition

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 for the 4 key parameters at the typhoon shelters located in Victoria Harbour from 2007 to 2009, and the bacterial level in terms of *E. coli* counts.

I. Dissolved Oxygen (DO) – Bottom & depth-averaged

From 2007 to 2009, all 8 typhoon shelters complied with the bottom DO WQO, which stipulates that over 90% of the sampling occasions should be above 2 mg/L.

Regarding the depth-averaged DO concentration of the typhoon shelters, the annual means are shown in Table 1. Although most typhoon shelters have an annual mean above 4 mg/L, however only three typhoon shelters (Chai Wan, To Kwa Wan and Rambler Channel) can fully comply with the WQO, which stipulates that over 90% of the sampling occasions the DO level should not be lower than 4 mg/L.

Table 1. Annual depth-averaged mean Level of DO (mg/L) from 2007 to 2009

Typhoon Shelters	Annual depth-averaged mean DO level (mg/L)		
	2007	2008	2009
Chai Wan Cargo Handling Basin (ET1)	5.2	5.1	6.4
Shaukeiwan Typhoon Shelter (ET2)	4.5	4.5	5.2
New Yau Ma Tei Typhoon Shelter (VT10)	3.6	4.0	4.5
To Kwa Wan Typhoon Shelter (VT11)	5.2	5.4	5.4
Causeway Bay Typhoon Shelter (VT2)	4.0	4.3	4.3
Sam Ka Tsuen Typhoon Shelter (VT3)	4.6	5.1	4.9
Kwun Tong Typhoon Shelter (VT4)	3.4	4.6	4.7
Rambler Channel Typhoon Shelter (VT8)	4.9	5.6	5.4

II. Total Inorganic Nitrogen (TIN)

In 2007 and 2008, all typhoon shelters except Kwun Tong, New Yau Ma Tei, Rambler Channel and Causeway Bay typhoon shelters complied with the TIN WQO, which stipulates that the annual depth-averaged mean does not exceed 0.4 mg/L. In 2009, all typhoon shelters except Kwun Tong typhoon shelter complied with the TIN WQO. The annual depth-averaged mean TIN levels of the typhoon shelters are shown in Table 2.

Table 2. Annual depth-averaged mean TIN level (mg/L) from 2007 to 2009

Typhoon Shelters	Annual depth-averaged mean TIN level (mg/L)		
	2007	2008	2009
Chai Wan Cargo Handling Basin (ET1)	0.20	0.24	0.14
Shaukeiwan Typhoon Shelter (ET2)	0.24	0.28	0.21
New Yau Ma Tei Typhoon Shelter (VT10)	0.54	0.56	0.39
To Kwa Wan Typhoon Shelter (VT11)	0.34	0.36	0.23
Causeway Bay Typhoon Shelter (VT2)	0.41	0.47	0.30
Sam Ka Tsuen Typhoon Shelter (VT3)	0.31	0.34	0.18
Kwun Tong Typhoon Shelter (VT4)	1.22	0.72	1.14
Rambler Channel Typhoon Shelter (VT8)	0.53	0.48	0.31

III. Ammonia-Nitrogen (as unionised form) (NH_3-N)

From 2007 to 2009, all typhoon shelters could fully comply with the WQO for Ammonia-Nitrogen (as unionised form), which stipulates that the annual depth-averaged mean does not exceed 0.021 mg/L. The annual depth-averaged mean NH_3-N levels of the typhoon shelters are shown in Table 3.

Table 3. Annual depth-averaged mean NH_3-N level (mg/L) from 2007 to 2009

Typhoon Shelters	Annual depth-averaged mean NH_3-N level (mg/L)		
	2007	2008	2009
Chai Wan Cargo Handling Basin (ET1)	0.004	0.005	0.002
Shaukeiwan Typhoon Shelter (ET2)	0.004	0.005	0.002
New Yau Ma Tei Typhoon Shelter (VT10)	0.010	0.010	0.006
To Kwa Wan Typhoon Shelter (VT11)	0.007	0.006	0.004
Causeway Bay Typhoon Shelter (VT2)	0.007	0.009	0.005
Sam Ka Tsuen Typhoon Shelter (VT3)	0.005	0.005	0.003
Kwun Tong Typhoon Shelter (VT4)	0.012	0.009	0.010
Rambler Channel Typhoon Shelter (VT8)	0.007	0.007	0.003

IV. E. coli bacteria

The *E. coli* counts of the typhoon shelters during 2007 to 2009 are set out in Table 4. Though we observe marked improvement of water quality (a reduction of bacterial levels ranging from 60 to 95%) brought about by the implementation of the sewerage improvement schemes and after the commissioning of the Harbour Area Treatment Scheme (HATS) Stage 1 over the last 10 years, the *E. coli* levels in several typhoon shelters remain relatively high and in the order of several hundreds counts/100ml.

Table 4 Annual Geometric Mean *E. coli* level (counts per 100 mL) from 2007 to 2009

Typhoon Shelters	Annual Geometric Mean *E. coli* level (counts/100mL)		
	2007	2008	2009
Chai Wan Cargo Handling Basin (ET1)	380	240	420
Shaukeiwan Typhoon Shelter (ET2)	710	720	570
New Yau Ma Tei Typhoon Shelter (VT10)	5200	1700	930
To Kwa Wan Typhoon Shelter (VT11)	2100	510	290
Causeway Bay Typhoon Shelter (VT2)	10000	3500	2000
Sam Ka Tsuen Typhoon Shelter (VT3)	260	780	610
Kwun Tong Typhoon Shelter (VT4)	13000	2300	1200
Rambler Channel Typhoon Shelter (VT8)	1200	730	680

Annex 1

Locations of 8 typhoon shelters within Victoria Harbour