Environmental Protection Department

Marine Water Quality in Hong Kong in 2004

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Marine Water Quality in Hong Kong in 2004

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Summary of Marine Water Quality in Hong Kong in 2004

In 2004, the overall compliance with the marine Water Quality Objectives (WQOs) in the territory was maintained at the record level of 87%, similar to that in the previous two years. On the other hand, the water quality in Inner Deep Bay remained very poor, with low dissolved oxygen (DO) and elevated levels of nitrogen and phosphorus, highlighting the pollution problem in the bay.

The water quality of Port Shelter and Mirs Bay continued to be excellent, with low bacteria, organic matter and high DO. In Victoria Harbour, the improvements following the commissioning of the Harbour Area Treatment Scheme (HATS) Stage 1 were sustained in 2004. These included an increase in DO and reduction in nutrients in the eastern and central parts of the harbour. While the eastern harbour experienced a reduction of *E. coli* bacteria, the higher levels in the central and western harbour persisted.

The water quality in Tolo Harbour followed its upward trend with declines in organic and inorganic pollutants. The condition in Deep Bay further deteriorated in 2004 with increases in ammonia and nitrogen and a reduction in the compliance with the WQOs.

Some increase of ammonia nitrogen was observed in the Southern, Western Buffer and North Western Water Control Zones in 2004. On the other hand, there was a widespread increase of DO of around 9% in the eastern and southern waters, probably related to natural fluctuation and the lower baseline in the previous year.

INTRODUCTION CHAPTER 1

1 INTRODUCTION

Chapter 1 - Introduction

Introduction

1.1 The Hong Kong Special Administrative Region (HKSAR) has a land area of 1,104 km^2 and 1,651 km^2 area of marine water. It has long coastlines, including 456 km in the Kowloon Peninsula and New Territories and 722 km in Hong Kong Island, Lantau Island and 260 small islands.

1.2 With a population of 6.9 million, Hong Kong relies heavily on marine water for recreation, fish culture, cooling, toilet flushing, transport and effluent disposal. Hong Kong's coastal water is under the influence of Pearl River, supporting a rich diversity of life ranging from microscopic plankton, sponges and corals to dolphins and porpoises.

1.3 To protect the ecology and human uses of marine water, the HKSAR Government has established Water Quality Objectives (WQOs) (Table 1.1) for the 10 Water Control Zones (WCZs) (Figure 1.1). The aim is to achieve the WQOs by implementing measures to reduce pollution and improve water quality. In order to assess the health status of the marine environment, detect long-term water quality changes and measure compliance with the WQOs, the Environmental Protection Department (EPD) implements a comprehensive marine monitoring programme.

Marine Monitoring Programme

1.4 The current marine monitoring programme has been in operation since 1986. Monitoring is mostly conducted onboard a 26-metre vessel, the *Dr. Catherine Lam*. The vessel is equipped with an advanced Differential Global Positioning System (DGPS) and an electronic navigation chart for precise location of monitoring stations in the sea.

1.5 A conductivity-temperature-depth (CTD) profiler linked to a computer -controlled rosette water sampler is used to measure field parameters and collect water samples. Bottom sediments are collected by a sediment grab. The water and sediment samples are analysed by EPD's laboratories and the Government Laboratory (http://www.govtlab.gov.hk) for over 80 physical, chemical and biological parameters (Tables 1.2 and 1.3).

1.6 In 2004, a total of 94 water quality stations were monitored (Table 1.4): 76 in open water sampled once a month and 18 in typhoon shelters sampled bi-monthly (Figures 1.2 and 1.4).

1 INTRODUCTION

Sediments were collected twice a year at 60 stations: 45 in open waters and 15 in typhoon shelters (Figures 1.3 and 1.4).

Uses and Characteristics of Marine Water

1.7 The major uses of Hong Kong marine water and ecologically important areas include:

- Bathing beaches and secondary contact recreational areas (Figure 1.5);
- Fish and shellfish culture zones and marine conservation sites (Figure 1.6);
- Marine dumping grounds for dredged spoil, public filling areas and major reclamation sites (Figure 1.7);
- Effluent disposal and outfalls of major public sewage treatment works (Figure 1.8).

The Marine Water Quality Report for 2004

1.8 This is EPD's 19th annual Marine Water Quality Report. In the report, the Hong Kong marine water is divided into four large water bodies (eastern, southern, central and western), each with distinct characteristics (Figure 1.9). The eastern waters are located in the eastern coast of Hong Kong, under greater oceanic influence and with high salinity. They include the Mirs Bay, Port Shelter, and Tolo Harbour and Channel WCZs. The southern waters cover the Southern WCZ where the impact of Pearl River is more pronounced in the west and north while diminishing towards the eastern end. The central waters consist of four WCZs in the urban area : the Victoria Harbour, Eastern Buffer, Junk Bay and Western Buffer WCZs. The waters generally have strong tidal flow and are heavily used for effluent disposal and navigation. The western waters cover the North Western and Deep Bay WCZs which are more estuarine and turbid, especially during the summer wet season.

1.9 This report summarises the monitoring data collected in 2004 and detects any significant water quality changes during the year. It also reports on the compliance with the key Water Quality Objectives (WQOs). The Seasonal Kendall statistical test was used to reveal long-term water quality trends, and increases or decreases of pollutants since 1986.

1.10 The 2004 Marine Water Quality Report (CD-ROM version) is kept in many public libraries (http://www.hkpl.gov.hk) and EPD's Environmental Resource Centres. The report and the monitoring data are also available on EPD's website (http://www.epd.gov.hk) for public's viewing and download.

Figure 1.1 Water Control Zones in Hong Kong

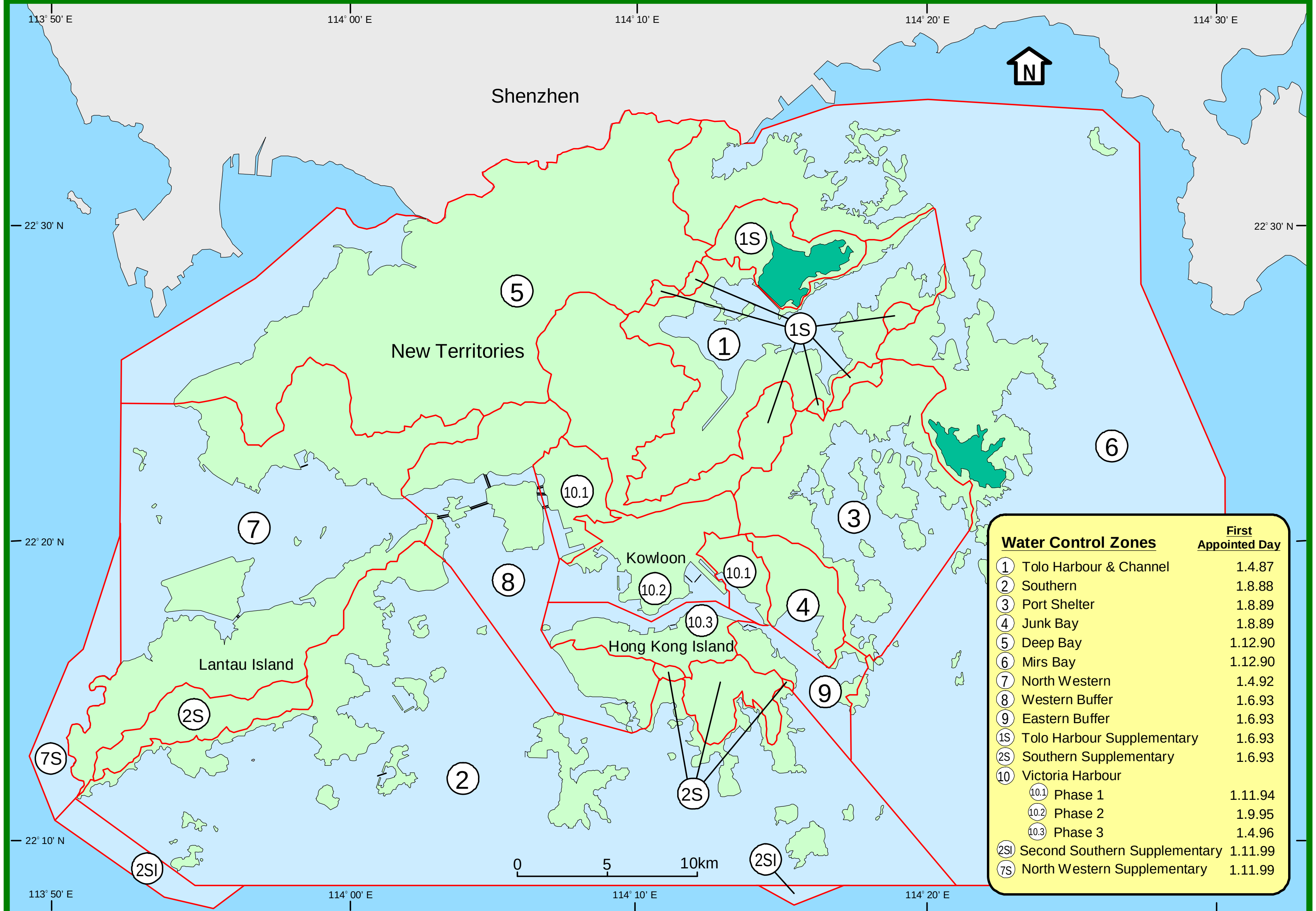


Figure 1.2 76 water quality monitoring stations in open waters of Hong Kong in 2004

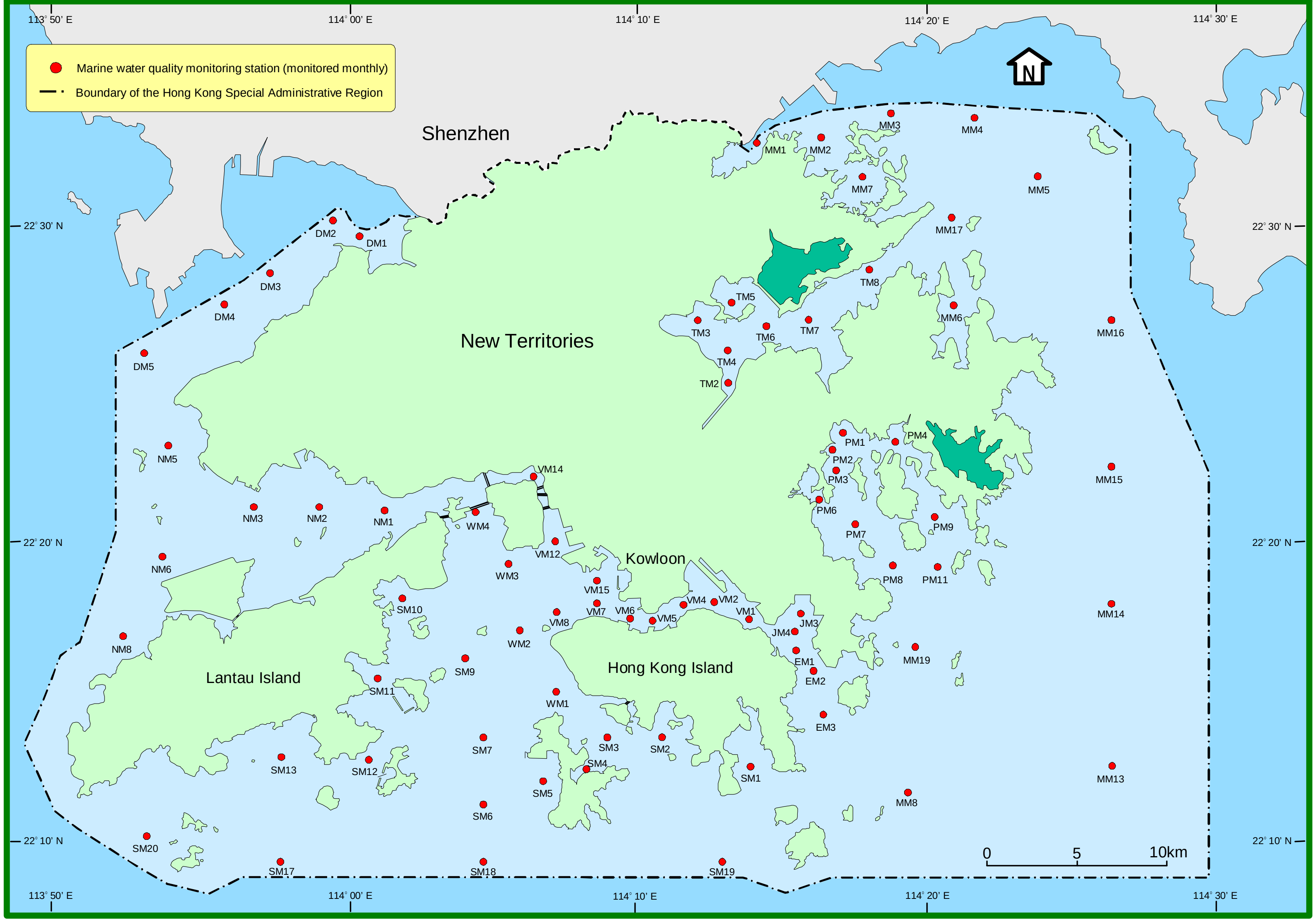


Figure 1.3 45 sediment monitoring stations in open waters of Hong Kong in 2004

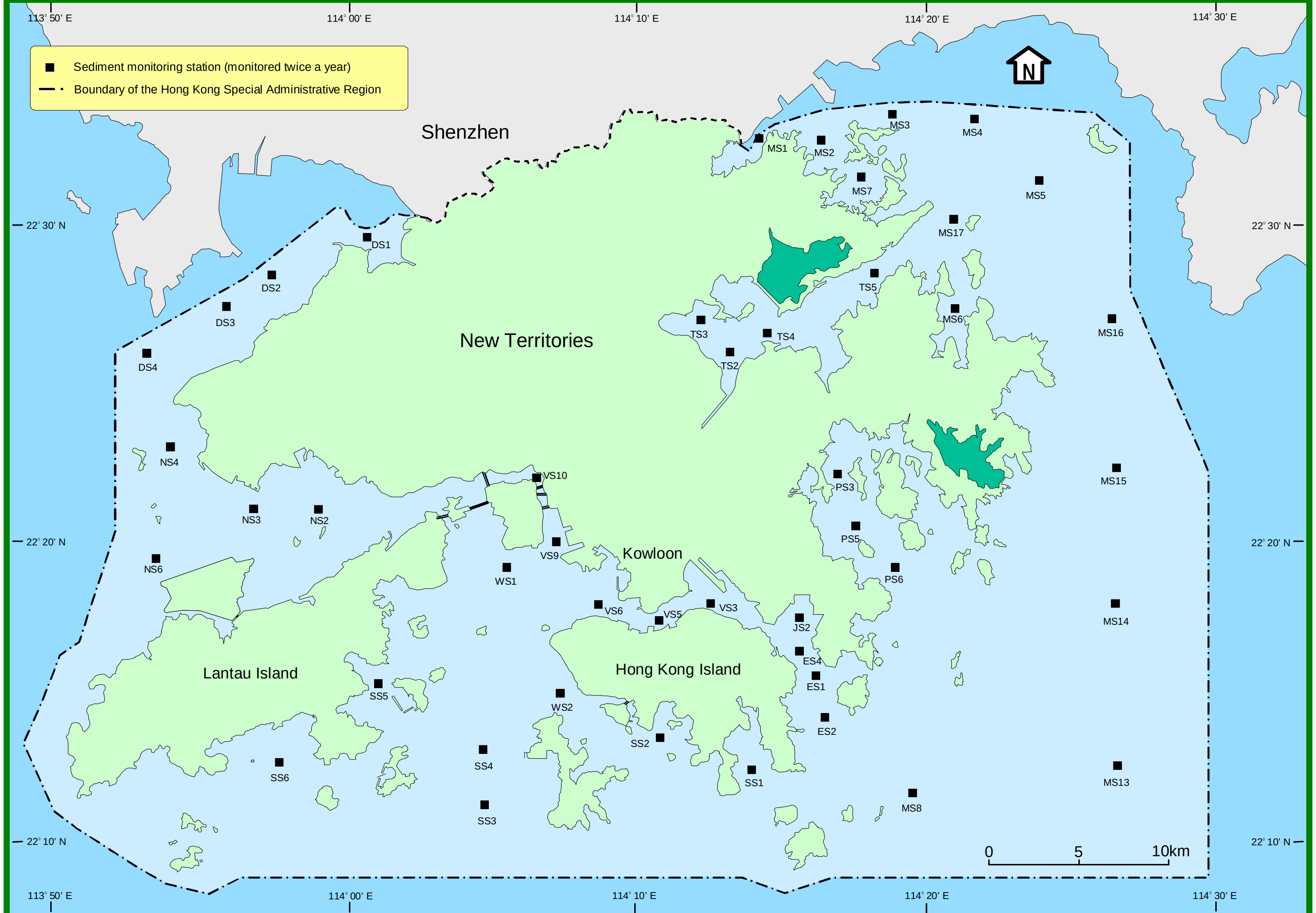


Figure 1.4 18 water quality monitoring stations and 15 sediment monitoring stations in typhoon shelters of Hong Kong in 2004

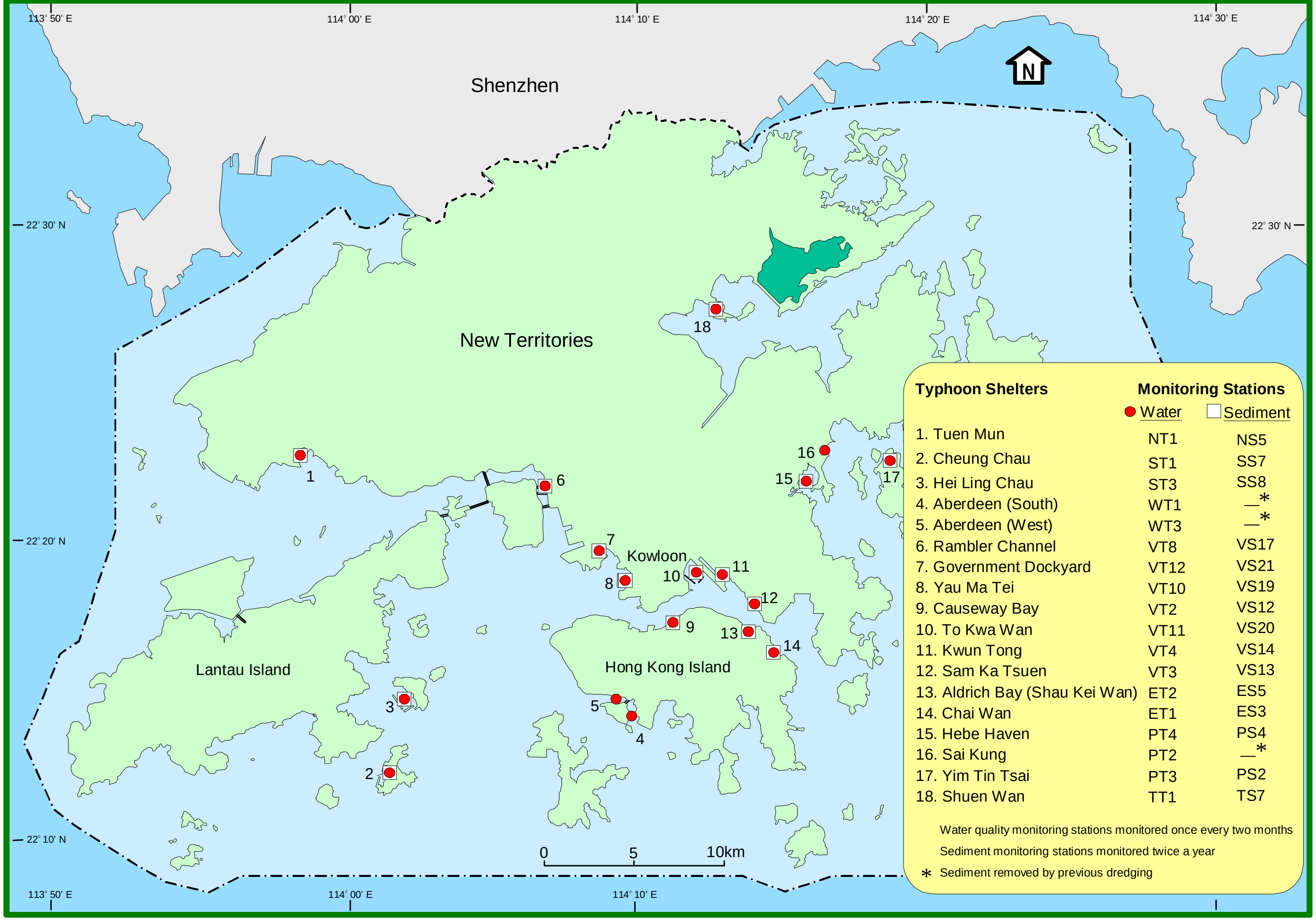


Figure 1.5 Bathing beaches and secondary contact recreational areas in Hong Kong in 2004

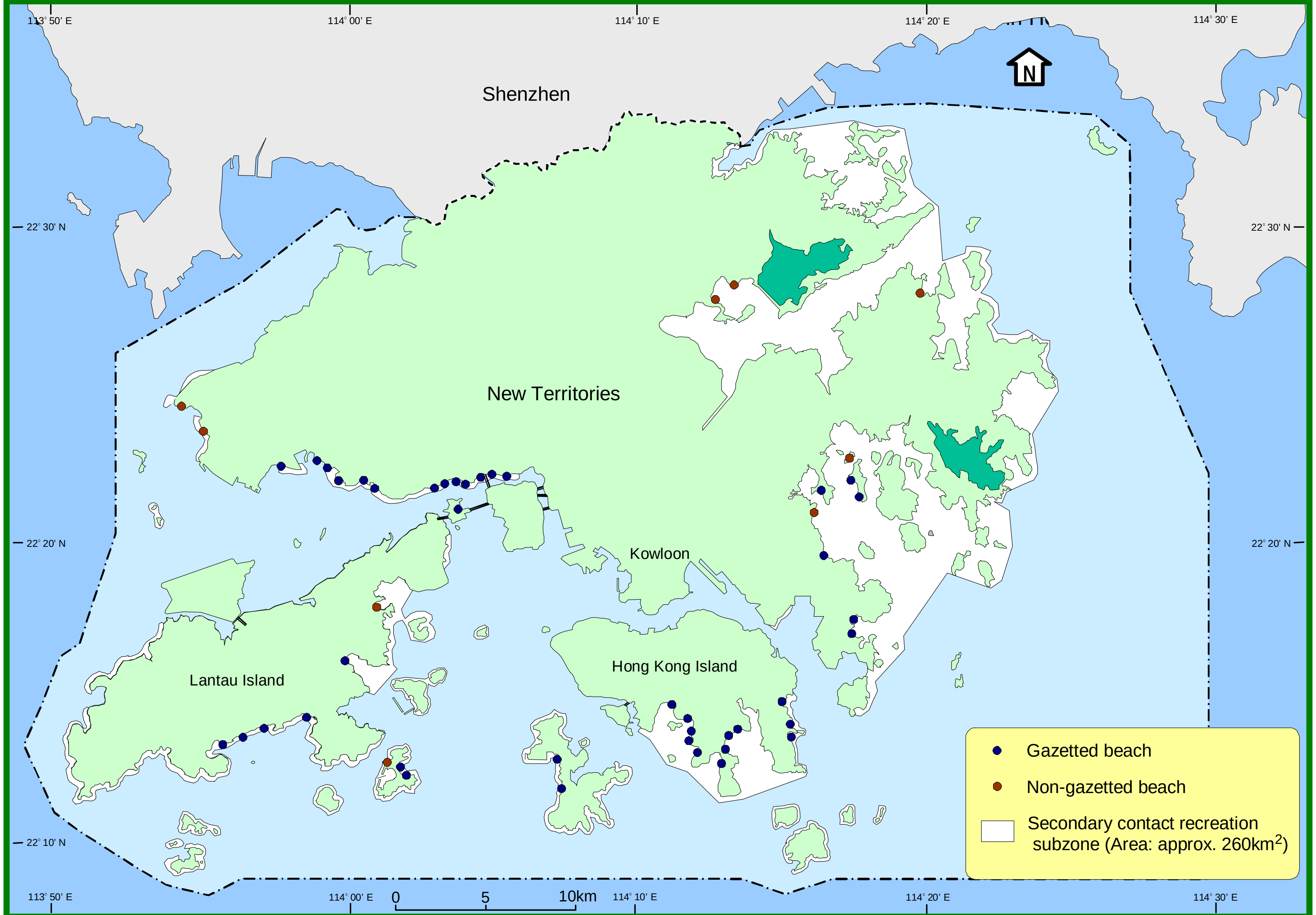


Figure 1.6 Fish and shellfish culture zones and marine conservation sites in Hong Kong in 2004

(Sources: Agriculture, Fisheries and Conservation Department)

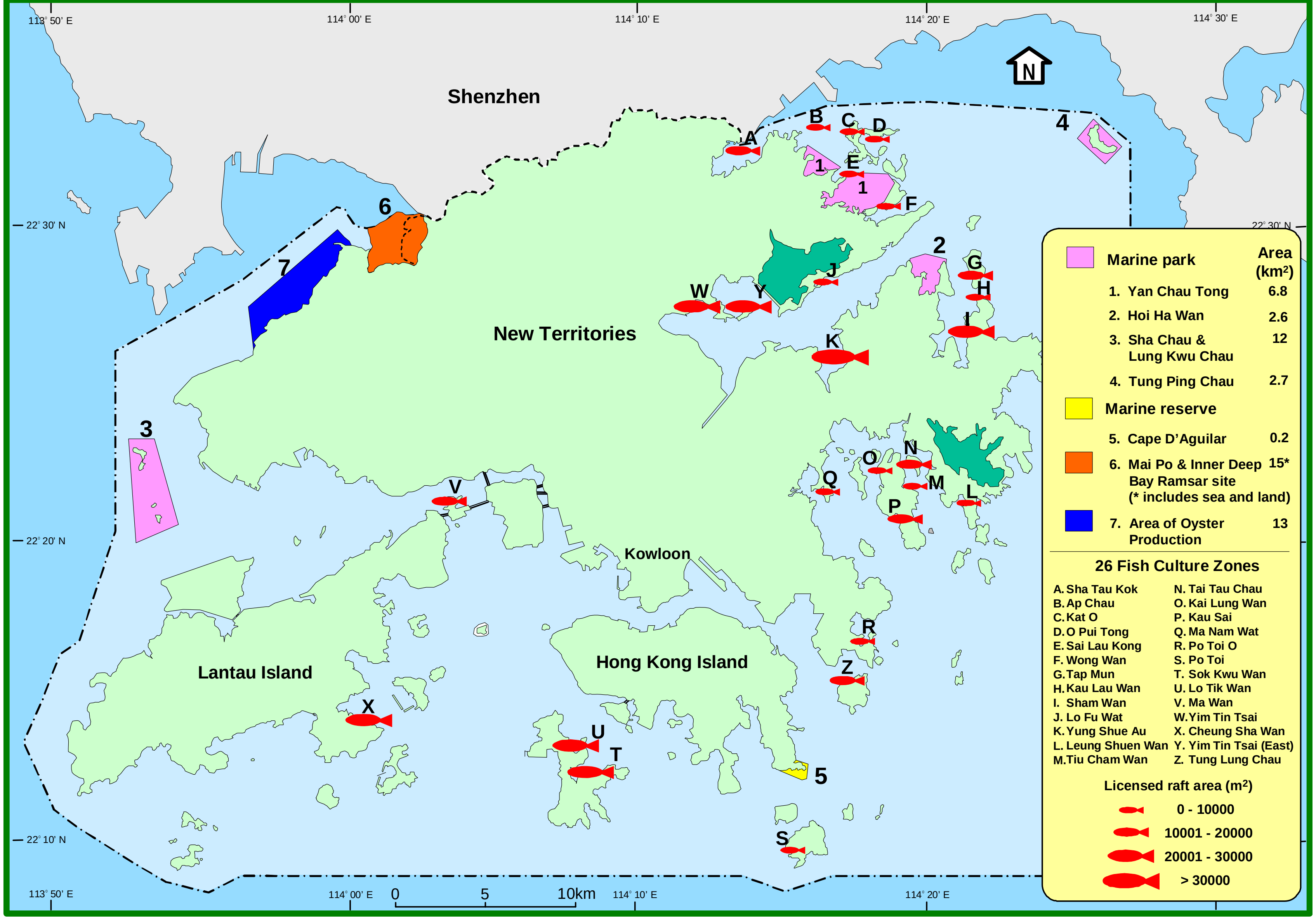


Figure 1.7 Marine dumping grounds, public filling areas and major reclamation sites in Hong Kong in 2004
(Sources: Civil Engineering Development Department and Environmental Protection Department)

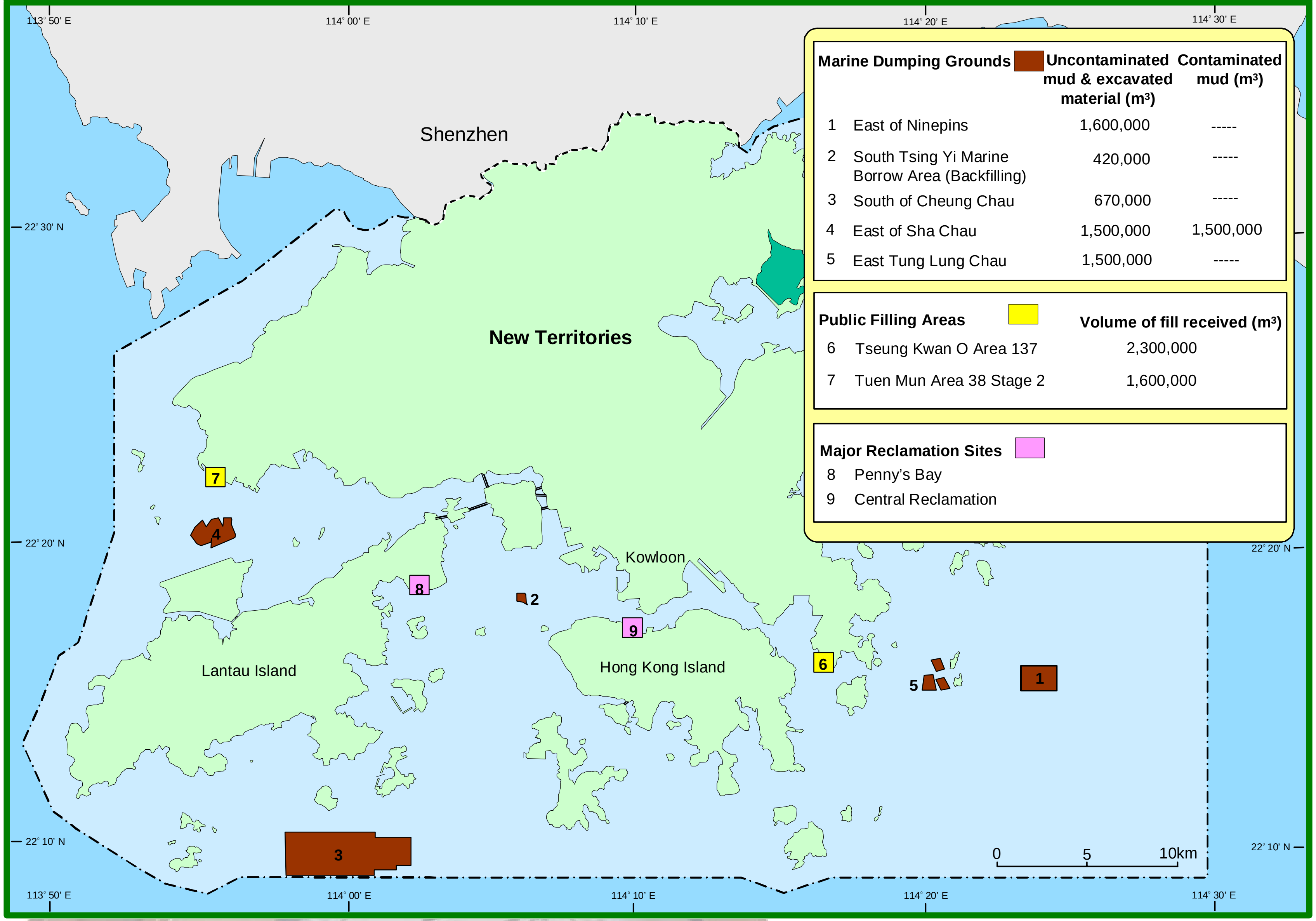
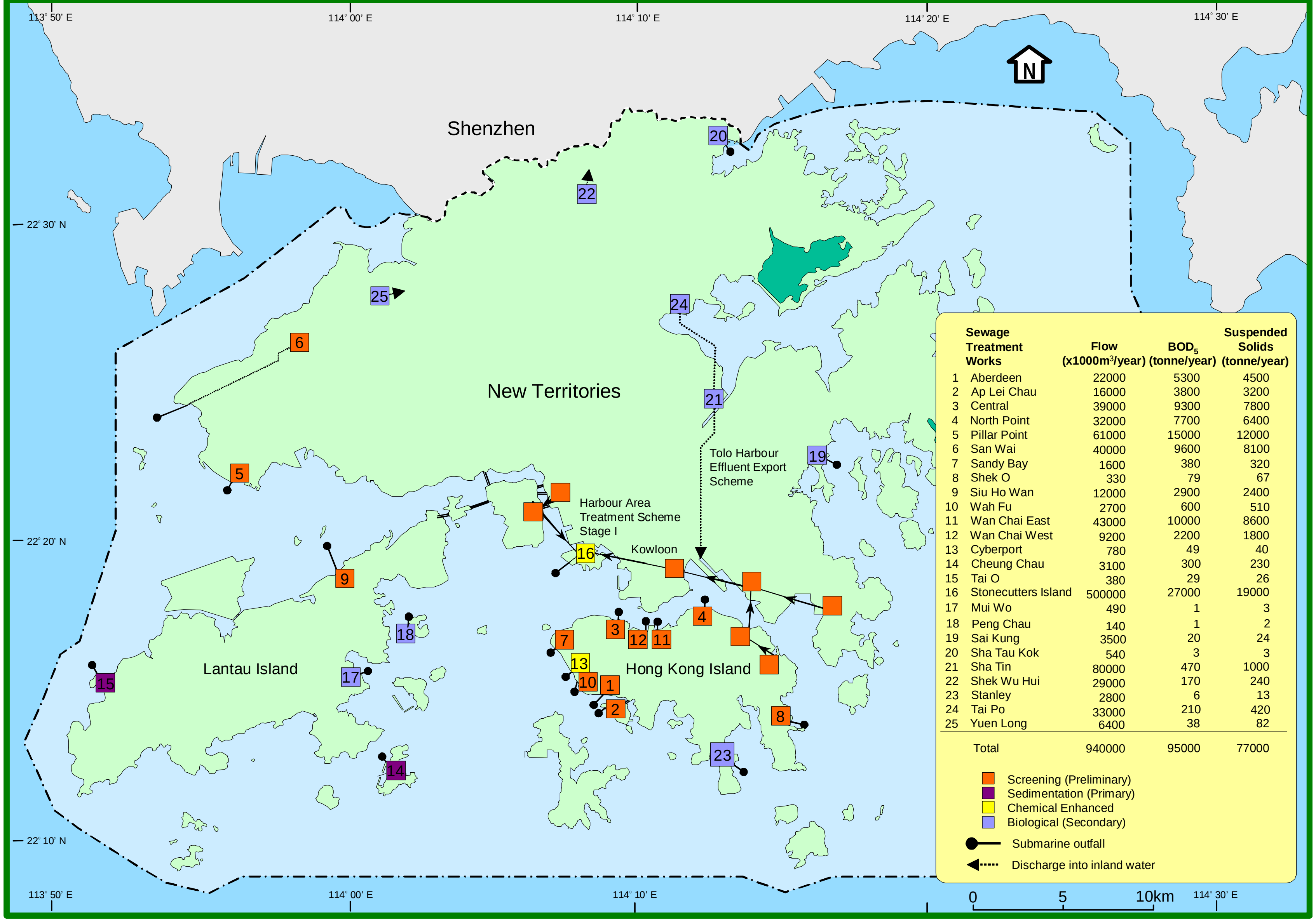


Figure 1.8 Major public sewage treatment works, outfalls and pollution loads in Hong Kong in 2004

(Sources: Drainage Services Department and Environmental Protection Department)



	Sewage Treatment Works	Flow ($\times 1000 m^3$/year)	BOD_5 (tonne/year)	Suspended Solids (tonne/year)
1	Aberdeen	22000	5300	4500
2	Ap Lei Chau	16000	3800	3200
3	Central	39000	9300	7800
4	North Point	32000	7700	6400
5	Pillar Point	61000	15000	12000
6	San Wai	40000	9600	8100
7	Sandy Bay	1600	380	320
8	Shek O	330	79	67
9	Siu Ho Wan	12000	2900	2400
10	Wah Fu	2700	600	510
11	Wan Chai East	43000	10000	8600
12	Wan Chai West	9200	2200	1800
13	Cyberport	780	49	40
14	Cheung Chau	3100	300	230
15	Tai O	380	29	26
16	Stonecutters Island	500000	27000	19000
17	Mui Wo	490	1	3
18	Peng Chau	140	1	2
19	Sai Kung	3500	20	24
20	Sha Tau Kok	540	3	3
21	Sha Tin	80000	470	1000
22	Shek Wu Hui	29000	170	240
23	Stanley	2800	6	13
24	Tai Po	33000	210	420
25	Yuen Long	6400	38	82
	Total	940000	95000	77000

Figure 1.9 Four marine water bodies in Hong Kong – Eastern, Southern, Central and Western Waters

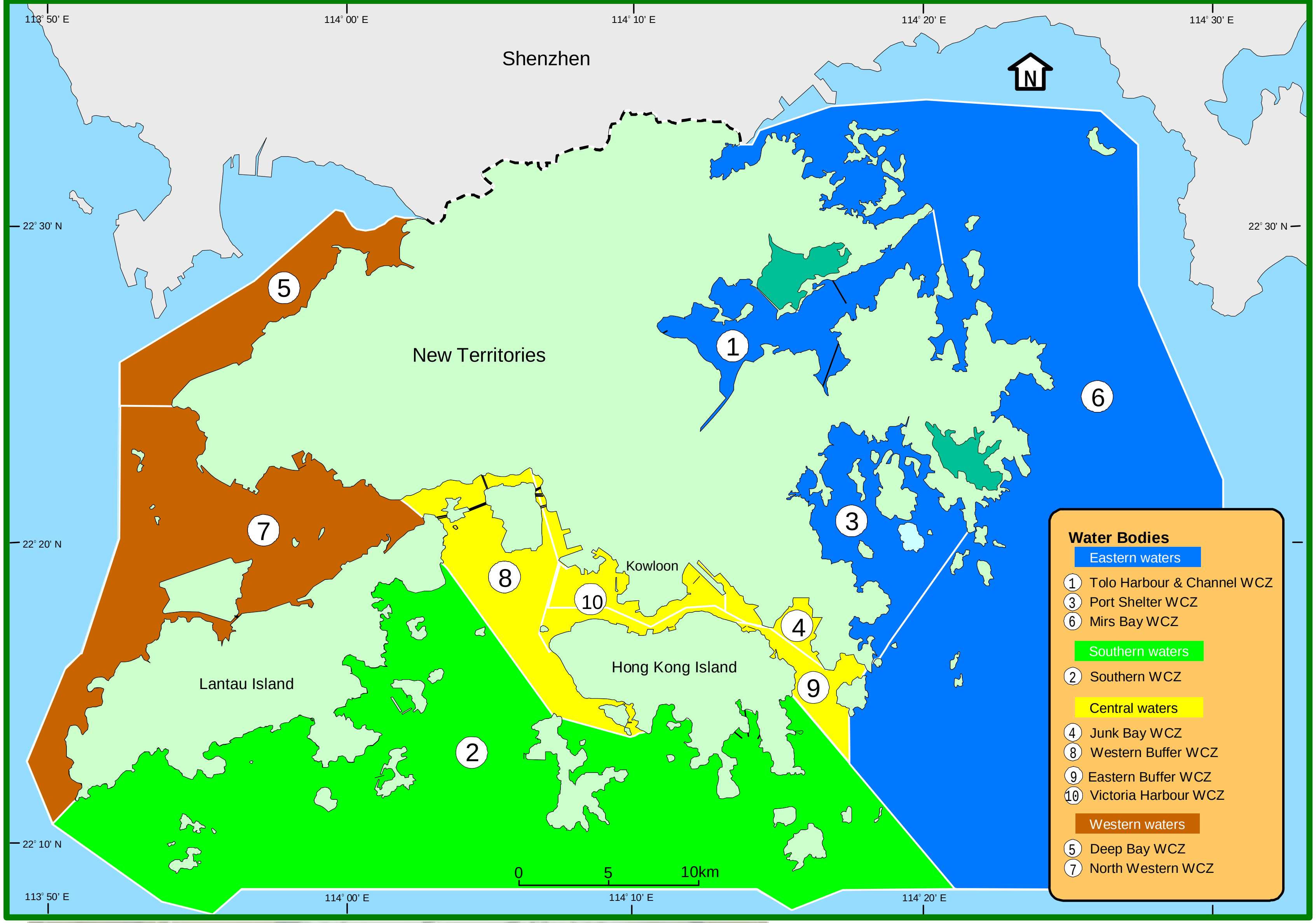


Table 1.1

Summary of Water Quality Objectives (WQOs) for marine waters of Hong Kong

Parameter	Water Quality Objective	Water Control Zone (WCZ) / Part(s) of zone / Subzone to which the WQO applies
Dissolved Oxygen (bottom)	Not less than 2 mg/L for 90% of samples ;	Marine waters of all WCZs except Tolo Harbour & Channel WCZ
Dissolved Oxygen (Depth-averaged)	Not less than 4 mg/L for 90% of samples ;	Marine waters of all WCZs except Tolo Harbour & Channel WCZ
Dissolved Oxygen (bottom)	Not less than 2mg/L	Harbour Subzone in Tolo Harbour & Channel WCZ
	Not less than 3mg/L	Buffer Subzone in Tolo Harbour & Channel WCZ
	Not less than 4mg/L	Channel Subzone in Tolo Harbour & Channel WCZ
Dissolved Oxygen (surface to 2m above bottom)	Not less than 4mg/L	Harbour Subzone and Buffer Subzone in Tolo Harbour & Channel WCZ
Dissolved Oxygen (all depths)	Not less than 4mg/L	Channel Subzone in Tolo Harbour & Channel WCZ
Nutrients	Annual mean depth-averaged total inorganic nitrogen not to exceed 0.1 mg/L	Marine waters of Southern WCZ and Port Shelter WCZ
	Annual mean depth-averaged total inorganic nitrogen not to exceed 0.3 mg/L	Marine waters of Mirs Bay WCZ, Junk Bay WCZ, North Western WCZ (Castle Peak Subzone)
	Annual mean depth-averaged total inorganic nitrogen not to exceed 0.4 mg/L	Marine waters of Eastern Buffer WCZ, Western Buffer WCZ, Victoria Harbour WCZ.
	Annual mean depth-averaged total inorganic nitrogen not to exceed 0.5 mg/L	Marine waters of Deep Bay WCZ (Outer Subzone) and North Western WCZ (Whole zone except Castle Peak Subzone).
	Annual mean depth-averaged total inorganic nitrogen not to exceed 0.7 mg/L	Marine waters of Deep Bay WCZ (Inner Subzone)
Unionised ammonia	Annual mean not to exceed 0.021 mg/L	All WCZs (whole zone) except Tolo Harbour & Channel WCZ
E. coli	Annual geometric mean not to exceed 610 cfu/100mL	Secondary contact recreation subzones in Tolo Habour & Channel WCZ, Southern WCZ, Port Shelter WCZ, Mirs Bay WCZ, Deep Bay WCZ, North Western WCZ, Western Buffer WCZ.
	Annual geometric mean not to exceed 610 cfu/100mL	Fish culture subzones in Tolo Habour & Channel WCZ, Southern WCZ, Port Shelter WCZ, Junk Bay, Mirs Bay WCZ, Deep Bay WCZ, Eastern Buffer WCZ, Western Buffer WCZ.
pH	To be in the range 6.5 - 8.5, change due to waste discharge not to exceed 0.2	Marine waters of all WCZs except Tolo Harbour & Channel WCZ
	Change due to waste discharge not to be greater than ±0.5	Harbour Subzone in Tolo Harbour & Channel WCZ
	Change due to waste discharge not to be greater than ±0.3	Buffer Subzone in Tolo Harbour & Channel WCZ
	Change due to waste discharge not to be greater than ±0.1	Channel Subzone in Tolo Harbour & Channel WCZ
Salinity	Change due to waste discharge not to exceed 10% of natural ambient level	All WCZs (Whole zone) except Tolo Harbour & Channel WCZ
	Change due to waste discharge not to be greater than ±3‰	Tolo Harbour & Channel WCZ
Temperature	Change due to waste discharge not to exceed 2℃	All WCZs (Whole zone) except Tolo Harbour & Channel WCZ
	Change due to waste discharge not to exceed 1℃	Tolo Harbour & Channel WCZ
Suspended solids	Waste discharge not to raise the natural ambient level by 30% nor cause the accumulation of suspended solids which may adversely affect aquatic communities	Marine waters of all WCZs except Tolo Harbour & Channel WCZ
Toxicants	Not to be present at levels producing significant toxic effect	All WCZs (Whole zone)
Chlorophyll-*a*	Not to exceed 20mg/m^3 (µg/L) calculated as running arithmetic mean of 5 daily measurements for any location and depth	Harbour Subzone in Tolo Harbour & Channel WCZ
	Not to exceed 10mg/m^3 (µg/L) calculated as running arithmetic mean of 5 daily measurements for any location and depth	Buffer Subzone in Tolo Harbour & Channel WCZ
	Not to exceed 6mg/m^3 (µg/L) calculated as running arithmetic mean of 5 daily measurements for any location and depth	Channel Subzone in Tolo Harbour & Channel WCZ

Table 1.2
Summary of marine water quality parameters

Parameter		Unit	Reporting Limit	Sampling Depth	Standard Method / Techniques used [20]	Analysed by
Physical and Aggregate Properties	Temperature[1]	°C	0.1	Depth Profiling[10]	Instrumental (thermistor), SEACAT19+ CTD and Water Quality Profiler	MMT/EPD[15]
	Salinity [1,8]	-	0.1	Depth Profiling	Instrumental (electrical conductivity), SEACAT19+ CTD and Water Quality Profiler	MMT/EPD
	Dissolved Oxygen[1]	mg/L % saturation [9]	0.1 1	Depth Profiling	Instrumental (membrane elelectrode), SBE23Y dissolved oxygen sensor linked to SEACAT19+ CTD and Water Quality Profiler	MMT/EPD
	Turbidity [2]	NTU	0.1	Depth Profiling	Instrumental (nephelometric / infrared back scattering), OBS-3 turbidity sensor linked to SEACAT 19+ CTD and Water Quality Profiler	MMT/EPD
	pH[1]	-	0.1	Depth Profiling	Instrumental (electrodemetric) SBE18 pH sensor linked to SEACAT19 + CTD and Water Quality Profiler	MMT/EPD
	Secchi Disc Depth[2]	m	0.1	---	Manual	MMT/EPD
	Suspended Solids[2]	mg/L	0.5	S,M,B[11]	In house method GL-PH-23, based on APHA 20ed. 2540D (weighing)	GL[18]
	Volatile Suspended Solids[3]	mg/L	0.5	S,M,B	In house method GL-PH-23, based on APHA 20ed. 2540E (weighing)	GL
Aggregate Organic Constituents	5-day Biochemical Oxygen Demand (BOD_5)[4]	mg/L	0.1	S,M,B	In house method based on APHA 18ed. 5210B	EML/EPD[16]
Nutrients and Inorganic Constituents	Ammonia Nitrogen[5]	mg/L	0.005	S,M,B	In house method GL-IN-15, based on ASTM D3590-89 B (FIA)	GL
	Unionised Ammonia[5]	mg/L	0.001	S,M,B	By calculation[12]	MMT/EPD
	Nitrite Nitrogen[5]	mg/L	0.002	S,M,B	In house method GL-IN-18, based on APHA 20ed. 4500-NO2- B (FIA)	GL
	Nitrate Nitrogen[5]	mg/L	0.002	S,M,B	In house method GL-IN-18, based on APHA 20ed. 4500-NO3- F & I (FIA)	GL
	Total Inorganic Nitrogen[5]	mg/L	0.01	S,M,B	By calculation[13]	MMT/EPD
	Total Kjeldahl Nitrogen[5] (soluble; soluble & particulate)	mg/L	0.05	S,M,B	In house method GL-IN-14 & GL-IN-15, based on ASTM D3590-89 B (FIA) & APHA 20ed 4500-N A&D (FIA)	GL
	Total Nitrogen[5]	mg/L	0.05	S,M,B	By calculation[13]	MMT/EPD
	Orthophosphate	mg/L	0.002	S,M,B	In house method GL-IN-16, based on ASTM D515-88 A (FIA)	GL
	Total Phosphorus[5] (soluble; soluble & particulate)	mg/L	0.02	S,M,B	In house method GL-IN-14 & GL-IN-16, based on ASTM D515-88 B (FIA) & APHA 20ed 4500-P G (FIA)	GL
	Silica (as SiO_2) (soluble) [5]	mg/L	0.05	S,M,B	In house method GL-IN-17, based on APHA 20ed. 4500-SiO2 C&E (FIA)	GL
Biological and Microbiological Examination	Chlorophyll-a [6]	µg/L	0.2	S,M,B	In house method GL-OR-34, based on APHA 20ed. 10200H 2 (spectrophotometric)	GL
	Escherichia coli (*E. coli*)[7]	count/100mL	1	S,M,B	In house method, membrane filtration with CHROMagar Liquid *E. coli* - coliform culture[14]	EML/EPD
	Faecal Coliforms[7]	count/100mL	1	S,M,B	In house method, membrane filtration with CHROMagar Liquid *E. coli* - coliform culture[14]	EML/EPD
	Phytoplankton	cell/mL	1	S	In house method, 10 ml settled sub-sample using plankton chamber and inverted microscope[19]	WSL/EPD[17]

Note: 1. Indicate general oceanographic conditions of marine water
2. Low transparency and light penetration would affect aesthetic value and photosynthesis in marine water
3. Indicate the amount of particulate organic matters in marine water
4. Indicate the amount of organic pollutants in marine water
5. Major nutrients (nitrogen, phosphorus, silica) promoting algal growth in marine water
6. Indicate the amount of algal biomass in marine water
7. Sewage bacteria indicate the extent of faecal pollution in marine water
8. Measuring and reporting of Salinity (S) is based on the Practical Salinity Scale and International Equation of State of Seawater (UNESCO Technical Papers in Marine Science No. 30 (1981) ; No. 36 (1981) and No. 45 (1985))
9. Percent saturation of dissolved oxygen is calculated from dissolved oxygen in mg/L based on Weiss R.F. (1970); The solubility of nitrogen, oxygen ad argon in water and seawater. Deep Sea Res. Vol. 17, pp.721-735
10. Depth profiling - continuous measurements at downcast are processed and presented at 1m intervals from 1m below the surface to 1m above the seabed
11. If water depth is 6m or above, sampling is taken at three depths during upcast: S - 1m below water surface; M - mid-depth of water column; B - 1m above seabed. If water depth is 4 to 5 m, 'M' is skipped; If water depth is 3m or less, 'M' and 'B' are skipped.
12. i) Bower C.E. and Bidwell J.P. (1978), Ionization of ammonia in seawater: Effect of temperature, pH and salinity. J. Fish. Res. Board Can. Vol.35, pp.1012-1016;
ii) K., Russo R.C. & et. al. (1975), Aqueous ammonia equilibrium calculations: effect of pH and temperature. J. Fish. Res. Board Can. Vol.32, pp.2379-2383
13. Total Inorganic Nitrogen = Ammonia Nitrogen + Nitrite Nitrogen + Nitrate Nitrogen ; Total Nitrogen = Total Kjeldahl Nitrogen (soluble & particulate) + Nitrite Nitrogen + Nitrate Nitrogen
14. i) DoE, DHSS & PHLS (1983); The Bacteriological Examination of Drinking Water Supplies 1982, Sec.7.8 & 7.9;
ii) B.S.W. Ho and T.Y. Tam (1997), Enumeration of *E. coli* in environmental waters and wastewater using a chromogenic medium. Wat. Sci. Tech.Vol.35, No.11-12, pp.409-413; method adopted in 1997.
15. MMT/EPD - Marine Monitoring Team, Waste & Water Science Group, Environmental Protection Department.
16. EML/EPD - Environmental Microbiology Laboratory, Waste & Water Science Group, Environmental Protection Department.
17. WSL/EPD - Water Sciences Laboratory, Waste & Water Science Group, Environmental Protection Department
18. GL - Environmental Chemistry B Section, Environmental Chemistry & Other Scientific Services Group, Government Laboratory.
19. i) Lund, J.H., Kipling, C. and Le Cren, E.D. 1958. The inverted microscope method of estimating algal numbers, and the statistical basis of estimations by counting. Hydrobiologia Vol. 11, pp. 143-170.
ii) Utermohl, H. 1958. Zur Vervollkommung der Quantitativen Phytoplankton-Methodik. Mitt. Inter. Verein. Lim. Vol. 9, pp. 1-38.
20. Mention of brand names and commercial products does not constitute or imply endorsement or recommendation by the Environmental Protection Department.

Table 1.3

Summary of marine sediment[1] parameters

	Parameter	Unit [2]	Reporting Limit	Standard Method / Techniques used [8]	Analysed by
Physical and Aggregate Properties	Particle Size Fractionation	% w/w	1	In house method, sieving and weighing ; 8 fractions : >4000µm, <4000µm, <2000µm, <1000µm, <500µm, <250µm, <125µm and <63µm	MMT/EPD [6]
	Electrochemical Potential [4]	mV	1	Instrumental, Orion Model 250A pH/Redox Meter (electrodemetric)	MMT/EPD
	Total Solids (TS) [3]	% w/w	0.1	In house method GL-PH-22, based on APHA 20ed 2540G (weighing)	GL [7]
	Total Volatile Solids (TVS) [3]	% TS	0.1	In house method GL-PH-22, based on APHA 20ed 2540G (weighing)	GL
	Dry Wet Ratio	-	0.01	In house method GL-PH-22, based on APHA 20ed 2540G (weighing)	GL
Aggregate Organic Constituents [3]	Chemical Oxygen Demand (COD)	mg/kg	2	In house method GL-OR-38, based on ASTM D1252-00 A (open reflux)	GL
	Total Carbon (TC)	% w/w	0.1	In house method GL-OR-33, based on APHA 20ed 5310 B (FIA)	GL
Nutrients and Inorganic Constituents [3]	Ammonia Nitrogen (NH_4-N)	mg/kg	0.05	In house method GL-IN-15, based on ASTM D3590-89 B (FIA)	GL
	Total Kjeldahl Nitrogen (TKN)	mg/kg	0.5	In house method GL-IN-14 & GL-IN-15, based on ASTM D3590-89 B (FIA) & APHA 20ed 4500-N A&D (FIA)	GL
	Total Phosphorus	mg/kg	0.2	In house method GL-IN-14 & GL-IN-16, based on ASTM D515-88 B (FIA) & APHA 20ed 4500-P G (FIA)	GL
	Total Sulphide	mg/kg	0.2	In house method GL-IN-45, based on APHA 20ed 4500-S^{2-} D (FIA)	GL
	Total Cyanide	mg/kg	0.1	In house method GL-IN-44, based on APHA, 20ed., 4500 CN -A&E (distillation and colorimetric)	GL
Metals & Metalloids [5]	Aluminium (Al)	mg/kg	1	In house method GL-TE-60, based on USEPA method 6010B (ICP-AES)	GL
	Arsenic (As)	mg/kg	0.1	In house method GL-TE-64 & GL-TE-66, based on USEPA method 6020 (ICP-MS)	GL
	Barium (Ba)	mg/kg	0.2	In house method GL-TE-60 & GL-TE-64, based on USEPA method 6010B (ICP-AES) and USEPA method 6020	GL
	Boron (B)	mg/kg	5	In house method GL-TE-60, based on USEPA method 6010B (ICP-AES)	GL
	Cadmium (Cd)	mg/kg	0.1	In house method GL-TE-64, based on USEPA method 6020 (ICP-MS)	GL
	Chromium (Cr)	mg/kg	0.2	In house method GL-TE-60 & GL-TE-64, based on USEPA method 6010B (ICP-AES) and USEPA method 6020	GL
	Copper (Cu)	mg/kg	0.2	In house method GL-TE-60 & GL-TE-64, based on USEPA method 6010B (ICP-AES) and USEPA method 6020	GL
	Iron (Fe)	mg/kg	5	In house method GL-TE-60, based on USEPA method 6010B (ICP-AES)	GL
	Lead (Pb)	mg/kg	0.2	In house method GL-TE-60 & GL-TE-64, based on USEPA method 6010B (ICP-AES) and USEPA method 6020	GL
	Manganese (Mn)	mg/kg	1	In house method GL-TE-60, based on USEPA method 6010B (ICP-AES)	GL
	Mercury (Hg)	mg/kg	0.05	In house method GL-TE-64 & GL-TE-66, based on USEPA method 6020 (ICP-MS)	GL
	Nickel (Ni)	mg/kg	0.2	In house method GL-TE-60 & GL-TE-64, based on USEPA method 6010B (ICP-AES) and USEPA method 6020	GL
	Silver (Ag)	mg/kg	0.2	In house method GL-TE-64, based on USEPA method 6020 (ICP-MS)	GL
	Vanadium (V)	mg/kg	0.1	In house method GL-TE-60 & GL-TE-64, based on USEPA method 6010B (ICP-AES) and USEPA method 6020	GL
	Zinc (Zn)	mg/kg	0.2	In house method GL-TE-60 & GL-TE-64, based on USEPA method 6010B (ICP-AES) and USEPA method 6020	GL
Trace Organic Compounds	Polychlorinated Biphenyls (PCBs)				
	18 PCB congeners : PCB 8, 18, 28, 44, 52, 66, 77, 101, 105, 118, 126, 128, 138, 153, 169, 170, 180, 187	µg/kg	2	In house method GL-OR-25, based on Reference Method for the Analysis of Polychlorinated Biphenyls, Environmental Protection Series: Report EPS 1/RM/31, March 1997, Environment Canada (GC-MS)	GL
	Polyaromatic Hydrocarbons (PAHs)				
	- Acenaphthene	µg/kg	50	In house method, GL-OR-15, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Acenaphthylene	µg/kg	50	In house method, GL-OR-15, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Naphthalene	µg/kg	60	In house method, GL-OR-15, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Fluorene	µg/kg	10	In house method, GL-OR-15, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Phenanthrene	µg/kg	5	In house method, GL-OR-15, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Anthracene	µg/kg	5	In house method, GL-OR-15, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Fluoranthene	µg/kg	5	In house method, GL-OR-15, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Pyrene	µg/kg	5	In house method, GL-OR-15, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Benzo(*a*)anthracene	µg/kg	3	In house method, GL-OR-15, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Chrysene	µg/kg	5	In house method, GL-OR-15, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Benzo(*b*)fluoranthene	µg/kg	1	In house method, GL-OR-15, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Benzo(*k*)fluoranthene	µg/kg	1	In house method, GL-OR-15, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Benzo(*a*)pyrene	µg/kg	1	In house method, GL-OR-15, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Dibenzo(*a,h*)anthracene	µg/kg	5	In house method, GL-OR-15, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Benzo(*ghi*)perylene	µg/kg	1	In house method, GL-OR-15, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Indeno(*1,2,3-cd*)pyrene	µg/kg	5	In house method, GL-OR-15, based on USEPA method 610, 1984 (UV-FLUO)	GL

Note : 1. Birge-Ekman (0.023m^2) grab / Van Veen (0.1m^2) grab / Smith-McIntyre (0.1m^2) grab is employed to collect sediment samples from the top 10cm of seabed.
2. All parameters are reported on a dry weight basis unless otherwise stated.
3. Determinants are reported on a wet weight basis.
4. Electrochemical potential (Eh) is measured 'on-site' at 3cm below the surface of freshly collected sediment samples (Reference : Handbook of Techniques for Aquatic Sediment Sampling. By A. Mudrock & S.D. MacKnight, 1994, CRC Press).
5. Digestion procedure for metals and metalloids in sediment follows In house method, WC-ME-2 (3.5 hours digestion in conc. HCl/conc. HNO_3 ; 3:1 v/v)
6. MMT/EPD - Marine Monitoring Team, Waste & Water Science Group, Environmental Protection Department.
7. GL - Environmental Chemistry B Section, Environmental Chemistry & Other Scientific Services Group, Government Laboratory.
8. Mention of brand names and commercial products does not constitute or imply endorsement or recommendation by the Environmental Protection Department.

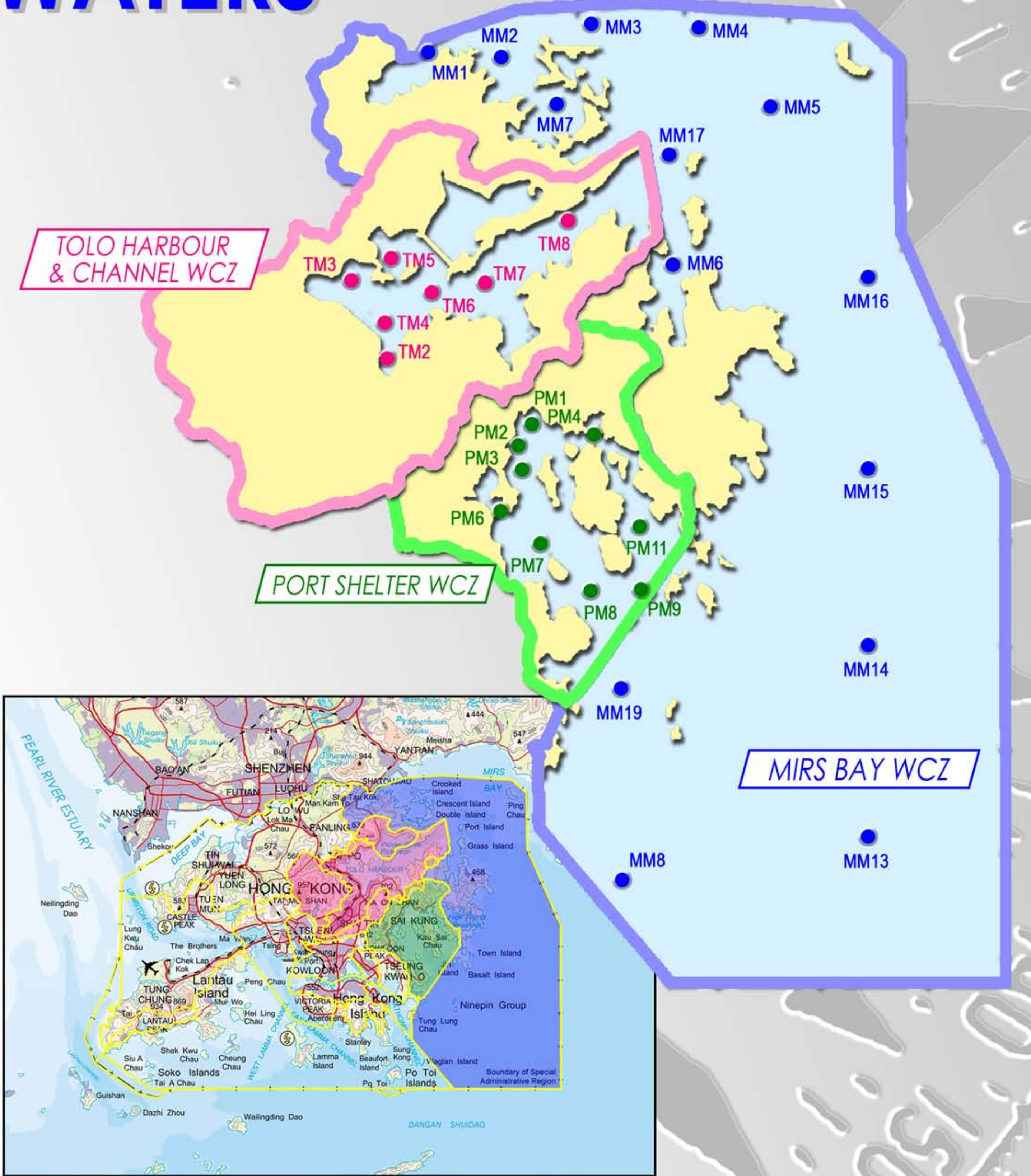
Table 1.4
Location of marine water and sediment monitoring stations

Water Control Zone	Station		Location		Depth (m)
	Water	Sediment	Latitude	Longitude	approx.
Tolo Harbour and Channel	TM2		22° 24.744' N	114° 13.085' E	4
	TM3	TS3	22° 26.857' N	114° 12.181' E	7
	TM4	TS2	22° 25.964' N	114° 13.176' E	8
	TM5		22° 27.426' N	114° 13.456' E	4
	TM6	TS4	22° 26.631' N	114° 14.506' E	12
	TM7		22° 26.907' N	114° 16.057' E	11
	TM8	TS5	22° 28.392' N	114° 18.003' E	22
	*TT1	*TS7	22° 27.270' N	114° 12.717' E	6
Southern Water	SM1	SS1	22° 12.738' N	114° 13.885' E	14
	SM2	SS2	22° 13.447' N	114° 10.691' E	14
	SM3		22° 13.527' N	114° 8.980' E	33
	SM4		22° 12.758' N	114° 8.315' E	11
	SM5		22° 12.141' N	114° 6.728' E	8
	SM6	SS3	22° 11.500' N	114° 4.743' E	14
	SM7	SS4	22° 13.740' N	114° 4.743' E	8
	SM9		22° 16.420' N	114° 4.024' E	8
	SM10		22° 18.125' N	114° 1.919' E	5
	SM11	SS5	22° 15.443' N	114° 1.078' E	8
	SM12		22° 12.861' N	114° 0.869' E	7
	SM13	SS6	22° 12.957' N	113° 57.724' E	6
	SM17		22° 9.211' N	113° 57.727' E	12
	SM18		22° 9.211' N	114° 4.746' E	21
	SM19		22° 9.211' N	114° 13.077' E	24
	SM20		22° 10.448' N	113° 52.932' E	7
	*ST1	*SS7	22° 12.607' N	114° 1.345' E	5
	*ST3	*SS8	22° 14.734' N	114° 1.928' E	6
Port Shelter	PM1		22° 23.242' N	114° 17.145' E	6
	PM2		22° 22.643' N	114° 16.687' E	8
	PM3	PS3	22° 22.156' N	114° 16.910' E	13
	PM4		22° 22.940' N	114° 18.819' E	6
	PM6		22° 21.102' N	114° 16.213' E	11
	PM7	PS5	22° 20.453' N	114° 17.703' E	17
	PM8	PS6	22° 19.168' N	114° 18.745' E	20
	PM9		22° 20.529' N	114° 20.196' E	15
	PM11		22° 19.240' N	114° 20.163' E	21
	*PT2		22° 22.798' N	114° 16.540' E	3
	*PT3	*PS2	22° 22.790' N	114° 18.400' E	6
	*PT4	*PS4	22° 21.728' N	114° 15.879' E	5
Junk Bay	JM3	JS2	22° 17.490' N	114° 15.657' E	10
	JM4		22° 16.873' N	114° 15.378' E	16
Deep Bay	DM1	DS1	22° 29.769' N	114° 0.644' E	2
	DM2		22° 30.454' N	113° 59.549' E	2
	DM3	DS2	22° 28.680' N	113° 57.551' E	3
	DM4	DS3	22° 27.335' N	113° 55.937' E	4
	DM5	DS4	22° 25.561' N	113° 53.388' E	8
North Western	NM1		22° 20.877' N	114° 1.286' E	34
	NM2	NS2	22° 21.130' N	113° 58.815' E	11
	NM3	NS3	22° 21.324' N	113° 56.783' E	14
	NM5	NS4	22° 23.051' N	113° 53.972' E	20
	NM6	NS6	22° 19.281' N	113° 53.908' E	5
	NM8		22° 16.695' N	113° 51.886' E	8
	*NT1	*NS5	22° 22.475' N	114° 58.353' E	4
Mirs Bay	MM1	MS1	22° 32.984' N	114° 14.271' E	6
	MM2	MS2	22° 32.626' N	114° 16.648' E	11
	MM3	MS3	22° 33.714' N	114° 18.615' E	16
	MM4	MS4	22° 33.817' N	114° 21.483' E	18
	MM5	MS5	22° 31.233' N	114° 23.633' E	20
	MM6	MS6	22° 27.334' N	114° 20.997' E	12
	MM7	MS7	22° 31.409' N	114° 17.824' E	13
	MM8	MS8	22° 12.021' N	114° 19.345' E	31
	MM13	MS13	22° 13.000' N	114° 26.920' E	28
	MM14	MS14	22° 17.560' N	114° 26.920' E	25
	MM15	MS15	22° 22.120' N	114° 26.920' E	24
	MM16	MS16	22° 26.670' N	114° 26.920' E	22
	MM17	MS17	22° 30.192' N	114° 20.960' E	17
	MM19		22° 15.921' N	114° 19.411' E	28
Western Buffer	WM1	WS2	22° 15.044' N	114° 7.363' E	35
	WM2		22° 17.074' N	114° 5.730' E	13
	WM3	WS1	22° 19.203' N	114° 5.826' E	20
	WM4		22° 20.940' N	114° 4.256' E	26
	*WT1		22° 14.584' N	114° 9.588' E	7
	*WT3		22° 14.900' N	114° 8.770' E	10
Eastern Buffer	EM1	ES4	22° 16.506' N	114° 15.335' E	16
	EM2	ES1	22° 15.732' N	114° 15.971' E	21
	EM3	ES2	22° 14.237' N	114° 16.144' E	21
	*ET1	*ES3	22° 16.203' N	114° 14.624' E	6
	*ET2	*ES5	22° 17.078' N	114° 13.783' E	12
Victoria Harbour	VM1		22° 17.280' N	114° 13.839' E	38
	VM2		22° 17.862' N	114° 12.619' E	12
		VS3	22° 17.631' N	114° 12.526' E	8
	VM4		22° 17.860' N	114° 11.654' E	12
	VM5		22° 17.266' N	114° 10.510' E	11
		VS5	22° 17.077' N	114° 10.600' E	8
	VM6		22° 17.371' N	114° 9.665' E	14
	VM7	VS6	22° 17.771' N	114° 8.416' E	10
	VM8		22° 17.564' N	114° 7.175' E	11
	VM12	VS9	22° 19.757' N	114° 7.278' E	14
	VM14	VS10	22° 21.935' N	114° 6.527' E	11
	VM15		22° 18.579' N	114° 8.539' E	13
	*VT2	*VS12	22° 17.194' N	114° 11.304' E	5
	*VT3	*VS13	22° 17.448' N	114° 14.250' E	5
	*VT4	*VS14	22° 18.734' N	114° 12.814' E	6
	*VT8	*VS17	22° 21.360' N	114° 6.867' E	5
	*VT10	*VS19	22° 18.590' N	114° 9.430' E	5
	*VT11	*VS20	22° 18.981' N	114° 11.814' E	6
	*VT12	*VS21	22° 19.429' N	114° 8.587' E	5

Note : 1. All locations are based on WGS84 datum
2. Water quality and sediment monitoring stations in typhoon shelters are marked with an asterisk *

EASTERN WATERS

CHAPTER 2



Chapter 2 – Eastern Waters

Water Quality in 2004

2.1 The eastern waters cover an area of 900 km^2. They include three Water Control Zones (WCZs) i.e. the Mirs Bay, Port Shelter and Tolo Harbour & Channel WCZs. Mirs Bay is the eastern most water of Hong Kong and is under considerable oceanic influence. While Port Shelter opens to the southern part of Mirs Bay, Tolo Harbour is connected to northern part through a narrow channel. Port Shelter, Tolo Harbour and Crooked Harbour in Mirs Bay are gazetted secondary recreational waters. The general water quality of the eastern waters is good, supporting a variety of marine life including corals. There are three marine parks and 21 fish culture zones in the eastern waters (Figure 1.6).

Mirs Bay Water Control Zone

2.2 Mirs Bay has good and stable water quality, with high dissolved oxygen (DO), low turbidity, nutrients and sewage bacteria. Starling Inlet in the northern part bordering Shenzhen is subject to localized effects of Sha Tau Kok town and has slightly higher pollutant levels. In 2004, Mirs Bay has experienced an increase of DO by 16% on average, in particular at the northern stations, e.g. MM1- MM7, also at MM13, MM19 (Table 2.4). The mean annual ammonia nitrogen (NH_4-N) concentration in the bay was found to have increased by 57% (similar to some other waters). However, there was no marked increase in total Kjeldahl nitrogen (TKN) or total inorganic nitrogen (TIN), and the chlorophyll-*a* level remained relatively stable indicating that there was no marked increase in phytoplankton biomass in the bay.

Port Shelter Water Control Zone

2.3 The water quality in the Port Shelter WCZ is amongst the best in the territory with high DO, low turbidity, nutrients and *E. coli* bacteria. In 2004, the mean DO and NH_4-N levels in the Port Shelter WCZ increased by 10% (0.6 mg/L) and 61% (0.009 mg/L) respectively (Table 2.5). No marked increase in other nitrogenous compounds or chlorophyll-*a*, however, was noted.

Tolo Harbour & Channel Water Control Zone

2.4 In the Tolo Harbour and Channel WCZ, there is a gradient of improved water quality from the inner and more densely populated Harbour Subzone to the outer Channel Subzone. In 2004, DO in the outer Tolo Harbour and Tolo Channel (TM6, TM7 and TM8) showed a 20% increase from a below normal level in 2003. NH_4-N at these stations increased by 23-53%, similar to other parts of the eastern waters (Table 2.6). On the other hand, some reduction in NH_4-N was seen in the inner harbour (TM2-TM4), indicating that the general increase of NH_4-N (especially in open eastern waters) was probably not related to land-based pollution. Within the Tolo Harbour and Channel WCZ, the levels of total phosphorus and chlorophyll-*a* remained largely stable in 2004.

Compliance with Water Quality Objectives

2.5 The Mirs Bay WCZ enjoys an excellent record of compliance with the Water Quality Objectives (WQOs), and full (100%) compliance with the WQOs was again achieved in 2004 (Figure 2.1). The secondary contact recreation subzones in Crooked Harbour (MM2), Long Harbour (MM6) and Double Haven (MM7) had very low *E. coli* counts and fully complied with the WQO for bacteria.

2.6 In 2004, the Port Shelter WCZ fully complied with the WQOs, including that for *E. coli*, indicating its suitability for secondary contact recreation (Figure 2.2). In the Tolo Harbour and Channel WCZ, the compliance of the DO objective increased from 63% in 2003 to 71% in 2004 due to an increase of DO at most stations (Figure 2.3). As in previous years, the WCZ achieved a 100% compliance with the *E. coli* WQO. Being a largely enclosed water body with weak tidal flushing, Tolo Harbour is susceptible to nutrient enrichment. In the last few years, TIN and unionised ammonia (NH_3-N) have been maintained at low levels (Figure 2.5), and the compliance with the WQO for chlorophyll-*a* in 2004 was high at 92% (Figure 2.4).

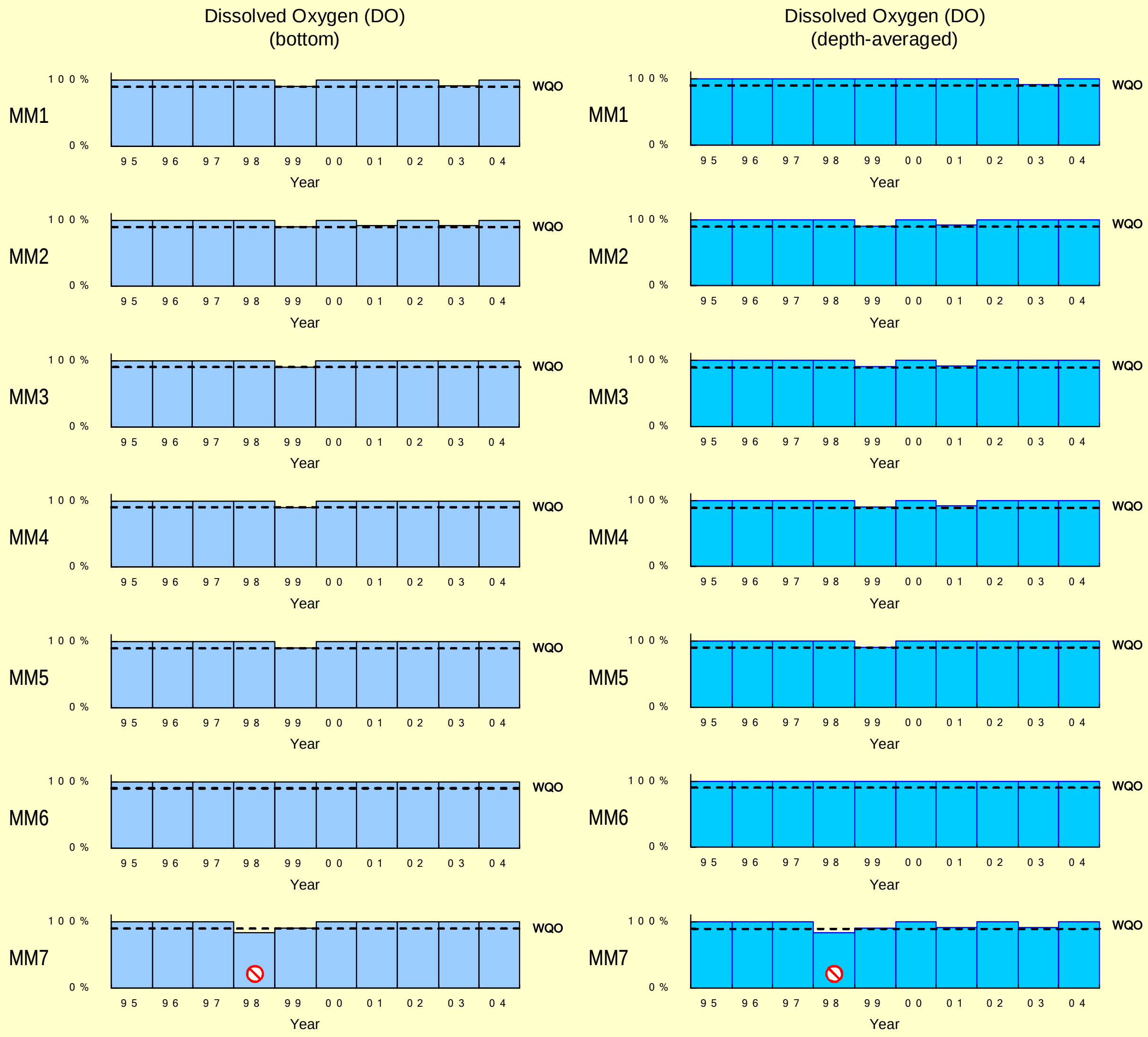
Long-term Water Quality Trends

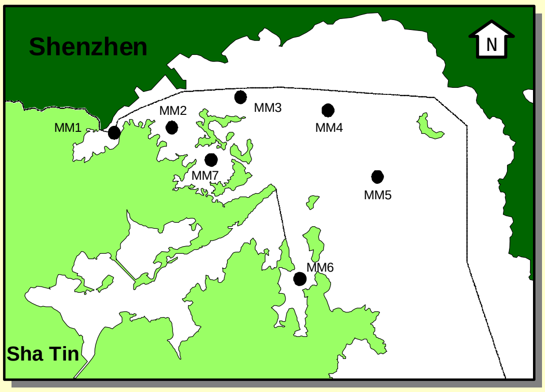
2.7 Mirs Bay has experienced a significant decrease in nutrients (e.g. total phosphorus, total nitrogen) since the early 90s (Table 2.1). On the other hand, an increase in chlorophyll-*a*, indicating enhanced algal productivity, was found at many northern stations (MM1-5, MM7) (Figure 2.6).

2.8 The water quality of Port Shelter showed notable improvements since the mid-80s due to provision of sewage infrastructure and implementation of pollution control measures in the catchment. Decreasing trends in total Kjeldahl nitrogen, total nitrogen and total phosphorus were noted at most monitoring stations of the bay (Table 2.2 and Figure 2.6).

2.9 As a result of the implementation of the Tolo Harbour Action Plan, the pollution problems in Tolo Harbour have been controlled and the water quality showed steady improvements in the last two decades. Significant decreases in BOD_5 (organic pollutants), *E. coli*, nitrogen and phosphate were evident (Table 2.3 and Figure 2.6), while chlorophyll-*a* in the harbour remained relatively stable.

Figure 2.1 Level of compliance with key Water Quality Objectives in the Mirs Bay WCZ





Dissolved Oxygen (DO)

1. Bottom

WQO : 90% sample with bottom DO ≥ 2 mg/L

% sample with bottom DO ≥ 2 mg/L

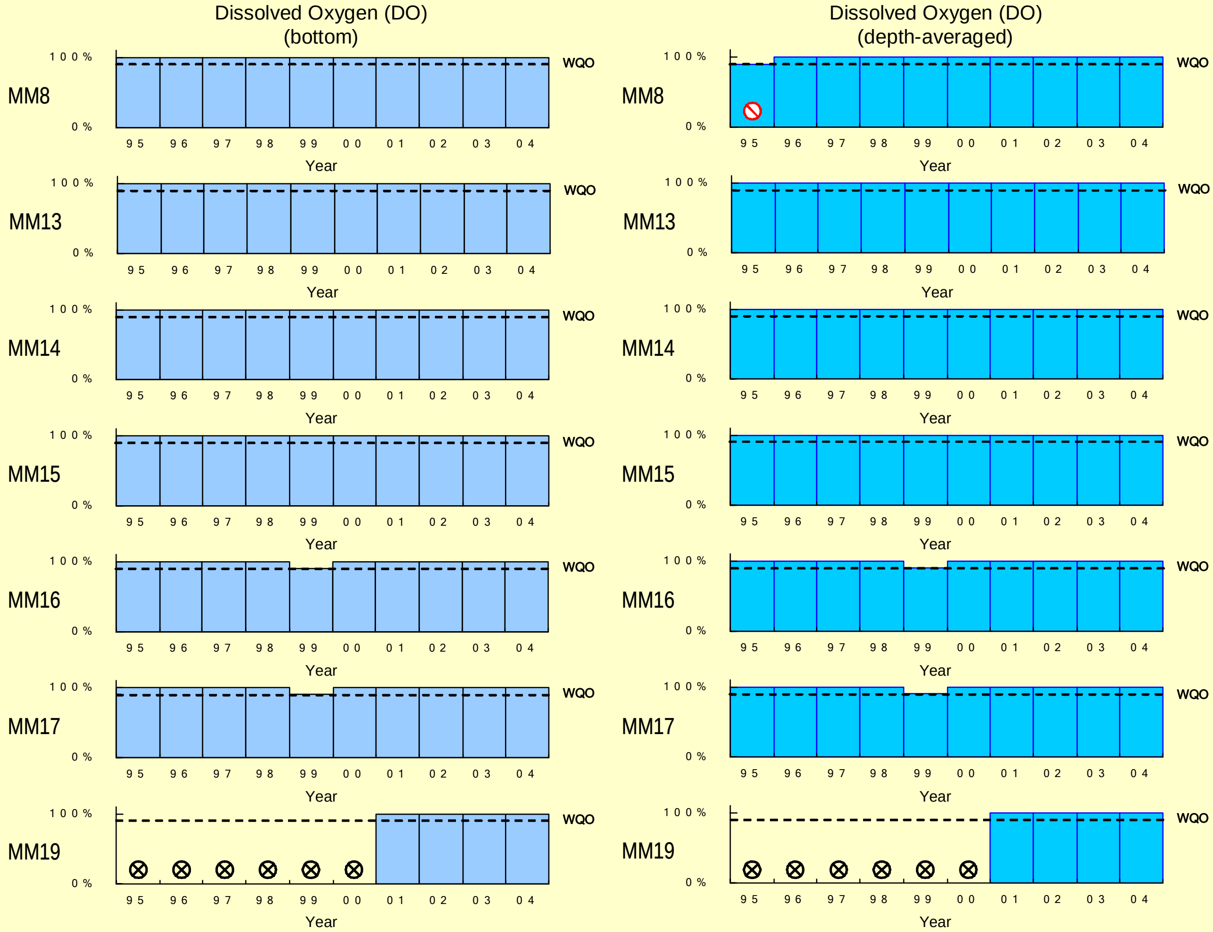
2. Depth-averaged

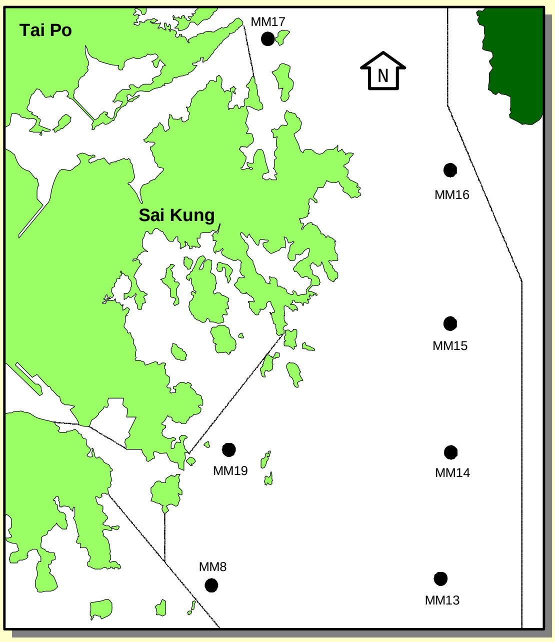
WQO : 90% sample with depth-averaged DO ≥ 4 mg/L

% sample with depth-averaged DO ≥ 4 mg/L

Non-compliance

Figure 2.1 (continued) Level of compliance with key Water Quality Objectives in the Mirs Bay WCZ





Dissolved Oxygen (DO)

1. Bottom

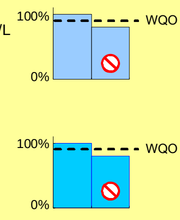
WQO : 90% sample with bottom DO ≥ 2 mg/L

% sample with bottom DO ≥ 2 mg/L

2. Depth-averaged

WQO : 90% sample with depth-averaged DO ≥ 4 mg/L

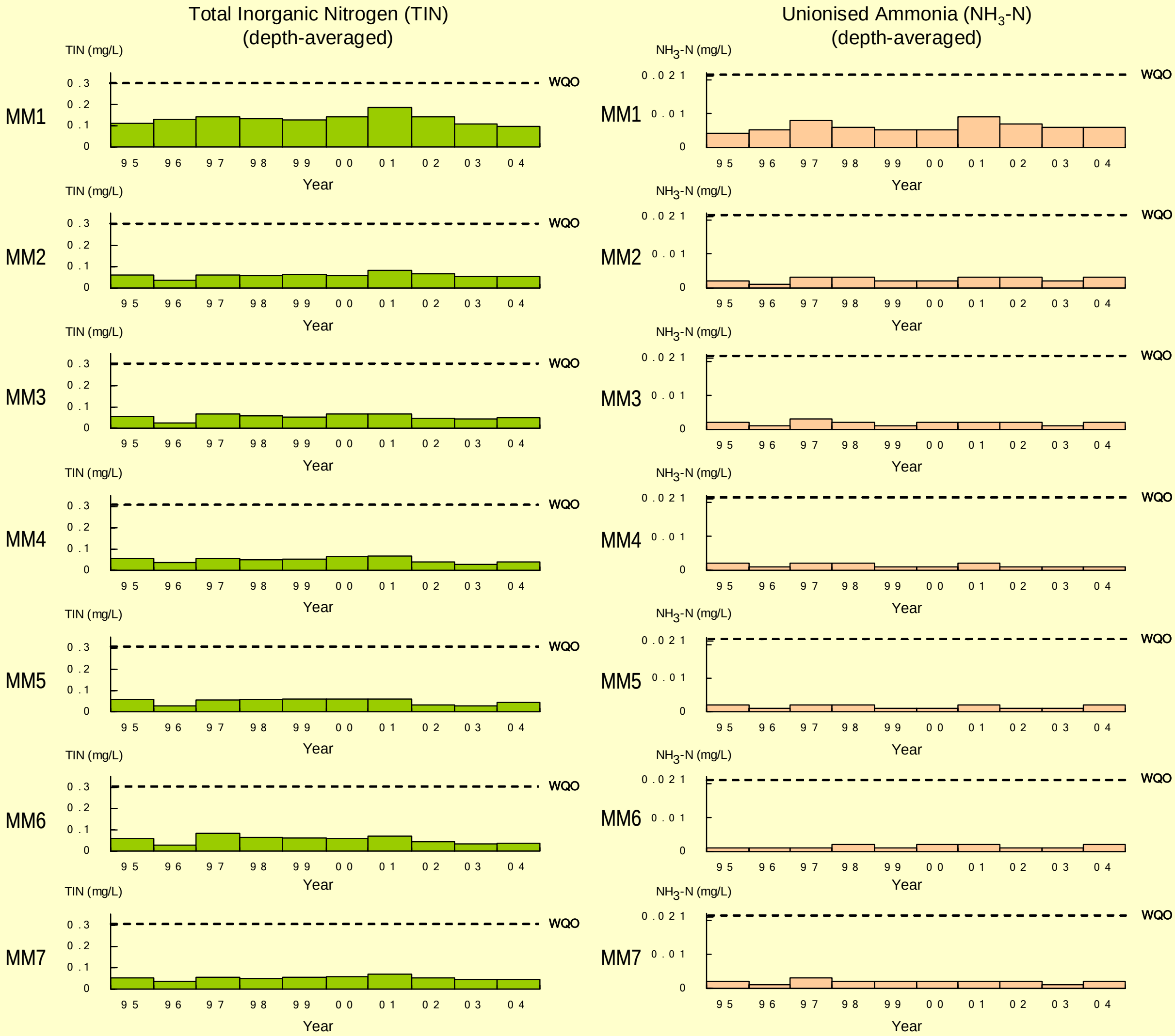
% sample with depth-averaged DO ≥ 4 mg/L

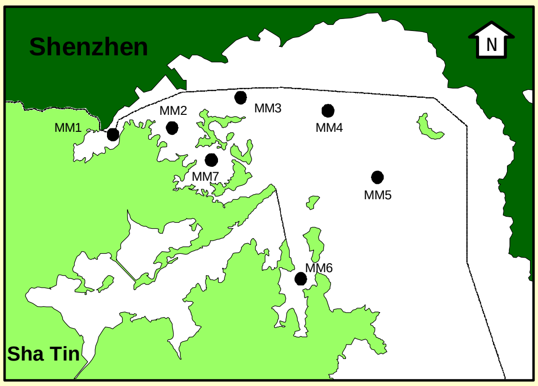


Non-compliance

No data ; monitoring has not started

Figure 2.1 (continued) Level of compliance with key Water Quality Objectives in the Mirs Bay WCZ

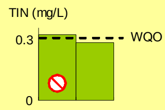




Total Inorganic Nitrogen (TIN)

WQO : annual mean for depth-averaged TIN ≤ 0.3 mg/L

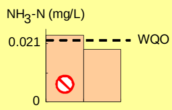
annual mean for depth-averaged TIN



Unionised Ammonia (NH_3-N)

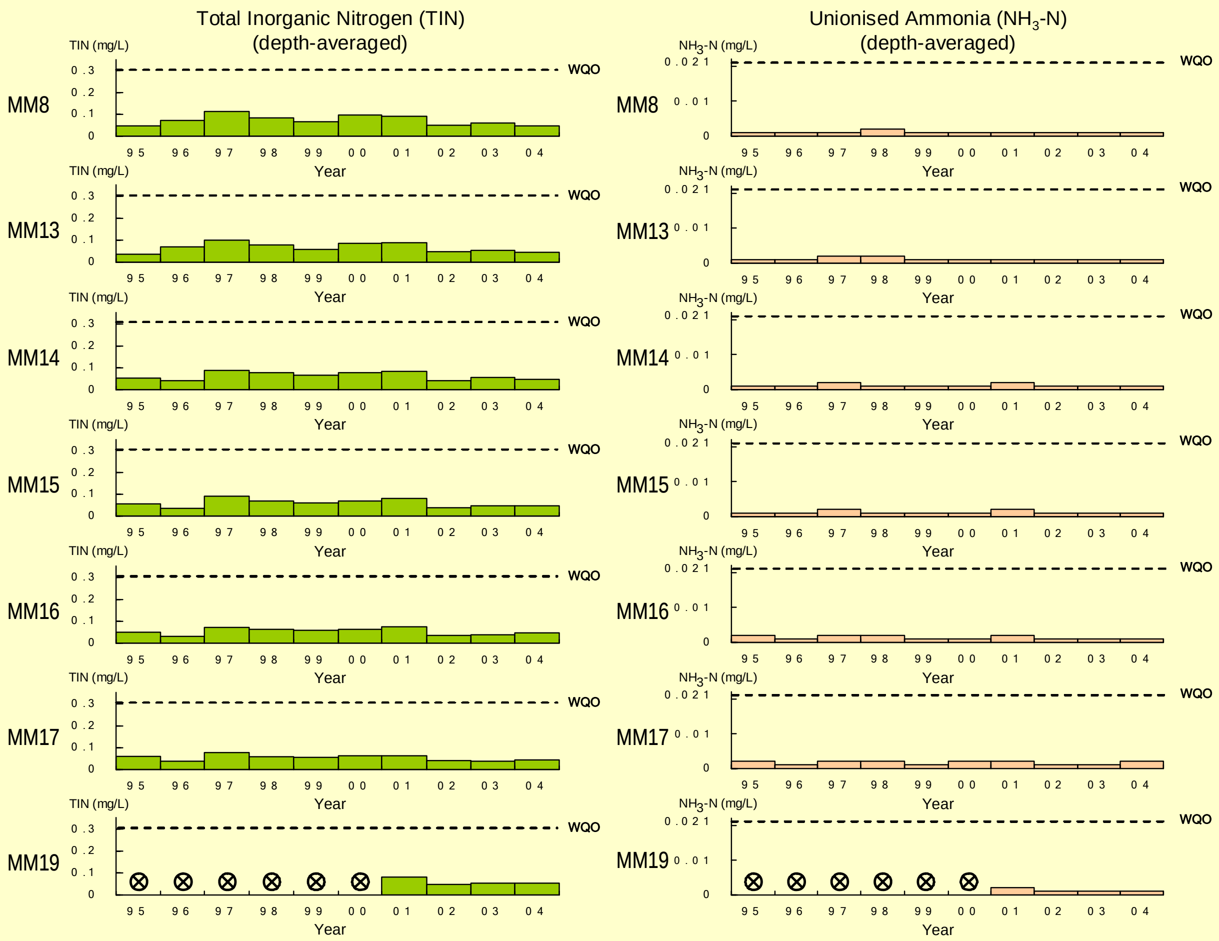
WQO : annual mean for depth-averaged NH_3-N ≤ 0.021 mg/L

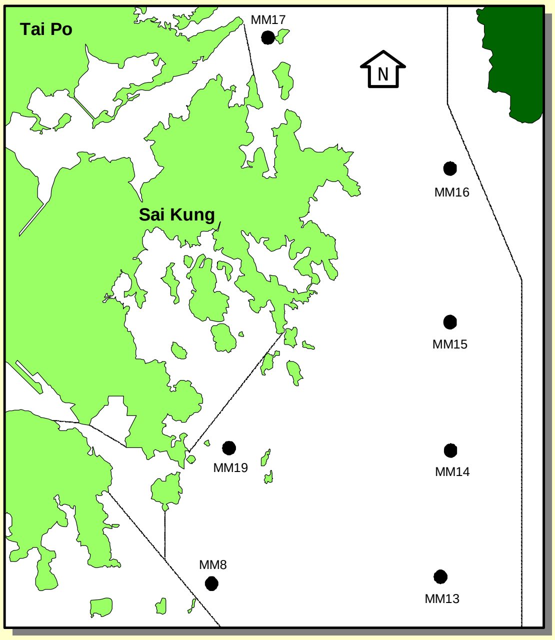
annual mean for depth-averaged NH_3-N



Non-compliance

Figure 2.1 (continued) Level of compliance with key Water Quality Objectives in the Mirs Bay WCZ





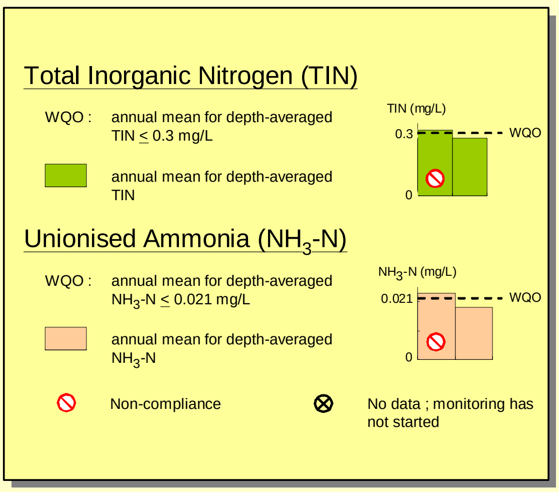


Figure 2.1 (continued) Level of compliance with key Water Quality Objectives in the Mirs Bay WCZ

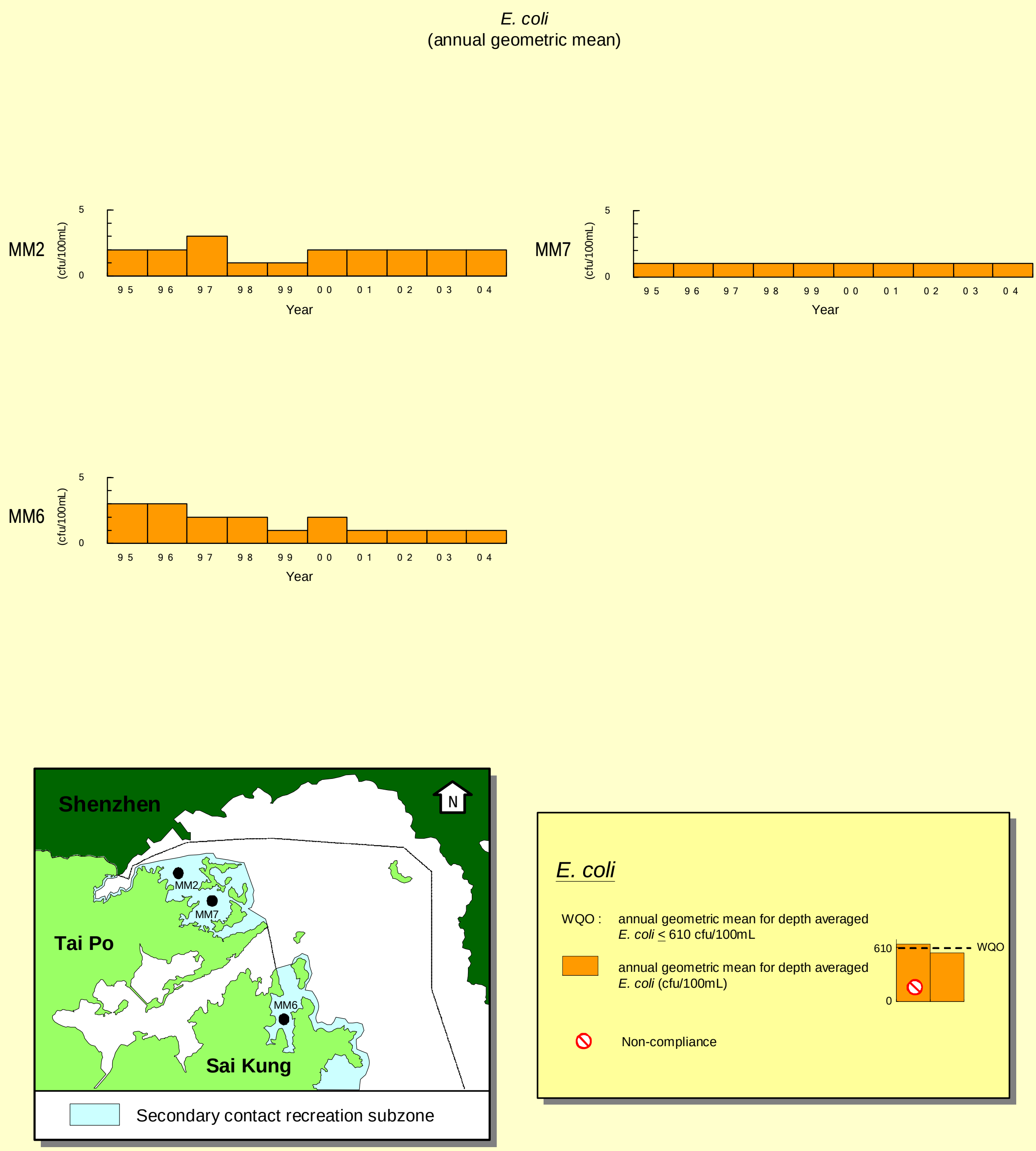
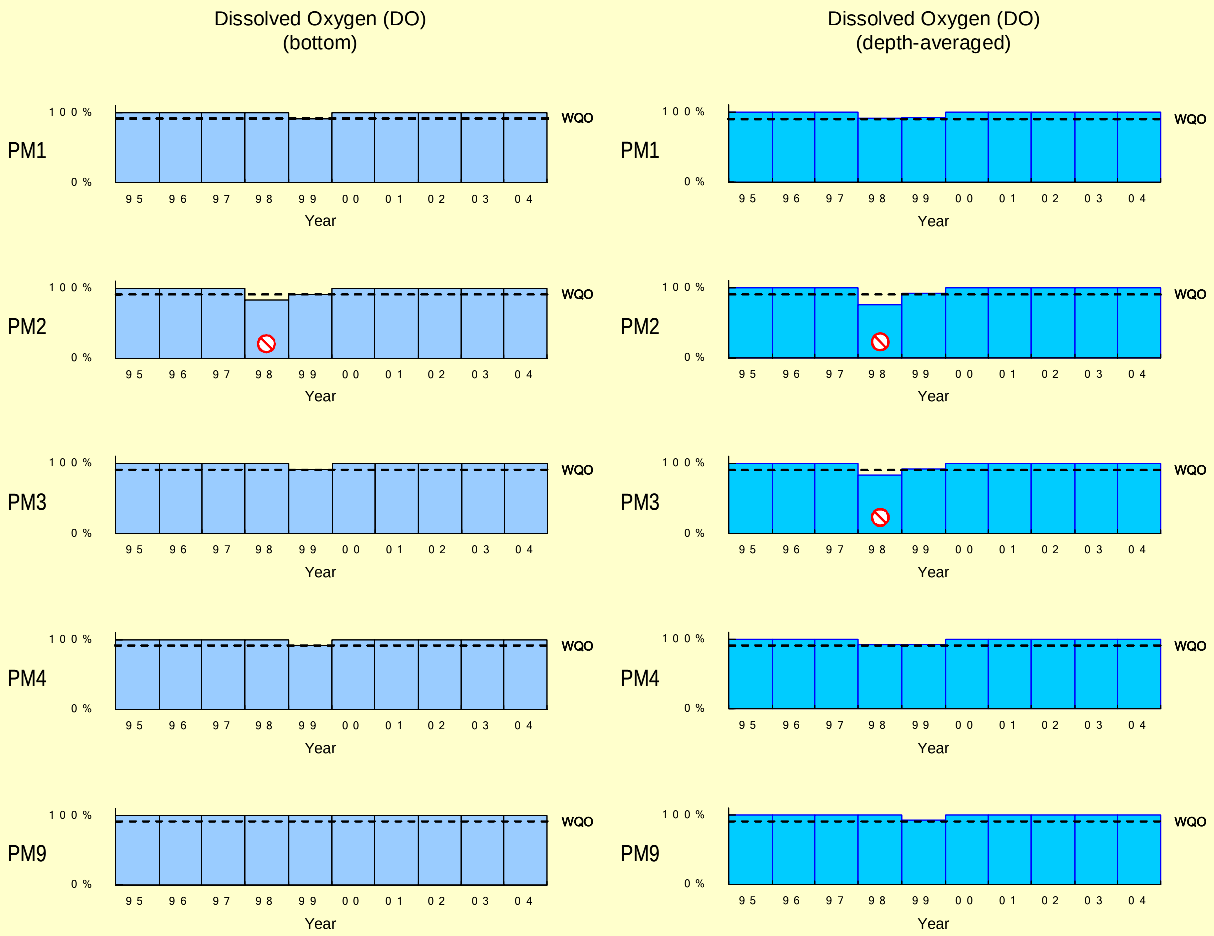
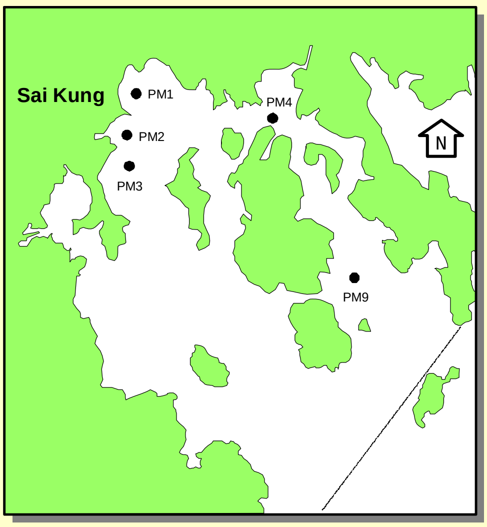


Figure 2.2 Level of compliance with key Water Quality Objectives in the Port Shelter WCZ





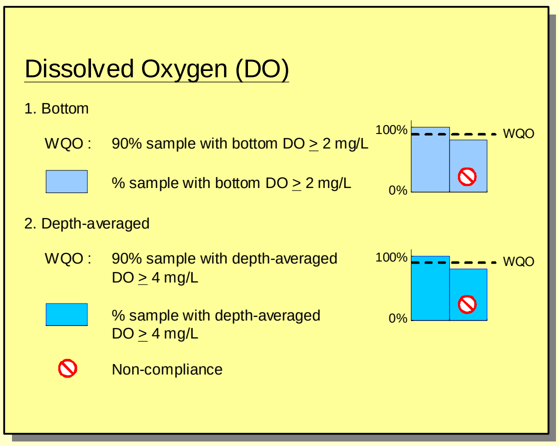
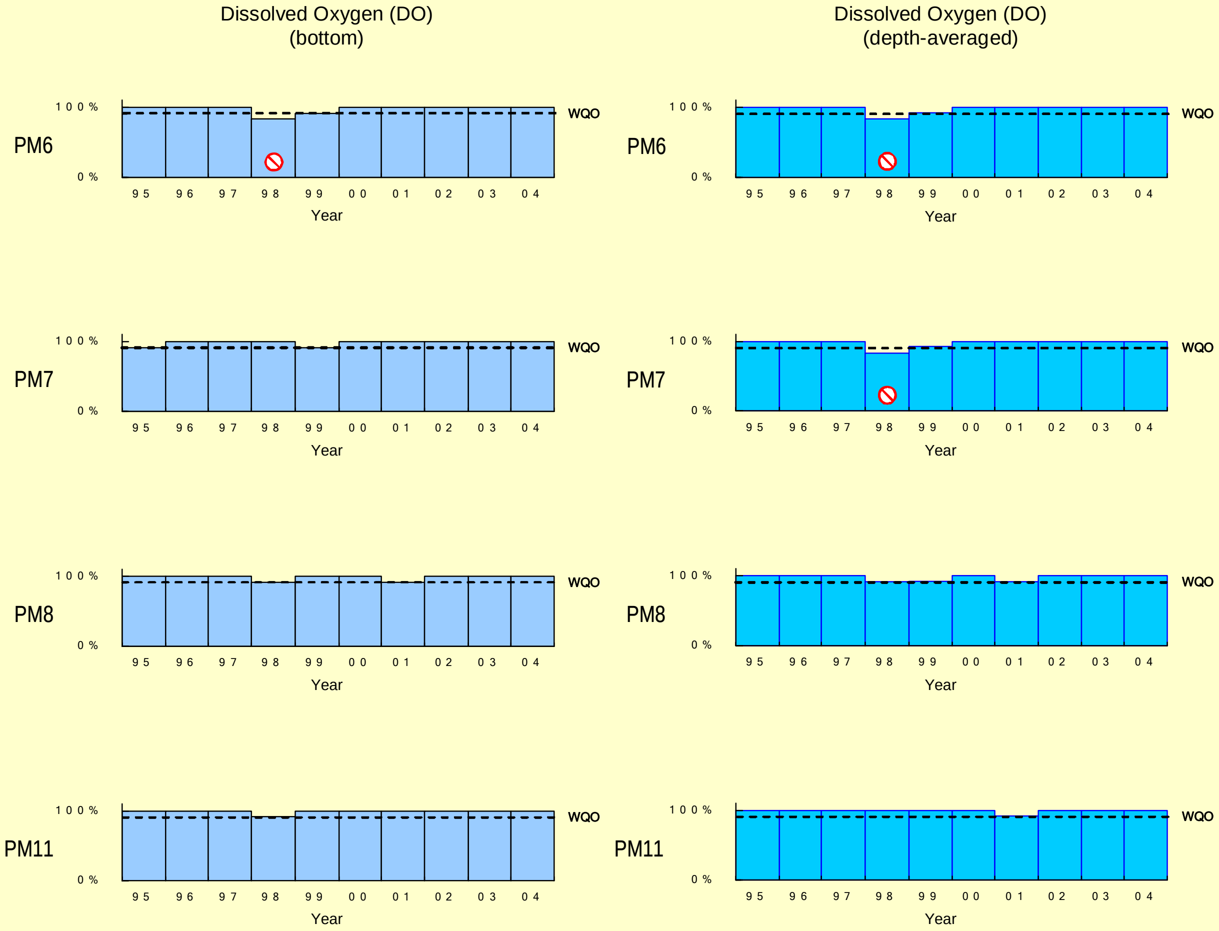
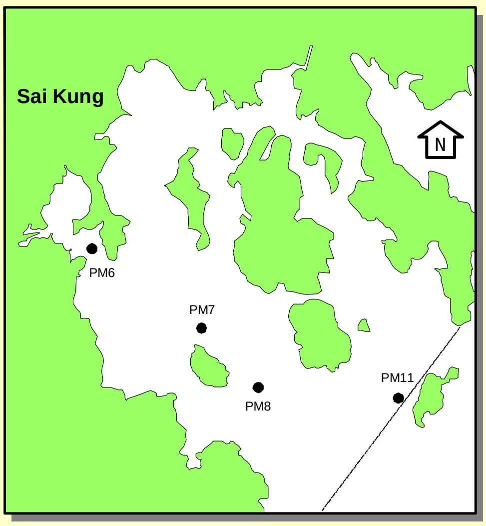


Figure 2.2 (continued) Level of compliance with key Water Quality Objectives in the Port Shelter WCZ





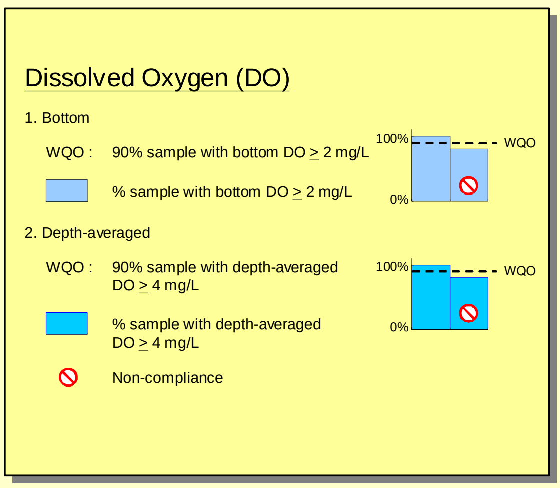


Figure 2.2 (continued) Level of compliance with key Water Quality Objectives in the Port Shelter WCZ

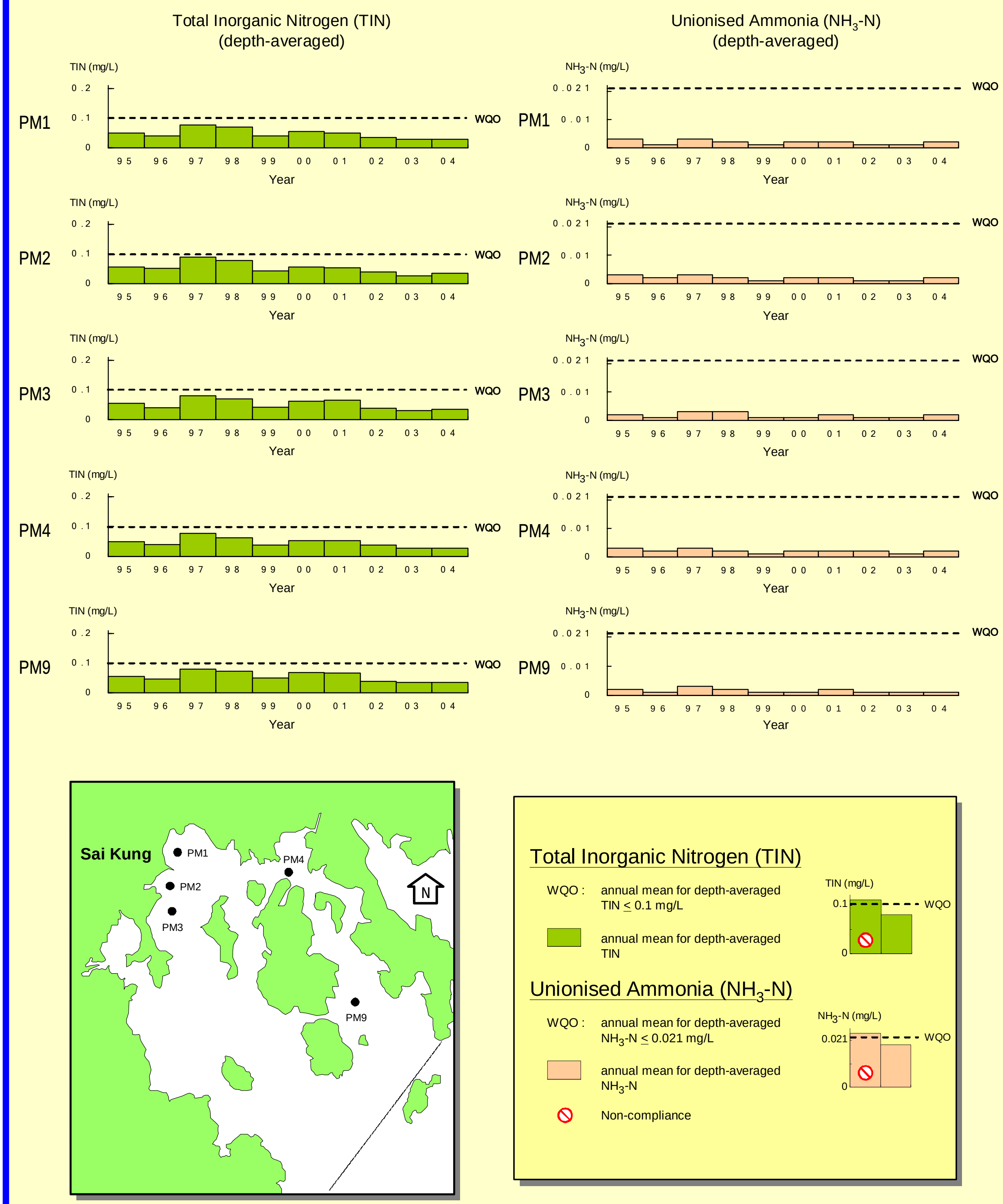


Figure 2.2 (continued) Level of compliance with key Water Quality Objectives in the Port Shelter WCZ

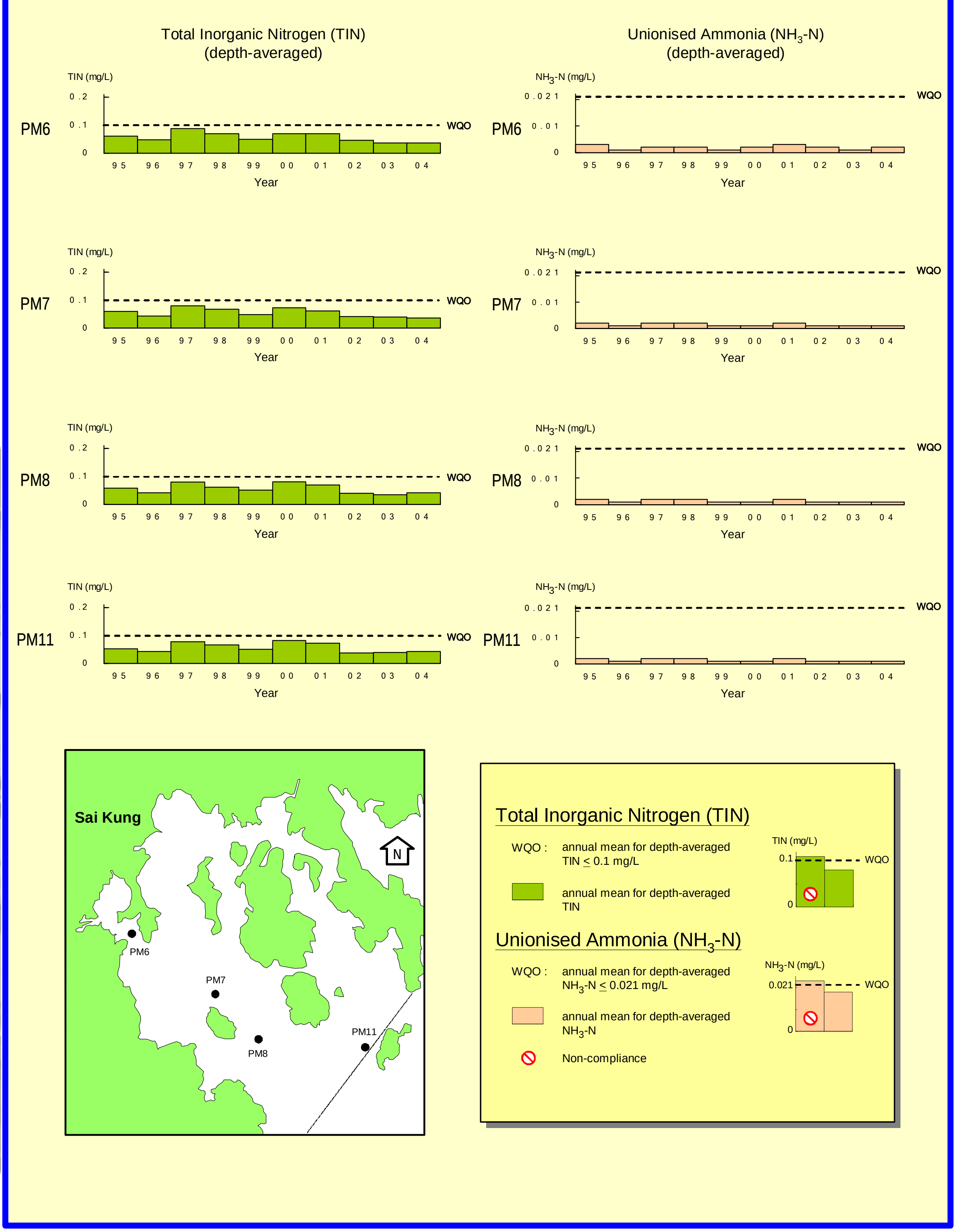
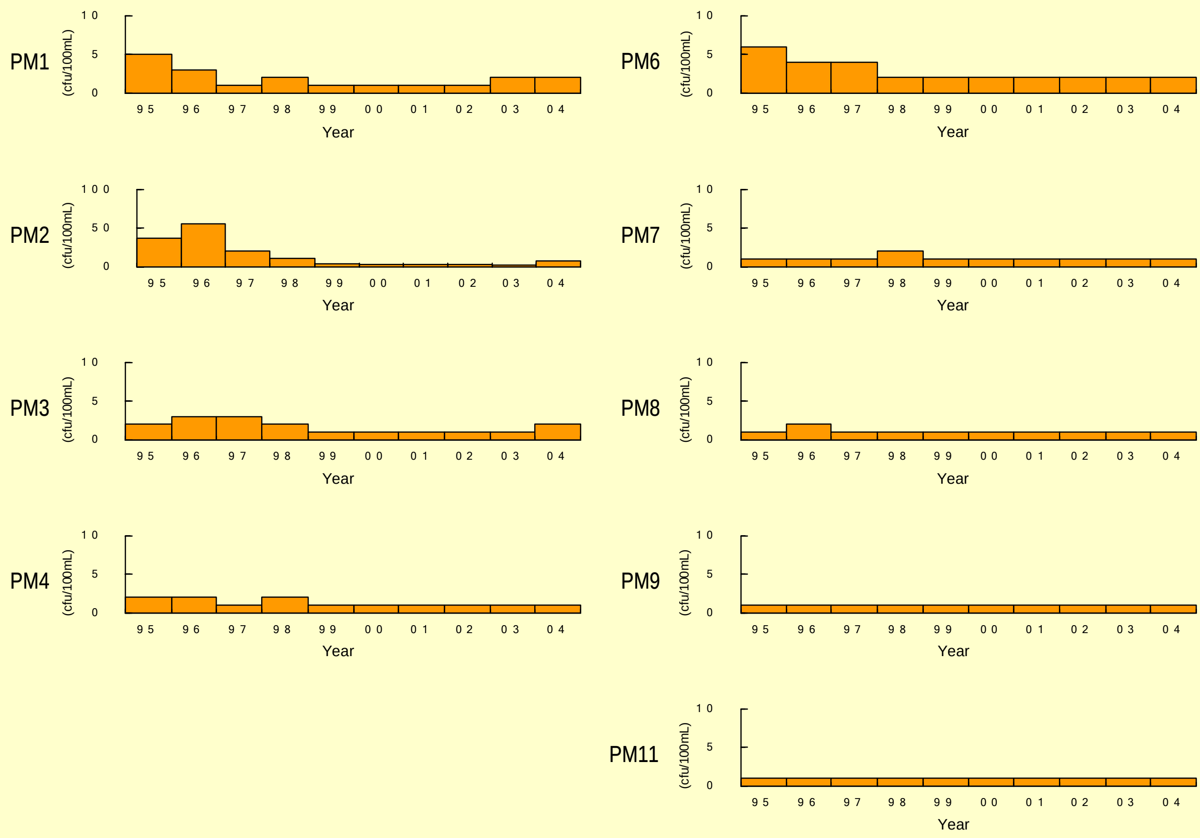
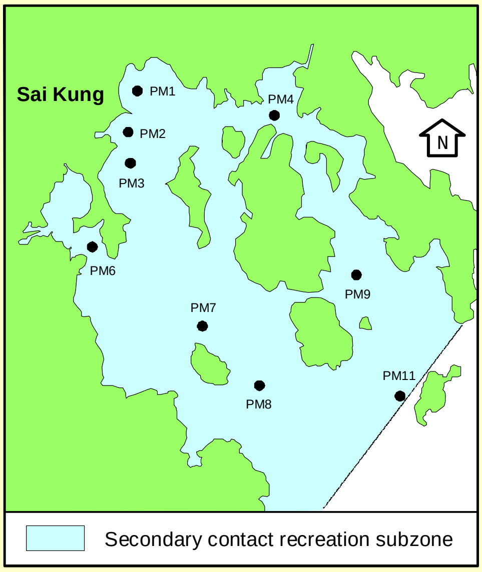


Figure 2.2 (continued) Level of compliance with key Water Quality Objectives in the Port Shelter WCZ

E. coli
(annual geometric mean)





E. coli

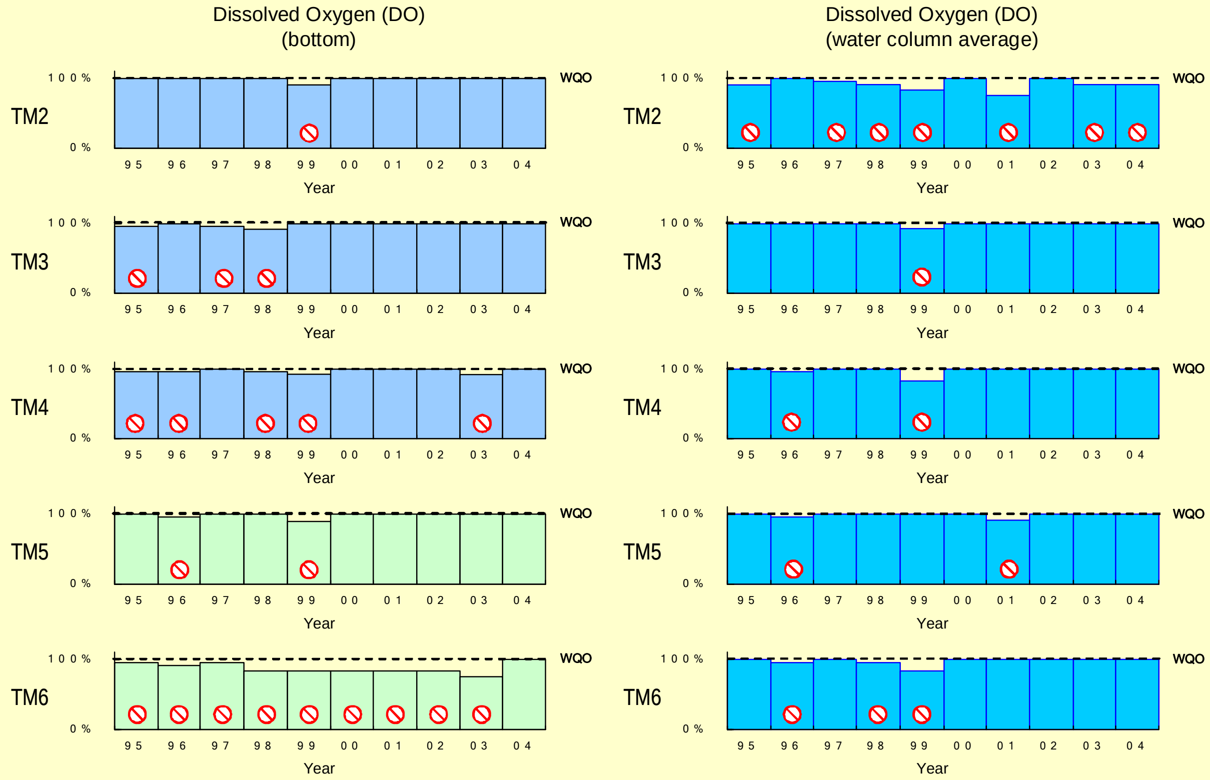
WQO : annual geometric mean for depth averaged *E. coli* ≤ 610 cfu/100mL

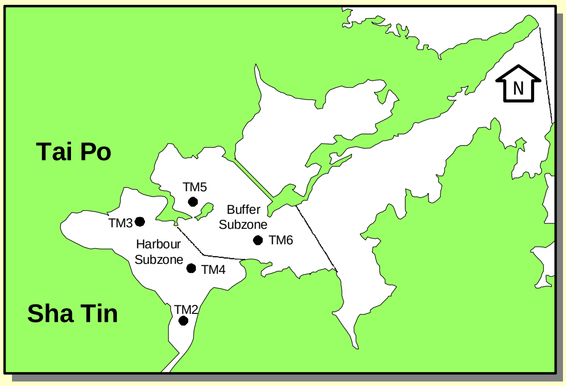
annual geometric mean for depth averaged *E. coli* (cfu/100mL)

610 WQO
0

Non-compliance

Figure 2.3 Level of compliance with key Water Quality Objectives in the Tolo Harbour and Channel WCZ





Dissolved Oxygen (DO)

Harbour Subzone (TM2 - TM4)

1. Bottom

WQO : 100% sample with bottom DO $\geq$ 2 mg/L

% sample with bottom DO $\geq$ 2 mg/L

2. Water column average (surface to 2m above bottom)

WQO : 100% sample with water column average DO $\geq$ 4 mg/L

% sample with water column average DO $\geq$ 4 mg/L

Buffer Subzone (TM5 - TM6)

1. Bottom

WQO : 100% sample with bottom DO $\geq$ 3 mg/L

% sample with bottom DO $\geq$ 3 mg/L

2. Water column average (surface to 2m above bottom)

WQO : 100% sample with water column average DO $\geq$ 4 mg/L

% sample with water column average DO $\geq$ 4 mg/L

Non-compliance

Figure 2.3 (continued) Level of compliance with key Water Quality Objectives in the Tolo Harbour and Channel WCZ

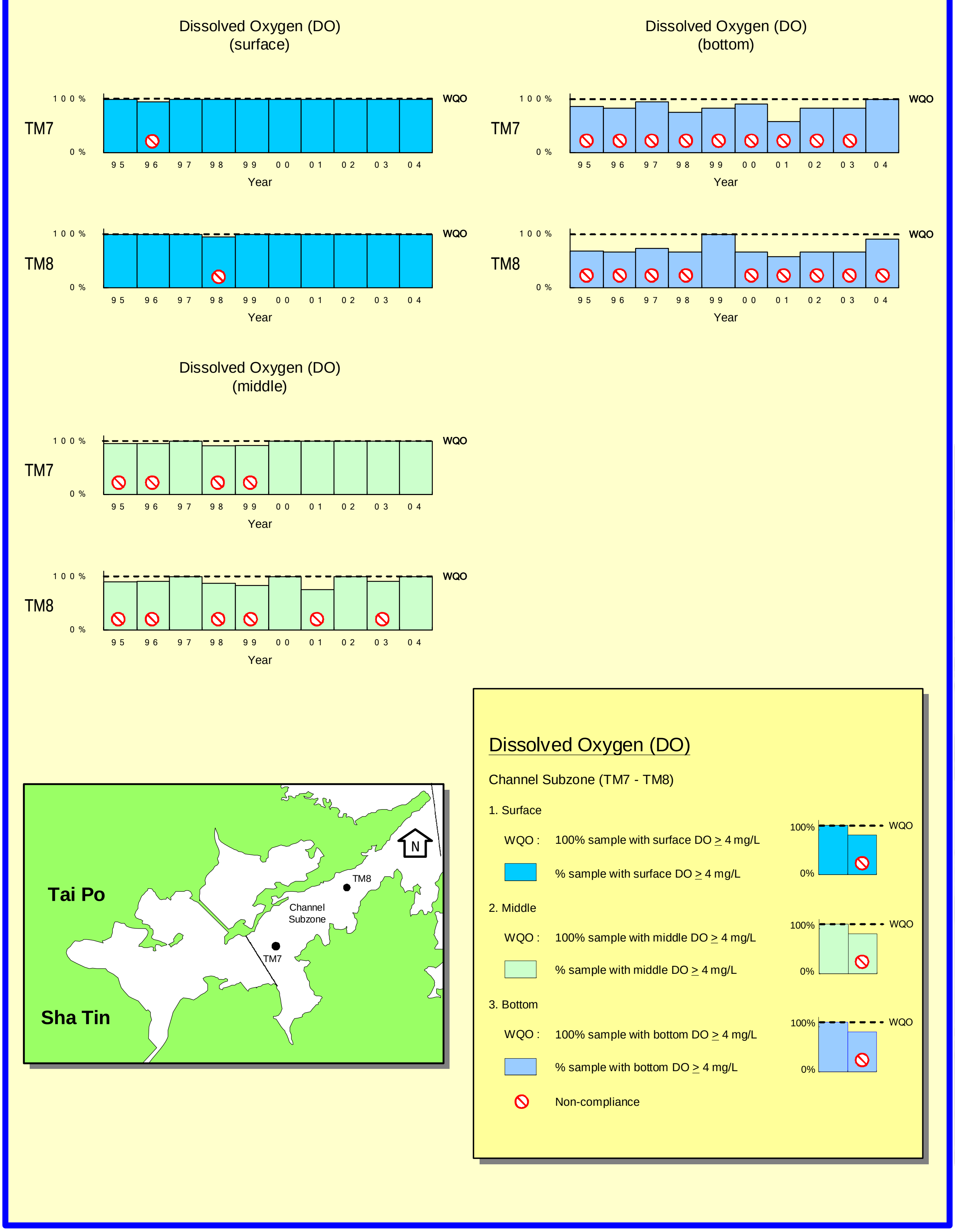
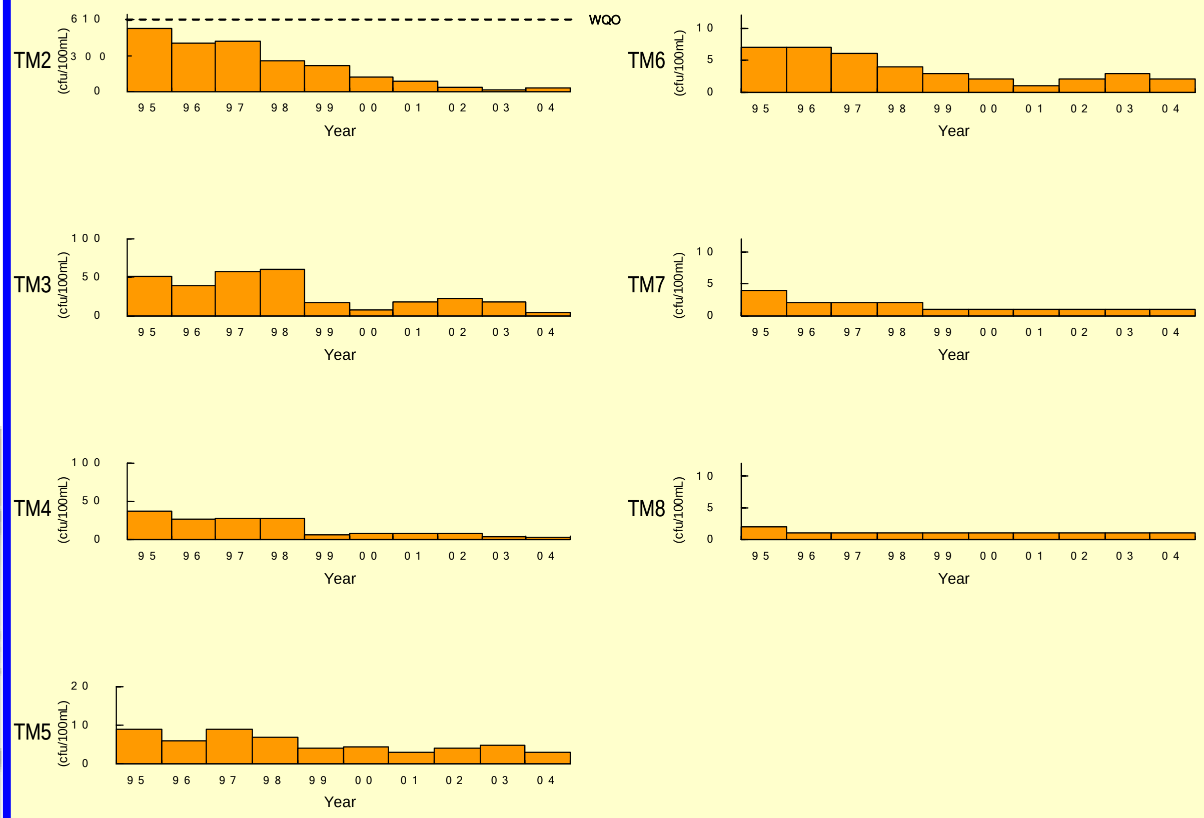
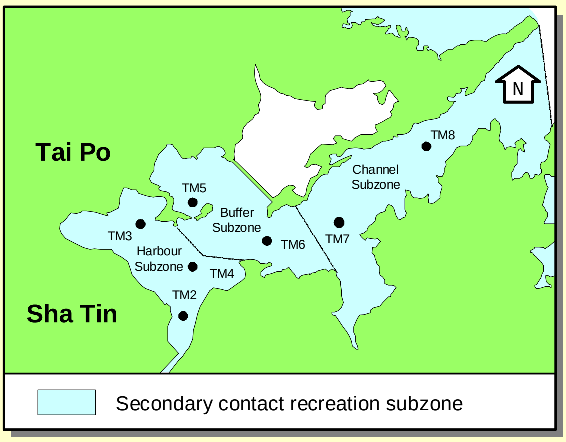


Figure 2.3 (continued) Level of compliance with key Water Quality Objectives in the Tolo Harbour and Channel WCZ

E. coli
(annual geometric mean)





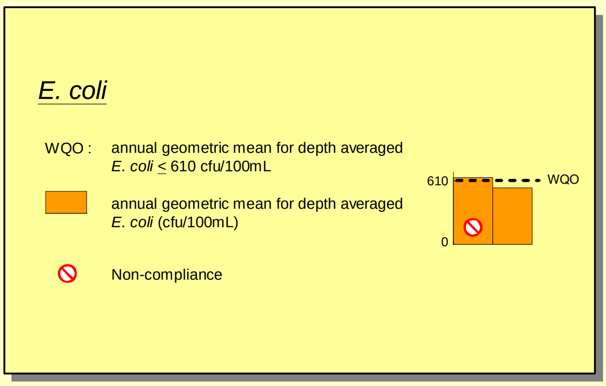
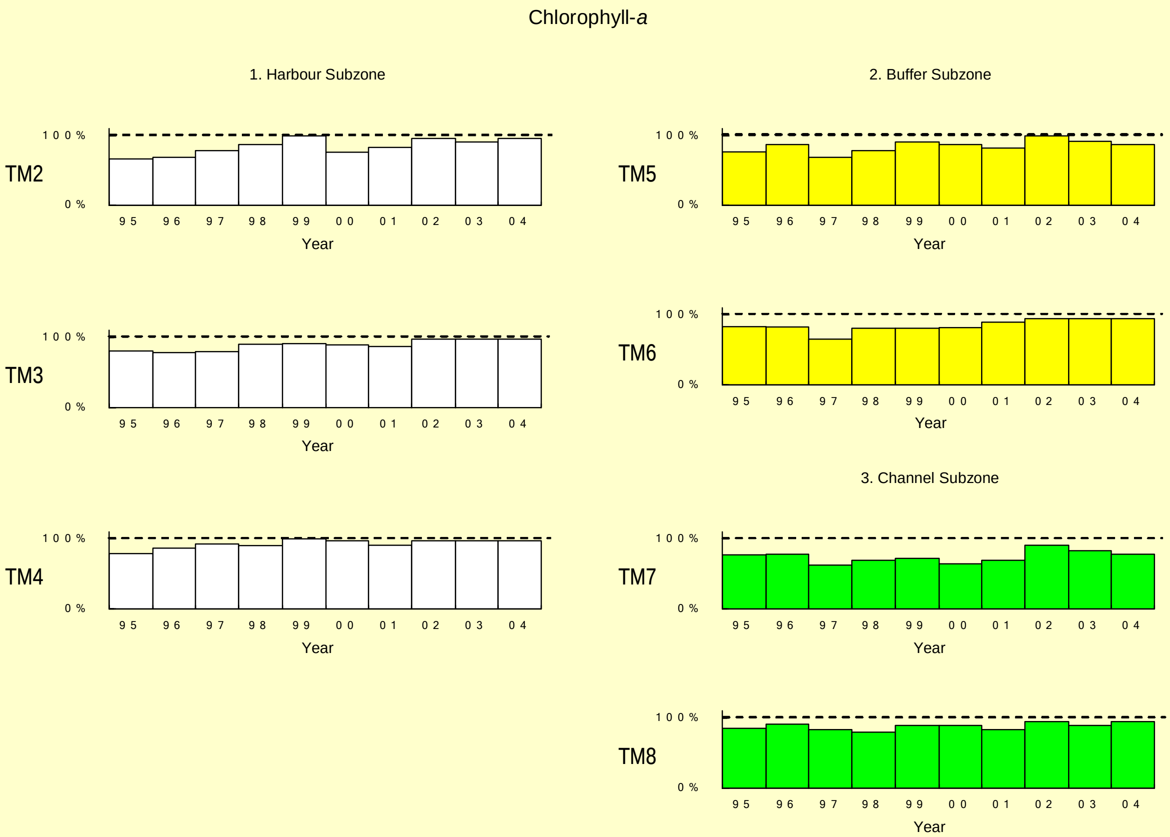
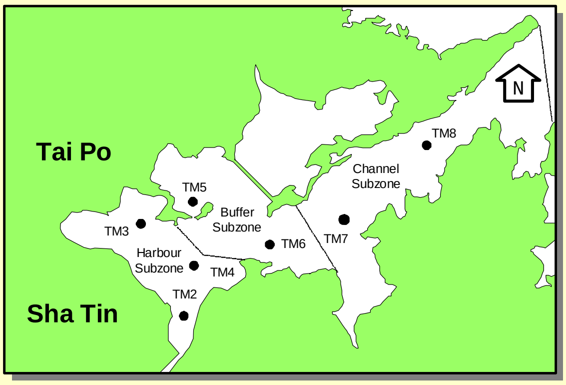


Figure 2.4 Level of chlorophyll-*a* in the Tolo Harbour and Channel WCZ





Chlorophyll-*a*

1. Harbour Subzone

% sample (S, M, B) with Chlorophyll-*a* ≤ 20 μg/L

WQO : Chlorophyll-*a* ≤ 20 μg/L

2. Buffer Subzone

% sample (S, M, B) with Chlorophyll-*a* ≤ 10 μg/L

WQO : Chlorophyll-*a* ≤ 10 μg/L

3. Channel Subzone

% sample (S, M, B) with Chlorophyll-*a* ≤ 6 μg/L

WQO : Chlorophyll-*a* ≤ 6 μg/L

Figure 2.5 Levels of total inorganic nitrogen and unionised ammonia in the Tolo Harbour and Channel WCZ

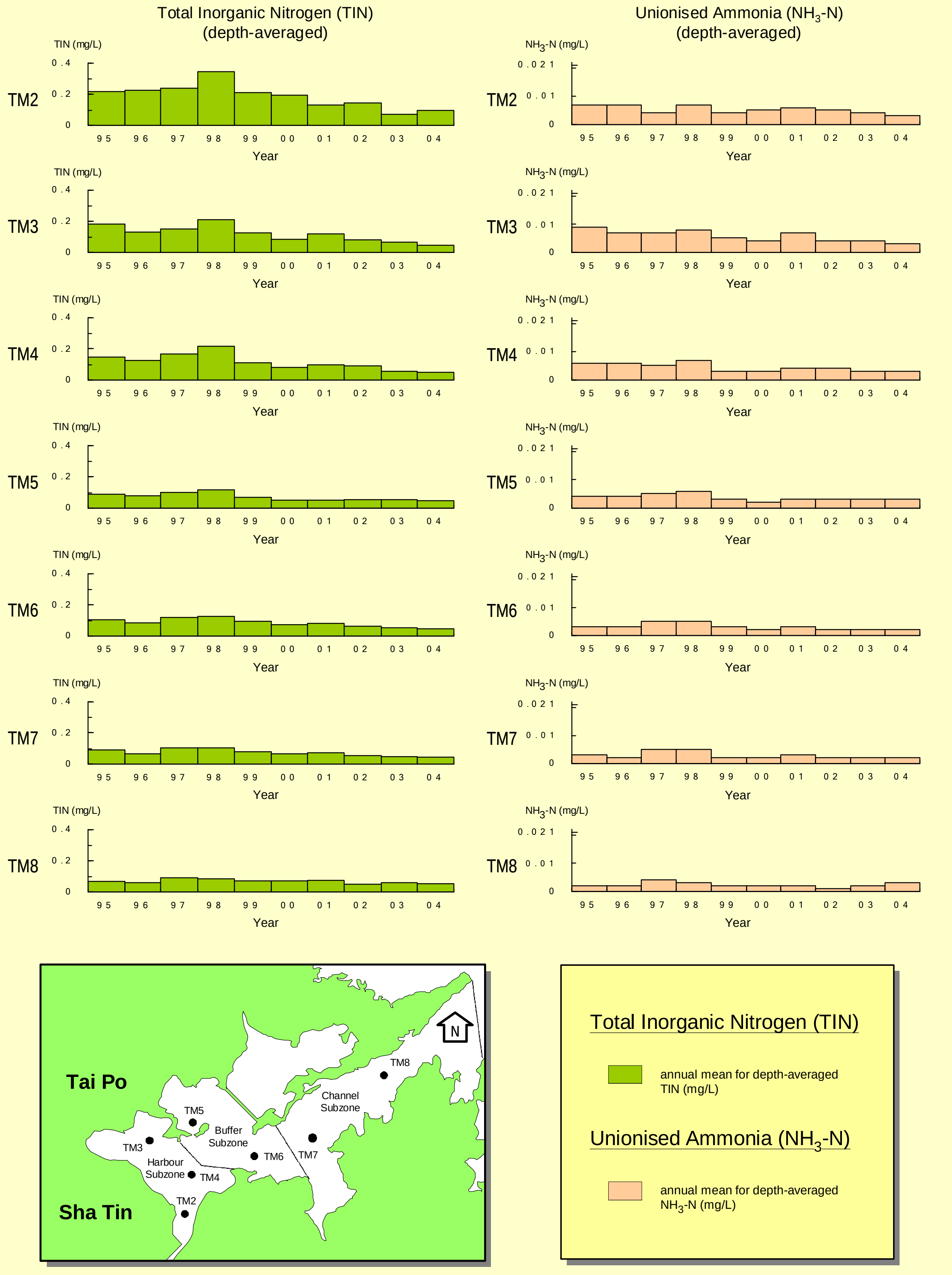
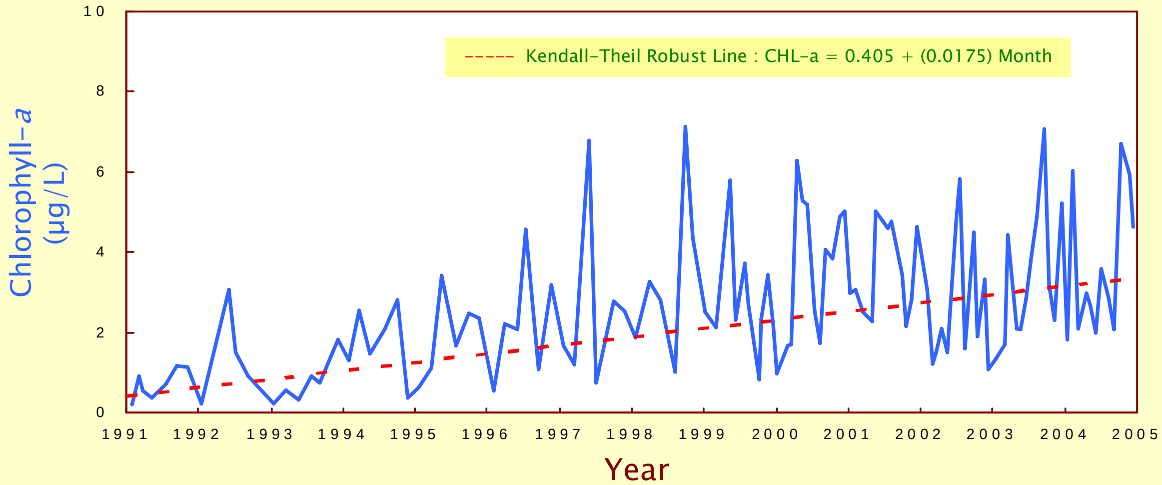
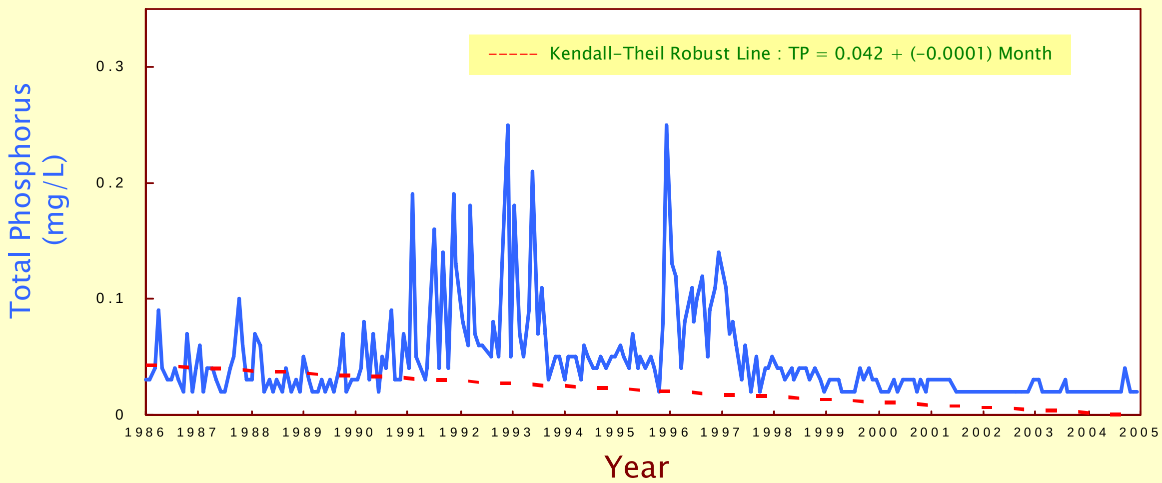


Figure 2.6 Marine water quality trends in the Eastern Waters
(based on the Seasonal Kendall Test significant at $p<0.05$)

Increasing trend in depth-averaged Chlorophyll-*a* at MM2, 1991 – 2004



Decreasing trend in depth-averaged Total Phosphorus at PM3, 1986 – 2004



Decreasing trend in depth-averaged Total Nitrogen at TM2, 1986 – 2004

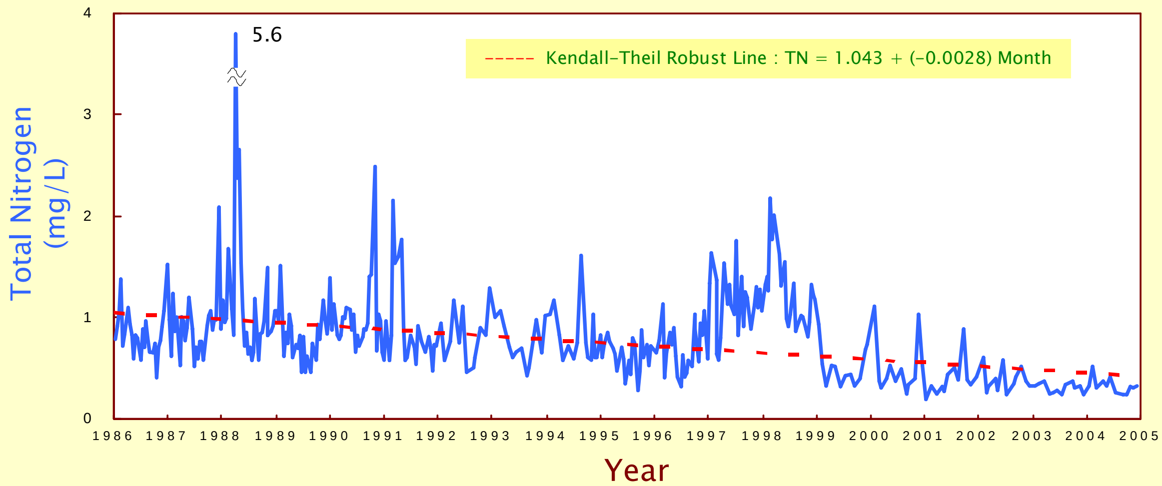


Table 2.1
Results of the Seasonal Kendall Test for water quality trends in the Mirs Bay WCZ, 1986 – 2004

Monitoring Station		MM1	MM2	MM3	MM4	MM5	MM6	MM7
Monitoring Period		1991 – 2004	1991 – 2004	1991 – 2004	1991 – 2004	1991 – 2004	1991 – 2004	1991 – 2004
Parameter	Water Depth							
Temperature (°C)	Surface	-	-	-	-	-	-	-
	Middle	↗	-	-	-	-	↗	-
	Bottom	-	-	-	↗	↗	-	↗
	Average	-	-	-	↗	-	-	-
Salinity	Surface	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	Surface	↘	↘	↘	↘	↘	↘	↘
	Middle	-	-	-	-	-	↘	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	↘	-
Dissolved Oxygen (%)	Surface	-	↘	↘	↘	↘	↘	↘
	Middle	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-
pH	Surface	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-
Secchi disc depth (m)		-	-	-	-	-	↗	-
Turbidity (NTU)	Surface	↗	↗	↗	↗	↗	↗	↗
	Middle	↗	↗	↗	↗	↗	↗	↗
	Bottom	↗	↗	↗	↗	↗	↗	↗
	Average	↗	↗	↗	↗	↗	↗	↗
Suspended Solids (mg/L)	Surface	-	-	-	-	-	-	-
	Middle	-	↗	-	-	-	-	-
	Bottom	↗	-	↗	-	-	-	↗
	Average	-	-	-	-	-	-	↗
Total volatile solids (mg/L)	Surface	↗	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	↘	-	-	-
5-day Biochemical Oxygen Demand (mg/L)	Surface	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-
Ammonia nitrogen (mg/L)	Surface	-	↘	↘	-	↘	↘	↘
	Middle	-	-	↘	↘	↘	↘	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	↘	↘	-
Nitrite nitrogen (mg/L)	Surface	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-
Nitrate nitrogen (mg/L)	Surface	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-
Total inorganic nitrogen (mg/L)	Surface	-	↘	↘	↘	↘	↘	↘
	Middle	-	-	↘	-	-	↘	-
	Bottom	-	-	-	↘	-	↘	-
	Average	-	↘	↘	↘	↘	↘	↘
Total Kjeldahl nitrogen (mg/L)	Surface	-	↘	↘	↘	↘	↘	-
	Middle	-	↘	↘	↘	↘	↘	↘
	Bottom	-	↘	↘	↘	↘	↘	-
	Average	-	↘	↘	↘	↘	↘	↘
Total nitrogen (mg/L)	Surface	-	↘	↘	↘	↘	↘	-
	Middle	-	↘	↘	↘	↘	↘	↘
	Bottom	-	↘	↘	↘	↘	↘	-
	Average	↘	↘	↘	↘	↘	↘	↘
Orthophosphate phosphorus (mg/L)	Surface	↘	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-
Total phosphorus (mg/L)	Surface	↘	↘	↘	↘	↘	↘	↘
	Middle	↘	↘	↘	↘	↘	↘	↘
	Bottom	↘	↘	↘	↘	↘	↘	↘
	Average	↘	↘	↘	↘	↘	↘	↘
Silica (mg/L)	Surface	↘	↘	-	-	-	-	↘
	Middle	↘	↘	-	↘	↘	-	↘
	Bottom	↘	↘	-	↘	-	↘	-
	Average	↘	↘	-	↘	↘	-	↘
Chlorophyll-*a* (µg/L)	Surface	↗	↗	↗	↗	-	-	↗
	Middle	↗	↗	↗	-	↗	-	↗
	Bottom	-	↗	↗	-	↗	-	↗
	Average	↗	↗	↗	↗	↗	-	↗
E. coli (cfu/100mL)	Surface	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-
Faecal coliforms (cfu/100mL)	Surface	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	↗	-	-	-	-	-

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. - indicates no significant trend is detected
3. Test applied to past 19 years' data from each monitoring station unless stated otherwise
4. ↗ represents a significant increase over time
5. ↘ represents a significant decrease over time

Table 2.1 (continued)

Results of the Seasonal Kendall Test for water quality trends in the Mirs Bay WCZ, 1986 – 2004

Monitoring Station		MM8	MM13	MM14	MM15	MM16	MM17
Monitoring Period		1991 – 2004	1991 – 2004	1994 – 2004	1994 – 2004	1994 – 2004	1986 – 2004
Parameter	Water Depth						
Temperature (°C)	Surface	↗	-	-	-	-	↗
	Middle	↗	↗	-	-	-	↗
	Bottom	↗	-	-	-	-	↗
	Average	↗	↗	-	-	-	↗
Salinity	Surface	↗	-	-	-	-	-
	Middle	-	-	-	-	-	-
	Bottom	↗	-	-	-	-	-
	Average	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	Surface	-	↘	-	-	-	↘
	Middle	↘	-	-	-	-	-
	Bottom	↘	-	-	-	-	-
	Average	↘	-	-	-	-	-
Dissolved Oxygen (%)	Surface	-	-	-	-	-	-
	Middle	-	-	-	-	-	-
	Bottom	-	-	-	-	-	↗
	Average	-	-	-	-	-	-
pH	Surface	-	-	-	-	-	-
	Middle	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-
	Average	-	-	-	-	-	-
Secchi disc depth (m)		-	-	-	-	-	-
Turbidity (NTU)	Surface	↗	↗	↗	↗	↗	↗
	Middle	↗	↗	↗	↗	↗	↗
	Bottom	↗	↗	↗	↗	↗	↗
	Average	↗	↗	↗	↗	↗	↗
Suspended Solids (mg/L)	Surface	-	-	-	-	-	↘
	Middle	-	-	-	-	-	↘
	Bottom	-	-	-	-	-	-
	Average	-	-	-	-	-	-
Total volatile solids (mg/L)	Surface	-	-	-	-	-	↘
	Middle	-	-	-	-	-	↘
	Bottom	-	-	-	-	-	↘
	Average	-	-	-	-	-	↘
5-day Biochemical Oxygen Demand (mg/L)	Surface	-	-	-	-	-	-
	Middle	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-
	Average	-	-	-	-	-	-
Ammonia nitrogen (mg/L)	Surface	↘	-	-	-	-	-
	Middle	↘	-	-	-	-	-
	Bottom	-	-	-	-	-	-
	Average	↘	-	-	-	-	-
Nitrite nitrogen (mg/L)	Surface	-	-	-	-	-	-
	Middle	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-
	Average	-	-	-	-	-	-
Nitrate nitrogen (mg/L)	Surface	-	-	-	-	-	-
	Middle	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-
	Average	-	-	-	-	-	-
Total inorganic nitrogen (mg/L)	Surface	↘	↘	-	-	-	-
	Middle	-	↘	-	-	-	-
	Bottom	-	-	-	-	-	-
	Average	-	-	-	-	-	-
Total Kjeldahl nitrogen (mg/L)	Surface	↘	↘	-	-	↘	↘
	Middle	↘	↘	-	↘	-	↘
	Bottom	↘	↘	-	↘	↘	↘
	Average	↘	↘	-	↘	↘	↘
Total nitrogen (mg/L)	Surface	↘	↘	↘	↘	↘	↘
	Middle	↘	↘	↘	↘	↘	↘
	Bottom	↘	↘	↘	↘	↘	↘
	Average	↘	↘	↘	↘	↘	↘
Orthophosphate phosphorus (mg/L)	Surface	-	-	-	-	-	-
	Middle	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-
	Average	-	-	-	-	-	-
Total phosphorus (mg/L)	Surface	↘	↘	↘	↘	↘	↘
	Middle	↘	↘	↘	↘	↘	↘
	Bottom	↘	↘	↘	↘	↘	↘
	Average	↘	↘	↘	↘	↘	↘
Silica (mg/L)	Surface	-	-	↘	-	-	↘
	Middle	-	-	↘	-	-	↘
	Bottom	-	-	-	-	-	-
	Average	-	-	↘	-	-	-
Chlorophyll-*a* (μg/L)	Surface	↗	↗	-	-	-	-
	Middle	↗	↗	-	-	-	-
	Bottom	↗	↗	-	-	-	-
	Average	↗	↗	-	-	-	-
E. coli (cfu/100mL)	Surface	-	-	-	-	-	-
	Middle	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-
	Average	-	-	-	-	-	-
Faecal coliforms (cfu/100mL)	Surface	-	-	-	-	-	-
	Middle	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-
	Average	-	-	-	-	-	-

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. - indicates no significant trend is detected
3. Test applied to past 19 years' data from each monitoring station unless stated otherwise
4. MM19 has four years' data only, which is insufficient to perform Seasonal Kendall Test
5. ↗ represents a significant increase over time
6. ↘ represents a significant decrease over time

Table 2.2

Results of the Seasonal Kendall Test for water quality trends in the Port Shelter WCZ, 1986 – 2004

Monitoring Station		PM1	PM2	PM3	PM4	PM6	PM7	PM8	PM9	PM11
Monitoring Period		1986 – 2004	1986 – 2004	1986 – 2004	1986 – 2004	1986 – 2004	1988 – 2004	1986 – 2004	1986 – 2004	1986 – 2004
Parameter	Water Depth									
Temperature (°C)	Surface	↗	↗	↗	↗	↗	↗	↗	↗	-
	Middle	↗	↗	↗	↗	↗	↗	↗	↗	-
	Bottom	↗	↗	↗	↗	↗	↗	↗	↗	-
	Average	↗	↗	↗	↗	↗	↗	↗	↗	-
Salinity	Surface	-	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	Surface	↘	↘	↘	↘	↘	↘	↘	↘	↘
	Middle	-	-	-	-	-	-	-	-	-
	Bottom	-	-	↗	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
Dissolved Oxygen (%)	Surface	↘	↘	↘	↘	↘	↘	↘	↘	↘
	Middle	-	-	-	-	-	-	-	-	-
	Bottom	↗	↗	↗	↗	-	↗	-	↗	-
	Average	-	-	-	-	-	-	-	-	-
pH	Surface	↘	-	↘	-	↘	-	-	-	-
	Middle	-	-	-	-	↘	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	↘	-	-	-	-
Secchi disc depth (m)		-	-	-	-	↗	-	-	-	-
Turbidity (NTU)	Surface	↗	↗	↗	↗	↗	↗	↗	↗	↗
	Middle	↗	↗	↗	↗	↗	↗	↗	↗	↗
	Bottom	↗	↗	↗	↗	↗	↗	↗	↗	↗
	Average	↗	↗	↗	↗	↗	↗	↗	↗	↗
Suspended Solids (mg/L)	Surface	-	-	↘	-	↘	↘	↘	-	-
	Middle	-	-	↘	-	↘	-	-	-	-
	Bottom	-	-	-	-	-	-	↗	↗	↗
	Average	-	-	↘	-	↘	-	-	-	-
Total volatile solids (mg/L)	Surface	↘	↘	↘	↘	↘	-	-	-	-
	Middle	-	↘	-	↘	↘	-	-	-	-
	Bottom	-	↘	-	↘	-	-	-	-	-
	Average	↘	↘	↘	↘	↘	↘	↘	↘	-
5-day Biochemical Oxygen Demand (mg/L)	Surface	-	↘	-	-	↘	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	↘	-	-	-	-
Ammonia nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	↘
	Average	-	-	-	-	-	-	-	-	-
Nitrite nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
Nitrate nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
Total inorganic nitrogen (mg/L)	Surface	-	-	-	-	↘	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	↘	-	-	-	-
Total Kjeldahl nitrogen (mg/L)	Surface	↘	↘	↘	↘	↘	↘	↘	↘	↘
	Middle	↘	↘	↘	↘	↘	↘	↘	↘	↘
	Bottom	↘	↘	↘	↘	↘	↘	↘	↘	↘
	Average	↘	↘	↘	↘	↘	↘	↘	↘	↘
Total nitrogen (mg/L)	Surface	↘	↘	↘	↘	↘	↘	↘	↘	↘
	Middle	↘	↘	↘	↘	↘	↘	↘	↘	↘
	Bottom	↘	↘	↘	↘	↘	↘	↘	↘	↘
	Average	↘	↘	↘	↘	↘	↘	↘	↘	↘
Orthophosphate phosphorus (mg/L)	Surface	-	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
Total phosphorus (mg/L)	Surface	↘	↘	↘	↘	↘	-	-	-	↘
	Middle	↘	↘	↘	-	↘	-	-	↘	↘
	Bottom	↘	↘	↘	↘	↘	↘	-	-	↘
	Average	↘	↘	↘	↘	↘	↘	-	↘	↘
Silica (mg/L)	Surface	-	-	-	-	-	-	-	-	-
	Middle	↘	-	-	-	-	-	-	-	-
	Bottom	↘	-	-	-	-	-	-	-	-
	Average	↘	-	-		-	-	-	-	-
Chlorophyll-*a* (μg/L)	Surface	-	-	-	-	-	-	-	-	-
	Middle	-	-	↗	-	-	-	-	-	-
	Bottom	-	↗	↗	↗	-	-	↗	↗	-
	Average	-	-	-	-	-	-	-	-	-
E. coli (cfu/100mL)	Surface	-	↘	-	-	↘	-	-	-	-
	Middle	-	↘	-	-	↘	-	-	-	-
	Bottom	-	↘	-	-	-	-	-	-	-
	Average	↘	↘	↘	-	↘	-	-	-	-
Faecal coliforms (cfu/100mL)	Surface	-	-	-	-	↘	-	-	-	-
	Middle	-	-	-	-	↘	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	↘	-	-	-	-

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. – indicates no significant trend is detected
3. Test applied to past 19 years' data from each monitoring station unless stated otherwise
4. ↗ represents a significant increase over time
5. ↘ represents a significant decrease over time

Table 2.3

Results of the Seasonal Kendall Test for water quality trends in the Tolo Harbour & Channel WCZ, 1986 - 2004

Monitoring Station		TM2	TM3	TM4	TM5	TM6	TM7	TM8
Monitoring Period		1986 - 2004	1986 - 2004	1986 - 2004	1986 - 2004	1986 - 2004	1986 - 2004	1986 - 2004
Parameter	Water Depth							
Temperature (°C)	Surface	↗	↗	↗	↗	↗	↗	↗
	Middle	NA	↗	↗	NA	↗	↗	↗
	Bottom	↗	↗	↗	↗	↗	↗	↗
	Average	↗	↗	↗	↗	↗	↗	↗
Salinity	Surface	-	-	-	-	-	-	-
	Middle	NA	-	-	NA	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	Surface	↘	↘	↘	↘	↘	↘	↘
	Middle	NA	-	-	NA	↗	-	-
	Bottom	↗	↗	↗	-	↗	↗	-
	Average	-	-	-	-	-	-	-
Dissolved Oxygen (%)	Surface	-	↘	↘	↘	↘	↘	↘
	Middle	NA	↗	↗	NA	↗	-	↗
	Bottom	↗	↗	↗	↗	↗	↗	↗
	Average	-	↗	-	-	-	-	-
pH	Surface	-	↘	↘	↘	↘	↘	↘
	Middle	NA	-	-	NA	-	↘	-
	Bottom	-	-	-	↘	-	-	-
	Average	-	-	-	↘	-	↘	-
Secchi disc depth (m)		-	-	↗	-	↗	↗	-
Turbidity (NTU)	Surface	↗	↗	↗	↗	↗	↗	↗
	Middle	NA	↗	↗	NA	↗	↗	↗
	Bottom	-	↗	↗	↗	↗	↗	↗
	Average	↗	↗	↗	↗	↗	↗	↗
Suspended Solids (mg/L)	Surface	-	-	-	-	-	-	↘
	Middle	NA	-	-	NA	-	-	↘
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-
Total volatile solids (mg/L)	Surface	-	-	-	-	-	-	↘
	Middle	NA	-	-	NA	↘	-	↘
	Bottom	-	-	↘	-	↘	-	↘
	Average	-	-	↘	-	↘	-	↘
5-day Biochemical Oxygen Demand (mg/L)	Surface	↘	↘	↘	↘	↘	↘	↘
	Middle	NA	↘	↘	NA	-	-	↘
	Bottom	-	-	-	↘	-	-	↘
	Average	↘	↘	↘	↘	↘	↘	↘
Ammonia nitrogen (mg/L)	Surface	↘	↘	-	-	-	-	-
	Middle	NA	↘	-	NA	↘	↘	-
	Bottom	-	↘	↘	-	-	-	-
	Average	↘	↘	↘	↘	-	↘	-
Nitrite nitrogen (mg/L)	Surface	↘	↘	-	-	-	-	-
	Middle	NA	-	-	NA	-	-	-
	Bottom	↘	↘	-	-	↘	-	-
	Average	↘	-	-	-	-	-	-
Nitrate nitrogen (mg/L)	Surface	↘	↘	↘	-	↘	-	-
	Middle	NA	↘	↘	NA	↘	↘	-
	Bottom	↘	↘	↘	↘	↘	↘	-
	Average	↘	↘	↘	↘	↘	↘	-
Total inorganic nitrogen (mg/L)	Surface	↘	↘	↘	-	↘	-	-
	Middle	NA	↘	↘	NA	↘	↘	-
	Bottom	↘	↘	-	↘	↘	-	-
	Average	↘	↘	↘	↘	↘	↘	-
Total Kjeldahl nitrogen (mg/L)	Surface	↘	↘	↘	↘	↘	↘	↘
	Middle	NA	↘	↘	NA	↘	↘	↘
	Bottom	↘	↘	↘	↘	↘	↘	↘
	Average	↘	↘	↘	↘	↘	↘	↘
Total nitrogen (mg/L)	Surface	↘	↘	↘	↘	↘	↘	↘
	Middle	NA	↘	↘	NA	↘	↘	↘
	Bottom	↘	↘	↘	↘	↘	↘	↘
	Average	↘	↘	↘	↘	↘	↘	↘
Orthophosphate phosphorus (mg/L)	Surface	↘	↘	↘	↘	↘	↘	-
	Middle	NA	↘	↘	NA	-	↘	-
	Bottom	↘	↘	↘	↘	-	-	-
	Average	↘	↘	↘	↘	↘	↘	-
Total phosphorus (mg/L)	Surface	↘	↘	↘	↘	↘	↘	↘
	Middle	NA	↘	↘	NA	↘	↘	↘
	Bottom	↘	↘	↘	↘	↘	↘	-
	Average	↘	↘	↘	↘	↘	↘	↘
Silica (mg/L)	Surface	-	-	-	↗	-	-	-
	Middle	NA	-	-	NA	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	↗	-	-	-
Chlorophyll-*a* (μg/L)	Surface	-	-	-	-	-	-	-
	Middle	NA	-	-	NA	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-
E. coli (cfu/100mL)	Surface	↘	-	↘	-	-	-	-
	Middle	NA	-	↘	NA	↘	-	-
	Bottom	↘	↘	↘	-	-	-	-
	Average	↘	↘	↘	-	↘	↘	-
Faecal coliforms (cfu/100mL)	Surface	-	-	-	↗	-	-	-
	Middle	NA	-	-	NA	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	↗	-	-	-

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. - indicates no significant trend is detected
3. NA (Not Applicable) indicates the measurement was not made due to shallow water
4. Test applied to past 19 years' data from each monitoring station unless stated otherwise
5. SM20 has six years' data only, which is insufficient to perform Seasonal Kendall Test
6. ↗ represents a significant increase over time
7. ↘ represents a significant decrease over time

Table 2.4

Summary water quality statistics of the Mirs Bay WCZ in 2004

Parameter	Starling Inlet	Crooked Island		Port Island	Mirs Bay North		
	MM1	MM2	MM7	MM17	MM3	MM4	MM5
Number of samples	12	12	12	12	12	12	12
Temperature (°C)	24.0 (15.7 - 30.6)	23.7 (15.8 - 29.4)	23.6 (15.5 - 29.9)	22.9 (15.5 - 28.2)	23.2 (15.9 - 28.3)	23.0 (16.0 - 28.2)	22.9 (15.4 - 27.6)
Salinity	32.3 (28.6 - 33.9)	32.7 (29.7 - 34.1)	32.9 (30.1 - 33.9)	33.3 (31.2 - 34.4)	33.2 (31.5 - 34.2)	33.4 (31.7 - 35.3)	33.4 (31.6 - 35.1)
Dissolved Oxygen (mg/L)	8.0 (5.3 - 10.6)	7.0 (5.7 - 8.9)	6.6 (5.5 - 8.2)	6.5 (5.3 - 8.1)	7.3 (6.0 - 10.3)	6.9 (5.8 - 8.1)	6.9 (5.5 - 8.3)
Bottom	8.2 (5.7 - 10.8)	7.0 (5.7 - 8.4)	6.6 (4.8 - 8.3)	6.1 (4.4 - 8.2)	7.2 (5.8 - 9.8)	6.9 (5.7 - 8.0)	6.5 (5.4 - 7.9)
Dissolved Oxygen (% Saturation)	117 (77 - 158)	99 (82 - 136)	94 (79 - 126)	91 (82 - 106)	102 (88 - 153)	97 (89 - 111)	96 (83 - 109)
Bottom	117 (83 - 160)	97 (84 - 126)	91 (68 - 125)	84 (62 - 104)	100 (84 - 140)	96 (86 - 111)	90 (78 - 102)
pH	8.3 (8.1 - 8.5)	8.2 (8.0 - 8.4)	8.2 (8.0 - 8.3)	8.1 (8.0 - 8.3)	8.2 (8.1 - 8.3)	8.2 (8.1 - 8.3)	8.2 (8.0 - 8.3)
Secchi Disc Depth (m)	1.7 (1.0 - 2.7)	2.8 (1.8 - 4.9)	3.2 (1.9 - 4.7)	4.6 (2.1 - 7.3)	3.9 (1.3 - 5.5)	4.1 (2.5 - 7.5)	4.8 (2.4 - 9.5)
Turbidity (NTU)	10.0 (7.7 - 13.1)	8.1 (6.5 - 9.8)	7.6 (4.9 - 10.3)	7.4 (4.6 - 9.7)	8.0 (4.8 - 11.2)	7.2 (4.3 - 8.2)	8.2 (6.0 - 11.9)
Suspended Solids (mg/L)	6.0 (2.4 - 8.3)	2.9 (1.5 - 5.1)	3.6 (1.2 - 13.5)	2.0 (0.7 - 4.9)	4.5 (1.2 - 22.0)	2.1 (0.6 - 4.1)	4.9 (1.2 - 23.0)
5-day Biochemical Oxygen Demand (mg/L)	2.2 (0.8 - 4.3)	1.1 (0.4 - 2.6)	1.0 (0.4 - 1.7)	0.8 (0.2 - 1.6)	1.3 (0.3 - 3.1)	0.8 (0.3 - 1.7)	0.8 (0.3 - 1.5)
Ammonia Nitrogen (mg/L)	0.08 (0.02 - 0.27)	0.04 (0.02 - 0.08)	0.03 (0.02 - 0.08)	0.03 (0.01 - 0.06)	0.03 (0.01 - 0.09)	0.02 (0.01 - 0.05)	0.02 (0.01 - 0.06)
Unionised Ammonia (mg/L)	0.006 (0.003 - 0.020)	0.003 (0.001 - 0.007)	0.002 (0.001 - 0.004)	0.002 (<0.001 - 0.003)	0.002 (<0.001 - 0.008)	0.001 (<0.001 - 0.003)	0.002 (<0.001 - 0.005)
Nitrite Nitrogen (mg/L)	<0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.04)	<0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.05)	<0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.02)
Nitrate Nitrogen (mg/L)	0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.06)	0.01 (<0.01 - 0.05)	0.01 (<0.01 - 0.07)	0.01 (<0.01 - 0.06)
Total Inorganic Nitrogen (mg/L)	0.10 (0.03 - 0.28)	0.05 (0.02 - 0.09)	0.04 (0.02 - 0.08)	0.04 (0.01 - 0.10)	0.05 (0.02 - 0.12)	0.04 (0.02 - 0.11)	0.04 (0.02 - 0.10)
Total Kjeldahl Nitrogen (mg/L)	0.30 (0.12 - 0.53)	0.15 (0.11 - 0.20)	0.15 (0.11 - 0.20)	0.11 (0.07 - 0.14)	0.14 (0.08 - 0.37)	0.11 (0.07 - 0.15)	0.10 (0.07 - 0.13)
Total Nitrogen (mg/L)	0.31 (0.13 - 0.54)	0.16 (0.12 - 0.23)	0.16 (0.11 - 0.21)	0.13 (0.08 - 0.22)	0.16 (0.09 - 0.38)	0.13 (0.08 - 0.20)	0.12 (0.08 - 0.20)
Orthophosphate Phosphorus (mg/L)	0.01 (<0.01 - 0.05)	0.01 (<0.01 - 0.01)	0.01 (<0.01 - 0.02)	0.01 (0.01 - 0.02)	0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.01)	0.01 (<0.01 - 0.01)
Total Phosphorus (mg/L)	0.03 (0.02 - 0.07)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.06)	0.02 (0.02 - 0.03)	0.03 (0.02 - 0.05)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.03)
Silica (as SiO_2) (mg/L)	0.6 (0.1 - 1.9)	0.5 (0.1 - 1.8)	0.5 (0.1 - 1.9)	0.6 (0.1 - 1.9)	0.6 (0.1 - 2.0)	0.6 (0.1 - 1.7)	0.6 (0.1 - 1.5)
Chlorophyll-a (µg/L)	10.7 (1.8 - 20.7)	3.6 (1.8 - 6.7)	3.2 (1.3 - 5.7)	2.0 (0.9 - 4.5)	3.5 (1.7 - 11.3)	2.0 (0.8 - 4.6)	2.0 (1.0 - 5.0)
E. coli (cfu/100mL)	44 (2 - 360)	2 (1 - 11)	1 (1 - 2)	1 (1 - 1)	2 (1 - 40)	1 (1 - 1)	1 (1 - 1)
Faecal Coliforms (cfu/100mL)	79 (3 - 510)	3 (1 - 130)	1 (1 - 12)	1 (1 - 3)	3 (1 - 82)	1 (1 - 2)	1 (1 - 1)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths: Surface (S), Mid-depth (M), Bottom (B).
2. Data presented are annual arithmetic means of the depth-averaged results except for *E. coli* and faecal coliforms which are annual geometric means.
3. Data in brackets indicate the ranges.

Table 2.4 (continued)

Summary water quality statistics of the Mirs Bay WCZ in 2004

Parameter		Ninepin Group MM19	Waglan Isalnd MM8	Mirs Bay (South) MM13	Mirs Bay (Central) MM14	Mirs Bay (Central) MM15	Mirs Bay (Central) MM16	Long Harbour MM6
Number of samples		12	12	12	12	12	12	12
Temperature (°C)		22.8 (15.7 - 27.6)	23.0 (15.6 - 27.6)	23.1 (15.2 - 27.5)	23.0 (15.2 - 27.5)	23.0 (15.6 - 27.5)	22.7 (15.7 - 27.6)	23.1 (15.4 - 29.5)
Salinity		33.6 (32.9 - 34.3)	33.6 (33.0 - 34.4)	33.7 (33.0 - 34.4)	33.7 (32.9 - 34.3)	33.6 (32.9 - 34.5)	33.6 (32.6 - 35.6)	33.1 (30.6 - 34.0)
Dissolved Oxygen (mg/L)		6.8 (5.6 - 8.6)	6.6 (5.4 - 7.5)	6.7 (5.8 - 7.6)	6.8 (5.5 - 8.1)	6.5 (5.6 - 7.3)	6.6 (5.5 - 7.7)	6.5 (5.2 - 7.7)
	Bottom	6.4 (5.2 - 7.7)	6.1 (4.4 - 7.3)	6.3 (5.2 - 7.4)	6.3 (5.0 - 7.5)	6.3 (5.2 - 7.5)	6.4 (5.3 - 7.5)	6.5 (5.1 - 8.0)
Dissolved Oxygen (% Saturation)		96 (84 - 124)	94 (81 - 101)	95 (88 - 114)	96 (83 - 120)	92 (84 - 105)	93 (82 - 114)	91 (71 - 113)
	Bottom	89 (78 - 102)	84 (62 - 96)	87 (73 - 95)	87 (73 - 105)	88 (78 - 106)	88 (79 - 102)	90 (69 - 116)
pH		8.1 (8.0 - 8.3)	8.1 (8.0 - 8.2)	8.1 (8.0 - 8.3)	8.2 (8.0 - 8.3)	8.1 (7.9 - 8.3)	8.1 (7.9 - 8.2)	8.1 (8.0 - 8.3)
Secchi Disc Depth (m)		3.7 (1.8 - 8.5)	3.8 (2.1 - 10.0)	4.8 (2.0 - 8.6)	4.4 (2.3 - 7.5)	4.9 (2.2 - 11.0)	5.6 (2.9 - 10.0)	4.0 (1.8 - 5.8)
Turbidity (NTU)		8.5 (4.7 - 12.0)	8.3 (4.4 - 10.8)	8.3 (4.0 - 11.3)	8.7 (4.8 - 12.8)	8.3 (5.1 - 11.1)	7.9 (4.9 - 9.6)	7.1 (4.8 - 8.2)
Suspended Solids (mg/L)		3.1 (1.1 - 6.4)	2.9 (1.0 - 4.7)	8.6 (1.0 - 71.3)	3.0 (1.1 - 6.2)	3.0 (0.8 - 5.8)	2.2 (1.1 - 3.5)	1.8 (0.6 - 3.5)
5-day Biochemical Oxygen Demand (mg/L)		0.8 (0.5 - 1.7)	0.6 (0.3 - 1.4)	0.5 (0.2 - 1.4)	0.7 (0.3 - 1.4)	0.6 (0.3 - 1.1)	0.7 (0.5 - 1.4)	1.0 (0.1 - 3.1)
Ammonia Nitrogen (mg/L)		0.02 (0.02 - 0.04)	0.02 (0.01 - 0.03)	0.02 (0.01 - 0.03)	0.02 (0.01 - 0.04)	0.02 (0.01 - 0.05)	0.03 (0.01 - 0.07)	0.03 (0.01 - 0.05)
Unionised Ammonia (mg/L)		0.001 (<0.001 - 0.003)	0.001 (<0.001 - 0.003)	0.001 (<0.001 - 0.002)	0.001 (<0.001 - 0.003)	0.001 (<0.001 - 0.004)	0.001 (<0.001 - 0.004)	0.002 (<0.001 - 0.004)
Nitrite Nitrogen (mg/L)		0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.03)	0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.02)	<0.01 (<0.01 - 0.02)
Nitrate Nitrogen (mg/L)		0.02 (<0.01 - 0.05)	0.02 (<0.01 - 0.05)	0.02 (<0.01 - 0.05)	0.02 (<0.01 - 0.05)	0.02 (<0.01 - 0.05)	0.01 (<0.01 - 0.06)	0.01 (<0.01 - 0.02)
Total Inorganic Nitrogen (mg/L)		0.05 (0.03 - 0.10)	0.05 (0.02 - 0.08)	0.04 (0.02 - 0.09)	0.05 (0.02 - 0.09)	0.05 (0.02 - 0.09)	0.05 (0.02 - 0.08)	0.03 (0.02 - 0.06)
Total Kjeldahl Nitrogen (mg/L)		0.09 (0.06 - 0.12)	0.09 (0.05 - 0.14)	0.09 (0.06 - 0.17)	0.09 (0.06 - 0.14)	0.09 (0.05 - 0.12)	0.09 (0.05 - 0.14)	0.13 (0.08 - 0.22)
Total Nitrogen (mg/L)		0.12 (0.07 - 0.17)	0.11 (0.06 - 0.19)	0.11 (0.07 - 0.18)	0.11 (0.06 - 0.15)	0.11 (0.07 - 0.16)	0.12 (0.07 - 0.17)	0.14 (0.09 - 0.23)
Orthophosphate Phosphorus (mg/L)		0.01 (0.01 - 0.01)	0.01 (0.01 - 0.01)	0.01 (0.01 - 0.01)	0.01 (0.01 - 0.01)	0.01 (0.01 - 0.01)	0.01 (0.01 - 0.01)	0.01 (<0.01 - 0.02)
Total Phosphorus (mg/L)		0.02 (0.02 - 0.02)	0.02 (0.02 - 0.02)	0.02 (0.02 - 0.06)	0.02 (0.02 - 0.02)	0.02 (0.02 - 0.02)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.05)
Silica (as SiO_2) (mg/L)		0.5 (0.2 - 0.8)	0.4 (0.1 - 0.7)	0.4 (0.1 - 0.6)	0.4 (0.2 - 0.7)	0.4 (0.2 - 0.8)	0.5 (0.2 - 0.9)	0.5 (0.1 - 1.6)
Chlorophyll-*a* (µg/L)		1.8 (0.6 - 4.3)	1.9 (0.5 - 6.9)	1.6 (0.6 - 5.1)	1.6 (0.5 - 3.6)	1.2 (0.5 - 1.9)	1.5 (0.6 - 3.7)	2.9 (1.1 - 9.0)
E. coli (cfu/100mL)		1 (1 - 1)	1 (1 - 3)	1 (1 - 1)	1 (1 - 1)	1 (1 - 1)	1 (1 - 1)	1 (1 - 2)
Faecal Coliforms (cfu/100mL)		1 (1 - 2)	1 (1 - 5)	1 (1 - 1)	1 (1 - 2)	1 (1 - 1)	1 (1 - 1)	1 (1 - 3)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths: Surface (S), Mid-depth (M), Bottom (B).
2. Data presented are annual arithmetic means of the depth-averaged results except for *E. coli* and faecal coliforms which are annual geometric means.
3. Data in brackets indicate the ranges.

Table 2.5

Summary water quality statistics of the Port Shelter WCZ in 2004

Parameter		Inner Port Shelter PM1	Inner Port Shelter PM2	Inner Port Shelter PM3	Inner Port Shelter PM4	Hebe Haven PM6
Number of samples		12	12	12	12	12
Temperature (°C)		24.7 (15.2 - 30.7)	24.9 (15.2 - 30.6)	24.2 (15.2 - 29.4)	24.7 (15.3 - 31.0)	24.2 (15.4 - 29.0)
Salinity		32.9 (29.6 - 34.3)	32.8 (29.6 - 34.1)	33.2 (30.7 - 35.8)	32.9 (29.1 - 34.8)	33.0 (30.3 - 34.6)
Dissolved Oxygen (mg/L)		6.3 (5.6 - 8.0)	6.3 (5.1 - 7.5)	6.5 (5.7 - 8.2)	6.2 (5.6 - 7.6)	6.2 (5.1 - 7.9)
	Bottom	6.5 (5.5 - 8.2)	6.4 (5.2 - 7.8)	6.6 (5.5 - 8.7)	6.4 (6.0 - 8.0)	6.3 (4.9 - 8.5)
Dissolved Oxygen (% Saturation)		92 (80 - 108)	91 (80 - 109)	94 (80 - 107)	90 (75 - 99)	89 (71 - 103)
	Bottom	93 (80 - 110)	93 (81 - 112)	94 (82 - 114)	92 (77 - 105)	89 (68 - 110)
pH		8.2 (8.1 - 8.3)	8.2 (8.0 - 8.5)	8.2 (8.1 - 8.3)	8.2 (8.0 - 8.4)	8.1 (8.0 - 8.3)
Secchi Disc Depth (m)		3.1 (1.7 - 4.2)	2.9 (1.8 - 3.9)	3.5 (2.2 - 5.1)	3.1 (1.8 - 4.3)	3.7 (2.3 - 5.0)
Turbidity (NTU)		7.6 (5.5 - 9.9)	7.4 (5.8 - 8.1)	7.5 (6.3 - 9.9)	7.5 (4.9 - 8.9)	7.2 (4.9 - 9.2)
Suspended Solids (mg/L)		2.1 (1.2 - 3.4)	2.4 (1.1 - 7.2)	2.0 (0.7 - 5.5)	2.2 (1.6 - 3.2)	1.9 (0.9 - 3.6)
5-day Biochemical Oxygen Demand (mg/L)		1.0 (0.5 - 2.9)	1.0 (0.4 - 2.9)	0.9 (0.5 - 2.2)	0.9 (0.5 - 1.8)	0.9 (0.3 - 1.7)
Ammonia Nitrogen (mg/L)		0.02 (0.01 - 0.04)	0.03 (0.02 - 0.06)	0.03 (0.02 - 0.07)	0.02 (0.01 - 0.04)	0.03 (0.01 - 0.06)
Unionised Ammonia (mg/L)		0.002 (0.001 - 0.004)	0.002 (0.001 - 0.009)	0.002 (0.001 - 0.008)	0.002 (0.001 - 0.004)	0.002 (0.001 - 0.005)
Nitrite Nitrogen (mg/L)		<0.01 (<0.01 - <0.01)	<0.01 (<0.01 - <0.01)	<0.01 (<0.01 - <0.01)	<0.01 (<0.01 - <0.01)	<0.01 (<0.01 - 0.01)
Nitrate Nitrogen (mg/L)		<0.01 (<0.01 - <0.01)	<0.01 (<0.01 - 0.01)	<0.01 (<0.01 - 0.02)	<0.01 (<0.01 - 0.01)	<0.01 (<0.01 - 0.01)
Total Inorganic Nitrogen (mg/L)		0.03 (0.02 - 0.04)	0.04 (0.02 - 0.06)	0.04 (0.02 - 0.08)	0.03 (0.01 - 0.04)	0.04 (0.02 - 0.08)
Total Kjeldahl Nitrogen (mg/L)		0.11 (0.08 - 0.18)	0.12 (0.07 - 0.20)	0.12 (0.07 - 0.21)	0.11 (0.07 - 0.17)	0.12 (0.07 - 0.18)
Total Nitrogen (mg/L)		0.12 (0.08 - 0.18)	0.12 (0.08 - 0.20)	0.12 (0.07 - 0.22)	0.12 (0.08 - 0.18)	0.13 (0.08 - 0.20)
Orthophosphate Phosphorus (mg/L)		0.01 (<0.01 - 0.01)	0.01 (<0.01 - 0.01)	0.01 (0.01 - 0.01)	0.01 (<0.01 - 0.01)	0.01 (0.01 - 0.01)
Total Phosphorus (mg/L)		0.02 (0.02 - 0.03)	0.02 (0.02 - 0.04)	0.02 (0.02 - 0.04)	0.02 (0.02 - 0.02)	0.02 (0.02 - 0.03)
Silica (as SiO_2) (mg/L)		0.4 (0.1 - 0.8)	0.4 (0.1 - 0.8)	0.5 (0.2 - 0.8)	0.4 (0.1 - 0.9)	0.4 (0.1 - 0.7)
Chlorophyll-*a* (µg/L)		1.9 (1.0 - 3.5)	2.4 (0.7 - 5.3)	2.4 (0.6 - 6.0)	2.0 (0.8 - 2.8)	3.0 (1.1 - 6.4)
E. coli (cfu/100mL)		2 (1 - 10)	8 (1 - 1000)	2 (1 - 13)	1 (1 - 2)	2 (1 - 20)
Faecal Coliforms (cfu/100mL)		3 (1 - 15)	30 (1 - 3600)	3 (1 - 24)	2 (1 - 6)	3 (1 - 45)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths: Surface (S), Mid-depth (M), Bottom (B).
2. Data presented are annual arithmetic means of the depth-averaged results except for *E. coli* and faecal coliforms which are annual geometric means.
3. Data in brackets indicate the ranges.

Table 2.5 (continued)

Summary water quality statistics of the Port Shelter WCZ in 2004

Parameter	Outer Port Shelter PM7	 PM8	Rocky Harbour PM9	Bluff Island PM11
Number of samples	12	12	12	12
Temperature (°C)	23.8 (15.3 - 28.9)	23.4 (15.6 - 27.5)	23.6 (15.4 - 28.4)	23.3 (15.6 - 27.5)
Salinity	33.5 (32.3 - 34.5)	33.6 (32.7 - 35.1)	33.5 (31.7 - 34.7)	33.6 (32.7 - 34.5)
Dissolved Oxygen (mg/L)	6.7 (5.6 - 8.4)	6.7 (5.6 - 8.1)	6.5 (5.7 - 8.2)	6.6 (5.8 - 7.8)
Bottom	6.8 (5.6 - 8.6)	6.8 (5.2 - 8.6)	6.7 (5.6 - 8.8)	6.7 (5.4 - 8.2)
Dissolved Oxygen (% Saturation)	96 (84 - 117)	94 (85 - 107)	92 (85 - 106)	94 (87 - 105)
Bottom	95 (84 - 115)	94 (77 - 115)	94 (85 - 114)	93 (80 - 107)
pH	8.1 (8.1 - 8.3)	8.1 (8.1 - 8.2)	8.2 (8.1 - 8.3)	8.1 (8.1 - 8.3)
Secchi Disc Depth (m)	4.9 (2.5 - 8.7)	5.6 (2.5 - 11.0)	4.4 (1.6 - 8.9)	5.2 (2.2 - 11.0)
Turbidity (NTU)	7.9 (4.7 - 14.0)	7.6 (5.0 - 10.9)	7.5 (5.2 - 10.9)	7.8 (5.9 - 11.4)
Suspended Solids (mg/L)	1.7 (0.6 - 5.5)	1.9 (0.9 - 5.6)	1.9 (0.9 - 4.2)	2.2 (1.1 - 5.0)
5-day Biochemical Oxygen Demand (mg/L)	0.8 (0.1 - 1.9)	0.7 (0.1 - 1.6)	0.7 (0.2 - 1.4)	0.9 (0.1 - 4.0)
Ammonia Nitrogen (mg/L)	0.02 (0.01 - 0.04)	0.02 (0.01 - 0.04)	0.02 (0.01 - 0.04)	0.02 (0.01 - 0.04)
Unionised Ammonia (mg/L)	0.001 (<0.001 - 0.004)	0.001 (0.001 - 0.003)	0.001 (<0.001 - 0.004)	0.001 (<0.001 - 0.003)
Nitrite Nitrogen (mg/L)	<0.01 (<0.01 - 0.01)	<0.01 (<0.01 - 0.01)	<0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.02)
Nitrate Nitrogen (mg/L)	0.01 (<0.01 - 0.06)	0.01 (<0.01 - 0.06)	0.01 (<0.01 - 0.05)	0.02 (<0.01 - 0.06)
Total Inorganic Nitrogen (mg/L)	0.03 (0.02 - 0.10)	0.04 (0.02 - 0.10)	0.04 (0.02 - 0.09)	0.04 (0.02 - 0.10)
Total Kjeldahl Nitrogen (mg/L)	0.10 (0.05 - 0.15)	0.09 (0.06 - 0.13)	0.10 (0.06 - 0.14)	0.09 (0.06 - 0.13)
Total Nitrogen (mg/L)	0.11 (0.06 - 0.19)	0.11 (0.07 - 0.19)	0.11 (0.07 - 0.19)	0.11 (0.06 - 0.17)
Orthophosphate Phosphorus (mg/L)	0.01 (0.01 - 0.01)	0.01 (0.01 - 0.01)	0.01 (0.01 - 0.01)	0.01 (0.01 - 0.01)
Total Phosphorus (mg/L)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.02)	0.02 (0.02 - 0.02)	0.02 (0.02 - 0.02)
Silica (as SiO_2) (mg/L)	0.5 (0.2 - 1.1)	0.5 (0.1 - 1.2)	0.5 (0.2 - 1.2)	0.6 (0.2 - 1.1)
Chlorophyll-a (µg/L)	1.9 (0.8 - 3.7)	1.6 (0.6 - 3.1)	1.6 (0.5 - 2.5)	1.7 (0.5 - 3.0)
E. coli (cfu/100mL)	1 (1 - 2)	1 (1 - 1)	1 (1 - 1)	1 (1 - 1)
Faecal Coliforms (cfu/100mL)	1 (1 - 2)	1 (1 - 1)	1 (1 - 2)	1 (1 - 1)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths: Surface (S), Mid-depth (M), Bottom (B).
2. Data presented are annual arithmetic means of the depth-averaged results except for *E. coli* and faecal coliforms which are annual geometric means.
3. Data in brackets indicate the ranges.

Table 2.6

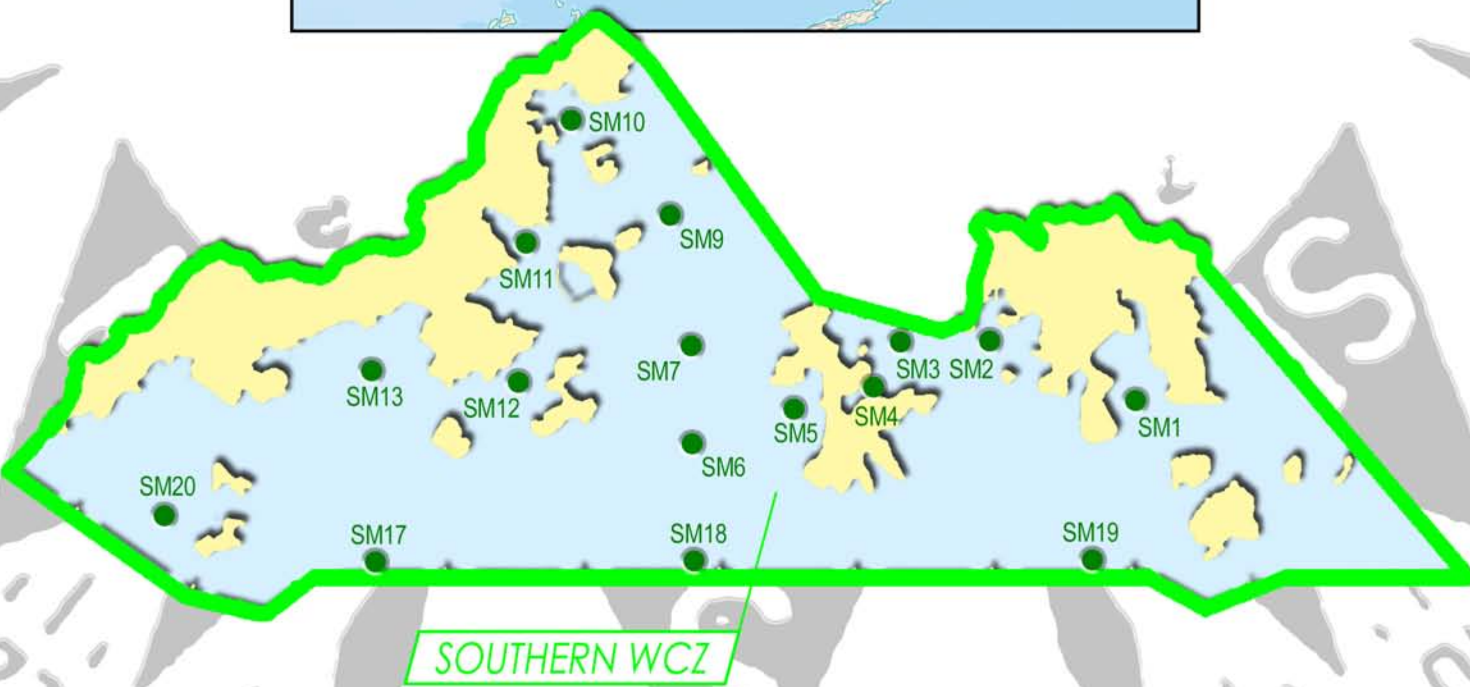
Summary water quality statistics of the Tolo Harbour & Channel WCZ in 2004

Parameter	Harbour Subzone			Buffer Subzone		Channel Subzone	
	TM2	TM3	TM4	TM5	TM6	TM7	TM8
Number of samples	12	12	12	12	12	12	12
Temperature (°C)	23.8 (13.5 - 29.1)	23.9 (14.3 - 29.0)	23.6 (13.9 - 28.8)	24.2 (14.2 - 29.1)	23.3 (14.1 - 28.1)	23.3 (14.2 - 28.2)	23.0 (14.1 - 27.6)
Salinity	31.5 (28.5 - 33.8)	32.1 (29.0 - 33.7)	32.1 (29.6 - 34.1)	32.1 (29.7 - 33.6)	32.6 (29.1 - 34.7)	32.8 (30.9 - 35.2)	33.2 (32.1 - 35.4)
Dissolved Oxygen (mg/L)	6.1 (3.6 - 7.9)	6.8 (5.3 - 7.8)	6.6 (4.9 - 7.8)	6.5 (4.7 - 8.4)	6.8 (5.5 - 8.5)	6.9 (5.5 - 10.4)	6.5 (5.5 - 7.8)
Bottom	5.9 (3.8 - 7.8)	6.9 (4.3 - 8.8)	6.7 (4.5 - 8.5)	6.7 (5.0 - 8.8)	6.6 (4.8 - 9.4)	6.9 (5.6 - 11.0)	6.0 (3.6 - 7.8)
Dissolved Oxygen (% Saturation)	84 (55 - 107)	96 (81 - 112)	93 (76 - 109)	92 (73 - 129)	94 (84 - 115)	96 (84 - 159)	90 (84 - 99)
Bottom	82 (59 - 105)	96 (66 - 123)	93 (69 - 117)	94 (79 - 136)	91 (73 - 126)	95 (83 - 167)	82 (51 - 95)
pH	8.1 (7.6 - 8.4)	8.2 (8.0 - 8.4)	8.2 (8.0 - 8.5)	8.2 (7.9 - 8.5)	8.1 (7.9 - 8.3)	8.2 (7.9 - 8.3)	8.1 (7.9 - 8.3)
Secchi Disc Depth (m)	2.1 (1.3 - 3.1)	2.4 (1.4 - 3.0)	2.5 (1.5 - 3.5)	2.6 (1.5 - 3.5)	3.0 (2.2 - 3.9)	3.3 (1.7 - 5.0)	4.2 (2.8 - 6.0)
Turbidity (NTU)	7.7 (2.7 - 9.1)	7.1 (2.2 - 9.2)	6.9 (2.2 - 9.2)	7.4 (1.9 - 11.4)	6.9 (2.5 - 8.8)	6.7 (1.7 - 8.7)	6.8 (1.9 - 8.3)
Suspended Solids (mg/L)	3.1 (1.4 - 6.1)	2.4 (0.8 - 4.1)	2.2 (1.2 - 4.6)	3.3 (1.3 - 8.0)	1.8 (0.9 - 2.6)	1.9 (0.7 - 4.3)	1.9 (0.7 - 3.6)
5-day Biochemical Oxygen Demand (mg/L)	2.4 (1.5 - 3.9)	2.1 (1.3 - 3.1)	1.9 (1.3 - 2.8)	1.8 (1.1 - 2.4)	1.4 (0.9 - 2.0)	1.4 (0.9 - 2.9)	1.1 (0.5 - 2.5)
Ammonia Nitrogen (mg/L)	0.05 (0.01 - 0.09)	0.04 (0.01 - 0.07)	0.04 (0.01 - 0.07)	0.04 (0.01 - 0.09)	0.04 (0.01 - 0.07)	0.03 (0.01 - 0.06)	0.04 (0.01 - 0.14)
Unionised Ammonia (mg/L)	0.003 (<0.001 - 0.009)	0.003 (<0.001 - 0.008)	0.003 (<0.001 - 0.006)	0.003 (<0.001 - 0.010)	0.002 (<0.001 - 0.007)	0.002 (<0.001 - 0.007)	0.003 (<0.001 - 0.019)
Nitrite Nitrogen (mg/L)	<0.01 (<0.01 - 0.03)	<0.01 (<0.01 - 0.02)	<0.01 (<0.01 - 0.03)	<0.01 (<0.01 - <0.01)	<0.01 (<0.01 - 0.02)	<0.01 (<0.01 - 0.03)	<0.01 (<0.01 - 0.02)
Nitrate Nitrogen (mg/L)	0.04 (<0.01 - 0.22)	<0.01 (<0.01 - 0.01)	0.01 (<0.01 - 0.03)	<0.01 (<0.01 - 0.02)	<0.01 (<0.01 - 0.01)	<0.01 (<0.01 - 0.01)	0.01 (<0.01 - 0.02)
Total Inorganic Nitrogen (mg/L)	0.09 (0.04 - 0.24)	0.05 (0.02 - 0.08)	0.05 (0.02 - 0.07)	0.05 (0.01 - 0.10)	0.05 (0.02 - 0.08)	0.04 (0.01 - 0.07)	0.05 (0.02 - 0.15)
Total Kjeldahl Nitrogen (mg/L)	0.28 (0.23 - 0.35)	0.23 (0.16 - 0.29)	0.21 (0.17 - 0.26)	0.21 (0.19 - 0.24)	0.17 (0.14 - 0.21)	0.17 (0.12 - 0.27)	0.14 (0.09 - 0.26)
Total Nitrogen (mg/L)	0.33 (0.23 - 0.52)	0.23 (0.16 - 0.29)	0.23 (0.18 - 0.29)	0.22 (0.19 - 0.25)	0.18 (0.15 - 0.21)	0.17 (0.14 - 0.27)	0.15 (0.10 - 0.26)
Orthophosphate Phosphorus (mg/L)	0.01 (<0.01 - 0.01)	0.01 (<0.01 - 0.01)	0.01 (<0.01 - 0.01)	0.01 (<0.01 - 0.02)	0.01 (0.01 - 0.01)	0.01 (0.01 - 0.02)	0.01 (0.01 - 0.02)
Total Phosphorus (mg/L)	0.03 (0.02 - 0.04)	0.03 (0.02 - 0.11)	0.02 (0.02 - 0.03)	0.03 (0.02 - 0.03)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.05)	0.02 (0.02 - 0.05)
Silica (as SiO_2) (mg/L)	0.9 (0.1 - 1.7)	0.7 (0.1 - 1.5)	0.8 (0.2 - 1.4)	0.7 (0.1 - 1.6)	0.8 (0.5 - 1.7)	0.8 (0.2 - 1.7)	0.7 (0.2 - 2.0)
Chlorophyll-*a* (µg/L)	12.5 (4.3 - 43.0)	8.5 (4.2 - 16.9)	7.3 (3.4 - 18.7)	5.6 (2.4 - 13.0)	4.6 (2.2 - 10.9)	4.1 (1.4 - 7.8)	2.5 (1.1 - 5.9)
E. coli (cfu/100mL)	29 (3 - 120)	5 (1 - 59)	3 (1 - 16)	3 (1 - 12)	2 (1 - 3)	1 (1 - 1)	1 (1 - 1)
Faecal Coliforms (cfu/100mL)	180 (30 - 2500)	28 (3 - 540)	14 (3 - 96)	9 (1 - 51)	4 (1 - 40)	2 (1 - 24)	1 (1 - 2)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths: Surface (S), Mid-depth (M), Bottom (B).
2. Data presented are annual arithmetic means of the depth-averaged results except for *E. coli* and faecal coliforms which are annual geometric means.
3. Data in brackets indicate the ranges.

SOUTHERN WATERS

CHAPTER 3



Chapter 3 – Southern Waters

Water Quality in 2004

3.1 The southern waters of Hong Kong include one Water Control Zone - the Southern Water Control Zone (WCZ). They cover an area of 400 km^2 located in south of Hong Kong Island and east of Lantau Island. The southern waters are affected by the Pearl River flow, coastal sewage discharges and marine works. The riverine influence is generally stronger in the western and northern parts of the southern waters and decreases towards the east end.

Southern Water Control Zone

3.2 A summary of the 2004 water quality data from the 15 monitoring stations in the Southern WCZ is shown in Table 3.2. In 2003, the levels of inorganic nitrogen in the southern waters were below normal; whereas in 2004, a general rise was detected. The mean ammonia nitrogen and total inorganic nitrogen (TIN) increased from 0.040 to 0.062 mg/L and from 0.140 to 0.172 mg/L respectively. Highest increases (by 0.05 - 0.06mg/L) were noted at two stations (SM7, SM9)directly impacted by discharges from the Stonecutters Island Sewage Treatment Works. The mean annual orthophosphate phosphorus also increased by 15% (0.011 to 0.013 mg/L). Despite the increases in nitrogen and phosphorus, the level of chlorophyll-*a* (indicates algal biomass) in the southern waters remained largely stable in 2004.

3.3 The mean dissolved oxygen (DO) level in the southern waters in 2004 increased by 10% (0.6 mg/L) from that in the previous year. This was more evident at the western stations SM12-13 and SM17-18 where the increases were statistically significant.

3.4 The level of sewage bacteria in the southern waters was generally low, similar to that in 2003. The highest *E.coli* count (310 cfu/100mL) was found at the northern station SM9 closer to the Stonecutters Island Sewage Treatment Works (SCISTW) outfall and was likely to be impacted by the discharge.

Compliance with Water Quality Objectives

3.5 In 2004, the Southern WCZ attained an overall 79% compliance with the Water Quality Objectives (WQOs), slightly lower than that in the previous year (83%). Full compliance (100%) was achieved with the WQOs for DO, unionised ammonia and *E. coli* (Figure 3.1). However, the compliance for TIN fell from 44% in 2003 to 31% due to an increase of ammonia nitrogen. The overall compliance rate, however, was still higher than that in 2002 and the previous ten years (1992-2001) which were below 20%. The stations which complied with the TIN objective were mostly located in the eastern part of the WCZ where influence from the Pearl River was lower. Generally Pearl River flow has a profound influence in the TIN levels in the western part of Hong Kong coastal waters.

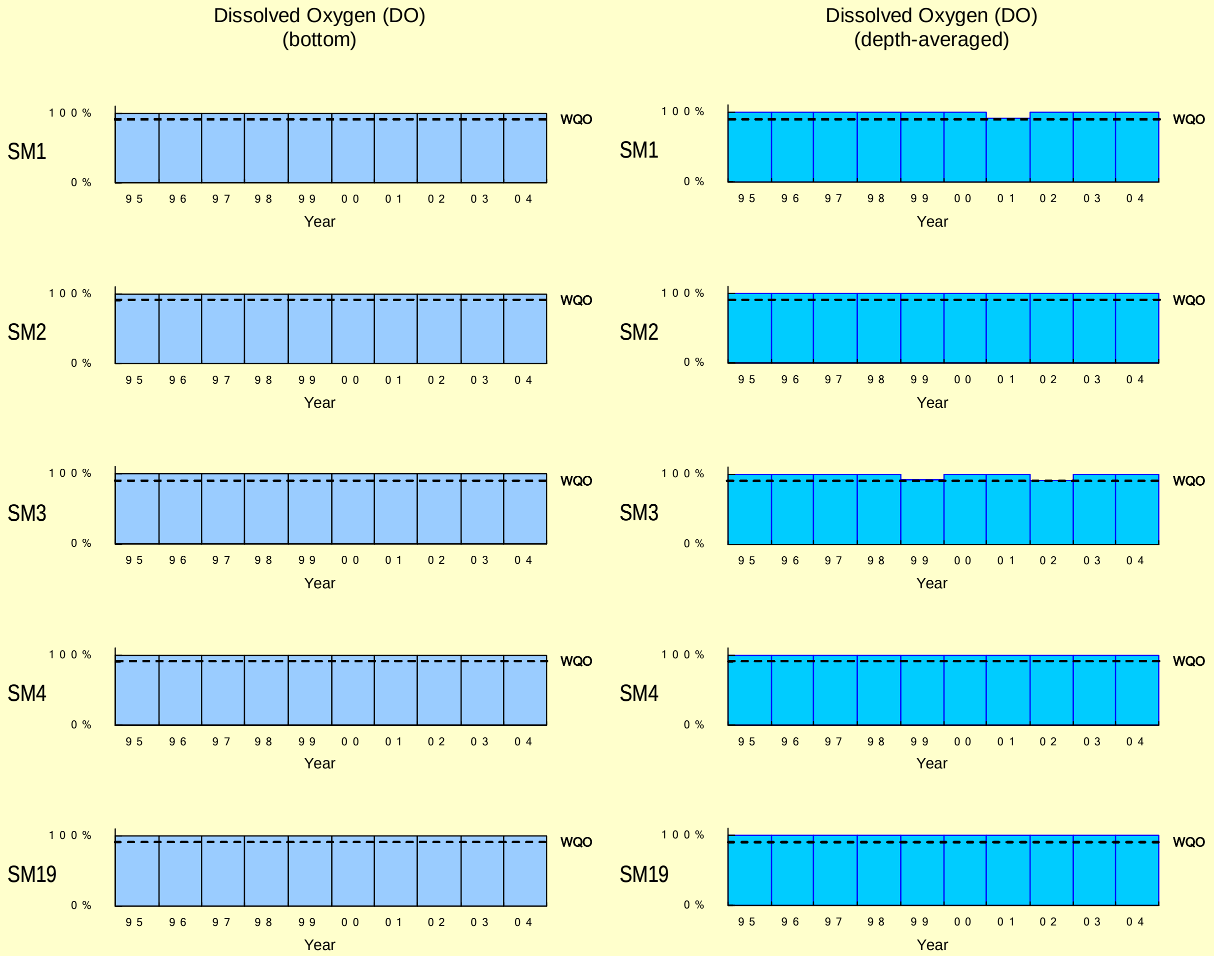
3.6 As in previous years, the secondary contact recreation subzones (stations SM1, SM2, SM10 and SM11) achieved full compliance (100%) with the *E. coli* objective in 2004, indicating their suitability for wind surfing, boating and other water sports activities.

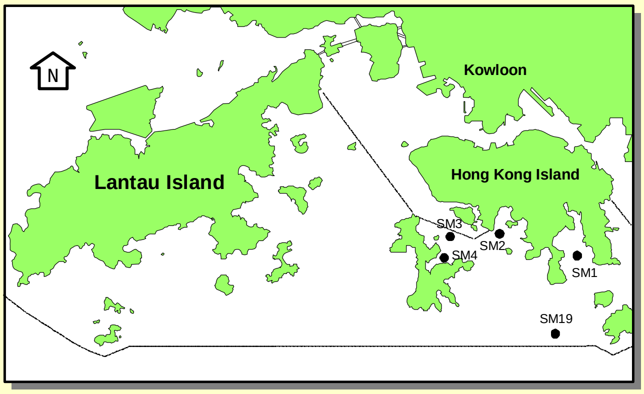
Long-term Water Quality Trends

3.7 Since the mid-1980s, long-term decreasing trends in total Kjeldahl nitrogen, total nitrogen and total phosphorus were detected in two areas: a) Southern coast of Hong Kong Island (SM1-3) and b) Southern edge of the territorial waters (SM17-19) (Table 3.1, Figure 3.2). On the other hand, significant increases in nitrate nitrogen (NO_3-N), nitrite nitrogen (NO_2-N) and TIN were found along the eastern coast of Lantau Island (SM10-13) (Figure 3.2)

3.8 The level of *E. coli* in the southern waters has remained low and stable with a few exceptions such as the stations SM4 and SM9 which showed long-term increasing trends (Figure 3.2). While the increase at SM9 may be related to the SCISTW outfall discharges, that at SM4 may indicate bacterial pollution from Sok Kwu Wan in Lamma Island.

Figure 3.1 Level of compliance with key Water Quality Objectives in the Southern WCZ



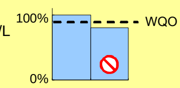


Dissolved Oxygen (DO)

1. Bottom

WQO : 90% sample with bottom DO ≥ 2 mg/L

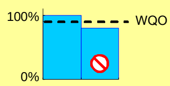
% sample with bottom DO ≥ 2 mg/L



2. Depth-averaged

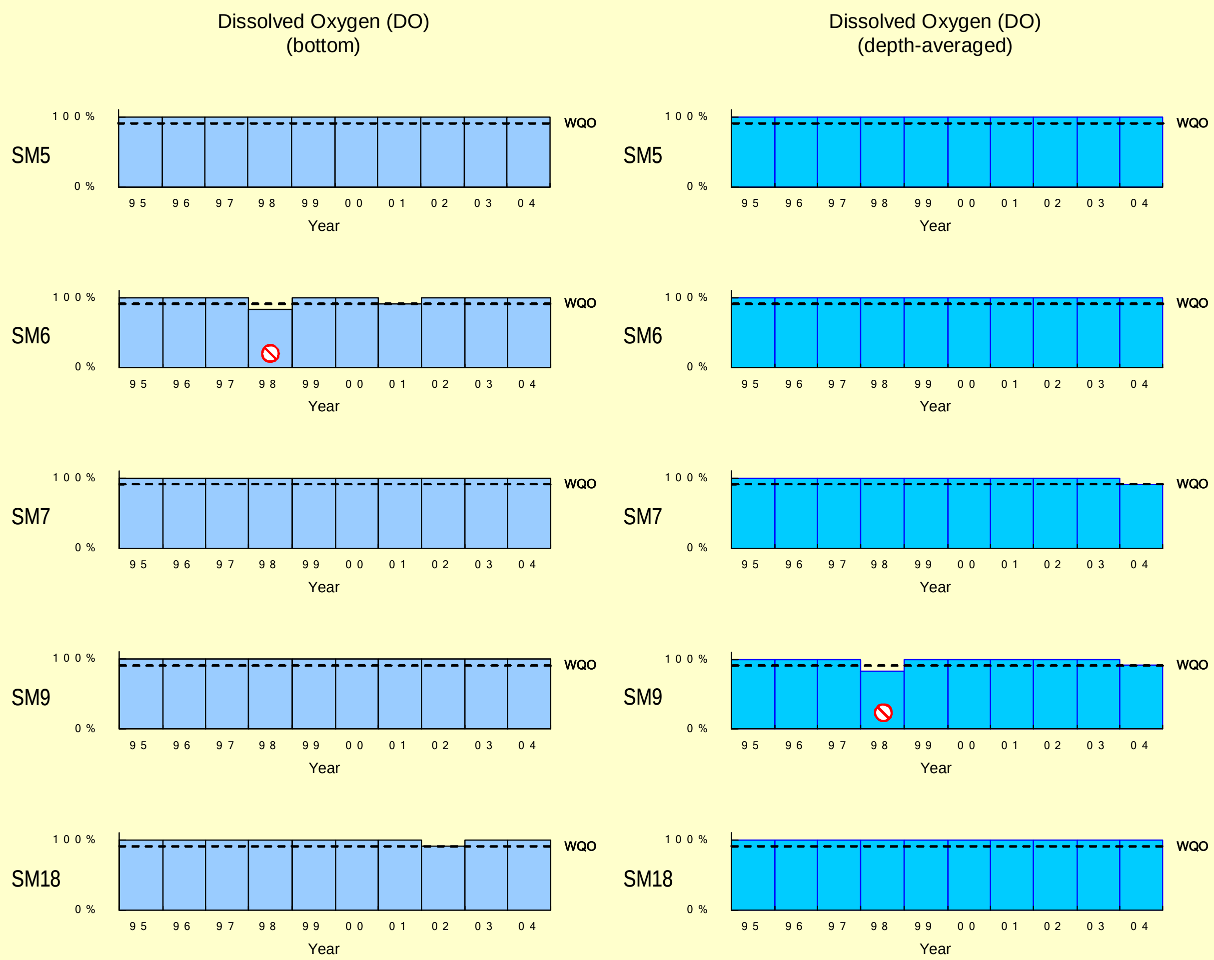
WQO : 90% sample with depth-averaged DO ≥ 4 mg/L

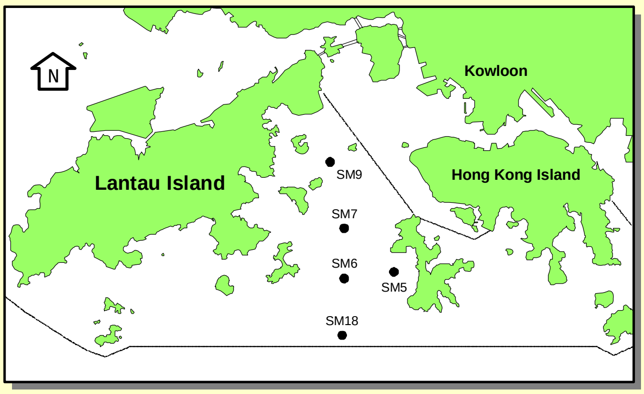
% sample with depth-averaged DO ≥ 4 mg/L



Non-compliance

Figure 3.1 (continued) Level of compliance with key Water Quality Objectives in the Southern WCZ





Dissolved Oxygen (DO)

1. Bottom

WQO : 90% sample with bottom DO ≥ 2 mg/L

% sample with bottom DO ≥ 2 mg/L

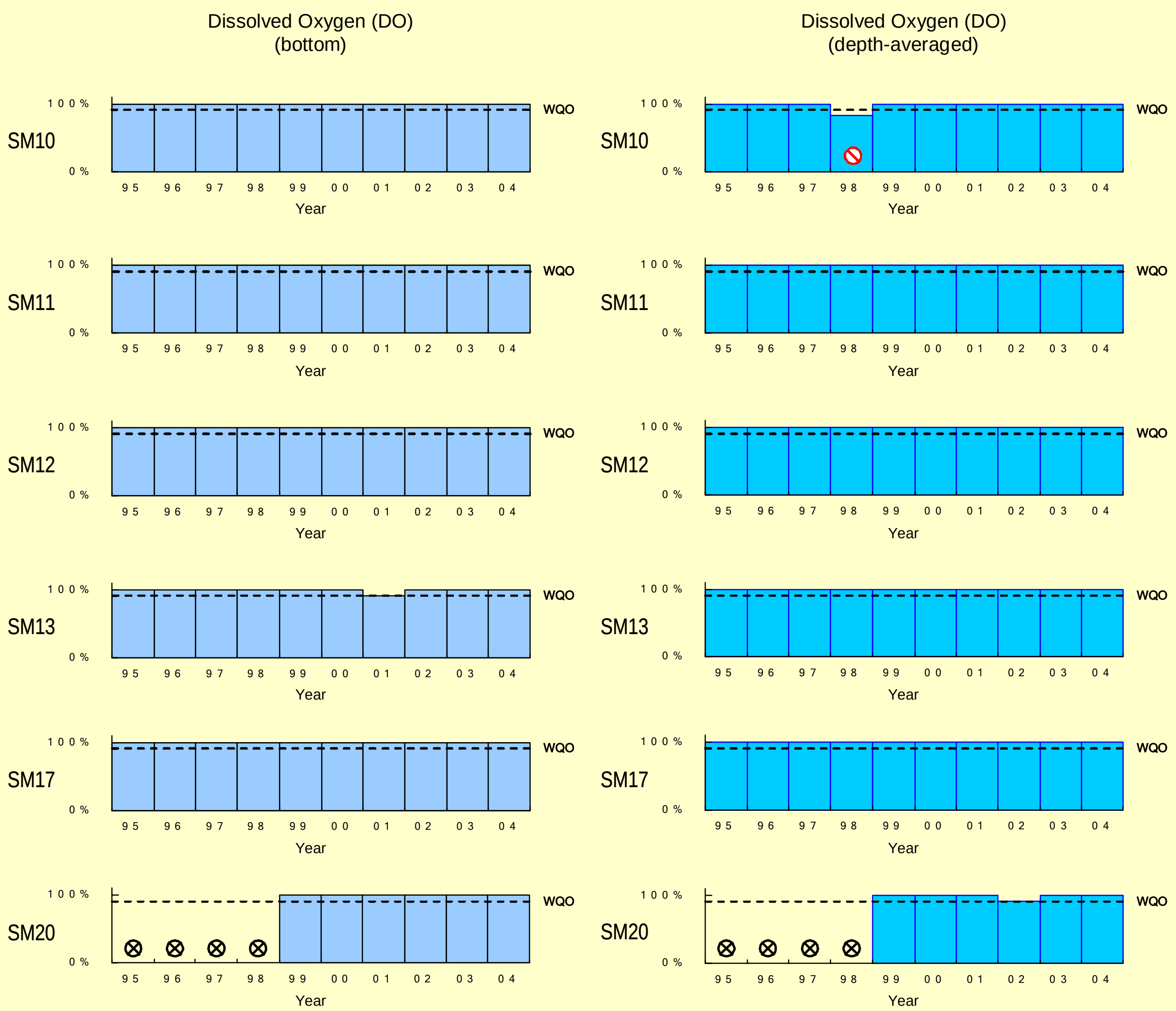
2. Depth-averaged

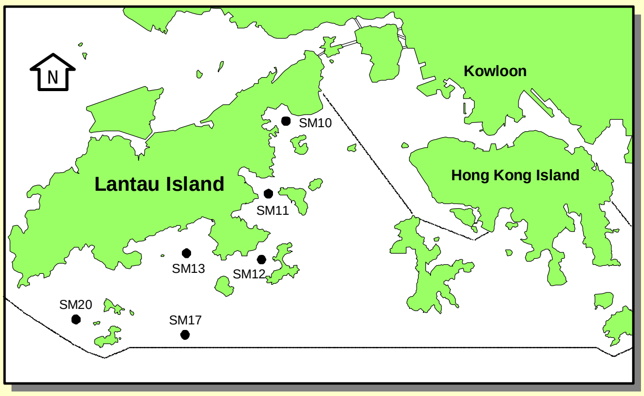
WQO : 90% sample with depth-averaged DO ≥ 4 mg/L

% sample with depth-averaged DO ≥ 4 mg/L

Non-compliance

Figure 3.1 (continued) Level of compliance with key Water Quality Objectives in the Southern WCZ





Dissolved Oxygen (DO)

1. Bottom

WQO : 90% sample with bottom DO ≥ 2 mg/L

% sample with bottom DO ≥ 2 mg/L

2. Depth-averaged

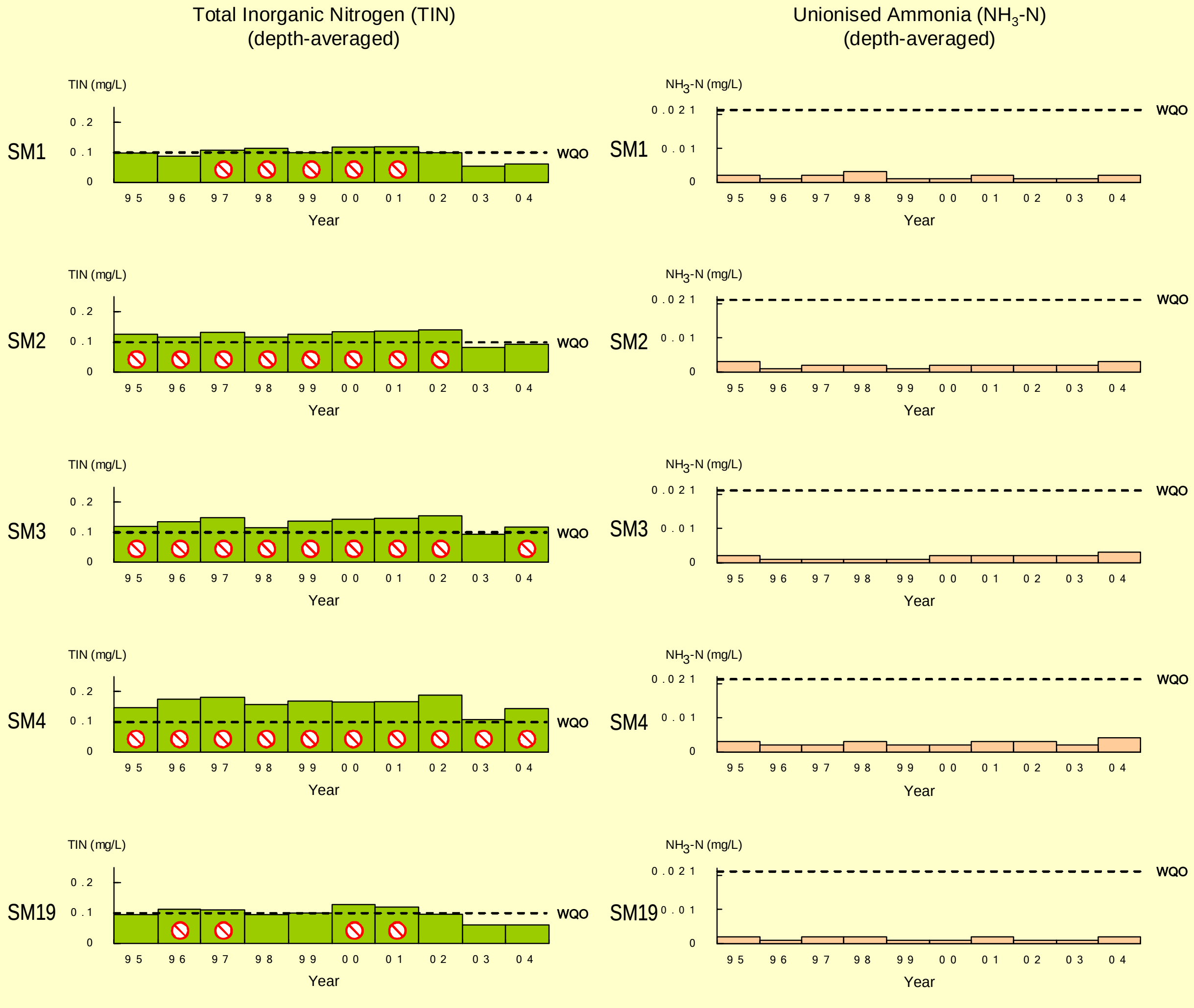
WQO : 90% sample with depth-averaged DO ≥ 4 mg/L

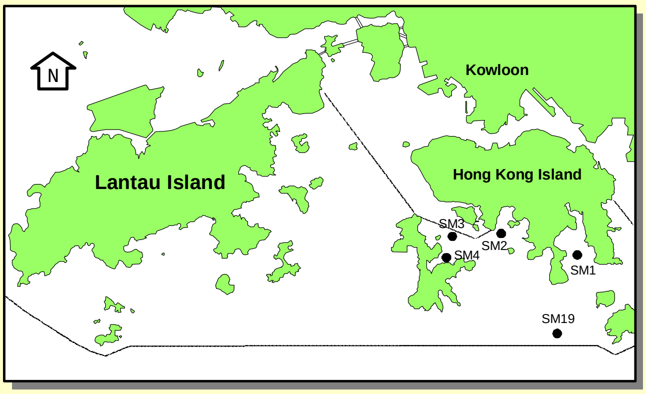
% sample with depth-averaged DO ≥ 4 mg/L

Non-compliance

No data ; monitoring of SM20 started in 1999

Figure 3.1 (continued) Level of compliance with key Water Quality Objectives in the Southern WCZ

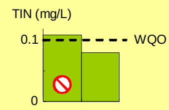




Total Inorganic Nitrogen (TIN)

WQO : annual mean for depth-averaged TIN $\leq$ 0.1 mg/L

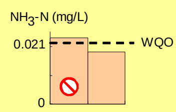
annual mean for depth-averaged TIN



Unionised Ammonia (NH_3-N)

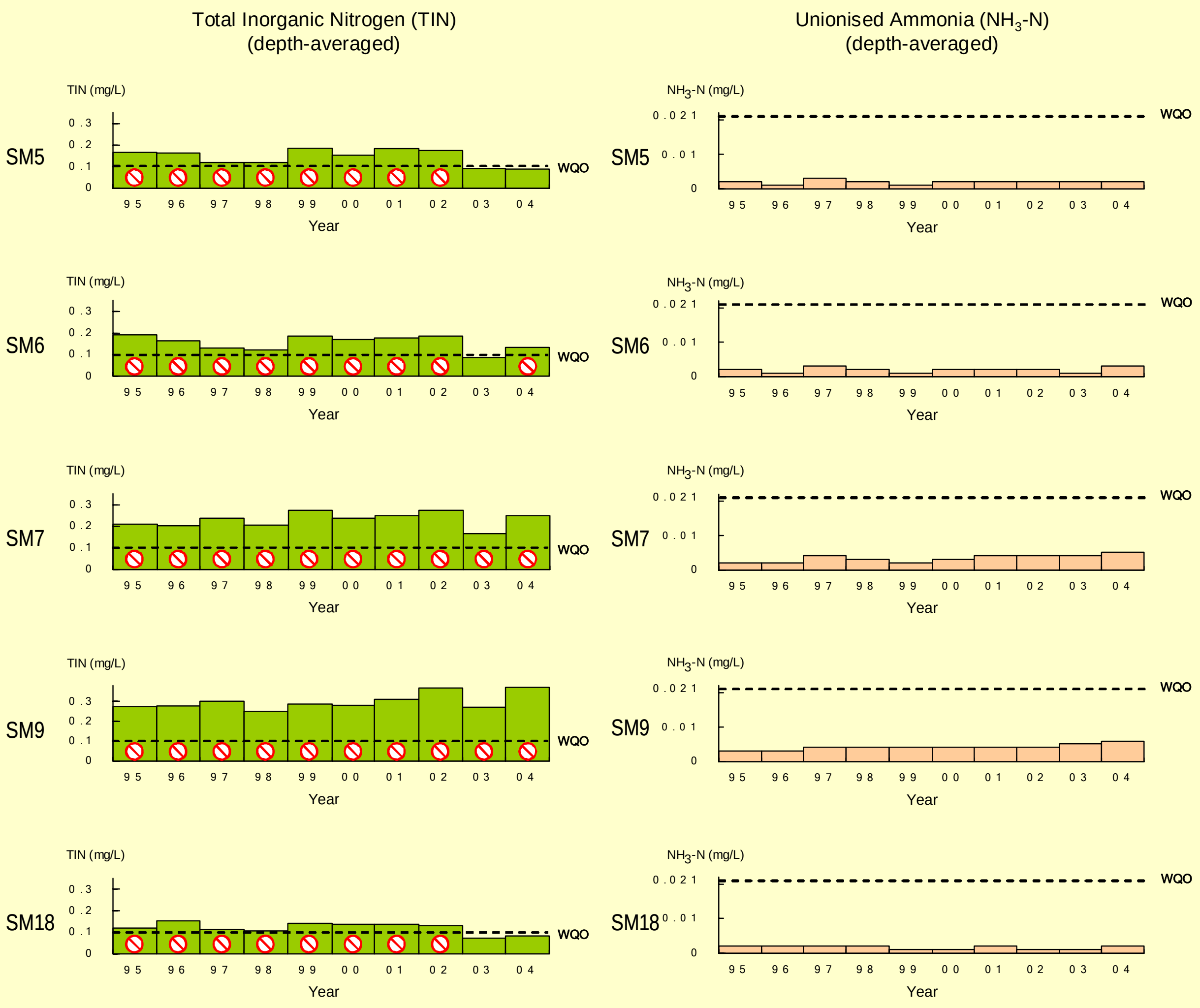
WQO : annual mean for depth-averaged NH_3-N $\leq$ 0.021 mg/L

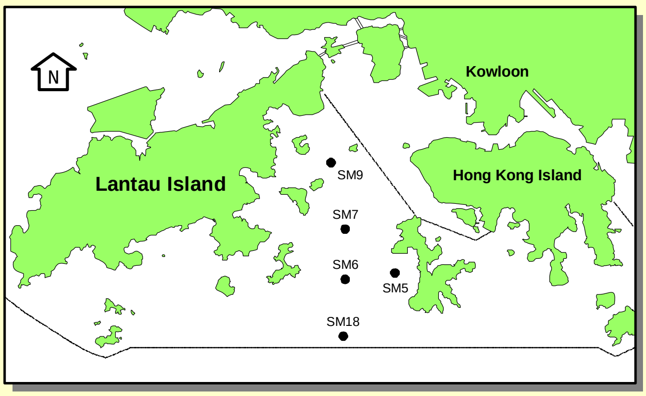
annual mean for depth-averaged NH_3-N



Non-compliance

Figure 3.1 (continued) Level of compliance with key Water Quality Objectives in the Southern WCZ





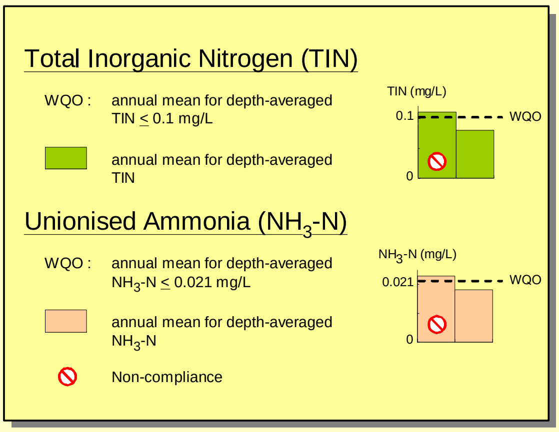
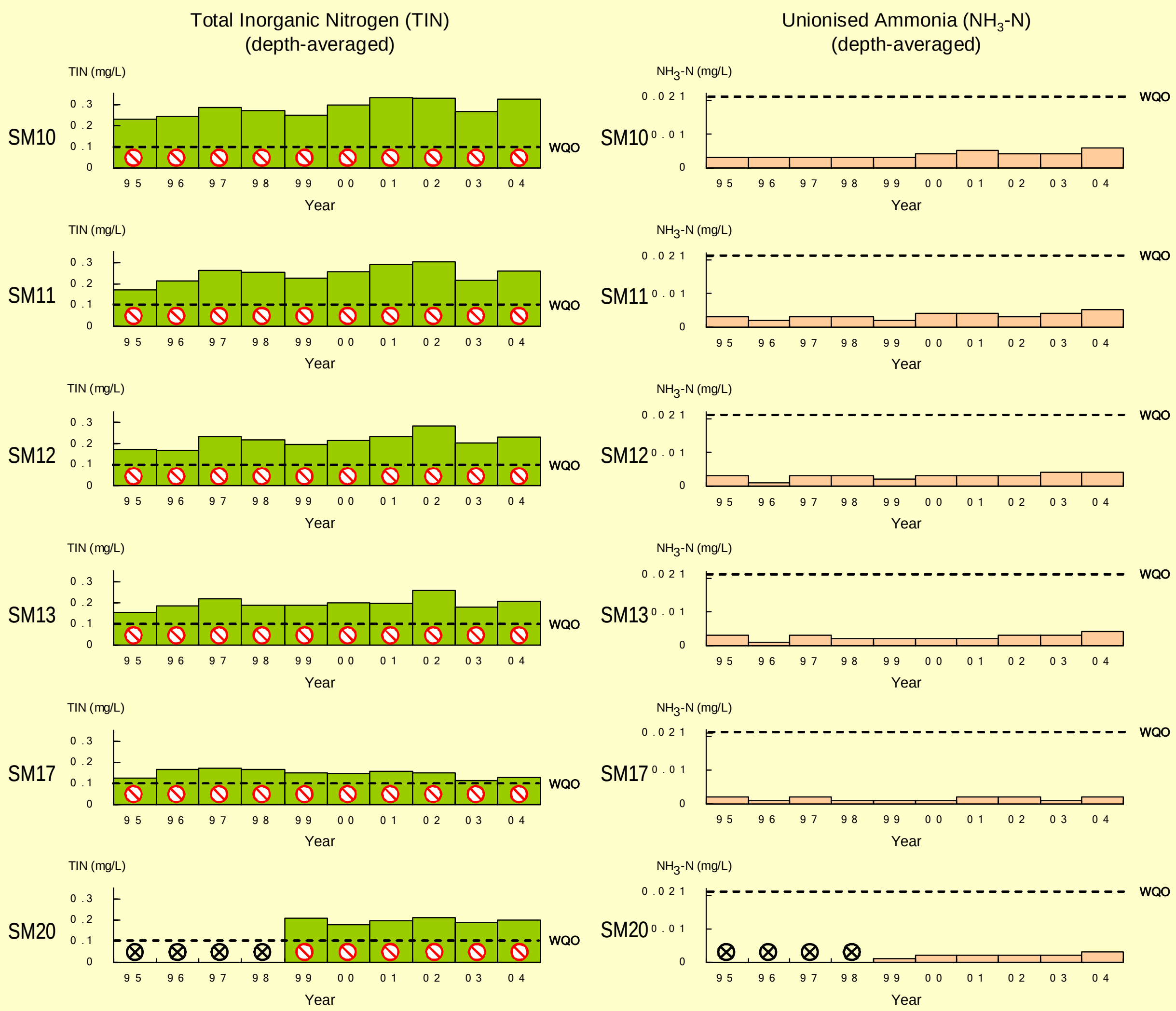
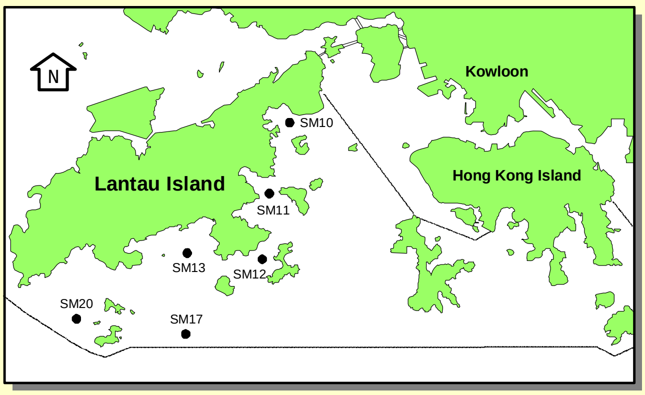


Figure 3.1 (continued) Level of compliance with key Water Quality Objectives in the Southern WCZ





Total Inorganic Nitrogen (TIN)

WQO : annual mean for depth-averaged TIN $\leq$ 0.1 mg/L

annual mean for depth-averaged TIN

Unionised Ammonia (NH_3-N)

WQO : annual mean for depth-averaged NH_3-N $\leq$ 0.021 mg/L

annual mean for depth-averaged NH_3-N

Non-compliance

No data ; monitoring of SM20 started in 1999

Figure 3.1 (continued) Level of compliance with key Water Quality Objectives in the Southern WCZ

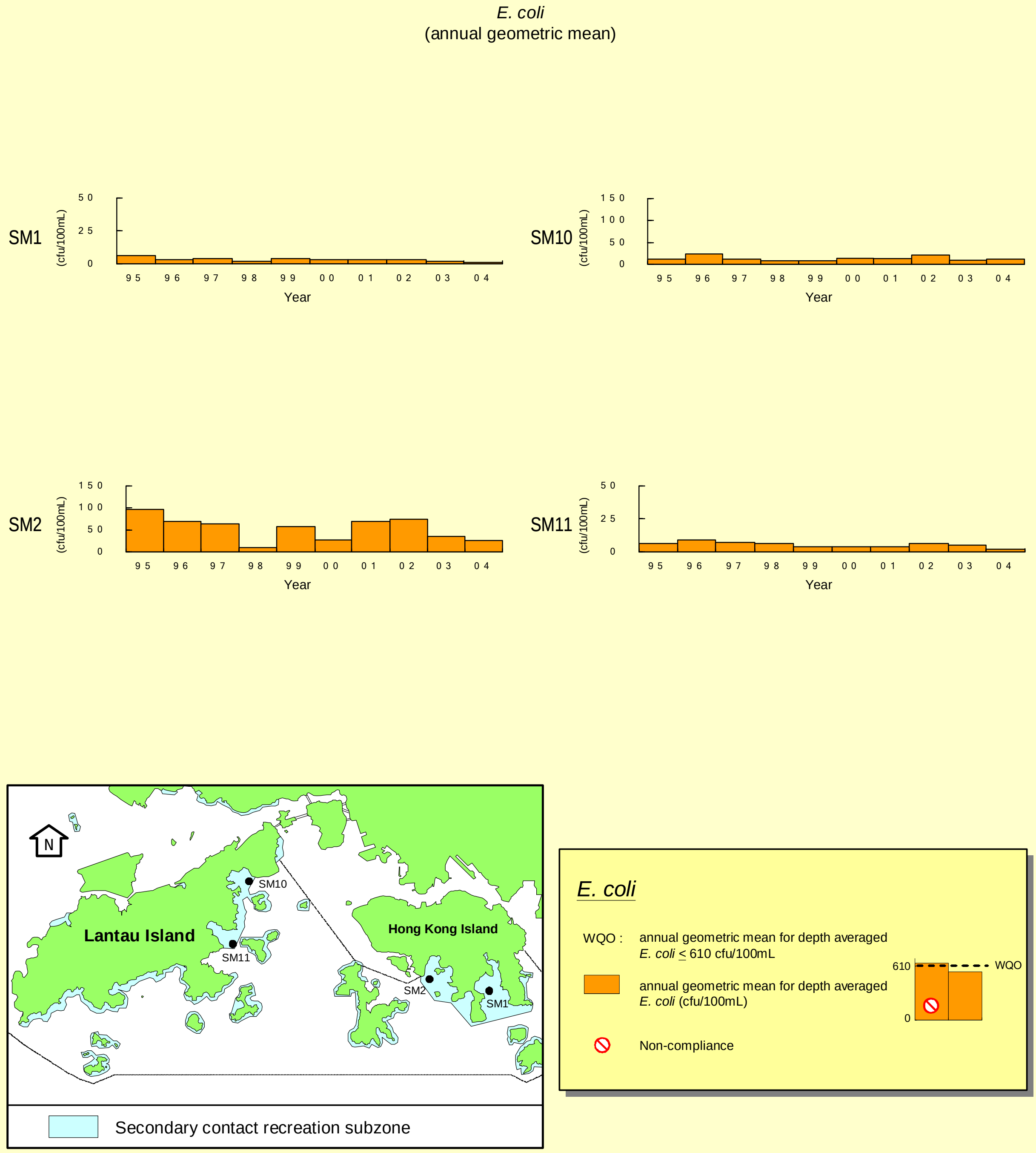
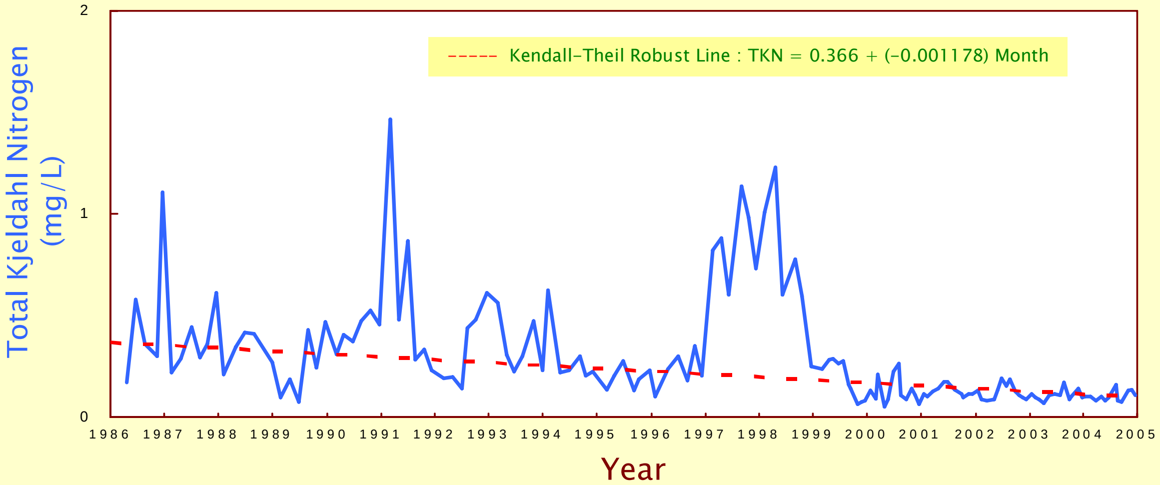
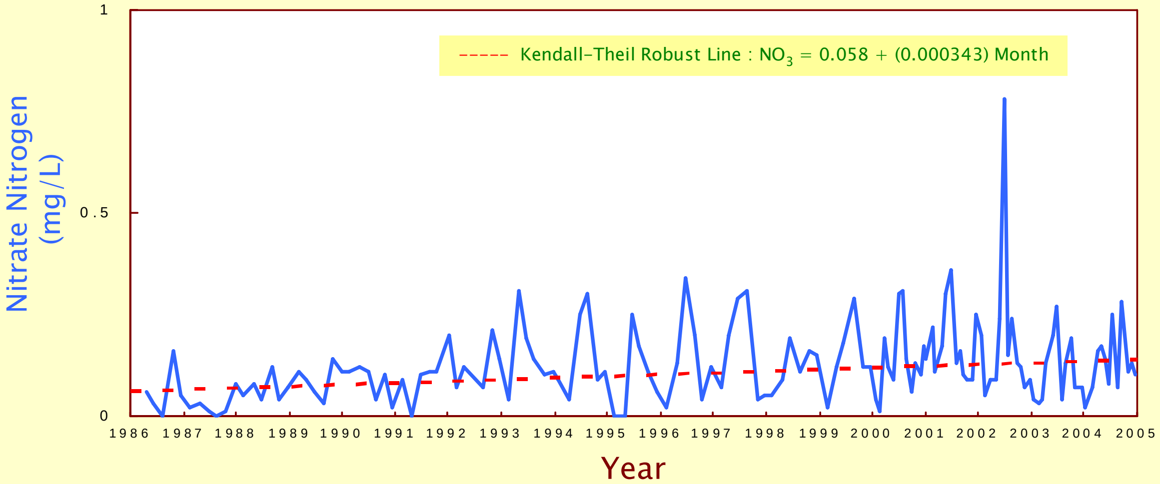


Figure 3.2 Marine water quality trends in the Southern WCZ
(based on the Seasonal Kendall Test significant at $p<0.05$)

Decreasing trend in depth-averaged Total Kjeldahl Nitrogen at SM1, 1986 – 2004



Increasing trend in depth-averaged Nitrate Nitrogen at SM11, 1986 – 2004



Increasing trend in depth-averaged *E. coli* at SM9, 1988 – 2004

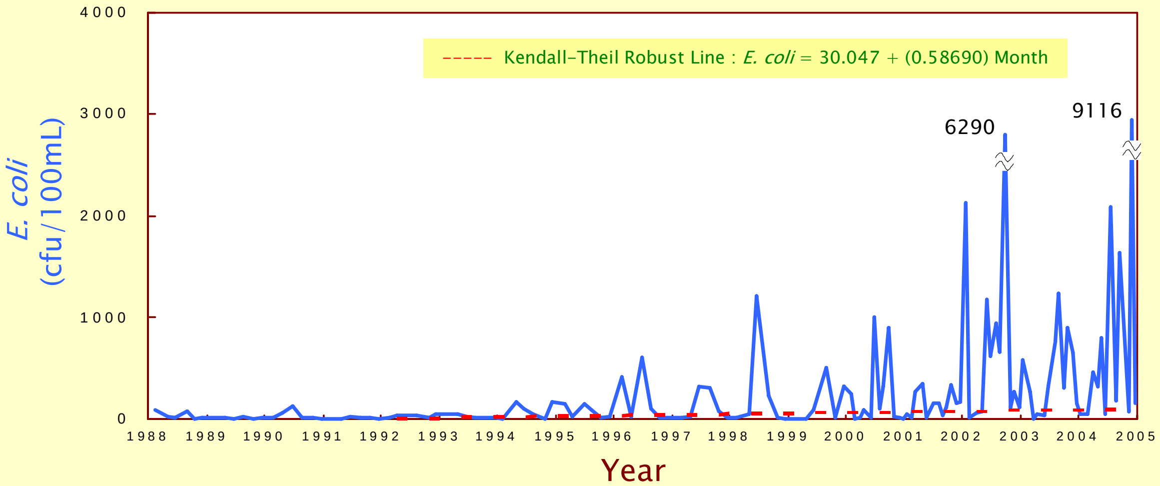


Table 3.1

Results of the Seasonal Kendall Test for water quality trends in the Southern WCZ, 1986 – 2004

Monitoring Station		SM1	SM2	SM3	SM4	SM5	SM6	SM7	SM9
Monitoring Period		1986 I 2004	1986 I 2004	1986 I 2004	1986 I 2004	1986 I 2004	1986 I 2004	1986 I 2004	1988 I 2004
Parameter	Water Depth								
Temperature (°C)	Surface	-	-	↗	↗	↗	↗	↗	↗
	Middle	↗	↗	↗	↗	↗	↗	↗	↗
	Bottom	↗	↗	↗	↗	↗	↗	↗	↗
	Average	↗	↗	↗	↗	↗	↗	↗	↗
Salinity	Surface	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	Surface	↘	-	↘	↘	-	-	-	-
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	↘	↘	-	-	-	-
Dissolved Oxygen (%)	Surface	↘	-	↘	↘	-	-	-	-
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-
pH	Surface	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-
Secchi disc depth (m)		-	-	-	-	-	-	-	-
Turbidity (NTU)	Surface	↗	↗	↗	↗	↗	↗	↗	↗
	Middle	↗	↗	↗	↗	↗	↗	↗	↗
	Bottom	↗	↗	↗	↗	↗	↗	↗	↗
	Average	↗	↗	↗	↗	↗	↗	↗	↗
Suspended Solids (mg/L)	Surface	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	↗	-	-	↗	-	-
	Average	-	-	-	-	-	-	-	-
Total volatile solids (mg/L)	Surface	↘	-	↘	↘	-	-	-	-
	Middle	↘	↘	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	↘	↘	-	↘	-	-	-	-
5-day Biochemical Oxygen Demand (mg/L)	Surface	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-
Ammonia nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-
Nitrite nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-
Nitrate nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-
Total inorganic nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-
Total Kjeldahl nitrogen (mg/L)	Surface	↘	↘	↘	↘	↘	↘	↘	-
	Middle	↘	↘	↘	↘	-	↘	-	-
	Bottom	↘	↘	↘	↘	↘	↘	-	-
	Average	↘	↘	↘	↘	↘	↘	-	-
Total nitrogen (mg/L)	Surface	↘	↘	↘	↘	-	-	-	-
	Middle	↘	↘	↘	↘	-	-	-	-
	Bottom	↘	↘	↘	↘	-	-	-	-
	Average	↘	↘	↘	-	-	-	-	-
Orthophosphate phosphorus (mg/L)	Surface	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-
Total phosphorus (mg/L)	Surface	↘	↘	↘	↘	↘	↘	-	↘
	Middle	↘	↘	↘	↘	↘	-	-	-
	Bottom	↘	↘	↘	↘	↘	↘	-	↘
	Average	↘	↘	↘	↘	↘	↘	-	↘
Silica (mg/L)	Surface	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-
Chlorophyll-*a* (µg/L)	Surface	-	-	-	-	-	-	-	↗
	Middle	-	-	-	-	↗	-	-	↗
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-
E. coli (cfu/100mL)	Surface	-	-	-	↗	-	-	↗	↗
	Middle	-	-	-	↗	-	-	-	↗
	Bottom	-	-	-	↗	-	-	↗	↗
	Average	-	-	-	↗	-	-	-	↗
Faecal coliforms (cfu/100mL)	Surface	-	↗	↗	↗	-	-	↗	↗
	Middle	-	-	-	↗	-	-	↗	↗
	Bottom	-	-	-	↗	-	-	↗	↗
	Average	-	↗	-	↗	↗	-	↗	↗

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. - indicates no significant trend is detected
3. NA (Not Applicable) indicates the measurement was not made due to shallow water
4. Test applied to past 19 years' data from each monitoring station unless stated otherwise
5. SM20 has six years' data only, which is insufficient to perform Seasonal Kendall Test
6. ↗ represents a significant increase over time
7. ↘ represents a significant decrease over time

Table 3.1 (continued)

Results of the Seasonal Kendall Test for water quality trends in the Southern WCZ, 1986 – 2004

Monitoring Station		SM10	SM11	SM12	SM13	SM17	SM18	SM19
Monitoring Period		1986 – 2004	1986 – 2004	1986 – 2004	1986 – 2004	1989 – 2004	1989 – 2004	1989 – 2004
Parameter	Water Depth							
Temperature (°C)	Surface	↗	↗	↗	↗	↗	↗	-
	Middle	NA	↗	↗	↗	↗	↗	↗
	Bottom	↗	↗	↗	↗	↗	↗	↗
	Average	↗	↗	↗	↗	↗	↗	-
Salinity	Surface	-	-	-	-	-	-	-
	Middle	NA	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	Surface	-	-	-	-	-	-	↘
	Middle	NA	-	-	-	-	-	↘
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	↘
Dissolved Oxygen (%)	Surface	-	-	-	-	-	-	-
	Middle	NA	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-
pH	Surface	-	-	-	-	-	-	-
	Middle	NA	-	↘	-	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-
Secchi disc depth (m)		-	-	-	-	-	-	-
Turbidity (NTU)	Surface	↗	↗	↗	↗	↗	↗	↗
	Middle	NA	↗	↗	↗	↗	↗	↗
	Bottom	↗	↗	↗	↗	↗	↗	↗
	Average	↗	↗	↗	↗	↗	↗	↗
Suspended Solids (mg/L)	Surface	↗	-	-	↗	-	-	-
	Middle	NA	↗	↗	↗	-	-	-
	Bottom	-	↗	↗	↗	↗	↗	↗
	Average	↗	-	-	↗	↗	-	↗
Total volatile solids (mg/L)	Surface	-	-	-	-	-	-	-
	Middle	NA	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-
5-day Biochemical Oxygen Demand (mg/L)	Surface	-	-	-	-	-	-	-
	Middle	NA	-	-	-	-	↘	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-
Ammonia nitrogen (mg/L)	Surface	-	-	-	-	-	-	-
	Middle	NA	-	-	-	-	-	-
	Bottom	-	↗	-	-	-	-	-
	Average	-	-	-	-	-	-	-
Nitrite nitrogen (mg/L)	Surface	↗	↗	↗	↗	-	-	-
	Middle	NA	↗	↗	↗	-	-	-
	Bottom	↗	↗	↗	↗	-	-	-
	Average	↗	↗	↗	↗	-	-	-
Nitrate nitrogen (mg/L)	Surface	↗	↗	↗	↗	-	-	-
	Middle	NA	↗	↗	↗	-	-	-
	Bottom	↗	↗	↗	↗	-	-	-
	Average	↗	↗	↗	↗	-	-	-
Total inorganic nitrogen (mg/L)	Surface	↗	↗	↗	↗	-	-	-
	Middle	NA	↗	↗	↗	-	↘	-
	Bottom	↗	↗	↗	↗	-	↘	-
	Average	↗	↗	↗	↗	-	-	-
Total Kjeldahl nitrogen (mg/L)	Surface	↘	-	-	-	↘	↘	↘
	Middle	NA	-	-	-	↘	↘	↘
	Bottom	-	-	-	-	↘	↘	↘
	Average	-	-	-	-	↘	↘	↘
Total nitrogen (mg/L)	Surface	-	-	-	-	-	↘	↘
	Middle	NA	-	-	-	↘	↘	↘
	Bottom	-	-	-	-	↘	↘	↘
	Average	-	-	-	-	↘	↘	↘
Orthophosphate phosphorus (mg/L)	Surface	-	-	-	-	-	-	-
	Middle	NA	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-
Total phosphorus (mg/L)	Surface	↘	↘	-	↘	↘	↘	↘
	Middle	NA	-	-	-	↘	↘	↘
	Bottom	-	-	-	↘	↘	↘	↘
	Average	↘	-	-	-	↘	↘	↘
Silica (mg/L)	Surface	-	-	-	-	-	↘	-
	Middle	NA	-	-	-	-	↘	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	↘	-
Chlorophyll-*a* (μg/L)	Surface	↗	-	-	↗	↗	↗	↗
	Middle	NA	-	-	↗	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-
E. coli (cfu/100mL)	Surface	↘	↘	-	-	-	-	-
	Middle	NA	↘	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	↘	-	-	-	-	-
Faecal coliforms (cfu/100mL)	Surface	-	-	-	-	-	-	-
	Middle	NA	-	-	↗	-	-	-
	Bottom	-	-	-	↗	-	-	-
	Average	-	-	-	↗	-	-	-

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. - indicates no significant trend is detected
3. NA (Not Applicable) indicates the measurement was not made due to shallow water
4. Test applied to past 19 years' data from each monitoring station unless stated otherwise
5. SM20 has six years' data only, which is insufficient to perform Seasonal Kendall Test
6. ↗ represents a significant increase over time
7. ↘ represents a significant decrease over time

Table 3.2

Summary water quality statistics of the Southern WCZ in 2004

		Hong Kong Island (South)			East Lamma Channel	
Parameter		SM1	SM2	SM19	SM3	SM4
Number of samples		12	12	12	12	12
Temperature (°C)		24.1 (18.1 - 29.8)	23.6 (18.2 - 27.9)	23.5 (18.2 - 28.2)	23.5 (18.3 - 27.8)	23.8 (18.1 - 28.0)
Salinity		32.8 (28.7 - 34.2)	33.1 (29.4 - 34.1)	33.5 (31.4 - 34.4)	32.9 (29.4 - 34.1)	32.7 (27.8 - 33.9)
Dissolved Oxygen (mg/L)		6.4 (5.5 - 7.7)	6.2 (5.1 - 7.7)	6.3 (4.7 - 7.7)	6.0 (4.5 - 8.1)	5.8 (4.4 - 7.6)
	Bottom	6.5 (5.6 - 8.1)	6.3 (5.1 - 8.1)	6.0 (3.2 - 7.9)	6.0 (4.3 - 8.1)	5.9 (4.4 - 7.8)
Dissolved Oxygen (% Saturation)		91 (83 - 99)	87 (75 - 105)	90 (69 - 99)	84 (66 - 105)	82 (65 - 100)
	Bottom	92 (86 - 105)	88 (76 - 105)	84 (46 - 103)	84 (62 - 106)	83 (65 - 102)
pH		8.2 (8.0 - 8.3)	8.2 (8.0 - 8.3)	8.2 (8.0 - 8.3)	8.1 (7.9 - 8.3)	8.1 (8.0 - 8.3)
Secchi Disc Depth (m)		3.2 (1.8 - 6.5)	2.7 (1.4 - 4.3)	3.3 (1.2 - 6.0)	2.4 (1.3 - 4.6)	2.3 (1.1 - 2.9)
Turbidity (NTU)		8.1 (2.9 - 13.4)	8.2 (4.3 - 11.3)	9.5 (4.6 - 15.3)	9.8 (3.9 - 12.7)	8.4 (5.2 - 12.5)
Suspended Solids (mg/L)		3.2 (1.5 - 7.6)	3.5 (1.9 - 6.6)	4.2 (1.3 - 8.6)	5.5 (2.8 - 10.4)	3.6 (2.0 - 8.3)
5-day Biochemical Oxygen Demand (mg/L)		0.7 (0.4 - 1.1)	0.9 (0.5 - 1.6)	0.7 (0.3 - 1.1)	0.8 (0.5 - 1.5)	1.0 (0.6 - 1.8)
Ammonia Nitrogen (mg/L)		0.03 (0.01 - 0.05)	0.04 (0.01 - 0.08)	0.03 (0.01 - 0.04)	0.05 (0.01 - 0.13)	0.07 (0.02 - 0.13)
Unionised Ammonia (mg/L)		0.002 (0.001 - 0.004)	0.003 (0.001 - 0.007)	0.002 (0.001 - 0.004)	0.003 (0.001 - 0.005)	0.004 (0.001 - 0.006)
Nitrite Nitrogen (mg/L)		0.01 (<0.01 - 0.03)	0.01 (<0.01 - 0.04)	0.01 (<0.01 - 0.03)	0.02 (<0.01 - 0.06)	0.02 (<0.01 - 0.06)
Nitrate Nitrogen (mg/L)		0.02 (<0.01 - 0.09)	0.04 (<0.01 - 0.16)	0.02 (<0.01 - 0.10)	0.05 (0.01 - 0.21)	0.06 (0.01 - 0.19)
Total Inorganic Nitrogen (mg/L)		0.06 (0.03 - 0.15)	0.09 (0.04 - 0.25)	0.06 (0.02 - 0.15)	0.12 (0.06 - 0.29)	0.14 (0.07 - 0.31)
Total Kjeldahl Nitrogen (mg/L)		0.10 (0.07 - 0.16)	0.13 (0.08 - 0.18)	0.10 (0.06 - 0.14)	0.14 (0.09 - 0.20)	0.16 (0.11 - 0.23)
Total Nitrogen (mg/L)		0.13 (0.08 - 0.26)	0.18 (0.12 - 0.33)	0.13 (0.07 - 0.23)	0.20 (0.13 - 0.37)	0.23 (0.15 - 0.39)
Orthophosphate Phosphorus (mg/L)		0.01 (0.01 - 0.01)	0.01 (0.01 - 0.01)	0.01 (0.01 - 0.01)	0.01 (0.01 - 0.02)	0.01 (0.01 - 0.02)
Total Phosphorus (mg/L)		0.02 (0.02 - 0.02)	0.02 (0.02 - 0.02)	0.02 (0.02 - 0.02)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.03)
Silica (as SiO_2) (mg/L)		0.5 (0.1 - 0.8)	0.5 (0.1 - 1.0)	0.5 (0.2 - 0.9)	0.6 (0.1 - 1.1)	0.6 (0.1 - 1.1)
Chlorophyll-*a* (µg/L)		2.4 (0.6 - 6.8)	2.8 (0.5 - 7.8)	2.7 (0.7 - 8.7)	2.5 (0.4 - 7.5)	2.9 (0.5 - 8.3)
E. coli (cfu/100mL)		1 (1 - 4)	25 (3 - 850)	1 (1 - 3)	18 (2 - 92)	22 (1 - 370)
Faecal Coliforms (cfu/100mL)		3 (1 - 340)	55 (10 - 1100)	2 (1 - 760)	43 (5 - 600)	53 (3 - 960)

Note :
1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths: Surface (S), Mid-depth (M), Bottom (B).
2. Data presented are annual arithmetic means of the depth-averaged results except for *E. coli* and faecal coliforms which are annual geometric means.
3. Data in brackets indicate the ranges.

Table 3.2 (continued)

Summary water quality statistics of the Southern WCZ in 2004

Parameter		West Lamma Channel			
	SM5	SM6	SM7	SM9	SM18
Number of samples	12	12	12	12	12
Temperature (°C)	24.0 (18.3 - 28.3)	23.8 (18.5 - 27.9)	23.8 (17.9 - 28.2)	23.8 (17.7 - 28.1)	23.6 (18.3 - 27.8)
Salinity	32.8 (28.1 - 34.2)	32.5 (26.1 - 34.2)	32.1 (27.2 - 33.8)	31.1 (23.0 - 33.4)	32.9 (28.7 - 34.3)
Dissolved Oxygen (mg/L)	6.8 (5.6 - 8.4)	6.6 (5.3 - 8.3)	6.2 (3.8 - 8.3)	6.6 (3.4 - 8.2)	6.8 (6.0 - 8.0)
Bottom	6.9 (5.5 - 9.5)	6.5 (5.1 - 8.5)	6.1 (3.8 - 8.7)	6.5 (3.4 - 8.0)	6.4 (5.2 - 8.1)
Dissolved Oxygen (% Saturation)	97 (84 - 122)	94 (78 - 111)	86 (55 - 110)	93 (49 - 119)	96 (90 - 109)
Bottom	97 (82 - 134)	92 (77 - 111)	85 (55 - 114)	90 (48 - 117)	90 (79 - 106)
pH	8.2 (8.1 - 8.4)	8.2 (8.0 - 8.4)	8.1 (7.9 - 8.3)	8.1 (7.8 - 8.3)	8.2 (8.0 - 8.3)
Secchi Disc Depth (m)	2.5 (1.4 - 5.6)	2.8 (0.5 - 10.0)	2.1 (1.2 - 3.5)	1.9 (1.2 - 2.5)	2.7 (0.9 - 6.0)
Turbidity (NTU)	9.0 (4.3 - 13.3)	9.6 (3.4 - 18.1)	13.2 (5.6 - 40.4)	13.4 (8.0 - 25.2)	8.9 (2.8 - 13.5)
Suspended Solids (mg/L)	4.7 (2.1 - 8.8)	5.3 (1.3 - 21.7)	9.5 (2.8 - 44.3)	11.1 (3.3 - 29.3)	4.1 (0.9 - 8.9)
5-day Biochemical Oxygen Demand (mg/L)	0.9 (0.2 - 2.1)	0.8 (0.3 - 1.4)	1.0 (0.4 - 2.4)	0.8 (0.2 - 1.4)	0.8 (0.2 - 1.4)
Ammonia Nitrogen (mg/L)	0.04 (0.02 - 0.06)	0.05 (0.02 - 0.08)	0.11 (0.02 - 0.19)	0.14 (0.05 - 0.23)	0.04 (0.01 - 0.06)
Unionised Ammonia (mg/L)	0.002 (0.001 - 0.005)	0.003 (0.001 - 0.005)	0.005 (0.001 - 0.008)	0.006 (0.003 - 0.009)	0.002 (<0.001 - 0.005)
Nitrite Nitrogen (mg/L)	0.01 (<0.01 - 0.04)	0.02 (<0.01 - 0.04)	0.03 (0.01 - 0.07)	0.04 (0.02 - 0.10)	0.01 (<0.01 - 0.03)
Nitrate Nitrogen (mg/L)	0.04 (<0.01 - 0.17)	0.07 (<0.01 - 0.29)	0.11 (0.04 - 0.31)	0.19 (0.05 - 0.51)	0.04 (0.01 - 0.15)
Total Inorganic Nitrogen (mg/L)	0.09 (0.03 - 0.25)	0.13 (0.03 - 0.40)	0.25 (0.11 - 0.48)	0.37 (0.23 - 0.66)	0.08 (0.03 - 0.23)
Total Kjeldahl Nitrogen (mg/L)	0.13 (0.07 - 0.18)	0.14 (0.08 - 0.20)	0.23 (0.12 - 0.33)	0.28 (0.20 - 0.36)	0.11 (0.06 - 0.16)
Total Nitrogen (mg/L)	0.18 (0.09 - 0.37)	0.23 (0.11 - 0.52)	0.37 (0.21 - 0.63)	0.51 (0.37 - 0.87)	0.16 (0.08 - 0.32)
Orthophosphate Phosphorus (mg/L)	0.01 (<0.01 - 0.01)	0.01 (0.01 - 0.01)	0.02 (0.01 - 0.03)	0.02 (0.01 - 0.03)	0.01 (0.01 - 0.01)
Total Phosphorus (mg/L)	0.02 (0.02 - 0.02)	0.02 (0.02 - 0.03)	0.04 (0.02 - 0.06)	0.05 (0.03 - 0.06)	0.02 (0.02 - 0.02)
Silica (as SiO_2) (mg/L)	0.5 (0.1 - 1.0)	0.6 (0.1 - 1.0)	0.8 (0.1 - 1.4)	1.0 (0.4 - 2.3)	0.5 (0.2 - 0.9)
Chlorophyll-*a* (µg/L)	4.5 (0.8 - 11.9)	3.7 (0.6 - 10.9)	4.3 (0.8 - 15.3)	5.0 (0.6 - 14.9)	2.8 (0.6 - 8.7)
E. coli (cfu/100mL)	1 (1 - 2)	2 (1 - 18)	11 (1 - 1400)	310 (45 - 9100)	1 (1 - 2)
Faecal Coliforms (cfu/100mL)	2 (1 - 610)	3 (1 - 170)	24 (2 - 1900)	560 (64 - 16000)	2 (1 - 190)

Note :
1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths: Surface (S), Mid-depth (M), Bottom (B).
2. Data presented are annual arithmetic means of the depth-averaged results except for *E. coli* and faecal coliforms which are annual geometric means.
3. Data in brackets indicate the ranges.

Table 3.2 (continued)

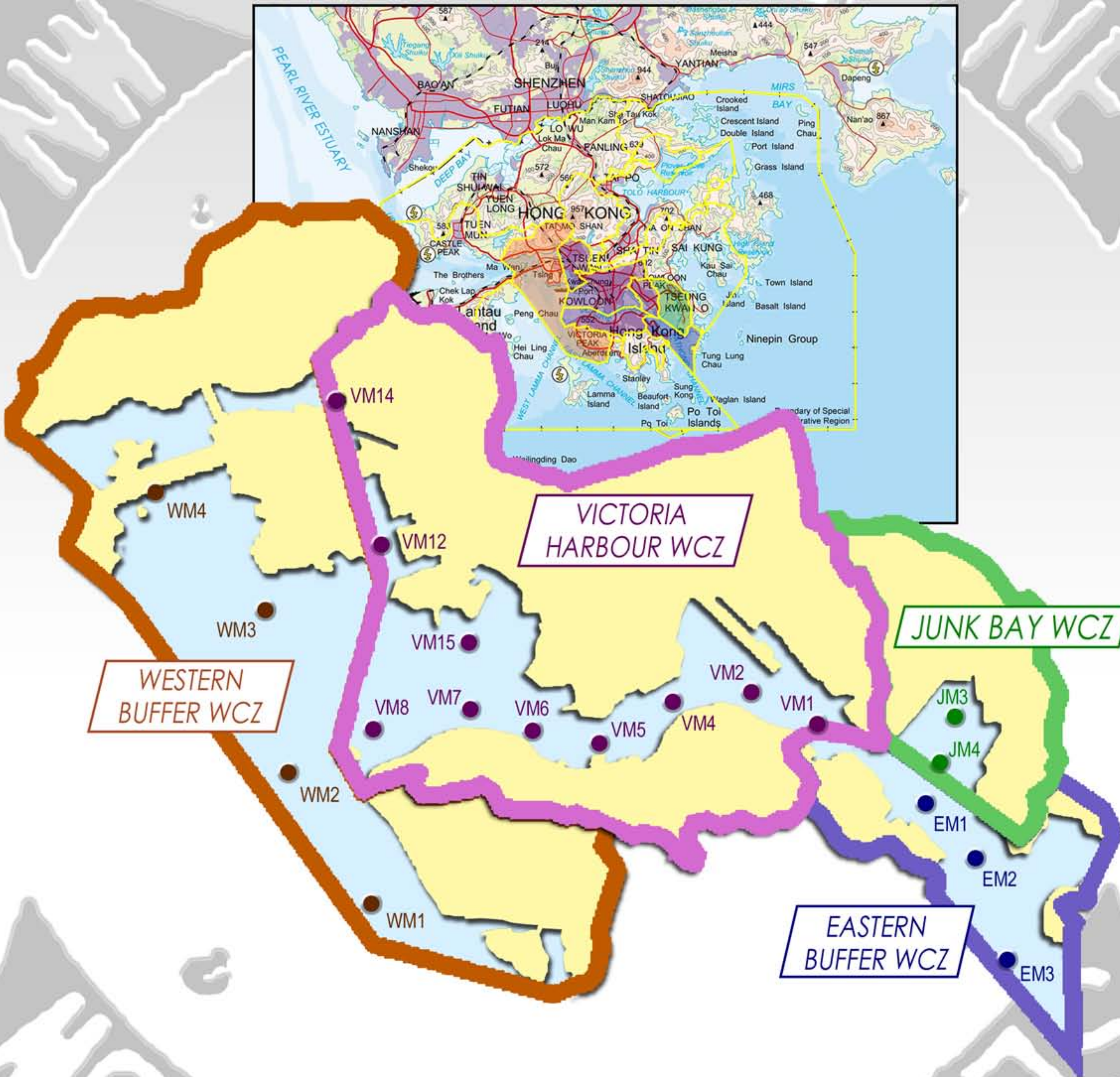
Summary water quality statistics of the Southern WCZ in 2004

		Lantau Island (East)		Lantau Island (South)			Soko Islands
Parameter		SM10	SM11	SM12	SM13	SM17	SM20
Number of samples		12	12	12	12	12	12
Temperature (°C)		24.3 (18.4 - 28.6)	24.3 (18.1 - 28.7)	24.2 (18.5 - 28.6)	24.2 (18.4 - 28.5)	23.6 (18.3 - 27.9)	23.9 (18.5 - 28.4)
Salinity		30.7 (22.3 - 33.5)	31.2 (24.6 - 33.7)	31.1 (22.7 - 33.9)	31.2 (22.3 - 33.9)	32.2 (27.5 - 34.2)	31.4 (26.8 - 34.0)
Dissolved Oxygen (mg/L)		7.5 (4.7 - 10.3)	7.7 (4.2 - 10.3)	7.5 (4.3 - 9.2)	7.8 (4.7 - 10.3)	7.2 (4.5 - 9.3)	6.9 (4.1 - 8.9)
	Bottom	7.6 (4.8 - 10.6)	7.7 (4.3 - 9.7)	7.6 (4.3 - 9.8)	7.9 (4.9 - 10.2)	6.8 (4.0 - 10.4)	6.9 (4.1 - 8.6)
Dissolved Oxygen (% Saturation)		107 (70 - 152)	110 (62 - 157)	106 (63 - 135)	110 (70 - 157)	101 (66 - 132)	98 (60 - 135)
	Bottom	107 (72 - 154)	109 (63 - 148)	106 (64 - 138)	112 (72 - 157)	96 (58 - 146)	97 (60 - 131)
pH		8.1 (7.9 - 8.4)	8.2 (7.9 - 8.4)	8.2 (7.9 - 8.5)	8.2 (7.9 - 8.5)	8.2 (7.9 - 8.3)	8.2 (7.9 - 8.4)
Secchi Disc Depth (m)		1.6 (0.8 - 2.3)	1.8 (1.1 - 2.8)	1.7 (0.8 - 2.7)	1.9 (1.0 - 4.4)	2.0 (1.0 - 3.0)	1.8 (0.7 - 3.3)
Turbidity (NTU)		13.6 (10.2 - 19.7)	11.7 (9.2 - 15.0)	11.6 (8.2 - 16.0)	11.1 (8.2 - 24.2)	11.7 (6.7 - 25.7)	18.8 (9.3 - 69.1)
Suspended Solids (mg/L)		10.2 (6.3 - 20.0)	7.1 (5.0 - 10.8)	10.3 (3.0 - 40.8)	7.6 (3.0 - 27.0)	7.4 (3.4 - 25.7)	18.9 (3.1 - 106)
5-day Biochemical Oxygen Demand (mg/L)		1.4 (0.2 - 3.8)	1.5 (0.4 - 3.2)	1.5 (0.4 - 3.1)	1.4 (0.5 - 3.3)	0.9 (0.4 - 1.7)	1.2 (0.4 - 4.0)
Ammonia Nitrogen (mg/L)		0.11 (0.04 - 0.23)	0.09 (0.04 - 0.21)	0.08 (0.03 - 0.18)	0.06 (0.03 - 0.15)	0.03 (0.01 - 0.06)	0.04 (0.01 - 0.11)
Unionised Ammonia (mg/L)		0.006 (0.002 - 0.008)	0.005 (0.002 - 0.007)	0.004 (0.002 - 0.007)	0.004 (0.001 - 0.006)	0.002 (<0.001 - 0.004)	0.003 (0.001 - 0.005)
Nitrite Nitrogen (mg/L)		0.04 (0.01 - 0.08)	0.03 (<0.01 - 0.08)	0.03 (<0.01 - 0.07)	0.03 (<0.01 - 0.07)	0.02 (<0.01 - 0.06)	0.03 (<0.01 - 0.07)
Nitrate Nitrogen (mg/L)		0.17 (0.06 - 0.41)	0.13 (0.02 - 0.28)	0.12 (0.02 - 0.33)	0.11 (<0.01 - 0.37)	0.07 (<0.01 - 0.24)	0.13 (<0.01 - 0.32)
Total Inorganic Nitrogen (mg/L)		0.32 (0.13 - 0.56)	0.26 (0.10 - 0.49)	0.23 (0.09 - 0.48)	0.21 (0.05 - 0.46)	0.13 (0.03 - 0.32)	0.20 (0.03 - 0.41)
Total Kjeldahl Nitrogen (mg/L)		0.29 (0.19 - 0.40)	0.27 (0.20 - 0.36)	0.24 (0.17 - 0.33)	0.21 (0.14 - 0.29)	0.14 (0.11 - 0.19)	0.18 (0.11 - 0.27)
Total Nitrogen (mg/L)		0.51 (0.35 - 0.86)	0.44 (0.31 - 0.65)	0.40 (0.21 - 0.70)	0.35 (0.17 - 0.71)	0.24 (0.14 - 0.44)	0.34 (0.14 - 0.51)
Orthophosphate Phosphorus (mg/L)		0.02 (<0.01 - 0.04)	0.02 (<0.01 - 0.04)	0.01 (<0.01 - 0.03)	0.01 (<0.01 - 0.03)	0.01 (0.01 - 0.02)	0.01 (<0.01 - 0.02)
Total Phosphorus (mg/L)		0.04 (0.02 - 0.07)	0.04 (0.02 - 0.05)	0.03 (0.02 - 0.05)	0.03 (0.02 - 0.04)	0.02 (0.02 - 0.03)	0.04 (0.02 - 0.10)
Silica (as SiO_2) (mg/L)		0.9 (0.1 - 2.7)	0.7 (0.1 - 2.8)	0.7 (0.1 - 2.5)	0.7 (0.1 - 2.4)	0.6 (0.1 - 1.9)	0.8 (0.1 - 2.5)
Chlorophyll-*a* (µg/L)		9.5 (1.7 - 35.0)	10.7 (1.7 - 33.3)	9.8 (1.0 - 29.0)	8.2 (1.1 - 21.7)	4.2 (0.6 - 9.2)	5.0 (0.5 - 14.7)
E. coli (cfu/100mL)		11 (1 - 140)	2 (1 - 40)	10 (2 - 86)	2 (1 - 43)	1 (1 - 3)	1 (1 - 6)
Faecal Coliforms (cfu/100mL)		23 (3 - 230)	6 (1 - 100)	25 (5 - 260)	5 (1 - 450)	2 (1 - 400)	3 (1 - 130)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths: Surface (S), Mid-depth (M), Bottom (B).
2. Data presented are annual arithmetic means of the depth-averaged results except for *E. coli* and faecal coliforms which are annual geometric means.
3. Data in brackets indicate the ranges.

CENTRAL WATERS

CHAPTER 4



Chapter 4 – Central Waters

Water Quality in 2004

4.1 The central waters consist of four Water Control Zones (WCZs) : the Victoria Harbour, Eastern Buffer, Western Buffer and Junk Bay WCZs. In the past, wastewater from both sides of Victoria Harbour was discharged directly into the harbour after simple screening, resulting in poor water quality with high nutrients and sewage bacteria. To improve the water quality, the Stonecutters Island Sewage Treatment Works (SCISTW) under Stage 1 of the Harbour Area Treatment Scheme (HATS) was commissioned in 2002. It receives 1,400,000 cubic meter per day of wastewater from Kowloon and parts of Hong Kong Island for Chemically Enhanced Primary Treatment and disposal in the western harbour area (Figure 1.8).

4.2 The implementation of HATS Stage 1 in 2002 has brought significant water quality improvements especially in eastern Victoria Harbour, the Eastern Buffer and Junk Bay WCZs. Some increase of bacteria, however, was observed in the western harbour areas.

Victoria Harbour Water Control Zone

4.3 In 2004, the marked improvements in eastern Victoria Harbour (VM1 and VM2) and moderate improvements in the mid harbour area (VM4 and VM5) and northern part of Rambler Channel (VM14) since HATS Stage 1 was commissioned were generally sustained (Table 4.5).

4.4 The depth-averaged and bottom dissolved oxygen (DO) in the Victoria Harbour WCZ were 5.4-5.9 mg/L and 5.3-6.0 mg/L respectively. No hypoxia (i.e. DO<2 mg/L) was observed at the bottom layer. The *E. coli* counts in the WCZ in 2004 were largely comparable to those in the previous two years, lower at the eastern end (VM1 and VM2) (ranging 480-630 cfu/100mL) and higher in the middle (VM5-VM7) and the western parts (VM12, VM14, VM15) of the harbour (3400-8300 cfu/100mL and 1300-2300 cfu/100mL respectively).

4.5 In 2004, a reduction of nitrate nitrogen (NO_3-N) (averaged 13%) was noted in the Victoria Harbour WCZ, resulting a slight decrease of total inorganic nitrogen (TIN) (by 5%). Unlike other waters, a generalised increase of ammonia nitrogen (NH_4-N) was not observed in Victoria Harbour. The level of orthophosphate phosphorus (PO_4-P) also was largely similar to that in 2003.

Eastern Buffer Water Control Zone

4.6 The Eastern Buffer WCZ has the best water quality among the central waters due to removal of sewage discharge in HATS Stage 1 and greater oceanic flushing. In 2004, DO in the Eastern Buffer WCZ further increased by 4% (from 5.9 in 2003 to 6.2 mg/L) (Table 4.6). The mean *E. coli* (10 cfu/100mL) and TIN (0.11 mg/L) levels were low. It was noted that total nitrogen (TN) and total Kjeldahl nitrogen (TKN) have reached their lowest levels since the mid-80s. On the other hand, NH_4-N showed a 23% increase from 0.042 to 0.051 mg/L, similar to many areas in the eastern and southern waters.

Junk Bay Water Control Zone

4.7 The water quality of the Junk Bay WCZ in 2004 was stable and improvements since HATS Stage 1 were sustained. A further decrease of *E. coli* (to 41 cfu/100mL) was observed, reaching its lowest level in 10 years (Table 4.7). While TIN and PO_4-P in the WCZ remained low, NH_4-N experienced a 30% increase (from 0.06 mg/L in 2003 to 0.08 mg/L in 2004) in the bay. The mean DO level in Junk Bay at 6.0 mg/L was similar to that in 2003.

Western Buffer Water Control Zone

4.8 The water quality in the Western Buffer WCZ in 2004 was largely stable with an increase of *E. coli* at the southern part of the WCZ (Table 4.8). This may be related to the increased discharges from the sewage treatment works in the western part of Hong Kong Island.

4.9 In 2004, while the mean DO level increased by 12 % (5.4 to 6.1 mg/L), the WCZ also experienced a 19-105% increase of NH_4-N (like many parts of Hong Kong waters) in particular at the two southern most stations (WM1 and WM2). On the other hand, other nitrogenous and phosphorus compounds, e.g. TIN, PO_4-P remained largely stable in the year.

Compliance with Water Quality Objectives

4.10 In 2004, the Eastern Buffer, Junk Bay and Western Buffer WCZs achieved full compliance (100%) with the key Water Quality Objectives (Figures 4.2-4.4).

4.11 The WQO compliance of the Victoria Harbour WCZ was 87%, slightly lower than that in 2003 (93%). While the compliance with the objective for unionized ammonia was 100%, that for DO and TIN were both at 80% (Figure 4.1).

Long-term Water Quality Trends

4.12 The long-term water quality changes in the Victoria Harbour WCZ are summarised in Table 4.1. For *E. coli* bacteria, the increasing trends observed in the eastern harbour area were arrested in 2002 after the implementation of HATS Stage 1, while those in mid harbour also ceased in 2003. A significant decline in TKN and TN was generally observed, except at the two western stations VM5 and VM8. On the other hand, an increase of nitrate nitrogen (NO_3-N) was detected in the western part of the harbour. Signs of water quality improvements: an increase in DO, decreases in nutrients (TN, total phosphorus (TP)) and organics (5-day Biochemical Oxygen Demand (BOD_5)) were also evident in the north Rambler Channel (VM14).

4.13 In the Eastern Buffer and Junk Bay WCZs, all monitoring stations showed significant improving trends in TKN, TN and TP (Tables 4.2 and 4.3). Long-term increases in *E. coli* bacteria were generally observed in the Western Buffer WCZ (Table 4.4). On the other hand, significant declines in TKN, TN, TP and silica were noted at most monitoring stations since the 80s.

Figure 4.1 Level of compliance with key Water Quality Objectives in the Victoria Harbour WCZ

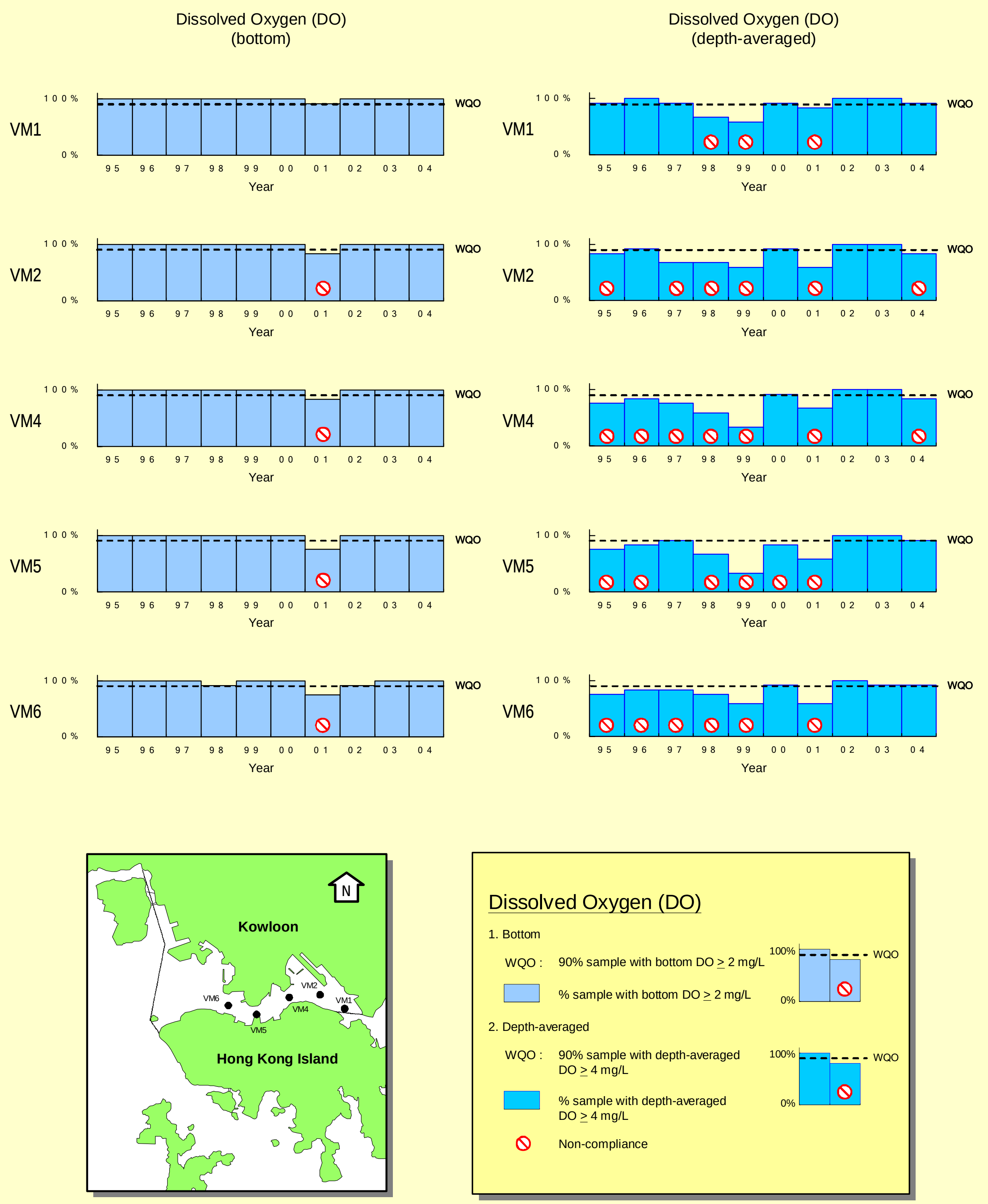
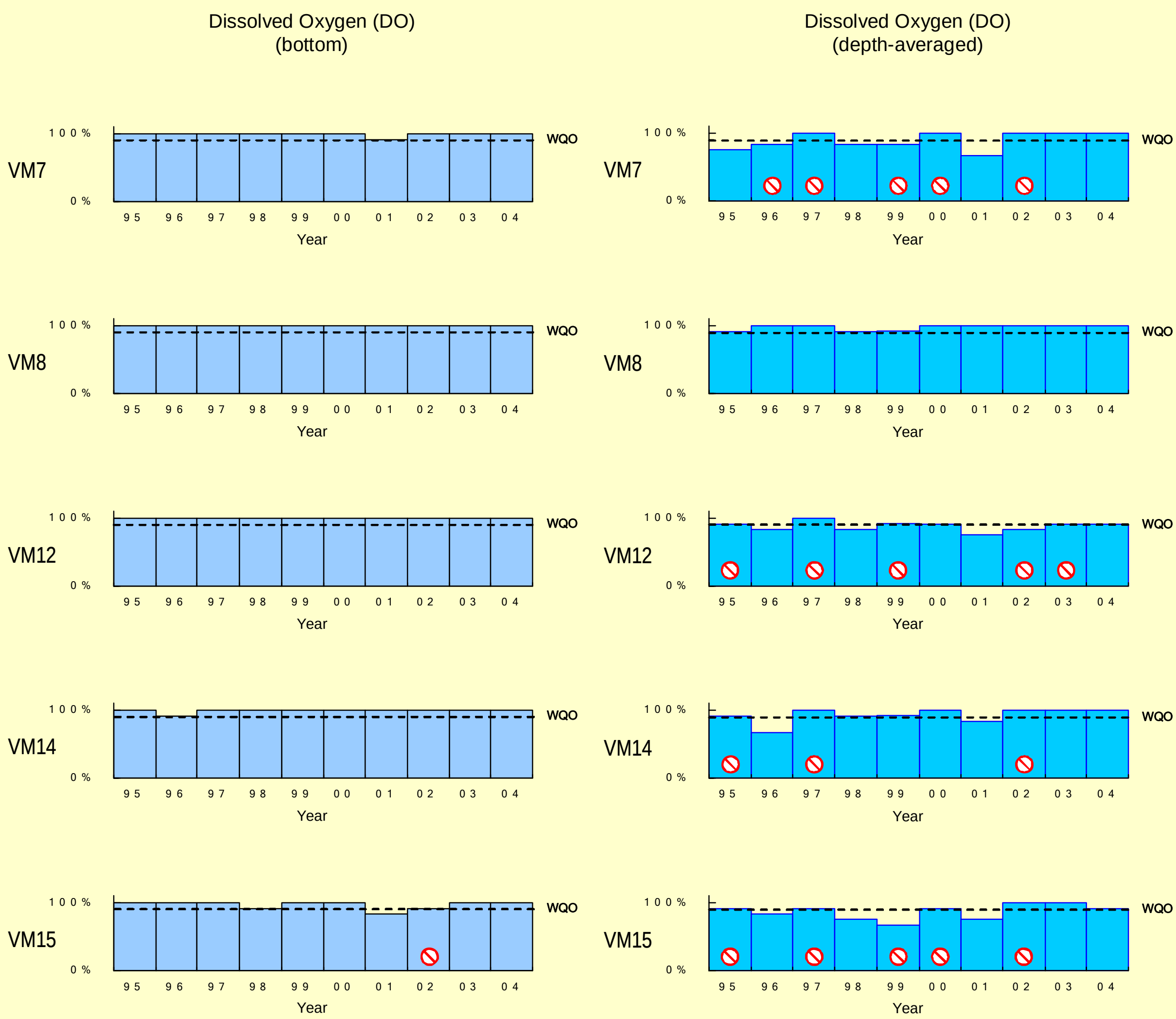
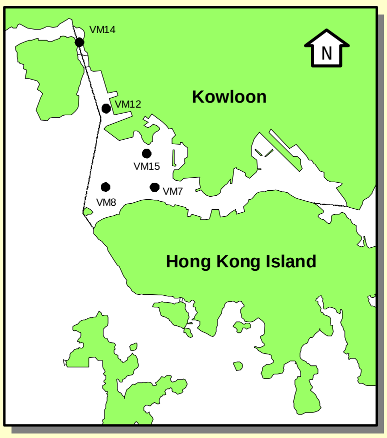


Figure 4.1 (continued) Level of compliance with key Water Quality Objectives in the Victoria Harbour WCZ





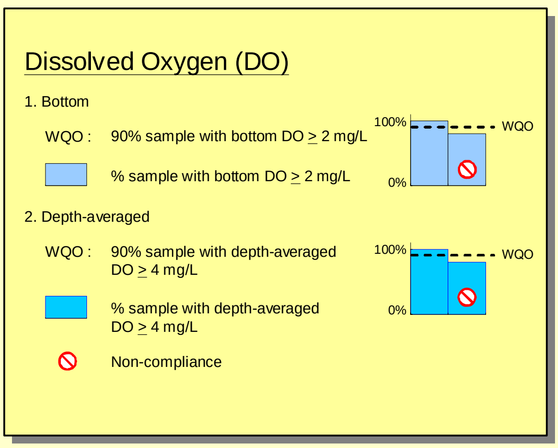


Figure 4.1 (continued) Level of compliance with key Water Quality Objectives in the Victoria Harbour WCZ

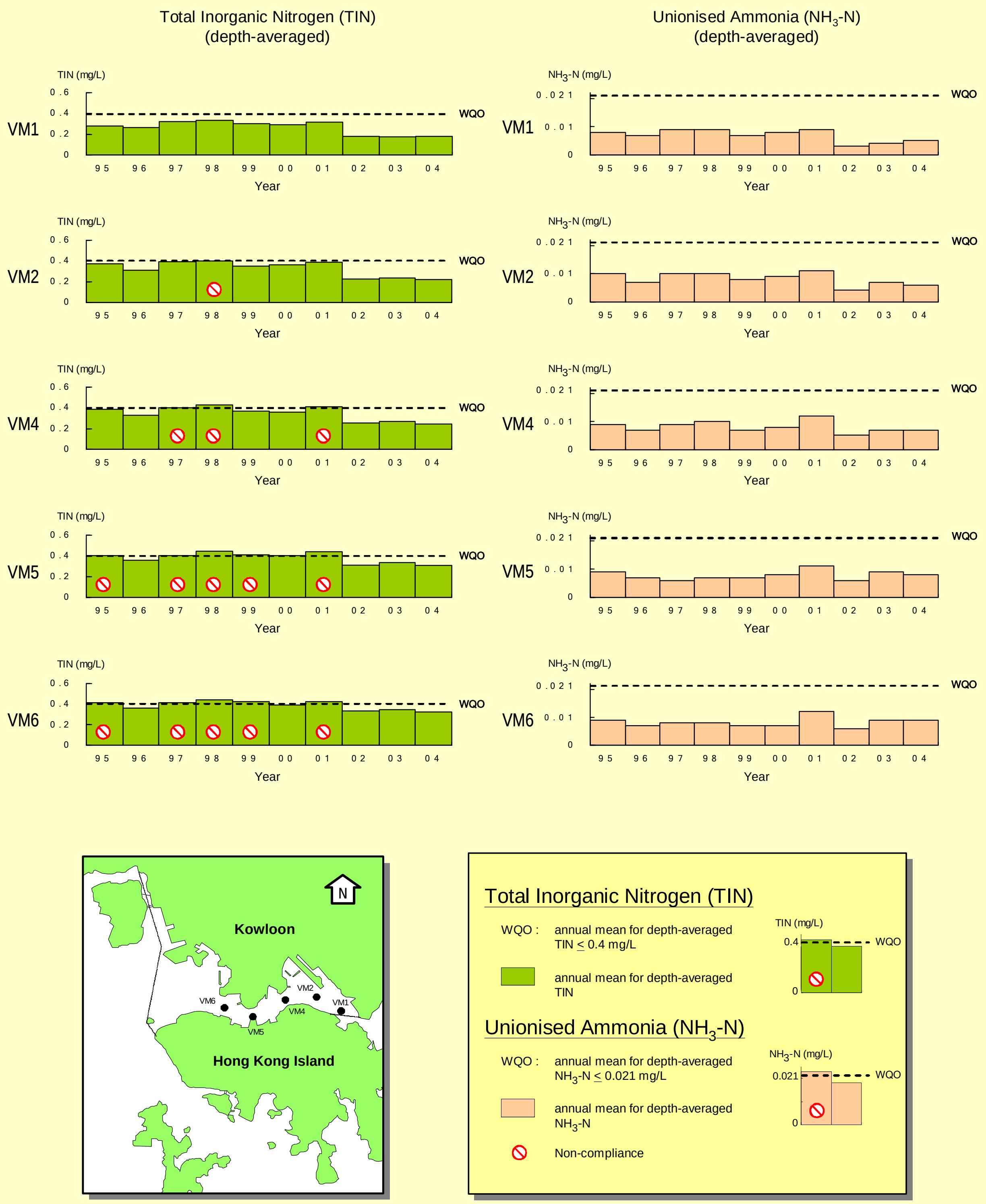


Figure 4.1 (continued) Level of compliance with key Water Quality Objectives in the Victoria Harbour WCZ

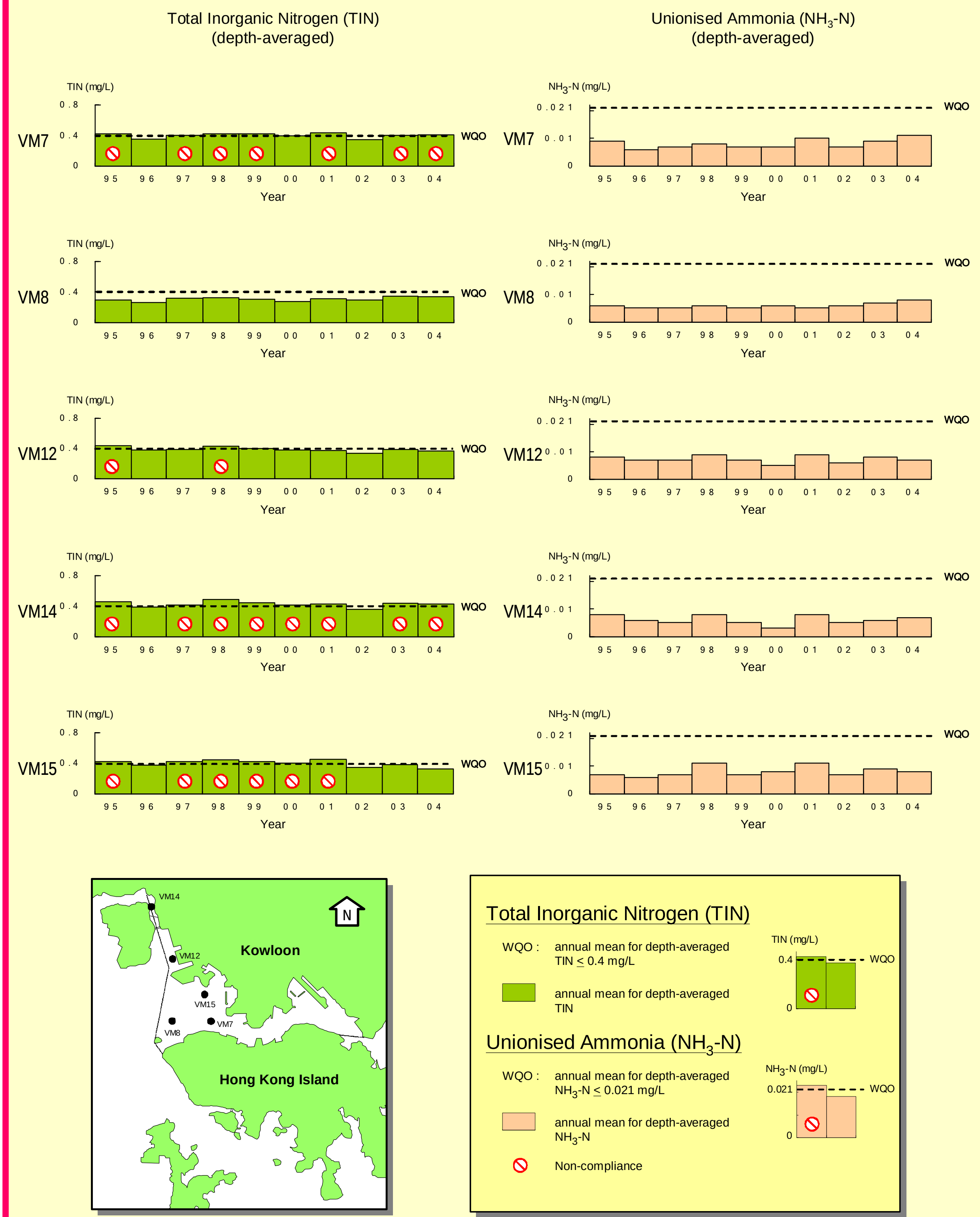


Figure 4.2 Level of compliance with key Water Quality Objectives in the Eastern Buffer WCZ

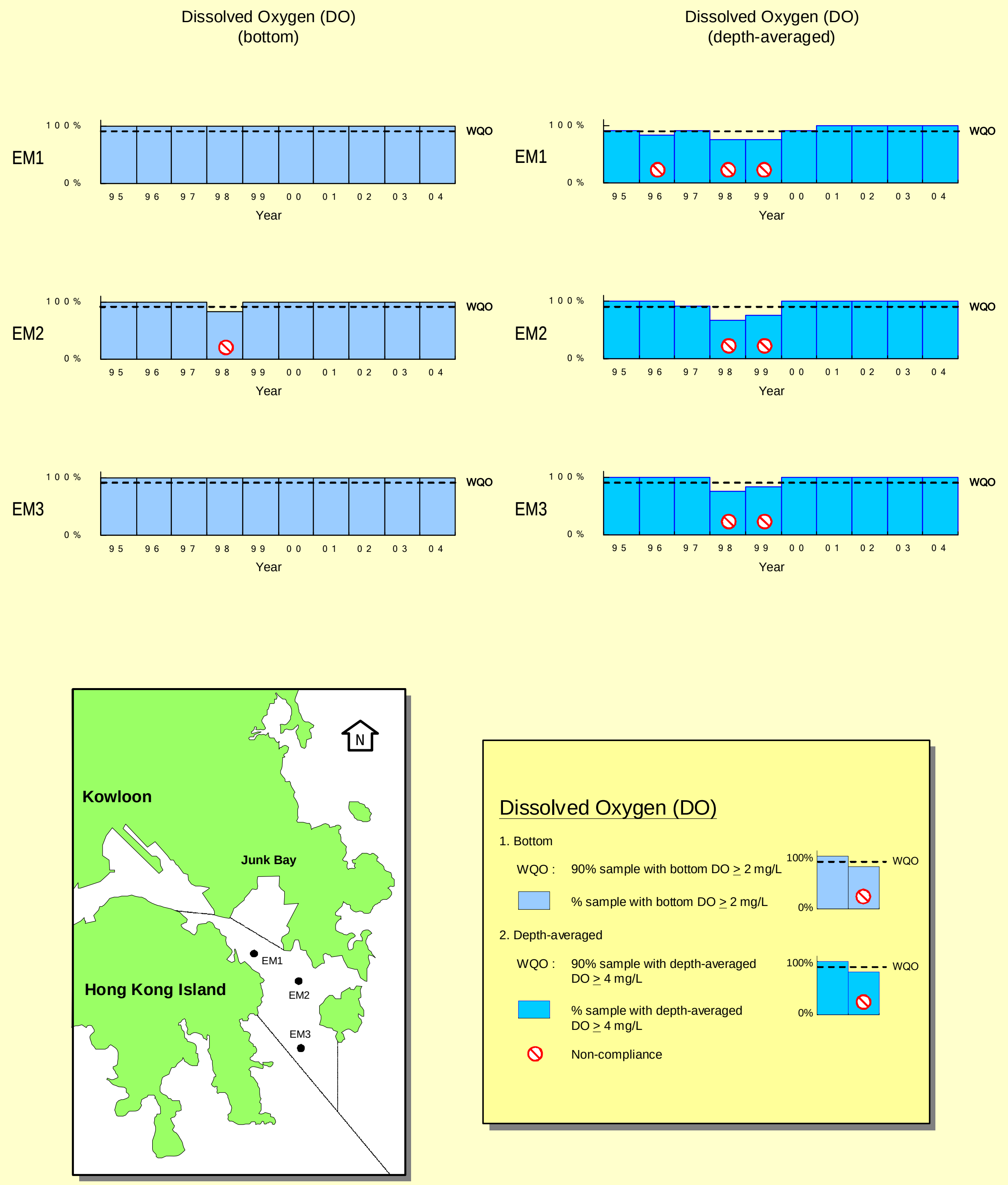
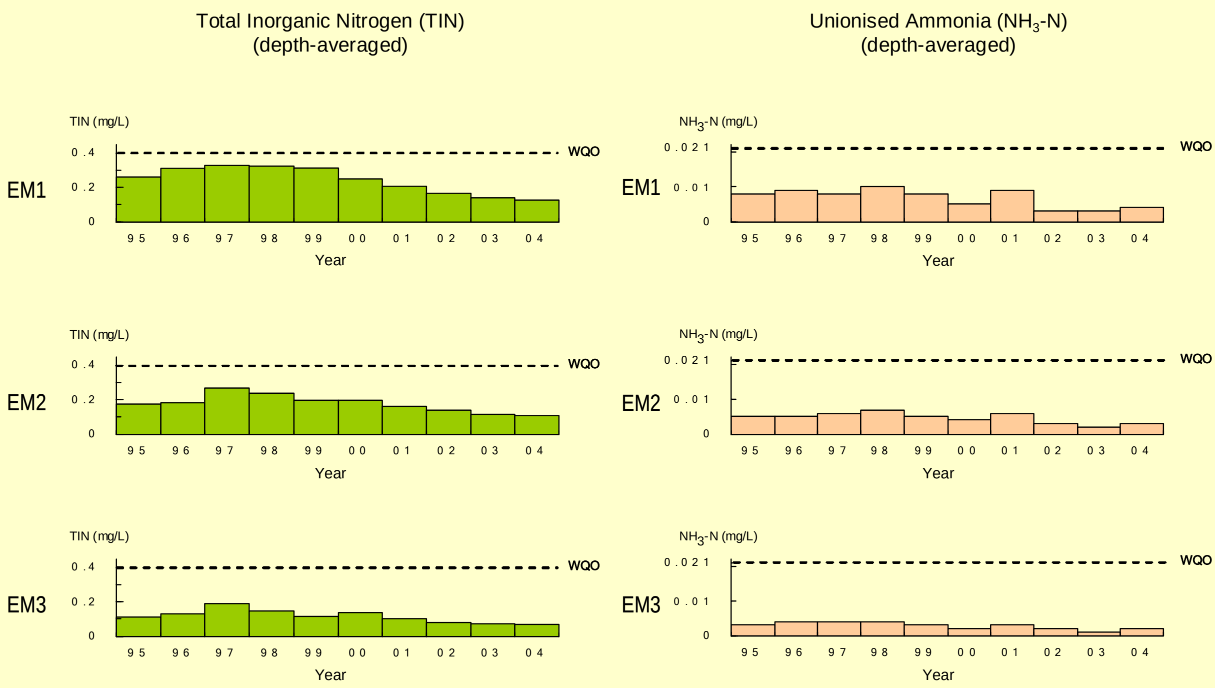
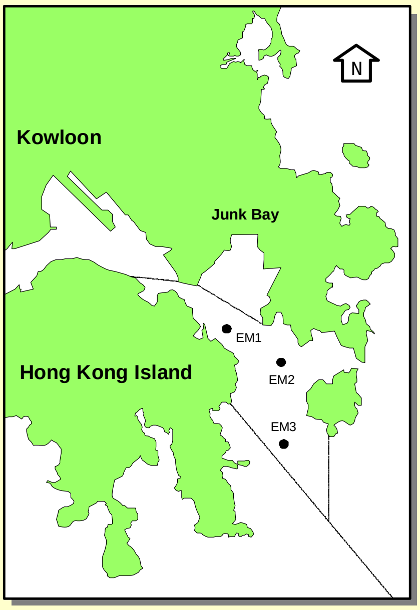


Figure 4.2 (continued) Level of compliance with key Water Quality Objectives in the Eastern Buffer WCZ





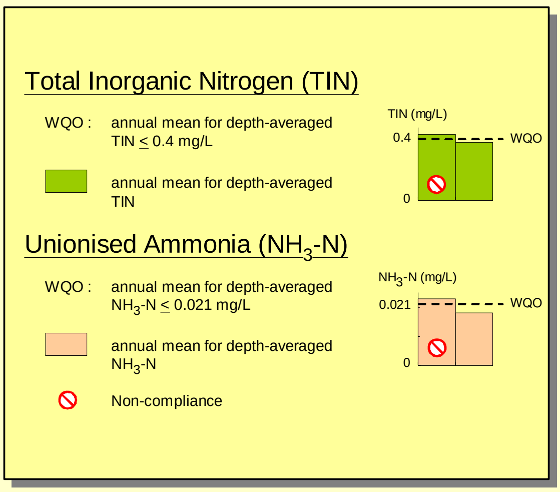
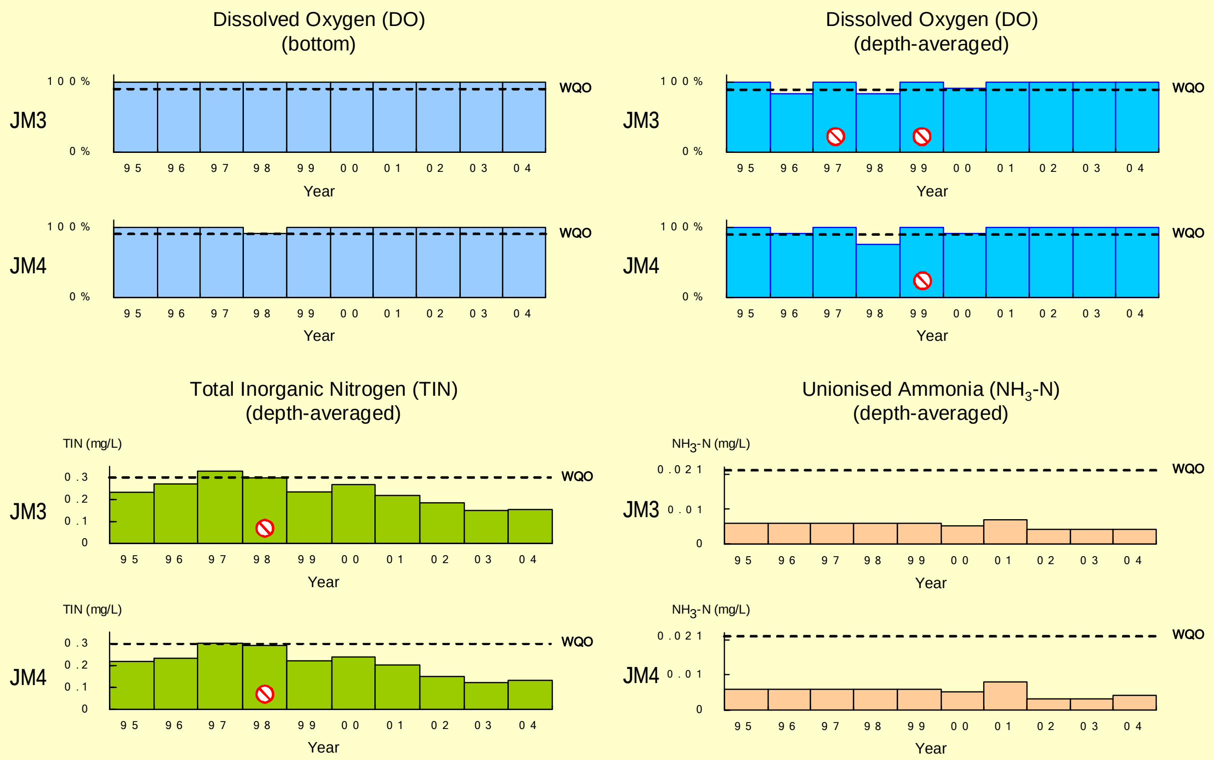
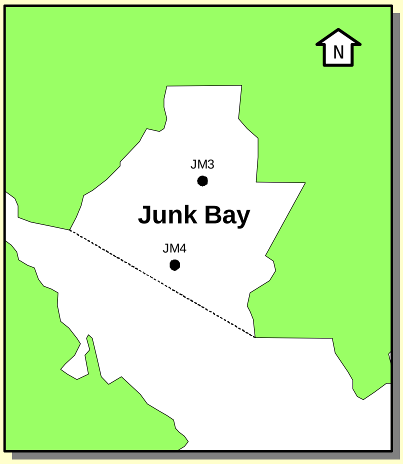


Figure 4.3 Level of compliance with key Water Quality Objectives in the Junk Bay WCZ





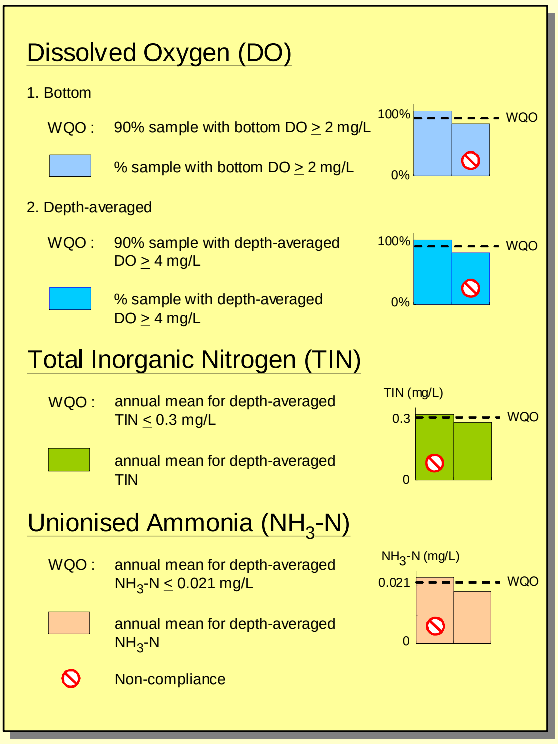
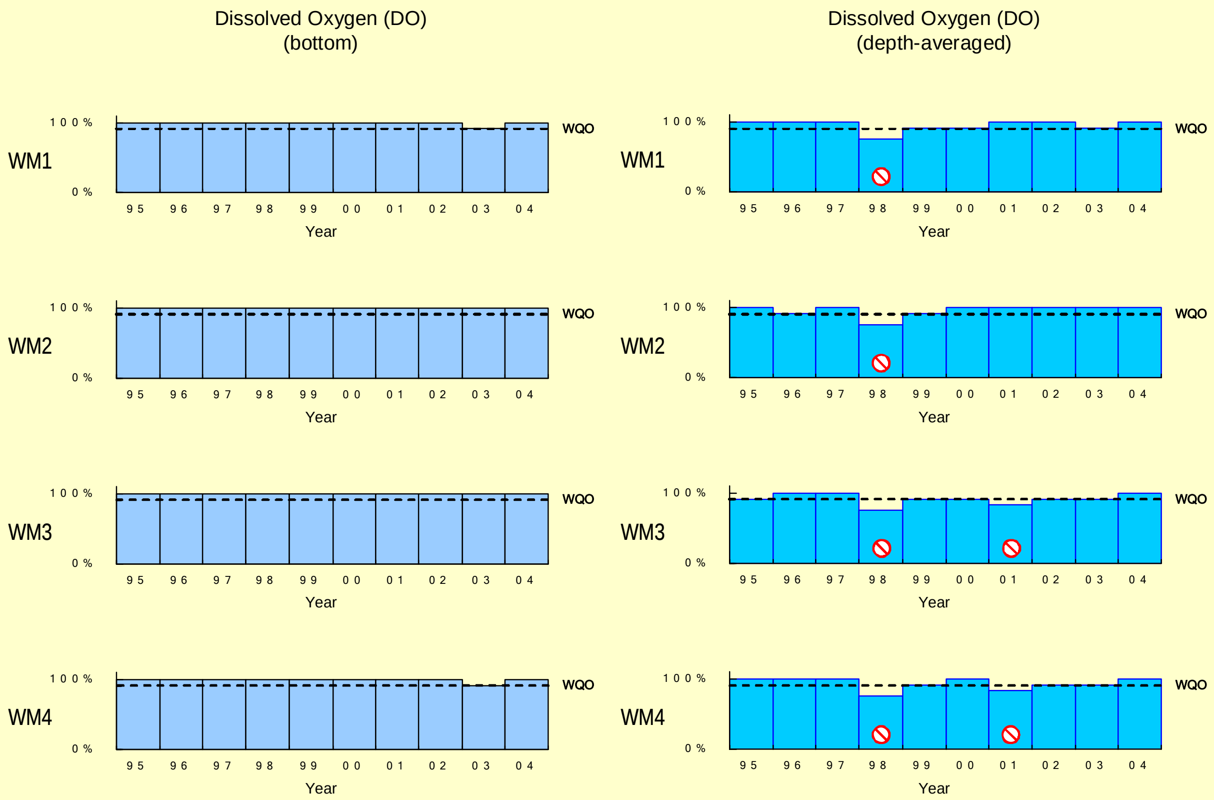
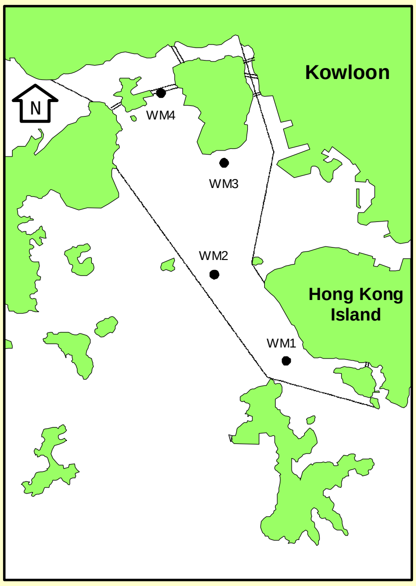


Figure 4.4 Level of compliance with key Water Quality Objectives in the Western Buffer WCZ





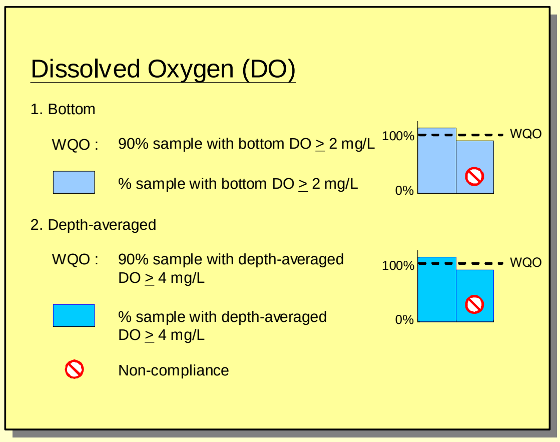


Figure 4.4 (continued) Level of compliance with key Water Quality Objectives in the Western Buffer WCZ

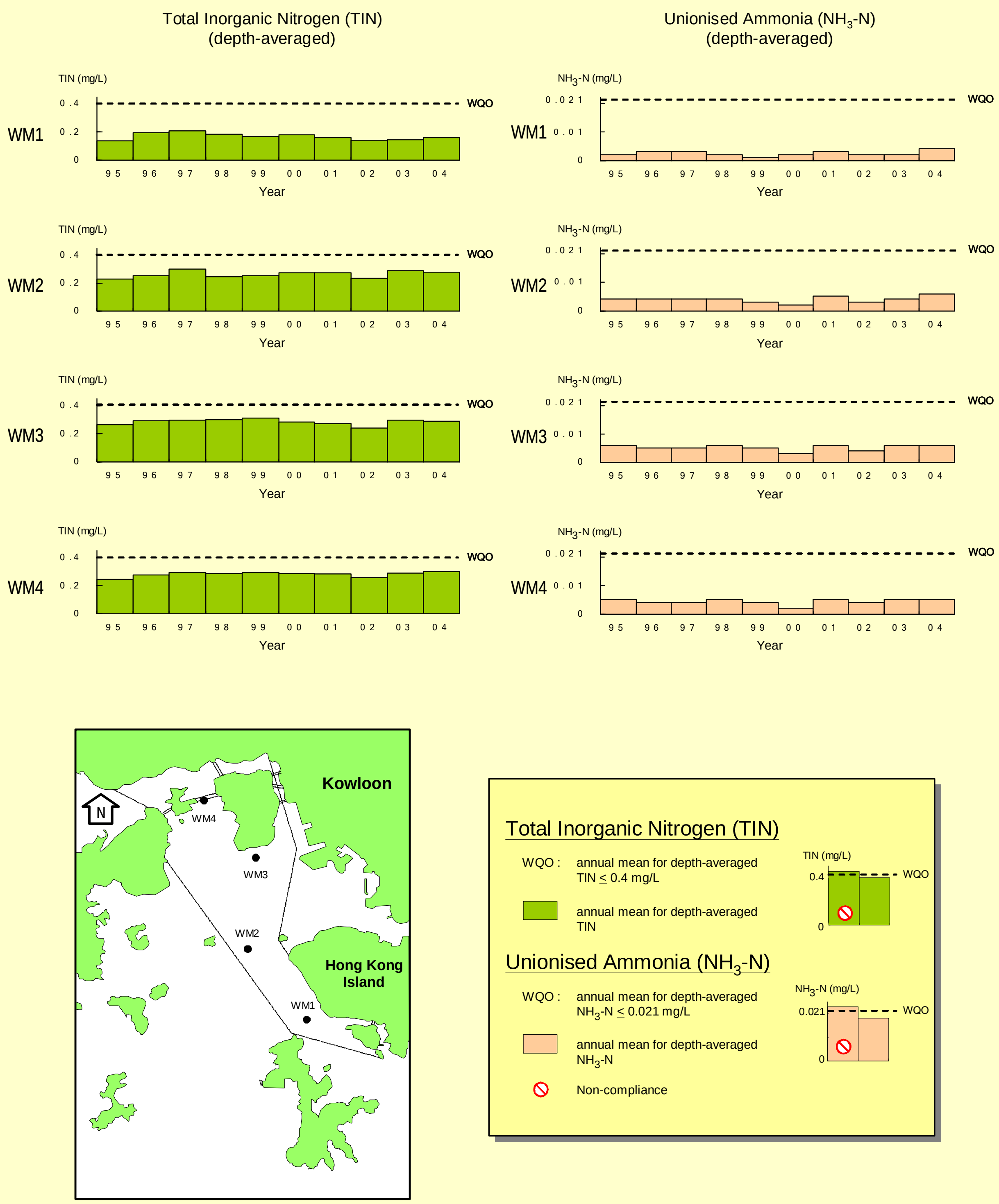


Table 4.1

Results of the Seasonal Kendall Test for water quality trends in the Victoria Harbour WCZ, 1986 – 2004

Monitoring Station		VM1	VM2	VM4	VM5	VM6
Monitoring Period		1988 – 2003	1988 – 2003	1988 – 2003	1986 – 2003	1988 – 2003
Parameter	Water Depth					
Temperature (°C)	Surface	↗	↗	↗	↗	↗
	Middle	↗	↗	↗	↗	↗
	Bottom	↗	↗	↗	↗	↗
	Average	↗	↗	↗	↗	↗
Salinity	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Dissolved Oxygen (mg/L)	Surface	-	-	-	-	-
	Middle	-	-	-	↗	↗
	Bottom	-	-	-	-	↗
	Average	-	-	-	-	-
Dissolved Oxygen (%)	Surface	-	-	-	-	-
	Middle	↗	-	↗	↗	↗
	Bottom	↗	↗	↗	↗	↗
	Average	↗	-	↗	↗	↗
pH	Surface	-	-	-	-	↘
	Middle	-	↘	-	-	↘
	Bottom	-	-	-	-	↘
	Average	-	-	-	-	↘
Secchi disc depth (m)		↗	↗	↗	↗	↗
Turbidity (NTU)	Surface	-	-	-	↗	↗
	Middle	↗	-	-	↗	↗
	Bottom	↗	-	-	↗	↗
	Average	↗	-	-	↗	↗
Suspended Solids (mg/L)	Surface	↘	↘	-	-	-
	Middle	-	↘	-	-	-
	Bottom	-	↘	-	-	-
	Average	-	↘	↘	-	-
Total volatile solids (mg/L)	Surface	↘	↘	↘	↘	↘
	Middle	↘	↘	↘	↘	↘
	Bottom	↘	↘	↘	↘	↘
	Average	↘	↘	↘	↘	↘
5-day Biochemical Oxygen Demand (mg/L)	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Ammonia nitrogen (mg/L)	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	↘	-	-	-	-
	Average	-	-	-	-	-
Nitrite nitrogen (mg/L)	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Nitrate nitrogen (mg/L)	Surface	-	-	-	↗	↗
	Middle	-	-	-	↗	↗
	Bottom	-	-	-	↗	-
	Average	-	-	-	↗	↗
Total inorganic nitrogen (mg/L)	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	↘	-	-	-	-
	Average	-	-	-	-	-
Total Kjeldahl nitrogen (mg/L)	Surface	↘	↘	↘	↘	↘
	Middle	↘	↘	↘	-	↘
	Bottom	↘	↘	↘	-	↘
	Average	↘	↘	↘	-	↘
Total nitrogen (mg/L)	Surface	↘	↘	↘	-	-
	Middle	↘	↘	↘	-	↘
	Bottom	↘	-	↘	-	↘
	Average	↘	↘	↘	-	↘
Orthophosphate phosphorus (mg/L)	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	↘	-	-	-	-
	Average	-	-	-	-	-
Total phosphorus (mg/L)	Surface	↘	↘	↘	-	-
	Middle	-	↘	-	-	-
	Bottom	↘	-	-	-	-
	Average	↘	↘	-	-	-
Silica (mg/L)	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Chlorophyll-*a* (μg/L)	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
E. coli (cfu/100mL)	Surface	-	-	-	↗	-
	Middle	-	-	-	↗	-
	Bottom	-	-	-	↗	-
	Average	-	-	-	↗	-
Faecal coliforms (cfu/100mL)	Surface	-	-	-	↗	-
	Middle	-	-	↗	↗	↗
	Bottom	-	-	↗	↗	↗
	Average	-	-	↗	↗	↗

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. - indicates no significant trend is detected
3. Test applied to past 19 years' data from each monitoring station unless stated otherwise
4. ↗ represents a significant increase over time
5. ↘ represents a significant decrease over time

Table 4.1 (continued)

Results of the Seasonal Kendall Test for water quality trends in the Victoria Harbour WCZ, 1986 – 2004

Monitoring Station		VM7	VM8	VM12	VM14	VM15
Monitoring Period		1986 – 2004	1986 – 2004	1986 – 2004	1986 – 2004	1993 – 2004
Parameter	Water Depth					
Temperature (°C)	Surface	↗	↗	↗	↗	-
	Middle	↗	↗	↗	↗	-
	Bottom	↗	↗	↗	↗	-
	Average	↗	↗	↗	↗	-
Salinity	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Dissolved Oxygen (mg/L)	Surface	-	-	-	-	-
	Middle	↗	-	↗	↗	-
	Bottom	↗	-	↗	↗	-
	Average	↗	-	↗	↗	-
Dissolved Oxygen (%)	Surface	-	-	↗	↗	-
	Middle	↗	-	↗	↗	↗
	Bottom	↗	-	↗	↗	-
	Average	↗	-	↗	↗	-
pH	Surface	-	↘	-	↘	-
	Middle	-	↘	-	-	-
	Bottom	-	↘	-	↘	-
	Average	-	↘	-	↘	-
Secchi disc depth (m)		-	↗	-	↗	↗
Turbidity (NTU)	Surface	↗	↗	↗	↗	↗
	Middle	↗	-	-	↗	↗
	Bottom	↗	↗	↗	↗	↗
	Average	↗	↗	↗	↗	↗
Suspended Solids (mg/L)	Surface	-	-	-	-	↘
	Middle	-	-	-	-	↘
	Bottom	-	-	-	-	-
	Average	-	-	-	-	↘
Total volatile solids (mg/L)	Surface	↘	↘	-	↘	↘
	Middle	↘	↘	-	↘	-
	Bottom	↘	↘	-	↘	-
	Average	↘	↘	-	↘	↘
5-day Biochemical Oxygen Demand (mg/L)	Surface	-	-	-	↘	-
	Middle	-	-	↘	↘	-
	Bottom	-	-	-	↘	-
	Average	-	-	-	↘	-
Ammonia nitrogen (mg/L)	Surface	-	-	↘	↘	-
	Middle	-	↗	↘	-	-
	Bottom	-	-	-	-	-
	Average	-	-	↘	-	-
Nitrite nitrogen (mg/L)	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Nitrate nitrogen (mg/L)	Surface	↗	↗	↗	↗	-
	Middle	↗	↗	↗	↗	-
	Bottom	↗	-	↗	↗	-
	Average	↗	↗	↗	↗	-
Total inorganic nitrogen (mg/L)	Surface	-	↗	-	-	-
	Middle	-	↗	-	-	↘
	Bottom	-	-	-	↗	↘
	Average	-	↗	-	-	↘
Total Kjeldahl nitrogen (mg/L)	Surface	↘	-	↘	↘	↘
	Middle	↘	-	↘	↘	↘
	Bottom	↘	↘	↘	↘	↘
	Average	↘	↘	↘	↘	↘
Total nitrogen (mg/L)	Surface	↘	-	↘	↘	↘
	Middle	↘	-	↘	↘	↘
	Bottom	↘	↘	↘	-	↘
	Average	↘	-	↘	↘	↘
Orthophosphate phosphorus (mg/L)	Surface	↘	-	↘	↘	↘
	Middle	-	-	↘	↘	↘
	Bottom	-	-	↘	↘	↘
	Average	-	-	↘	↘	↘
Total phosphorus (mg/L)	Surface	↘	-	↘	↘	↘
	Middle	-	-	↘	↘	↘
	Bottom	-	-	↘	↘	↘
	Average	-	-	↘	↘	↘
Silica (mg/L)	Surface	-	-	-	↘	↘
	Middle	-	-	-	-	↘
	Bottom	-	-	-	-	↘
	Average	-	-	-	-	↘
Chlorophyll-*a* (μg/L)	Surface	-	-	-	-	↗
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	↗
E. coli (cfu/100mL)	Surface	↗	↗	↗	-	-
	Middle	↗	↗	↗	-	-
	Bottom	↗	↗	↗	↗	-
	Average	↗	↗	↗	-	-
Faecal coliforms (cfu/100mL)	Surface	↗	↗	↗	-	-
	Middle	↗	↗	↗	↗	-
	Bottom	↗	↗	↗	↗	-
	Average	↗	↗	↗	↗	-

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. - indicates no significant trend is detected
3. Test applied to past 19 years' data from each monitoring station unless stated otherwise
4. ↗ represents a significant increase over time
5. ↘ represents a significant decrease over time

Table 4.2

Results of the Seasonal Kendall Test for water quality trends in the Eastern Buffer WCZ, 1986 – 2004

Monitoring Station		EM1	EM2	EM3
Monitoring Period		1986 - 2004	1986 - 2004	1986 - 2004
Parameter	Water Depth			
Temperature (°C)	Surface	↗	↗	↗
	Middle	↗	↗	↗
	Bottom	↗	↗	↗
	Average	↗	↗	↗
Salinity	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Dissolved Oxygen (mg/L)	Surface	-	-	↘
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Dissolved Oxygen (%)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
pH	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Secchi disc depth (m)		-	-	-
Turbidity (NTU)	Surface	↗	↗	↗
	Middle	↗	↗	↗
	Bottom	↗	↗	↗
	Average	↗	↗	↗
Suspended Solids (mg/L)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Total volatile solids (mg/L)	Surface	↘	↘	↘
	Middle	↘	↘	↘
	Bottom	↘	↘	-
	Average	↘	↘	↘
5-day Biochemical Oxygen Demand (mg/L)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Ammonia nitrogen (mg/L)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Nitrite nitrogen (mg/L)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Nitrate nitrogen (mg/L)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Total inorganic nitrogen (mg/L)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Total Kjeldahl nitrogen (mg/L)	Surface	↘	↘	↘
	Middle	↘	↘	↘
	Bottom	↘	↘	↘
	Average	↘	↘	↘
Total nitrogen (mg/L)	Surface	↘	↘	↘
	Middle	↘	↘	↘
	Bottom	↘	↘	↘
	Average	↘	↘	↘
Orthophosphate phosphorus (mg/L)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Total phosphorus (mg/L)	Surface	-	↘	↘
	Middle	↘	↘	↘
	Bottom	↘	-	↘
	Average	↘	↘	↘
Silica (mg/L)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Chlorophyll-*a* (μg/L)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
E. coli (cfu/100mL)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	↘	↘
	Average	-	-	-
Faecal coliforms (cfu/100mL)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-

Note 1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. - indicates no significant trend is detected
3. ↗ represents a significant increase over time
4. ↘ represents a significant decrease over time

Table 4.3

Results of the Seasonal Kendall Test for water quality trends in the Junk Bay WCZ, 1986 – 2004

Monitoring Station		JM3	JM4
Monitoring Period		1986 – 2004	1986 – 2004
Parameter	Water Depth		
Temperature (°C)	Surface	↗	↗
	Middle	↗	↗
	Bottom	↗	↗
	Average	↗	↗
Salinity	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Dissolved Oxygen (mg/L)	Surface	↘	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Dissolved Oxygen (%)	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
pH	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Secchi disc depth (m)		-	-
Turbidity (NTU)	Surface	↗	↗
	Middle	↗	↗
	Bottom	↗	↗
	Average	↗	↗
Suspended Solids (mg/L)	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Total volatile solids (mg/L)	Surface	↘	↘
	Middle	↘	↘
	Bottom	↘	-
	Average	↘	↘
5-day Biochemical Oxygen Demand (mg/L)	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Ammonia nitrogen (mg/L)	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Nitrite nitrogen (mg/L)	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Nitrate nitrogen (mg/L)	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Total inorganic nitrogen (mg/L)	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Total Kjeldahl nitrogen (mg/L)	Surface	↘	↘
	Middle	↘	↘
	Bottom	↘	↘
	Average	↘	↘
Total nitrogen (mg/L)	Surface	↘	↘
	Middle	↘	↘
	Bottom	↘	↘
	Average	↘	↘
Orthophosphate phosphorus (mg/L)	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Total phosphorus (mg/L)	Surface	↘	↘
	Middle	↘	↘
	Bottom	↘	↘
	Average	↘	↘
Silica (mg/L)	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Chlorophyll-*a* (μg/L)	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
E. coli (cfu/100mL)	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Faecal coliforms (cfu/100mL)	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. – indicates no significant trend is detected
3. ↗ represents a significant increase over time
4. ↘ represents a significant decrease over time

Table 4.4

Results of the Seasonal Kendall Test for trends in water quality parameters measured in the Western Buffer WCZ, 1986 – 2004

Monitoring Station / Monitoring Period		WM1 1988 – 2004	WM2 1988 – 2004	WM3 1986 – 2004	WM4 1986 – 2004
Parameter	Water Depth				
Temperature (°C)	Surface	↗	↗	↗	↗
	Middle	↗	↗	↗	↗
	Bottom	↗	↗	↗	↗
	Average	↗	↗	↗	↗
Salinity	Surface	-	-	-	-
	Middle	-	-	-	-
	Bottom	↗	-	-	-
	Average	↗	-	-	-
Dissolved Oxygen (mg/L)	Surface	-	-	-	-
	Middle	-	-	-	-
	Bottom	-	-	-	-
	Average	-	-	-	-
Dissolved Oxygen (%)	Surface	-	-	-	-
	Middle	-	-	-	-
	Bottom	-	-	-	-
	Average	-	-	-	-
pH	Surface	-	-	-	-
	Middle	-	-	-	-
	Bottom	-	-	-	-
	Average	-	-	-	-
Secchi disc depth (m)		-	-	-	-
Turbidity (NTU)	Surface	↗	↗	↗	↗
	Middle	↗	↗	↗	↗
	Bottom	↗	↗	↗	↗
	Average	↗	↗	↗	↗
Suspended Solids (mg/L)	Surface	-	-	-	-
	Middle	-	-	-	-
	Bottom	↗	-	-	-
	Average	↗	-	-	-
Total volatile solids (mg/L)	Surface	-	-	↘	-
	Middle	-	-	↘	-
	Bottom	-	-	-	-
	Average	-	-	-	-
5-day Biochemical Oxygen Demand (mg/L)	Surface	-	-	-	-
	Middle	-	-	-	-
	Bottom	-	-	-	-
	Average	-	-	-	-
Ammonia nitrogen (mg/L)	Surface	-	-	-	-
	Middle	-	-	-	-
	Bottom	↘	-	-	-
	Average	-	-	-	-
Nitrite nitrogen (mg/L)	Surface	-	-	-	-
	Middle	-	-	-	-
	Bottom	-	-	-	-
	Average	-	-	-	-
Nitrate nitrogen (mg/L)	Surface	-	-	↗	↗
	Middle	-	-	-	↗
	Bottom	-	-	-	-
	Average	-	-	↗	↗
Total inorganic nitrogen (mg/L)	Surface	-	↗	↗	↗
	Middle	-	↗	-	-
	Bottom	-	-	-	-
	Average	-	↗	-	↗
Total Kjeldahl nitrogen (mg/L)	Surface	↘	↘	↘	↘
	Middle	↘	↘	↘	↘
	Bottom	↘	↘	↘	↘
	Average	↘	↘	↘	↘
Total nitrogen (mg/L)	Surface	-	-	-	-
	Middle	↘	-	-	-
	Bottom	↘	↘	↘	↘
	Average	↘	-	↘	-
Orthophosphate phosphorus (mg/L)	Surface	-	-	-	-
	Middle	-	-	-	-
	Bottom	-	-	-	-
	Average	-	-	-	-
Total phosphorus (mg/L)	Surface	↘	↘	↘	-
	Middle	↘	↘	↘	-
	Bottom	↘	↘	↘	-
	Average	↘	↘	↘	-
Silica (mg/L)	Surface	↘	-	↘	-
	Middle	-	↘	-	-
	Bottom	-	-	-	-
	Average	-	↘	↘	-
Chlorophyll-*a* (µg/L)	Surface	↗	↗	↗	↗
	Middle	-	↗	↗	-
	Bottom	-	↗	-	-
	Average	↗	↗	-	-
E. coli (cfu/100mL)	Surface	-	↗	↗	↗
	Middle	-	↗	↗	↗
	Bottom	↘	↗	↗	↗
	Average	-	↗	↗	↗
Faecal coliforms (cfu/100mL)	Surface	↘	↗	↗	↗
	Middle	-	↗	↗	↗
	Bottom	-	↗	↗	↗
	Average	-	↗	↗	↗

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. - indicates no significant trend is detected
3. Test applied to past 19 years' data from each monitoring station unless stated otherwise
4. ↗ represents a significant increase over time
5. ↘ represents a significant decrease over time

Table 4.5

Summary water quality statistics of the Victoria Harbour WCZ in 2004

Parameter		Victoria Harbour (East) VM1	Victoria Harbour (East) VM2	Victoria Harbour (Central) VM4	Victoria Harbour (Central) VM5	Victoria Harbour (Central) VM6
Number of samples		12	12	12	12	12
Temperature (°C)		23.4 (15.9 - 28.0)	23.5 (15.9 - 28.0)	23.6 (16.0 - 28.0)	23.7 (16.0 - 28.1)	23.6 (16.0 - 28.0)
Salinity		32.9 (30.5 - 34.0)	32.5 (28.6 - 33.8)	32.4 (29.2 - 33.9)	32.2 (28.5 - 33.7)	32.1 (27.1 - 33.6)
Dissolved Oxygen (mg/L)		5.6 (3.4 - 7.7)	5.4 (3.4 - 7.9)	5.4 (3.9 - 7.5)	5.4 (3.9 - 7.5)	5.4 (4.0 - 7.5)
	Bottom	5.5 (3.3 - 7.8)	5.4 (3.2 - 7.9)	5.4 (3.9 - 7.5)	5.3 (3.8 - 7.6)	5.3 (3.9 - 7.5)
Dissolved Oxygen (% Saturation)		77 (51 - 101)	75 (51 - 102)	75 (59 - 104)	74 (60 - 104)	74 (60 - 102)
	Bottom	76 (50 - 102)	74 (49 - 102)	74 (59 - 96)	72 (58 - 98)	72 (57 - 93)
pH		8.1 (7.9 - 8.2)	8.1 (7.9 - 8.2)	8.0 (7.9 - 8.2)	8.0 (7.9 - 8.2)	8.0 (7.9 - 8.2)
Secchi Disc Depth (m)		2.6 (1.5 - 4.0)	2.5 (1.2 - 3.8)	2.4 (1.6 - 3.2)	2.2 (1.4 - 3.5)	2.2 (1.2 - 3.1)
Turbidity (NTU)		10.1 (4.1 - 12.3)	8.9 (5.5 - 12.1)	9.5 (6.7 - 12.6)	9.6 (7.4 - 12.4)	9.4 (7.1 - 11.3)
Suspended Solids (mg/L)		5.7 (2.1 - 10.8)	5.2 (2.1 - 12.8)	5.4 (2.2 - 8.3)	5.7 (2.2 - 10.8)	5.2 (2.4 - 8.9)
5-day Biochemical Oxygen Demand (mg/L)		0.8 (0.3 - 1.7)	0.8 (0.3 - 1.9)	0.9 (0.4 - 1.9)	1.1 (0.5 - 2.3)	1.1 (0.5 - 2.6)
Ammonia Nitrogen (mg/L)		0.11 (0.05 - 0.21)	0.13 (0.06 - 0.28)	0.15 (0.06 - 0.28)	0.19 (0.09 - 0.32)	0.20 (0.12 - 0.32)
Unionised Ammonia (mg/L)		0.005 (0.002 - 0.013)	0.006 (0.003 - 0.014)	0.007 (0.003 - 0.015)	0.008 (0.004 - 0.018)	0.009 (0.004 - 0.019)
Nitrite Nitrogen (mg/L)		0.02 (<0.01 - 0.05)	0.02 (<0.01 - 0.05)	0.02 (<0.01 - 0.05)	0.02 (0.01 - 0.05)	0.02 (0.01 - 0.05)
Nitrate Nitrogen (mg/L)		0.06 (0.01 - 0.12)	0.07 (0.02 - 0.15)	0.08 (0.02 - 0.18)	0.09 (0.03 - 0.21)	0.09 (0.04 - 0.25)
Total Inorganic Nitrogen (mg/L)		0.18 (0.07 - 0.30)	0.22 (0.08 - 0.39)	0.25 (0.08 - 0.37)	0.31 (0.13 - 0.43)	0.32 (0.17 - 0.45)
Total Kjeldahl Nitrogen (mg/L)		0.21 (0.09 - 0.34)	0.25 (0.12 - 0.45)	0.28 (0.11 - 0.46)	0.35 (0.19 - 0.53)	0.35 (0.20 - 0.50)
Total Nitrogen (mg/L)		0.28 (0.11 - 0.43)	0.33 (0.15 - 0.55)	0.37 (0.14 - 0.56)	0.47 (0.23 - 0.61)	0.47 (0.25 - 0.61)
Orthophosphate Phosphorus (mg/L)		0.02 (0.01 - 0.04)	0.03 (0.01 - 0.05)	0.03 (0.01 - 0.05)	0.04 (0.02 - 0.06)	0.04 (0.03 - 0.06)
Total Phosphorus (mg/L)		0.04 (0.02 - 0.06)	0.04 (0.02 - 0.07)	0.05 (0.02 - 0.06)	0.05 (0.04 - 0.08)	0.05 (0.04 - 0.07)
Silica (as SiO_2) (mg/L)		0.7 (0.2 - 1.5)	0.7 (0.2 - 1.5)	0.7 (0.2 - 1.5)	0.8 (0.2 - 1.4)	0.8 (0.2 - 1.5)
Chlorophyll-*a* (µg/L)		2.4 (0.6 - 5.9)	2.4 (0.6 - 7.3)	2.3 (0.4 - 9.3)	2.8 (0.5 - 9.6)	2.9 (0.4 - 8.1)
E. coli (cfu/100mL)		480 (65 - 3900)	630 (27 - 3300)	2400 (510 - 9600)	6200 (1800 - 15000)	3400 (970 - 15000)
Faecal Coliforms (cfu/100mL)		940 (130 - 9000)	1400 (41 - 13000)	4700 (2100 - 15000)	12000 (2700 - 34000)	6800 (1300 - 36000)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths: Surface (S), Mid-depth (M), Bottom (B).
2. Data presented are annual arithmetic means of the depth-averaged results except for *E. coli* and faecal coliforms which are annual geometric means.

Table 4.5 (continued)

Summary water quality statistics of the Victoria Harbour WCZ in 2004

Parameter		Victoria Harbour (West) VM7	Victoria Harbour (West) VM8	Stonecutters Island VM15	Rambler Channel VM12	Rambler Channel VM14
Number of samples		12	12	12	12	12
Temperature (°C)		23.8 (16.1 - 29.0)	23.7 (16.3 - 28.7)	23.7 (16.0 - 28.0)	23.6 (16.1 - 28.8)	24.0 (16.1 - 29.3)
Salinity		31.6 (26.7 - 33.5)	31.7 (27.2 - 33.9)	32.1 (26.5 - 33.6)	31.5 (25.8 - 33.7)	29.9 (20.3 - 33.8)
Dissolved Oxygen (mg/L)		5.8 (4.3 - 7.5)	5.9 (4.0 - 9.0)	5.4 (3.9 - 7.5)	5.6 (3.3 - 7.5)	5.9 (4.4 - 7.5)
	Bottom	5.7 (4.2 - 7.5)	6.0 (3.9 - 10.9)	5.3 (3.9 - 7.5)	5.4 (3.4 - 7.5)	5.8 (4.6 - 7.5)
Dissolved Oxygen (% Saturation)		80 (64 - 98)	83 (59 - 128)	73 (58 - 100)	77 (49 - 107)	82 (65 - 102)
	Bottom	78 (63 - 91)	84 (58 - 155)	72 (58 - 91)	74 (49 - 93)	80 (67 - 97)
pH		8.0 (7.9 - 8.2)	8.0 (7.9 - 8.2)	8.0 (7.9 - 8.2)	8.0 (7.9 - 8.2)	8.1 (8.0 - 8.2)
Secchi Disc Depth (m)		2.0 (1.1 - 3.1)	2.2 (1.0 - 3.6)	2.2 (1.4 - 3.5)	1.8 (1.1 - 2.8)	1.8 (0.6 - 2.7)
Turbidity (NTU)		10.2 (8.1 - 12.4)	10.8 (8.4 - 14.8)	10.9 (6.5 - 15.7)	13.9 (9.9 - 17.7)	11.6 (8.6 - 17.3)
Suspended Solids (mg/L)		5.9 (2.8 - 8.8)	7.0 (3.6 - 13.0)	9.5 (2.9 - 37.1)	10.5 (4.7 - 13.7)	8.1 (3.5 - 15.7)
5-day Biochemical Oxygen Demand (mg/L)		1.4 (0.8 - 4.7)	0.9 (0.3 - 2.4)	0.9 (0.5 - 1.4)	0.8 (0.3 - 1.2)	1.0 (0.3 - 1.8)
Ammonia Nitrogen (mg/L)		0.24 (0.13 - 0.35)	0.18 (0.09 - 0.45)	0.20 (0.12 - 0.35)	0.17 (0.11 - 0.26)	0.16 (0.09 - 0.23)
Unionised Ammonia (mg/L)		0.011 (0.004 - 0.027)	0.008 (0.004 - 0.023)	0.008 (0.004 - 0.016)	0.007 (0.004 - 0.010)	0.007 (0.003 - 0.013)
Nitrite Nitrogen (mg/L)		0.03 (0.01 - 0.06)	0.03 (0.01 - 0.08)	0.02 (0.01 - 0.05)	0.04 (0.01 - 0.08)	0.05 (0.01 - 0.10)
Nitrate Nitrogen (mg/L)		0.14 (0.05 - 0.30)	0.13 (0.04 - 0.29)	0.10 (0.05 - 0.29)	0.16 (0.06 - 0.33)	0.23 (0.07 - 0.58)
Total Inorganic Nitrogen (mg/L)		0.41 (0.20 - 0.57)	0.34 (0.17 - 0.59)	0.33 (0.19 - 0.51)	0.37 (0.27 - 0.49)	0.43 (0.24 - 0.73)
Total Kjeldahl Nitrogen (mg/L)		0.41 (0.23 - 0.60)	0.31 (0.20 - 0.64)	0.34 (0.22 - 0.51)	0.30 (0.21 - 0.37)	0.31 (0.24 - 0.43)
Total Nitrogen (mg/L)		0.58 (0.29 - 0.72)	0.47 (0.26 - 0.77)	0.46 (0.28 - 0.64)	0.50 (0.38 - 0.63)	0.58 (0.35 - 0.90)
Orthophosphate Phosphorus (mg/L)		0.04 (0.03 - 0.07)	0.03 (0.02 - 0.07)	0.04 (0.03 - 0.05)	0.03 (0.02 - 0.04)	0.03 (0.01 - 0.04)
Total Phosphorus (mg/L)		0.06 (0.04 - 0.09)	0.05 (0.04 - 0.08)	0.05 (0.04 - 0.07)	0.05 (0.04 - 0.06)	0.05 (0.04 - 0.06)
Silica (as SiO_2) (mg/L)		0.8 (0.3 - 1.3)	0.8 (0.2 - 1.6)	0.8 (0.2 - 1.6)	0.9 (0.2 - 1.8)	1.1 (0.3 - 2.2)
Chlorophyll-*a* (µg/L)		4.2 (0.3 - 16.8)	3.0 (0.5 - 10.9)	2.6 (0.4 - 6.6)	2.7 (0.4 - 6.3)	5.7 (0.4 - 25.0)
E. coli (cfu/100mL)		8300 (540 - 26000)	4000 (620 - 56000)	1500 (280 - 5400)	2300 (760 - 5800)	1300 (330 - 5900)
Faecal Coliforms (cfu/100mL)		19000 (1600 - 95000)	7900 (1000 - 160000)	3300 (410 - 12000)	5100 (1600 - 14000)	2800 (600 - 17000)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths: Surface (S), Mid-depth (M), Bottom (B).
2. Data presented are annual arithmetic means of the depth-averaged results except for *E. coli* and faecal coliforms which are annual geometric means.

Table 4.6

Summary water quality statistics of the Eastern Buffer WCZ in 2004

Parameter		Chai Wan EM1	Tathong Channel EM2	Tathong Channel EM3
Number of samples		12	12	12
Temperature (°C)		23.0 (17.3 - 28.1)	23.0 (17.6 - 28.1)	22.9 (17.0 - 28.1)
Salinity		33.4 (32.7 - 33.9)	33.5 (32.7 - 34.0)	33.5 (32.7 - 34.1)
Dissolved Oxygen (mg/L)		6.0 (4.9 - 8.1)	6.2 (5.0 - 8.0)	6.3 (5.0 - 7.8)
	Bottom	6.0 (4.7 - 8.0)	6.2 (5.0 - 8.2)	6.1 (3.8 - 8.0)
Dissolved Oxygen (% Saturation)		82 (72 - 105)	86 (73 - 104)	88 (72 - 101)
	Bottom	82 (68 - 104)	86 (74 - 106)	85 (55 - 103)
pH		8.1 (7.9 - 8.3)	8.1 (8.0 - 8.3)	8.2 (8.0 - 8.3)
Secchi Disc Depth (m)		2.7 (1.5 - 4.5)	3.0 (1.7 - 5.3)	3.3 (1.7 - 5.8)
Turbidity (NTU)		8.7 (4.0 - 14.2)	9.0 (4.5 - 17.2)	9.5 (4.4 - 17.2)
Suspended Solids (mg/L)		3.9 (1.2 - 10.8)	5.8 (1.3 - 22.9)	4.0 (1.7 - 14.2)
5-day Biochemical Oxygen Demand (mg/L)		0.8 (0.3 - 1.6)	0.7 (0.2 - 2.4)	0.6 (0.2 - 1.4)
Ammonia Nitrogen (mg/L)		0.07 (0.03 - 0.17)	0.05 (0.02 - 0.10)	0.03 (0.01 - 0.07)
Unionised Ammonia (mg/L)		0.004 (0.001 - 0.007)	0.003 (0.001 - 0.009)	0.002 (0.001 - 0.004)
Nitrite Nitrogen (mg/L)		0.02 (<0.01 - 0.04)	0.02 (<0.01 - 0.04)	0.01 (<0.01 - 0.03)
Nitrate Nitrogen (mg/L)		0.04 (0.01 - 0.09)	0.04 (0.01 - 0.10)	0.02 (0.01 - 0.07)
Total Inorganic Nitrogen (mg/L)		0.13 (0.05 - 0.24)	0.11 (0.04 - 0.18)	0.07 (0.03 - 0.13)
Total Kjeldahl Nitrogen (mg/L)		0.15 (0.07 - 0.27)	0.13 (0.06 - 0.21)	0.10 (0.06 - 0.21)
Total Nitrogen (mg/L)		0.21 (0.13 - 0.35)	0.18 (0.11 - 0.28)	0.14 (0.08 - 0.26)
Orthophosphate Phosphorus (mg/L)		0.02 (0.01 - 0.03)	0.01 (0.01 - 0.02)	0.01 (0.01 - 0.01)
Total Phosphorus (mg/L)		0.03 (0.02 - 0.05)	0.03 (0.02 - 0.04)	0.02 (0.02 - 0.03)
Silica (as SiO_2) (mg/L)		0.7 (0.2 - 1.5)	0.6 (0.3 - 1.4)	0.6 (0.2 - 1.4)
Chlorophyll-*a* (µg/L)		2.4 (0.7 - 6.3)	2.4 (0.5 - 5.5)	1.7 (0.6 - 5.5)
E. coli (cfu/100mL)		38 (1 - 140)	14 (1 - 76)	2 (1 - 5)
Faecal Coliforms (cfu/100mL)		84 (1 - 400)	38 (1 - 270)	5 (1 - 89)

Note :
1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths: Surface (S), Mid-depth (M), Bottom (B).
2. Data presented are annual arithmetic means of the depth-averaged results except for *E. coli* and faecal coliforms which are annual geometric means.
3. Data in brackets indicate the ranges.

Table 4.7

Summary water quality statistics of the Junk Bay WCZ in 2004

	Junk Bay	
Parameter	JM3	JM4
Number of samples	12	12
Temperature (°C)	23.1 (16.2 - 28.2)	23.0 (16.6 - 28.2)
Salinity	33.2 (32.6 - 33.9)	33.3 (32.3 - 34.0)
Dissolved Oxygen (mg/L)	5.8 (4.3 - 7.5)	6.2 (4.8 - 7.8)
Bottom	5.9 (4.6 - 7.7)	6.3 (4.8 - 8.1)
Dissolved Oxygen (% Saturation)	80 (64 - 100)	85 (71 - 116)
Bottom	81 (61 - 100)	87 (72 - 118)
pH	8.1 (8.0 - 8.2)	8.1 (8.0 - 8.2)
Secchi Disc Depth (m)	2.7 (1.9 - 4.1)	2.8 (0.5 - 4.5)
Turbidity (NTU)	8.4 (4.7 - 11.6)	8.6 (4.2 - 14.4)
Suspended Solids (mg/L)	3.6 (1.5 - 7.0)	3.8 (2.0 - 7.7)
5-day Biochemical Oxygen Demand (mg/L)	0.8 (0.3 - 1.3)	0.8 (0.2 - 2.3)
Ammonia Nitrogen (mg/L)	0.09 (0.04 - 0.17)	0.07 (0.03 - 0.13)
Unionised Ammonia (mg/L)	0.004 (0.002 - 0.007)	0.004 (0.001 - 0.010)
Nitrite Nitrogen (mg/L)	0.02 (<0.01 - 0.05)	0.02 (<0.01 - 0.05)
Nitrate Nitrogen (mg/L)	0.05 (0.02 - 0.09)	0.04 (0.01 - 0.07)
Total Inorganic Nitrogen (mg/L)	0.15 (0.09 - 0.26)	0.13 (0.06 - 0.20)
Total Kjeldahl Nitrogen (mg/L)	0.18 (0.10 - 0.29)	0.16 (0.08 - 0.24)
Total Nitrogen (mg/L)	0.25 (0.16 - 0.41)	0.22 (0.12 - 0.33)
Orthophosphate Phosphorus (mg/L)	0.02 (0.01 - 0.03)	0.02 (0.01 - 0.03)
Total Phosphorus (mg/L)	0.03 (0.02 - 0.05)	0.03 (0.02 - 0.04)
Silica (as SiO_2) (mg/L)	0.7 (0.2 - 1.7)	0.6 (0.2 - 1.5)
Chlorophyll-*a* (µg/L)	2.6 (0.7 - 6.0)	2.7 (0.7 - 7.0)
E. coli (cfu/100mL)	52 (6 - 460)	33 (3 - 300)
Faecal Coliforms (cfu/100mL)	130 (8 - 1100)	79 (6 - 620)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths: Surface (S), Mid-depth (M), Bottom (B).
2. Data presented are annual arithmetic means of the depth-averaged results except for *E. coli* and faecal coliforms which are annual geometric means.
3. Data in brackets indicate the ranges.

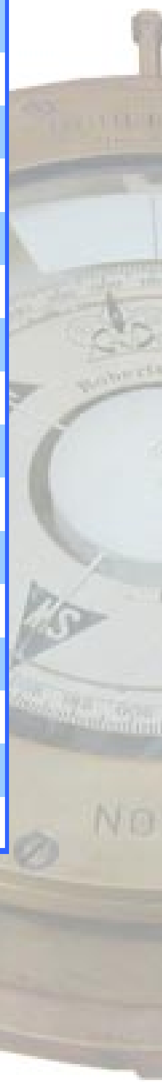


Table 4.8

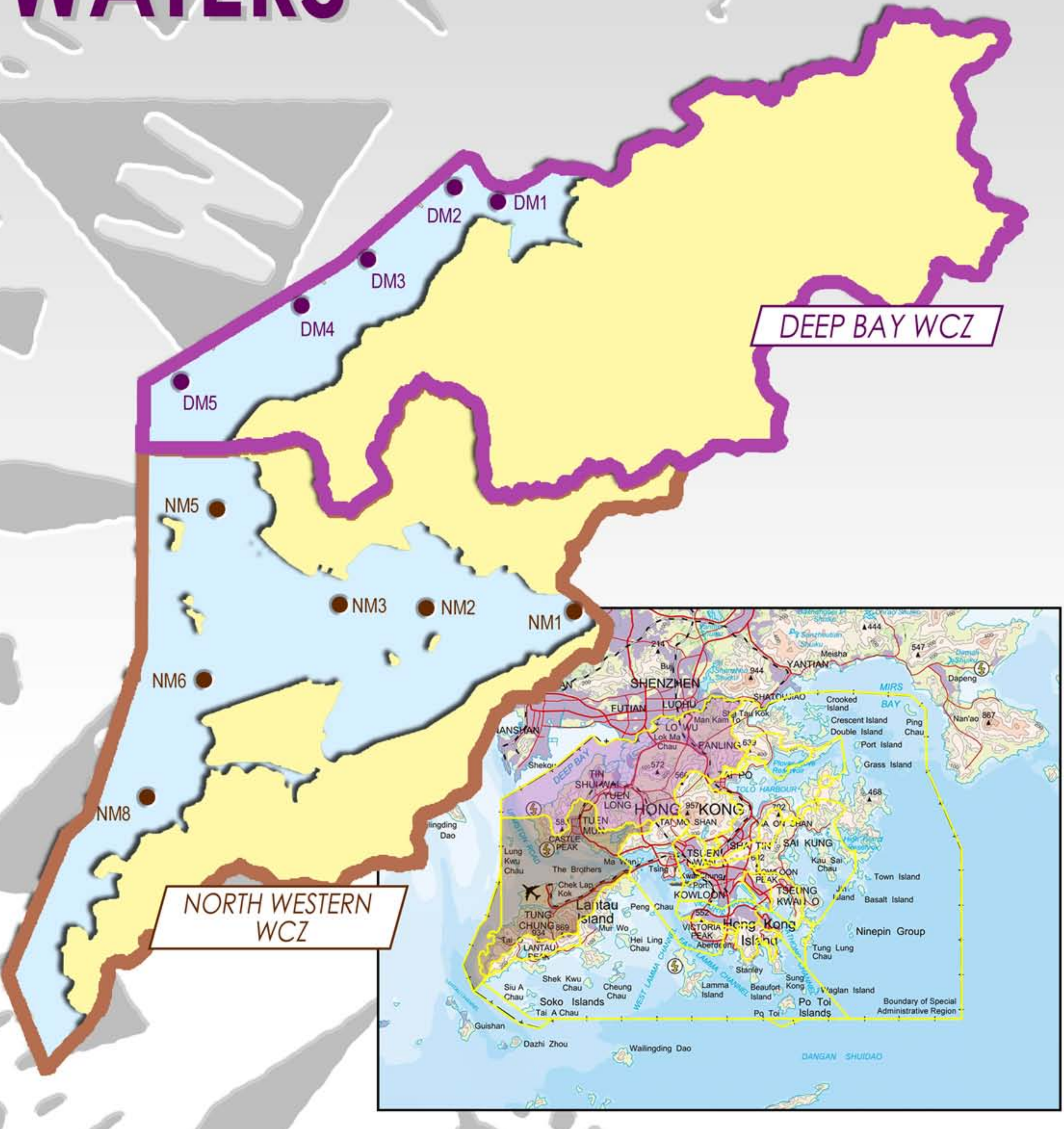
Summary water quality statistics of the Western Buffer WCZ in 2004

Parameter	Hong Kong Island (West) WM1	Hong Kong Island (West) WM2	Tsing Yi (South) WM3	Tsing Yi (West) WM4
Number of samples	12	12	12	12
Temperature (°C)	23.5 (16.4 - 28.3)	23.8 (16.1 - 29.1)	23.4 (15.9 - 28.5)	23.4 (15.8 - 28.7)
Salinity	32.6 (29.3 - 34.1)	31.6 (24.8 - 33.9)	32.2 (27.9 - 33.8)	31.7 (26.1 - 33.6)
Dissolved Oxygen (mg/L)	6.2 (5.0 - 7.5)	6.3 (4.9 - 7.9)	5.9 (4.8 - 7.5)	5.8 (4.0 - 7.5)
Bottom	5.7 (3.7 - 7.6)	6.0 (4.9 - 7.5)	5.8 (4.6 - 7.5)	5.6 (3.6 - 7.5)
Dissolved Oxygen (% Saturation)	87 (72 - 104)	88 (71 - 121)	82 (72 - 100)	80 (59 - 96)
Bottom	80 (53 - 99)	84 (71 - 98)	81 (69 - 96)	77 (52 - 95)
pH	8.1 (7.9 - 8.3)	8.1 (7.9 - 8.3)	8.0 (7.9 - 8.2)	8.0 (7.9 - 8.2)
Secchi Disc Depth (m)	2.6 (1.5 - 6.3)	2.2 (1.2 - 4.5)	2.0 (1.0 - 2.7)	2.2 (1.5 - 3.7)
Turbidity (NTU)	10.6 (8.0 - 13.2)	10.3 (7.0 - 14.3)	11.9 (8.1 - 14.9)	13.7 (9.3 - 22.0)
Suspended Solids (mg/L)	6.1 (3.0 - 14.7)	5.7 (2.0 - 11.1)	8.0 (2.8 - 12.0)	10.6 (3.9 - 24.0)
5-day Biochemical Oxygen Demand (mg/L)	0.9 (0.5 - 1.5)	1.1 (0.5 - 1.9)	0.9 (0.2 - 1.4)	0.8 (0.3 - 1.3)
Ammonia Nitrogen (mg/L)	0.07 (0.04 - 0.13)	0.12 (0.06 - 0.19)	0.14 (0.08 - 0.26)	0.12 (0.05 - 0.20)
Unionised Ammonia (mg/L)	0.004 (0.002 - 0.008)	0.006 (0.004 - 0.013)	0.006 (0.003 - 0.014)	0.005 (0.002 - 0.008)
Nitrite Nitrogen (mg/L)	0.02 (<0.01 - 0.07)	0.03 (<0.01 - 0.08)	0.03 (0.01 - 0.08)	0.03 (0.01 - 0.09)
Nitrate Nitrogen (mg/L)	0.07 (0.01 - 0.20)	0.12 (0.01 - 0.40)	0.12 (0.05 - 0.31)	0.15 (0.04 - 0.34)
Total Inorganic Nitrogen (mg/L)	0.16 (0.05 - 0.28)	0.28 (0.07 - 0.55)	0.29 (0.19 - 0.46)	0.30 (0.18 - 0.45)
Total Kjeldahl Nitrogen (mg/L)	0.17 (0.10 - 0.21)	0.25 (0.11 - 0.32)	0.25 (0.17 - 0.37)	0.23 (0.14 - 0.34)
Total Nitrogen (mg/L)	0.26 (0.11 - 0.37)	0.40 (0.13 - 0.70)	0.40 (0.30 - 0.58)	0.41 (0.31 - 0.55)
Orthophosphate Phosphorus (mg/L)	0.01 (0.01 - 0.02)	0.02 (0.01 - 0.03)	0.02 (0.01 - 0.04)	0.02 (0.02 - 0.04)
Total Phosphorus (mg/L)	0.03 (0.02 - 0.04)	0.04 (0.02 - 0.05)	0.04 (0.03 - 0.06)	0.04 (0.03 - 0.06)
Silica (as SiO_2) (mg/L)	0.7 (0.1 - 1.3)	0.7 (0.1 - 1.5)	0.8 (0.2 - 1.4)	0.9 (0.1 - 1.6)
Chlorophyll-*a* (µg/L)	3.3 (0.5 - 8.6)	4.5 (0.5 - 13.6)	2.8 (0.5 - 7.4)	3.1 (0.5 - 8.1)
E. coli (cfu/100mL)	220 (20 - 4700)	1100 (18 - 11000)	2400 (770 - 25000)	1300 (260 - 19000)
Faecal Coliforms (cfu/100mL)	430 (35 - 9700)	2000 (37 - 31000)	5000 (1800 - 50000)	2700 (520 - 77000)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths: Surface (S), Mid-depth (M), Bottom (B).
2. Data presented are annual arithmetic means of the depth-averaged results except for *E. coli* and faecal coliforms which are annual geometric means.
3. Data in brackets indicate the ranges.

WESTERN WATERS

CHAPTER 5



Chapter 5 – Western Waters

Water Quality in 2004

5.1 The western waters of Hong Kong comprise the Deep Bay and North Western Water Control Zones (WCZs). Bordering Shenzhen, Deep Bay is a shallow and sediment-laden water body with the ecologically important Mai Po and Inner Deep Bay Ramsar site, and an area of oyster production. The North Western WCZ is heavily influenced by the Pearl River and is the home of the Chinese White Dolphins. A summary of the monthly data of the western waters in 2004 is shown in Tables 5.3 and 5.4.

Deep Bay Water Control Zone

5.2 In 2004, the water quality of Deep Bay remained poor, in particular in the Inner Deep Bay, characterised by high organic and inorganic pollutants and low dissolved oxygen (DO). The 5-day Biochemical Oxygen Demand (BOD_5), suspended solids and nitrogenous nutrients showed a distinct increasing gradient from the outer Deep Bay to the inner part. The levels of nitrogen compounds in Deep Bay continued to be the highest in the territory. In 2004, while the mean ammonia nitrogen (NH_4-N) at DM1 and DM2 were 5.7 mg/L and 4.0 mg/L respectively, total nitrogen (TN) reached 7.6 mg/L and 5.7 mg/L (showing a 13 – 26% increase). Although the mean BOD_5 (2.6 mg/L) and DO (4.7 mg/L) levels were comparable with those in 2003, hypoxia in the water (DO < 2 mg/L) was detected during the months of June and July. Discharges from livestock farms and unsewered villages were the major pollution sources in the Hong Kong side of the Deep Bay catchment.

North Western Water Control Zone

5.3 In 2004, the water quality in the North Western WCZ was largely stable. While the western stations (NM3, NM6 and NM8) experienced a decrease of *E. coli* bacteria (by 22-86%), the eastern side (NM1 and NM2) showed some increases (by 40-70%). The bacterial increase at NM2 may be related to the discharges from the Stonecutters Island Sewage Treatment Works (STW) and the Siu Ho Wan STW. Similar to other waters of Hong Kong, there has been a 40% rise of NH_4-N in the WCZ. On the other hand, other nitrogenous compounds, i.e. total inorganic nitrogen (TIN), total Kjeldahl nitrogen (TKN) and TN did not show a corresponding increase during the year. The levels of orthophosphate phosphorus (PO_4-P) and total phosphorus (TP) were largely stable in 2004.

Compliance with Water Quality Objectives

5.4 In 2004, the Inner Bay (DM1-3) failed to comply with the DO objective (Figure 5.1) while the whole Deep Bay WCZ failed to meet the TIN objective. Of all the monitoring stations, only DM5 in the outer bay met the WQO for unionized ammonia (NH_3-N), which is toxic to marine organisms. The overall WQO compliance in the Deep Bay WCZ deteriorated further from 27% in 2003 to 20% in 2004, being the lowest ever recorded.

5.5 The North Western WCZ achieved an overall 89% compliance with the Water Quality Objectives (WQOs) in 2004, higher than that in 2003 (78%). All stations except that at the eastern end (NM1) complied with the WQO for DO (Figure 5.2). The western-most station NM5, nearest to Deep Bay and Pearl River, was the only station which did not meet the WQO for TIN. Full (100%) compliance with the NH_3-N objective was achieved in the North Western WCZ.

Long-term Water Quality Trends

5.6 The water in Deep Bay showed a long-term increase in nitrogenous nutrients and a decline in DO since 1986 (Table 5.1). Rising *E. coli* and BOD_5 were also detected at most stations (Figure 5.3). Deep Bay is facing serious pollution problems of increasing nutrient and organic enrichment, hypoxia, ammonia toxicity and bacterial contamination which threaten the sensitive ecosystem in the bay.

5.7 In the North Western WCZ, long-term increases in NH_4-N and TIN were detected at the stations NM2, NM3 and NM5 which may be related to local discharges as well as Pearl River flow. The increasing trend of *E. coli* at NM1 could be due to the impact of Victoria Harbour, whereas the increase at NM5 may be related to the flow from the San Wai sewage treatment works nearby (Table 5.2 and Figure 5.3).

Figure 5.1 Level of compliance with key Water Quality Objectives in the Deep Bay WCZ

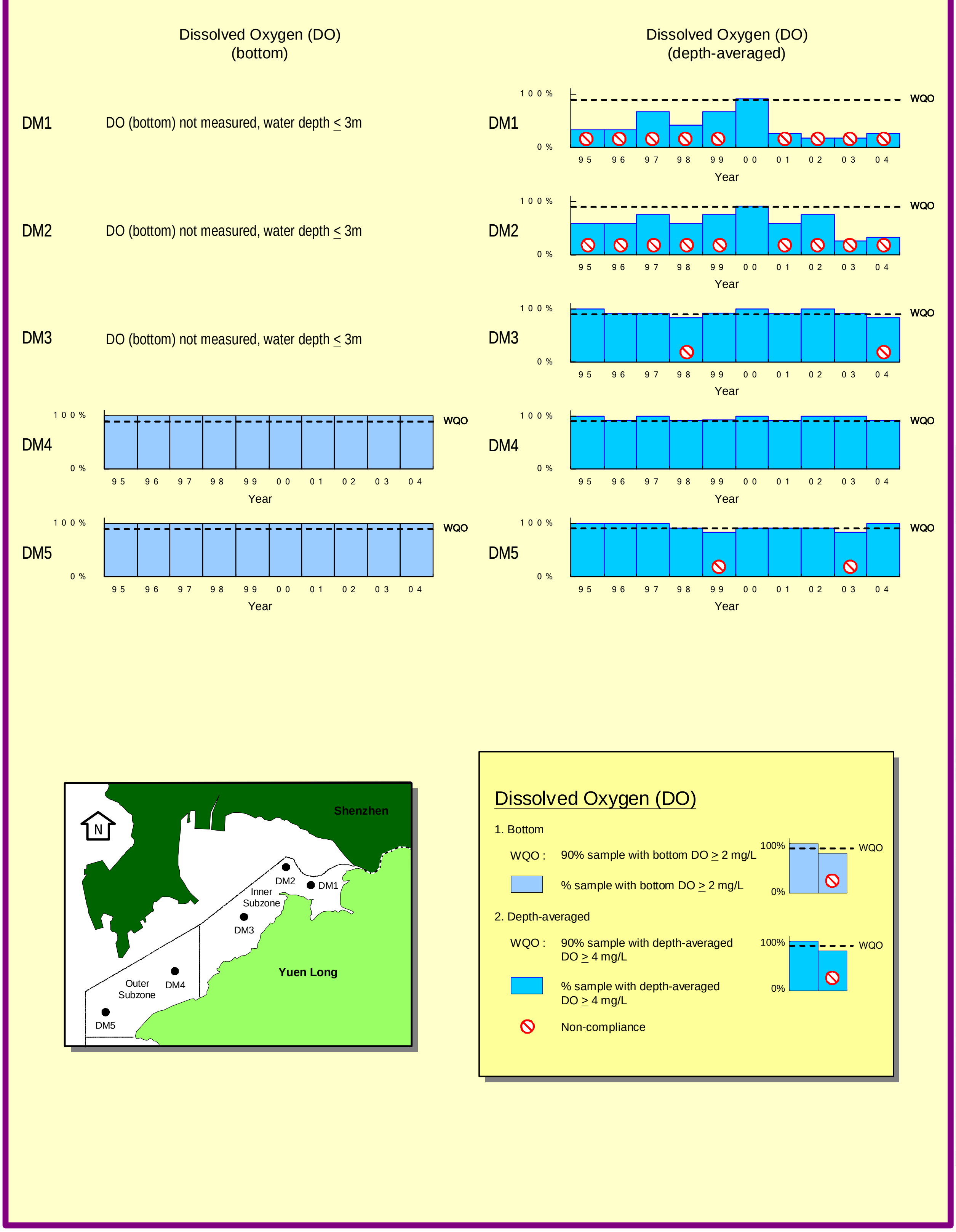
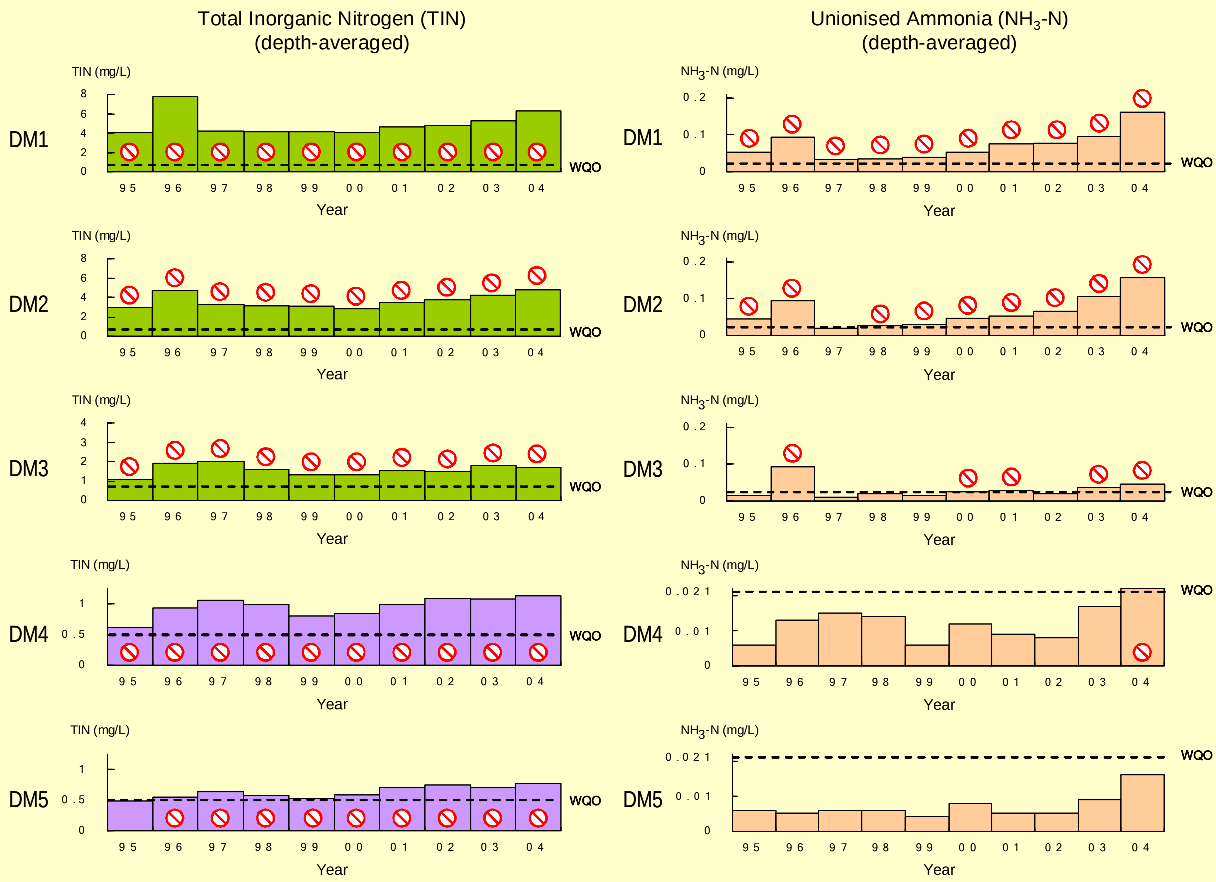
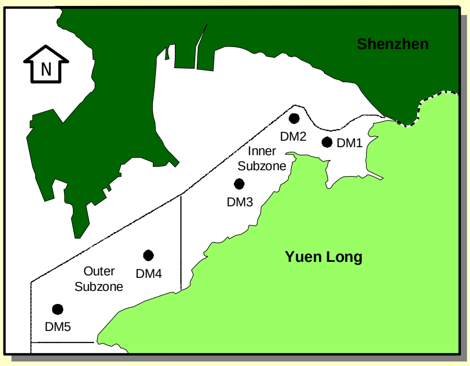


Figure 5.1 (continued) Level of compliance with key Water Quality Objectives in the Deep Bay WCZ



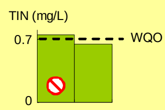


Total Inorganic Nitrogen (TIN)

Inner Subzone (DM1 - DM3)

WQO : annual mean for depth-averaged TIN ≤ 0.7 mg/L

annual mean for depth-averaged TIN



Outer Subzone (DM4 - DM5)

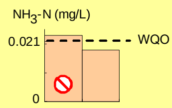
WQO : annual mean for depth-averaged TIN ≤ 0.5 mg/L

annual mean for depth-averaged TIN

Unionised Ammonia (NH_3-N)

WQO : annual mean for depth-averaged NH_3-N ≤ 0.021 mg/L

annual mean for depth-averaged NH_3-N



Non-compliance

Figure 5.2 Level of compliance with key Water Quality Objectives in the North Western WCZ

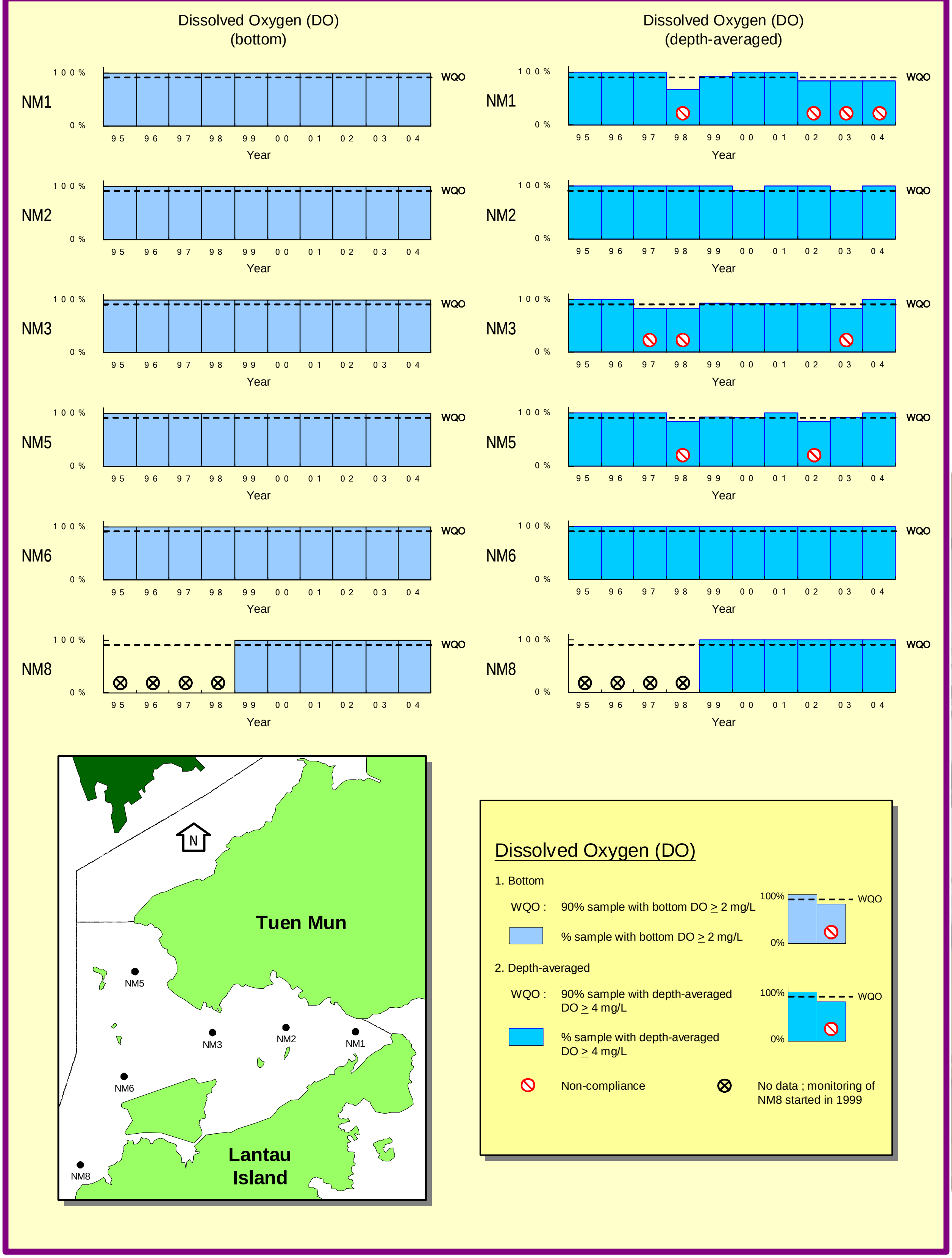


Figure 5.2 (continued) Level of compliance with key Water Quality Objectives in the North Western WCZ

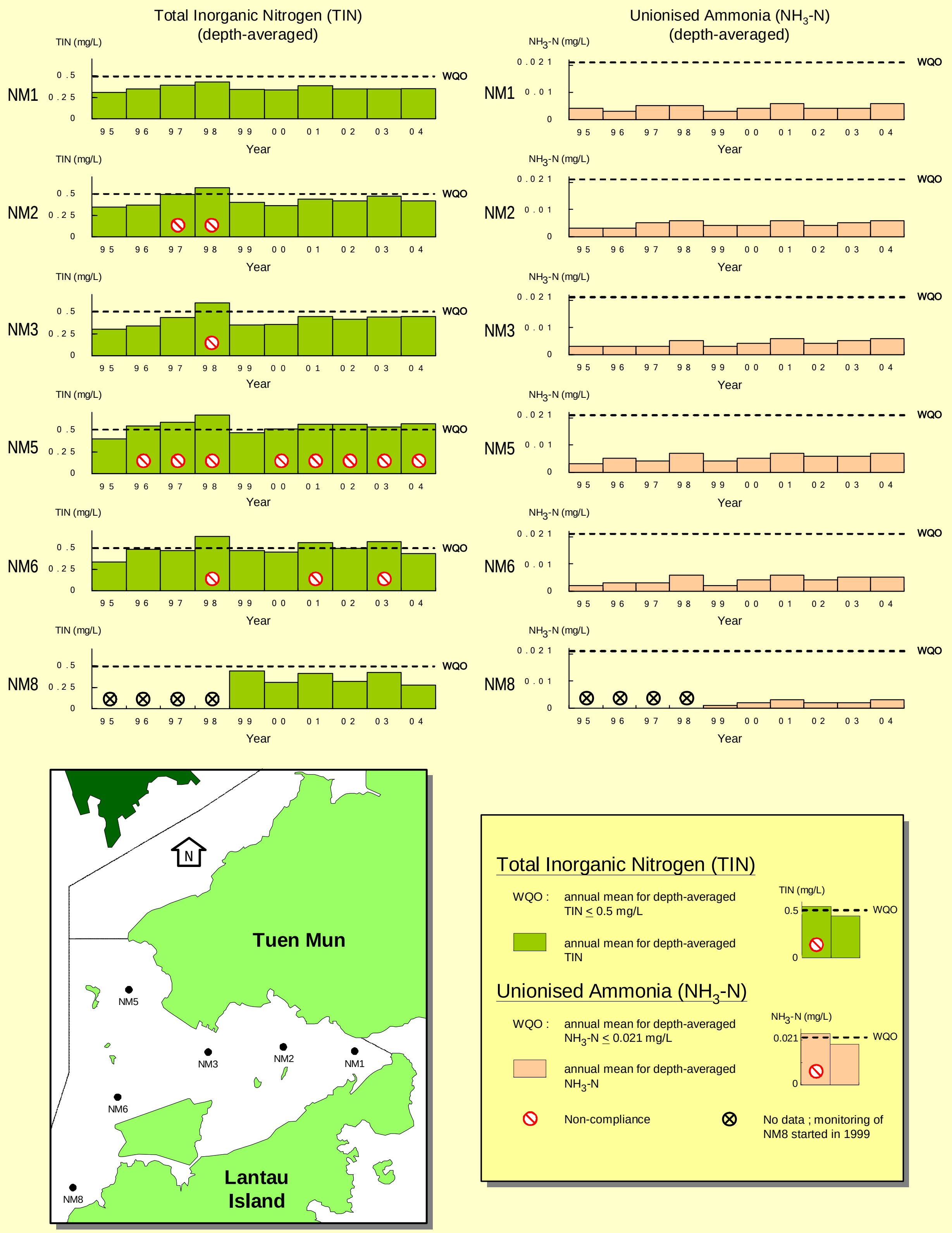
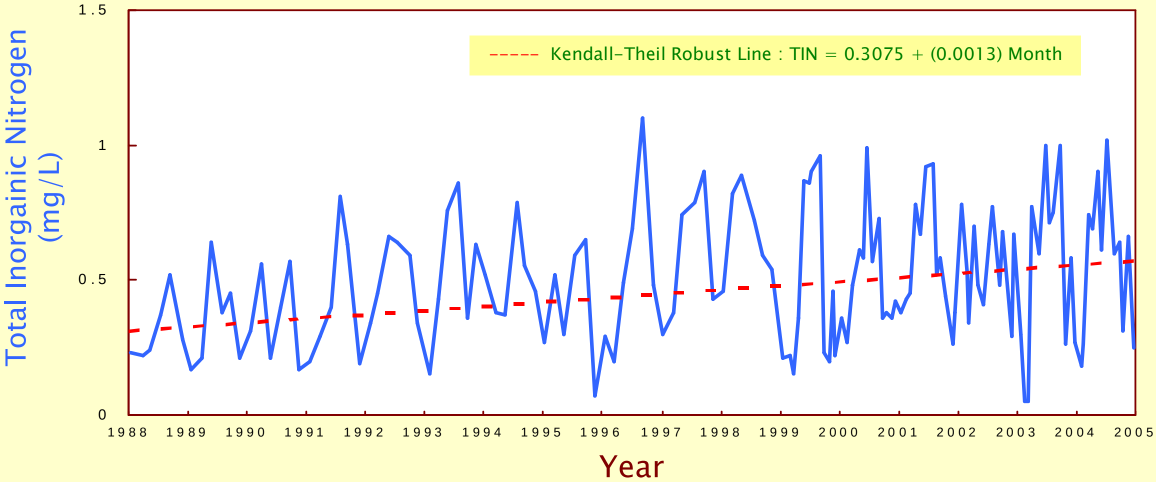
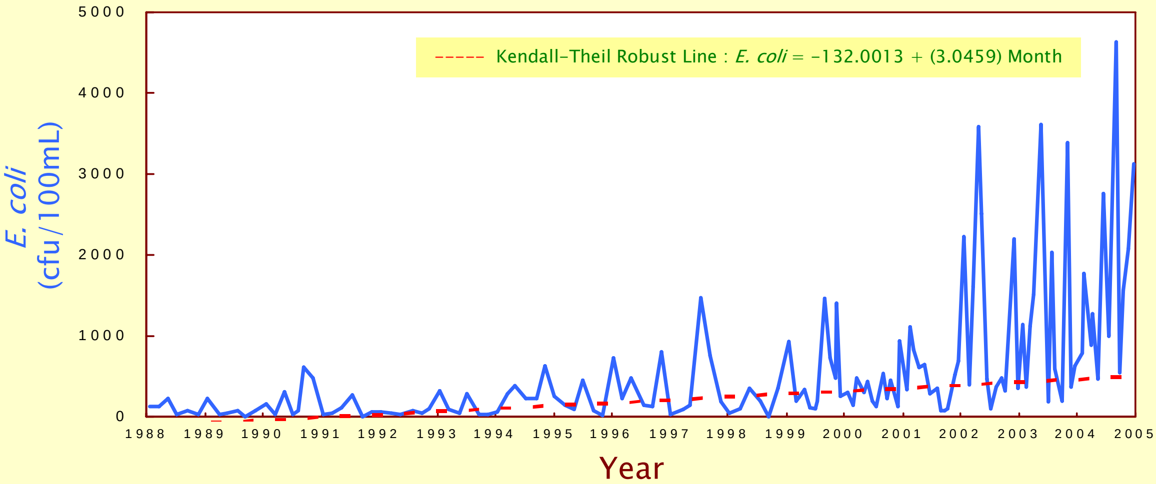


Figure 5.3 Marine water quality trends in the Western Waters (based on the Seasonal Kendall Test significant at $p<0.05$)

Increasing trend in depth-averaged Total Inorganic Nitrogen at NM5, 1988 - 2004



Increasing trend in depth-averaged *E. coli* at NM1, 1988 - 2004



Increasing trend in depth-averaged 5-day Biochemical Oxygen Demand at DM1, 1986 - 2004

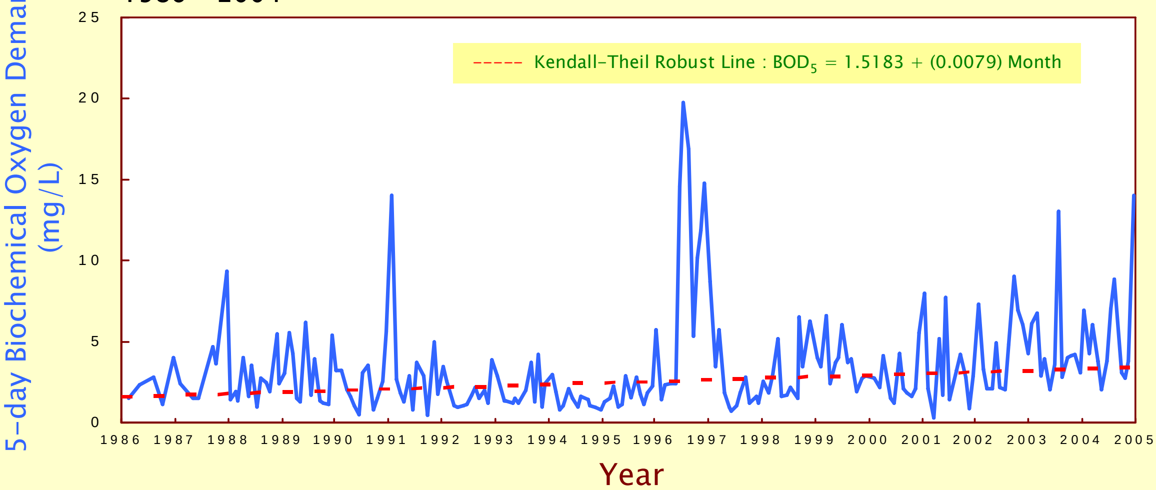


Table 5.1

Results of the Seasonal Kendall Test for water quality trends in the Deep Bay WCZ, 1986 – 2004

Monitoring Station		DM1	DM2	DM3	DM4	DM5
Monitoring Period		1986 – 2004	1986 – 2004	1986 – 2004	1986 – 2004	1991 – 2004
Parameter	Water Depth					
Temperature (°C)	Surface	-	-	-	↗	-
	Middle	NA	NA	NA	NA	-
	Bottom	NA	NA	NA	↗	-
	Average	-	-	-	↗	-
Salinity	Surface	↘	↘	-	-	-
	Middle	NA	NA	NA	NA	-
	Bottom	NA	NA	NA	-	-
	Average	↘	↘	-	-	-
Dissolved Oxygen (mg/L)	Surface	↘	↘	↘	↘	↘
	Middle	NA	NA	NA	NA	↘
	Bottom	NA	NA	NA	↘	↘
	Average	↘	↘	↘	↘	↘
Dissolved Oxygen (%)	Surface	↘	↘	↘	↘	↘
	Middle	NA	NA	NA	NA	↘
	Bottom	NA	NA	NA	↘	↘
	Average	↘	↘	↘	↘	↘
pH	Surface	-	↘	-	↘	-
	Middle	NA	NA	NA	NA	-
	Bottom	NA	NA	NA	↘	-
	Average	-	↘	-	↘	-
Secchi disc depth (m)		NA	NA	NA	-	-
Turbidity (NTU)	Surface	↗	↗	↗	-	↗
	Middle	NA	NA	NA	NA	↗
	Bottom	NA	NA	NA	-	-
	Average	↗	↗	↗	-	-
Suspended Solids (mg/L)	Surface	↗	↗	↗	-	-
	Middle	NA	NA	NA	NA	-
	Bottom	NA	NA	NA	-	-
	Average	↗	↗	↗	-	-
Total volatile solids (mg/L)	Surface	-	-	-	-	-
	Middle	NA	NA	NA	NA	-
	Bottom	NA	NA	NA	-	-
	Average	-	-	-	-	-
5-day Biochemical Oxygen Demand (mg/L)	Surface	↗	↗	-	↗	↗
	Middle	NA	NA	NA	NA	-
	Bottom	NA	NA	NA	↗	-
	Average	↗	↗	-	-	-
Ammonia nitrogen (mg/L)	Surface	↗	↗	↗	↗	↗
	Middle	NA	NA	NA	NA	↗
	Bottom	NA	NA	NA	↗	↗
	Average	↗	↗	↗	↗	↗
Nitrite nitrogen (mg/L)	Surface	-	↗	↗	↗	↗
	Middle	NA	NA	NA	NA	↗
	Bottom	NA	NA	NA	↗	↗
	Average	-	↗	↗	↗	↗
Nitrate nitrogen (mg/L)	Surface	-	-	↗	↗	↗
	Middle	NA	NA	NA	NA	-
	Bottom	NA	NA	NA	↗	-
	Average	-	-	↗	↗	-
Total inorganic nitrogen (mg/L)	Surface	↗	↗	↗	↗	↗
	Middle	NA	NA	NA	NA	↗
	Bottom	NA	NA	NA	↗	↗
	Average	↗	↗	↗	↗	↗
Total Kjeldahl nitrogen (mg/L)	Surface	↗	↗	-	-	-
	Middle	NA	NA	NA	NA	-
	Bottom	NA	NA	NA	-	-
	Average	↗	↗	-	-	-
Total nitrogen (mg/L)	Surface	↗	↗	↗	↗	-
	Middle	NA	NA	NA	NA	-
	Bottom	NA	NA	NA	-	-
	Average	↗	↗	↗	↗	-
Orthophosphate phosphorus (mg/L)	Surface	-	-	-	↗	-
	Middle	NA	NA	NA	NA	-
	Bottom	NA	NA	NA	↗	-
	Average	-	-	-	↗	-
Total phosphorus (mg/L)	Surface	-	-	-	-	↘
	Middle	NA	NA	NA	NA	↘
	Bottom	NA	NA	NA	-	↘
	Average	-	-	-	-	↘
Silica (mg/L)	Surface	-	↗	-	-	-
	Middle	NA	NA	NA	NA	-
	Bottom	NA	NA	NA	-	-
	Average	-	↗	-	-	-
Chlorophyll-*a* (μg/L)	Surface	-	-	-	-	↗
	Middle	NA	NA	NA	NA	↗
	Bottom	NA	NA	NA	-	↗
	Average	-	-	-	-	↗
E. coli (cfu/100mL)	Surface	-	↗	↗	↗	↗
	Middle	NA	NA	NA	NA	↗
	Bottom	NA	NA	NA	↗	↗
	Average	-	↗	↗	↗	↗
Faecal coliforms (cfu/100mL)	Surface	-	↗	↗	↗	↗
	Middle	NA	NA	NA	NA	↗
	Bottom	NA	NA	NA	↗	↗
	Average	-	↗	↗	↗	↗

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. - indicates no significant trend is detected
3. NA (Not Applicable) indicates the measurement was not made due to shallow water
4. Test applied to past 19 years' data from each monitoring station unless stated otherwise
5. ↗ represents a significant increase over time
6. ↘ represents a significant decrease over time

Table 5.2

Results of the Seasonal Kendall Test for water quality trends in the North Western WCZ, 1986 - 2004

Monitoring Station		NM1	NM2	NM3	NM5	NM6
Monitoring Period		1988 - 2004	1986 - 2004	1986 - 2004	1988 - 2004	1991 - 2004
Parameter	Water Depth					
Temperature (°C)	Surface	-	-	↗	↗	-
	Middle	-	-	↗	↗	-
	Bottom	-	-	↗	-	-
	Average	-	-	↗	↗	-
Salinity	Surface	-	-	-	-	-
	Middle	↗	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Dissolved Oxygen (mg/L)	Surface	↘	-	-	↘	↘
	Middle	-	↘	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	↘	↘
Dissolved Oxygen (%)	Surface	↘	-	↘	-	↘
	Middle	-	↘	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	↘
pH	Surface	↘	-	-	-	-
	Middle	-	-	-	↘	-
	Bottom	-	-	-	↘	-
	Average	-	-	-	-	-
Secchi disc depth (m)		-	↗	-	-	-
Turbidity (NTU)	Surface	-	↗	↗	-	↗
	Middle	-	↗	-	-	↗
	Bottom	-	-	-	-	↗
	Average	-	-	-	-	↗
Suspended Solids (mg/L)	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Total volatile solids (mg/L)	Surface	-	↘	-	↘	-
	Middle	-	-	-	-	-
	Bottom	-	↘	-	-	-
	Average	-	↘	-	-	-
5-day Biochemical Oxygen Demand (mg/L)	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Ammonia nitrogen (mg/L)	Surface	-	↗	↗	↗	-
	Middle	↗	↗	↗	↗	-
	Bottom	↗	↗	↗	↗	-
	Average	↗	↗	↗	↗	-
Nitrite nitrogen (mg/L)	Surface	-	↗	↗	↗	↗
	Middle	-	↗	↗	↗	-
	Bottom	-	-	-	-	-
	Average	-	↗	↗	↗	-
Nitrate nitrogen (mg/L)	Surface	-	↗	↗	↗	-
	Middle	-	-	↗	-	-
	Bottom	-	-	-	-	↘
	Average	-	-	↗	-	-
Total inorganic nitrogen (mg/L)	Surface	-	↗	↗	↗	-
	Middle	-	↗	↗	↗	-
	Bottom	-	-	↗	-	-
	Average	-	↗	↗	↗	-
Total Kjeldahl nitrogen (mg/L)	Surface	↘	↘	↘	-	-
	Middle	↘	↘	↘	↘	-
	Bottom	↘	↘	↘	-	↘
	Average	↘	↘	↘	-	↘
Total nitrogen (mg/L)	Surface	-	-	-	-	-
	Middle	↘	-	-	-	-
	Bottom	-	↘	-	-	↘
	Average	-	-	-	-	-
Orthophosphate phosphorus (mg/L)	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Total phosphorus (mg/L)	Surface	-	-	-	-	↘
	Middle	-	-	-	-	↘
	Bottom	↘	↘	-	-	↘
	Average	↘	-	-	-	↘
Silica (mg/L)	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	↘
	Average	-	-	-	-	↘
Chlorophyll-*a* (µg/L)	Surface	-	-	-	-	↗
	Middle	-	↘	-	-	↗
	Bottom	-	-	-	-	↗
	Average	-	-	-	-	↗
E. coli (cfu/100mL)	Surface	↗	-	-	↗	-
	Middle	↗	↗	-	↗	-
	Bottom	↗	↗	-	↗	-
	Average	↗	-	-	↗	-
Faecal coliforms (cfu/100mLl)	Surface	↗	-	-	↗	-
	Middle	↗	-	-	↗	-
	Bottom	↗	↗	↗	↗	-
	Average	↗	↗	-	↗	-

Note 1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. - indicates no significant trend is detected
3. Test applied to past 19 years' data from each monitoring station unless stated otherwise
4. NM8 has six years' data only, which is insufficient to perform Seasonal Kendall Test
5. ↗ represents a significant increase over time
6. ↘ represents a significant decrease over time

Table 5.3

Summary water quality statistics of the Deep Bay WCZ in 2004

	Inner Deep Bay			Outer Deep Bay	
Parameter	DM1	DM2	DM3	DM4	DM5
Number of samples	12	12	12	12	12
Temperature (°C)	24.3 (13.0 - 30.6)	24.3 (13.3 - 30.7)	24.2 (13.9 - 30.2)	24.2 (15.1 - 30.1)	24.0 (15.5 - 29.1)
Salinity	18.5 (6.0 - 25.6)	20.3 (7.4 - 26.8)	23.9 (11.3 - 30.2)	25.1 (12.3 - 32.4)	27.9 (19.7 - 33.0)
Dissolved Oxygen (mg/L)	3.3 (1.6 - 7.0)	3.8 (2.5 - 7.9)	5.2 (2.4 - 9.0)	5.4 (3.8 - 7.7)	5.5 (4.3 - 7.5)
Bottom	NM	NM	NM	5.3 (3.8 - 8.0)	5.2 (3.8 - 6.9)
Dissolved Oxygen (% Saturation)	44 (22 - 96)	52 (34 - 101)	74 (49 - 116)	74 (54 - 99)	77 (61 - 98)
Bottom	NM	NM	NM	73 (53 - 104)	73 (55 - 90)
pH	7.7 (7.2 - 8.3)	7.7 (7.2 - 8.7)	8.0 (7.5 - 8.9)	8.1 (7.6 - 8.7)	8.2 (7.8 - 8.6)
Secchi Disc Depth (m)	0.3 (0.1 - 0.5)	0.5 (0.3 - 0.8)	0.6 (0.3 - 1.2)	0.9 (0.5 - 1.5)	1.4 (0.9 - 1.8)
Turbidity (NTU)	69.0 (20.1 - 163.8)	45.7 (10.5 - 139.1)	23.0 (10.0 - 44.4)	17.3 (7.1 - 32.2)	15.1 (9.5 - 31.2)
Suspended Solids (mg/L)	74.3 (19.0 - 180)	46.9 (9.8 - 150)	22.1 (10.0 - 53.0)	11.8 (4.6 - 23.5)	10.7 (4.5 - 20.2)
5-day Biochemical Oxygen Demand (mg/L)	5.5 (2.0 - 14.0)	3.8 (1.6 - 9.2)	1.5 (0.5 - 5.4)	1.1 (0.4 - 2.3)	0.9 (0.2 - 2.5)
Ammonia Nitrogen (mg/L)	5.68 (2.50 - 8.50)	4.03 (2.10 - 6.50)	0.87 (0.09 - 1.80)	0.41 (0.08 - 0.83)	0.25 (0.03 - 0.43)
Unionised Ammonia (mg/L)	0.162 (0.022 - 0.521)	0.156 (0.018 - 0.760)	0.045 (0.009 - 0.255)	0.022 (0.007 - 0.065)	0.016 (0.003 - 0.045)
Nitrite Nitrogen (mg/L)	0.27 (0.06 - 0.66)	0.37 (0.12 - 1.10)	0.20 (0.10 - 0.36)	0.14 (0.03 - 0.36)	0.09 (0.02 - 0.21)
Nitrate Nitrogen (mg/L)	0.32 (0.10 - 0.60)	0.40 (0.22 - 0.62)	0.64 (0.23 - 1.20)	0.58 (0.12 - 1.20)	0.42 (0.07 - 0.90)
Total Inorganic Nitrogen (mg/L)	6.26 (2.98 - 8.97)	4.79 (2.59 - 7.93)	1.70 (0.86 - 2.44)	1.14 (0.49 - 1.80)	0.77 (0.32 - 1.40)
Total Kjeldahl Nitrogen (mg/L)	7.00 (3.30 - 11.00)	4.92 (2.60 - 8.00)	1.13 (0.30 - 2.00)	0.61 (0.27 - 1.25)	0.41 (0.19 - 0.66)
Total Nitrogen (mg/L)	7.59 #VALUE!	5.68 (3.09 - 9.43)	1.97 (1.07 - 2.57)	1.33 (0.68 - 2.20)	0.92 (0.48 - 1.64)
Orthophosphate Phosphorus (mg/L)	0.55 (0.29 - 0.86)	0.42 (0.26 - 0.76)	0.12 (0.07 - 0.22)	0.06 (0.04 - 0.13)	0.04 (0.03 - 0.05)
Total Phosphorus (mg/L)	0.79 (0.42 - 1.20)	0.56 (0.33 - 0.86)	0.17 (0.10 - 0.28)	0.09 (0.06 - 0.16)	0.06 (0.05 - 0.08)
Silica (as SiO_2) (mg/L)	6.1 (2.1 - 11.0)	5.2 (1.5 - 9.7)	3.1 (1.1 - 5.5)	2.7 (1.0 - 5.2)	2.0 (0.7 - 3.8)
Chlorophyll-*a* (µg/L)	16.3 (2.1 - 71.0)	9.2 (0.8 - 71.0)	6.1 (0.5 - 55.0)	2.4 (0.9 - 10.6)	2.6 (0.7 - 12.2)
E. coli (cfu/100mL)	3600 (70 - 37000)	820 (21 - 7400)	81 (20 - 690)	480 (74 - 2100)	660 (390 - 1200)
Faecal Coliforms (cfu/100mL)	5300 (170 - 39000)	1300 (43 - 7900)	140 (35 - 800)	770 (180 - 4800)	1100 (450 - 2800)

Note :
1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths: Surface (S), Mid-depth (M), Bottom (B).
2. Data presented are annual arithmetic means of the depth-averaged results except for *E. coli* and faecal coliforms which are annual geometric means.
3. Data in brackets indicate the ranges.
4. NM – not measured

Table 5.4

Summary water quality statistics of the North Western WCZ in 2004

Parameter		Lantau Island (North) NM1	Pearl Island NM2	Pillar Point NM3	Urmston Road NM5	Chek Lap Kok (North) NM6	Chek Lap Kok (West) NM8
Number of samples		12	12	12	12	12	12
Temperature (°C)		23.1 (16.0 - 27.5)	23.4 (15.6 - 28.5)	23.5 (15.6 - 28.7)	23.6 (15.5 - 29.2)	23.6 (15.1 - 29.4)	23.4 (15.4 - 28.6)
Salinity		31.7 (28.0 - 33.4)	30.4 (20.1 - 33.4)	30.2 (21.7 - 33.3)	29.1 (18.7 - 33.3)	29.4 (20.4 - 33.4)	30.6 (23.7 - 33.5)
Dissolved Oxygen (mg/L)		5.3 (3.7 - 7.4)	5.6 (4.1 - 7.4)	5.8 (4.2 - 7.4)	5.7 (4.1 - 8.3)	6.2 (4.5 - 8.2)	6.5 (4.7 - 8.1)
	Bottom	5.2 (3.5 - 7.4)	5.6 (4.1 - 7.4)	5.7 (3.6 - 7.8)	5.6 (3.9 - 7.4)	6.2 (4.5 - 8.9)	6.5 (4.6 - 8.6)
Dissolved Oxygen (% Saturation)		73 (54 - 93)	77 (62 - 96)	79 (63 - 106)	78 (60 - 118)	85 (68 - 116)	90 (63 - 116)
	Bottom	71 (51 - 87)	76 (59 - 95)	77 (54 - 110)	76 (59 - 102)	86 (68 - 126)	91 (63 - 123)
pH		8.0 (7.8 - 8.2)	8.0 (7.9 - 8.2)	8.0 (7.9 - 8.2)	8.0 (7.9 - 8.2)	8.1 (7.9 - 8.3)	8.1 (7.9 - 8.3)
Secchi Disc Depth (m)		1.9 (1.4 - 2.2)	1.9 (1.5 - 2.5)	1.8 (1.2 - 2.3)	1.5 (1.0 - 2.5)	1.6 (1.0 - 2.2)	1.5 (1.0 - 2.5)
Turbidity (NTU)		14.3 (4.5 - 21.7)	11.8 (4.7 - 21.8)	14.2 (6.8 - 20.0)	16.5 (7.3 - 27.5)	14.4 (9.7 - 24.5)	16.2 (9.2 - 25.4)
Suspended Solids (mg/L)		11.0 (3.7 - 25.7)	7.0 (4.0 - 12.6)	9.4 (6.9 - 13.7)	12.1 (5.4 - 28.7)	10.7 (4.4 - 26.7)	11.6 (5.9 - 28.2)
5-day Biochemical Oxygen Demand (mg/L)		0.7 (0.3 - 1.1)	0.8 (0.3 - 1.5)	0.8 (0.3 - 1.4)	0.7 (0.3 - 1.1)	0.9 (0.4 - 2.2)	0.7 (0.4 - 1.5)
Ammonia Nitrogen (mg/L)		0.14 (0.04 - 0.26)	0.13 (0.05 - 0.28)	0.14 (0.05 - 0.28)	0.18 (0.03 - 0.40)	0.11 (0.02 - 0.33)	0.06 (0.02 - 0.16)
Unionised Ammonia (mg/L)		0.006 (0.002 - 0.009)	0.006 (0.003 - 0.009)	0.006 (0.002 - 0.010)	0.007 (0.002 - 0.013)	0.005 (0.001 - 0.012)	0.003 (0.001 - 0.006)
Nitrite Nitrogen (mg/L)		0.05 (0.01 - 0.12)	0.06 (0.01 - 0.17)	0.06 (0.01 - 0.19)	0.08 (0.01 - 0.17)	0.06 (0.01 - 0.13)	0.04 (0.01 - 0.08)
Nitrate Nitrogen (mg/L)		0.17 (0.04 - 0.37)	0.23 (0.03 - 0.66)	0.24 (0.03 - 0.76)	0.31 (0.04 - 0.81)	0.27 (0.03 - 0.73)	0.17 (0.02 - 0.50)
Total Inorganic Nitrogen (mg/L)		0.35 (0.18 - 0.54)	0.42 (0.15 - 0.87)	0.45 (0.15 - 0.99)	0.57 (0.18 - 1.02)	0.44 (0.08 - 0.89)	0.27 (0.07 - 0.60)
Total Kjeldahl Nitrogen (mg/L)		0.24 (0.16 - 0.34)	0.25 (0.20 - 0.38)	0.26 (0.20 - 0.37)	0.31 (0.19 - 0.50)	0.23 (0.13 - 0.43)	0.17 (0.11 - 0.22)
Total Nitrogen (mg/L)		0.46 (0.31 - 0.67)	0.54 (0.27 - 1.05)	0.57 (0.26 - 1.14)	0.70 (0.32 - 1.20)	0.56 (0.20 - 1.04)	0.38 (0.17 - 0.77)
Orthophosphate Phosphorus (mg/L)		0.03 (0.01 - 0.04)	0.03 (0.01 - 0.04)	0.03 (0.01 - 0.05)	0.03 (0.02 - 0.05)	0.02 (0.01 - 0.04)	0.01 (<0.01 - 0.02)
Total Phosphorus (mg/L)		0.05 (0.03 - 0.06)	0.04 (0.03 - 0.06)	0.05 (0.03 - 0.06)	0.05 (0.04 - 0.06)	0.04 (0.02 - 0.06)	0.03 (0.03 - 0.05)
Silica (as SiO_2) (mg/L)		1.0 (0.2 - 2.1)	1.2 (0.3 - 2.9)	1.3 (0.2 - 3.3)	1.5 (0.5 - 3.4)	1.3 (0.4 - 3.3)	1.1 (0.2 - 2.6)
Chlorophyll-*a* (μg/L)		1.9 (0.6 - 6.1)	2.6 (0.6 - 10.5)	2.4 (0.6 - 7.3)	2.3 (0.6 - 8.5)	3.3 (0.8 - 11.0)	3.0 (0.8 - 7.8)
E. coli (cfu/100mL)		1400 (460 - 4600)	540 (160 - 1300)	340 (160 - 1800)	440 (140 - 900)	6 (1 - 77)	3 (1 - 92)
Faecal Coliforms (cfu/100mL)		2900 (1100 - 14000)	1100 (480 - 2400)	720 (230 - 4800)	870 (330 - 1800)	18 (2 - 190)	6 (1 - 150)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths: Surface (S), Mid-depth (M), Bottom (B).
2. Data presented are annual arithmetic means of the depth-averaged results except for *E. coli* and faecal coliforms which are annual geometric means.
3. Data in brackets indicate the ranges.

SEDIMENT QUALITY

CHAPTER 6

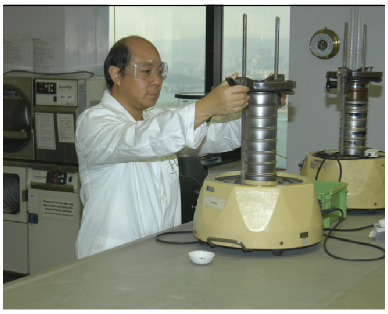
Chapter 6 – Sediment

6.1 Sediments in the sea bottom are often regarded as the ultimate sink of pollutants in the marine environment. They are also an important habitat for a variety of marine life, including ecologically and commercially important species. The organic and inorganic pollutants accumulated in sediments may pose a potential threat to marine organisms and human health, and therefore need to be monitored regularly.

6.2 In 2004, the Environmental Protection Department (EPD) monitored marine sediments twice, at 45 stations in open waters (Figure 1.3) and 15 stations in typhoons shelters (Figure 1.4). Sediment samples were collected using a grab sampler. Field measurements, e.g. electrochemical potential, were done on board the monitoring vessel and laboratory tests were conducted on over 60 physical, chemical and biological parameters (Table 1.3). A summary of the marine sediment quality in the territory in the past 5 years (2000–2004) is shown in Tables 6.1–6.6.

6.3 The marine sediments in Hong Kong consist mainly of silt. The sediments in the eastern waters, in particular the deeper and inshore water of Mirs Bay, are of a finer consistency, with 90% (w/w) of the sediment particles below the size of 63µm (Figure 6.1). In areas with stronger currents such as the North Western water and Victoria Harbour, the sediment particles are coarser and only about 40-80% of the particles are smaller than 63µm.

6.4 The marine sediments in Hong Kong are generally anoxic, i.e. with negative electrochemical potential. Highly anoxic sediments (below -300mV) were found in the Victoria Harbour WCZ (-326mV to -363mV), inner Mirs Bay, i.e. Double Haven and Crooked Harbour (-326mV to -358mV), and Tolo Harbour (-310mV to -324mV) as shown in Figure 6.2. The low electrochemical potential in Victoria Harbour was mainly related to organic deposition from effluent discharges. Double Haven and Crooked Harbour in Mirs Bay and Tolo Harbour had many fish culture zones (Figure 1.6). Sediments in these areas were subject to the long-term effects of organic pollution from fish excreta, fishfeed and other sources.



6.5 In assessing contamination of marine sediments by contaminants, guideline values in the '*Environment, Transport and Work Bureau Technical Circular ETWB(W) No. 34/2002 -*

Management of Dredged / Excavated Sediment' were used as bench marks. The Upper Chemical Exceedance Levels (UCELs) and Lower Chemical Exceedance Levels (LCELs) of 12 individual or groups of chemical contaminants are shown in Table 6.7.

Metals, Metalloid and Trace Organics

6.6 Sediments in Victoria Harbour (VS3, VS5 and VS6), Junk Bay (JS2) and Tsuen Wan Bay (VS9 and VS10) had higher levels of heavy metals, in particular copper and silver, which exceeded the UCELs (Figures 6.3 and 6.5). This was likely to be related to discharges from printed circuit board, electroplating industries and photo-developing business in the old industrial areas i.e. Kwun Tong, To Kwa Wan, Yau Tong and Tsuen Wan between the 60s and 80s. Mercury in marine sediments was generally low except at one station (VS6) in western Victoria Harbour where the level exceeded the UCEL (Figure 6.4). Mercury contamination may be related to the former discharges from dental clinics and industries.

6.7 Among the trace organic pollutants, the levels of polychlorinated biphenyls (PCBs) in the marine sediments of Hong Kong were generally low, below the LCEL except at VS6 (Figure 6.6). The 18 PCB congeners in over 90% of the sediment samples were below the reporting limits (<2µg/kg dry weight). Eight PCB congeners (i.e. PCB 101, 118, 128, 138, 153, 170, 180 and 187) were detected in central and western Victoria Harbour (VS5, VS6, VS9 and VS10). The levels of low and high molecular weight PAHs in the marine sediment samples were mostly below the LCELs with the exception of one station in western Victoria Harbour (VS6) where high molecular weight PAHs exceeded the LCEL (Figures 6.7 and 6.8).

Figure 6.1 Particle Size Fractionation <63 µm in marine sediments in Hong Kong, 2000 – 2004

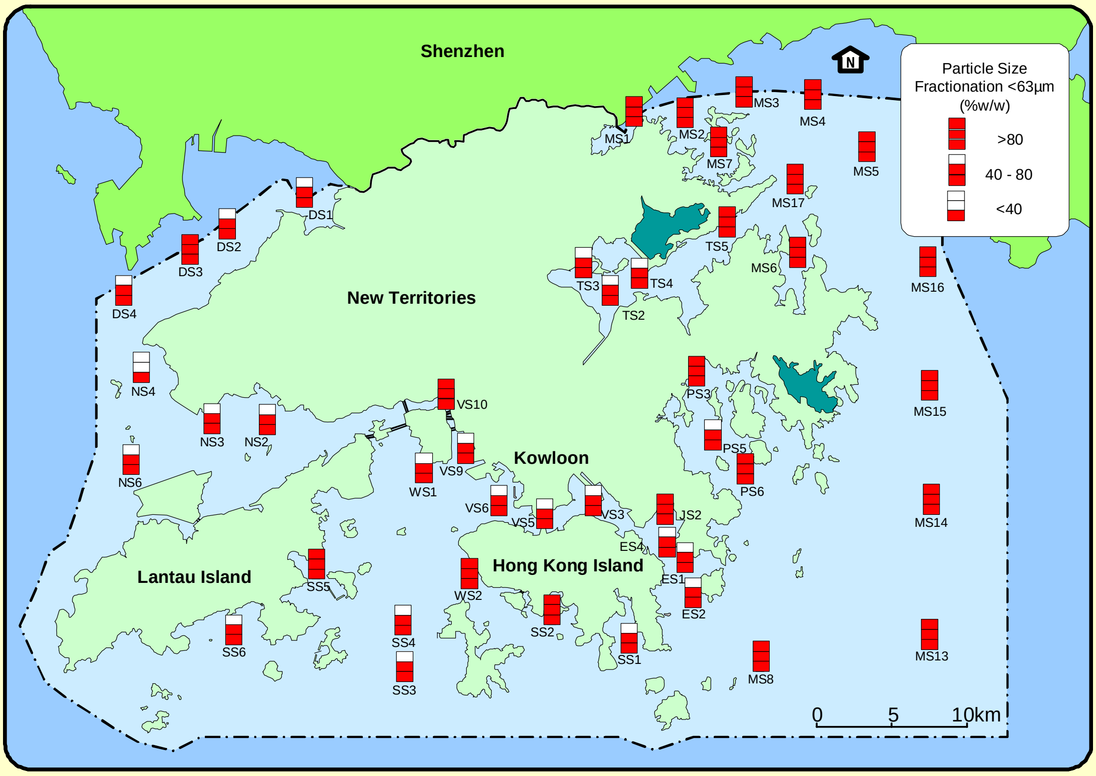


Figure 6.2 Electrochemical potential in marine sediments in Hong Kong, 2000 – 2004

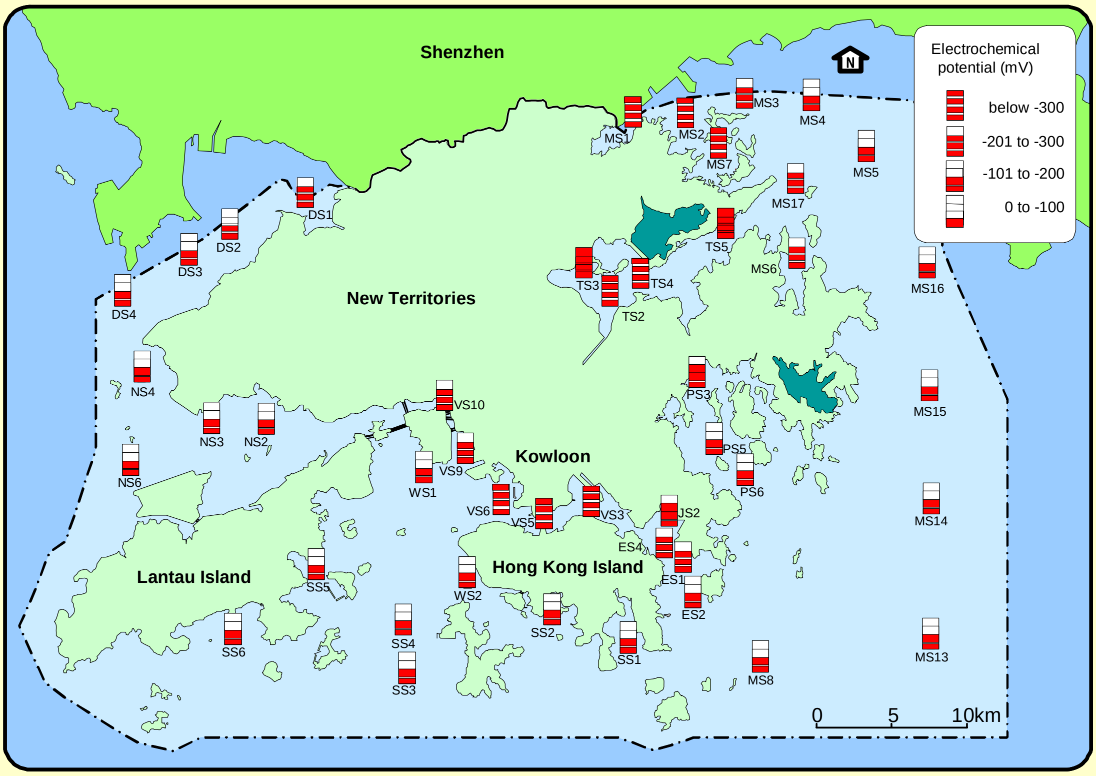


Figure 6.3 Copper in marine sediments in Hong Kong, 2000 – 2004

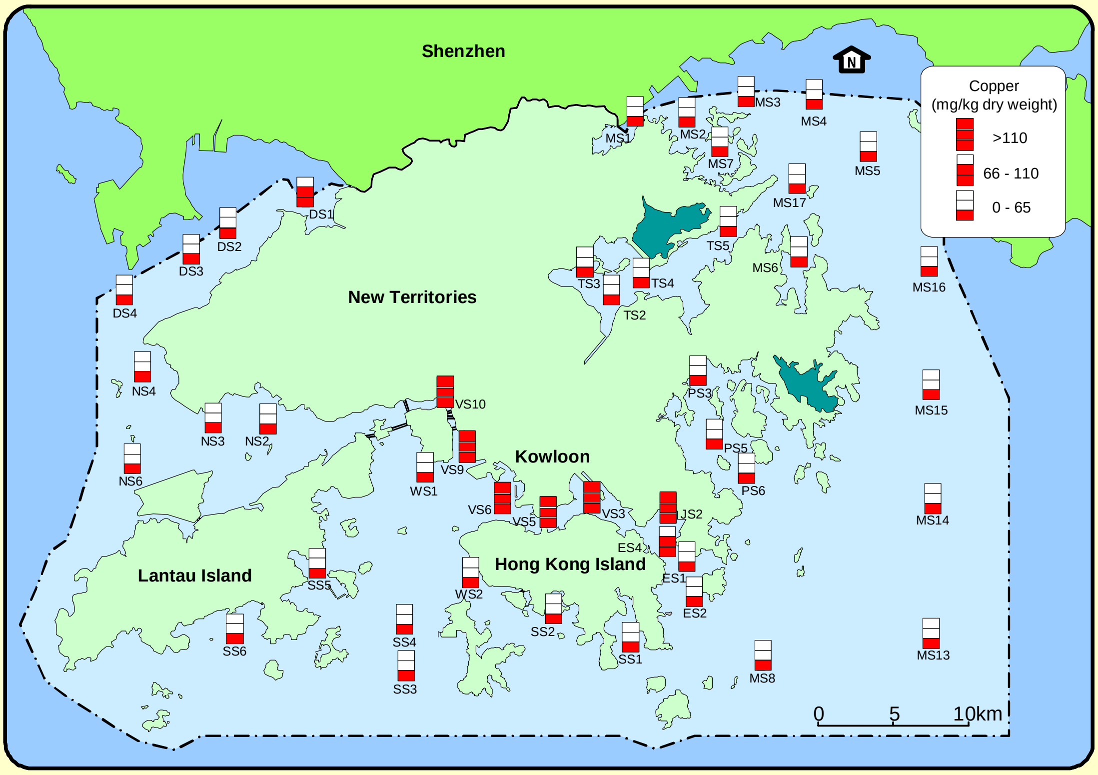


Figure 6.4 Mercury in marine sediments in Hong Kong, 2000 – 2004

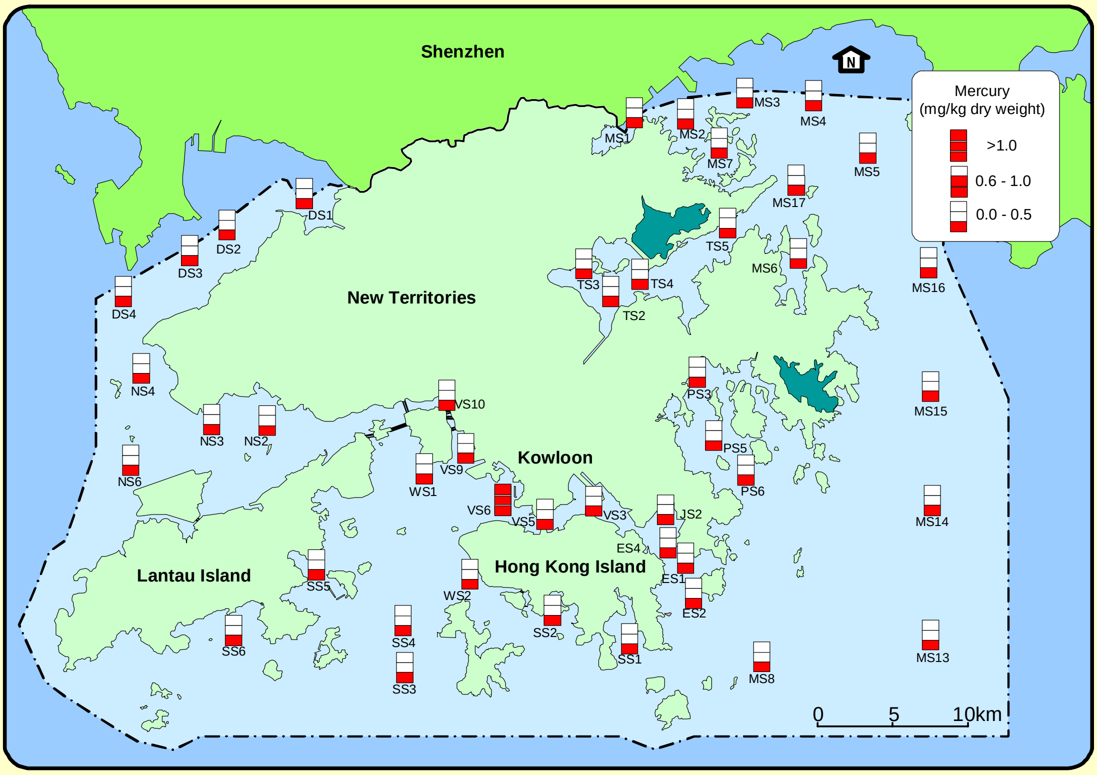


Figure 6.5 Silver in marine sediments in Hong Kong, 2000 – 2004

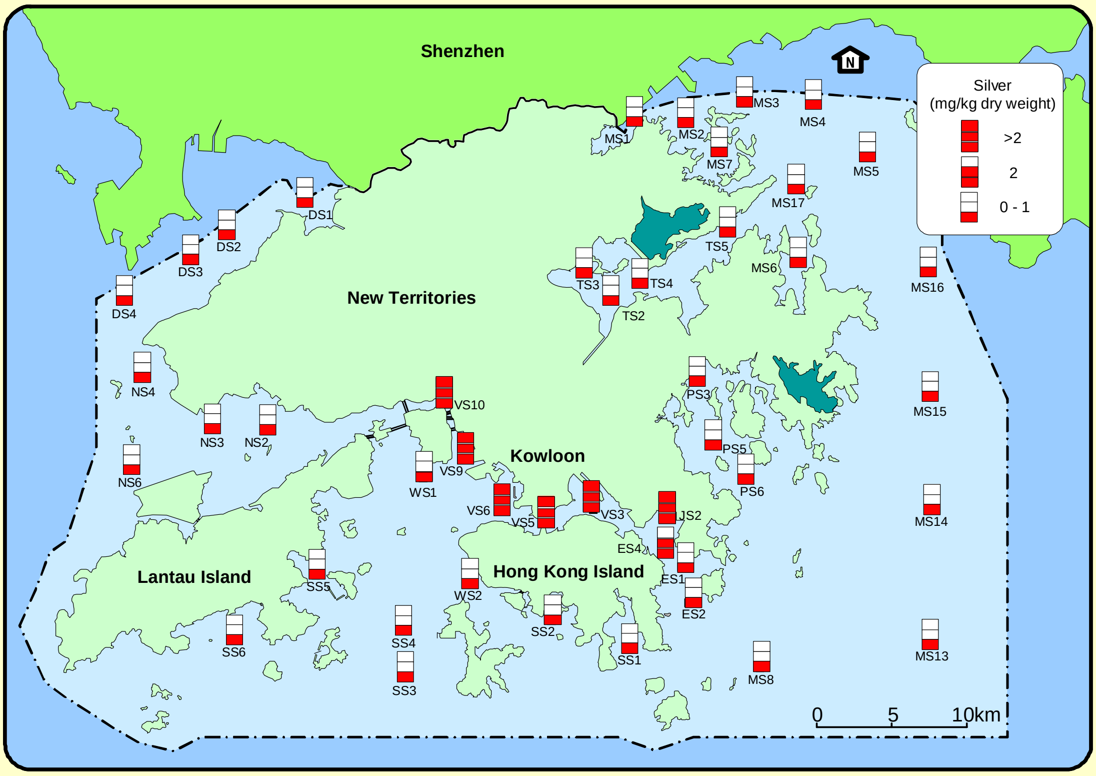


Figure 6.6 Total polychlorinated biphenyls (PCBs) in marine sediments in Hong Kong, 2002 – 2004

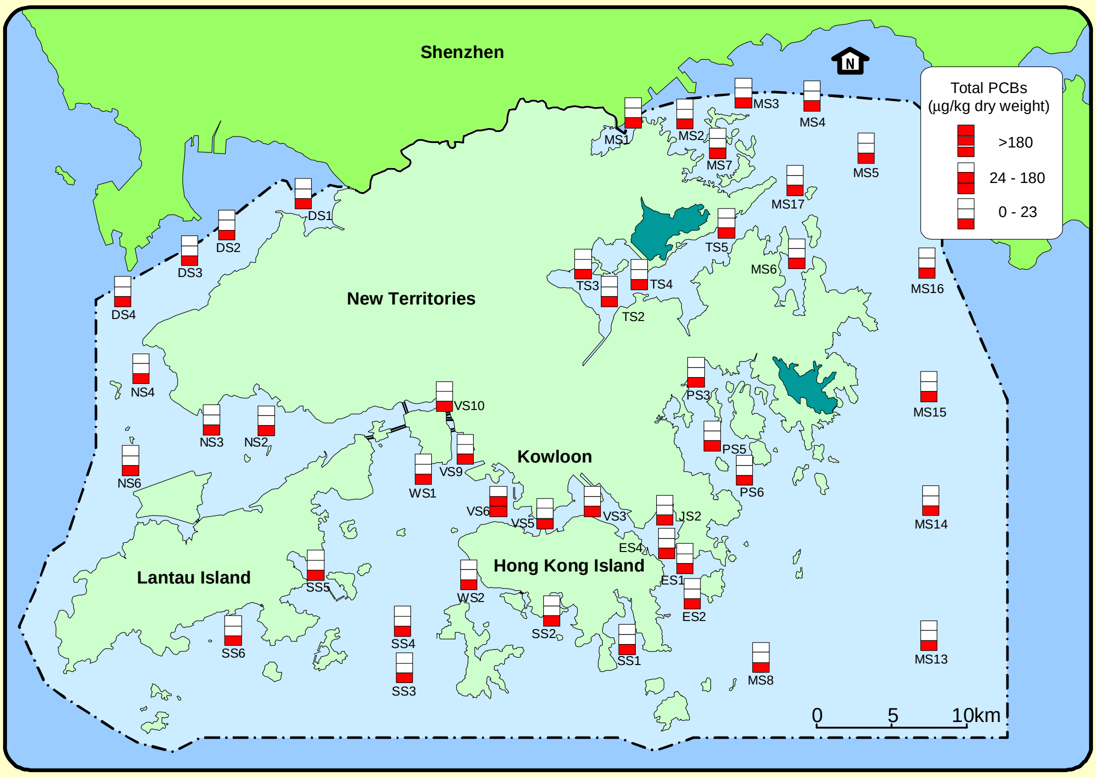


Figure 6.7 Low molecular weight polycyclic aromatic hydrocarbons (PAHs) in marine sediments in Hong Kong, 2002 – 2004

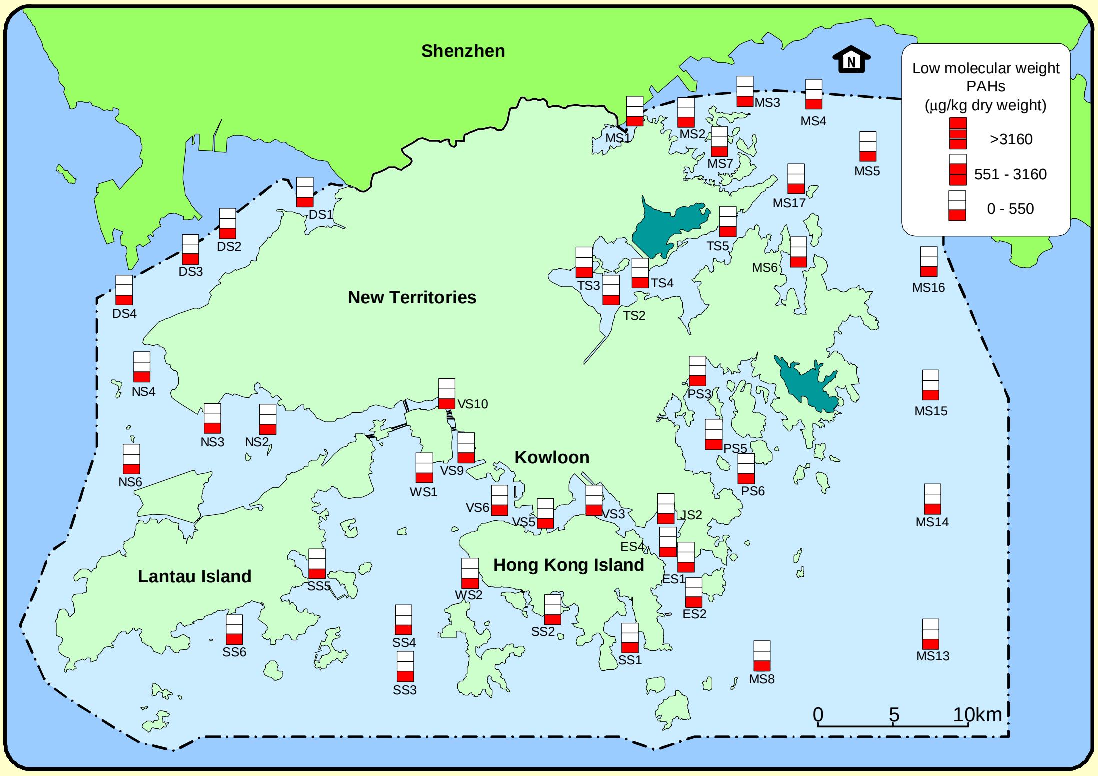


Figure 6.8 High molecular weight polycyclic aromatic hydrocarbons (PAHs) in marine sediments in Hong Kong, 2000 – 2004

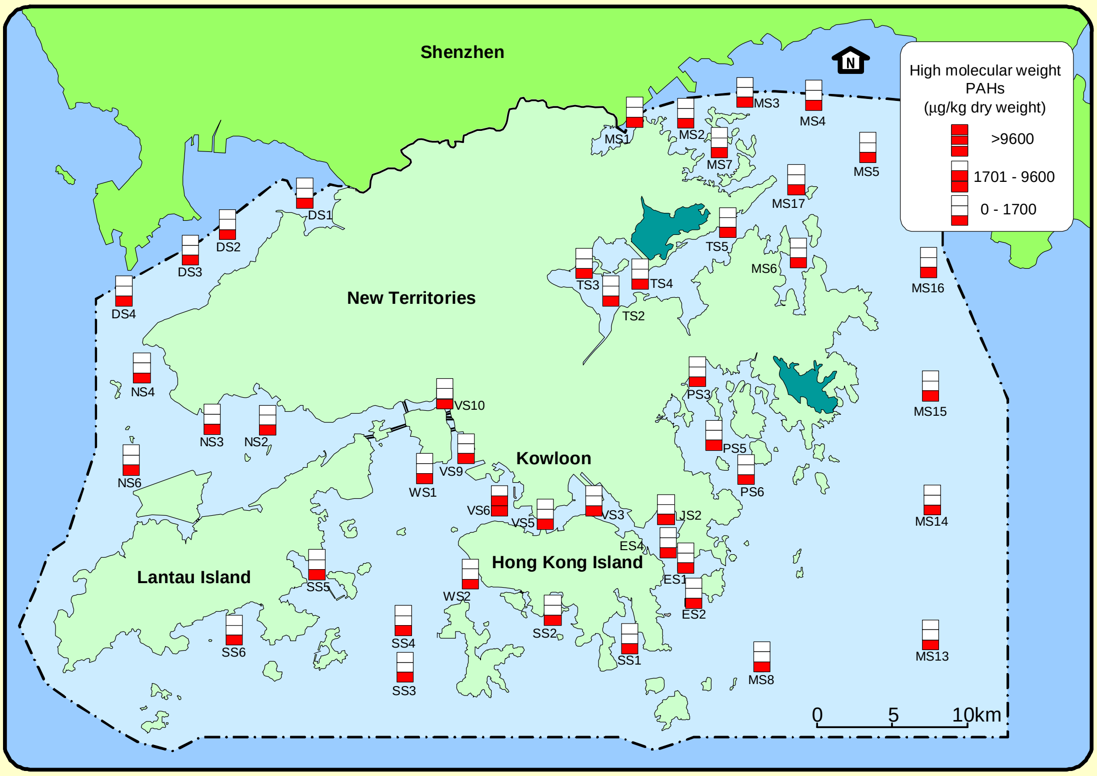


Table 6.1
Summary statistics of marine sediment quality of the Tolo Harbour and Channel and Southern WCZs, 2000 – 2004

	Tolo Harbour and Channel				Hong Kong Island (South)		West Lamma Channel	
	Harbour Subzone		Buffer Subzone	Channel Subzone				
Parameter	TS2	TS3	TS4	TS5	SS1	SS2	SS3	SS4
Number of samples	10	10	10	10	10	10	10	10
Particle Size Fractionation <63µm (%w/w)	72 (14 - 86)	69 (43 - 85)	63 (34 - 78)	91 (80 - 95)	71 (57 - 92)	87 (74 - 92)	73 (52 - 93)	80 (49 - 96)
Electrochemical Potential (mV)	-321 ((-376) - (-212))	-310 ((-364) - (-183))	-324 ((-390) - (-198))	-312 ((-355) - (-130))	-142 ((-205) - (-95))	-147 ((-338) - (-32))	-173 ((-280) - (-91))	-143 ((-192) - (-84))
Total Solids (%w/w)	34 (30 - 40)	34 (28 - 45)	40 (32 - 54)	30 (28 - 35)	55 (48 - 59)	47 (43 - 51)	52 (47 - 59)	46 (42 - 51)
Total Volatile Soilds (%w/w)	10.2 (8.6 - 12.0)	9.8 (7.4 - 12.0)	9.5 (5.0 - 12.0)	11.3 (9.7 - 13.0)	6.5 (5.9 - 7.6)	7.5 (6.7 - 8.0)	6.8 (6.0 - 7.3)	7.4 (6.4 - 7.9)
Chemical Oxygen Demand (mg/kg)	24000 (21000 - 28000)	22000 (15000 - 25000)	21000 (17000 - 23000)	19000 (16000 - 22000)	11000 (10000 - 13000)	15000 (13000 - 16000)	19000 (14000 - 25000)	16000 (14000 - 18000)
Total Carbon (%w/w)	0.8 (0.7 - 0.9)	0.7 (0.5 - 0.8)	0.8 (0.7 - 1.0)	0.8 (0.7 - 0.9)	0.9 (0.6 - 1.0)	0.7 (0.6 - 0.7)	0.9 (0.7 - 1.4)	0.6 (0.6 - 0.7)
Ammonical Nitrogen (mg/kg)	11.2 (1.6 - 32.0)	6.2 (2.1 - 14.0)	11.6 (2.1 - 24.0)	18 (6.0 - 25.0)	6.3 (0.2 - 11.0)	11.2 (0.4 - 37.0)	6.3 (1.6 - 16.0)	4.8 (0.4 - 9.6)
Total Kjeldahl Nitrogen (mg/kg)	598 (470 - 720)	525 (350 - 640)	596 (460 - 820)	730 (620 - 890)	388 (260 - 490)	391 (230 - 520)	366 (240 - 460)	366 (240 - 420)
Total Phosphorus (mg/kg)	182 (160 - 220)	165 (140 - 200)	191 (140 - 230)	207 (180 - 240)	219 (160 - 250)	193 (150 - 240)	235 (200 - 270)	193 (160 - 240)
Total Sulphide (mg/kg)	215 (13 - 400)	167 (30 - 320)	170 (17 - 330)	175 (53 - 240)	37 (10 - 70)	52 (8 - 100)	32 (11 - 72)	49 (21 - 140)
Total Cyanide (mg/kg)	0.2 (0.1 - 0.3)	0.1 (<0.1 - 0.2)	0.1 (<0.1 - 0.3)	0.1 (<0.1 - 0.2)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.2)	<0.1 (<0.1 - 0.2)	<0.1 (<0.1 - 0.1)
Arsenic (mg/kg)	9.2 (7.0 - 11.0)	9.3 (5.9 - 13.0)	8.3 (6.6 - 9.8)	6.8 (5.6 - 8.2)	6.7 (4.6 - 8.2)	9.3 (7.9 - 12.0)	7.4 (6.0 - 8.8)	8.9 (6.2 - 11.0)
Cadmium (mg/kg)	0.5 (0.4 - 0.6)	0.5 (0.2 - 0.7)	0.4 (0.2 - 0.6)	0.3 (0.2 - 0.3)	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)
Chromium (mg/kg)	29 (23 - 34)	23 (14 - 35)	25 (19 - 30)	36 (30 - 40)	26 (17 - 36)	35 (28 - 38)	32 (25 - 38)	38 (26 - 44)
Copper (mg/kg)	47 (37 - 60)	38 (22 - 60)	26 (15 - 39)	24 (20 - 26)	13 (8 - 18)	23 (19 - 27)	20 (15 - 23)	36 (20 - 43)
Lead (mg/kg)	89 (76 - 100)	98 (75 - 130)	68 (55 - 82)	54 (49 - 62)	29 (21 - 40)	36 (28 - 41)	34 (23 - 41)	42 (25 - 50)
Mercury (mg/kg)	0.09 (<0.05 - 0.17)	0.06 (<0.05 - 0.1)	0.06 (<0.05 - 0.08)	0.06 (<0.05 - 0.12)	0.05 (<0.05 - 0.08)	0.08 (<0.05 - 0.11)	0.08 (0.06 - 0.11)	0.12 (0.08 - 0.15)
Nickel (mg/kg)	18 (15 - 22)	14 (8 - 22)	16 (13 - 20)	25 (22 - 28)	18 (12 - 23)	23 (20 - 26)	22 (17 - 26)	23 (16 - 27)
Silver (mg/kg)	0.5 (0.4 - 1.0)	0.5 (0.4 - 1.0)	0.4 (<0.2 - 1.0)	0.4 (0.2 - 1.0)	0.3 (<0.2 - 1.0)	0.4 (0.3 - 1.0)	0.4 (<0.2 - 1.0)	0.5 (0.4 - 1.0)
Zinc (mg/kg)	200 (140 - 270)	201 (170 - 220)	142 (75 - 220)	126 (100 - 140)	75 (56 - 110)	102 (93 - 120)	87 (68 - 110)	111 (75 - 130)
Total Polychlorinated Biphenyls (PCBs) (µg/kg) (3) (4)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)
Low Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (µg/kg) (5) (6) (9)	91 (90 - 98)	91 (90 - 94)	90 (90 - 90)	90 (90 - 93)	93 (90 - 106)	90 (90 - 93)	91 (90 - 95)	91 (90 - 98)
High Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (µg/kg) (7) (8) (9)	60 (31 - 120)	43 (21 - 100)	53 (20 - 137)	58 (16 - 90)	58 (28 - 188)	66 (30 - 133)	61 (23 - 123)	110 (41 - 174)

Note : 1. Data presented are arithmetic means ; data in brackets indicate ranges.
2. All data are based on the analyses of bulk (unsieved) sediment and are reported on a dry weight basis unless stated otherwise.
3. The Technical Circular 'ETWB (W) No. 34/2002 Management of Dredged / Excavated Sediment' issued in 2002 has revised the definition of 'Total PCBs' as the summation of 18 specific PCB congeners. Following the new definition, the monitoring of these 18 PCB congeners started in 2002 and the Total PCBs results only refer to 2002 – 2004.
4. Total PCBs results are derived from the summation of 18 congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.
5. Low molecular weight polyaromatic hydrocarbons (PAHs) include 6 congeners of molecular weight below 200, namely : Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene and Phenanthrene.
6. As the monitoring of Naphthalene only started in 2002, the Low Molecular Weight PAHs results are based on sediments samples collected in 2002 – 2004.
7. High molecular weight polyaromatic hydrocarbons (PAHs) include 10 congeners of molecular weight above 200, namely : Fluoranthene, Pyrene, Benzo (a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, Benzo(g,h,i)perylene and Indeno(1,2, 3-cd)pyrene.
8. Low and high molecular weight PAHs results are derived from the summation of the corresponding congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.

Table 6.2
Summary statistics of marine sediment quality of the Southern, Junk Bay and Deep Bay WCZs, 2000 – 2004

Parameter	Lantau Island (East) SS5	Lantau Island (South) SS6	Junk Bay JS2	Inner Deep Bay DS1	Inner Deep Bay DS2	Outer Deep Bay DS3	Outer Deep Bay DS4
Number of samples	10	10	10	10	10	10	10
Particle Size Fractionation <63μm (%w/w)	94 (79 - 99)	71 (44 - 100)	82 (56 - 93)	71 (8 - 99)	78 (63 - 95)	87 (68 - 96)	70 (37 - 92)
Electrochemical Potential (mV)	-167 ((-299) - (-71))	-140 ((-207) - (-41))	-210 ((-323) - (-98))	-263 ((-366) - (-145))	-191 ((-272) - (-131))	-168 ((-237) - (-61))	-125 ((-204) - (-29))
Total Solids (%w/w)	37 (35 - 39)	61 (57 - 65)	45 (40 - 54)	46 (34 - 53)	46 (42 - 50)	46 (43 - 50)	53 (41 - 66)
Total Volatile Soilds (%w/w)	8.5 (8.2 - 9.0)	4.7 (4.1 - 5.2)	7.3 (5.8 - 7.8)	7.1 (4.7 - 9.2)	7 (6.0 - 7.8)	7.1 (6.5 - 7.6)	6.1 (4.6 - 7.7)
Chemical Oxygen Demand (mg/kg)	15000 (13000 - 17000)	11000 (9200 - 12000)	16000 (11000 - 19000)	21000 (15000 - 25000)	17000 (12000 - 19000)	15000 (12000 - 18000)	15000 (13000 - 19000)
Total Carbon (%w/w)	0.6 (0.5 - 0.6)	0.5 (0.5 - 0.6)	0.7 (0.6 - 0.8)	0.6 (0.4 - 0.7)	0.5 (0.4 - 0.6)	0.5 (0.4 - 0.6)	0.5 (0.5 - 0.8)
Ammonical Nitrogen (mg/kg)	13.1 (0.2 - 34.0)	8.9 (0.3 - 21.0)	8 (4.8 - 14.0)	26.2 (2.5 - 65.0)	6.3 (0.1 - 32.0)	3.3 (0.2 - 7.3)	4.4 (0.1 - 11.0)
Total Kjeldahl Nitrogen (mg/kg)	490 (350 - 870)	296 (200 - 370)	437 (340 - 520)	427 (210 - 800)	389 (160 - 510)	364 (230 - 470)	267 (110 - 490)
Total Phosphorus (mg/kg)	208 (150 - 340)	182 (130 - 220)	200 (170 - 240)	338 (200 - 620)	291 (140 - 380)	244 (140 - 320)	173 (77 - 270)
Total Sulphide (mg/kg)	71 (9 - 110)	31 (9 - 59)	114 (19 - 230)	440 (29 - 1200)	123 (30 - 320)	57 (3 - 160)	23 (2 - 76)
Total Cyanide (mg/kg)	0.1 (<0.1 - 0.2)	<0.1 (<0.1 - 0.2)	0.1 (<0.1 - 0.2)	0.2 (0.1 - 0.4)	0.2 (<0.1 - 0.6)	0.1 (<0.1 - 0.3)	0.1 (<0.1 - 0.3)
Arsenic (mg/kg)	8.8 (7.8 - 9.6)	6.3 (5.4 - 7.6)	7.8 (5.8 - 9.6)	13 (8.5 - 20.0)	14.1 (11.0 - 18.0)	15.2 (13.0 - 17.0)	13.7 (7.6 - 19.0)
Cadmium (mg/kg)	(<0.1) (<0.1 - 0.1)	(<0.1) (<0.1 - <0.1)	0.2 (0.2 - 0.3)	0.4 (<0.1 - 0.6)	0.3 (0.2 - 0.4)	0.2 (0.1 - 0.4)	<0.1 (<0.1 - 0.2)
Chromium (mg/kg)	43 (34 - 47)	26 (20 - 32)	53 (41 - 65)	44 (28 - 57)	43 (36 - 49)	47 (39 - 53)	36 (26 - 50)
Copper (mg/kg)	40 (30 - 48)	14 (11 - 17)	133 (98 - 190)	67 (16 - 100)	59 (51 - 70)	59 (39 - 77)	28 (15 - 57)
Lead (mg/kg)	52 (41 - 60)	27 (22 - 32)	54 (35 - 110)	64 (39 - 87)	60 (46 - 87)	57 (49 - 69)	42 (29 - 59)
Mercury (mg/kg)	0.15 (0.12 - 0.18)	0.06 (0.05 - 0.09)	0.24 (0.14 - 0.35)	0.13 (<0.05 - 0.29)	0.14 (0.11 - 0.23)	0.14 (0.09 - 0.16)	0.07 (<0.05 - 0.11)
Nickel (mg/kg)	27 (22 - 30)	16 (13 - 22)	25 (17 - 38)	26 (18 - 33)	26 (23 - 29)	31 (23 - 37)	20 (15 - 30)
Silver (mg/kg)	0.5 (0.6 - 1.0)	0.3 (<0.2 - 1.0)	2.3 (1.0 - 3.0)	0.8 (<0.2 - 2.0)	0.6 (0.6 - 1.0)	0.6 (0.6 - 1.0)	0.4 (<0.2 - 1.0)
Zinc (mg/kg)	138 (110 - 160)	71 (61 - 86)	145 (100 - 200)	237 (100 - 380)	190 (140 - 240)	167 (140 - 230)	103 (60 - 180)
Total Polychlorinated Biphenyls (PCBs) (μg/kg) (3) (4)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)
Low Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (μg/kg) (5) (6) (9)	90 (90 - 90)	90 (90 - 90)	92 (90 - 97)	93 (90 - 104)	91 (90 - 94)	92 (90 - 96)	91 (90 - 94)
High Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (μg/kg) (7) (8) (9)	75 (44 - 131)	25 (19 - 33)	172 (121 - 268)	133 (18 - 355)	98 (54 - 190)	89 (54 - 120)	73 (16 - 254)

Note : 1. Data presented are arithmetic means ; data in brackets indicate ranges.
2. All data are based on the analyses of bulk (unsieved) sediment and are reported on a dry weight basis unless stated otherwise.
3. The Technical Circular 'ETWB (W) No. 34/2002 Management of Dredged / Excavated Sediment' issued in 2002 has revised the definition of 'Total PCBs' as the summation of 18 specific PCB congeners. Following the new definition, the monitoring of these 18 PCB congeners started in 2002 and the Total PCBs results only refer to 2002 – 2004.
4. Total PCBs results are derived from the summation of 18 congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.
5. Low molecular weight polyaromatic hydrocarbons (PAHs) include 6 congeners of molecular weight below 200, namely : Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene and Phenanthrene.
6. As the monitoring of Naphthalene only started in 2002, the Low Molecular Weight PAHs results are based on sediments samples collected in 2002 – 2004.
7. High molecular weight polyaromatic hydrocarbons (PAHs) include 10 congeners of molecular weight above 200, namely : Fluoranthene, Pyrene, Benzo (a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, Benzo(g,h,i)perylene and Indeno(1,2, 3-cd)pyrene.
8. Low and high molecular weight PAHs results are derived from the summation of the corresponding congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.

6 SEDIMENT QUALITY

Table 6.3

Summary statistics of marine sediment quality of the Port Shelter and Mirs Bay WCZs, 2000 – 2004

Parameter	Inner Port Shelter PS3	Outer Port Shelter PS5	Outer Port Shelter PS6	Starling Inlet MS1	Crooked Island MS2	Crooked Island MS7	Port Island MS17	Mirs Bay (North) MS3
Number of samples	10	10	10	10	10	10	10	10
Particle Size Fractionation <63μm (%w/w)	87 (55 - 96)	40 (8 - 68)	83 (73 - 90)	86 (78 - 92)	93 (83 - 98)	92 (85 - 99)	92 (84 - 98)	90 (73 - 98)
Electrochemical Potential (mV)	-231 ((-324) - (-110))	-135 ((-249) - (-51))	-179 ((-281) - (-33))	-326 ((-379) - (-230))	-349 ((-385) - (-243))	-358 ((-388) - (-319))	-232 ((-342) - (-143))	-243 ((-346) - (-135))
Total Solids (%w/w)	37 (32 - 53)	57 (44 - 63)	47 (43 - 51)	40 (32 - 46)	32 (30 - 35)	30 (27 - 34)	36 (34 - 42)	38 (35 - 41)
Total Volatile Soilds (%w/w)	12.1 (8.2 - 14.0)	7.6 (5.5 - 9.9)	9.5 (8.8 - 11.0)	8.3 (7.4 - 10.0)	10.5 (9.2 - 12.0)	11.3 (9.6 - 12.0)	10.1 (9.1 - 11.0)	9.8 (8.3 - 11.0)
Chemical Oxygen Demand (mg/kg)	19000 (15000 - 22000)	12000 (7200 - 17000)	15000 (12000 - 19000)	20000 (14000 - 22000)	19000 (17000 - 20000)	19000 (17000 - 21000)	18000 (14000 - 19000)	18000 (14000 - 20000)
Total Carbon (%w/w)	1 (0.5 - 1.2)	1.3 (0.3 - 2.2)	1 (0.4 - 1.3)	0.7 (0.6 - 0.8)	0.7 (0.7 - 0.9)	0.8 (0.7 - 0.9)	0.8 (0.7 - 1.2)	0.8 (0.7 - 0.9)
Ammonical Nitrogen (mg/kg)	8.1 (3.7 - 15.0)	9.2 (3.8 - 15.0)	6.6 (2.2 - 14.0)	17.6 (0.2 - 50.0)	16.7 (5.0 - 25.0)	11.9 (1.3 - 18.0)	8 (0.2 - 16.0)	5.2 (0.2 - 11.0)
Total Kjeldahl Nitrogen (mg/kg)	635 (420 - 780)	366 (300 - 510)	469 (270 - 600)	549 (270 - 760)	658 (510 - 720)	686 (630 - 780)	633 (420 - 760)	593 (380 - 700)
Total Phosphorus (mg/kg)	208 (170 - 240)	165 (120 - 210)	193 (110 - 250)	188 (150 - 230)	205 (180 - 240)	201 (170 - 240)	217 (190 - 270)	202 (170 - 230)
Total Sulphide (mg/kg)	82 (44 - 200)	15 (3 - 36)	37 (14 - 59)	197 (31 - 350)	175 (43 - 340)	104 (64 - 190)	56 (26 - 77)	31 (10 - 55)
Total Cyanide (mg/kg)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.2)	0.1 (<0.1 - 0.2)	0.1 (<0.1 - 0.2)	0.1 (<0.1 - 0.2)	0.1 (<0.1 - 0.2)	<0.1 (<0.1 - 0.2)
Arsenic (mg/kg)	6.6 (4.7 - 9.7)	4.6 (2.5 - 8.2)	6.3 (5.1 - 9.3)	9.5 (7.5 - 12.0)	7.5 (5.8 - 9.4)	7.3 (5.7 - 10.0)	6.9 (5.3 - 8.8)	7.3 (5.1 - 9.6)
Cadmium (mg/kg)	(<0.1) (<0.1 - <0.1)	(<0.1) (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)	0.3 (0.2 - 0.4)	0.2 (0.1 - 0.3)	0.2 (0.1 - 0.2)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.1)
Chromium (mg/kg)	28 (20 - 35)	21 (16 - 30)	29 (23 - 34)	29 (26 - 32)	35 (28 - 40)	35 (32 - 38)	36 (28 - 41)	34 (27 - 39)
Copper (mg/kg)	24 (19 - 31)	10 (5 - 17)	14 (11 - 21)	40 (32 - 45)	22 (19 - 26)	21 (18 - 25)	17 (13 - 20)	15 (12 - 19)
Lead (mg/kg)	39 (34 - 44)	25 (18 - 37)	34 (31 - 38)	51 (38 - 55)	47 (39 - 51)	43 (36 - 49)	45 (34 - 53)	39 (32 - 49)
Mercury (mg/kg)	0.1 (0.06 - 0.18)	<0.05 (<0.05 - 0.07)	<0.05 (<0.05 - 0.09)	0.09 (0.07 - 0.15)	0.07 (<0.05 - 0.09)	0.07 (0.06 - 0.11)	0.05 (<0.05 - 0.08)	0.05 (<0.05 - 0.07)
Nickel (mg/kg)	17 (9 - 22)	15 (9 - 24)	20 (17 - 23)	18 (15 - 21)	23 (20 - 26)	24 (21 - 26)	27 (21 - 31)	24 (19 - 28)
Silver (mg/kg)	0.4 (0.2 - 1.0)	0.4 (<0.2 - 1.0)	0.3 (<0.2 - 1.0)	0.7 (0.8 - 1.0)	0.4 (0.2 - 1.0)	0.4 (<0.2 - 1.0)	0.3 (<0.2 - 1.0)	0.3 (<0.2 - 1.0)
Zinc (mg/kg)	98 (77 - 130)	60 (36 - 98)	79 (67 - 100)	106 (80 - 120)	100 (77 - 110)	94 (78 - 100)	95 (66 - 120)	91 (60 - 160)
Total Polychlorinated Biphenyls (PCBs) (μg/kg) (3) (4)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)
Low Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (μg/kg) (5) (6) (9)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)	91 (90 - 95)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)
High Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (μg/kg) (7) (8) (9)	63 (29 - 103)	28 (19 - 37)	42 (21 - 89)	52 (29 - 93)	63 (34 - 109)	79 (32 - 200)	51 (29 - 78)	48 (21 - 94)

Note : 1. Data presented are arithmetic means ; data in brackets indicate ranges.
2. All data are based on the analyses of bulk (unsieved) sediment and are reported on a dry weight basis unless stated otherwise.
3. The Technical Circular 'ETWB (W) No. 34/2002 Management of Dredged / Excavated Sediment' issued in 2002 has revised the definition of 'Total PCBs' as the summation of 18 specific PCB congeners. Following the new definition, the monitoring of these 18 PCB congeners started in 2002 and the Total PCBs results only refer to 2002 – 2004.
4. Total PCBs results are derived from the summation of 18 congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.
5. Low molecular weight polyaromatic hydrocarbons (PAHs) include 6 congeners of molecular weight below 200, namely : Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene and Phenanthrene.
6. As the monitoring of Naphthalene only started in 2002, the Low Molecular Weight PAHs results are based on sediments samples collected in 2002 – 2004.
7. High molecular weight polyaromatic hydrocarbons (PAHs) include 10 congeners of molecular weight above 200, namely : Fluoranthene, Pyrene, Benzo (a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, Benzo(g,h,i)perylene and Indeno(1,2, 3-cd)pyrene.
8. Low and high molecular weight PAHs results are derived from the summation of the corresponding congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.

Table 6.4

Summary statistics of marine sediment quality of the Mirs Bay WCZ, 2000 – 2004

Parameter	Mirs Bay (North) MS4	MS5	Long Harbour MS6	Waglan Island MS8	Mirs Bay (South) MS13	Mirs Bay (Central) MS14	MS15	MS16
Number of samples	10	10	10	10	10	10	10	10
Particle Size Fractionation <63µm (%w/w)	94 (85 - 99)	89 (78 - 96)	93 (85 - 98)	94 (83 - 98)	92 (83 - 95)	89 (77 - 95)	88 (81 - 94)	84 (71 - 94)
Electrochemical Potential (mV)	-187 ((-282) - (-100))	-180 ((-246) - (-95))	-215 ((-300) - (-104))	-156 ((-237) - (-84))	-128 ((-195) - (-28))	-136 ((-202) - (-77))	-131 ((-209) - (-32))	-121 ((-191) - (-39))
Total Solids (%w/w)	35 (33 - 36)	40 (36 - 44)	34 (31 - 37)	47 (45 - 51)	49 (48 - 51)	50 (46 - 54)	52 (49 - 55)	52 (46 - 56)
Total Volatile Soilds (%w/w)	9.5 (8.3 - 10.0)	8.6 (7.1 - 10.0)	11.3 (10.0 - 12.0)	7.3 (6.6 - 7.8)	6.7 (6.1 - 7.5)	6.8 (5.7 - 7.4)	6.4 (5.3 - 7.0)	6.6 (6.0 - 7.1)
Chemical Oxygen Demand (mg/kg)	15000 (13000 - 17000)	15000 (14000 - 17000)	20000 (17000 - 21000)	12000 (10000 - 14000)	11000 (9700 - 12000)	11000 (9600 - 12000)	11000 (9500 - 13000)	12000 (9600 - 13000)
Total Carbon (%w/w)	0.6 (0.6 - 0.7)	0.7 (0.6 - 0.9)	0.9 (0.8 - 1.0)	0.6 (0.5 - 0.6)	0.6 (0.5 - 0.6)	0.6 (0.5 - 0.7)	0.6 (0.5 - 0.8)	0.6 (0.5 - 0.8)
Ammonical Nitrogen (mg/kg)	8.8 (0.1 - 20.0)	9.8 (0.1 - 21.0)	10.2 (0.4 - 21.0)	4.1 (0.3 - 9.3)	10 (0.3 - 48.0)	10.6 (0.1 - 69.0)	4.1 (0.3 - 9.5)	9.4 (1.5 - 37.0)
Total Kjeldahl Nitrogen (mg/kg)	607 (440 - 680)	579 (360 - 670)	721 (640 - 840)	402 (320 - 520)	427 (350 - 540)	417 (280 - 560)	387 (270 - 540)	400 (260 - 480)
Total Phosphorus (mg/kg)	202 (140 - 230)	209 (140 - 240)	242 (220 - 290)	207 (180 - 230)	234 (210 - 260)	225 (190 - 260)	218 (180 - 260)	217 (160 - 260)
Total Sulphide (mg/kg)	49 (18 - 86)	57 (5 - 180)	86 (36 - 210)	48 (1 - 180)	34 (9 - 130)	22 (9 - 89)	18 (9 - 27)	41 (3 - 210)
Total Cyanide (mg/kg)	<0.1 (<0.1 - 0.2)	<0.1 (<0.1 - 0.1)	0.1 (<0.1 - 0.2)	<0.1 (<0.1 - 0.2)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.1)
Arsenic (mg/kg)	7 (4.9 - 9.0)	7.4 (5.7 - 9.7)	6.7 (5.0 - 8.8)	7.6 (6.6 - 9.0)	7.9 (6.4 - 9.3)	7.8 (6.5 - 8.9)	6.9 (5.6 - 8.1)	6.6 (5.0 - 7.7)
Cadmium (mg/kg)	(<0.1) (<0.1 - 0.1)	(<0.1) (<0.1 - 0.2)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)
Chromium (mg/kg)	37 (30 - 43)	34 (26 - 38)	32 (27 - 35)	33 (26 - 39)	31 (29 - 34)	31 (28 - 36)	30 (25 - 35)	28 (24 - 34)
Copper (mg/kg)	16 (13 - 18)	15 (11 - 18)	18 (15 - 23)	14 (11 - 20)	13 (11 - 14)	12 (10 - 16)	11 (9 - 13)	11 (8 - 14)
Lead (mg/kg)	41 (33 - 47)	43 (33 - 47)	42 (36 - 47)	34 (27 - 38)	31 (26 - 34)	31 (26 - 36)	31 (25 - 39)	32 (26 - 39)
Mercury (mg/kg)	<0.05 (<0.05 - 0.07)	<0.05 (<0.05 - 0.07)	0.07 (0.06 - 0.1)	0.05 (<0.05 - 0.09)	<0.05 (<0.05 - 0.06)	<0.05 (<0.05 - 0.05)	<0.05 (<0.05 - 0.09)	<0.05 (<0.05 - 0.05)
Nickel (mg/kg)	27 (23 - 32)	25 (20 - 26)	24 (21 - 28)	24 (20 - 31)	24 (21 - 26)	23 (20 - 27)	22 (18 - 26)	21 (17 - 26)
Silver (mg/kg)	0.3 (<0.2 - 1.0)	0.3 (<0.2 - 1.0)	0.3 (<0.2 - 1.0)	0.3 (<0.2 - 1.0)	0.3 (<0.2 - 1.0)	0.3 (<0.2 - 1.0)	0.3 (<0.2 - 1.0)	0.3 (<0.2 - 1.0)
Zinc (mg/kg)	90 (66 - 100)	89 (62 - 100)	99 (78 - 110)	83 (59 - 100)	78 (56 - 95)	78 (58 - 92)	72 (53 - 94)	72 (54 - 82)
Total Polychlorinated Biphenyls (PCBs) (µg/kg) (3) (4)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)
Low Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (µg/kg) (5) (6) (9)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)
High Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (µg/kg) (7) (8) (9)	49 (28 - 79)	43 (22 - 75)	68 (35 - 123)	55 (22 - 120)	34 (21 - 48)	32 (20 - 48)	30 (19 - 51)	27 (19 - 47)

Note :
1. Data presented are arithmetic means ; data in brackets indicate ranges.
2. All data are based on the analyses of bulk (unsieved) sediment and are reported on a dry weight basis unless stated otherwise.
3. The Technical Circular 'ETWB (W) No. 34/2002 Management of Dredged / Excavated Sediment' issued in 2002 has revised the definition of 'Total PCBs' as the summation of 18 specific PCB congeners. Following the new definition, the monitoring of these 18 PCB congeners started in 2002 and the Total PCBs results only refer to 2002 - 2004.
4. Total PCBs results are derived from the summation of 18 congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.
5. Low molecular weight polyaromatic hydrocarbons (PAHs) include 6 congeners of molecular weight below 200, namely : Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene and Phenanthrene.
6. As the monitoring of Naphthalene only started in 2002, the Low Molecular Weight PAHs results are based on sediments samples collected in 2002 – 2004.
7. High molecular weight polyaromatic hydrocarbons (PAHs) include 10 congeners of molecular weight above 200, namely : Fluoranthene, Pyrene, Benzo (a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, Benzo(g,h,i)perylene and Indeno(1,2, 3-cd)pyrene.
8. Low and high molecular weight PAHs results are derived from the summation of the corresponding congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.

Table 6.5

Summary statistics of bottom sediment quality of the North Western and Western Buffer WCZs, 2000 – 2004

Parameter	Pearl Island NS2	Pillar Point NS3	Urmston Road NS4	Chek Lap Kok (North) NS6	Tsing Yi (South) WS1	Hong Kong Island (West) WS2
Number of samples	10	10	10	10	9	10
Particle Size Fractionation <63µm (%w/w)	65 (41 - 79)	47 (5 - 82)	37 (12 - 85)	47 (10 - 92)	76 (27 - 95)	83 (66 - 97)
Electrochemical Potential (mV)	-138 ((-186) - (-84))	-148 ((-236) - (-18))	-168 ((-230) - (-82))	-158 ((-205) - (-115))	-184 ((-263) - (-108))	-143 ((-212) - (-93))
Total Solids (%w/w)	54 (50 - 62)	60 (51 - 69)	64 (61 - 68)	63 (47 - 73)	48 (38 - 65)	46 (41 - 54)
Total Volatile Soilds (%w/w)	6.2 (5.0 - 7.0)	5.5 (3.1 - 7.4)	5.1 (4.5 - 5.9)	4.8 (2.9 - 8.3)	6.6 (4.0 - 9.0)	6.9 (5.6 - 8.4)
Chemical Oxygen Demand (mg/kg)	14000 (10000 - 17000)	15000 (8400 - 19000)	14000 (12000 - 19000)	12000 (8300 - 17000)	15000 (11000 - 19000)	13000 (9800 - 17000)
Total Carbon (%w/w)	0.6 (0.5 - 1.0)	0.6 (0.4 - 0.8)	0.5 (0.3 - 0.7)	0.5 (0.4 - 0.8)	0.7 (0.5 - 1.1)	0.6 (0.5 - 0.6)
Ammonical Nitrogen (mg/kg)	3 (0.1 - 8.2)	6.6 (0.1 - 16.0)	14.5 (0.2 - 39.0)	5.7 (0.1 - 16.0)	17.6 (5.8 - 38.0)	6.4 (0.9 - 11.0)
Total Kjeldahl Nitrogen (mg/kg)	303 (220 - 370)	285 (120 - 440)	245 (160 - 320)	244 (140 - 390)	397 (200 - 570)	355 (260 - 460)
Total Phosphorus (mg/kg)	182 (130 - 220)	182 (86 - 240)	148 (92 - 210)	159 (100 - 260)	183 (110 - 240)	183 (140 - 220)
Total Sulphide (mg/kg)	23 (2 - 64)	15 (5 - 32)	27 (3 - 77)	10 (2 - 38)	101 (13 - 210)	66 (15 - 200)
Total Cyanide (mg/kg)	<0.1 (<0.1 - 0.1)	0.1 (<0.1 - 0.5)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.1)	0.1 (<0.1 - 0.3)	<0.1 (<0.1 - 0.2)
Arsenic (mg/kg)	10 (7.5 - 14.0)	10.4 (6.3 - 14.0)	10.3 (9.1 - 13.0)	10.6 (6.1 - 22.0)	9.4 (4.7 - 13.0)	11.7 (8.8 - 16.0)
Cadmium (mg/kg)	(<0.1) (<0.1 - 0.1)	(<0.1) (<0.1 - 0.3)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.1)	0.1 (<0.1 - 0.2)	<0.1 (<0.1 - 0.1)
Chromium (mg/kg)	33 (25 - 43)	30 (16 - 41)	28 (23 - 36)	26 (15 - 45)	38 (13 - 51)	38 (32 - 45)
Copper (mg/kg)	31 (27 - 42)	30 (17 - 47)	23 (18 - 42)	16 (8 - 34)	46 (9 - 85)	27 (18 - 39)
Lead (mg/kg)	37 (32 - 50)	36 (20 - 45)	38 (29 - 46)	29 (17 - 46)	38 (15 - 49)	39 (34 - 48)
Mercury (mg/kg)	0.09 (0.06 - 0.15)	0.12 (0.06 - 0.19)	0.07 (0.06 - 0.1)	0.05 (<0.05 - 0.13)	0.16 (<0.05 - 0.49)	0.1 (<0.05 - 0.26)
Nickel (mg/kg)	20 (15 - 27)	19 (10 - 25)	17 (14 - 22)	16 (9 - 27)	22 (8 - 27)	24 (21 - 27)
Silver (mg/kg)	0.5 (0.3 - 1.0)	0.4 (0.2 - 1.0)	0.4 (<0.2 - 1.0)	0.4 (<0.2 - 1.0)	0.9 (0.5 - 2.0)	0.4 (0.2 - 1.0)
Zinc (mg/kg)	94 (73 - 130)	87 (48 - 120)	98 (67 - 110)	69 (34 - 120)	102 (31 - 150)	102 (82 - 130)
Total Polychlorinated Biphenyls (PCBs) (µg/kg) (3) (4)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)
Low Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (µg/kg) (5) (6) (9)	90 (90 - 90)	91 (90 - 94)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)
High Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (µg/kg) (7) (8) (9)	44 (27 - 65)	62 (31 - 114)	55 (22 - 139)	23 (16 - 37)	95 (22 - 187)	66 (22 - 140)

Note :
1. Data presented are arithmetic means ; data in brackets indicate ranges.
2. All data are based on the analyses of bulk (unsieved) sediment and are reported on a dry weight basis unless stated otherwise.
3. The Technical Circular 'ETWB (W) No. 34/2002 Management of Dredged / Excavated Sediment' issued in 2002 has revised the definition of 'Total PCBs' as the summation of 18 specific PCB congeners. Following the new definition, the monitoring of these 18 PCB congeners started in 2002 and the Total PCBs results only refer to 2002 – 2004.
4. Total PCBs results are derived from the summation of 18 congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.
5. Low molecular weight polyaromatic hydrocarbons (PAHs) include 6 congeners of molecular weight below 200, namely : Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene and Phenanthrene.
6. As the monitoring of Naphthalene only started in 2002, the Low Molecular Weight PAHs results are based on sediments samples collected in 2002 – 2004.
7. High molecular weight polyaromatic hydrocarbons (PAHs) include 10 congeners of molecular weight above 200, namely : Fluoranthene, Pyrene, Benzo (a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, Benzo(g,h,i)perylene and Indeno(1,2, 3-cd)pyrene.
8. Low and high molecular weight PAHs results are derived from the summation of the corresponding congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.

Table 6.6

Summary statistics of marine sediment quality of the Eastern Buffer and Victoria Harbour WCZs, 2000 – 2004

Parameter	Eastern Buffer			Victoria Harbour			Rambler Channel	
	Chai Wan	Tathong Channel		(East)	(Central)	(West)		
	ES1	ES2	ES4	VS3	VS5	VS6	VS9	VS10
Number of samples	10	10	10	10	10	9	10	10
Particle Size Fractionation <63µm (%w/w)	51 (39 - 94)	68 (15 - 92)	57 (27 - 87)	57 (10 - 91)	69 (28 - 93)	57 (43 - 79)	79 (57 - 90)	82 (29 - 97)
Electrochemical Potential (mV)	-203 ((-246) - (-151))	-161 ((-202) - (-107))	-270 ((-349) - (-187))	-326 ((-421) - (-213))	-363 ((-409) - (-258))	-343 ((-409) - (-218))	-234 ((-365) - (-100))	-250 ((-365) - (-148))
Total Solids (%w/w)	64 (51 - 70)	56 (44 - 66)	54 (45 - 66)	50 (39 - 73)	44 (31 - 66)	51 (41 - 70)	47 (40 - 53)	42 (34 - 60)
Total Volatile Soilds (%w/w)	5 (3.8 - 6.6)	5.8 (4.3 - 7.6)	6.3 (4.9 - 8.1)	6.7 (3.2 - 8.2)	8.7 (5.2 - 12.0)	7.5 (5.0 - 8.8)	7.1 (6.0 - 8.4)	7.9 (4.8 - 9.0)
Chemical Oxygen Demand (mg/kg)	12000 (9400 - 27000)	13000 (8000 - 21000)	16000 (11000 - 21000)	17000 (7300 - 23000)	25000 (15000 - 32000)	25000 (13000 - 32000)	18000 (12000 - 23000)	20000 (13000 - 27000)
Total Carbon (%w/w)	1 (0.3 - 1.8)	0.7 (0.5 - 0.9)	0.7 (0.3 - 1.1)	0.7 (0.5 - 0.9)	0.8 (0.5 - 1.1)	1 (0.7 - 1.6)	0.7 (0.6 - 0.8)	0.6 (0.4 - 0.8)
Ammonical Nitrogen (mg/kg)	10.2 (1.5 - 22.0)	6.2 (2.3 - 9.7)	8 (2.5 - 17.0)	10.8 (0.4 - 22.0)	34.3 (1.5 - 86.0)	15.3 (5.3 - 42.0)	18.3 (1.1 - 49.0)	15.5 (3.3 - 34.0)
Total Kjeldahl Nitrogen (mg/kg)	311 (190 - 430)	366 (250 - 530)	423 (290 - 620)	468 (220 - 590)	584 (360 - 690)	437 (300 - 580)	329 (160 - 460)	462 (270 - 630)
Total Phosphorus (mg/kg)	155 (100 - 210)	183 (130 - 230)	178 (120 - 240)	174 (120 - 220)	196 (130 - 240)	226 (190 - 280)	164 (120 - 200)	215 (150 - 260)
Total Sulphide (mg/kg)	72 (3 - 140)	55 (7 - 150)	222 (15 - 360)	318 (200 - 590)	747 (170 - 1700)	247 (120 - 490)	108 (0.3 - 460)	300 (110 - 1100)
Total Cyanide (mg/kg)	<0.1 (<0.1 - 0.2)	<0.1 (<0.1 - 0.2)	0.2 (<0.1 - 0.4)	0.1 (<0.1 - 0.2)	0.3 (<0.1 - 0.8)	0.2 (<0.1 - 0.3)	0.1 (<0.1 - 0.3)	0.3 (<0.1 - 0.5)
Arsenic (mg/kg)	5.4 (3.5 - 7.0)	6.3 (4.9 - 8.2)	6 (4.1 - 8.1)	6 (0.9 - 9.4)	7.8 (6.2 - 8.5)	8.9 (6.6 - 11.0)	6.6 (4.0 - 9.3)	9.9 (6.6 - 11.0)
Cadmium (mg/kg)	(<0.1) (<0.1 - 0.2)	(<0.1) (<0.1 - <0.1)	0.2 (<0.1 - 0.3)	0.3 (<0.1 - 0.6)	0.7 (0.3 - 1.0)	0.4 (0.2 - 0.6)	0.4 (<0.1 - 1.3)	0.8 (0.4 - 2.4)
Chromium (mg/kg)	23 (15 - 36)	29 (20 - 38)	33 (23 - 54)	38 (12 - 70)	54 (28 - 70)	45 (32 - 60)	54 (33 - 76)	103 (56 - 190)
Copper (mg/kg)	41 (17 - 87)	27 (16 - 48)	78 (52 - 140)	111 (27 - 230)	177 (84 - 250)	130 (76 - 210)	122 (11 - 280)	277 (130 - 760)
Lead (mg/kg)	25 (21 - 32)	29 (21 - 44)	36 (23 - 69)	41 (21 - 59)	61 (42 - 84)	97 (51 - 130)	45 (25 - 81)	63 (42 - 76)
Mercury (mg/kg)	0.19 (0.06 - 1)	0.07 (<0.05 - 0.14)	0.17 (0.09 - 0.3)	0.29 (<0.05 - 0.72)	0.39 (0.2 - 0.52)	1.65 (0.29 - 8)	0.18 (<0.05 - 0.39)	0.2 (0.13 - 0.29)
Nickel (mg/kg)	13 (10 - 18)	19 (14 - 25)	16 (8 - 22)	16 (6 - 27)	23 (12 - 31)	20 (14 - 28)	29 (19 - 43)	45 (23 - 110)
Silver (mg/kg)	0.7 (0.2 - 2.0)	0.5 (<0.2 - 1.0)	1.9 (1.0 - 3.0)	3.2 (1.0 - 6.0)	7.4 (3.0 - 11.0)	3.8 (1.6 - 6.0)	3.0 (0.9 - 8.0)	8.2 (4.0 - 14.0)
Zinc (mg/kg)	65 (46 - 100)	74 (54 - 110)	96 (63 - 140)	128 (17 - 210)	230 (110 - 340)	193 (120 - 250)	123 (62 - 210)	199 (110 - 260)
Total Polychlorinated Biphenyls (PCBs) (µg/kg) (3) (4)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 19)	19 (18 - 23)	28 (18 - 45)	19 (18 - 23)	22 (18 - 30)
Low Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (µg/kg) (5) (6) (9)	96 (90 - 126)	91 (90 - 94)	94 (90 - 101)	102 (90 - 124)	119 (90 - 181)	141 (113 - 169)	90 (90 - 90)	92 (90 - 99)
High Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (µg/kg) (7) (8) (9)	120 (21 - 391)	58 (30 - 132)	147 (74 - 265)	324 (66 - 689)	548 (278 - 985)	1724 (357 - 5780)	116 (16 - 281)	200 (119 - 339)

Note : 1. Data presented are arithmetic means ; data in brackets indicate ranges.
2. All data are based on the analyses of bulk (unsieved) sediment and are reported on a dry weight basis unless stated otherwise.
3. The Technical Circular 'ETWB (W) No. 34/2002 Management of Dredged / Excavated Sediment' issued in 2002 has revised the definition of 'Total PCBs' as the summation of 18 specific PCB congeners. Following the new definition, the monitoring of these 18 PCB congeners started in 2002 and the Total PCBs results only refer to 2002 – 2004.
4. Total PCBs results are derived from the summation of 18 congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.
5. Low molecular weight polyaromatic hydrocarbons (PAHs) include 6 congeners of molecular weight below 200, namely : Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene and Phenanthrene.
6. As the monitoring of Naphthalene only started in 2002, the Low Molecular Weight PAHs results are based on sediments samples collected in 2002 – 2004.
7. High molecular weight polyaromatic hydrocarbons (PAHs) include 10 congeners of molecular weight above 200, namely : Fluoranthene, Pyrene, Benzo (a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, Benzo(g,h,i)perylene and Indeno(1,2, 3-cd)pyrene.
8. Low and high molecular weight PAHs results are derived from the summation of the corresponding congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.

Table 6.7

Sediment Quality Criteria for the Classification of Sediments[1]

Contaminants	Lower Chemical Exceedance Level (LCEL)	Upper Chemical Exceedance Level (UCEL)
Metals ***(mg/kg dry weight)***		
Cadmium (Cd)	1.5	4
Chromium (Cr)	80	160
Copper (Cu)	65	110
Mercury (Hg)	0.5	1
Nickel (Ni) [2]	40	40
Lead (Pb)	75	110
Silver (Ag)	1	2
Zinc (Zn)	200	270
Metalloid ***(mg/kg dry weight)***		
Arsenic (As)	12	42
Organic-PAHs ***(µg/kg dry weight)***		
Low Molecular Weight PAHs [3]	550	3160
High Molecular Weight PAHs [4]	1700	9600
Organic-non-PAHs ***(µg/kg dry weight)***		
Total PCBs	23	180
Organometallics ***(mg TBT/L in Interstitial water)***		
Tributyltin [2]	0.15	0.15

Footnote : 1. The table is extracted from Appendix A of ETWB (W) No. 34/2002 Management of Dredged / Excavated Sediment (http://www.etwb.gov.hk).

2. When the LCEL and UCEL for a contaminant are the same, the contaminant level would exceed UCEL if it is greater than the value shown.
3. Low molecular weight PAHs include acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene.
4. High molecular weight PAHs include benzo[a]anthracene, benzo[a]pyrene, chrysene, dibenzo[a,h]anthracene, fluoranthene, pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, indeno[1,2,3-c,d]pyrene and benzo[g,h,i] perylene.
5. Total PCBs include 18 congeners: PCB 8, 18, 28, 44, 52, 66, 77, 101, 105, 118, 126, 128, 138, 153, 169, 170, 180, 187.

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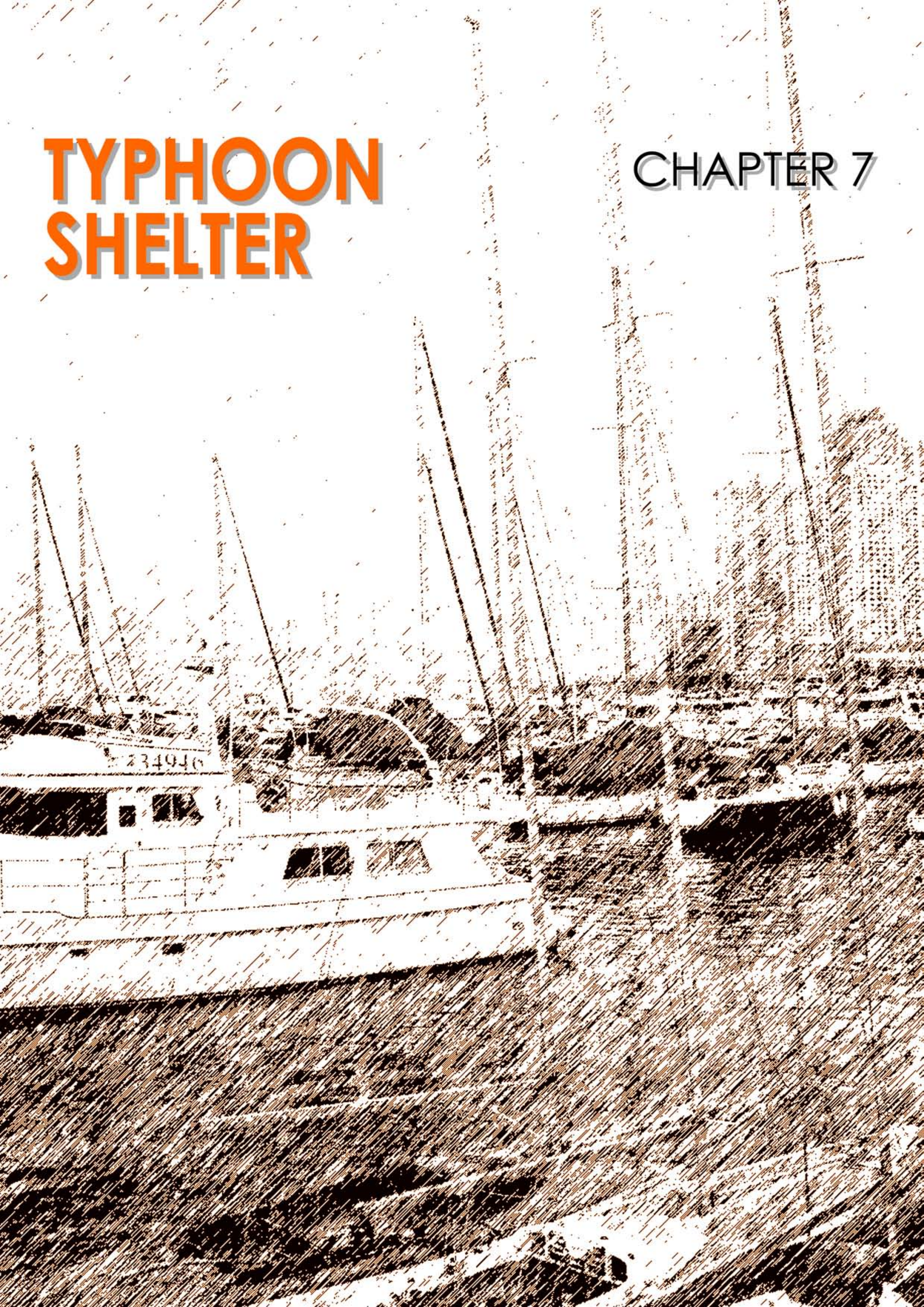
CHAPTER 7



Chapter 7 – Typhoon Shelter

Water Quality in 2004

7.1 Typhoon shelters are in embayments with low tidal flushing and are vulnerable to pollution from the shore and marine sources. In 2004, the Environment Protection Department (EPD) conducted monitoring at 18 water and 15 sediment stations in 17 typhoon shelters and boat anchorages in the territory (Figure 1.4). A summary of the monitoring data is found in Table 7.2 and levels of the key water quality parameters are illustrated in Figure 7.1.

7.2 While EPD controls land-based discharges, the Marine Department is responsible for controlling pollution from vessels and cleaning up floating refuse in marine waters (http://www.mardep.gov.hk).

Water Quality in 2004

7.3 In 2004, Yim Tin Tsai and Hebe Haven Typhoon Shelters in the Port Shelter Water Control Zone (WCZ) had the best water quality amongst the typhoon shelters. Kwun Tong Typhoon Shelter had the highest levels of *E. coli*, ammonia nitrogen (NH_4-N) and total inorganic nitrogen (TIN) (Figure 7.1, Table 7.2). Causeway Bay, Yau Ma Tei, Rambler Channel, Aberdeen (West) and Sam Ka Tsuen Typhoon Shelters also had higher *E. coli* (1,400 - 10,000 cfu/100mL) indicating faecal contamination.

7.4 The water in the typhoon shelters is generally well oxygenated, with the mean dissolved oxygen (DO) varying between 3.9 mg/L in Kwun Tong Typhoon Shelter and 7.2 mg/L in Hei Ling Chau Typhoon Shelter. No serious hypoxia (<2 mg/L) occurred in 2004 while an increase of DO by over 20% was observed in the Yau Ma Tei Typhoon Shelter.

7.5 The typhoon shelters in eastern Victoria Harbour, e.g. Chai Wan, Aldrich Bay (Shau Kei Wan), Sam Ka Tsuen, To Kwa Wan experienced a marked reduction of *E. coli* and NH_4-N in 2002 after the commissioning of the Harbour Area Treatment Scheme (HATS) Stage 1. These water quality improvements were sustained in 2004.

Long-term Water Quality Trends

7.6 Significant long-term improvements in terms of decreasing trends in total nitrogen, TIN, orthophosphate phosphorus and total phosphorus were observed in many typhoon shelters in the Victoria Harbour area, e.g. Causeway Bay and To Kwa Wan (Table 7.1). An increase in DO and decreases in 5-day Biochemical Oxygen Demand, *E. coli* and NH_4-N were also observed in Kwun Tong and Sam Ka Tsuen Typhoon Shelters.

Sediment Quality

7.7 Bottom sediments in many typhoon shelters in the Victoria Harbour and Eastern Buffer WCZs were contaminated by heavy metals. Kwun Tong Typhoon Shelter had the highest levels of cadmium, chromium, copper, lead, nickel and zinc in the sediments (Table 7.3).

7.8 Using the guideline values in '*ETWB(W) No. 34/2002 - Management of Dredged / Excavated Sediment*' as a bench mark, the typhoon shelters in the Victoria Harbour, Eastern Buffer, Tolo Harbour and Channel and Southern WCZs often exceeded the Upper Chemical Exceedance Levels (UCELs) for copper (110 mg/kg) and silver (2 mg/kg); whereas Yau Ma Tei Typhoon Shelter and the Government Dockyard exceeded the Lower Chemical Exceedance Level (LCEL) for copper (65 mg/kg) and silver (1 mg/kg) respectively (Figures 7.2 and 7.3). For zinc, while six typhoon shelters in eastern Victoria Harbour, Rambler Channel and Tolo Harbour and Channel exceeded the UCEL, three typhoon shelters in the central and western harbour exceeded the LCEL (Figure 7.4). The contamination of typhoon shelter sediments by heavy metals was likely to be related to discharges from printed circuit board, electroplating and electronic industries in old industrial areas between the 60s and 80s.

7.9 The highest level of total Polychlorinated Biphenyls (PCBs) in the sediment, which exceeded the UCEL was found at Kwun Tong Typhoon Shelter. This was probably related to the use of PCB transformers and capacitors which have now been largely phased out. (Figure 7.5)

7.10 The levels of high and low molecular weight Polycyclic Aromatic Hydrocarbons (PAHs) in the typhoon shelter sediments were all below the LCELs with the exception of To Kwa Wan Typhoon Shelter (Figures 7.6 and 7.7), where the concentrations exceeded the UCELs. The presence of PAHs at this site may be related to contamination by aviation fuel from the former Kai Tak Airport.

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Figure 7.1 Water quality of typhoon shelters in Hong Kong in 2004

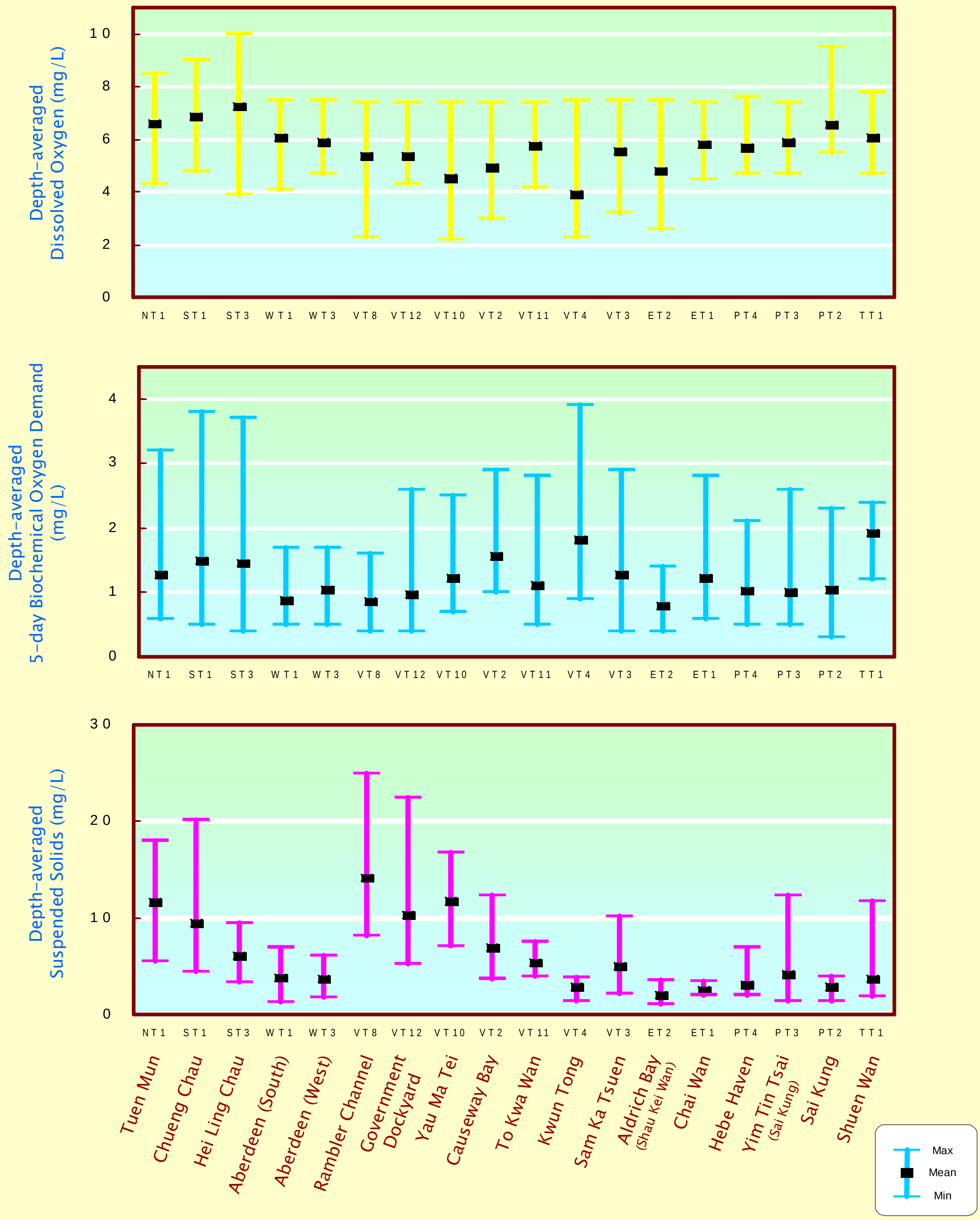

Figure 7.1 Water quality of typhoon shelters in Hong Kong in 2004 (continued)

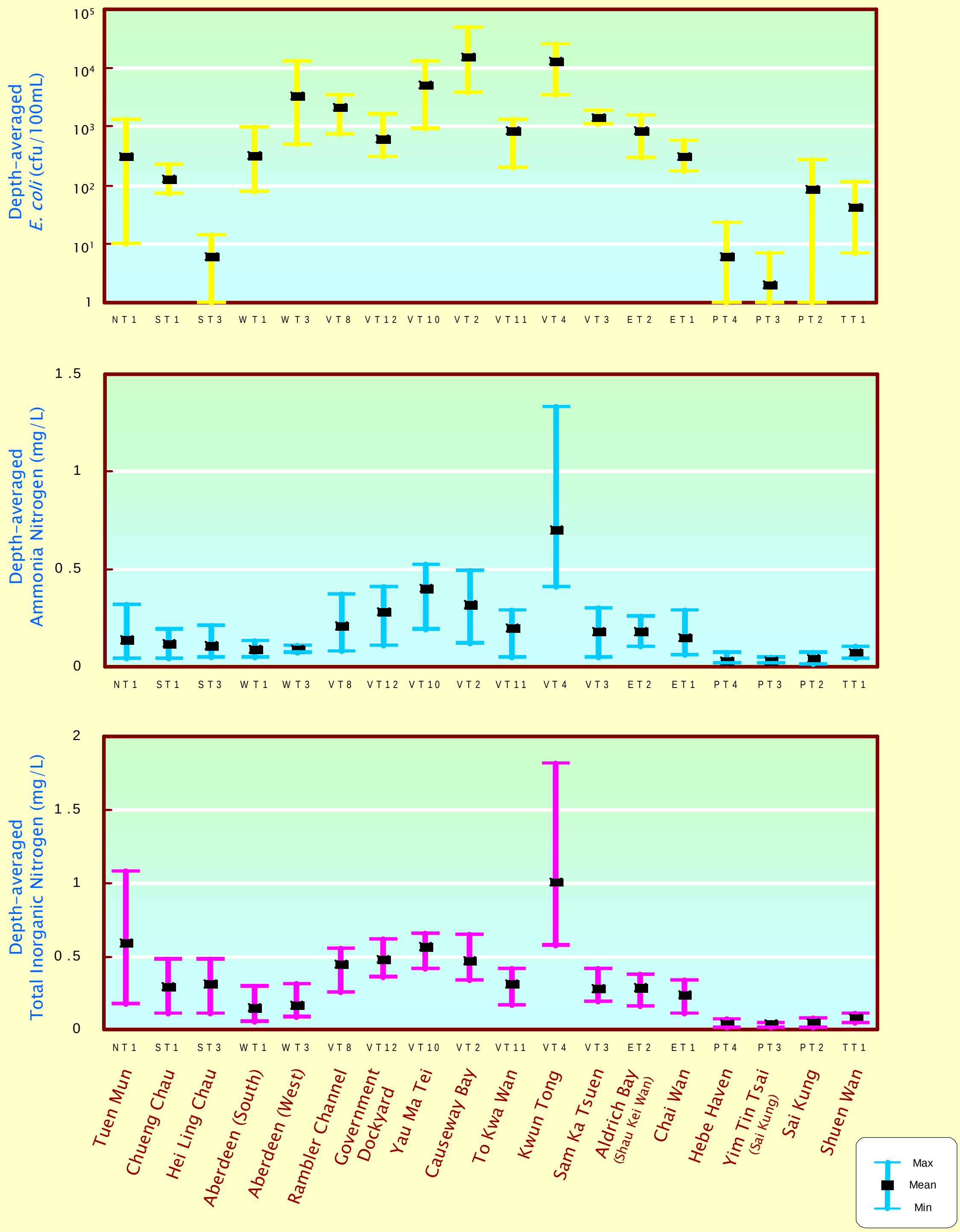

Figure 7.2 Copper in typhoon shelter sediments in Hong Kong, 2000 – 2004

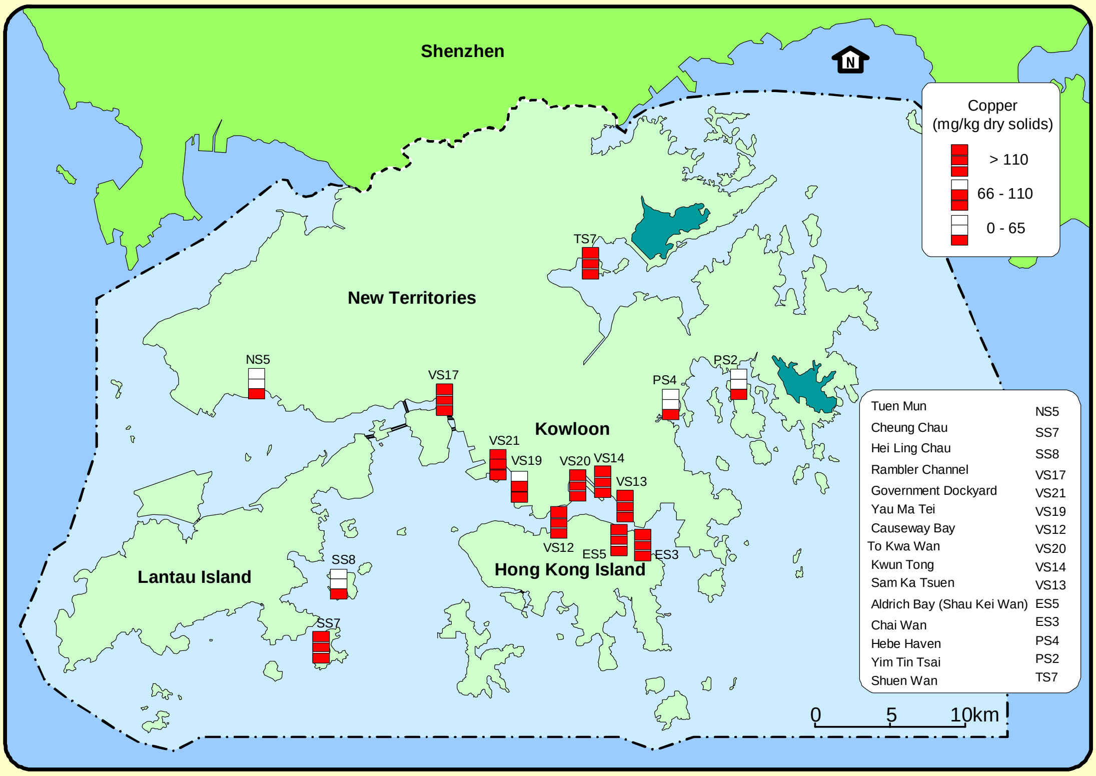

Figure 7.3 Silver in typhoon shelter sediments in Hong Kong, 2000 – 2004

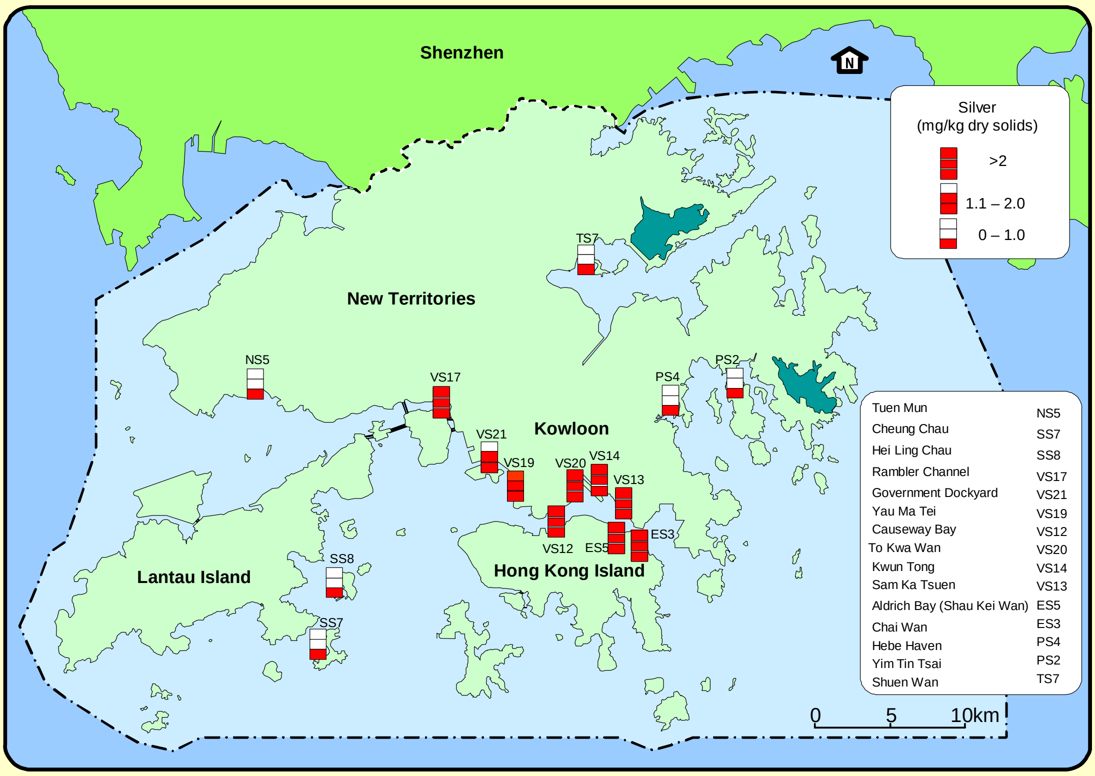

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Figure 7.4 Zinc in typhoon shelter sediments in Hong Kong, 2000 – 2004

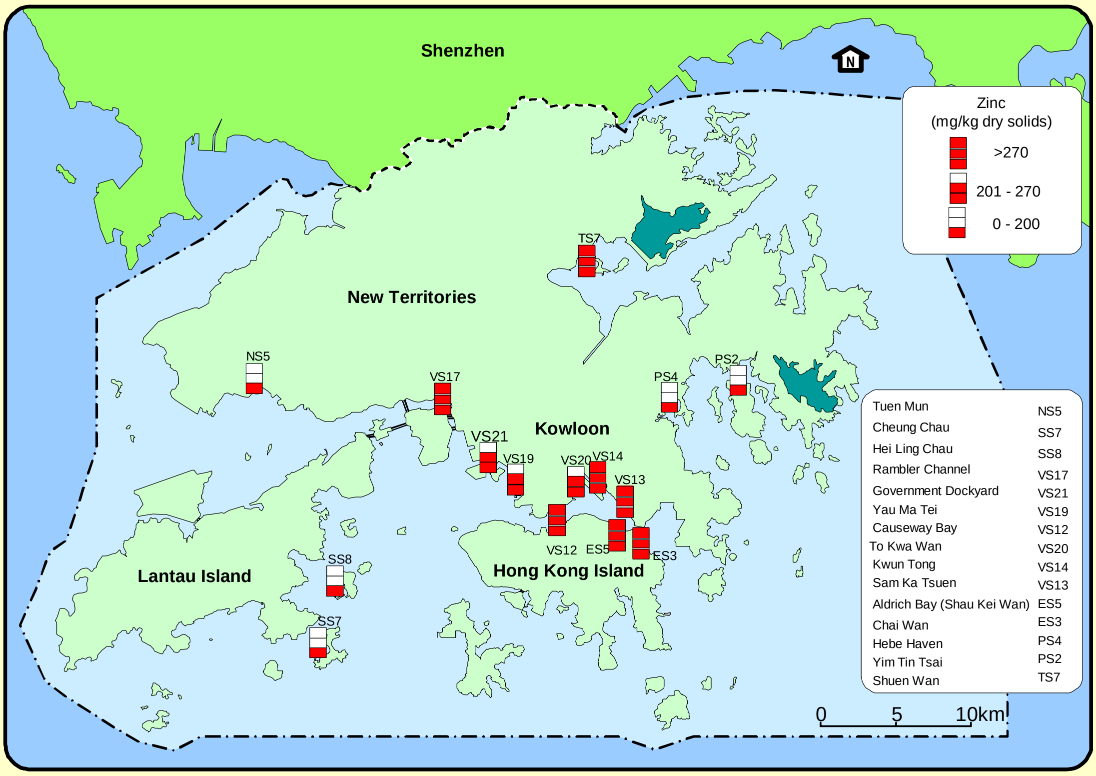


Figure 7.5 Total polychlorinated biphenyls (PCBs) in typhoon shelter sediments in Hong Kong, 2002 – 2004

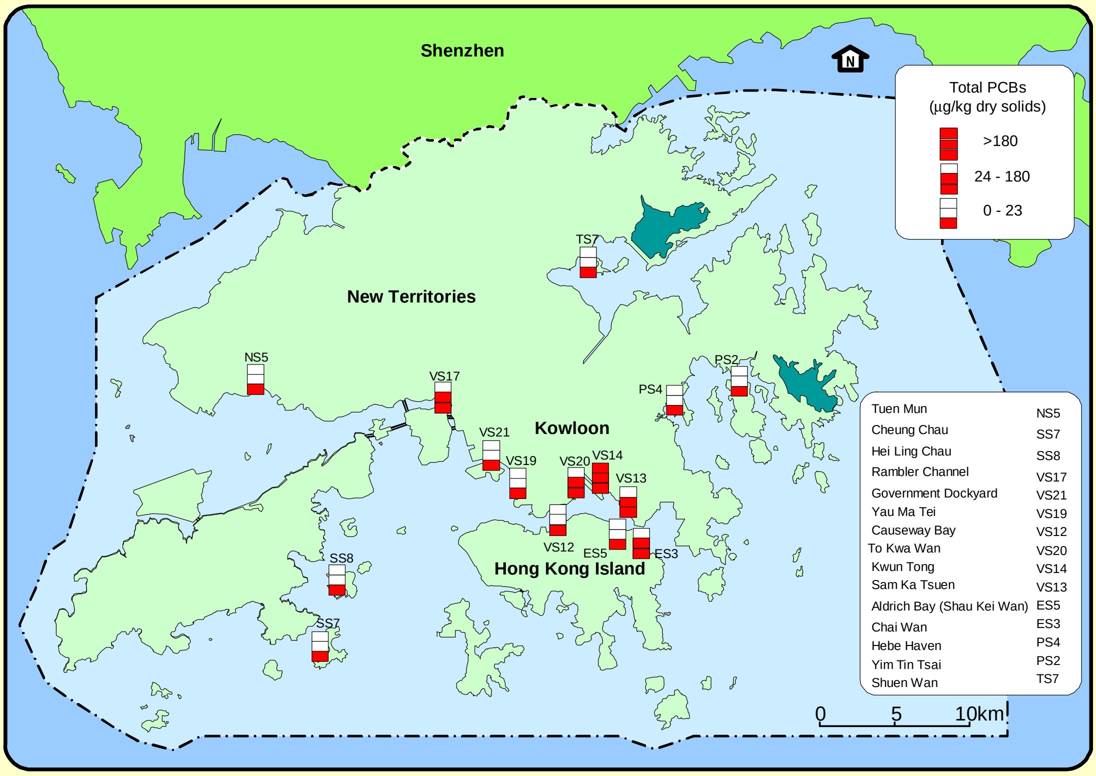


Figure 7.6 Low molecular weight polycyclic aromatic hydrocarbons (PAHs) in typhoon shelter sediments in Hong Kong, 2002 – 2004

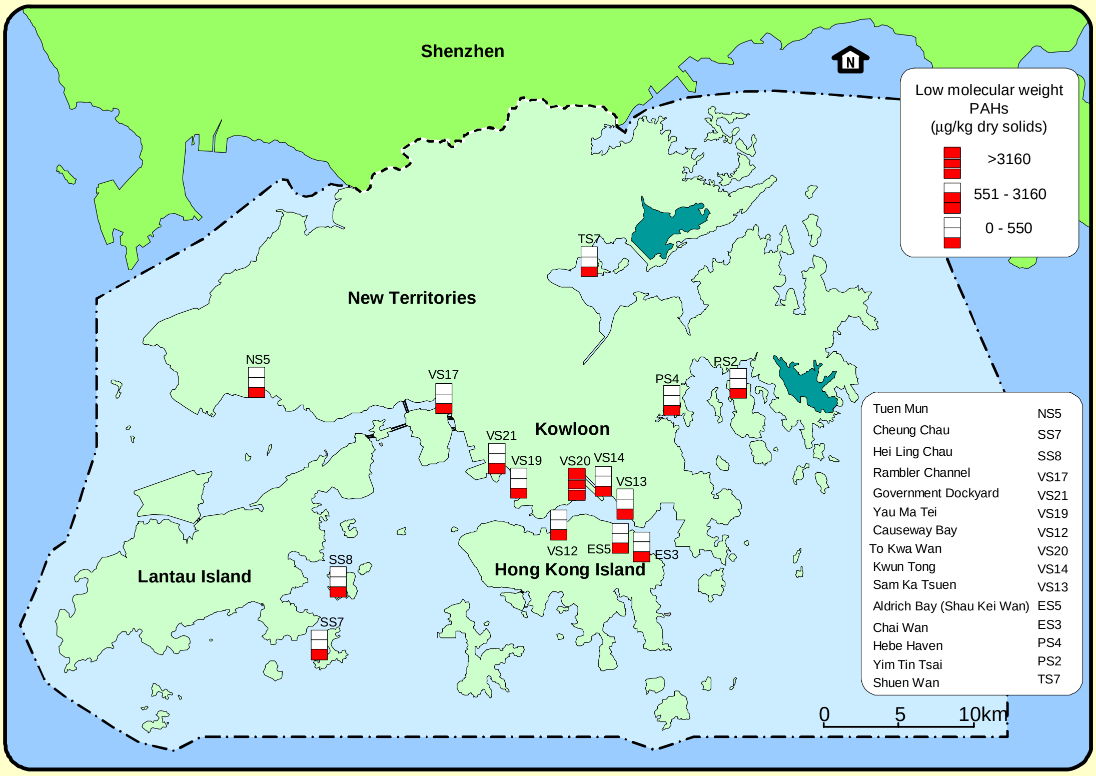
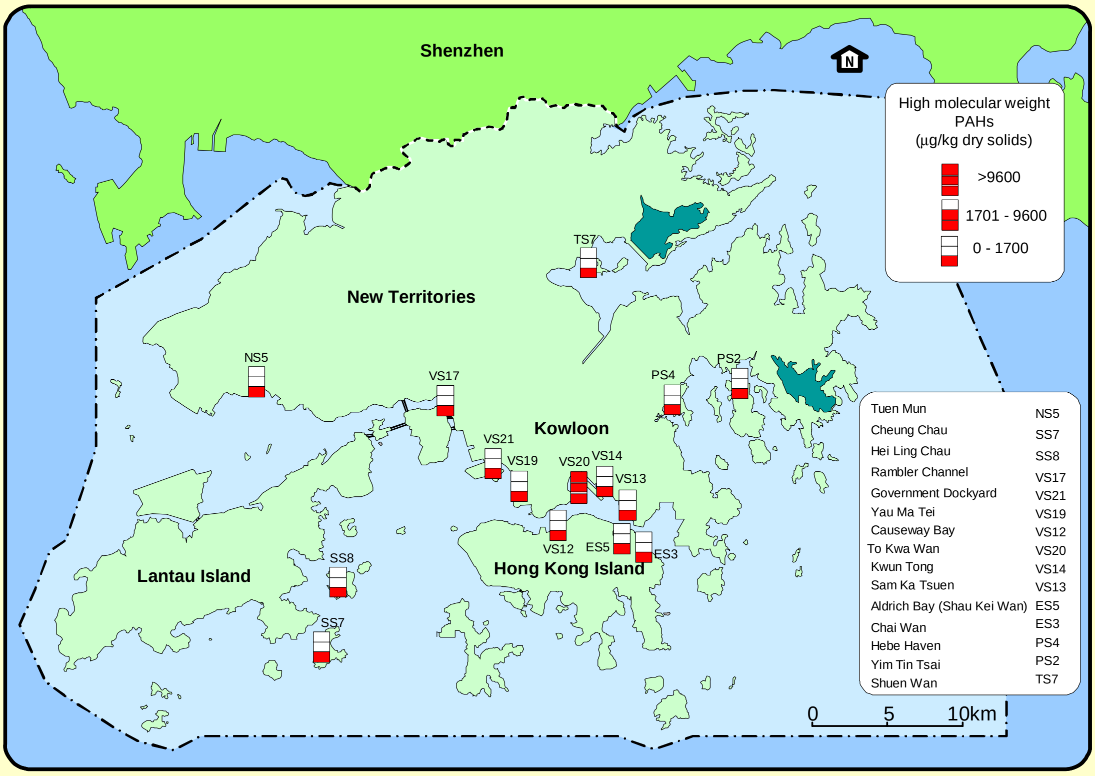


Figure 7.7 High molecular weight polycyclic aromatic hydrocarbons (PAHs) in typhoon shelter sediments in Hong Kong, 2000 – 2004



7 TYPHOON SHELTER

Table 7.1

Results of the Seasonal Kendall Test for water quality trends in typhoon shelters, 1986 – 2004

Monitoring Station		NT1	ST1	WT3	WT1	VT8	VT10	VT2	VT11
Monitoring Period		1986–2004	1986–2004	1986–2004	1986–2004	1986–2004	1993–2004	1986–2004	1994–2004
Parameter	Water Depth								
Temperature (°C)	Surface	-	↗	-	↗	-	-	-	-
	Middle	NA	↗	-	-	-	-	-	-
	Bottom	-	↗	-	-	-	-	-	-
	Average	-	↗	-	-	-	-	-	-
Salinity	Surface	-	-	-	-	-	-	-	-
	Middle	NA	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	Surface	↗	-	-	-	-	-	↗	-
	Middle	NA	-	-	-	↗	-	-	↗
	Bottom	↗	-	-	↗	↗	-	↗	↗
	Average	↗	-	-	-	↗	-	↗	↗
Dissolved Oxygen (%)	Surface	↗	-	-	-	-	-	↗	-
	Middle	NA	-	-	↗	-	-	-	↗
	Bottom	↗	-	-	↗	↗	-	↗	↗
	Average	↗	-	-	↗	↗	-	↗	↗
pH	Surface	-	↘	↘	↘	-	-	-	-
	Middle	NA	-	↘	↘	-	-	-	-
	Bottom	-	↘	↘	↘	-	-	-	-
	Average	-	↘	↘	↘	↘	-	-	-
Secchi disc depth (m)		↗	-	↗	↗	-	↗	↗	-
Turbidity (NTU)	Surface	-	-	-	-	↗	-	↗	↗
	Middle	NA	-	-	-	↗	-	-	↗
	Bottom	-	-	-	-	↗	-	↗	↗
	Average	-	-	-	-	↗	-	↗	↗
Suspended Solids (mg/L)	Surface	-	↗	-	-	-	-	-	-
	Middle	NA	-	-	-	-	-	-	-
	Bottom	-	↗	-	-	-	-	-	-
	Average	-	↗	-	-	-	-	-	-
Total volatile solids (mg/L)	Surface	↘	-	↘	↘	↘	-	↘	-
	Middle	NA	-	↘	↘	-	-	-	-
	Bottom	-	-	↘	↘	-	-	-	-
	Average	↘	-	↘	↘	-	-	↘	↘
5-day Biochemical Oxygen Demand (mg/L)	Surface	-	↘	-	-	↘	-	↘	-
	Middle	NA	-	-	-	↘	-	↘	-
	Bottom	-	↘	-	-	↘	-	↘	-
	Average	-	↘	-	-	↘	-	↘	-
Ammonia nitrogen (mg/L)	Surface	↘	-	-	↘	-	-	↘	↘
	Middle	NA	-	-	-	-	-	-	↘
	Bottom	-	-	-	-	-	-	↘	↘
	Average	↘	-	-	-	-	-	↘	↘
Nitrite nitrogen (mg/L)	Surface	↗	-	-	-	-	-	-	-
	Middle	NA	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	↗	-	-	-	-	-	-	-
Nitrate nitrogen (mg/L)	Surface	↗	↗	-	-	-	-	↗	-
	Middle	NA	-	-	-	↗	-	↗	-
	Bottom	↗	-	-	-	-	-	↗	-
	Average	↗	-	-	-	-	-	↗	-
Total inorganic nitrogen (mg/L)	Surface	-	-	-	-	-	↘	↘	↘
	Middle	NA	-	-	-	-	↘	-	↘
	Bottom	↗	-	-	-	-	↘	-	-
	Average	-	-	-	-	-	↘	↘	-
Total Kjeldahl nitrogen (mg/L)	Surface	↘	-	-	-	↘	-	↘	↘
	Middle	NA	-	-	-	↘	-	-	↘
	Bottom	-	-	-	-	↘	-	↘	↘
	Average	↘	-	-	-	↘	-	↘	↘
Total nitrogen (mg/L)	Surface	-	-	-	-	↘	-	↘	-
	Middle	NA	-	-	-	↘	-	-	↘
	Bottom	-	-	-	-	↘	↘	↘	↘
	Average	-	-	-	-	↘	-	↘	↘
Orthophosphate phosphorus (mg/L)	Surface	↘	-	-	-	↘	-	↘	↘
	Middle	NA	-	-	-	↘	↘	-	↘
	Bottom	-	-	-	-	↘	↘	↘	↘
	Average	↘	-	-	-	↘	-	↘	↘
Total phosphorus (mg/L)	Surface	↘	-	-	-	↘	↘	↘	↘
	Middle	NA	-	-	-	↘	↘	-	↘
	Bottom	-	-	-	-	↘	↘	↘	↘
	Average	↘	-	-	-	↘	↘	↘	↘
Silica (mg/L)	Surface	-	-	-	-	-	↘	-	↘
	Middle	NA	-	-	-	-	↘	-	↘
	Bottom	-	-	-	-	-	↘	-	-
	Average	-	-	-	-	-	↘	-	-
Chlorophyll-*a* (μg/L)	Surface	-	-	-	↗	-	-	-	-
	Middle	NA	-	-	-	-	-	-	-
	Bottom	-	-	↗	↗	-	-	-	-
	Average	↗	-	-	↗	-	-	-	-
E. coli (cfu/100mL)	Surface	↘	-	-	↘	↗	-	↘	-
	Middle	NA	-	-	↘	-	-	-	-
	Bottom	-	-	-	-	↗	-	↘	-
	Average	↘	-	-	↘	↗	-	↘	-
Faecal coliforms (cfu/100mL)	Surface	-	-	-	-	↗	-	-	-
	Middle	NA	-	-	-	-	-	-	-
	Bottom	-	-	-	-	↗	-	-	-
	Average	-	↗	-	-	↗	-	-	-

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. – indicates no significant trend is detected
3. NA (Not Applicable) indicates the measurement was not made due to shallow water
4. Test applied to past 19 years' data from each monitoring station unless stated otherwise
5. ST3 has five years' data only, which is insufficient to perform Seasonal Kendall Test
6. ↗ represents a significant increase over time
7. ↘ represents a significant decrease over time

Table 7.1 (continued)

Results of the Seasonal Kendall Test for water quality trends in typhoon shelters, 1986 – 2004

Monitoring Station		VT4	VT3	ET2	ET1	PT4	PT2	PT3	TT1
Monitoring Period		1987 – 2004	1986 – 2004	1993 – 2004	1986 – 2004	1986 – 2004	1986 – 2004	1986 – 2004	1986 – 2004
Parameter	Water Depth								
Temperature (°C)	Surface	-	-	-	↗	↗	↗	↗	↗
	Middle	-	-	-	↗	NA	NA	↗	↗
	Bottom	-	↗	-	↗	↗	↗	↗	-
	Average	-	↗	-	↗	↗	↗	↗	↗
Salinity	Surface	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	NA	NA	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	Surface	↗	↗	-	-	↘	↗	-	↘
	Middle	↗	↗	↗	-	NA	NA	-	-
	Bottom	↗	↗	↗	-	-	-	-	-
	Average	↗	↗	↗	-	-	↗	-	-
Dissolved Oxygen (%)	Surface	↗	↗	-	-	↘	↗	-	↘
	Middle	↗	↗	↗	-	NA	NA	-	-
	Bottom	↗	↗	↗	-	-	-	-	-
	Average	↗	↗	↗	-	-	↗	-	-
pH	Surface	-	-	-	-	↘	-	↘	↘
	Middle	↗	-	-	-	NA	NA	-	↘
	Bottom	-	-	-	-	↘	-	-	↘
	Average	-	-	-	-	↘	-	-	↘
Secchi disc depth (m)		↗	-	↗	-	-	↗	-	-
Turbidity (NTU)	Surface	-	↗	↗	-	↗	-	-	-
	Middle	-	↗	↗	-	NA	NA	↗	↗
	Bottom	↗	↗	↗	-	↗	-	-	↗
	Average	-	↗	↗	-	↗	-	-	-
Suspended Solids (mg/L)	Surface	↘	↘	↘	-	-	-	-	-
	Middle	↘	-	-	-	NA	NA	↗	-
	Bottom	↘	-	-	-	-	↘	-	-
	Average	↘	↘	-	-	-	-	-	-
Total volatile solids (mg/L)	Surface	↘	-	↘	↘	↘	↘	-	-
	Middle	↘	↘	↘	↘	NA	NA	-	↘
	Bottom	↘	↘	-	↘	-	-	-	-
	Average	↘	↘	-	↘	↘	-	-	-
5-day Biochemical Oxygen Demand (mg/L)	Surface	↘	↘	-	-	↘	↘	-	↘
	Middle	↘	↘	-	-	NA	NA	-	-
	Bottom	↘	↘	-	-	↘	-	-	↘
	Average	↘	↘	-	-	↘	↘	-	↘
Ammonia nitrogen (mg/L)	Surface	-	↘	↘	-	-	↘	-	-
	Middle	↘	↘	↘	-	NA	NA	-	-
	Bottom	↘	↘	-	-	-	-	-	-
	Average	↘	↘	↘	-	-	↘	-	-
Nitrite nitrogen (mg/L)	Surface	↗	-	-	-	-	↘	-	-
	Middle	↗	-	-	-	NA	NA	-	-
	Bottom	↗	-	↘	-	-	-	-	-
	Average	↗	-	↘	-	-	↘	-	-
Nitrate nitrogen (mg/L)	Surface	↗	-	-	-	-	↘	-	-
	Middle	↗	-	-	-	NA	NA	-	-
	Bottom	↗	-	↘	-	-	↘	↘	-
	Average	↗	-	-	-	-	↘	-	-
Total inorganic nitrogen (mg/L)	Surface	-	↘	↘	-	-	↘	-	-
	Middle	↘	-	↘	↗	NA	NA	-	-
	Bottom	↘	-	↘	-	-	↘	-	-
	Average	↘	↘	↘	↗	-	↘	-	-
Total Kjeldahl nitrogen (mg/L)	Surface	↘	↘	↘	-	↘	-	-	-
	Middle	↘	↘	-	-	NA	NA	-	-
	Bottom	↘	↘	-	-	↘	-	-	-
	Average	↘	↘	-	-	↘	-	-	-
Total nitrogen (mg/L)	Surface	-	↘	↘	-	↘	-	-	-
	Middle	↘	↘	↘	-	NA	NA	-	-
	Bottom	↘	↘	↘	-	-	-	-	-
	Average	↘	↘	↘	-	↘	-	-	-
Orthophosphate phosphorus (mg/L)	Surface	-	↘	↘	-	-	-	-	↘
	Middle	↘	↘	↘	-	NA	NA	-	↘
	Bottom	↘	↘	↘	-	-	-	↘	-
	Average	-	↘	↘	-	-	-	↘	↘
Total phosphorus (mg/L)	Surface	-	↘	↘	-	↘	-	-	↘
	Middle	↘	↘	↘	↘	NA	NA	-	↘
	Bottom	↘	↘	↘	-	-	-	-	-
	Average	↘	↘	↘	↘	-	-	-	↘
Silica (mg/L)	Surface	-	-	↘	↗	-	-	-	-
	Middle	↘	-	↘	-	NA	NA	-	-
	Bottom	↘	↘	-	-	-	↘	-	-
	Average	-	↘	↘	-	-	-	-	-
Chlorophyll-*a* (μg/L)	Surface	↗	↗	-	-	-	-	-	-
	Middle	↗	-	-	-	NA	NA	-	-
	Bottom	↗	↗	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-
E. coli (cfu/100mL)	Surface	↘	↘	-	-	↘	↘	-	-
	Middle	↘	↘	-	-	NA	NA	-	-
	Bottom	↘	↘	↘	-	↘	↘	-	↘
	Average	↘	↘	-	-	↘	↘	-	↘
Faecal coliforms (cfu/100mL)	Surface	-	-	-	↗	↘	-	-	-
	Middle	↘	-	-	↗	NA	NA	-	-
	Bottom	↘	-	-	↗	-	↘	-	-
	Average	↘	-	-	↗	↘	↘	-	-

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. - indicates no significant trend is detected
3. NA (Not Applicable) indicates the measurement was not made due to shallow water
4. Test applied to past 19years' data from each monitoring station unless stated otherwise
5. VT12 has five years' data only, which is insufficient to perform Seasonal Kendall Test
6. ↗ represents a significant increase over time
7. ↘ represents a significant decrease over time

Table 7.2

Summary water quality statistics of typhoon shelters in 2004

Parameter	Tuen Mun NT1	Cheung Chau ST1	Hei Ling Chau ST3	Aberdeen (South) WT1	Aberdeen (West) WT3	Rambler Channel VT8
Number of samples	6	6	6	6	6	6
Temperature (°C)	24.5 (15.6 - 29.4)	24.4 (19.3 - 29.0)	24.3 (19.3 - 28.8)	23.8 (18.0 - 27.5)	23.7 (18.0 - 27.7)	23.4 (16.1 - 27.7)
Salinity	28.4 (19.2 - 33.1)	30.7 (23.1 - 33.7)	30.8 (25.1 - 33.5)	32.0 (28.4 - 34.1)	32.0 (28.0 - 34.1)	31.0 (26.1 - 33.2)
Dissolved Oxygen (mg/L)	6.6 (4.3 - 8.5)	6.8 (4.8 - 9.0)	7.2 (3.9 - 10.0)	6.1 (4.1 - 7.5)	5.9 (4.7 - 7.5)	5.4 (2.3 - 7.4)
Bottom	N.M.	6.9 (5.0 - 9.4)	7.2 (3.8 - 10.1)	5.9 (4.3 - 7.5)	5.9 (5.0 - 7.5)	5.4 (2.2 - 7.4)
Dissolved Oxygen (% Saturation)	88 (65 - 125)	95 (72 - 133)	102 (57 - 149)	84 (61 - 99)	81 (71 - 98)	70 (34 - 85)
Bottom	N.M.	96 (74 - 139)	100 (56 - 151)	81 (63 - 94)	81 (73 - 89)	71 (33 - 86)
pH	8.0 (7.9 - 8.4)	8.1 (7.9 - 8.5)	8.1 (7.9 - 8.4)	8.1 (8.0 - 8.3)	8.1 (8.0 - 8.3)	8.0 (7.9 - 8.1)
Secchi Disc Depth (m)	1.5 (0.8 - 2.3)	1.8 (1.0 - 3.3)	2.0 (1.1 - 3.4)	2.6 (1.2 - 5.3)	2.6 (1.6 - 4.2)	1.7 (1.0 - 3.8)
Turbidity (NTU)	15.9 (9.4 - 33.7)	11.5 (9.4 - 13.4)	10.1 (8.5 - 12.2)	8.4 (6.7 - 9.9)	8.6 (6.9 - 10.5)	12.7 (8.5 - 19.8)
Suspended Solids (mg/L)	11.6 (5.5 - 18.0)	9.4 (4.5 - 20.2)	6.1 (3.4 - 9.5)	3.8 (1.3 - 6.9)	3.8 (1.8 - 6.1)	14.2 (8.2 - 25.0)
5-day Biochemical Oxygen Demand (mg/L)	1.3 (0.6 - 3.2)	1.5 (0.5 - 3.8)	1.5 (0.4 - 3.7)	0.9 (0.5 - 1.7)	1.1 (0.5 - 1.7)	0.9 (0.4 - 1.6)
Ammonia Nitrogen (mg/L)	0.14 (0.04 - 0.32)	0.12 (0.04 - 0.19)	0.11 (0.05 - 0.21)	0.09 (0.05 - 0.13)	0.09 (0.07 - 0.11)	0.21 (0.08 - 0.37)
Unionised Ammonia (mg/L)	0.006 (0.003 - 0.013)	0.006 (0.004 - 0.006)	0.006 (0.004 - 0.007)	0.005 (0.002 - 0.012)	0.005 (0.003 - 0.011)	0.008 (0.003 - 0.019)
Nitrite Nitrogen (mg/L)	0.08 (0.01 - 0.19)	0.02 (<0.01 - 0.05)	0.03 (<0.01 - 0.07)	0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.03)	0.04 (0.01 - 0.09)
Nitrate Nitrogen (mg/L)	0.37 (0.05 - 0.83)	0.16 (0.03 - 0.29)	0.16 (0.03 - 0.29)	0.05 (0.01 - 0.16)	0.06 (0.02 - 0.19)	0.20 (0.06 - 0.38)
Total Inorganic Nitrogen (mg/L)	0.59 (0.18 - 1.08)	0.30 (0.11 - 0.48)	0.31 (0.11 - 0.48)	0.15 (0.06 - 0.30)	0.17 (0.09 - 0.31)	0.45 (0.26 - 0.55)
Total Kjeldahl Nitrogen (mg/L)	0.30 (0.16 - 0.43)	0.28 (0.23 - 0.37)	0.27 (0.19 - 0.38)	0.19 (0.13 - 0.25)	0.21 (0.16 - 0.25)	0.37 (0.26 - 0.61)
Total Nitrogen (mg/L)	0.76 (0.29 - 1.18)	0.46 (0.25 - 0.69)	0.46 (0.30 - 0.63)	0.25 (0.15 - 0.41)	0.28 (0.18 - 0.42)	0.61 (0.35 - 0.80)
Orthophosphate Phosphorus (mg/L)	0.03 (<0.01 - 0.05)	0.02 (0.01 - 0.03)	0.02 (<0.01 - 0.03)	0.01 (0.01 - 0.02)	0.01 (0.01 - 0.02)	0.03 (0.01 - 0.06)
Total Phosphorus (mg/L)	0.05 (0.03 - 0.06)	0.04 (0.03 - 0.05)	0.04 (0.02 - 0.05)	0.03 (0.02 - 0.03)	0.03 (0.02 - 0.03)	0.06 (0.04 - 0.09)
Silica (as SiO_2) (mg/L)	1.4 (0.1 - 3.4)	0.9 (0.1 - 2.6)	0.8 (0.1 - 2.5)	0.4 (0.2 - 0.9)	0.4 (0.2 - 0.6)	0.9 (0.3 - 1.4)
Chlorophyll-*a* (µg/L)	6.2 (1.1 - 18.0)	7.6 (1.4 - 27.0)	9.4 (1.6 - 30.0)	2.1 (0.4 - 4.3)	2.5 (0.4 - 4.8)	4.7 (0.6 - 14.3)
E.coli (cfu/100mL)	120 (10 - 1300)	120 (71 - 220)	4 (1 - 14)	220 (79 - 960)	1800 (510 - 13000)	1900 (730 - 3400)
Faecal Coliforms (cfu/100mL)	440 (60 - 8800)	270 (140 - 480)	6 (1 - 45)	610 (170 - 3800)	3000 (720 - 23000)	4400 (1000 - 18000)

Note :
1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths: Surface (S), Mid-depth (M), Bottom (B).
2. Data presented are annual arithmetic means of the depth-averaged results except for *E.coli* and faecal coliforms which are annual geometric means.
3. Data in brackets indicate the ranges.
4. NM - not measured

Table 7.2 (continued)

Summary water quality statistics of typhoon shelters in 2004

Parameter		Government Dockyard VT12	Yau Ma Tei VT10	Causeway Bay VT2	To Kwa Wan VT11	Kwun Tong VT4	Sam Ka Tsuen VT3
Number of samples		6	6	6	6	6	6
Temperature (°C)		23.8 (16.1 - 28.2)	23.5 (16.1 - 28.0)	23.4 (15.9 - 28.1)	23.4 (15.8 - 28.0)	23.5 (16.4 - 27.9)	23.3 (15.9 - 28.1)
Salinity		31.3 (27.3 - 32.9)	31.3 (27.7 - 33.1)	31.5 (28.0 - 33.2)	32.1 (28.7 - 33.6)	30.4 (26.6 - 32.2)	31.8 (28.6 - 33.3)
Dissolved Oxygen (mg/L)		5.4 (4.3 - 7.4)	4.5 (2.2 - 7.4)	5.0 (3.0 - 7.4)	5.7 (4.2 - 7.4)	3.9 (2.3 - 7.5)	5.5 (3.2 - 7.5)
	Bottom	5.4 (4.3 - 7.4)	4.4 (2.0 - 7.4)	4.9 (2.9 - 7.4)	5.8 (3.9 - 7.4)	3.9 (2.2 - 7.4)	5.5 (3.2 - 7.4)
Dissolved Oxygen (% Saturation)		69 (61 - 86)	55 (33 - 74)	59 (39 - 81)	76 (64 - 101)	45 (34 - 74)	71 (48 - 84)
	Bottom	70 (61 - 87)	54 (31 - 74)	58 (38 - 82)	77 (60 - 102)	46 (33 - 79)	72 (49 - 81)
pH		7.8 (7.7 - 8.0)	7.8 (7.7 - 7.9)	7.9 (7.8 - 8.0)	8.0 (7.9 - 8.2)	7.8 (7.6 - 7.9)	8.0 (7.8 - 8.1)
Secchi Disc Depth (m)		1.6 (0.6 - 3.1)	1.6 (1.0 - 2.6)	1.9 (1.2 - 3.6)	2.2 (1.7 - 3.7)	1.7 (0.5 - 3.8)	2.2 (1.7 - 4.0)
Turbidity (NTU)		14.0 (8.1 - 20.6)	12.2 (9.7 - 14.7)	9.8 (3.9 - 13.8)	8.6 (3.7 - 11.7)	9.3 (4.6 - 19.8)	8.6 (3.5 - 12.3)
Suspended Solids (mg/L)		10.3 (5.3 - 22.5)	11.7 (7.1 - 16.8)	6.9 (3.7 - 12.3)	5.5 (4.0 - 7.5)	2.8 (1.5 - 3.9)	5.0 (2.1 - 10.2)
5-day Biochemical Oxygen Demand (mg/L)		1.0 (0.4 - 2.6)	1.3 (0.7 - 2.5)	1.5 (1.0 - 2.9)	1.1 (0.5 - 2.8)	1.8 (0.9 - 3.9)	1.3 (0.4 - 2.9)
Ammonia Nitrogen (mg/L)		0.28 (0.11 - 0.41)	0.40 (0.19 - 0.52)	0.32 (0.12 - 0.49)	0.20 (0.05 - 0.29)	0.70 (0.41 - 1.33)	0.18 (0.05 - 0.30)
Unionised Ammonia (mg/L)		0.008 (0.004 - 0.010)	0.010 (0.005 - 0.017)	0.009 (0.004 - 0.017)	0.008 (0.004 - 0.016)	0.014 (0.009 - 0.021)	0.007 (0.003 - 0.017)
Nitrite Nitrogen (mg/L)		0.04 (0.02 - 0.06)	0.03 (0.02 - 0.05)	0.03 (0.02 - 0.04)	0.02 (0.01 - 0.03)	0.11 (0.03 - 0.27)	0.02 (0.01 - 0.03)
Nitrate Nitrogen (mg/L)		0.16 (0.09 - 0.21)	0.14 (0.08 - 0.22)	0.13 (0.08 - 0.19)	0.09 (0.06 - 0.11)	0.20 (0.07 - 0.64)	0.08 (0.06 - 0.12)
Total Inorganic Nitrogen (mg/L)		0.48 (0.36 - 0.62)	0.57 (0.42 - 0.66)	0.47 (0.34 - 0.65)	0.31 (0.17 - 0.42)	1.01 (0.58 - 1.82)	0.28 (0.19 - 0.42)
Total Kjeldahl Nitrogen (mg/L)		0.45 (0.35 - 0.57)	0.64 (0.50 - 0.81)	0.58 (0.42 - 0.87)	0.36 (0.29 - 0.50)	0.97 (0.60 - 1.43)	0.34 (0.28 - 0.47)
Total Nitrogen (mg/L)		0.65 (0.47 - 0.81)	0.81 (0.66 - 0.95)	0.73 (0.52 - 1.03)	0.47 (0.37 - 0.63)	1.28 (0.76 - 1.93)	0.44 (0.36 - 0.59)
Orthophosphate Phosphorus (mg/L)		0.05 (0.01 - 0.07)	0.06 (0.02 - 0.07)	0.06 (0.01 - 0.09)	0.04 (<0.01 - 0.05)	0.24 (0.13 - 0.39)	0.03 (<0.01 - 0.05)
Total Phosphorus (mg/L)		0.07 (0.06 - 0.09)	0.09 (0.07 - 0.10)	0.08 (0.06 - 0.13)	0.05 (0.03 - 0.06)	0.28 (0.15 - 0.51)	0.05 (0.04 - 0.08)
Silica (as SiO_2) (mg/L)		0.9 (0.1 - 2.0)	0.8 (0.1 - 1.5)	0.8 (0.1 - 1.3)	0.5 (0.1 - 0.8)	1.4 (0.8 - 2.1)	0.5 (0.1 - 0.8)
Chlorophyll-*a* (μg/L)		6.0 (0.6 - 24.5)	5.7 (0.6 - 21.3)	4.8 (0.6 - 19.5)	4.9 (0.8 - 15.3)	8.6 (1.0 - 35.0)	4.4 (0.7 - 13.5)
E.coli (cfu/100mL)		490 (300 - 1600)	3800 (920 - 13000)	10000 (3800 - 50000)	730 (200 - 1300)	10000 (3600 - 25000)	1400 (1100 - 1900)
Faecal Coliforms (cfu/100mL)		1000 (360 - 4000)	12000 (2500 - 51000)	26000 (5000 - 110000)	1900 (710 - 4000)	20000 (8200 - 69000)	3200 (2200 - 6600)

Note :
1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths: Surface (S), Mid-depth (M), Bottom (B).
2. Data presented are annual arithmetic means of the depth-averaged results except for *E.coli* and faecal coliforms which are annual geometric means.
3. Data in brackets indicate the ranges.
4. NM – not measured

Table 7.2 (continued)

Summary water quality statistics of typhoon shelters in 2004

Parameter		Aldrich Bay (Shau Kei Wan) ET2	Chai Wan ET1	Hebe Haven PT4	Yim Tin Tsai PT3	Sai Kung PT2	Shuen Wan TT1
Number of samples		6	6	6	6	6	6
Temperature (°C)		23.0 (18.5 - 25.5)	23.4 (18.5 - 27.3)	24.9 (18.8 - 29.1)	24.6 (18.6 - 28.9)	24.9 (18.8 - 29.2)	24.3 (17.8 - 28.7)
Salinity		32.7 (31.2 - 33.6)	32.7 (31.5 - 33.6)	32.6 (28.4 - 33.8)	33.1 (30.4 - 34.1)	32.7 (29.3 - 33.9)	32.4 (30.9 - 33.6)
Dissolved Oxygen (mg/L)		4.8 (2.6 - 7.5)	5.8 (4.5 - 7.4)	5.7 (4.7 - 7.6)	5.9 (4.7 - 7.4)	6.5 (5.5 - 9.5)	6.1 (4.7 - 7.8)
	Bottom	5.0 (2.9 - 7.5)	5.8 (4.7 - 7.4)	5.9 (4.8 - 7.6)	6.3 (5.0 - 7.7)	7.0 (5.6 - 10.0)	6.3 (5.0 - 7.8)
Dissolved Oxygen (% Saturation)		60 (39 - 82)	77 (65 - 91)	82 (68 - 100)	85 (70 - 98)	95 (82 - 125)	83 (72 - 108)
	Bottom	63 (41 - 87)	77 (67 - 90)	86 (71 - 100)	89 (73 - 102)	98 (85 - 131)	86 (75 - 113)
pH		8.0 (7.8 - 8.2)	8.1 (7.9 - 8.2)	8.2 (8.0 - 8.3)	8.1 (8.0 - 8.4)	8.1 (8.0 - 8.4)	8.2 (8.0 - 8.3)
Secchi Disc Depth (m)		3.0 (1.5 - 5.3)	2.5 (1.3 - 4.0)	2.4 (1.4 - 3.0)	3.2 (2.4 - 4.6)	2.3 (1.5 - 3.0)	2.4 (1.7 - 3.3)
Turbidity (NTU)		6.8 (2.8 - 8.3)	7.6 (2.6 - 12.6)	7.6 (5.5 - 8.7)	9.3 (6.4 - 17.8)	7.2 (5.4 - 9.2)	7.7 (5.1 - 11.0)
Suspended Solids (mg/L)		2.0 (1.1 - 3.6)	2.5 (2.0 - 3.5)	3.1 (2.0 - 7.0)	4.2 (1.5 - 12.3)	2.9 (1.5 - 4.0)	3.7 (1.9 - 11.8)
5-day Biochemical Oxygen Demand (mg/L)		0.8 (0.4 - 1.4)	1.2 (0.6 - 2.8)	1.0 (0.5 - 2.1)	1.0 (0.5 - 2.6)	1.0 (0.3 - 2.3)	1.9 (1.2 - 2.4)
Ammonia Nitrogen (mg/L)		0.18 (0.10 - 0.26)	0.15 (0.06 - 0.29)	0.03 (0.02 - 0.06)	0.03 (0.02 - 0.05)	0.04 (0.01 - 0.07)	0.07 (0.04 - 0.10)
Unionised Ammonia (mg/L)		0.006 (0.004 - 0.009)	0.008 (0.002 - 0.025)	0.002 (0.001 - 0.008)	0.002 (0.001 - 0.006)	0.003 (0.001 - 0.010)	0.004 (0.002 - 0.009)
Nitrite Nitrogen (mg/L)		0.02 (0.01 - 0.06)	0.02 (0.01 - 0.05)	<0.01 (<0.01 - <0.01)	<0.01 (<0.01 - <0.01)	<0.01 (<0.01 - <0.01)	<0.01 (<0.01 - 0.02)
Nitrate Nitrogen (mg/L)		0.09 (0.04 - 0.16)	0.07 (0.03 - 0.11)	<0.01 (<0.01 - 0.01)	<0.01 (<0.01 - 0.01)	0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.01)
Total Inorganic Nitrogen (mg/L)		0.29 (0.16 - 0.38)	0.24 (0.11 - 0.34)	0.04 (0.02 - 0.07)	0.04 (0.02 - 0.05)	0.05 (0.02 - 0.08)	0.08 (0.05 - 0.11)
Total Kjeldahl Nitrogen (mg/L)		0.30 (0.16 - 0.40)	0.30 (0.13 - 0.52)	0.13 (0.10 - 0.21)	0.11 (0.07 - 0.19)	0.12 (0.09 - 0.18)	0.26 (0.21 - 0.35)
Total Nitrogen (mg/L)		0.41 (0.29 - 0.52)	0.39 (0.25 - 0.56)	0.14 (0.10 - 0.22)	0.12 (0.08 - 0.19)	0.13 (0.10 - 0.19)	0.27 (0.21 - 0.35)
Orthophosphate Phosphorus (mg/L)		0.04 (0.02 - 0.05)	0.03 (0.01 - 0.06)	0.01 (<0.01 - 0.01)	0.01 (0.01 - 0.01)	0.01 (0.01 - 0.01)	0.01 (0.01 - 0.02)
Total Phosphorus (mg/L)		0.05 (0.03 - 0.06)	0.05 (0.03 - 0.08)	0.02 (0.02 - 0.04)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.03)	0.04 (0.03 - 0.05)
Silica (as SiO_2) (mg/L)		1.0 (0.3 - 1.9)	0.8 (0.2 - 1.5)	0.3 (0.2 - 0.6)	0.5 (0.2 - 0.8)	0.4 (0.1 - 0.9)	0.7 (0.4 - 1.1)
Chlorophyll-*a* (µg/L)		1.6 (0.6 - 3.1)	5.8 (0.6 - 16.5)	3.2 (1.5 - 5.5)	1.7 (0.5 - 2.6)	3.0 (0.7 - 4.7)	9.2 (3.4 - 16.9)
E.coli (cfu/100mL)		740 (290 - 1600)	280 (170 - 570)	3 (1 - 23)	1 (1 - 7)	24 (1 - 270)	29 (7 - 110)
Faecal Coliforms (cfu/100mL)		1400 (410 - 3900)	730 (330 - 1600)	9 (2 - 53)	2 (1 - 10)	110 (2 - 700)	72 (24 - 330)

Note :
1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths: Surface (S), Mid-depth (M), Bottom (B).
2. Data presented are annual arithmetic means of the depth-averaged results except for *E.coli* and faecal coliforms which are annual geometric means.
3. Data in brackets indicate the ranges.
4. NM - not measured

Table 7.3

Summary statistics of bottom sediment quality of typhoon shelters, 2000 – 2004

Parameter	Tuen Mun NS5	Cheung Chau SS7	Hei Ling Chau SS8 [10]	Rambler Channel VS17	Government Dockyard VS21 [10]	Yau Ma Tei VS19	Causeway Bay VS12
Number of samples	10	10	6	10	6	10	10
Particle Size Fractionation <63µm (%w/w)	67.15 (39-85)	66.32 (7-97)	93.56 (87-99)	72.68 (42-86)	96.66 (89-100)	75.65 (59-93)	79.29 (27-98)
Electrochemical Potential (mV)	-196.7 ((-286)-(-85))	-220.2 ((-300)-(-130))	-183 ((-278)-(-25))	-293 ((-366)-(-184))	-317.2 ((-388)-(-97))	-366.6 ((-407)-(-270))	-350.7 ((-407)-(-266))
Total Solids (%w/w)	47.5 (39-58)	45.2 (34-68)	38.7 (34-45)	45.4 (40-53)	36.8 (31-44)	49.2 (41-59)	41.9 (33-68)
Total Volatile Soilds (%w/w)	7 (5.8-8.4)	7.51 (3.8-8.5)	8.1 (7.4-8.8)	8.06 (7.0-8.9)	8.45 (7.4-9.4)	7.13 (6.0-8.1)	8.7 (3.9-11.0)
Chemical Oxygen Demand (mg/kg)	18900 (15000-22000)	21200 (10000-27000)	14200 (13000-16000)	28500 (20000-41000)	16890 (9900-21000)	21400 (13000-26000)	29600 (26000-32000)
Total Carbon (%w/w)	0.66 (0.5-0.9)	0.8 (0.6-1.7)	0.51 (0.5-0.6)	0.88 (0.7-1.1)	0.55 (0.5-0.8)	0.78 (0.5-0.9)	0.85 (0.7-1.0)
Ammonical Nitrogen (mg/kg)	8.78 (0.1-28)	10.86 (2-20)	11.61 (2-22)	15.77 (0.1-36)	12.52 (2-29)	31.7 (11-48)	36.6 (4-67)
Total Kjeldahl Nitrogen (mg/kg)	344 (170-580)	447 (180-550)	430 (290-540)	485 (320-640)	358 (310-410)	442 (300-570)	606 (290-820)
Total Phosphorus (mg/kg)	193 (86-330)	323 (230-510)	187 (160-220)	228 (160-300)	204 (180-230)	216 (160-240)	217 (150-250)
Total Sulphide (mg/kg)	122.9 (1-370)	179.2 (22-280)	108.8 (48-200)	863 (200-2500)	197.32 (8.-630)	329.9 (26-960)	436 (180-960)
Total Cyanide (mg/kg)	0.14 (<0.1-0.3)	0.19 (<0.1-0.3)	<0.1 (<0.1-0.2)	0.39 (0.2-0.6)	0.14 (<0.1-0.3)	0.1 (<0.1-0.2)	0.17 (<0.1-0.3)
Arsenic (mg/kg)	8.88 (6.8-11.0)	8.41 (4.4-11.0)	8.25 (6.9-12.0)	8.15 (5.2-10.0)	8.8 (7.3-9.7)	6.37 (4.0-8.8)	8.34 (2.9-12.0)
Cadmium (mg/kg)	0.24 (<0.1-0.4)	0.16 (<0.1-0.3)	<0.1 (<0.1-0.1)	1.08 (0.5-1.5)	0.31 (0.1-0.5)	0.46 (0.1-0.9)	0.94 (0.2-1.2)
Chromium (mg/kg)	34.3 (26-49)	55.8 (14-70)	42.9 (34-58)	198.5 (85-310)	53.2 (50-56)	41.8 (26-54)	69.8 (15-92)
Copper (mg/kg)	45.2 (13-83)	142.8 (41-250)	40 (33-55)	339 (130-490)	127.9 (29-180)	97.9 (33-160)	259.8 (48-410)
Lead (mg/kg)	44.8 (27-60)	63.2 (39-99)	53.9 (41-78)	81.2 (54-110)	51.6 (34-65)	52.4 (24-79)	81.6 (24-110)
Mercury (mg/kg)	0.08 (<0.05-0.12)	0.31 (0.10-0.60)	0.17 (0.12-0.39)	0.39 (0.14-1.50)	0.15 (<0.05-0.21)	0.3 (0.1-0.74)	0.72 (0.18-0.95)
Nickel (mg/kg)	19.6 (16-22)	18.1 (7-23)	26.4 (22-33)	85.4 (39-150)	31.7 (28-36)	23.7 (18-32)	27 (7-39)
Silver (mg/kg)	0.5 (0.2-1.0)	0.5 (0.3-1.0)	0.5 (0.5-1.0)	8.7 (3.0-18.0)	1.6 (1.0-2.0)	2 (1.0-3.7)	7 (0.8-9.0)
Zinc (mg/kg)	137.5 (87-200)	162.5 (65-210)	141 (120-160)	294 (170-380)	210 (110-270)	201.9 (99-340)	292.6 (66-380)
Total Polychlorinated Biphenyls (PCBs) (µg/kg) (3) (4)	18 (18-18)	18.17 (18-19)	18 (18-18)	34.17 (18-48)	20.67 (18-25)	23.33 (18-30)	29.17 (18-55)
Low Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (µg/kg) (5) (6) (9)	90 (90-90)	100 (90-118)	90 (90-90)	114.4 (96-142)	95.83 (90-117)	111.83 (98-132)	116.83 (90-150)
High Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (µg/kg) (7) (8) (9)	135.9 (19-291)	563.06 (128-1427)	80.76 (38-150)	990.5 (358-2141)	194.65 (49-5284)	656 (64-1409)	604.75 (169-999)

Note : 1. Data presented are arithmetic means ; data in brackets indicate ranges.
2. All data are based on the analyses of bulk (unsieved) sediment and are reported on a dry weight basis unless stated otherwise.
3. The Technical Circular 'ETWB (W) No. 34/2002 Management of Dredged / Excavated Sediment' issued in 2002 has revised the definition of 'Total PCBs' as the summation of 18 specific PCB congeners. Following the new definition, the monitoring of these 18 PCB congeners started in 2002 and the Total PCBs results only refer to 2002 to 2004.
4. Total PCBs results are derived from the summation of 18 congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.
5. Low molecular weight polyaromatic hydrocarbons (PAHs) include 6 congeners of molecular weight below 200, namely : Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene and Phenanthrene.
6. As the monitoring of Naphthalene only started in 2002, the Low Molecular Weight PAHs results are based on sediments samples collected in 2002 to 2004.
7. High molecular weight polyaromatic hydrocarbons (PAHs) include 10 congeners of molecular weight above 200, namely : Fluoranthene, Pyrene, Benzo(a) anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, Benzo(g,h,i)perylene and Indeno(1,2,3-cd) pyrene.
8. Low and high molecular weight PAHs results are derived from the summation of the corresponding congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.

Table 7.3 (continued)

Summary statistics of bottom sediment quality of typhoon shelters, 2000 – 2004

Parameter	To Kwa Wan VS20	Kwun Tong VS14	Sam Ka Tsuen VS13	Aldrich Bay (Shau Kei Wan) ES5 [11]	Chai Wan ES3	Hebe Haven PS4	Yim Tin Tsai PS2	Shuen Wan TS7
Number of samples	10	10	10	10	10	10	10	10
Particle Size Fractionation <63µm (%w/w)	72.92 (53-94)	70.52 (36-85)	90.11 (70-97)	81.97 (8-99)	77.14 (25-90	93.02 (85-98)	73.9 (13-98)	63.49 (45-81)
Electrochemical Potential (mV)	-377.8 ((-412)-(-321))	-393.1 ((-437)-(-357))	-375.5 ((-410)-(-276))	-386.3 ((-422)-(-324))	-332.8 ((-394)-(-247))	-267.2 ((-325)-(-169))	-196.4 ((-286)-(75))	-344.5 ((-392)-(-201))
Total Solids (%w/w)	47.2 (34-63)	38.2 (33-43)	41 (39-44)	32.8 (30-36)	42.2 (39-45)	36.6 (34-46)	49.4 (40-75)	39.9 (29-51)
Total Volatile Soilds (%w/w)	7.86 (5.3-10.0)	10.3 (8.9-11.0)	9.96 (8.7-11.0)	10.85 (9.7-12.0)	8.27 (7.4-9.2)	10 (8.6-11.0)	10.08 (4.3-12.0)	8.72 (6.6-12.0)
Chemical Oxygen Demand (mg/kg)	32200 (29000-37000)	40600 (37000-45000)	27700 (22000-32000)	26500 (18000-33000)	24000 (18000-32000)	22300 (18000-26000)	18510 (7100-30000)	28200 (25000-32000)
Total Carbon (%w/w)	1.06 (0.8-1.5)	1.27 (1.1-1.5)	0.79 (0.7-0.9)	0.87 (0.7-1.0)	0.82 (0.7-1.0)	0.74 (0.5-0.9)	1.54 (0.6-4.4)	0.81 (0.7-1.0)
Ammonical Nitrogen (mg/kg)	23.01 (8-53)	43.3 (12-66)	19.58 (9-49)	37.7 (14-61)	9.66 (4-15)	6.84 (2-14)	11.45 (5-28)	12.78 (4-25)
Total Kjeldahl Nitrogen (mg/kg)	555 (390-740)	784 (680-950)	483 (380-600)	540 (470-640)	490 (420-560)	541 (450-620)	469 (180-630)	587 (310-780)
Total Phosphorus (mg/kg)	220 (170-260)	296 (250-360)	239 (180-370)	215 (150-270)	243 (210-270)	192 (160-240)	149.3 (48-200)	205 (140-270)
Total Sulphide (mg/kg)	360 (100-1300)	1292 (180-2500)	1174 (770-2300)	1290 (710-2800)	272.2 (22-680)	99.7 (10-210)	56.4 (18-110)	236.9 (49-460)
Total Cyanide (mg/kg)	0.17 (0.1-0.3)	0.34 (<0.1-0.5)	0.27 (0.2-0.6)	0.17 (<0.1-0.2)	0.21 (<0.1-0.3)	0.16 (<0.1-0.2)	<0.1 (<0.1-0.2)	0.22 (<0.1-0.4)
Arsenic (mg/kg)	7.55 (6.3-9.0)	7.97 (5.9-10.0)	7.22 (6.2-8.2)	8.64 (6.9-11.0)	10.24 (8.4-12.0)	10.16 (7.9-12.0)	5.02 (0.6-9.1)	10.02 (7.0-13.0)
Cadmium (mg/kg)	0.99 (0.4-1.6)	4.07 (3.0-5.3)	0.73 (0.5-0.9)	0.76 (0.5-1.6)	0.59 (0.4-0.9)	0.21 (0.1-0.3)	<0.1 (<0.1-<0.1)	0.45 (0.2-0.7)
Chromium (mg/kg)	93.6 (64-130)	380 (250-560)	59.8 (36-90)	74.1 (63-89)	112.7 (83-180)	32.4 (24-41)	17.8 (5-24)	23.2 (15-33)
Copper (mg/kg)	632 (410-810)	2470 (1700-4000)	176.7 (97-280)	326 (290-390)	329 (240-540)	49 (31-58)	14.8 (1-20)	143.5 (52-310)
Lead (mg/kg)	100.9 (77-130)	152 (100-230)	119.4 (84-150)	89.8 (67-130)	86.3 (63-140)	43.6 (38-52)	30.3 (9-39)	103.7 (77-140)
Mercury (mg/kg)	1.09 (0.65-1.40)	1 (0.77-1.40)	0.52 (0.34-0.84)	0.37 (0.29-0.59)	0.47 (0.42-0.55)	0.15 (0.09-0.21)	0.059 (<0.05-0.15)	0.14 (0.07-0.21)
Nickel (mg/kg)	35.4 (29-40)	104.4 (68-170)	19.2 (11-26)	28.7 (21-36)	30.6 (20-55)	8.8 (7-12)	11.5 (5-14)	11.6 (8-17)
Silver (mg/kg)	5.5 (3.0-9.0)	11.8 (8.0-16.0)	3.3 (2.0-4.0)	6.1 (5.0-7.0)	12.5 (6.0-32.0)	0.5 (0.3-1.0)	0.3 (<0.2-1.0)	0.5 (0.2-1.0)
Zinc (mg/kg)	256 (180-310)	520 (420-670)	279 (210-310)	372 (310-480)	298 (220-500)	155 (120-170)	74.5 (24-140)	293 (170-440)
Total Polychlorinated Biphenyls (PCBs) (µg/kg) [(3) (4)]	90.33 (18-120)	193.17 (35-292)	30.17 (21-41)	18.83 (18-21)	42.17 (34-56)	18.33 (18-20)	18 (18-18)	18 (18-19)
Low Molecular Weight Polycyclic Aromatic Hydrocarbons (PAHs) (µg/kg) [(5) (6) (9)]	8874.33 (1752-17405)	149.33 (116-191)	96.4 (93-103)	99.17 (90-113)	125 (104-172)	90.46 (90-93)	90 (90-90)	91.33 (90-98)
High Molecular Weight Polycyclic Aromatic Hydrocarbons (PAHs) (µg/kg) [(7) (8) (9)]	69969 (2137-155620)	1356.65 (1052-2026)	419.11 (231-514)	743.02 (524-993)	629.68 (341-920)	82.45 (59-103)	57.87 (21-116)	106.5 (46-193)

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3. The Technical Circular 'ETWB (W) No. 34/2002 Management of Dredged / Excavated Sediment' issued in 2002 has revised the definition of 'Total PCBs' as the summation of 18 specific PCB congeners. Following the new definition, the monitoring of these 18 PCB congeners started in 2002 and the Total PCBs results only refer to 2002 to 2004.
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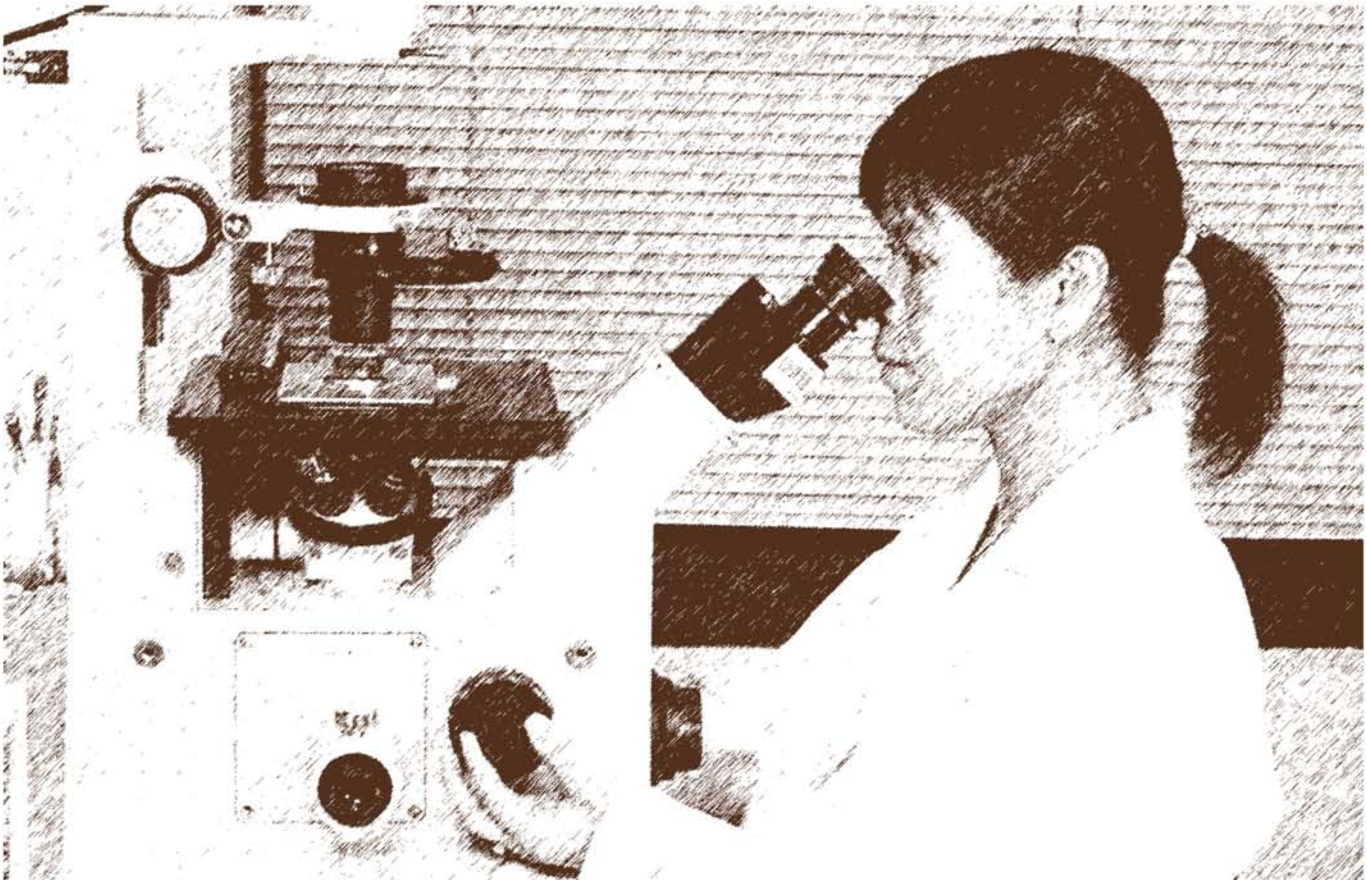
5. Low molecular weight polyaromatic hydrocarbons (PAHs) include 6 congeners of molecular weight below 200, namely : Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene and Phenanthrene.
6. As the monitoring of Naphthalene only started in 2002, the Low Molecular Weight PAHs results are based on sediments samples collected in 2002 to 2004.
7. High molecular weight polyaromatic hydrocarbons (PAHs) include 10 congeners of molecular weight above 200, namely : Fluoranthene, Pyrene, Benzo(a) anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, Benzo(g,h,i)perylene and Indeno(1,2,3-cd) pyrene.
8. Low and high molecular weight PAHs results are derived from the summation of the corresponding congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.

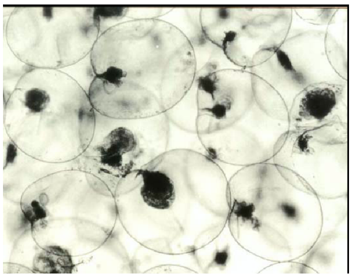
PHYTOPLANKTON & RED TIDES

CHAPTER 8



Chapter 8 – Phytoplankton & Red Tides

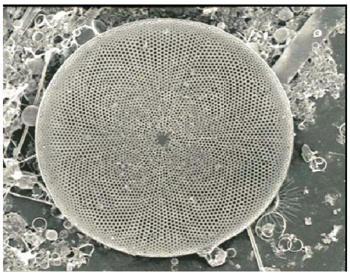
Introduction



8.1 Phytoplankton is a critical component of coastal ecosystems and represents the first biological response to the nutrient enrichment problem. Phytoplankton monitoring can track the biological consequences of nutrient enrichment over time and therefore forms an essential part of coastal eutrophication management.

8.2 The Environmental Protection Department (EPD) conducts long-term monitoring of phytoplankton at 25 stations covering nine Water Control Zones (WCZs) in the territory (Figure 8.1). Monthly phytoplankton samples are collected from 1m below water surface. Detailed identification and enumeration of phytoplankton taxa are carried out using light and electron microscopes.

Composition of phytoplankton



8.3 A total of 84 phytoplankton species was recorded in Hong Kong waters in 2004. Of these, 49 were diatoms (58%), 24 were dinoflagellates (29%), 11 were from other minor groups (13%) including Cyanophyta, Chrysophyta and Prozotoa. The most dominant diatom species were *Skeletonema costatum*, *Chaetoceros* spp. and *Pseudo-nitzschia delicatissima* which constituted 60-82% of the diatom population in the Eastern Buffer, Victoria Harbour, Southern, North Western, Western Buffer and Deep Bay WCZs (Table 8.1). The most abundant dinoflagellate species were *Scrippsiella* spp., *Gymnodinium vestifici* and *Prorocentrum micans* comprising more than 60% of the dinoflagellate populations in 8 out of the 9 WCZs (i.e. Mirs Bay, Eastern Buffer, Port Shelter, Victoria Harbour, Southern, North Western, Western Buffer and Deep Bay) (Table 8.1). The majority of the other phytoplankton groups were made up of small flagellates (>65%) in all the WCZs (Table 8.1).

8.4 Of the samples examined in 2004, diatoms constituted the largest component of phytoplankton in term of species number (i.e. 48-65%) followed by dinoflagellates (22-37%) and other phytoplanktons (13-17%) (Figure 8.2). In terms of cell density, diatom was also the largest phytoplankton group in five WCZs, i.e. Western Buffer (71%), Southern (66%), Victoria Harbour (62%), Mirs Bay (58%) and Tolo Harbour & Channel (48%) (Figure 8.3). Other minor phytoplankton groups formed the majority in three WCZs, i.e. Deep Bay (63%), Eastern Buffer (57%) and North Western (54%). The general pattern was similar with that recorded in 2003.

Abundance of phytoplankton groups

8.5 Figure 8.4 shows the annual mean densities of total phytoplankton at 25 sampling stations in 2004. In general, the total phytoplankton densities were 2-6 times higher at stations in Tolo Harbour & Channel than those in other WCZs. Diatom densities were found to be higher at stations in Tolo Harbour & Channel (Figure 8.5); whereas dinoflagellate densities were generally higher in Eastern in-shore waters (Figure 8.6). Like diatoms, other minor phytoplankton groups were also more abundant in Tolo Harbour & Channel than other waters in Hong Kong (Figures 8.7).

Occurrence of red tides

8.6 Red tides and algal blooms are natural phenomena which occur in both polluted and unpolluted waters. In Hong Kong, red tides occur more frequently in the eastern waters and southern waters (Figure 8.8). From 1980 to 2004, some 297 of 709 red tides (42%) occurred in the Tolo Harbour and Channel WCZ, and 130 (18%) in the Mirs Bay WCZ, 93 (13%) in the Port Shelter WCZ and 117 (17%) in the Southern WCZ respectively.

8.7 Red tides increased significantly in the 80s and reached a peak in 1988, when a total of 88 incidents was reported (Figure 8.9). In the last ten years, red tides fluctuated between 19 and 45 incidents per year. A total of 34 red tides was recorded in 2004 (14 more than in 2003). Of these, 20 occurred in the eastern waters and 9 in the Southern WCZ. There was no red tide related fish kill in 2004.

8.8 Among all red tide cases recorded between 1980 and 2004, 451 were caused by dinoflagellates (64%); 124 were by diatoms (18%) and 111 were by other minor phytoplankton groups (16%) (Figure 8.10) (Note: The causative species of some red tides were unknown). Red tides caused by dinoflagellates formed a peak in spring, i.e. between March and May; whereas those caused by diatoms occurred more frequently in summer, i.e. between May and August. Red tides formed by other minor phytoplankton groups mostly occurred in the winter and spring months (Figure 8.10).

Red tide causative species

8.9 A total of 80 red tide species have been identified from Hong Kong waters since 1980 (Table 8.2). The most common species was the dinoflagellate *Noctiluca scintillans*, which accounted for 28% of the reported red tides. The diatom *Skeletonema costatum* and dinoflagellate *Gonyaulax polygramma* were also frequently encountered. The number of red tide species varied considerably between different WCZs: ranging from 54 species in Tolo Harbour and Channel to six species in Deep Bay.

8.10 A total of 17 red tide species was recorded from different waters in 2004. Of these, *Prorocentrum micans, Skeletonema costatum* and *Trichodesmium erythraeum* were more widely distributed than others. The species compositions in the Tolo Harbour & Channel WCZ and Southern WCZ were more diverse (i.e. there were more species) than in other WCZs.

Figure 8.1 Phytoplankton monitoring stations in Hong Kong waters in 2004

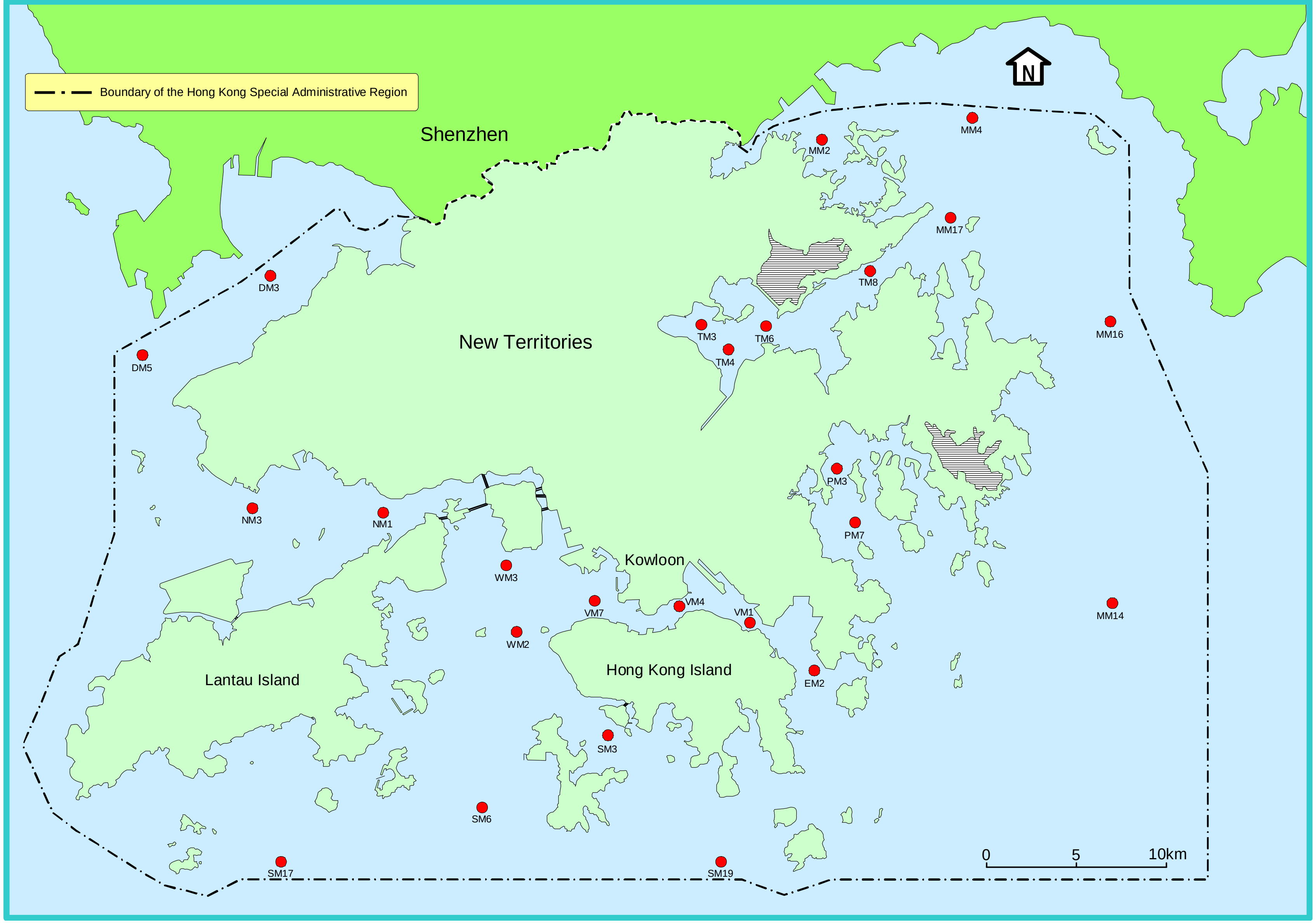


Figure 8.2 Percentage contribution of phytoplankton groups to the total number of species in the nine WCZs (2004)

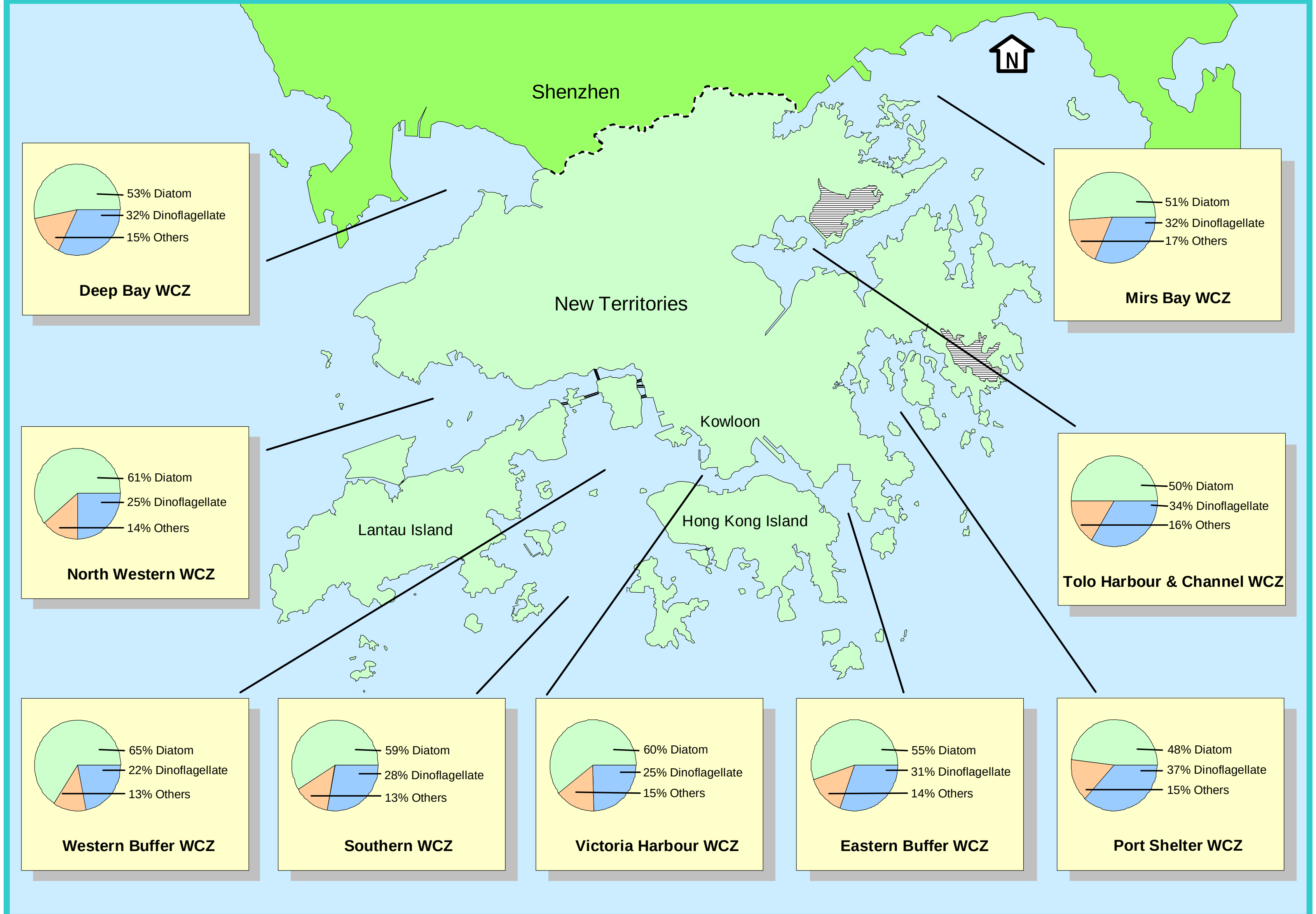


Figure 8.3 Percentage contribution of phytoplankton groups to the total density in the nine WCZs (2004)

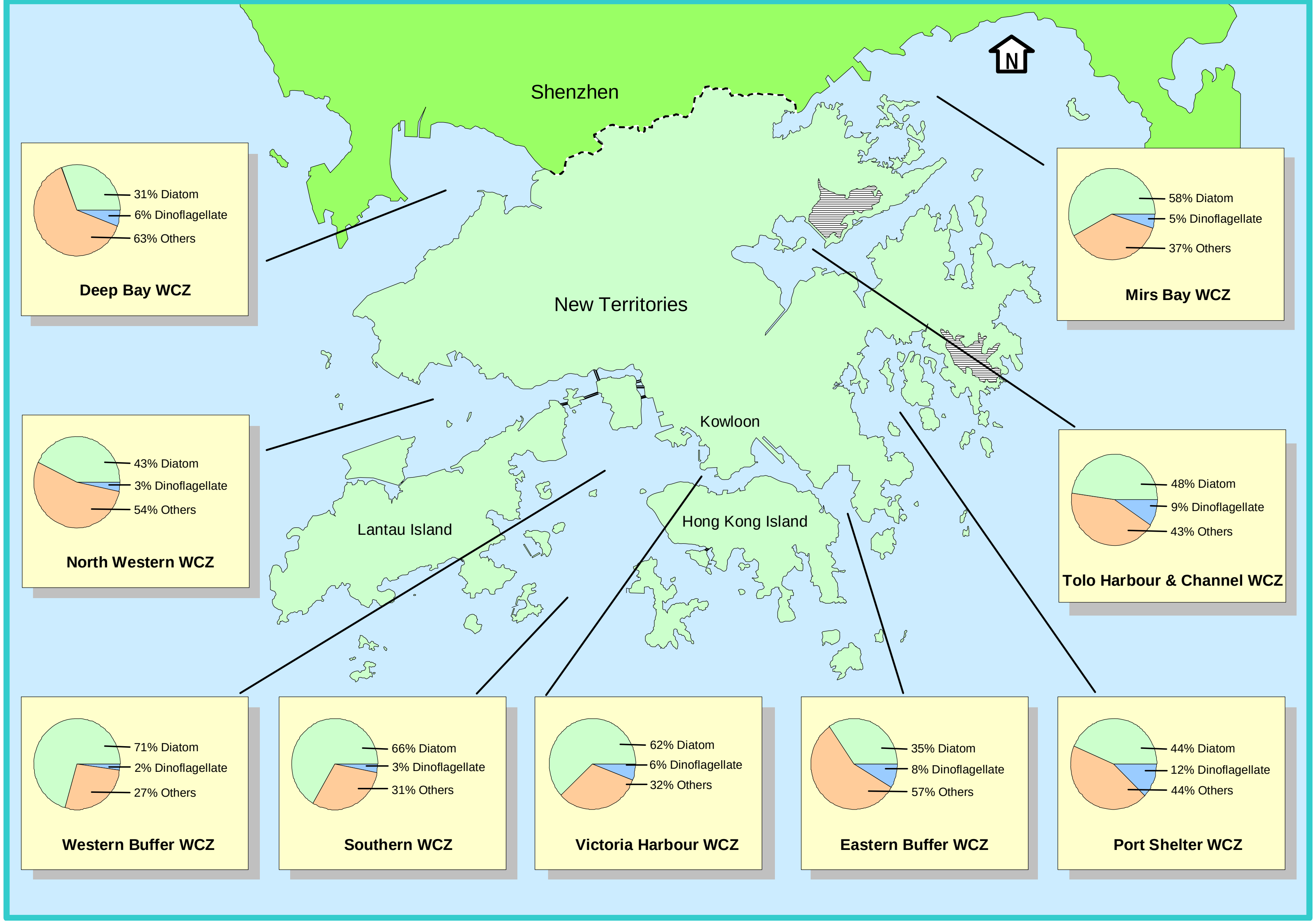


Figure 8.4 Annual mean densities (cell/mL) of total phytoplankton at 25 monitoring stations in Hong Kong waters in 2004

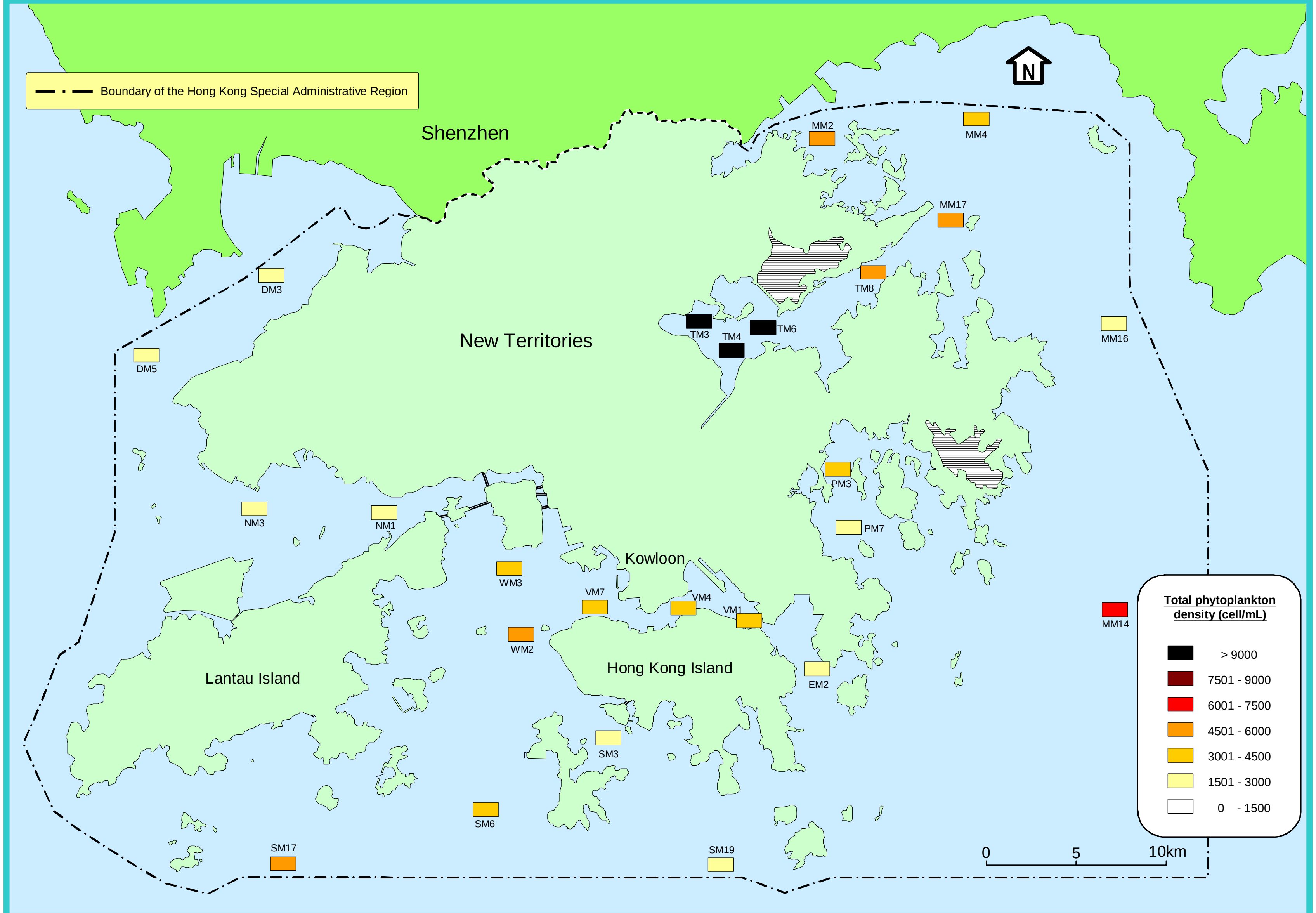


Figure 8.5 Annual mean densities (cell/mL) of diatoms at 25 monitoring stations in Hong Kong waters in 2004

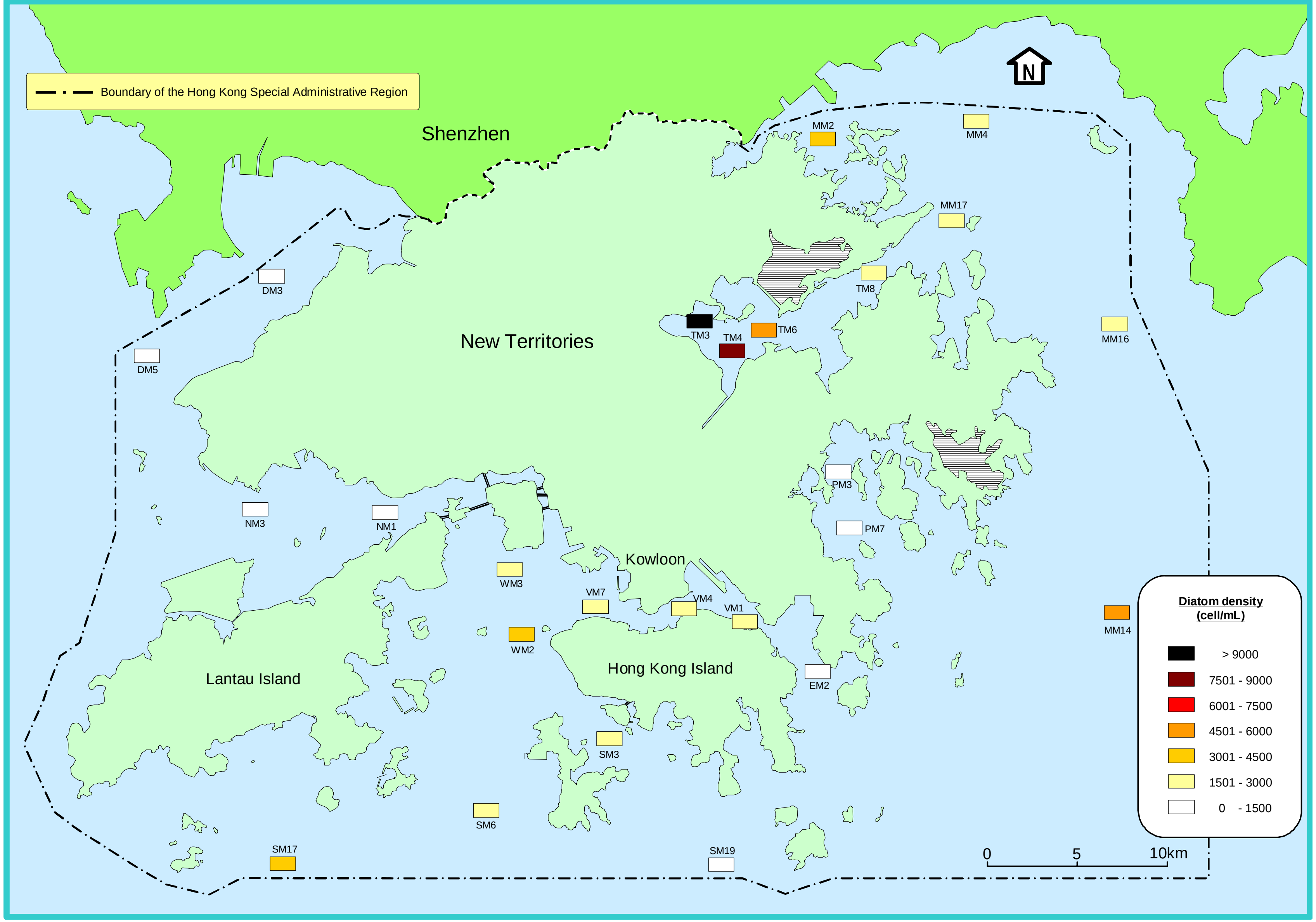


Figure 8.6 Annual mean densities (cell/mL) of dinoflagellates at 25 monitoring stations in Hong Kong waters in 2004

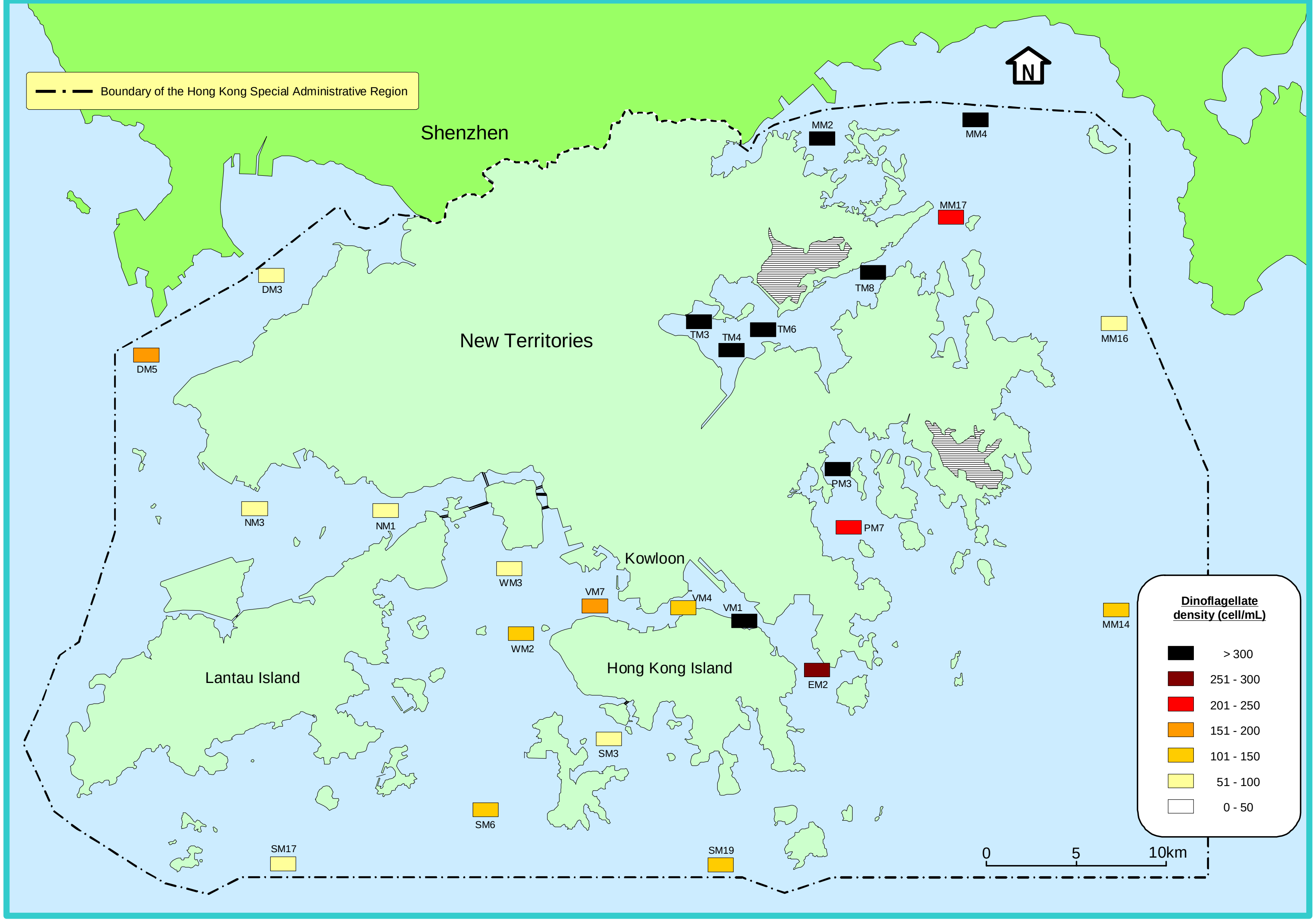


Figure 8.7 Annual mean densities (cell/mL) of other phytoplankton groups at 25 monitoring stations in Hong Kong waters in 2004

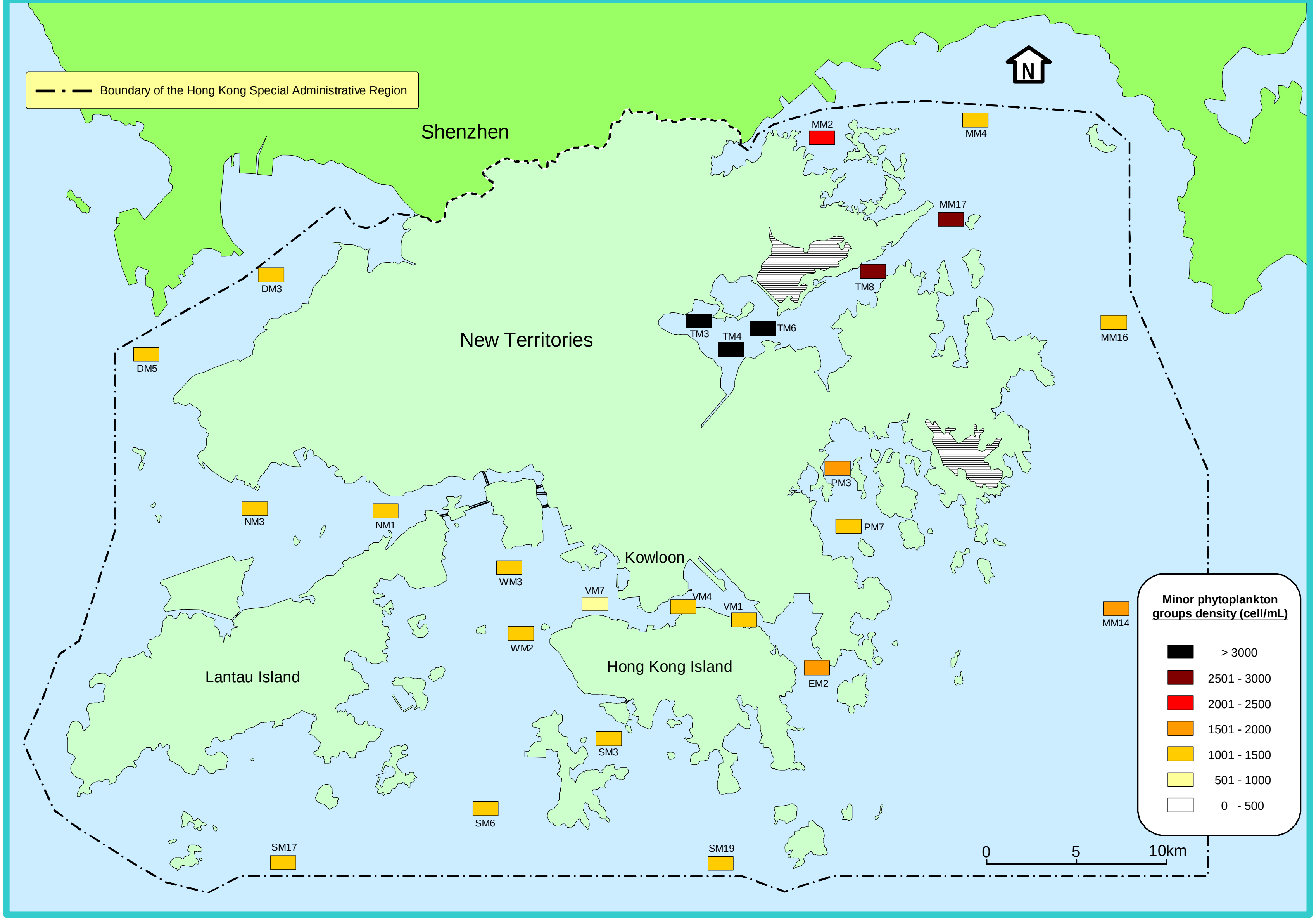


Figure 8.8 Frequency of red tides in 10 WCZs in Hong Kong, 1980 - 2004

(Sources: Agriculture, Fisheries and Conservation Department and Environmental Protection Department

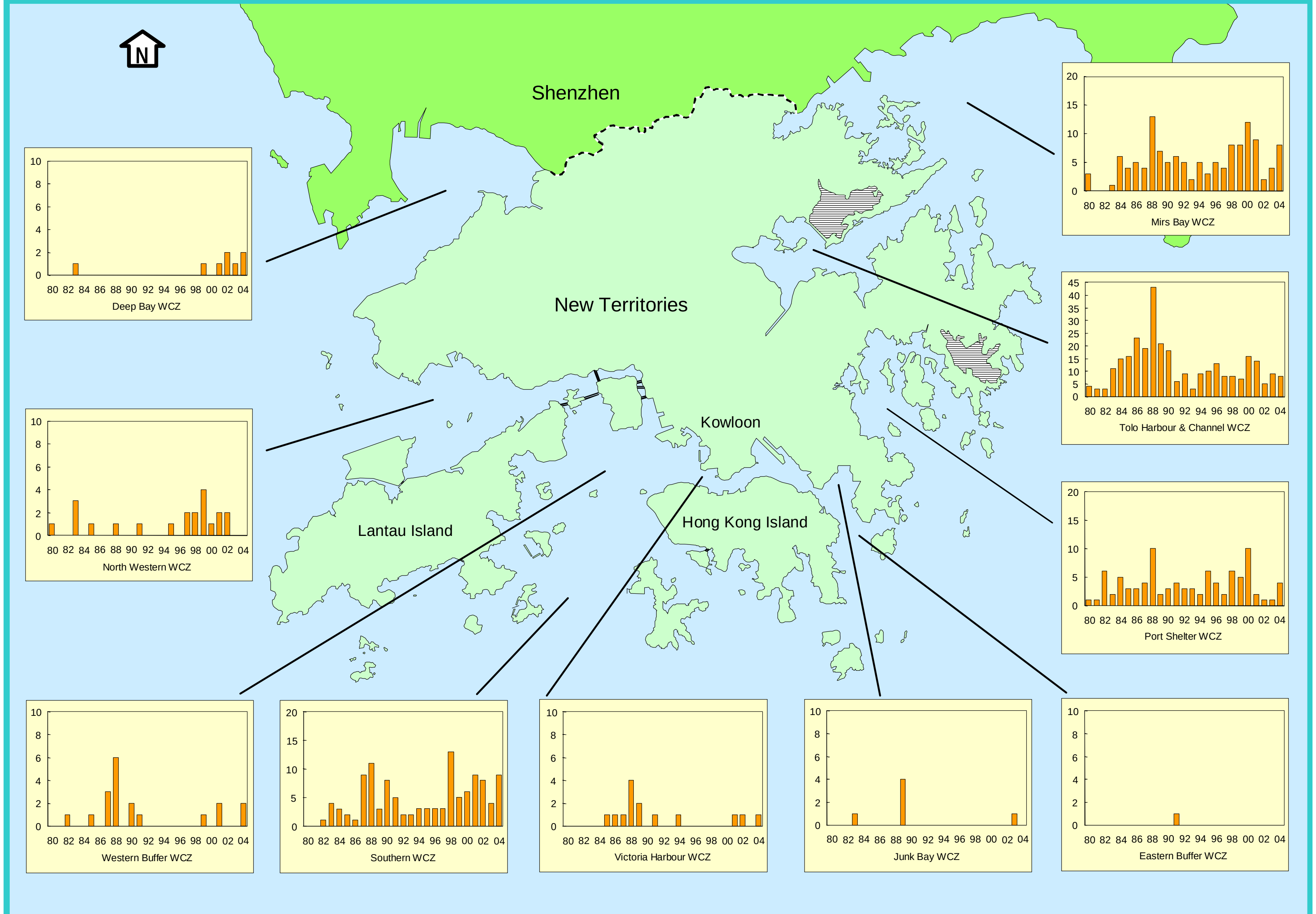
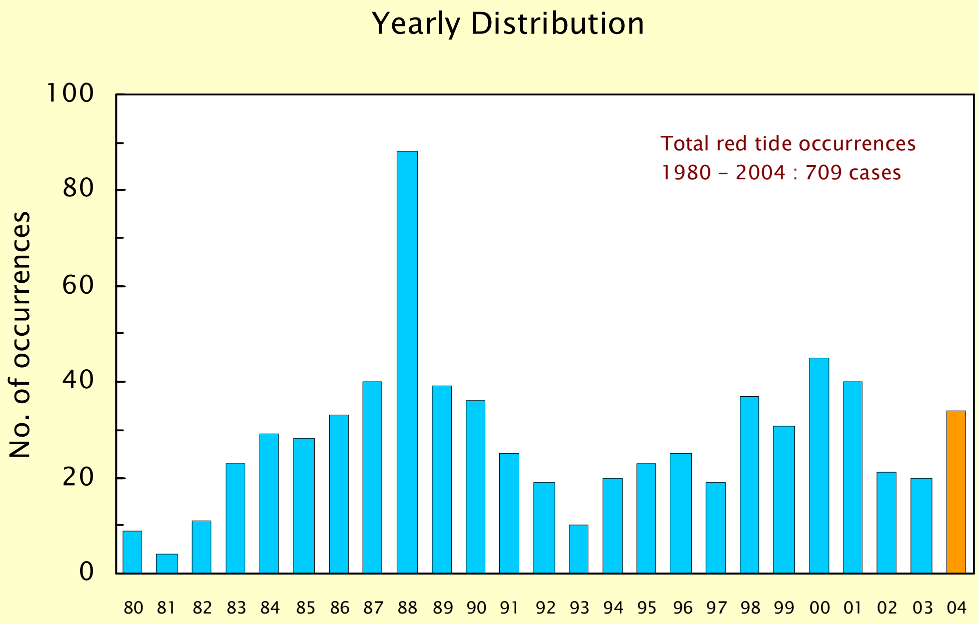


Figure 8.9 Occurrence of red tides in Hong Kong waters, 1980 – 2004
(Sources: Agriculture, Fisheries and Conservation Department and Environmental Protection Department)



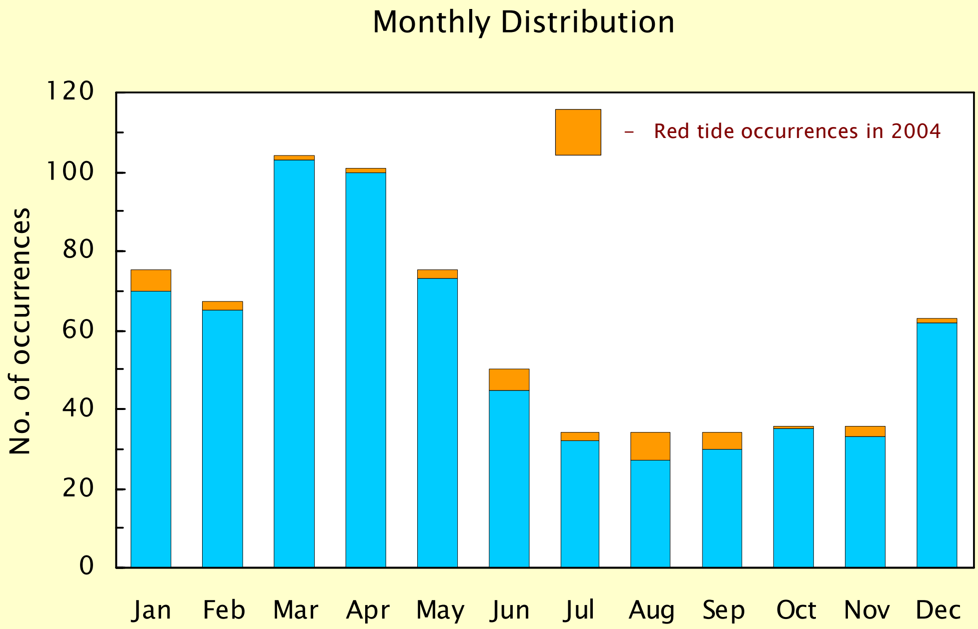
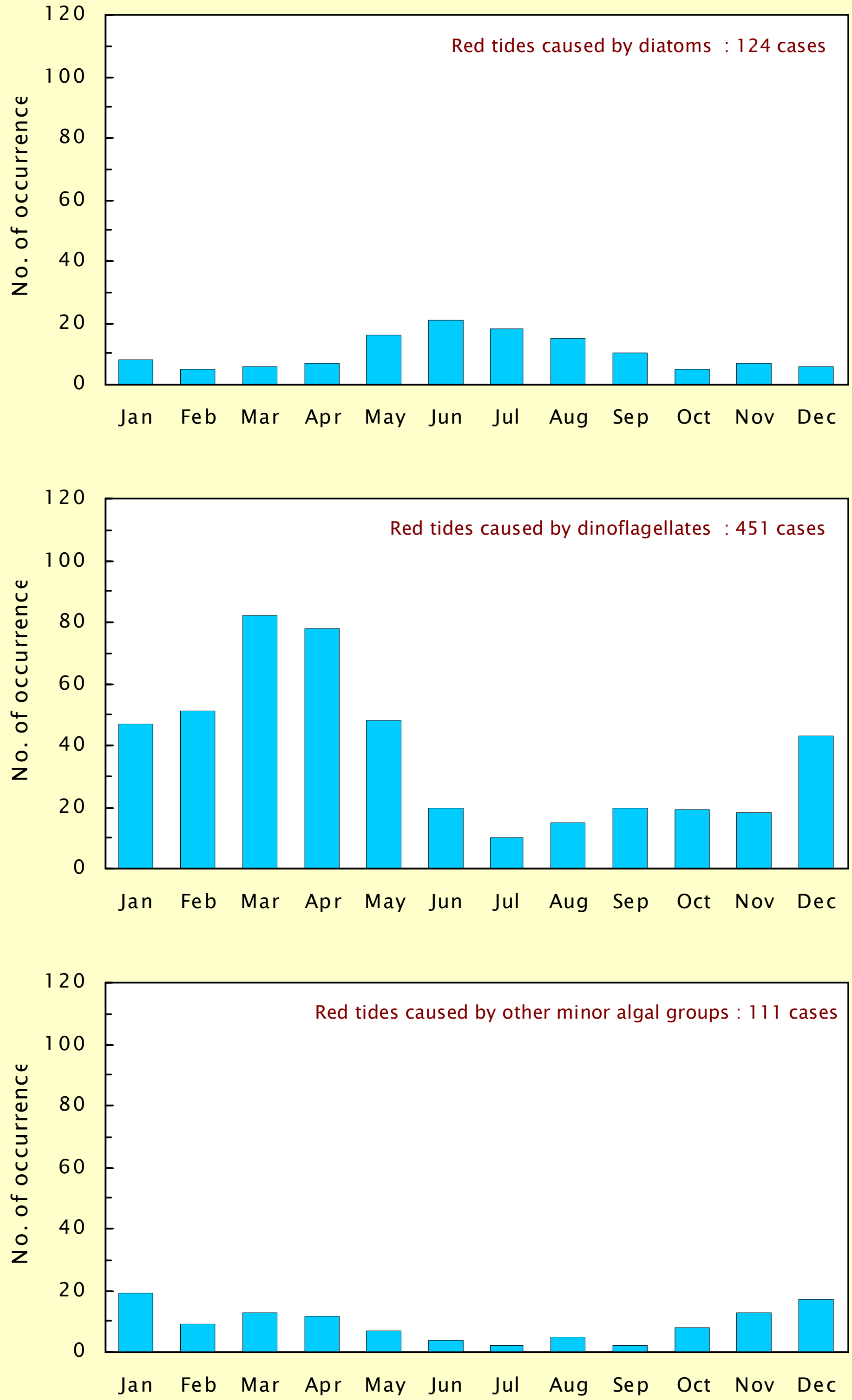


Figure 8.10 Seasonal occurrence of red tides caused by different phytoplankton groups in Hong Kong, 1980 – 2004

(Sources: Agriculture, Fisheries and Conservation Department and Environmental Protection Department)



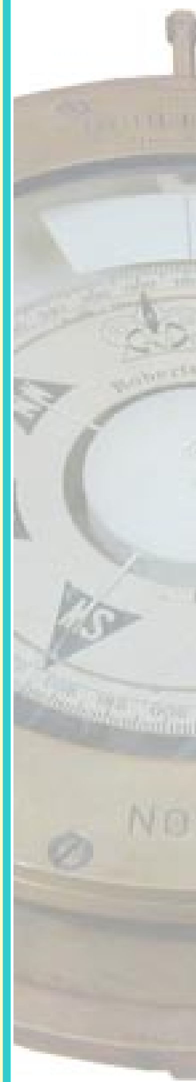


Table 8.1
Abundance and frequency of the dominant phytoplankton species in different WCZs in 2004

Species	% Abundance[1]	Frequency[2]
Tolo Harbour & Channel		
Diatoms		
Chaetoceros spp.	26.3	12
Leptocylindrus danicus	23.4	8
Cylindrotheca closterium	13.9	11
Dinoflagellates		
Prorocentrum minimum	49.3	7
Gymnodinium spp.	9.6	12
Scrippsiella spp.	8.8	12
Others		
small flagellates	86.3	12
Plagioselmis prolonga	11.1	12
Teleaulax acuta	1.7	12
Mirs Bay		
Diatoms		
Dactyliosolen fragilissimus	33	11
Pseudo-nitzschia delicatissima	22.6	12
Skeletonema costatum	14.7	9
Dinoflagellates		
Prorocentrum micans	43.6	2
Scrippsiella spp.	16.3	12
Gymnodinium vestifici	10.9	12
Others		
small flagellates	87.4	12
Plagioselmis prolonga	8.9	12
Teleaulax acuta	2	12
Eastern Buffer		
Diatoms		
Pseudo-nitzschia delicatissima	33.2	10
Chaetoceros spp.	23.8	11
Skeletonema costatum	12.2	10
Dinoflagellates		
Prorocentrum micans	56.4	1
Gymnodinium vestifici	11.9	12
Scrippsiella spp.	10.1	11
Others		
small flagellates	78.8	12
Plagioselmis prolonga	16.9	12
Teleaulax acuta	3.8	11
Port Shelter		
Diatoms		
Chaetoceros spp.	28.8	10
Dactyliosolen fragilissimus	22.5	7
Pseudo-nitzschia delicatissima	16.2	11
Dinoflagellates		
Prorocentrum micans	69.3	3
Gymnodinium spp.	8.6	12
Scrippsiella spp.	6.8	11
Others		
small flagellates	89	12
Plagioselmis prolonga	9.1	12
Teleaulax acuta	1.5	10
Victoria Harbour		
Diatoms		
Skeletonema costatum	55	12
Pseudo-nitzschia delicatissima	13.3	9
Chaetoceros spp.	13.2	11
Dinoflagellates		
Prorocentrum micans	66.6	3
Gymnodinium vestifici	10.7	12
Gymnodinium spp.	6.9	12
Others		
small flagellates	84.9	12
Plagioselmis prolonga	11.9	12
Teleaulax acuta	2.7	11

Species	% Abundance[1]	Frequency[2]
Southern		
Diatoms		
Chaetoceros spp.	43.6	12
Pseudo-nitzschia delicatissima	18.1	11
Skeletonema costatum	13.6	11
Dinoflagellates		
Gymnodinium vestifici	27.4	12
Scrippsiella spp.	20.1	12
Prorocentrum micans	19.3	3
Others		
small flagellates	85.9	12
Plagioselmis prolonga	12	12
Teleaulax acuta	1.8	12
North Western		
Diatoms		
Skeletonema costatum	35.7	11
Chaetoceros spp.	30.3	10
Thalassiosira spp.	10.5	11
Dinoflagellates		
Scrippsiella spp.	44.3	12
Gymnodinium vestifici	18.3	12
Gymnodinium spp.	13.8	12
Others		
small flagellates	73.8	12
Plagioselmis prolonga	19.1	12
Teleaulax acuta	5.4	12
Western Buffer		
Diatoms		
Skeletonema costatum	38	11
Chaetoceros spp.	21.5	11
Thalassiosira spp.	12.3	12
Dinoflagellates		
Gymnodinium vestifici	30.3	10
Prorocentrum micans	19.8	1
Scrippsiella spp.	15.5	11
Others		
small flagellates	86.3	12
Plagioselmis prolonga	10.3	12
Teleaulax acuta	2.9	11
Deep Bay		
Diatoms		
Skeletonema costatum	33.8	12
Thalassiosira spp.	33	12
Chaetoceros spp.	28.2	8
Dinoflagellates		
Scrippsiella spp.	71.4	12
Gymnodinium spp.	11.5	11
Gymnodinium vestifici	5.7	5
Others		
small flagellates	65.7	12
Plagioselmis prolonga	18.3	12
Teleaulax acuta	13.8	12

1 % of species/group in diatoms, dinoflagellates and other phytoplankton

2 Number of occurrences out of 12 sampling occasions

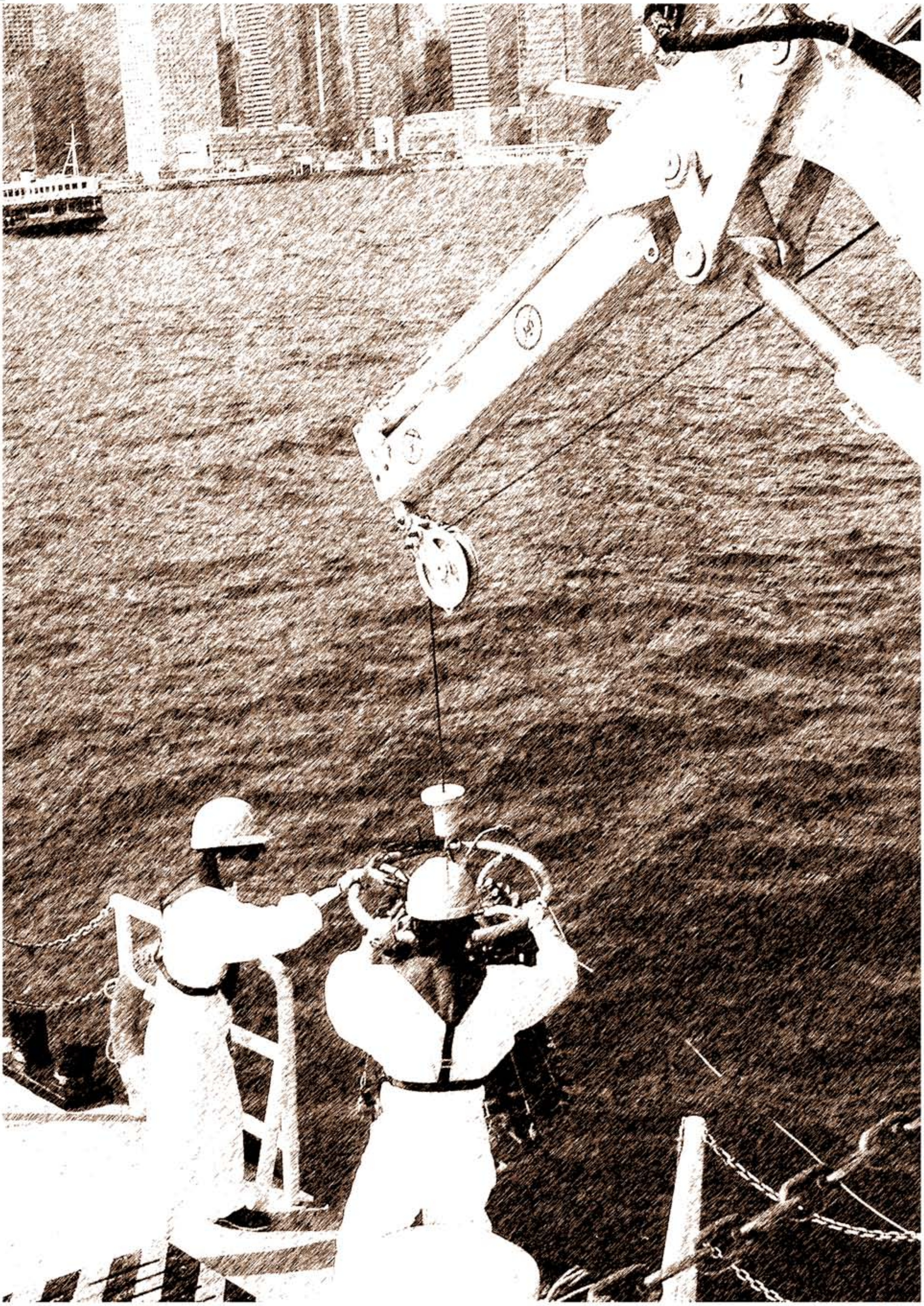
Table 8.2
Occurrence and distribution of red tide species in different WCZs, 1980 - 2004

Species	Tolo Harbour & Channel WCZ	Mirs Bay WCZ	Eastern Buffer WCZ	Port Shelter WCZ	Junk Bay WCZ	Victoria Harbour WCZ	Southern Waters WCZ	North Western WCZ	Western Buffer WCZ	Deep Bay WCZ	Total
	Number of occurrences										
Noctiluca scintillans	54	57		39			50	4	6		210
Skeletonema costatum	23	3		1	3	8	8	3	8	1	58
Gonyaulax polygramma	21	8		12			6	1			48
Prorocentrum minimum	44	1									45
Mesodinium rubrum	8	8		7	1		13	5		2	44
Prorocentrum triestinum	33										33
Ceratium furca	10	6		10							26
Scrippsiella trochoidea	14	4		2			1				21
Heterocapsa circularisquama	13	3									16
Prorocentrum sigmoides	14	1		1							16
Heterosigma akashiwo	10	2						3			15
Prorocentrum dentatum	7	3		1			1				12
Prorocentrum micans	4	4		1		1	1				11
Thalassiosira nordenskioeldii	2	3				1	3		2		11
Trichodesmium erythraeum		5		3			3				11
Karenia mikimotoi	6	1		3							10
Leptocylindrus minimus	10										10
Cryptomonas sp.	8										8
Dactyliosolen fragilissimus	6	1		1							8
Thalassiosira mala	6						2				8
Chaetoceros spp.	6			1							7
Karenia digitata	1	3		2			1				7
Thalassiosira proschkinae	6	1									7
Akashiwo sanguinea	2	2						1		1	6
Gyrodinium instriatum						1	1	2	1	1	6
Thalassiosira spp.	2				1		2				5
Dictyocha speculum		2		1			1				4
Eutreptiella spp.	4										4
Haematococcus pluvialis	4										4
Leptocylindrus danicus	3	1									4
Plagioselmis prolonga	4										4
Pseudo-nitzschia pseudodelicatissima	1						2		1		4
Chaetoceros curvisetus			1		1		1				3
Chattonella ovata		2		1							3
Chattonella marina	2	1									3
Gymnodinium simplex	3										3
Karenia longicanalis	1	1					1				3
Pseudo-nitzschia seriata	1					2					3
Teleaulax acuta	3										3
Trichodesmium sp.		1		1			1				3
Alexandrium tamarense				2							2
Cerataulina pelagica	2										2
Chaetoceros socialis							2				2
Chattonella sp.	1						1				2
Cochlodinium polykrikoides							2				2
Cochlodinium sp.	2										2
Eucampia zodiacus							1	1			2
Gymnodinium sp. X				2							2
Nitzschia longissima	1						1				2
Phaeocystis globosa							2				2
Prorocentrum balticum	1	1									2
Prorocentrum spp.	1	1									2
Alexandrium catenella					1						1
Chaetoceros pseudocrinitus	1										1
Chaetoceros pseudocurvisetus							1				1
Chaetoceros sp.0105	1										1
Chaetoceros tenuissimus		1									1
Chlamydomonas sp.	1										1
Chlamydomonas uva-maris	1										1
Cyclotella caspia	1										1
Cyclotella spp.	1										1
Cyttarocylis sp.				1							1
Cylindrotheca closterium	1										1
Guinardia delicatula	1										1
Guinardia striata	1										1
Gymnodinium sp.		1									1
Gyrodinium spirale							1				1
Hermesinum adriaticum		1									1
Karlodinium micrum		1									1
Katodinium rotundatum								1			1
Leptocylindrus spp.							1				1
Navicula sp.										1	1
Odontella mobiliensis	1										1
Odontella sinensis	1										1
Pedinomonadaceae species	1										1
Protoperidinium quinquecorne	1										1
Pseudo-nitzschia spp.							1				1
Thalassiosira weissflogii										1	1
Thalassomonas sp.	1										1
Trichodesmium thiebautii							1				1
Total : 80 species	358	130	1	92	7	13	112	21	18	7	759

Note: a red tide incident may involve more than one causative species.
Source: Agriculture, Fisheries and Conservation Department and Environmental Protection Department

MARINE WATER QUALITY IN 2004

CHAPTER 9



Chapter 9 – Marine Water Quality in 2004

Water Quality in 2004

9.1 In 2004, the water quality of the Port Shelter and Mirs Bay Water Control Zones (WCZs) in the eastern waters continued to be excellent with low bacteria, organic matter and high dissolved oxygen (DO). Tolo Harbour showed steady improvement with significant reduction in organic and inorganic pollutants. Within the southern waters, the eastern end was largely pristine while the western side was under the influence of the Pearl River with higher inorganic nutrients. In the western waters, the North Western WCZ was impacted by riverine flow as well as local effluent discharges and had higher nutrient levels. The water quality in the Deep Bay WCZ was the poorest in the territory, with low dissolved oxygen (DO) and elevated levels of nitrogen and phosphorus, in particular in the inner bay area. The condition in Deep Bay deteriorated in 2004 with further increases in ammonia and nitrogen.

9.2 Within the central waters, the water quality improvements following the commissioning of the Harbour Area Treatment Scheme (HATS) Stage 1, i.e. increase in DO and reduction in nutrients and bacteria in the eastern Victoria Harbour, Junk Bay and Eastern Buffer WCZs were largely sustained in 2004. The higher levels of *E. coli* in the central and western Victoria Harbour and the Western Buffer WCZ also persisted.

9.3 A general increase in DO by 9% was observed in 2004, especially in the eastern waters, i.e. Mirs Bay, outer Tolo Harbour, Port Shelter, and southern waters. This may be part of the natural fluctuation from a lower baseline in the previous year. Significant increases in ammonia nitrogen were observed in many areas in the Southern, Western Buffer and North Western WCZs; however, other forms of nitrogen, e.g. nitrate, nitrite, organic nitrogen and chlorophyll-*a* remained relatively stable.

Compliance with Water Quality Objectives

9.4 In 2004, the overall compliance with the marine Water Quality Objectives (WQOs) in the territory was maintained at a high level of 87%, similar to that in the previous two years (Figure 9.3). Among the ten WCZs, five achieved full compliance (100%) with the WQOs (Mirs Bay, Port Shelter, Eastern Buffer, Junk Bay and Western Buffer). The Tolo Harbour, Southern, Victoria Harbour and North Western WCZs attained 80-90% compliance with the WQOs; whereas the Deep Bay WCZ had the lowest compliance rate of 20% (Figure 9.1).

9.5 The overall compliance with the WQO for DO in the territory was 89%, slightly higher than that in 2003 (87%) (Figure 9.2). The compliance with the TIN objective was maintained at 72%. Full compliance with the unionised ammonia objective was achieved with the exception of the Deep Bay WCZ which showed a further decline to 20% in 2004. For *E. coli* bacteria, the Tolo Harbour, Port Shelter, Mirs Bay WCZs and the secondary contact recreation subzones in the Southern WCZ fully achieved the objective indicating their suitability for secondary contact recreational activities.

Long-term Water Quality Trends

9.6 Long-term decreasing trends in the depth-averaged DO were observed in Deep Bay, while increasing trends were evident in Rambler Channel and western Victoria Harbour in 2004 (Figure 9.4). Reductions in 5-day Biochemical Oxygen Demand (BOD_5) and *E. coli* bacteria were detected in Tolo Harbour, while Deep Bay, North Western water as well as western Victoria Harbour showed increasing trends in bacterial pollution (Figures 9.5 and 9.6).

9.7 In term of nutrients, Tolo Harbour showed long-term decreases in nitrogen (ammonia nitrogen, nitrate nitrogen and total inorganic nitrogen) and orthophosphate phosphorus but chlorophyll-*a* (algal biomass) remained largely stable (Figures 9.7-9.11). Increasing trends in nitrate nitrogen and total inorganic nitrogen were observed in the North Western and Western Buffer WCZs, and the western part of the southern waters, reflecting the influence of Pearl River. Long-term increases in ammonia nitrogen were largely confined to Deep Bay and North Western waters (Figures 9.7-9.9).

Figure 9.1 Level of compliance with key marine Water Quality Objectives for 10 Water Control Zones in Hong Kong, 2000 – 2004

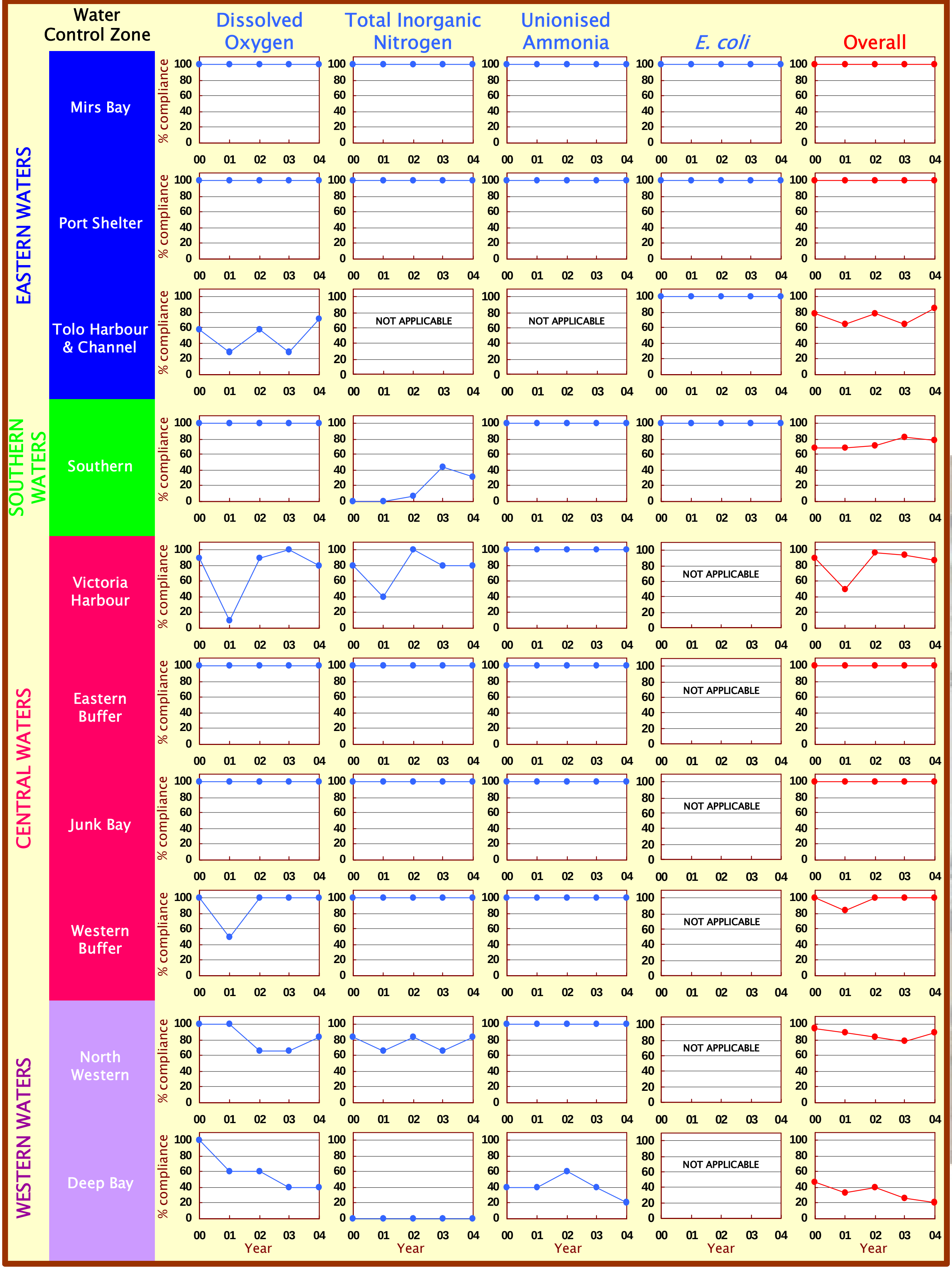


Figure 9.2 Level of compliance with key marine Water Quality Objectives in Hong Kong, 1995 – 2004

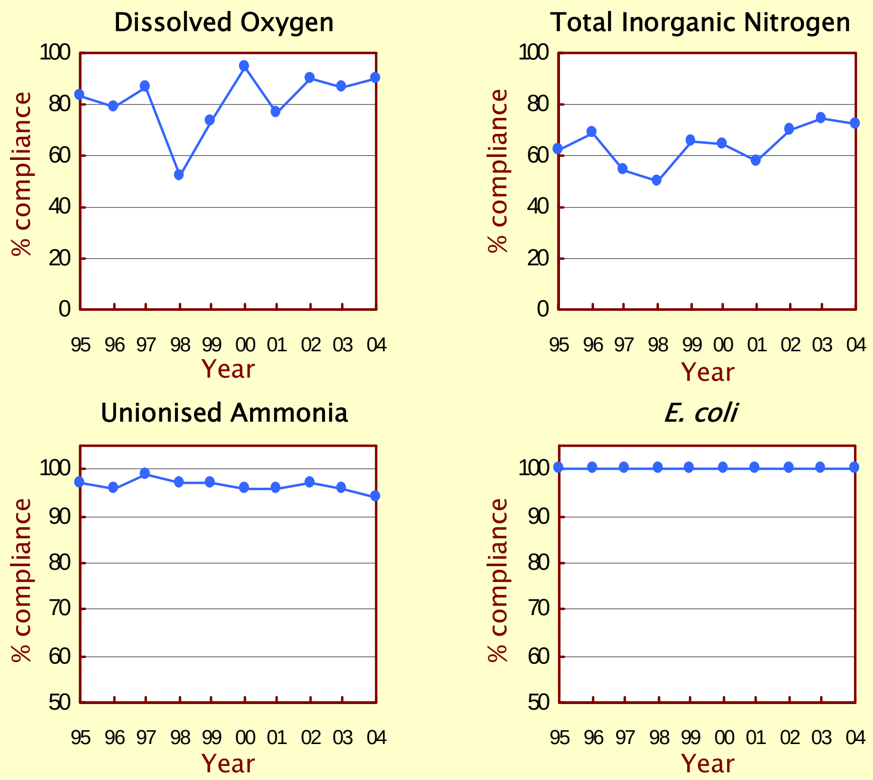


Figure 9.3 Overall level of compliance with key marine Water Quality Objectives in Hong Kong, 1986 – 2004

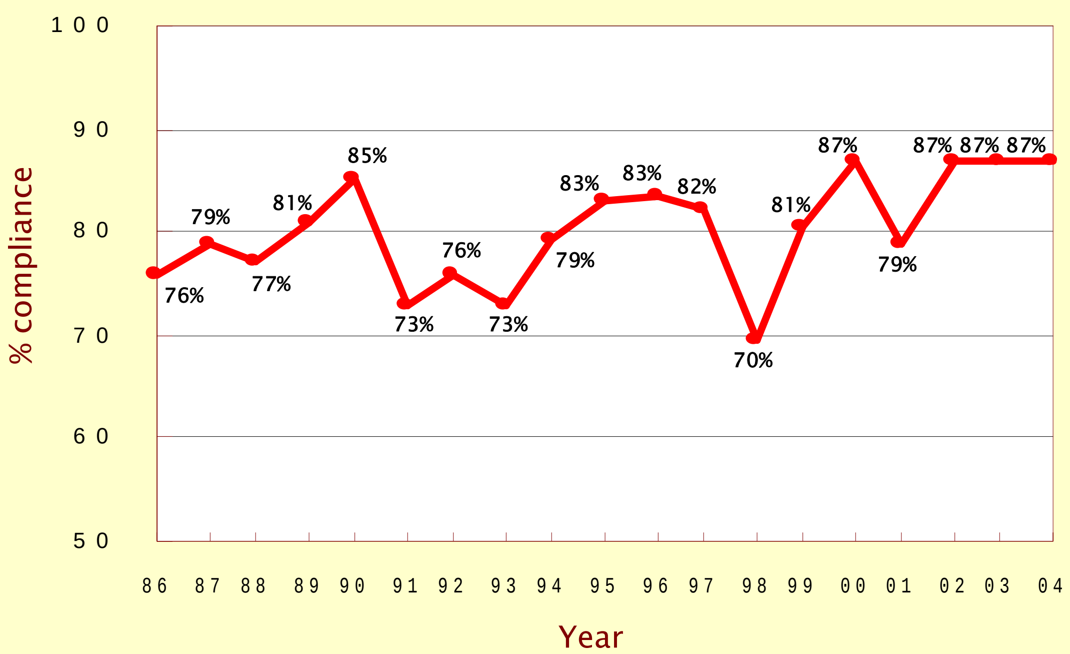


Figure 9.4 Long-term changes in dissolved oxygen in marine waters of Hong Kong, 1986 - 2004

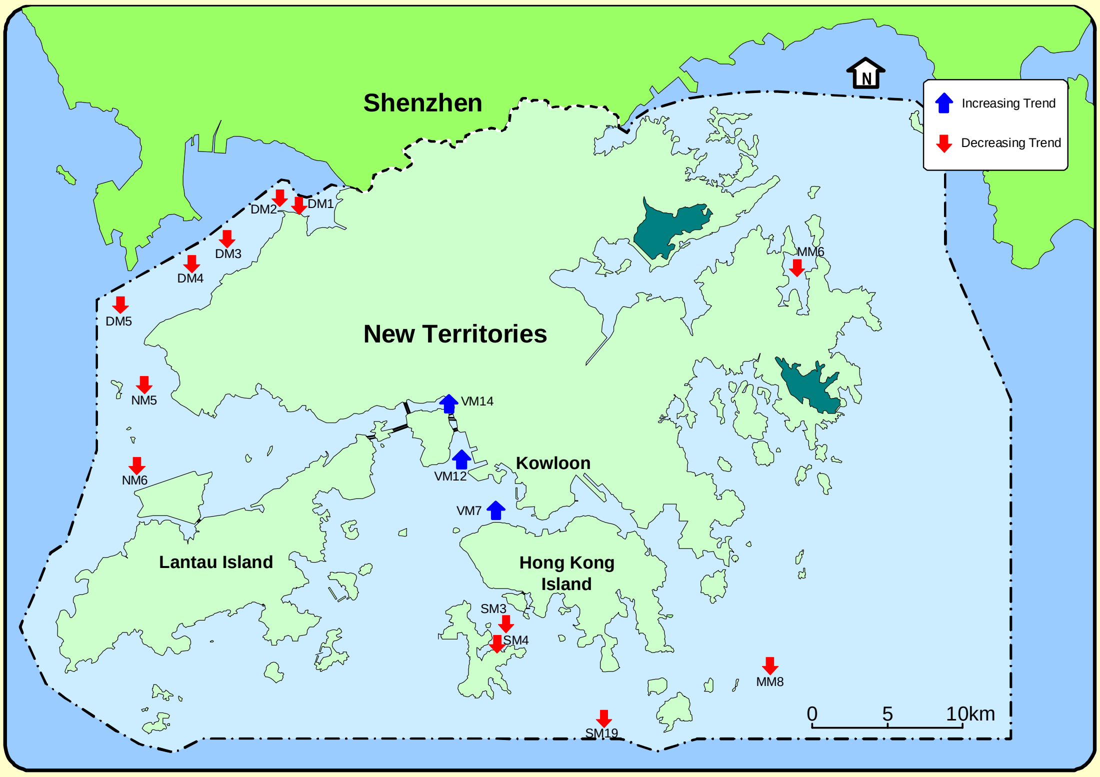


Figure 9.5 Long-term changes in 5-day Biochemical Oxygen Demand in marine waters of Hong Kong, 1986 - 2004

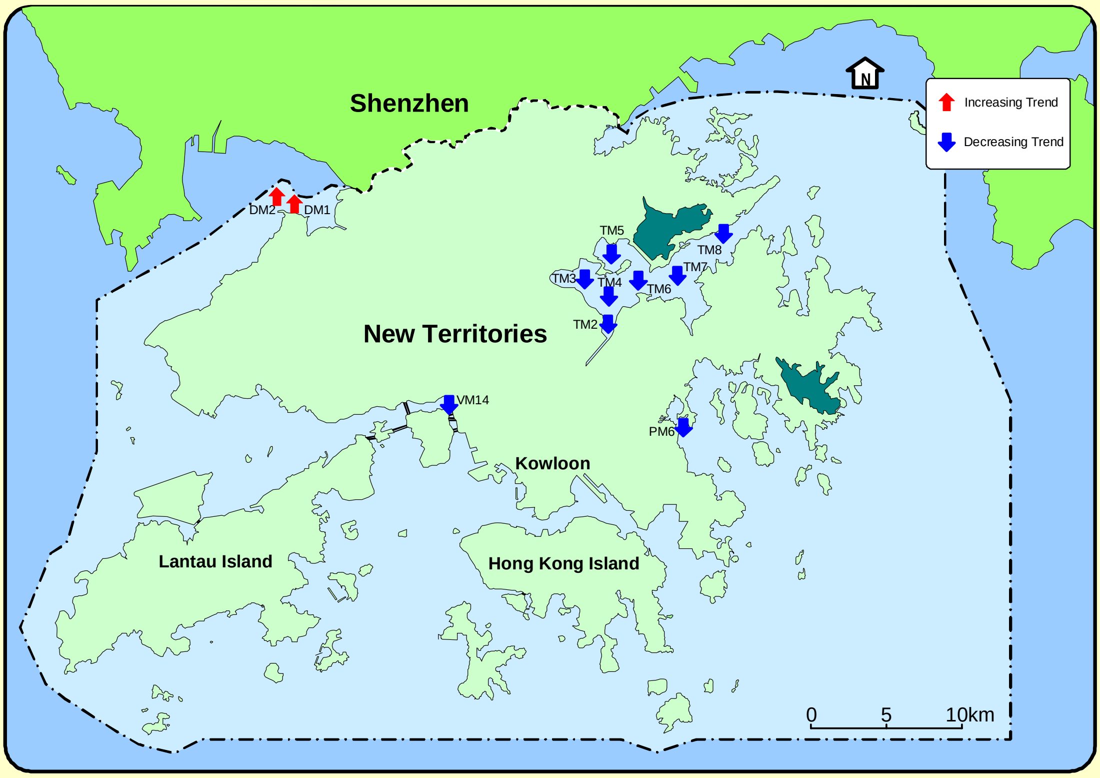


Figure 9.6 Long-term changes in *E. coli* in marine waters of Hong Kong, 1986 – 2004

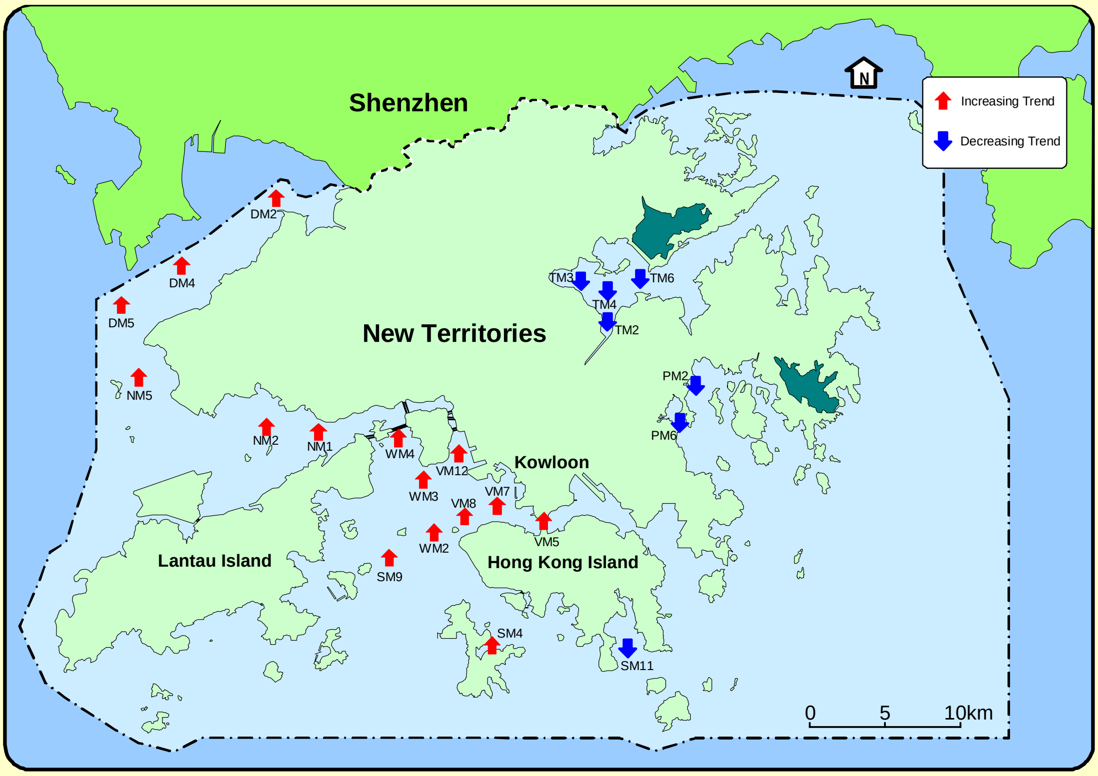


Figure 9.7 Long-term changes in ammonia nitrogen in marine waters of Hong Kong, 1986 – 2004

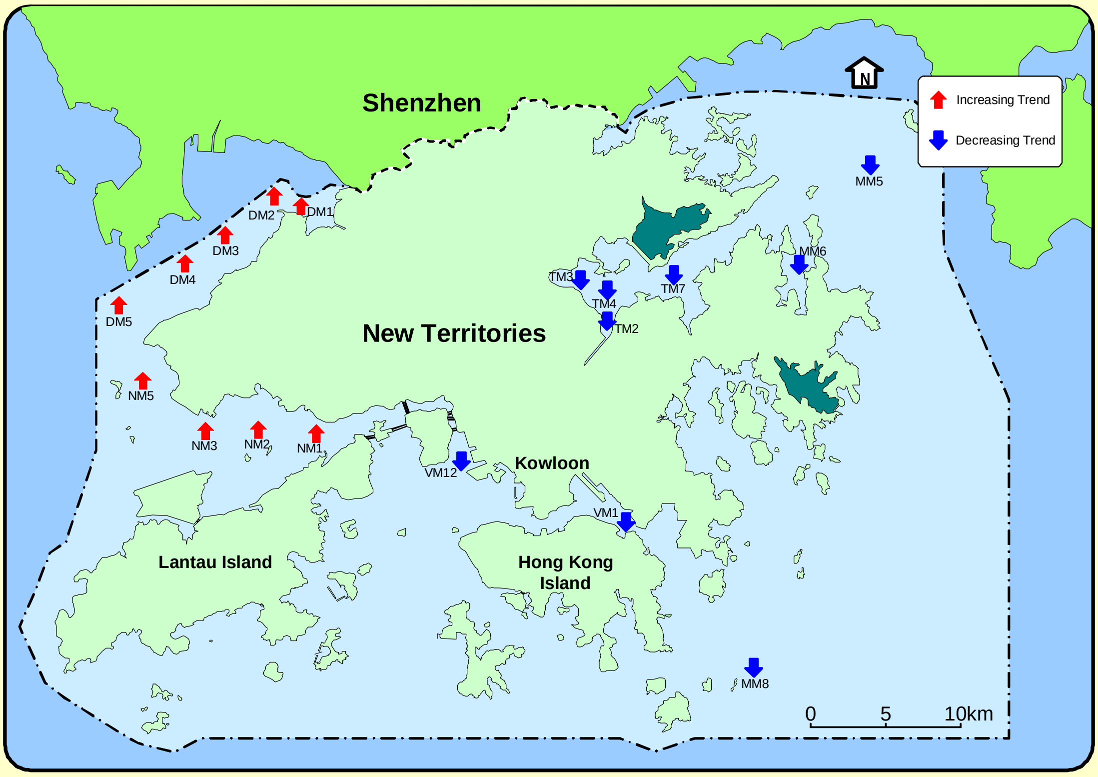


Figure 9.8 Long-term changes in nitrate nitrogen in marine waters of Hong Kong, 1986 - 2004

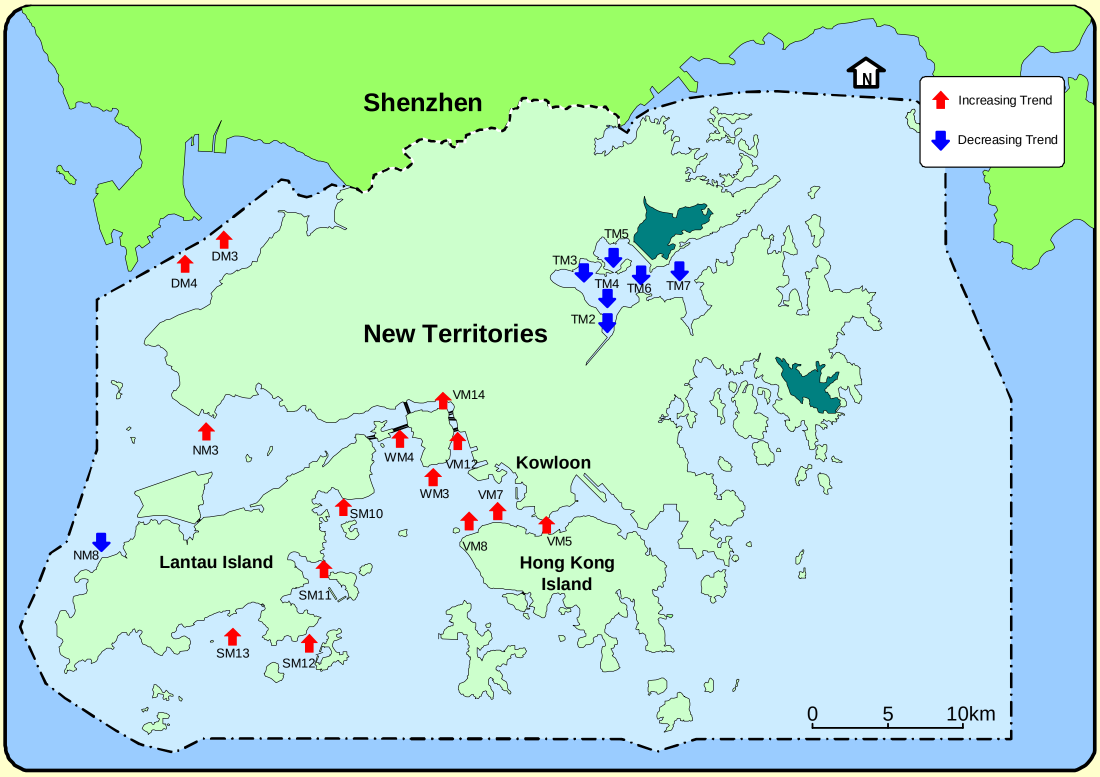


Figure 9.9 Long-term changes in total inorganic nitrogen in marine waters of Hong Kong, 1986 - 2004

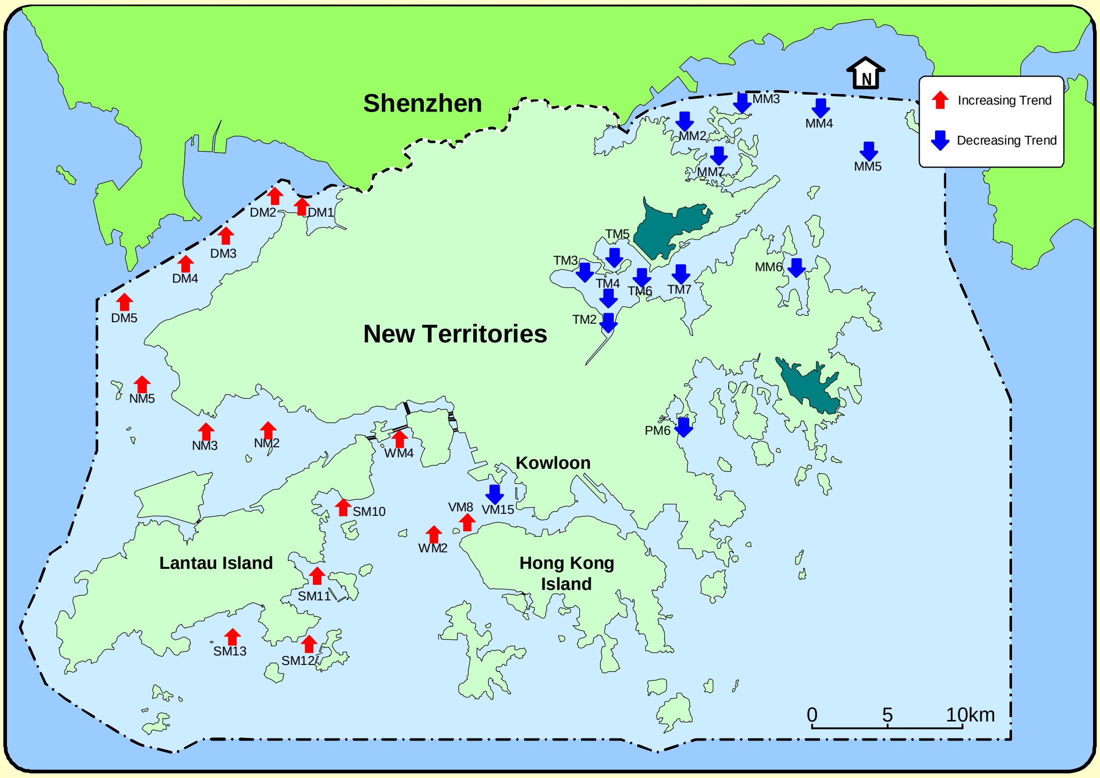


Figure 9.10 Long-term changes in orthophosphate phosphorus in marine waters of Hong Kong, 1986 – 2004

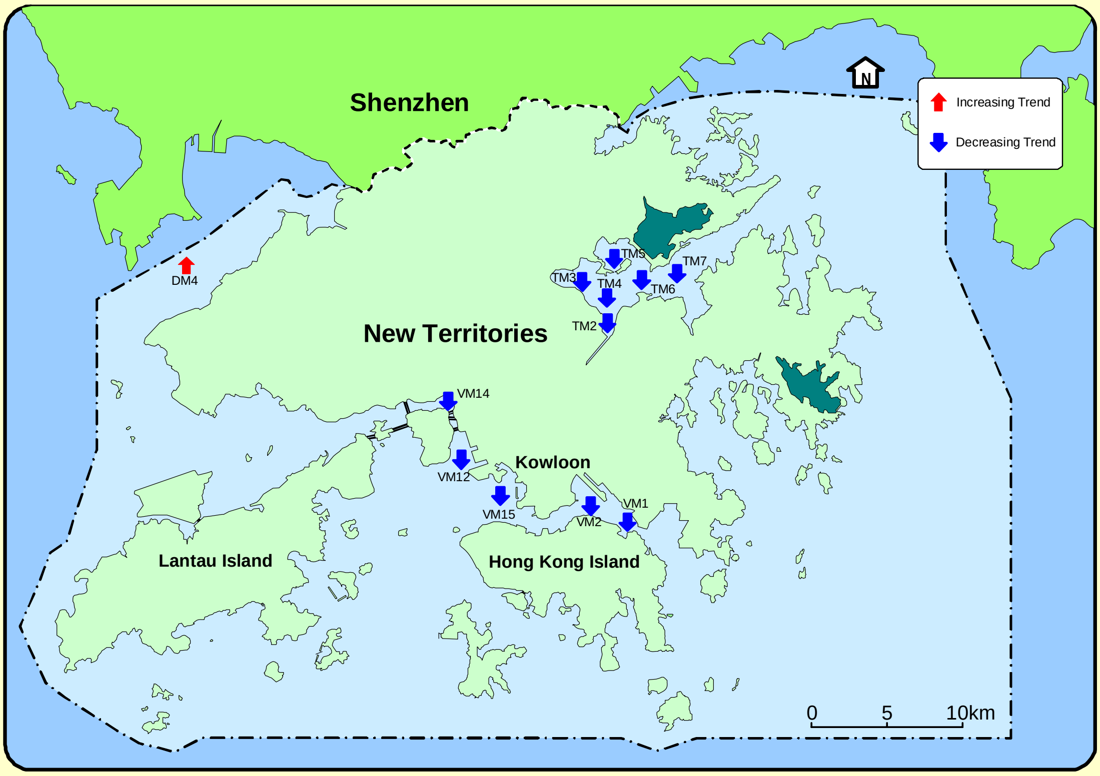


Figure 9.11 Long-term changes in chlorophyll-a in marine waters of Hong Kong, 1986 – 2004

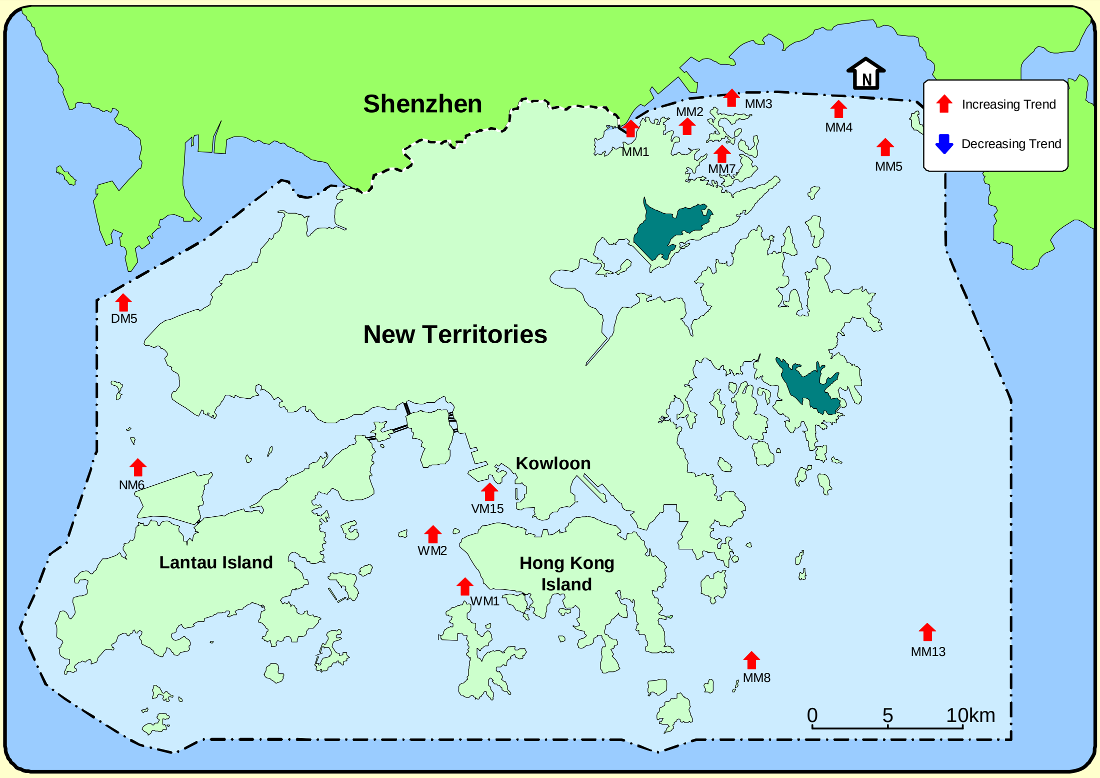


Figure 9.12 Long-term changes in temperature in marine waters of Hong Kong, 1986 - 2004

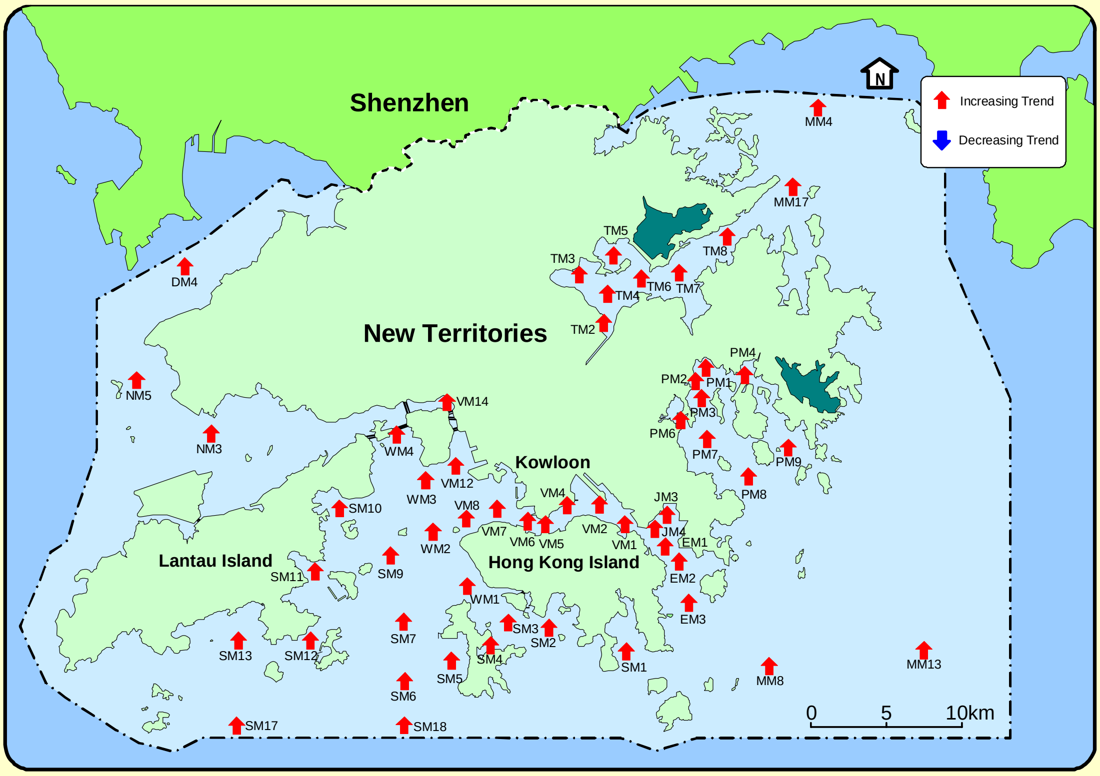


Figure 9.13 Long-term changes in pH in marine waters of Hong Kong, 1986 - 2004