Appendix 3.13
Details of Odour Survey

APPENDIX 3.13 DETAILS OF ODOUR SURVEY

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1. OBJECTIVE OF THE ODOUR SURVEY

1.1 In accordance with Section 3.4.5.3 (iii)(b) of EIA Study Brief ESB-153/2006 for the Project "Wan Chai Development Phase II and Central-Wan Bypass", the potential operational stage emission sources shall take into account the potential odour sources identified within the Project area and in the vicinity of and traversing the Project in particular for air sensitive uses which are proposed close to these sources.

1.2 Referring to Section 3.4.5.3 (v)(d) of the EIA Study Brief, the assumptions used for determining the reasonable worst case scenario in the odour impact assessment shall be clearly specified and justified. Assessment on the odour generation mechanism with a view to reasonably determined the existing and future emission strength of the odour sources shall also be included in the EIA report.

1.3 Referring to the scope of the works in the Project, there is no odour emission source to be proposed within the study area. Therefore, the assessment would be focused on the existing odour emission sources in the study area. In order to identify any existing potential odour impact, odour surveys including odour patrol and air sampling on potential odour source area for olfactometry analysis were carried out.

1.4 This appendix is to present the details of the odour surveys including procedures of odour patrol and sampling and olfactometry analysis. The survey results were also presented.

2. ODOUR PATROL (YEAR 2006)

Odour Patrol Procedure

2.1 Odour patrol means a simple judgment by observers patrolling and sniffing around to detect any odour at different hours. It is a screening process to identify the odour problems and the locations of odour sources in vicinity of the ex-PCWA and CBTS.

2.2 A two-day odour patrol exercise for the area in the vicinity of the CBTS and ex-PCWA was carried out on 11 and 14 September 2006 by two observers who are qualified odour panel members from the Odour Laboratory of the Hong Kong Polytechnic University (PolyU). These observers were free from any respiratory diseases and do not normally work at or live in the area in the vicinity of CBTS and any typhoon shelter.

2.3 Each patrol day consisted of two patrol exercises in two different time periods (morning and afternoon/evening). At least one of patrol exercises was conducted during the low tide period of the day so as to catch up the worst conditions of any odour emissions from the ex-PCWA and CBTS.

2.4 The two observers patrolled slowly along the route and used their olfactory senses to detect any odour. The odour patrol route was along the coastline of CBTS and ex-PCWA as shown in **Figure 1**.

2.5 During the odour patrol, the observers recorded the following findings.

- the prevailing weather condition
- the wind direction & temperature
- location where odour is spotted
- possible source of odour
- perceived intensity of the odour

- duration of odour
- characteristics of the odour detected (e.g. unpleasant smell such as sewage or rotten-egg smell, etc).

2.6 The relevant meteorological data (e.g. ambient temperature, wind speed and direction, etc.) from the Hong Kong Observatory Meteorological Station during the survey period were also recorded for reference.

2.7 The perceived intensity was divided into 5 levels which are ranked in order as follows:

0	Not detected	No odour perceived or an odour so weak that it cannot be easily characterised or described
1	Slight	Identifiable odour, slight
2	Moderate	Identifiable odour, moderate
3	Strong	Identifiable odour, strong
4	Extreme	Severe odour

2.8 In conjunction with the odour patrol, on-site H_2S measurement was conducted at the locations where odour was detected during the odour patrol. The purpose of the measurement was to provide initial idea about the strength of odour emission in terms of H_2S concentration.

2.9 The H_2S concentration was measured by a portable H_2S analyzer (Jerome 631-X H_2S analyzer) at the odorous locations identified by the odour patrol members. The analyser is able to measure H_2S concentration in the range of 1 ppb to 50 ppm, and the sensitivity of the analyzer is 0.003 ppm H_2S. The analyzer operates within a temperature range of 0 to 40°C, at an air flow rate of 0.15 L/min. Grab air sample is drawn by built-in suction pump of the analyzer and passed across a gold film sensor. The electrical resistance of the gold film changes according to the change in mass of hydrogen sulphide in the gas sample.

2.10 In order to ensure that the analyzer is functioning properly, manual sensor regeneration and zero adjustment was performed before each set of the measurement. Verification of the H_2S analyzer was conducted prior to each set of measurement, with a known concentration of gaseous H_2S of 0.25 ppm, generated by the functional test module. The analyzer would be used in the impact monitoring if the verified data exhibited error of not more than 20% (i.e. fall outside the calibration range between 0.2 and 0.3 ppm H_2S). Calibration of the analyzer and functional test module was checked against with a sophisticated NIST traceable calibration system every year at the laboratory of the manufacturer.

Odour Patrol Result (Year 2006)

2.11 The odour patrol was conducted on 11 and 14 September 2006. The two patrol exercises (morning and afternoon) on 11 September 2006 and morning patrol exercise on 14 September 2006 were conducted during the low tide of the day (less than 1m) to capture potential worst odour level of the day. The temperature on 11 and 14 September 2006 during odour patrol period was ranged from 26 – 28°C and 27 – 29°C. Along the patrol route, seven representative locations were identified for detection of odour intensity. The identified locations are indicated in **Figure 1**. The mean odour intensities of these locations and the associated odour characteristics are summarized in **Table 2.1**.

Table 2.1 Summary of Odour Patrol Result (Year 2006)

Site ID	Location	Odour Intensity Level#			Odour Character	Duration	On-site H_2S Conc. (ppb)	Possible Sources	WS (m/s)		WD @
		Min	Max	Mean					11/9/06	14/9/06	
1	CBTS near Victoria Park	0	0	0	n.d.	n.d.	3-5	n.d.	2.3(a.m.) 2.5(p.m.)	0(a.m.) 0.1(p.m.)	N/E-SE
1a	CBTS near Fire Station	0-1	0-1	0.5	Rotten organics + sea wind blow	Intermittent	5	Sea water and refuse near the bank		0.3(p.m.)	N/E-SE
2	CBTS near Victoria Park Road	0	0-1	0.06	Rotten organics + sea wind blow*	Intermittent	3-10	Sea water and refuse near the bank	2 (a.m.) 0.7(p.m.)	0.2(a.m.) 0.4(p.m.)	N/E-SE
2a	CBTS near Noonday Gun	0	1	0.25	Rotten organics + sea wind blow*	Intermittent	7-10	Sea water and refuse near the bank	0.9(p.m.)	0 (a.m.) 0.9(p.m.)	N/E-SE
3	CBTS near Police Officers' Club	0-1	2-3	1.44	Rotten organics/ decayed sediment + diesel smell	Persistent	7-15	Sea water and boats at CBTS	1.6(a.m.) 0.6(p.m.)	2.1(a.m.) 1.8(p.m.)	N/E-SE
4	CBTS near carpark of Police Officers Club	0-1	1	0.75	Rotten organics/ decayed sediment + diesel smell	Persistent/ intermittent	4-7	Sea water and boats at CBTS	0.4(a.m.) 0(p.m.)	1.7(a.m.) 0.7(p.m.)	N/E-SE
5	Ex-PCWA , GFS Temporary Helipad	0	0	0	n.d.	n.d.	3-6	n.d.	2(a.m.) 1.2(p.m.)	1.3(a.m.) 2.7(p.m.)	N/E-SE

Note: # - summary for odour patrol results on 11 & 14 September 2006; n.d.- Not detected; * only detected on 11 September 2006; WD@ - Wind direction on 11 Sept 06 / Data on 14 Sept 06; WS – Wind speed.

2.12 The results indicated that negligible odour was detected at the shoreline of the ex-PCWA area and the CBTS except the area near Police Officers' Club (POC), CBTS near Noonday Gun (Site 2a) and CBTS near Victory Park Road (Site 2). As identified by odour patrol members, the smell detected at the identified odour location was dominantly from rotten organics/decay sediment at CBTS. The maximum measured H_2S concentration was found at Location 3, around 7 – 15 ppb on site, while a range of 3 – 10 ppb was measured at other locations during the odour patrol.

3. AIR SAMPLING AND OLFACTOMETRY ANALYSIS (YEAR 2006)

Air Sampling Procedure

3.1 Based on the findings of the odour patrols, potential odour sources locations were identified. In order to determine the odour concentration of the emission sources and the ambient air in the vicinity of emission sources, air samples were collected for olfactometry analysis.

3.2 A follow-up air sampling exercise for potential odour source locations identified in the odour patrol and representative locations along the CBTS and the ex-PCWA was conducted on 15 September 2006. The sampling period was at the low tide period of the day. The sampling

exercise was carried out in sunny day and the recorded temperature during sampling was 25 – 29 °C.

3.3 For each sampling location, one air sample above water surface in the vicinity of shoreline and one ambient sample on land-based were collected. The locations of the sampling locations are shown in **Figure 1**.

3.4 The requirements and procedures of the sampling are described below:

(a) All air sampling should be based on "hood" methods [1], whereby a flux hood type apparatus is placed on the emission surface of selected locations, and air is blown through it. The emission rate is then given by airflow through the hood and the odour concentration of the exit air.

(b) Flux hood systems, Tedlar bags and airtight plastic containers should be used for surface sampling of odorous gas. The plastic container should be pre-treated and then evacuated before sampling.

(c) During collection of the samples of odorous gas, the wind speed, temperature and humidity should be recorded during measurement.

(d) For the sources which are not area sources or "hood" method cannot be applied, the air samples should be collected via a sampling tube in connection with an odour sampling system (i.e. air pumps and Tedlar bags). The empty sample bag should be placed in a rigid plastic container and the container is then evacuated at a controlled rate and the bag is filled.

(e) The odour sample should not be contaminated, lost or altered during storage. The odour bags should be:

- Odour-free, i.e. they should not add odours to the sample;
- Of a material which does not absorb or react with odorous samples;
- Sufficiently impervious to prevent any significant loss of odour components;
- Reasonably robust;
- Leak-free;
- Equipped with leak-free fittings, compatible with olfactometer and other sampling equipment; and
- Of sufficient capacity to enable a full test series to be completed.

(f) The temperature should be kept above dew point of the samples to avoid condensation. Exposure of samples to direct sunlight should be avoided to minimize photochemical reactions.

(g) At least 60L of foul gas should be collected for each sample. The collected air samples should be delivered to a qualified laboratory for olfactometry analysis within 24 hours.

3.5 The collected samples were sent to the Odour Laboratory of the Hong Kong Polytechnic University for olfactometry analysis within 24 hours.

[1] Sampling for Measurement of Odours, P.Gostelow, P. Longhurst, S.A. Parsons and R.Mstuetz, 2003.

Olfactometry Analysis Procedure

3.6 The odour concentration of the samples were determined by a forced-choice dynamic olfactometer with a panel of human assessors being the sensor in accordance with the European Standard Method (EN13725).

3.7 The odour laboratory should be ventilated to maintain an odour-free environment and to provide fresh air to the panel members. Each odour testing session comprise at least six qualified panellists. All the panellists should be screened beforehand by using a 50 ppm solution/mixture of certified n-butanol standard gas. The most sensitive and least sensitive individuals would be eliminated.

Olfactometry Analysis Results (Year 2006)

3.8 Analytical results of odour concentrations are summarized in **Table 3.1**. Results showed that the odour concentrations of ambient air at representative five locations were in the range of 19 – 42 ou/m^3. The odour was detected at the Locations 2, 3 and 4 from weak to moderate levels.

3.9 According to odour patrol result, the possible sources at Location 3 (area in the vicinity of POC) were possibly due to the decayed sediment. There is no doubt that the water circulation is poor at these locations as the tidal flows are inhibited by the typhoon shelter breakwater and limited flushing effect would be expected at the corner of CBTS. As a result, sediment has accumulated and rotten egg smell was detected from the breakdown of organic matter in the sediment. The other possible odour source was discharge from outfall. There are two outfalls, Outfall P and Q, located at and near the corner of CBTS.

3.10 A dynamic flux hood was employed in the sampling work t collect odour samples from ether water surfaces , in which an odour-free gas from a nitrogen gas cylinder was supplied to generate an air flow at 20L/min inside the flux hood. The specific odour emission rate (SOER) at each area source was calculated by the following equation:

$$\text{SOER (ou/m}^2\text{.s)} = \frac{\text{Odour concentration(ou/m}^3\text{) x Air flow rate inside hood (m}^3\text{/s)}}{\text{Covered water surface area (m}^2\text{)}}$$

$$= \text{OC x } (0.02/60)/(0.2\text{x}0.2\text{x}3.14) = \text{OC x } 0.00265$$

Table 3.1 Results of Olfactometry Analysis (Year 2006)

Sample ID	Source	Odour Concentrations (ou/m^3)	Odour Emission Rate (ou/m^2/s)
1-A	Ambient Source (land based)	19	-
1-E	Water Surface	61	0.16
2-A	Ambient Source (land based)	32	-
2-E	Water Surface	82	0.22
3-A	Ambient Source (land based)	42	-
3-E	Water Surface	143	0.38
4-A	Ambient Source (land based)	37	-
4-E	Water Surface	134	0.36
5-A	Ambient Source (land based)	20	-
5-E	Water Surface	75	0.20

4. ADDITIONAL ODOUR SURVEY (YEAR 2007)

4.1 Additional odour survey is required as (i) The results of odour survey in September 2006 indicate the potential odour source locations at the shoreline of CBTS but cannot

demonstrate any odour problems at the centre of CBTS and breakwater locations; (ii) it is to prevent the uncertainties in the spatial distribution of emission.

Additional Odour Patrol

4.2 Further to odour patrol along the CBTS and ex-PCWA, a one-day odour patrol exercise was carried out for the whole area of CBTS (water surface), ex-PCWA (along coastline and water surface), Northern Breakwater and Eastern Breakwater as indicated in **Figure 1a**. The patrol day consisted of two patrol exercises in two different time periods (i.e. daytime and evening time/night time). One of the patrol exercises was undertaken during low tide condition with reference to the tidal chart of Hong Kong Observatory. The weather of the odour patrol was sunny and the temperature was ranged from around 30 - 33°C. Carbon filter masks were used by the observers to refresh their noses during the odour patrol. The observers followed the odour patrol procedures mentioned in Section 2.5 – 2.10.

Odour Patrol Result (Year 2007)

4.3 The odour patrol including two patrol exercises (morning/noon and afternoon/evening) was conducted on 10 July 2007. The patrol exercise in the morning session was conducted during the low tide of the day (less than 1m) to capture potential worst odour level of the day. Along the patrol route, several locations were identified for detection of odour intensity. The identified locations are indicated in **Figure 1b**. The mean odour intensities of these locations and the associated odour characteristics are summarized in **Table 4.1** and **Table 4.2**.

Table 4.1 Summary of Odour Patrol Result in Morning/Noon Session (Year 2007)

Location	Time	Odour Intensity Level			Odour Nature	On-site H_2S Conc. (ppb)	Possible Sources	Duration	WS (m/s)	WD
		Oi-1	Oi-2	Mean						
P1	10:36	2	2	2	Oily & decayed waste	5 – 9	Floating debris, sediment	Persistent	0.7	SW
P2	10:40	2	2	2	Oily & decayed waste	5 – 11	Floating debris, sediment	Persistent	0.1	SW
P3	10:45	1	1	1	Oily & decayed waste	4 – 6	Floating debris, sediment	Persistent	2.0	SW
P4	10:47	1	1	1	Oily & decayed waste	2 – 4	Floating debris, sediment	Intermittent	1.2	SW
P5	10:51	0	0	0	-	0 – 1	-	-	1.7	SW
P6	10:55	0	0	0	-	1	-	-	1.1	SW
P7	11:02	0	0	0	-	1	-	-	2.6	SW
P8	11:06	0	0	0	-	1 – 2	-	-	2.7	SW
P9	11:08	0	0	0	-	1	-	-	3.7	SW
P10	11:10	0	0	0	-	1	-	-	0.4	SW
P11	11:13	0	0	0	-	0 - 2	-	-	0.5	SW
P12	11:15	1	1	1	Sewage + rotten-egg	2 - 27	Outfall + air bubbles from sediment	Persistent	2.7	SW
P13	11:19	2	3	2.5	Sewage + rotten-egg	14 – 37	Outfall + air bubbles from sediment	Persistent	1.6	SW
P14	11:22	3	3	3	Rotten-egg	10 - 57	Air bubbles from sediment	Persistent	2.0	SW

Location	Time	Odour Intensity Level			Odour Nature	On-site H_2S Conc. (ppb)	Possible Sources	Duration	WS (m/s)	WD
		Oi-1	Oi-2	Mean						
P15	11:25	1	1	1	Oily and decayed wastes	4 – 12	Floating debris	Intermittent	0.6	SW
P16	11:29	0	0	0	-	2 – 3	-	-	1.0	SW
P17	11:32	0	0	0	-	2 – 3	-	-	1.2	SW
P18	11:37	0	0	0	-	1 – 2	-	-	5.0	SW
P19	11:40	0	0	0	-	0 – 1	-	-	3.0	SW
P20	11:43	0	0	0	-	0 – 1	-	-	4.5	SW
P21	11:46	0	0	0	-	1 – 2	-	-	3.9	SW
P22	11:49	0	0	0	-	1 – 3	-	-	4.0	SW
P23	11:56	0	0	0	-	2 – 7	-	-	0.0	SW
P24	11:56	0	0	0	-	2 – 5	-	-	0.5	SW
P25	12:03	2	1	1.5	Rotten-egg	5 – 27	Air bubbles from nearby area.	Intermittent	0.4	SW
P26	12:19	0	0	0	-	0 – 2	-	-	1.5	SW
P27	12:22	0	0	0	-	1	-	-	0.6	SW
P28	12:24	0	0	0	-	1 – 2	-	-	0.9	SW
P29	12:29	0	0	0	-	0 – 1	-	-	0.3	SW
P30	12:31	1	1	1	Rotten-egg	0 – 1	Air bubbles from nearby area	Intermittent	1.1	SW
P31	12:35	2	2	2	Sewage + rotten-egg	2 – 13	Outfall + air bubbles from sediment	Persistent	3.0	SW
P32	12:38	0	0	0	-	1 – 2	-	-	2.5	SW
P33	12:45	0	0	0	-	2 – 3	-	-	0.0	SW
P34	12:47	0	0	0	-	1 – 6	-	-	0.7	SW
P35	12:52	1	1	1	Decayed wastes	9 – 10	Floating debris	Intermittent	0.5	SW
P36	12:55	0	0	0	-	2	-	-	2.8	SW

Note: - Not detected; WS – wind speed; WD – wind direction

Table 4.2 Summary of Odour Patrol Result in Afternoon/Evening Session (Year 2007)

Location	Time	Odour Intensity Level			Odour Nature	On-site H_2S Conc. (ppb)	Possible Sources	Duration	WS (m/s)	WD
		Oi-1	Oi-2	Mean						
P1	17:11	2	2	2	Oily & decayed waste	3 – 4	Floating debris, sediment	Persistent	0.1	SW
P2	17:14	2	2	2	Oily & decayed waste	4 - 6	Floating debris, sediment	Persistent	2.3	SW
P3	17:17	1	1	1	Oily & decayed waste	2 – 3	Floating debris, sediment	Persistent	0.7	SW
P4	17:20	1	1	1	Oily & decayed waste	2 – 3	Floating debris, sediment	Intermittent	1.0	SW
P5	17:24	0	0	0	-	2 – 3		-	0.2	SW
P6	17:27	0	0	0	-	2	-	-	0.5	SW
P7	17:30	0	0	0	-	2	-	-	2.3	SW
P8	17:33	0	0	0	-	2	-	-	0.7	SW
P9	17:36	0	0	0	-	2	-	-	1.9	SW
P10	17:39	1	1	1	Rotten-egg	0 – 1	Air bubbles were noted from nearby area	Intermittent	2.2	SW
P11	17:42	3	2	2.5	Rotten-egg	7 - 11	Air bubbles from sediment	Persistent	1.1	SW
P12	17:45	3	3	3	Sewage + rotten-egg	11 – 44	Outfall + air bubbles from sediment	Persistent	0.8	SW
P13	17:48	2	2	2	Sewage + rotten-egg	42 – 70	Outfall + air bubbles from sediment	Persistent	3.0	SW

Location	Time	Odour Intensity Level			Odour Nature	On-site H_2S Conc. (ppb)	Possible Sources	Duration	WS (m/s)	WD
		Oi-1	Oi-2	Mean						
P14	17:52	2	2	2	Oily and decayed wastes	41 – 81	Floating debris	-	0.2	SW
P15	17:55	0	0	0	-	2 – 3	-	-	2.1	SW
P16	17:58	0	0	0	-	2	-	-	3.2	SW
P17	18:01	0	0	0	-	1 – 2	-	-	1.5	SW
P18	18:05	0	0	0	-	0 – 1	-	-	3.1	SW
P19	18:09	0	0	0	-	0 – 1	-	-	0.0	SW
P20	18:13	0	0	0	-	1 – 2	-	-	1.4	SW
P21	18:17	0	0	0	-	1 – 2	-	-	1.2	SW
P22	18:22	0	0	0	-	1 – 3	-	-	0.0	SW
P23	18:28	1	1	1	Oily and decayed wastes	2 – 4	Floating debris	Intermittent	0.2	SW
P24	18:33	0	0	0	-	1 – 2	-	-	0.2	SW
P25	18:39	0	0	0	-	2 – 5	-	-	0.0	SW
P26	18:54	0	0	0	-	1 - 2	-	-	1.6	SW
P27	18:58	0	0	0	-	2 – 5	-	-	0.1	SW
P28	19:02	0	0	0	-	2 – 4	-	-	2.0	SW
P29	19:08	0	0	0	-	1	-	-	0.7	SW
P30	19:11	0	0	0	-	0 – 1	-	-	1.1	SW
P31	19:16	1	1	1	Sewage + rotten-egg	5 – 13	Outfall + air bubbles from nearby area	Intermittent	0.1	SW
P32	19:28	0	0	0	-	3 – 4	-	-	0.2	SW
P33	19:36	0	0	0	-	2 – 4	-	-	1.3	SW
P34	19:42	0	0	0	-	1 – 4	-	-	1.4	SW
P35	19:36	0	0	0		1 – 2	-	-	1.2	SW
P36	19:42	0	0	0	-	2 – 6	-	-	0.5	SW

Note: - Not detected; WS – wind speed; WD – wind direction

4.4 The results indicated that no odour was detected at the eastern and northern breakwater locations and its nearby area, the areas in the vicinity of Outfall R and S, water surface of the ex-PCWA area and the CBTS except the area near Police Officers' Club (POC), and CBTS near Victory Park Road (i.e. the area in the vicinity of Outfall Q). Moderate to strong odour impact (odour intensity = 2 – 3) was detected at a few locations including P1 – P2, P11 – P14, and P31. As identified by odour patrol members, the smell detected at the identified odour locations were dominantly from rotten organics/decay sediment at CBTS, outfall discharge and floating debris.

Additional Air Sampling & Olfactometry Analysis

4.5 Based on the findings of the odour patrols, the odour level intensity recorded at some locations within CBTS was equal to or higher than Level 1 which is classified as identifiable odour. However, it was found that the duration of the odour detected was in a snap time (less than 1 minute). These locations are unlikely to be odour sources as the duration of odour should at least be persistent in 2 – 3 minutes. The intermittent odour was most likely due to wind dispersion from nearby odour source areas. Hence, the potential odour sources locations should fulfill the following both criteria:

(i) Mean odour level intensity equal to or higher than 1 during patrol exercise; and
(ii) The duration of odour was persistent during patrol

4.6 Follow up odour sampling exercise was conducted on 28 July 2007 at the potential odour source locations identified in the additional odour patrol as shown in **Figure 2**. For each sampling location, one air sample above water surface was collected. Headspaces sampling at Outfall P and Q were also be conducted and one air sample was collected for each outfall. The locations of the outfall and tentative sampling locations are shown in **Figure 2** and **3**.

The sampling exercise was conducted at the low tide condition of the day (noon/afternoon, from 13:00-15:00). The temperature during sampling period was ranged from 31 - 34°C. The sampling and olfactometry analysis procedures followed Section 3.4 – 3.7.

Olfactometry Analysis Results (Year 2007)

4.7 Analytical results of odour concentrations are summarized in **Table 4.3**. According to olfactometry results, very high concentrations were detected at the area in the vicinity of outfall Q (Sample ID 8 – 11). Referring to site observation record, high odour intensity was detected near the outfall Q and sewage discharge from the outfall was noted. The other possible sources contributing to high odour concentrations at these areas would be decayed sediment as gas bubble was observed at these areas during sampling. Very high odour concentration was also recorded at the corner of CBTS (Sample ID 1) due to sediment and sewage.

4.8 A dynamic flux hood was employed in the sampling work t collect odour samples from ether water surfaces, in which an odour-free gas from a nitrogen gas cylinder was supplied to generate an air flow at 20L/min inside the flux hood. The specific odour emission rate (SOER) at each area source was calculated by the equation shown in Section 3.10.

Table 4.3 Results of Olfactometry Analysis (Year 2007)

Sample ID	Odour Nature	Possible Source	In-situ H_2S (ppb)	Odour Concentrations (ou/m^3)	Odour Emission Rate ($ou/m^2/s$)
1	Oily & decayed wastes + rotten-egg	Floating debris + sediment + sewage	120 – 130	5792	15.32
2	Oily & decayed wastes + rotten-egg	Floating debris + sediment + sewage	5 – 6	164	0.43
3	Oily & decayed wastes + rotten-egg	Floating debris + sediment + sewage	11 – 12	889	2.35
4	Oily & decayed wastes + rotten-egg	Floating debris + sediment + sewage	3 – 4	484	1.28
5	Oily & decayed wastes + rotten-egg	Floating debris + sediment + sewage	3 – 4	469	1.24
8	Septic sewage + rotten-egg	Outfall + sediment with gas bubbling	2400	30,530	80.77
9	Septic sewage + rotten-egg	Outfall + sediment with gas bubbling	15	670	1.77
10	Septic sewage + rotten-egg	Outfall + sediment with gas bubbling	370 – 380	6208	16.42
11	Septic sewage + rotten-egg	Outfall + sediment with gas bubbling	12 - 13	433	1.15

4.9 The odour concentrations and H_2S concentrations of air samples in headspaces of outfall P (Sample ID 6) and Q (Sample ID 7) were 884 ou/m^3 and 71320 ou/m^3, and 24 – 25 ppb and 5300 – 5600 ppb, respectively.

5. SUMMARY OF ODOUR SURVEY FINDING

5.1 According to the results from odour surveys, the water area at the corner of CBTS and the area in the vicinity of the POC were identified as potential odour source emission area and the odour emissions were possibly due to the rotten organics/decayed sediment and polluted discharges from drainage outfall. The floating refuses at CBTS were also identified as one of odour problem in the odour patrol. Another potential location was the area in the vicinity of Outfall Q and its dominant odour sources were the sewage discharges from Outfall Q and air bubbles from seabed sediments. The slime attached at the seawall at the corner of CBTS was also considered to have contribution to the odour problems at affected area of CBTS.

5.2 Referring to the findings of odour surveys, the following four odour sources are considered to be existing odour emission sources found at CBTS.

(a) Sediment at CBTS

(b) Slime attached on the shoreline seawall

(c) Polluted discharge/sewage from drainage outfall

(d) Floating debris

5.3 Comparing the results of the two odour surveys, higher odour emission rates were obtained in the 2007 odour survey. This might be due to the fact that the sampling day in 2007 was very hot and the sampling exercise was conducted at the lowest tide (below 0.5mPD) and during period with very high temperature (31 – 33 degrees Celsius). Discharges from Outfall Q with sewage-like smell were noted during the entire odour sampling period. The odour emission rates derived from the 2007 odour survey were considered as reasonable worst case emission rates and were therefore adopted in the assessment for the prediction of the worst odour concentrations at the representative ASRs. However, the odour emission rate derived from Sample ID 8 (Year 2007) was unreasonably high (80.77 ou/m^2/s). The emission rates derived from other air samples collected in the vicinity of outfall Q such as Sample ID 9 (the closest point to the outfall Q) and Sample ID10 were significantly lower. These two air sample locations were also close to Sample ID8. In accordance with the past experience in other odour projects, the odour emission rates for sewage and sludge related sources were not higher than 40 ou/m^2/s. It was therefore suspected that the air sample of Sample ID8 might be contaminated in the laboratory analysis. The result for this sample was therefore discarded and the emission rate used in the modelling was based on the second highest odour emission rate (i.e. 16.42 ou/m^2/s) derived from Sample ID10 which was also close to Sample ID8.

5.4 The odour concentrations of air samples collected inside the headspaces of outfall P and Q were 884 ou/m^3 and 71320 ou/m^3, respectively. The results indicated that high odour concentrations were detected in the headspace of outfall Q. Under the worst case condition as identified by the odour surveys during low tide, the rate of change in tide level is very slow and hence the rate of displacement of the headspace air volume from the outfalls to the atmosphere, if any, would also be very low. Therefore, no air displacement from the headspace of the outfalls was considered in the odour modelling. During other tidal conditions, the rate of displacement of the headspace air volume from the outfalls to the atmosphere might be higher, yet the odour emissions from other potential odour source locations would be significantly less and are therefore not considered as worst case conditions.

5.5 Based on the findings of the odour surveys, the locations of potential odour source areas considered in the odour modelling for the worst case scenario are shown in Appendix 3.14. Besides, with reference to the results of the odour surveys carried out in 2006 and 2007, it is

noted that the odour emission rates of the identified odour source areas would be lower under lower ambient temperature. The recorded ambient temperature during the sampling period in 2006 and 2007 was in the range of 25-29°C and 31-34°C respectively. The estimated odour emission rates based on the 2006 odour survey results are significantly lower than those derived based on the 2007 odour survey results. The highest odour emission rate derived from the 2006 odour survey results is 0.38 ou/m^2/s whereas the highest odour emission rate derived from the 2007 odour survey results is 16.42 ou/m^2/s. For the purpose of this assessment to produce reasonable prediction under different ambient temperature, the odour emission rates during periods with ambient temperature equal to or greater than 30°C were derived from the 2007 odour survey results, whereas the odour emission rates during periods with ambient temperature less than 30°C were taken as the highest odour emission rate derived from the 2006 odour survey results, ie. 0.38 ou/m^2/s. The emission factors of the existing source areas under different temperature ranges are summarized in **Table 4.4**.

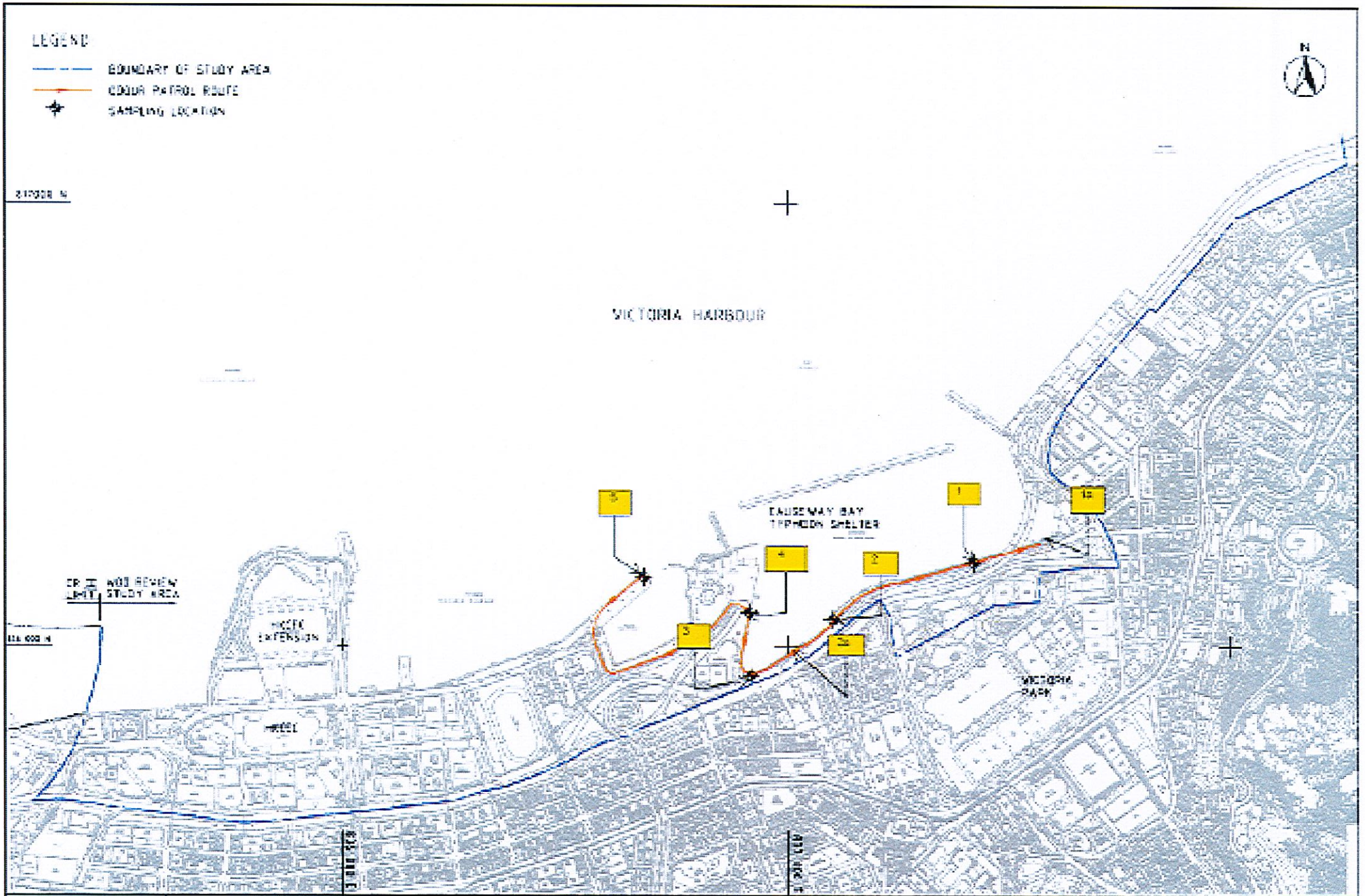
5.6 The odour emission rates to be adopted in the future scenarios for odour modelling under the worst case condition are summarized in **Table 4.5**.

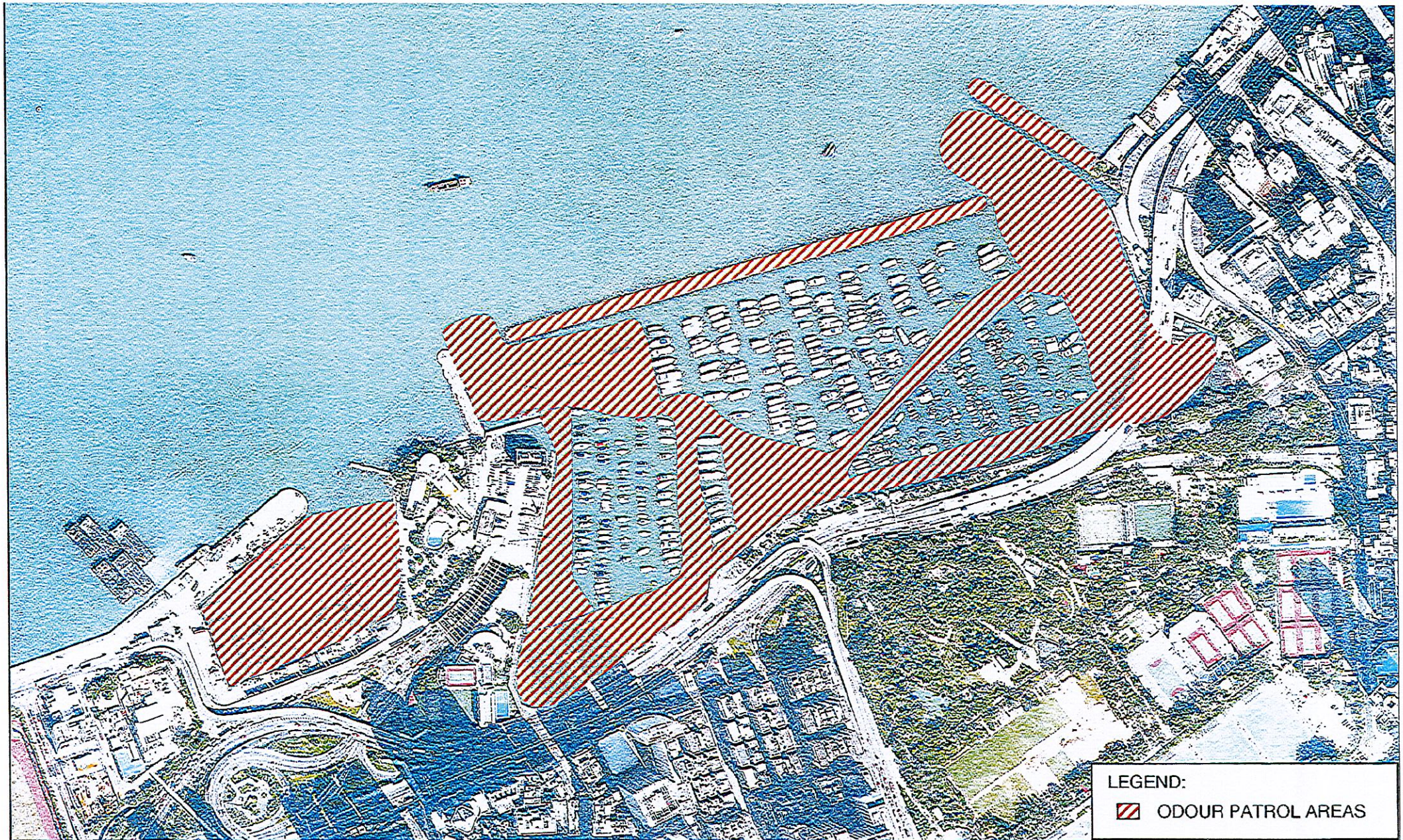
Table 4.4 Existing Odour Emission Inventory for the Worst Case Scenario

Sample ID	Odour Emission Rate (ou/m^2/s)	
	(for ambient temperature <30 °C)	(for ambient temperature >= 30 °C)
1	0.38	15.32
2	0.38	0.43
3	0.38	2.35
4	0.38	1.28
5	0.38	1.24
8	0.38	16.42
9	0.38	1.77
10	0.38	16.42
11	0.38	1.15

Table 4.5 Future Odour Inventory for the Worst Case Scenario

Sample ID	Odour Emission Rate (ou/m^2/s) (70% odour reduction)	
	(for ambient temperature <30 °C)	(for ambient temperature >= 30 °C)
1	0.114	4.596
2	0.114	0.129
3	0.114	0.705
4	0.114	0.384
5	0.114	0.372
8	0.114	4.926
9	0.114	0.531
10	0.114	4.926
11	0.114	0.345


LEGEND
BOUNDARY OF STUDY AREA
ODOUR PATROL ROUTE
SAMPLING LOCATION
N
VICTORIA HARBOUR
CAUSEWAY BAY
TYPHOON SHELTER
WAN CHAI DEVELOPMENT PHASE II - PLANNING AND ENGINEERING REVIEW
PROPOSED ODOUR PATROL ROUTE AND SAMPLING LOCATIONS
FIGURE 1



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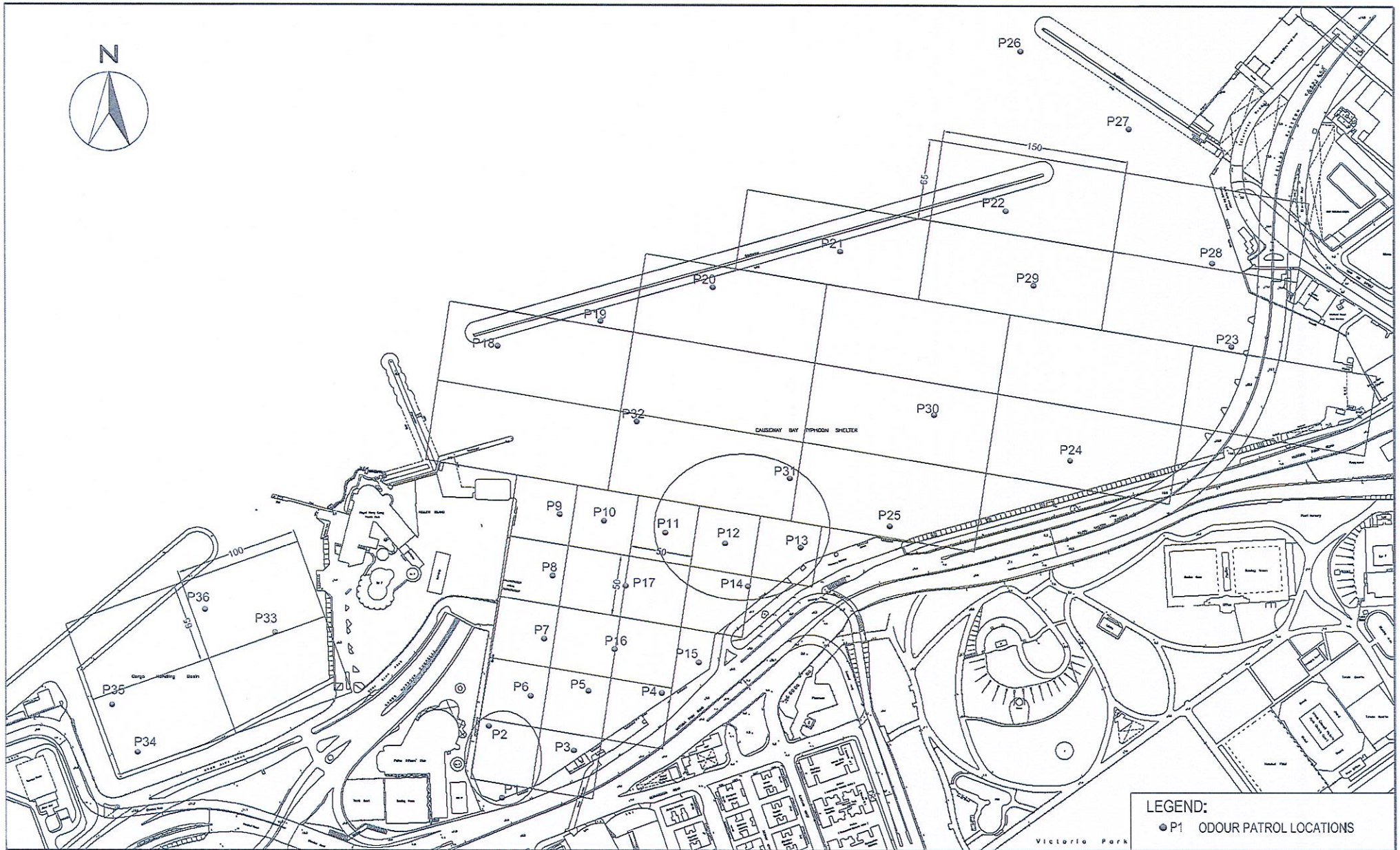
PROPOSED ODOUR PATROL AREAS

FIGURE 1a

P:/60017193/REPORTS\AIR\ODOUR\ADDITIONAL SPEC\FIG1a.xls

SCALE N.T.S.



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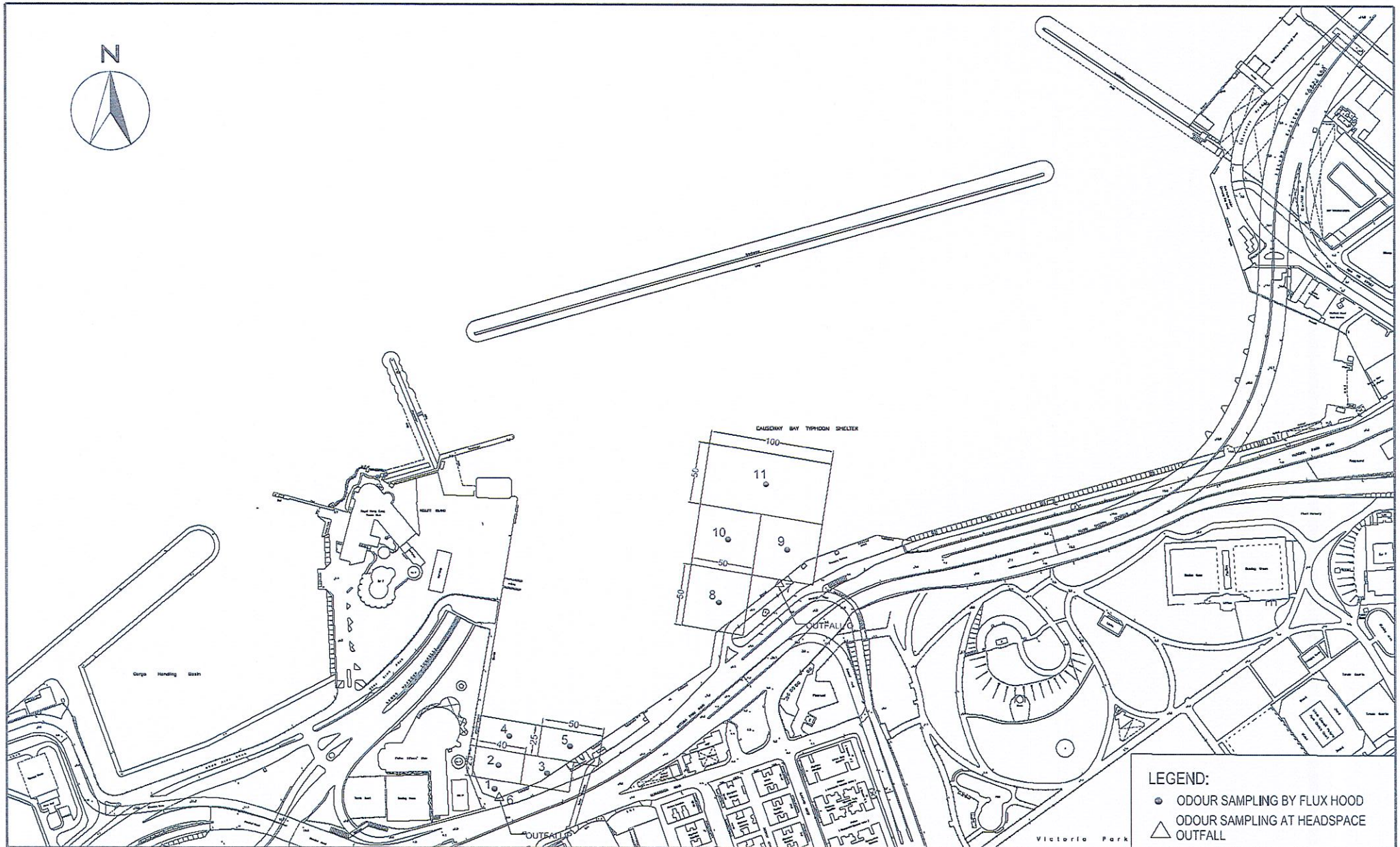
ODOUR PATROL LOCATIONS

FIGURE 1b

P:/60017193/REPORTS\AIR\ODOUR\ODOUR PATROL\FIG1b.DWG SCALE 1:4000 (A4)



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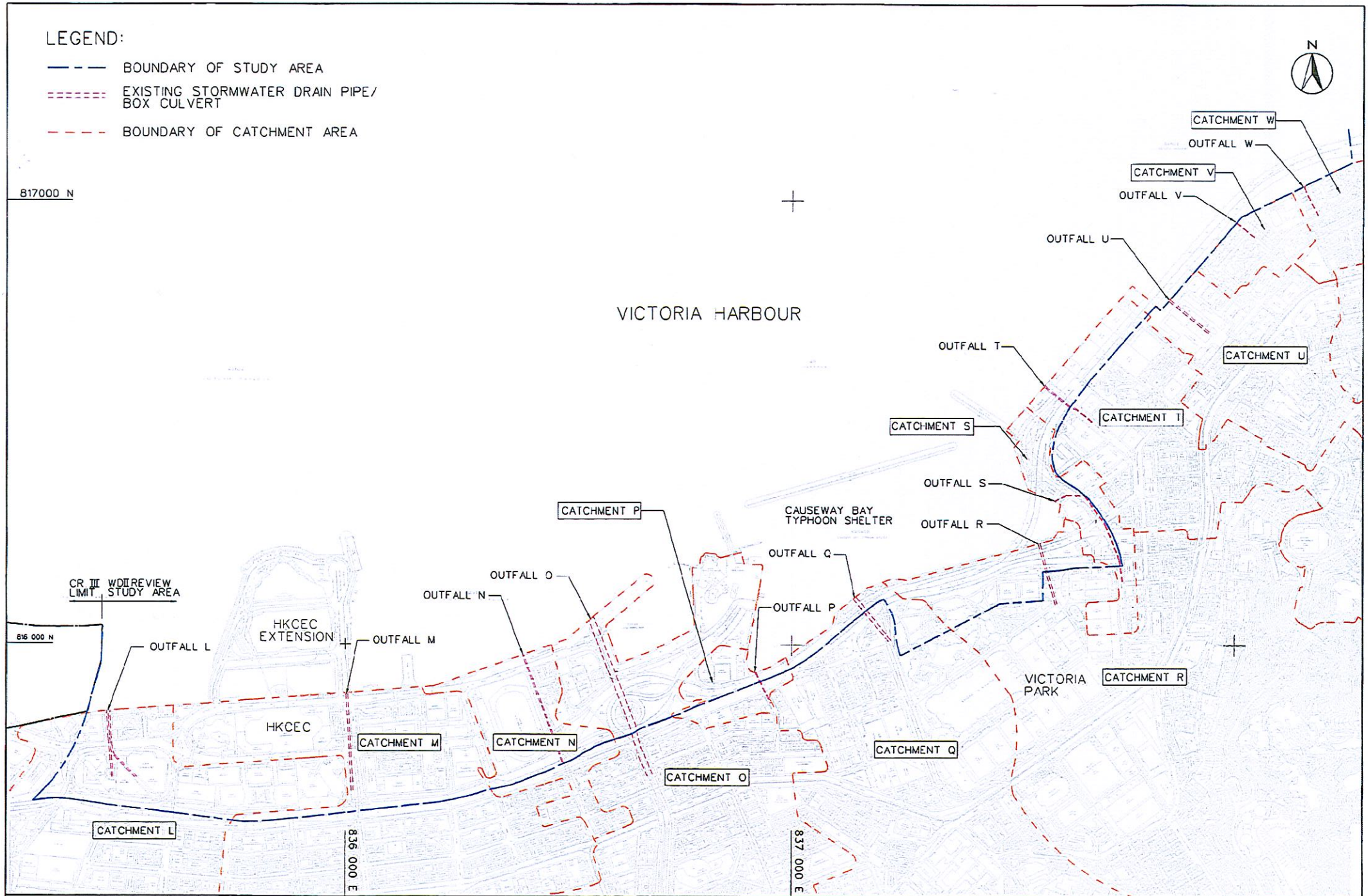
ODOUR SAMPLING LOCATIONS

FIGURE 2

P:/60017193/REPORTS\AIR\ODOUR\ODOUR SAMPLINGS\FIG2.DWG SCALE 1:4000 (A4)



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LOCATIONS OF EXISTING STORM OUTFALLS

FIGURE 3