5 ENVIRONMENTAL MONITORING PROGRAMME DURING THE OPERATION PHASE

Water quality and odour monitoring are required prior to and during the initial operation of the Stage III Extension. The purpose of the monitoring exercise is ensure that the recommended mitigation measures are effective and that no residual impacts that occur after the commissioning of the Project.

5.1 WATER QUALITY

The treated sewage from the existing and the Stage III Extension of the Sha Tin STW will continue to be discharged into Victoria Harbour via the THEES and therefore shall be subject to a comprehensive performance verification programme to confirm the predictions made in this report. The performance verification programme will comprise one year baseline monitoring in both wet and dry seasons before commissioning and one year operational monitoring in both dry and wet seasons following commissioning of Stage III Extension of the Sha Tin STW. The need of the baseline monitoring would depend on the prevailing environmental conditions at the time before commissioning of Stage III Extension. This programme will follow similar requirements of Agreement No. CE 1/98 with elements such as monitoring of effluent quality, effluent dispersion plume, marine water quality, etc as bounded by the EIA report. Details of the programme will be subject to EPD's endorsement.

At the Sha Tin STW, effluent quality monitoring is already required by the discharge licence conditions under the *Water Pollution Control Ordinance* and is independent of the EM&A programme for this Project This monitoring shall be continued to be carried out by the DSD to show compliance with the effluent discharge licence conditions.

5.2 ODOUR MONITORING AND COMPLAINT REGISTRATION PROGRAMME

5.2.1 *Introduction*

In this section, the requirements, methodology, equipment, monitoring locations, criteria and protocols for the odour monitoring and a complaints registration programme prior to and during the operation of the Stage III Extension are presented. The purpose of the odour monitoring and complaints registration programme is to ensure that there is no residual odour nuisance from the operation of the Stage III Extension, or cumulatively from the entire Sha Tin STW after the implementation of the mitigation measures proposed in the *EIA Report*.

5.2.2 *Overall Methodology*

According to *Annex 4* of the EIAO TM, an odour concentration as a result of odour emissions of 5 OU m^{-3} or above based on an averaging time of 5 seconds at an Air Sensitive Receiver (ASR) is considered an odour nuisance.

In order to demonstrate compliance with the odour nuisance criterion of 5 OU m^{-3} as a 5 second mean, it would be necessary to measure odours

continuously throughout the year at all of the ASRs. This is not feasible, because the measurement of the odour concentration in an air sample is carried out by collecting a sample of air and then transporting it to a laboratory for measurement by an odour panel. Furthermore, samples of air collected at ASRs would contain odours from many sources, not just the Sha Tin STW. Thus odour concentrations measured at ASRs could not be attributed directly to the STW emissions.

Since the principal objective of the odour EM&A programme is to assess whether the ASRs experience odour nuisance as a result of emissions from the Sha Tin STW and its Stage III Extension, a more meaningful approach is the establishment of a project-specific odour complaints register, which should be undertaken by DSD starting one year prior to the commencement of the operation of the Project and continue throughout the life of the STW. In addition, the complaints register shall be backed-up by the following:

- a programme to monitor odour concentrations by olfactometry and hydrogen sulphide (H_2S) measurements at sources;
- odour measurement at identified ASRs near the Sha Tin STW.

Odour Complaint Registration

In the event that an odour complaint is received at the Sha Tin STW, the complainant shall be requested to complete an Odour Complaint Registration Form which shall contain, but will not be limited to the following information:

- location of where the odour nuisance occurred, including whether the odour was experienced indoors or outdoors;
- date and time of the complaint and the nuisance event;
- description of the complaint, i.e. the type and characteristics of the odour; and an indication of the odour strength (highly offensive / offensive / slightly offensive / just continuously detectable / intermittently detectable);
- name and contact information of the complainant.

This information shall be obtained by the plant engineer or his representative(s) of the Sha Tin STW when the complaint is received. A sample of the Odour Complaint Registration Form is shown in *Annex A* for reference.

In addition, the following information shall be obtained from the nearest meterological monitoring station (i.e. at the Sha Tin Race Course) and at the Sha Tin STW.

- meteorological conditions (including temperature, wind speed, relative humidity) at the time of the complaint;
- whether any abnormal operations were being carried out at the STW at the time the nuisance occurred.

The Odour Complaint Register shall be kept at the Sha Tin STW.

Odour Monitoring at Sources and at ASRs

Hydrogen sulphide is one of the main components of STW odour emissions. Other components of odorous emissions from sewage treatment works include ammonia, mercaptans, skatoles and indoles. Although H_2S is only one of the odorous compounds in STW emissions, ambient H_2S concentrations can be readily monitored at ASRs and so can serve as a surrogate indicator for STW odours in addition to odour measurement using olfactometry techniques.

Prior the commissioning of the Stage III Extension, odour sampling at sources and at the selected ASRs (as detailed below) shall be conducted simultaneously to establish the averaged baseline H_2S concentrations conditions at each measurement position at source and at ASRs, and to establish the correlation between odour concentration (OUm^{-3}) and H_2S concentrations. These baseline H_2S concentrations are used to establish the action levels to gauge the operating conditions of the STW. The correlation is used to check whether the mitigation measures adopted for Stage III Extension can reduce the odour concentration to meet the odour criteria.

During the commissioning of the Stage III Extension, only measurements of H_2S concentrations at source and at the selected ASRs simultaneously are required. This is to indicate whether the odour concentrations are higher or lower than the baseline condition, and within the odour criteria.

5.2.3 *Monitoring Parameters*

15-min H_2S concentration (in parts per billion or in parts per million) should be measured at sources and at ASRs using the equipment described in *Section 5.2.4*. Meteorological conditions including temperature, wind speed, wind direction and relative humidity should also be measured at the time of the monitoring.

Air samples should also be collected for a period of 15-min at the selected location in order to provide sufficient volume for olfactometric analysis. Odour concentrations should be expressed as OUm^{-3}.

5.2.4 *Monitoring Equipment*

Hydrogen Sulphide Monitoring

Concentrations of H_2S should be recorded using a Jerome H_2S Analyser which utilises a gold film sensor for the detection of hydrogen sulfide. The instrument is controlled by microprocessor, ensuring rapid accurate analysis, and shall be fitted with the following accessories:

- data logger (to allow the instrument to operate unattended);
- interface cable and interface software;
- data download and graphics service.

The instrument is capable of measuring H_2S concentrations in the range 1 ppb (1.4 $\mu g\ m^{-3}$) to 50 ppm (70 $mg\ m^{-3}$) to an accuracy of 6%. If the H_2S concentrations at sources within the Sha Tin STW are too high to be measured by this equipment, wet chemical method should be considered to analyse the H_2S concentrations of the collected air samples in the laboratory.

Meteorological information including wind speed, wind direction and

temperature shall be retrieved from the Sha Tin Racecourse Meteorological Monitoring Station operated by the Hong Kong Observatory.

Olfactometry Analysis

For the establishment of the correlationship between odour concentrations (OUm^{-3}) and the measured H_2S concentrations, grab samples shall be collected from the sources and at selected ASRs. The odour concentration shall be measured by a force-choice dynamic olfactometer in accordance with the Dutch National Standard Method (NVN2820).

During the sampling, weather conditions including wind direction, wind speed and temperature shall be recorded. The collected samples shall be transported to an odour laboratory as soon as possible and should be analysed within 24 hours. Qualified odour panellists shall be selected and those participating in the odour testings shall be screened by using a 50 ppm of certified n-butanol standard gas.

5.2.5 *Monitoring Locations*

Monitoring Locations for ASRs

Odour monitoring at four representative ASRs as indicated in *Table 5.2a* and *Figure 5.2a* shall be carried out. Odour sampling or H_2S measurements shall be taken outside the premises of the identified ASRs and, as far as possible, these locations shall not be influenced by other nearby odour sources.

Table 5.2a ***Locations of Odour Monitoring at ASRs***

ASR	Description	Direction of ASR from Sha Tin STW
A1	Kamon Gardens	West
A2	Marine Police North Division Base	North
A3	Home Ownership Scheme (HOS) Housing Area	North-east
A4	Sha Tin New Fishermans Village	South-east

Monitoring Locations at Sources of Sha Tin STW

Odour monitoring and sampling shall be taken at 5 locations of the Sha Tin STW in order to obtain the odour and H_2S concentrations at sources. The selected locations are shown in *Figure 5.2b* and listed below.

- Inlet Works (W1)
- Primary Sedimentation Tank (W2)
- Sludge Holding Tank (W3)
- Sludge Storage Tank (W4)
- Sludge Dewatering House (W5)

For uncommon locations between existing facilities and the Stage III Extension, equivalent locations at the existing facilities shall be used for the baseline monitoring described in *Section 5.2.6*.

As far as possible, the monitoring or sampling should be taken at a height of 1.5m from the surface of the sources concerned.

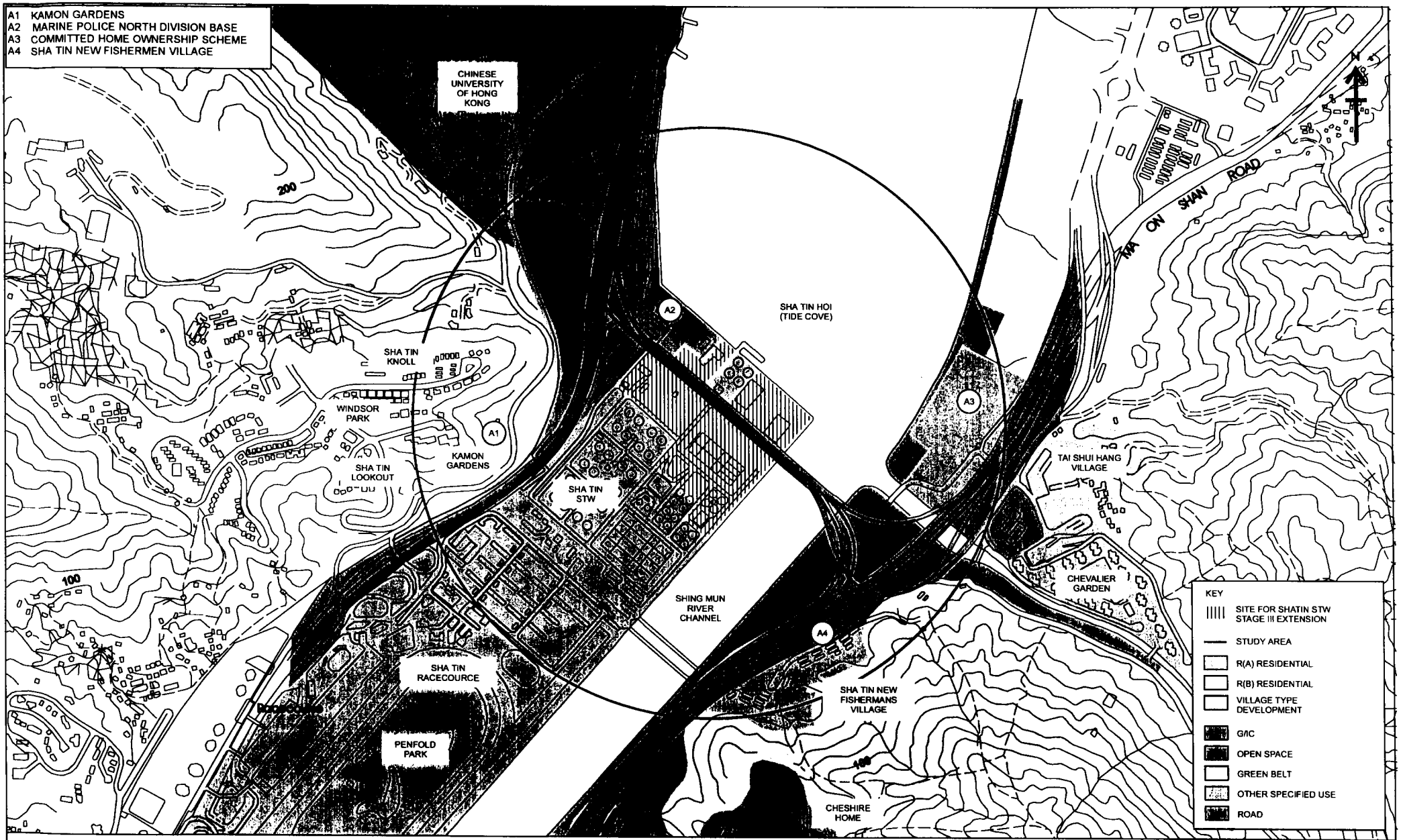

FIGURE 5.2a

LOCATION OF ODOUR MONITORING AT ASRs

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Environmental Resources Management

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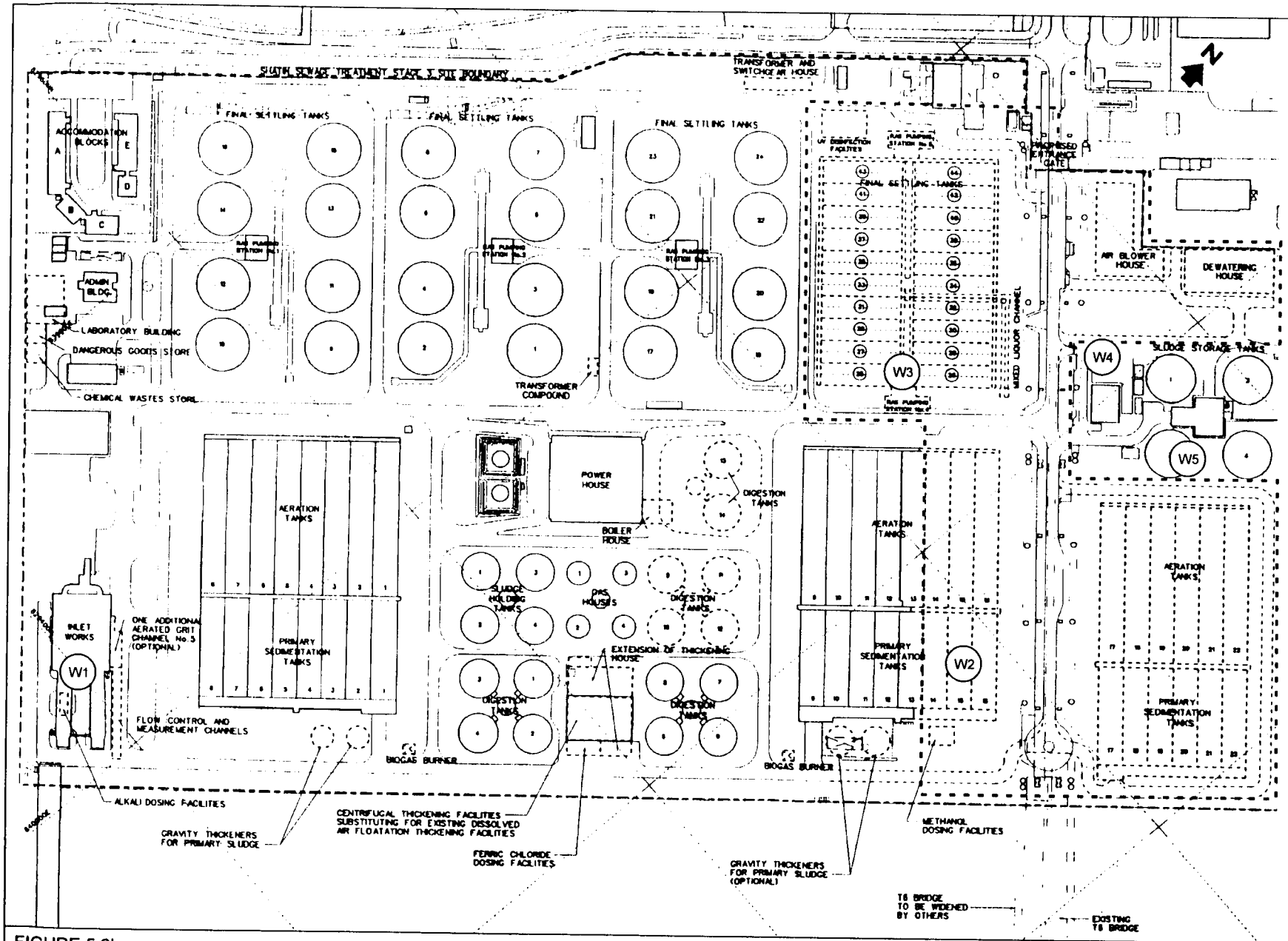

FIGURE 5.2b

ODOUR MONITORING LOCATIONS AT SHA TIN STW

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5.2.6 *Baseline Monitoring*

One year prior to the operation of the Stage III Extension, the following shall be undertaken:

- establish odour complaint register; and
- a programme to monitor concentrations of odour and hydrogen sulphide (H_2S) at the selected ASRs and sources within the Sha Tin STW.

The incidence rate for odour complaints from the odour complaint register, as well as the measured results of H_2S and odour concentrations will serve as the baseline data set prior to the commissioning the Stage III Extension. These will be compared with the results obtained during the impact monitoring stage.

The First Set of Odour Monitoring

The first set of odour monitoring shall consist of both odour sampling and H_2S measurement. Sampling at sources and at any selected ASRs using olfactometry and an H_2S analyser shall be carried out simultaneously using the equipment and methodology described in *Section 5.2.4*. The purpose is to establish both the correlation between odour level (OUm^{-3}) and H_2S concentration, and the averaged baseline H_2S concentration condition for each measurement position at source and ASRs.

A 15-min sample should be collected every 3 hours for a duration of 24 hours at each of the monitoring locations. The purpose of sampling in 3-hour intervals and to cover a duration of a whole day is to capture the different atmospheric conditions at different time periods. If, due to insufficient monitoring equipment or monitoring personnel, sampling/ monitoring can be spread to 3 to 4 consecutive days as long as the different monitoring periods and each of monitoring locations are covered. Pairwise monitoring at ASR and at source should be carried out simultaneously. However, as the variation of odour concentration at sources should be less significant, timing of sampling or monitoring within the STW should be more flexible so as to accommodate the available resources for the monitoring programme.

As the first set of odour sampling/monitoring is fundamentally to establish the correlation between OUm^{-3} and H_2S, the timing of this event should be selected during the summer period, as far as possible, to capture the highest odour concentrations.

In case the baseline monitoring cannot be carried out at the designated monitoring locations presented in this *Manual* during the baseline monitoring period, DSD shall carry out the monitoring at alternative locations which can effectively represent the baseline conditions at the impact monitoring locations. The alternative baseline monitoring locations shall be agreed with EPD.

In exceptional cases, when insufficient baseline monitoring data or questionable results are obtained, DSD shall liaise with EPD to agree on an appropriate set of data to be used as the baseline.

Subsequent Baseline Monitoring

Once the correlation of OUm^{-3} and H_2S is established, subsequent baseline

monitoring (i.e. the 2nd, 3rd and 4th monitoring event should be carried out by measuring the H_2S concentration only. However, if clear correlations could not be established in the first baseline monitoring period, correlation of OUm^{-3} and H_2S should be established subsequently.

Subsequent baseline monitoring event shall be carried out every three months at the same locations before the Stage III Extension is commissioned. Instead of a measurement every 3 hours, the measurement frequency should be as high as practicable (most likely governed by the logging capability and/or the threshold limit of the H_2S analyser).

In order to gauge the most recent baseline condition before the Stage III Extension is operational, the last baseline monitoring event should be assigned at a time 1 to 2 weeks before the actual commissioning of the Stage III works.

5.2.7 *Impact Monitoring*

The impact monitoring shall provide a continuation of the H_2S monitoring at sources and at ASRs undertaken prior to the operation of the Stage III Extension.

Impact monitoring shall be carried out every 3 months for the first year of operation of the Stage III Extension. For the 2nd and 3rd year, if complaints (if any) are all determined as unrelated to the Sha Tin STW and the monitoring results are below the limit levels represented in *Section 5.2.8* in the previous year, the frequency of the impact monitoring could be reduced to once every 6 months. The final decision will be subject to EPD's endorsement.

The same monitoring regime as the first baseline monitoring should be followed, except that odour sampling and analysis by olfactometry is not required in the impact phase monitoring.

The impact monitoring should be carried out for a period not less than 3 years. Whether the odour monitoring should be continued after the 3 year monitoring programme should be reviewed at the end of the period.

5.2.8 *Responsibilities for the Odour Monitoring Programme*

The odour monitoring programme should be the responsibility of the DSD Sewage Treatment Division (ST1) and the Sha Tin STW plant engineer. In order to carry out the odour monitoring programme in an effective manner and not to affect routine functions of ST1, it is recommended that a sub-contractor or laboratory should be hired to carried out both the baseline and impact phase monitoring.

5.2.9 *Event and Action Plan*

The baseline monitoring results form the basis for determining the odour criteria for the impact monitoring. DSD shall compare the impact monitoring results with odour criteria shown in *Table 5.2b*, namely Action and Limit Levels. Should a non-compliance of the odour criteria occur, DSD shall undertake the relevant actions in accordance with the Event/Action Plan in *Table 5.2c*.

Table 5.2b *Action and Limit Levels for Odour Monitoring*

Parameters	Action Level	Limit Level
H_2S conc. in ppb/ppm	Averaged baseline H_2S concentration measured at any sources in the Sha Tin STW	Averaged baseline H_2S concentration, or the 5 OUm^{-3} equivalent whichever is greater, at ASRs.
Incidence of odour complaints	Any incidence of odour complaint received through the Odour Complaint Register	Two or more odour complaints received through the Odour Complaint Register within three months.

Note:
Data to determine average baseline H_2S concentration shall not include data which may be related to odour complaints.

Table 5.2c ***Event/Action Plan for Odour Monitoring***

EVENT	ACTION		
	Sha Tin STW Engineer In-Charge of Odour Monitoring	DSD CE/ST1	DSD SP / E&MP[a]
ACTION LEVEL			
1. Exceedance of Action Level for one sample at source, or receipt of any odour complaint	1. Identify source/reason of exceedence or odour complaints 2. Repeat measurement to confirm finding	1. Carry out investigation to identify the source/reason of exceedence or complaints. Investigation shall be completed within 1 week. 2. Rectify any unacceptable practice 3. Amend working methods as required. 4. Inform DSD SP/E&MP if cause of complaint or exceedence is considered to be caused by civil or E&M design problems. 5. Correspond to the complainant within 10 days to inform the cause of the nuisance and actions taken 6. Implement amended working methods	1. Assist ST1 to find the root cause of the complaint or exceedence. 2. Modify or improve design as appropriate.
LIMIT LEVEL			
2. Exceedance of Limit Level for one or more samples at the ASR, or receipt of two or more complaints in 3 months	1. Identify source/reason of exceedence of odour complaints 2. Repeat measurements to confirm findings 3. Increase monitoring frequency to monthly 4. If exceedance stops, cease additional monitoring	1. Carry out investigation to identify the source/reason of exceedence or complaints. Investigation shall be completed within 1 week. 2. Rectify any unacceptable practice 3. Amend working methods as required. 4. Notify DSD/SP and DSD/E&MP 5. Formulate remedial actions. 6. Ensure amended working methods and remedial actions properly implemented. 7. If exceedance continues, consider what portion of the work is responsible and stop that portion of work until the exceedance is abated 8. Correspond to the complainants within 10 days to explain the cause of the nuisance and the remedial actions taken.	1. Assist ST1 to find the root cause of the complaint or exceedence. 2. Modify or improve design as appropriate. 3. Formulate remedial actions in association with ST1.

Note:

(a) The role of DSD/SP and DSD/E&MP would be ceased one year after the commissioning of the Stage III.