



Hong Kong Government
Drainage Services Department

Strategic Sewage Disposal Scheme Stage 1 Principal Collection and Treatment System

Environmental Impact Assessment

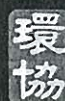
Volume I

May 1996



MONTGOMERY WATSON

環協顧問工程師



EIA-092.1/BC



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in association with



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MOTT CONNELL LIMITED
HONG KONG GOVERNMENT
DRAINAGE SERVICES DEPARTMENT


Strategic Sewage Disposal Scheme
Stage 1
Principal Collection and Treatment System

ENVIRONMENTAL IMPACT ASSESSMENT


(Final)

Prepared for Submission to:
ENVIRONMENTAL PROTECTION DEPARTMENT

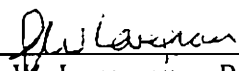
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May 1996

**Hong Kong Government
Drainage Services Department**

**Strategic Sewage Disposal Scheme
Stage 1
Principal Collection and Treatment System**

Environmental Impact Assessment

May 1996

**A Paper Prepared by Mott Connell Limited
for Montgomery Watson**

Strategic Sewage Disposal Scheme

Stage I : Detailed Design Environmental Assessment

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1.1 Background

In 1988 the Government commissioned the Sewage Strategy Study (SSS) in response to growing concern that marine, and bathing beach water quality was deteriorating. The stated aims of the SSS were to review and recommend water quality objectives for the coastal waters of Hong Kong based on their beneficial uses, and to develop strategic collection, treatment and disposal options for domestic and industrial effluent. The SSS was also charged with reviewing the overall adequacy of existing and planned facilities in a strategic context. All of the options considered were examined in terms of engineering feasibility and a programme for the implementation of the recommended options was developed in the form of Sewerage Master Plans or Implementation Packages.

The basic tenet of the overall sewage strategy, which had to encompass both urban and rural catchment areas, was that it should be fully flexible, with the ability to accommodate changes in fundamental assumptions should the need arise. Even in concept the strategic developments had to provide value for money and be feasible in engineering terms. When the sewage strategy was being formulated detailed consideration was given to the constraints of technical feasibility, system reliability, costs, timescale for implementation and to the future planning horizon and environmental effectiveness. Within this framework, account had to be taken of the large increases in pollution loads generated in the hinterland of the Pearl River Delta, the development trends both in Hong Kong and further afield, and the industrial and agricultural policies within the region. It was recognised that all of the aforementioned potentially place severe constraints on the options available for long term strategic planning.

The Sewage Strategy Study concluded that in the long term an acceptable approach for treating industrial and domestic effluent could be achieved by combining land-based pollution reduction processes and natural treatment within the marine environment. Marine disposal of certain materials, such as toxic metals is unacceptable and the removal of these pollutants at source or at a land based treatment plant was a basic precept upon which the strategy was developed. A phased approach was thus derived aiming to provide early relief on the water quality within Victoria Harbour, minimise disturbance to the environment during construction, without the need to reclaim additional land, and with a view to providing a low maintenance system with maximum flexibility.

This concept was further developed in the site investigations and engineering studies, commissioned in June 1990, (concluded in 1993) which confirmed that the Strategic Sewage Disposal Scheme (SSDS) could be implemented in four phases. The Stage I Scheme, which is the subject of this Project, provides the integral collection and treatment system. The other stages which are adjuncts to this, are the Ocean Outfall, the Hong Kong Island North Scheme, and the Hong Kong Island South West Scheme.

The Stage I Scheme comprises a conveyance system in deep tunnel which will connect Tseung Kwan O, Chai Wan and Tsuen Wan with Kwun Tong, whence effluent shall be conveyed to the new sewage treatment works at Stonecutters Island, for treatment by chemically assisted sedimentation, prior to disposal via the Stage I Outfall, into marine waters to the southwest of Stonecutters Island as illustrated on Figure 1.1. A schematic diagram of the collection system is illustrated in Figure 1.2. Layout plans of preliminary treatment works along the collection system are shown in Figures 1.3 to 1.9.

The Stage I Outfall was initially referred to as the Interim Outfall which in fact reflects its function. It was a fundamental precept of the overall schemes that Stage I would proceed on the basis that implementation of Stages II, III and IV would follow successively. As such the Stage I Outfall is only a temporary facility until such times as the Ocean Outfall is constructed.

As a detailed Environmental Impact Assessment (EIA) of the Preliminary Design had already been carried out, it was a basic precept of this Study that the findings of that EIA would be incorporated, wherever possible, into the present assessment. In many cases, however, the design assumptions have changed, construction methods have been revised and basic design parameters, such as effluent flows and pollution loads have been altered. All of these amendments to the design of the Stage I Scheme have been considered in connection with the findings of the previous EIA and taken into consideration in the present

assessment. In keeping with the adoptive approach to the EIA it was agreed at the start of the study that no further modelling of the impact on air quality during construction would be necessary for the EIA for Detailed Design.

During the Adoptive Review of the Preliminary Design EIA it was identified that the odour assessments carried out for the Preliminary Design required revision and thus the conclusions drawn previously were modified.

Water quality assessments were also explicitly excluded from the EIA Brief for the Detailed Design Study. However, during the course of the review of the effluent flow rates and pollution loads (undertaken for the design of the system hydraulics and the details of the outfall) the effluent flow rate was estimated to be about 20% higher than previously calculated. In addition to which the change from a primary sedimentation process to one based on the use of ferric chloride also necessitated investigation in terms of the impacts on receiving water quality. Supplementary water quality assessments were thus commissioned by Drainage Services Department (DSD) to investigate the effects of the higher flows and the addition of different dosages of lime or ferric chloride on future water quality.

1.2 Purpose of the Environmental Assessment

The purpose of this Environmental Impact-Assessment is to identify and, wherever possible, to quantify the impacts of the construction and operation of the Stage I Scheme, or components thereof. Based on these findings, the nature and extent of measures required to mitigate these effects to at least within Government statutory limits and guidelines were defined in keeping with the aim of minimising the impact of constructing this scheme on the surrounding environment.

The Stage I Scheme is divided into fifteen separate contract packages for the construction phase, most of which cover more than one site. A series of Environmental Assessment Working Papers (EAWP) were prepared which focussed mainly on the construction phase, although where necessary issues relating to the operations of the Scheme were addressed. A list of titles is given in Appendix A. Mitigation measures, monitoring proposals and any specific environmental protection requirements were defined in the EAWP's and subsequently incorporated into individual contract documents as "Particular Specification Clauses for Environmental Protection." A standard set of Particular Specification Clauses for Environmental Protection were developed for this Project and were used for all contracts. Supplementary conditions were also defined to reflect conditions or circumstances at individual sites.

The findings of the Environmental Assessment Working Papers, have been incorporated into this Environmental Impact Assessment Report which, in contrast to the Working Papers, discusses the potential impacts on a site-by-site basis, rather than by individual contracts. By definition, the environmental assessments address the cumulative impact when more than one construction activity is being carried out simultaneously.

The effects of operating the scheme have also been considered and the findings are contained in Section 7. Potential impacts primarily pertain to future water quality, odours and disposal of screenings from the treatment works and noise generated by the new facilities. Where problems might arise, mitigation measures were recommended so that these could be specified in the contract documents.

1.3 Objectives of the Environmental Assessment

The stated objectives of the Environmental Assessment (Refer to Brief of May 1993) are:

- (a) to describe the proposed installations and related facilities and the requirements for their development;
- (b) to identify and describe the elements of the community and environment likely to be affected by the Project;
- (c) to minimise pollution and nuisance arising from the Project and its operation and environmental disturbance during construction and operation of the Project;
- (d) to identify and evaluate the net environmental impacts and cumulative effects with other development projects expected to arise during the construction and operation phases of the Project;
- (e) to identify and specify methods, measures and standards to be included in the detailed design, which may be necessary to mitigate these impacts and reduce them to acceptable levels; and
- (f) to design and specify the environmental monitoring and audit requirements necessary to ensure the effectiveness of the environmental protection measures adopted.

The technical requirements of the Environmental Impact Assessment stated in the Brief are as follows:

"The Environmental Impact Assessment with respect to representative sensitive receivers agreed with EPD shall include, but shall not necessarily be limited to, the following:

Construction Phase Assessment

A. Vibration and Noise Impact Study

(a) Identification of Sensitive Receivers

From a consideration of existing and future land-use in the study area prepare schedules and plans identifying sensitive receivers. Noise sensitive receivers should include those described in the Environment Chapter of the Hong Kong Planning Standards and Guidelines (HKPSG). The future land-uses should refer to those that will be occupied by the time construction works commence for each phase of the works.

(b) Analysis of Construction Activities

From a knowledge of the likely type, sequence and duration of construction activities required for project implementation, identify those activities likely to have an impact on vibration and noise sensitive receivers.

(c) Assessment of Construction Vibration and Noise Levels

Identify interactions between sensitive receivers and construction activities to determine the extent of potentially unacceptable construction vibration and noise impacts. The assessment should follow the requirements contained in all Ordinances and their Regulations for the time being in force in Hong Kong governing the control of construction noise and follow guidelines advised by EPD.

(d) Proposals for Vibration and Noise Control Measures

Formulate appropriate vibration and noise control measures for inclusion in contract documentation.

Section 1

(B) Air Pollution Study

(a) Identification of Sensitive Receivers

From a consideration of existing and future land use in the study area, prepare plans identifying sensitive receivers in the vicinity of the proposed project (including off-site works area). The future land-uses should refer to those that will be occupied by the time construction works commence for each phase of the works.

(b) Analysis of Construction Activities

Identify those construction activities likely to cause potential dust (or other air pollutant) problems to sensitive receivers.

(c) Dust (or other air pollutant) Impact Assessment

Assess the dust (or other air pollutant) level at the sensitive receivers due to the Project (including constructional traffic arising).

(d) Proposals for Dust (or other air pollutant) Control Measures

Recommend appropriate dust (or other air pollutant) control measures for inclusion in contract documentation.

(C) Water Quality Impact Study

(a) Identification of Sensitive Receivers

Identify the watercourses/water bodies which may be affected by the construction of the proposed works (including off-site works area).

(b) Analysis of Construction Activities

From a knowledge of the likely type, sequence and duration of construction activities required for project implementation, identify those activities likely to have an impact on the affected watercourses/water bodies.

(c) Assessment of Water Pollution Problems

Identify interactions between sensitive receivers and construction activities to determine the adverse effects (if any) of construction on water quality of watercourses/water bodies. This should include the impact of any proposed dredging activities.

(d) Proposals for Water Pollution Control Measures

Recommend appropriate control measures for inclusion in contract documentation. Where appropriate, make suggestions for practical mitigation measures and monitoring for compliance.

(D) Waste Disposal Study

(a) Assessment of Waste Disposal

Assess and determine the quantities of spoil arising from the Project (including mud arising from dredging works) and the likely time scale for disposal of such material. The Consultants shall, in consultation with the Fill Management Committee (FMC), examine possible engineering uses of such spoil material, including the backfilling of marine borrow areas and the formation of reclamation areas for future development.

(b) Marine Disposal of Dredged Mud

Provide both EPD and FMC with a notification of the marine disposal requirements at least eight months prior to contract tendering or dredging, whichever is earlier. The notification shall include a detailed programme for sampling and testing the mud. The Consultants shall then carry out such sampling and testing of the mud in accordance with the requirements given by the Principal Environmental Protection Officer of the Solid Waste Control Group of EPD (PEPO/SC) and upon completion of the sampling and testing, or at least three months prior to contract tendering or dredging, whichever is earlier, the Consultants shall submit a formal Sediment Quality Report to PEPO/SC. This Sediment Quality Report shall include records of the sampling and the results of the testing. Special attention should be paid to identifying the quantity of contaminated mud that may arise from the Project, and an acceptable method for its disposal. Liaison with the Environmental Protection Department will be necessary on this point. Every effort should be made to design facilities so that marine muds (whether contaminated or not) can be left in place.

Operation Phase Assessment

(A) Noise Impact Study

(a) Identification of Sensitive Receivers

Identify noise sensitive receivers, as described in the Environment Chapter of the HKPSG, for both existing and planned uses.

(b) Calculation of Future Noise

Future noise generation at each site is to be calculated at the nearest facade of any existing building classified as a noise sensitive receiver. For planned developments, representative points are to be selected as shown on draft Layout Plans if available.

(c) Presentation of Existing Noise Levels

Measure existing noise level at the identified NSR and present them on a plan of suitable scale.

(d) Assessment of Need for Noise Amelioration Measures

Assess the need for noise amelioration measures when an existing or planned building classified as a noise sensitive receiver is subjected to a predicted noise level in the design year which is in excess of the maxima recommended in the HKPSG.

(e) Proposals for Noise Amelioration Measures

Propose noise amelioration measures for each situation where the predicted noise level exceeds the HKPSG maxima. In the case where an existing building is already subject to noise levels equal to, or in excess of, the recommended maximum, measures to avoid (as far as possible) deterioration of the situation are to be put forward. Proposals for the implementation of noise amelioration measures are to be framed with regard to their cost effectiveness in terms of the following parameters:

- (i) Estimated number of persons affected
- (ii) Effective reduction in predicted noise level
- (iii) Estimated construction costs

Section 1

(B) Air Pollution Study

(a) Identification of Sensitive Receivers

From a consideration of existing and future land-use in the study area, prepare plans identifying sensitive receivers within 50 m of the Project.

(b) Air Pollution Impact Assessment

Assess the air pollution (dust and odour) levels at the sensitive receivers due to the Project using a methodology to be agreed with the EPD.

(c) Assessment of Air Pollution Impact from Stonecutters Island Sewage Treatment Works

Assess the air pollution (dust and odour) impacts within 300 m of the proposed Stonecutters Island Sewage Treatment Works using a model. The Consultants shall agree the assessment methodology with the EPD prior to commencing this task.

(d) Proposals for Amelioration Measures

Propose cost effective amelioration measures in situations where the predicted air pollutant (dust and odour) levels exceed the Hong Kong Air Quality Objectives.

(C) Visual and Land Use Impacts

(a) Assessment of Visual Impacts

Assess the visual impacts, if any, caused by the Project.

(b) Assessment of the Implications on Land Use

Assess the implications on land use in the vicinity of the Project, both long and short term implications have to be assessed.

(c) Proposals for Mitigation Measures

Recommend appropriate cost effective mitigation measures such as detailed landscaping plans to minimise any adverse effects identified in a) and b) above.

Special attention should be paid to minimise the restraints on the potential development of the area in the vicinity of the Project.

Monitoring and Post-Project Audit Requirement

(A) Environmental Monitoring

Define environmental monitoring requirements including any necessary programmes for baselines, impact and compliance monitoring. The monitoring requirements are to cover aspects arising from this Assignment as well as water quality impact during the operation phase.

Post-Project Audit

Formulate environmental audit requirements including any necessary compliance and post-project audit programmes to review the environmental monitoring data. Assess compliance with regulatory requirements, policies and standards and identify any remedial works required to redress unacceptable consequential or unanticipated environmental impacts."

1.4 Environmental Benefits of the Scheme

The main benefit of this Environmental Improvement Scheme will be derived by implementing the Stage II Scheme when the Ocean Outfall is commissioned. At that time, the Water Quality Objectives specified in the SSS will be fully achieved.

The Stage I Scheme is however of considerable value in its own right through the collection of numerous point sources of pollution which presently discharge, with little or no treatment, into receiving waters no longer having the capacity to assimilate these pollution loads.

Water quality within the Western and Victoria Harbour, and the Port Shelter Water Control Zones is expected to improve following implementation of the Stage I Scheme. This is particularly important in the Eastern New Territories as the Port Shelter Water Control Zone provides the amenity for water sports and recreational activities as well as supporting diverse marine life.

The sewage catchment areas to be served under the Stage I Scheme encompass Tseung Kwan O, Chai Wan, Shau Kei Wan, Kwun Tong, To Kwa Wan, Kwai Chung, Tsing Yi and North West Kowloon. Domestic and industrial effluent from these areas will be collected and conveyed, through a network of tunnels connecting Tsuen Wan to Kwun Tong and the area between Shau Kei Wan and Chai Wan to Kwun Tong, to the new sewage treatment plant at Stonecutters Island. Primary treatment will be applied to all wastewaters received at the Stonecutter Island treatment works. The final effluent will then be discharged to the marine environment via a submerged outfall. Effluent flows generated in Tseung Kwan O and Port Shelter will also be connected to the system, by tunnel, to Kwun Tong. The components of the Stage I Scheme are illustrated in Figure 1.2.

Within the sewage catchment areas, liquid effluents are often discharged to the marine environment by inadequate or inappropriate outlets and frequently without any treatment to reduce pollution loads. Under the SSDS, effluent generated in the catchment areas will be collected, treated and disposed of through the single discharge point off Stonecutters Island. The removal of the numerous point sources of pollution will result in an early and substantial benefit to the marine water quality in Victoria Harbour. Furthermore, the combined effluent will be treated to a higher level than at present, thereby further reducing the pollution load to be assimilated by the receiving waters.

It should also be noted that the collection system has been designed to reduce the scope for making illegal, otherwise referred to as expedient, connections to the sewers which is a common practice.

Provision of centralised facilities for treatment and disposal of effluent from the extensive sewage catchment area, will be beneficial in that the location of the main sewage treatment works is remote, with few potentially sensitive receivers in the vicinity. If a series of treatment plants were to be located within individual districts, the impacts would be more significant, with a greater number of people potentially affected. Ensuring compliance with environmental standards will also be facilitated by having only one centralised facility rather than several smaller facilities located throughout the urban area.

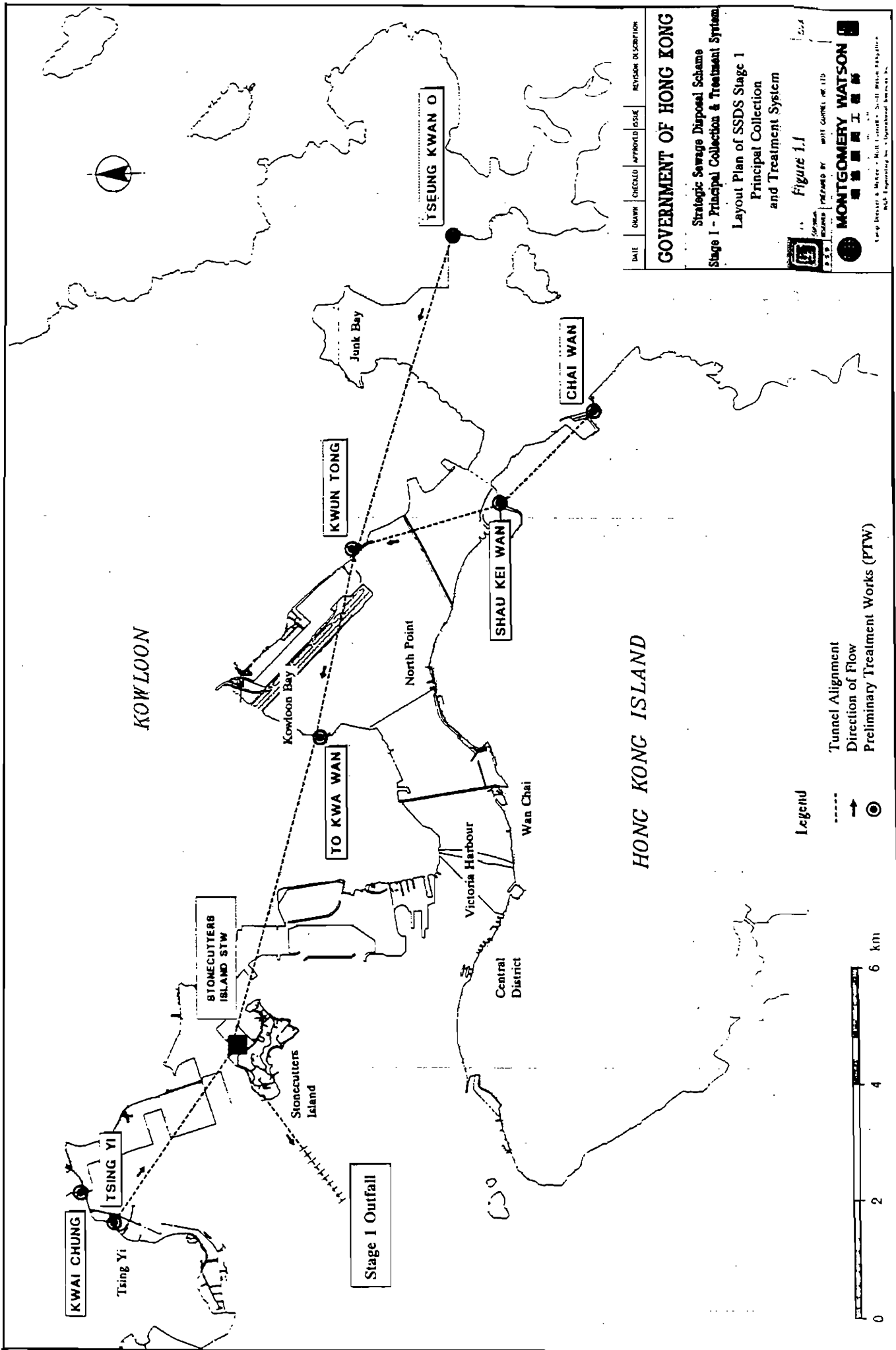
Furthermore, the frequent flooding or surcharging of sewers which commonly occurs in parts of the urban area will be eliminated through these improvement works, this being a major contribution to enhancing the general environmental quality of the urban area. The above ground installations of this scheme are the primary sewage treatment works at Stonecutters Island and the pumping stations. Collection systems will be formed by tunnelling and, although construction sites will be above ground, most of the necessary construction activities will take place below ground.

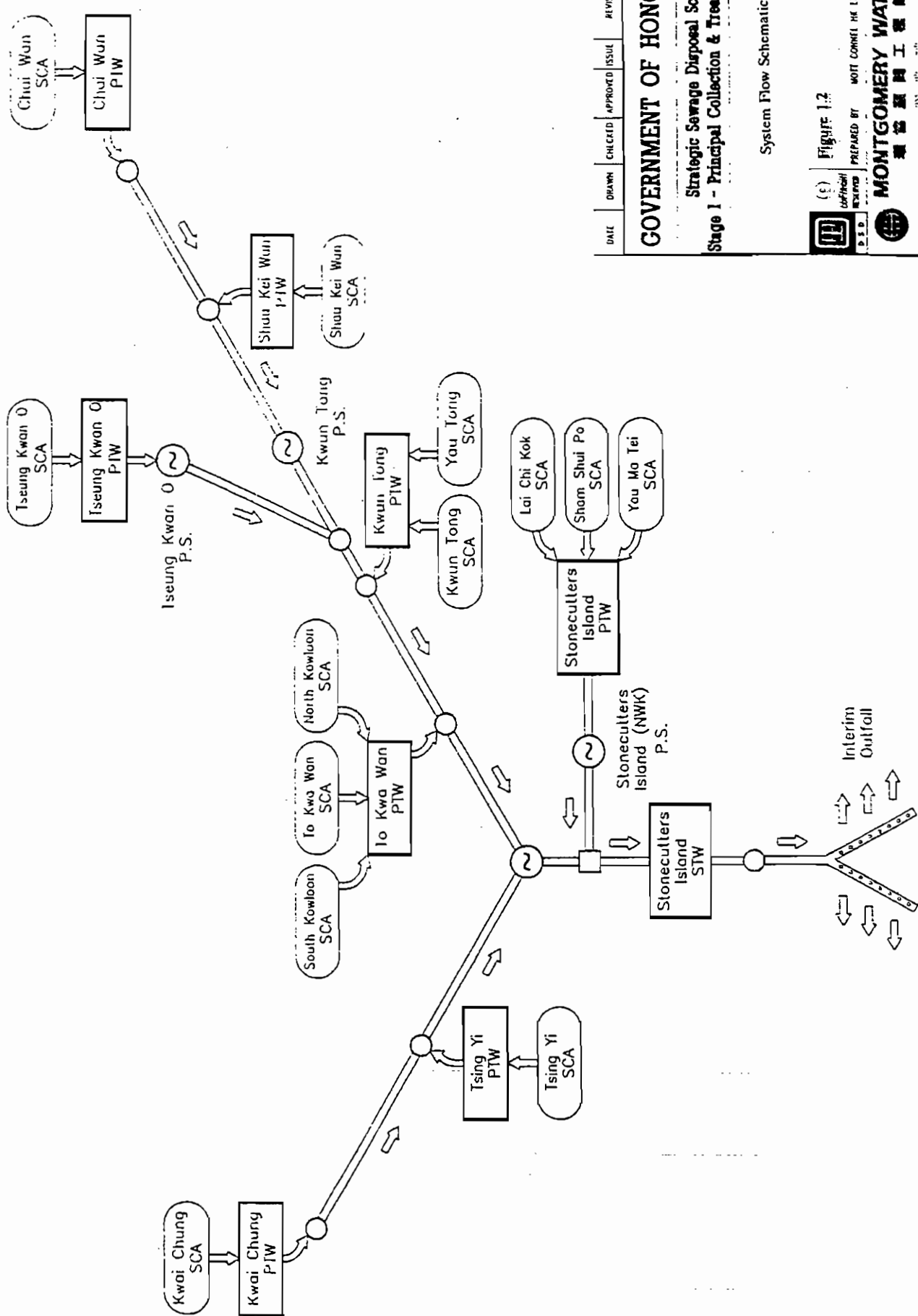
1.5 Summary of the Findings

A summary of the results of this assessment for the construction and operation of the Stage I Scheme, are given in Table 1.1.

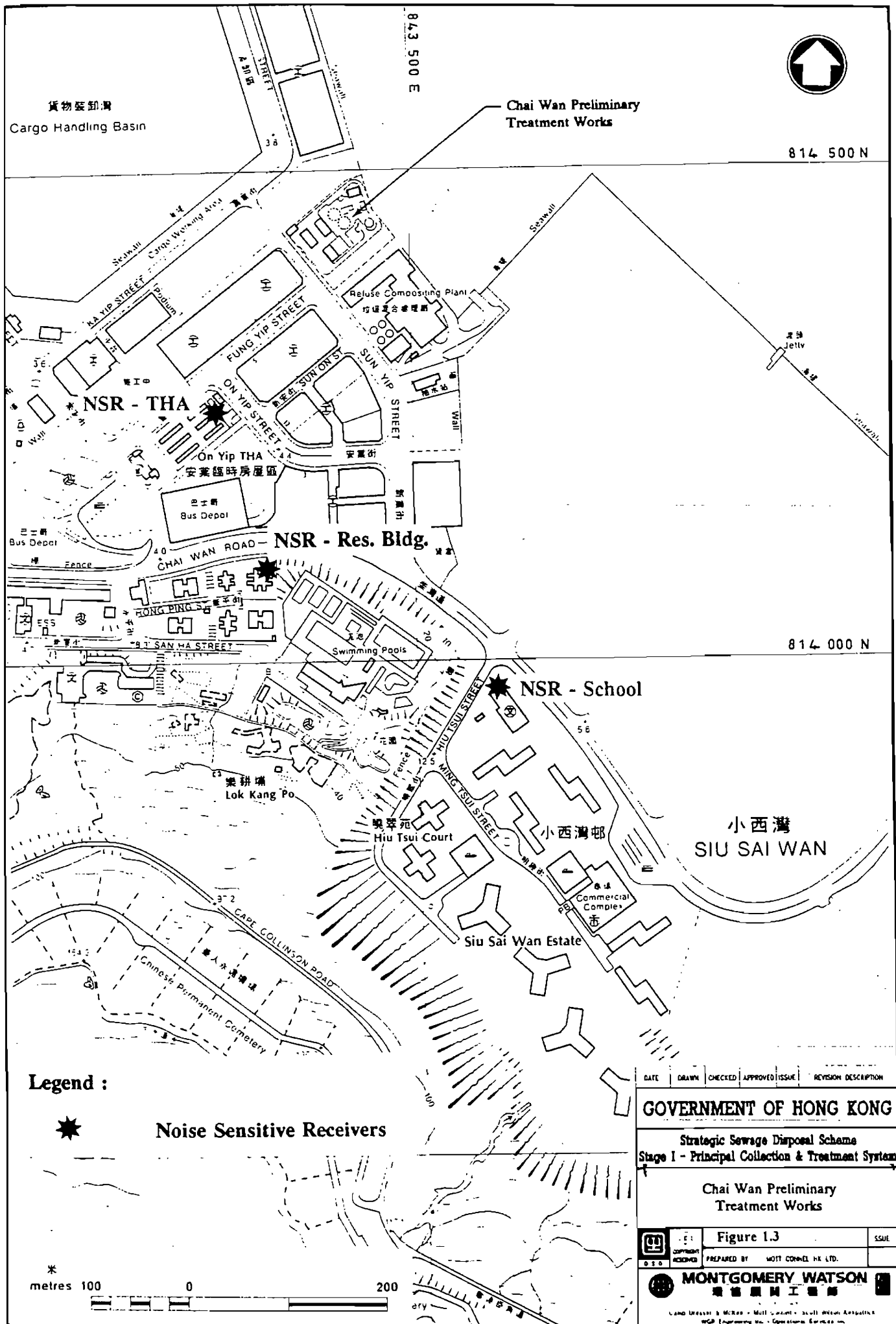
Table 1.1 Summary of the Impacts Associated with Construction and Operation at Individual Sites Comprising the Stage I Scheme

Site	Construction Works	Potential Impacts		Recommended Mitigation Measures for the Operation Phase
		Construction Phase	Operational Phase	
Stonecutters Island	sewage treatment works, pumping stations, sludge collection, treatment and disposal facilities, production shafts, modifications to existing pumping station	noise, dust	odour, noise, visual	Design of odour removal facilities, acoustic louvres and extensive landscaping
Stage I Outfall	on Stonecutters Island; drop chamber to connect to outfall tunnel and pair of diffusers	noise, water quality	water quality	Environmental controls during construction, design of diffuser and treatment level to achieve best degree of compliance with WQOs
Chai Wan	upgrading preliminary treatment works, construction of drop shaft and production shaft	noise, dust, traffic	odour, noise	Design of odour control facilities, silenced ventilation equipment
Shau Kei Wan	upgrading preliminary treatment works, construction of drop shaft	noise, dust, traffic, visual	odour, noise, visual	Screen planting of trees and inclusion of odour control facilities, silenced ventilation equipment and acoustic louvres
Kwun Tong	upgrading of preliminary treatment works, construction of drop shaft, pumping station and production shaft	noise, dust, traffic	noise, odour	Inclusion of odour control facilities, silenced ventilation equipment and acoustic louvres
To Kwa Wan	upgrading of preliminary treatment works, construction of drop shaft	noise, dust, traffic impacts	noise, odour	Inclusion of odour control facilities, silenced ventilation equipment and acoustic louvres
Tsing Yi	upgrading of preliminary treatment works, construction of a production/drop shaft	noise, dust	noise, odour	Inclusion of odour control facilities, silenced ventilation equipment and acoustic louvres
Tseung Kwan O	upgrading of preliminary treatment works and pumping station, construction of a production/drop shaft	dust and noise minimised by distance between site and sensitive receivers	odour	Inclusion of odour control facilities
Kwai Chung	modification to provide new treatment plant (under construction), construction of drop shaft	dust and noise	minimal	Not applicable (Minimal residual impacts expected)

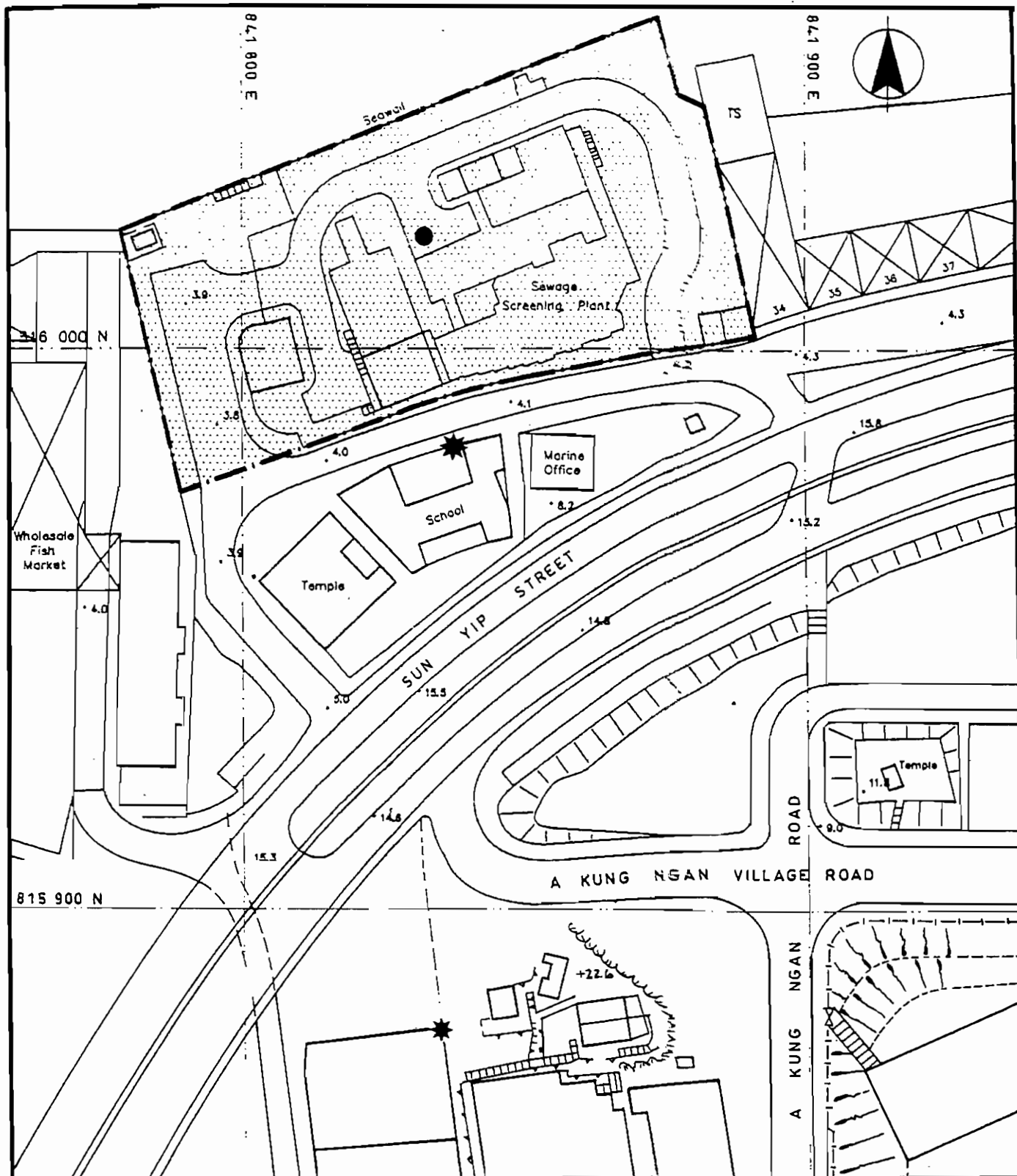




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<p>GOVERNMENT OF HONG KONG</p> <p>Strategic Sewage Disposal Scheme</p> <p>Stage 1 - Principal Collection & Treatment System</p> <p>System Flow Schematic</p> <p>Figure 1.2</p> <p>PREPARED BY: MOTT MACNEIL HE LTD.</p> <p>MONTGOMERY WATSON</p> <p>顧問工程師</p> <p>1000 Dresser & McKee - Main Building - 3000 Wilson, Kowloon</p> <p>WGP Engineering Co., Operational Services Ltd.</p>					



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GOVERNMENT OF HONG KONG					
Strategic Sewage Disposal Scheme Stage I - Principal Collection & Treatment System					
Chai Wan Preliminary Treatment Works					
Figure 1.3					SSUE
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MONTGOMERY WATSON 環境顧問工程師					
Land Use and Planning, Mott, MacDonald, and Wilson Associates 200 Engineering Avenue, Operational Services Inc.					



Legend:



Noise Sensitive Receivers

METRES 20 10 0 20 40 60

GOVERNMENT OF HONG KONG

Strategic Sewage Disposal Scheme
Stage 1 - Principal Collection & Treatment System

Shau Kei Wan Preliminary Treatment Works



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Figure 1.4

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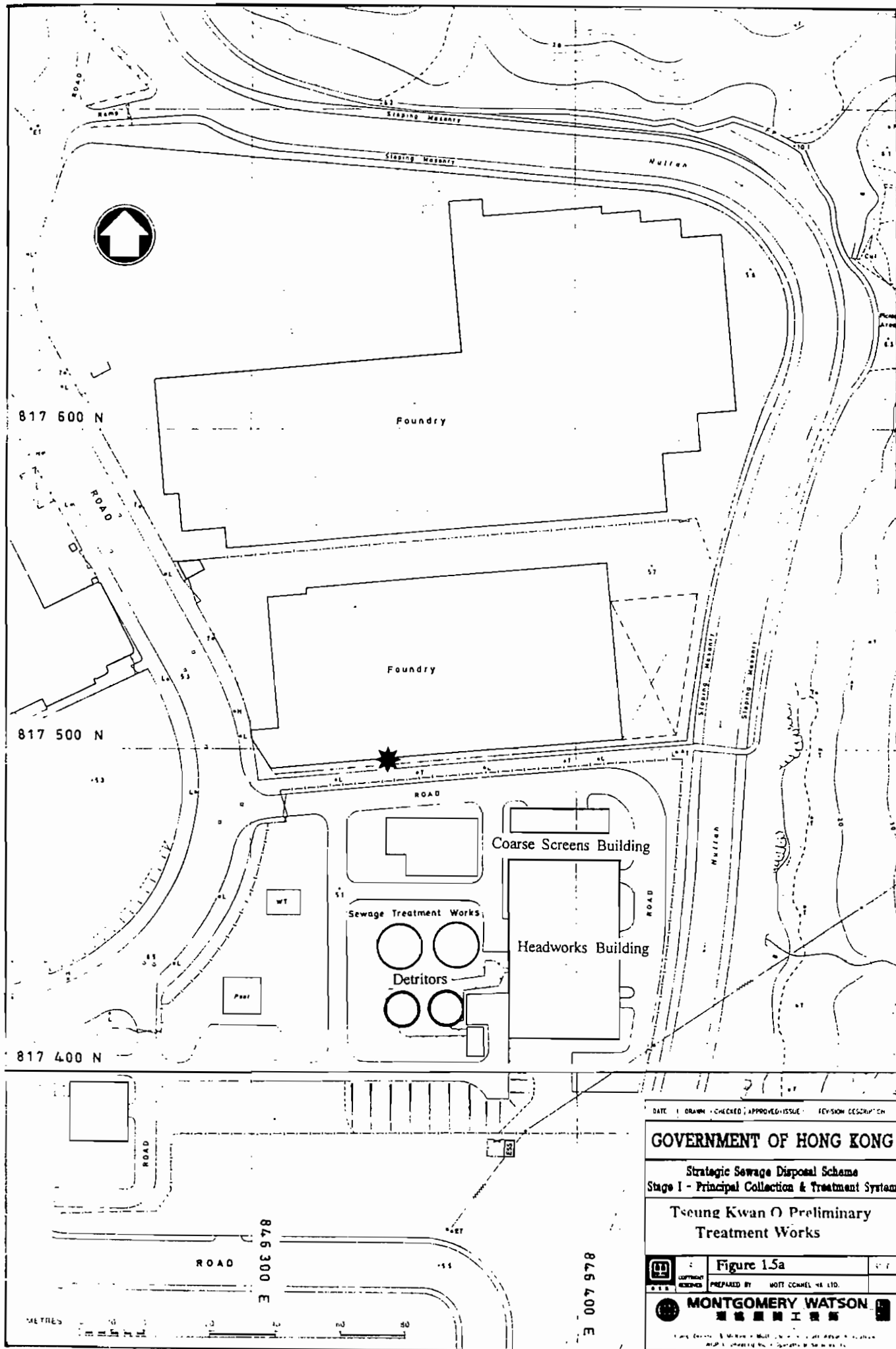
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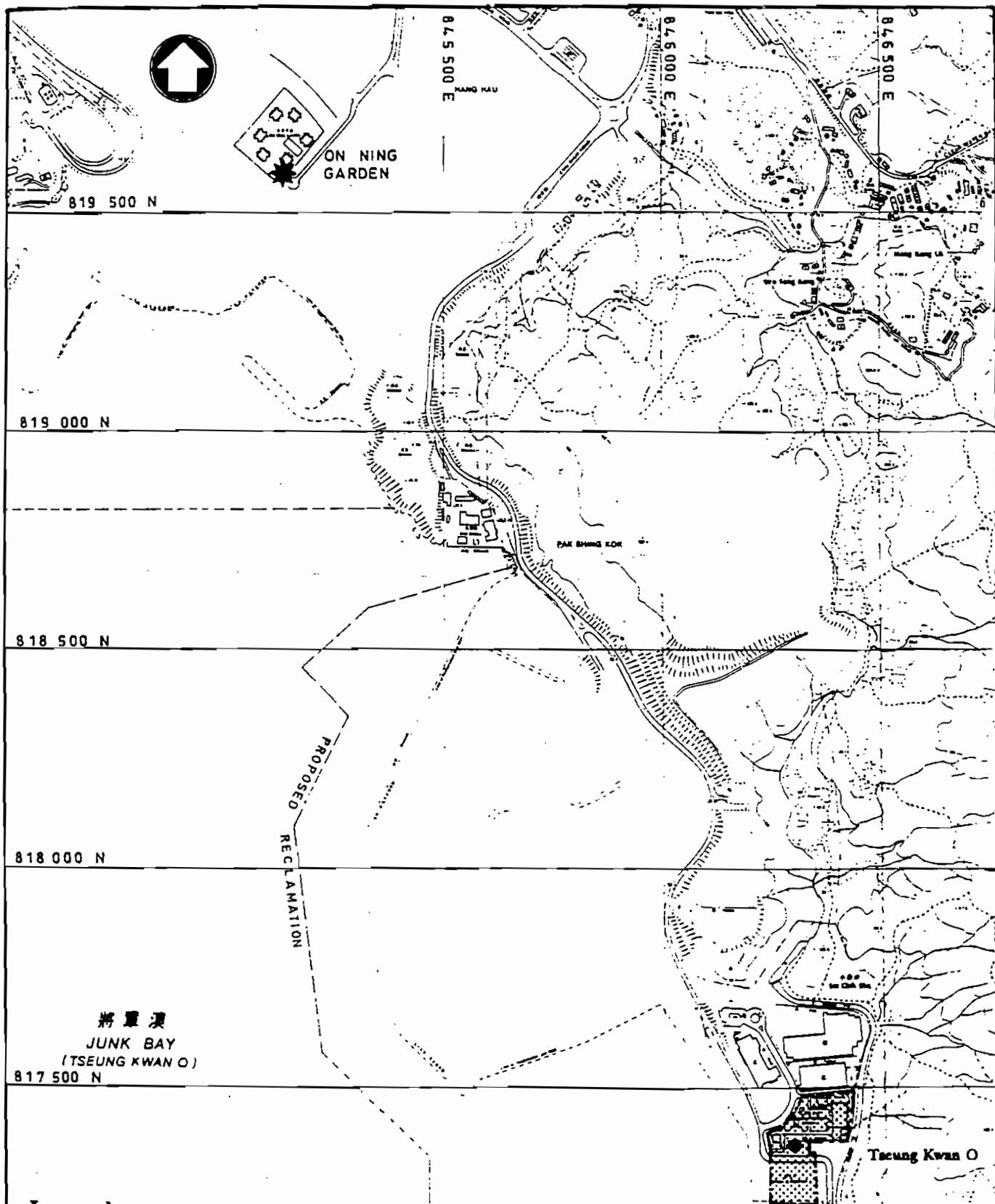


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GOVERNMENT OF HONG KONG Strategic Sewage Disposal Scheme Stage I - Principal Collection & Treatment System Tseung Kwan O Preliminary Treatment Works											
Figure 15a											
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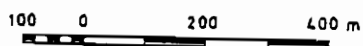
Location of Production Shaft/
Drop Shaft



Works Area



Noise Sensitive Receiver



GOVERNMENT OF HONG KONG

Strategic Sewage Disposal Scheme
Stage I - Principal Collection & Treatment System

Tseung Kwan O Preliminary
Treatment Works



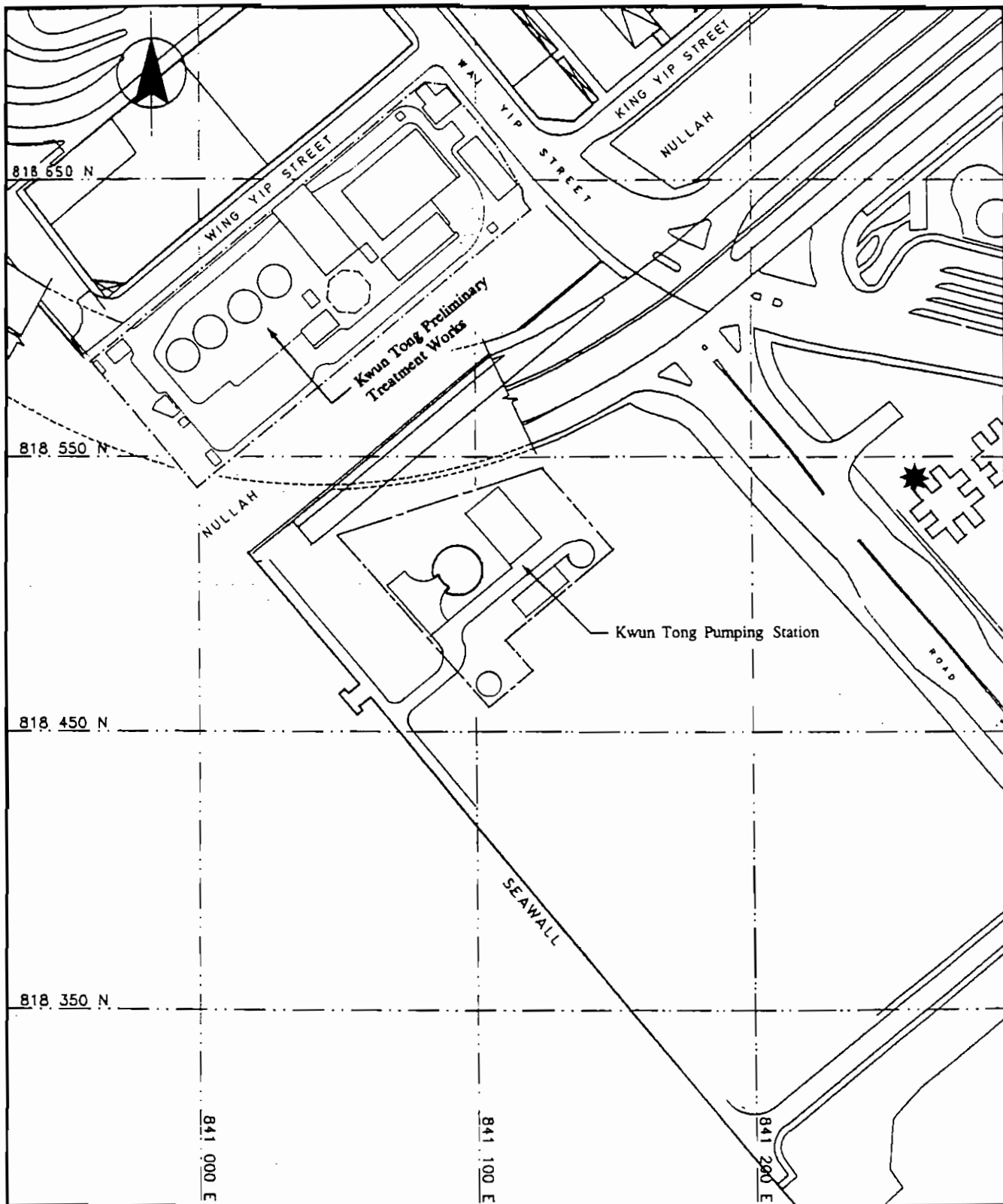
Figure 1.5b

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Legend :



Noise Sensitive Receivers

GOVERNMENT OF HONG KONG

**Strategic Sewage Disposal Scheme
Stage I - Principal Collection & Treatment System**

**Kwun Tong Preliminary
Treatment Works and Pumping Station**



Figure 1.6

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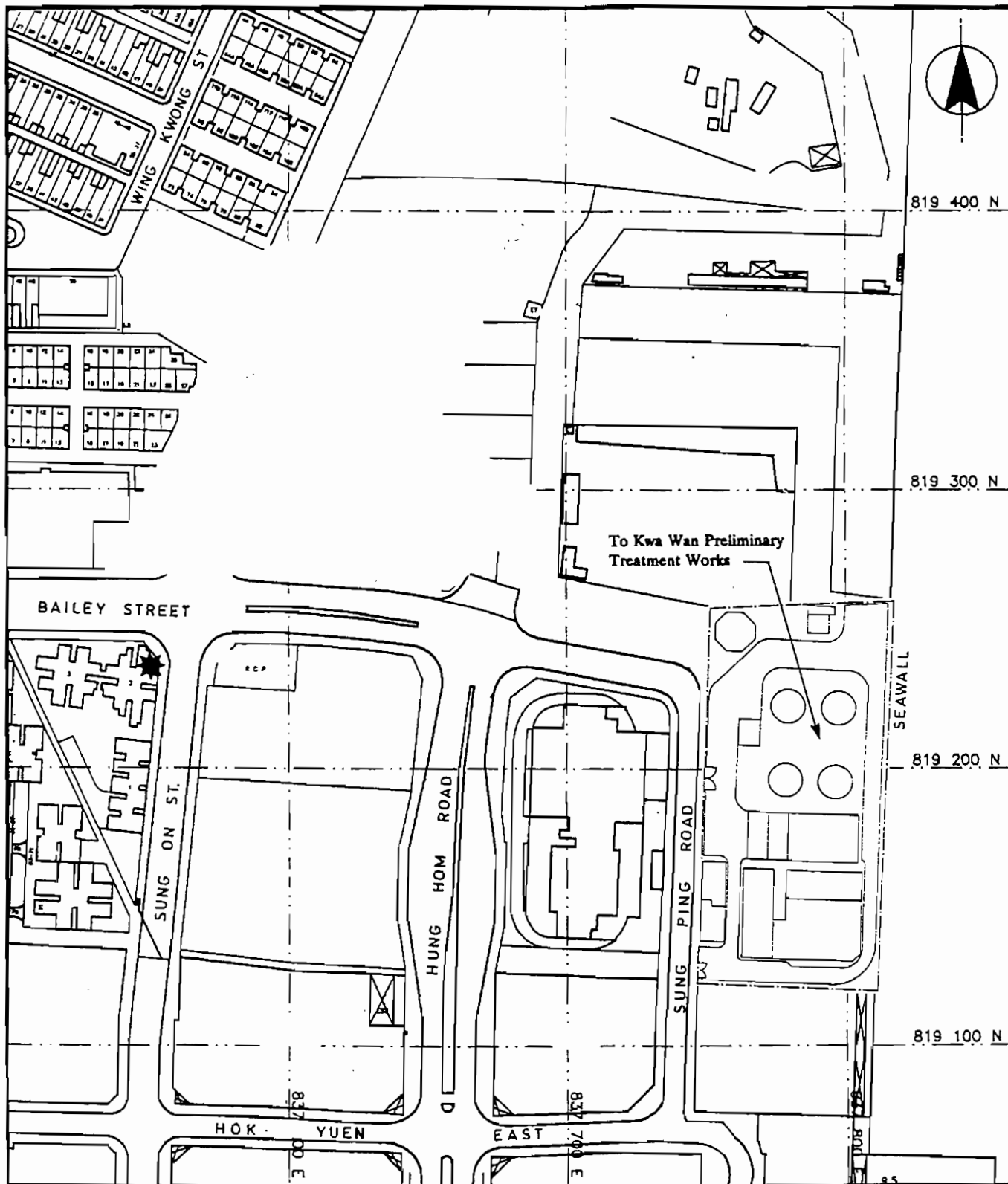
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Noise Sensitive Receivers

GOVERNMENT OF HONG KONG

**Strategic Sewage Disposal Scheme
Stage I - Principal Collection & Treatment System**

**To Kwa Wan Preliminary
Treatment Works**



Figure 1.7

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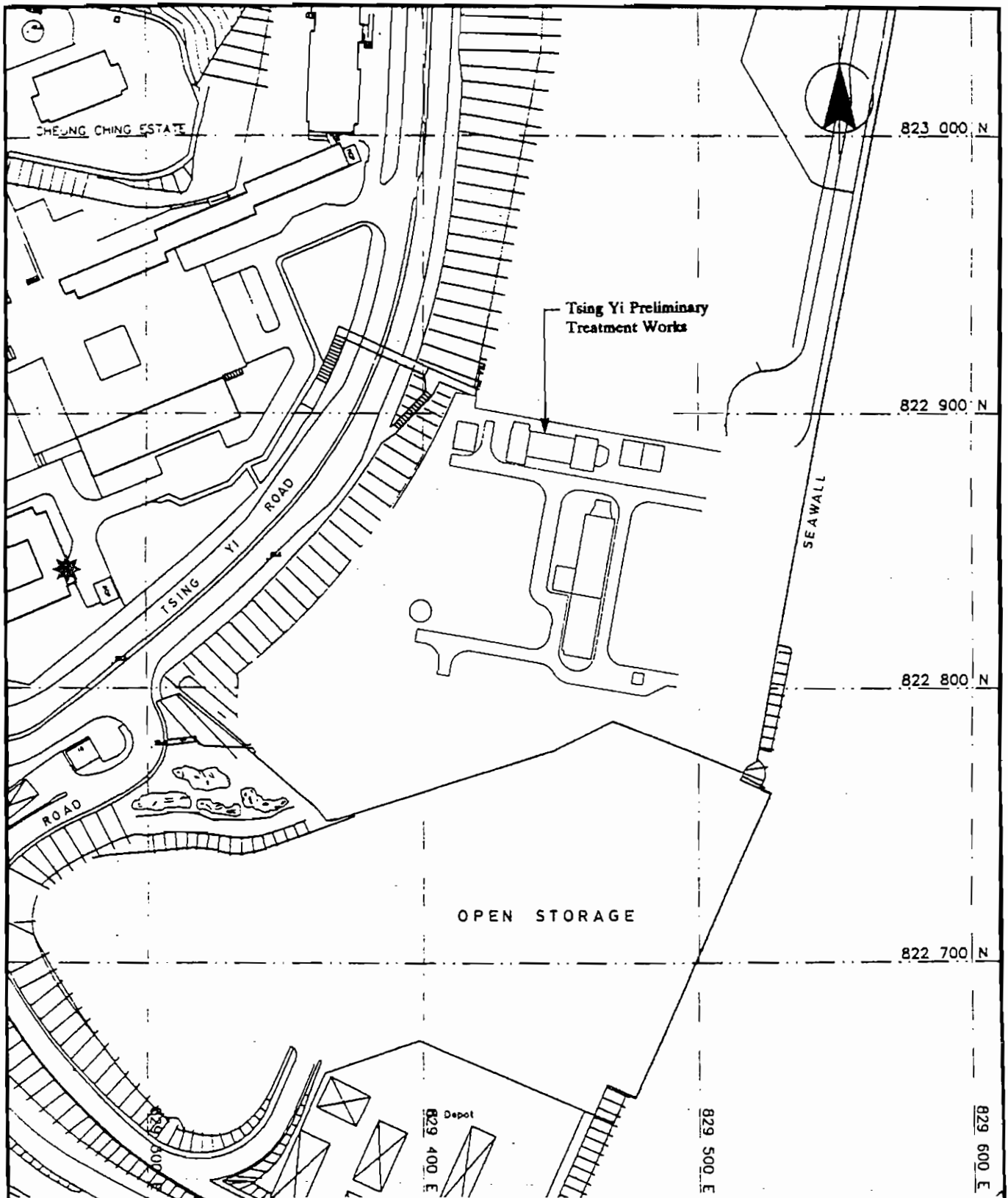
PREPARED BY: MOTT MACDONALD LTD



MONTGOMERY WATSON
環境顧問工程師

Corporate & Mott MacDonald • Mott MacDonald • Mott MacDonald • Mott MacDonald
WGF Engineering Inc. • Operational Services Inc.

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Legend :



Noise Sensitive Receivers

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**Strategic Sewage Disposal Scheme
Stage 1 - Principal Collection & Treatment System**

**Tsing Yi Preliminary
Treatment Works**



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Figure 1.8

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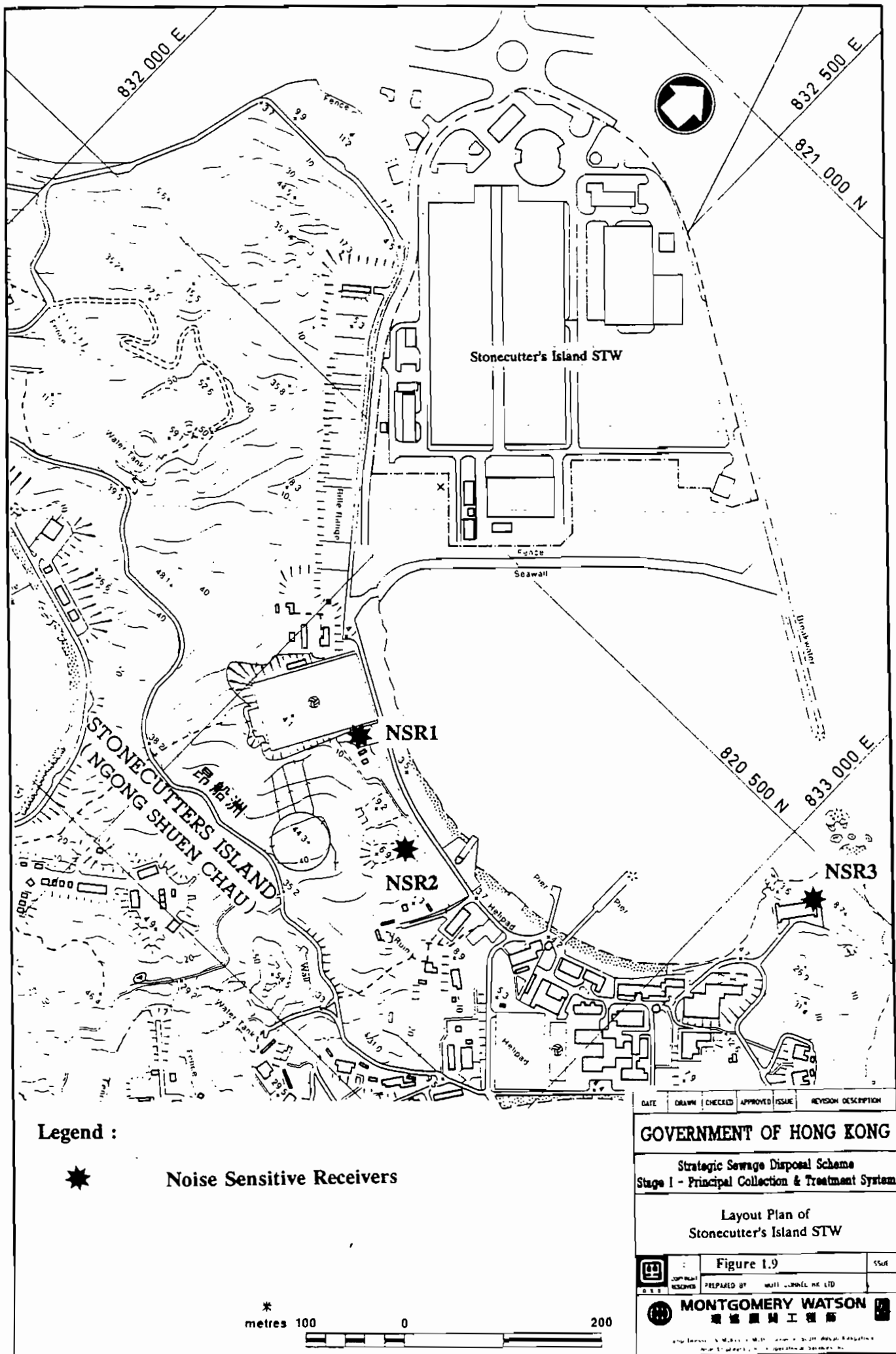


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Lamp Director & McKee • Mott Connell • Scott Wilson Knaptrick
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Noise Sensitive Receivers

DATE	DRAWN	CHECKED	APPROVED	ISSUE	REVISION DESCRIPTION
<p>GOVERNMENT OF HONG KONG</p> <p>Strategic Sewage Disposal Scheme Stage 1 - Principal Collection & Treatment System</p> <p>Layout Plan of Stonecutter's Island STW</p> <p>Figure 1.9</p> <p>PREPARED BY: MONTGOMERY WATSON</p> <p>MONTGOMERY WATSON 環境顧問工程師</p>					

2.1 The Design Objectives

The Stage I Scheme was conceived to provide rapid and tangible benefit, to water quality and must be viewed as an intermediate solution, pending implementation of Stage II of the SSDS. The primary objective is to improve the quality of water in and around the Harbour as soon as possible, with commissioning of the Stage I Scheme scheduled for mid-1997.

The water quality objectives which are most threatened and which Stage I will directly improve, are those relating to bacteriological pollution. The design objective of the scheme, stated in the Design Memorandum issued in December 1993, is to collect and remove at least 95% of E.coli load. This shall be achieved using a chemically assisted sedimentation process. A further benefit of the chemically assisted sedimentation process is that it will markedly reduce the discharge of metals to the Harbour and most particularly copper, which is one of the most prevalent forms of pollution at present. (In the medium and long term however, the proposed strategy is to control toxic metal discharges at source by legislation and enforcement.)

Removal of nutrients is a long term objective and will only be achieved through implementation of the Stage II Scheme.

The primary engineering objectives for the Stage I (Interim) and Stage II (Ocean) Outfalls, as defined in the Design Memorandum December 1993, are to provide a cost-effective scheme with a high degree of reliability, easy to maintain and flexible for expansion in the future. Basic precepts of the SSDS are that impacts on people and the environment are to be reduced as far as is practical during both construction and operation of the Scheme, and that all statutory control limits and authoritative guidelines shall be met as an absolute minimum requirement. Specifically, the engineering objectives for components of the Scheme may be summarised as follows:

(i) Stage I (Interim) and Stage II (Ocean) Outfall

- to provide sufficient hydraulic capacity for effluent until the ocean outfall is commissioned;
- to locate and configure the outfalls to best achieve the water quality objectives whilst satisfying navigational and other physical constraints;
- to ensure robust design to minimise potential damage from shipping; and
- to ensure that saline purging can be easily effected.

(ii) Modifications to Existing Screening and De-gritting Works

- to ensure adequate treatment to avoid sediment deposition in downstream tunnels which form part of the SSDS System; and
- to arrange facilities and operations to reduce overflows to inshore waters to a minimum.

(iii) Connections to Shafts

- to minimise disruption to operation of the existing system when building connections to existing works;
- to ensure that all sewage discharge to the tunnels has received preliminary treatment; and
- to reduce overflows to the Harbour to a minimum.

(iv) Tunnels

- to design conveyors to transport sediment, so as to avoid sediment build-up;
- where possible, to design tunnels of optimum economic size taking into account the most likely flow scenario and the capital and the operating costs of the conveyance system, including the pumping stations;
- to design tunnels to be capable of operating efficiently over a long period of time (of the order to 100 years) on a 'minimum maintenance' basis, therefore, high durability is a prerequisite for design of the conduits; and
- to design tunnels to provide access and any in-built facilities required for pumping out in emergency cases.

(v) Pumping Stations

- to reduce capital and operating costs to a minimum;
- to ensure sufficient hydraulic capacity under maximum flow conditions;
- to ensure security of operation;
- to provide capability for the continuous operation of at least one pump to prevent saline intrusion in the Stage I Outfall (until Stage II is commissioned), and the Stage II Ocean Outfall; and
- to reduce maintenance requirements to a minimum.

(vi) Sewage Treatment Works

- to provide sufficient hydraulic capacity;
- to provide sufficient capability to achieve an acceptable standard of effluent at an appropriate cost, taking into account dilution and dispersion after discharge through the appropriate design of the diffusers;;
- to provide capability for sludge treatment and disposal operations; and
- to provide ease of operation and maintenance of mechanical, electrical and instrumentation control and automation (ICA) plant.

(vii) Power Supply and Distribution Systems

- to provide highly reliable systems; designed to assist efficient operation and maintenance of the Scheme, which will minimise the risk associated with a failure in the system.

2.2

Revisions to the Preliminary Design Concept

Following a review of the Preliminary Design fundamental modifications were made in the Detailed Design for the Stage I Outfall upon which this EIA is based. The most significant change in terms of impacts on the marine environment is that the outfall will not be constructed as an immersed tube, as recommended in the Preliminary Design, but rather as a tunnel for the reasons summarised below:

- (i) the immersed tube option would involve either constructing the outfall ahead of schedule in conjunction with the seawall for Container Terminal No. 8 (CT8), or would involve excavating through the seawall at a later date. The tunnelled option does not impinge on the CT8 reclamation at all.
- (ii) the immersed tube option has the potential to disrupt shipping in the busy Northern Fairway for a period of several months. The tunnelled option does not present this problem.

- (iii) the immersed tube option requires extensive land availability for fabricating components of the outfall. If no suitable site was available in Hong Kong, sites would need to be sought further afield with associated problems of the procurement and preparation of land, in addition to the transportation difficulties.

An added benefit of the tunnelled option compared to the immersed tube alternative, is that it involves significantly reduced impacts during construction on surrounding property and neighbouring facilities which as stated previously, is a fundamental aim of this Project.

Construction of a driven tunnel will also greatly reduce the size of casting basins required, reduce the quantity of concrete used, the volume of spoil generated and the duration of construction in terms of marine impacts. The reduction in the amount of spoil to be disposed of constitutes a direct benefit at the disposal grounds; in addition, it requires fewer marine transport operations for its disposal, causing less disruption to maritime traffic and reducing the potential of spoil discharge prior to reaching the designated disposal area.

Another fundamental change in the Detailed Design, is a revision of projected future discharge rates which are significantly greater than those forecast previously. Furthermore, the commissioning date of Stage II of the Scheme, in which the ocean outfall will be constructed, has been postponed from the original anticipated date of 2001, to a date some years later, thereby necessitating the Stage I Outfall to be operational for a longer period of time than originally anticipated.

The Marine Department has also indicated that the Northern Fairway may be widened at some stage in the future, which poses a constraint in terms of the location of the outfall diffusers.

2.3 Revision to the Detailed Design

2.3.1 Design Flows

A range of design flows were generated for different planning horizons using data sourced from planning studies. The design flows take account of both seasonal and diurnal variations and made allowances for groundwater infiltration which was added to the per capita flow rates.

The ADWF corresponds to the averaged daily flow occurring on "dry" days throughout the year, where a "dry" day is defined as one in which less than 1 mm of rainfall was recorded and which is followed by at least a further 3 consecutive dry days. The MDWF corresponds to night-time flows in the dry season (January - February) whilst the PDWF corresponds to day-time flows on "dry" days during the wet season (July - August).

Based upon the figures for seasonal and diurnal variations, the MDWF was derived from the ADWF in accordance with $MDWF = 0.45 \times 0.89 \times ADWF$ for each Sewage Catchment Area (SCA). This method of estimation was adopted for determining minimum dry weather flows for detail design.

Dry weather peaking factors were developed during the SSS and are depicted graphically in Figure 03.2 of the SSS for estimation of wastewater flows in sewerage and for application to preliminary/primary treatment systems. Derivation of flows using the SSS figure results in peaking factors of between $x 1.65$ to $x 1.95$ and more accurately reflects the differing nature and spatial variation of the Stage I sewage catchments. Accordingly, the application of dry weather peaking factors as described in Figure 03.2 of the SSS was considered to be more appropriate in deriving peak dry weather flows for the Stage I Scheme.

Peak wet weather flows coincide with unusual rainfall events and occur infrequently (perhaps at intervals of 9-24 months). However, these extreme flow values need to be accommodated within the sewerage system and preliminary treatment facilities to minimise the risk of overloading and flooding, and to control the level and frequency of overflow of wastewater into the storm drainage system.

The projected design flows vary from those presented in the Preliminary Engineering Review (PER) in two main areas :

- (i) the ADWF and the PDWF are higher in sewage catchment areas on the Kowloon Peninsula as a result of the inclusion of the findings of the Kowloon Density Study
- (ii) the PDWF's are higher in all sewage catchment areas as a result of applying the peaking factors derived under the Sewage Strategy Study.

Design flow projections adopted for sewage catchment areas within the Stage I Scheme are provided in Tables A1 - A5 for the commissioning year (1997) and key planning years of 2001, 2006, 2011 and 2021 in Appendix A of the SSS. Comparison of the Stage I flows forecast during the Preliminary Engineering Review and those now calculated under the Detailed Design are illustrated in Table 2.1.

Table 2.1 Comparison of Stage I Tunnel Flow Projections

Tunnel Section	Year		
		Proposed during Preliminary Design	Proposed for Detail Design
Tseung Kwan O → Kwun Tong	1997	1.44	1.86
	2001	2.07	2.83
	2006	2.83	3.96
	2011	3.66	4.89
	2021	4.89	4.89
Chai Wan → Shau Kei Wan	1997	1.11	1.66
	2001	1.09	1.66
	2006	1.11	1.66
	2011	1.13	1.66
	2021	1.16	1.66
Shau Kei Wan → Kwun Tong	1997	1.84	2.62
	2001	1.78	2.55
	2006	1.91	2.69
	2011	2.05	2.72
	2021	2.22	2.72
Kwun Tong → To Kwa Wan	1997	8.45	11.04
	2001	8.89	12.58
	2006	10.37	13.85
	2011	11.94	14.81
	2021	14.12	14.81
To Kwa Wan → Stonecutters Island	1997	13.65	18.03
	2001	13.93	19.57
	2006	15.99	20.84
	2011	18.07	21.80
	2021	21.11	21.80
Kwai Chung → Tsing Yi	1997	6.21	7.36
	2001	5.99	7.36
	2006	6.39	7.36
	2011	6.78	7.36
	2021	7.36	7.36

Table 2.1 Comparison of Stage I Tunnel Flow Projections (Cont'd)

Tunnel Section	Year		
		Proposed during Preliminary Design	Proposed for Detail Design
Tsing Yi → Stonecutters Island	1997	7.49	9.00
	2001	7.90	9.45
	2006	8.38	9.45
	2011	8.85	9.45
	2021	9.45	9.45
Total Tunnel Flow to Stonecutters Island Main P.S.	1997	21.14	27.03
	2001	21.83	29.02
	2006	24.37	30.29
	2011	26.92	31.25
	2021	30.56	31.25

2.3.2 Stage I Outfall

In the Initial Design Memorandum, December 1993, it was anticipated that there would be no contaminated mud to be dredged to provide the trench for the outfall. Subsequently site investigations were carried out and a Sediment Quality Report was prepared for the Fill Management Committee and EPD, which quantified the volume and extent of contaminated mud to be disposed of at the Contaminated Spoil Disposal Ground at East Shau Chau. Conditions were specified in the relevant Contract Document to minimise the impacts of this activity on water quality at the dredging and disposal grounds.

Since the issue of the PER the projected future flow rates have increased to varying degrees in the wet season and dry season. Increases in average and peak flow rates are of the order of 20-30%. During the detailed design an additional study was undertaken to identify the implications of the increase in the projected flow rate.

The overall conclusion was that despite the predicted increases in effluent flow rates and pollution loads, general improvements in water quality will still be realised in many areas, including Victoria Harbour, following the implementation of the Stage I Scheme.

2.3.3 Design Criteria for Unit Processes

The design criteria which were adopted for use in the water quality assessments reported upon in March 1995, were based on the assumptions made in the Initial Design Memorandum, dated December 1993. The design criteria now adopted for use are given in Table 2.2.

Table 2.2 Unit Process Design Criteria

Treatment Plant Design Flows		
	Units	Year 2021
Peak Wet Weather Flow (PWWF)	m ³ /s (Mld)	39.75 (3435)
Avg. Dry Weather Flow (ADWF)	m ³ /s (Mld)	19.97 (1725)
Min. Dry Weather Flow (MDWF)	m ³ /s (Mld)	8.51 (735)
Avg. Influent Design Concentrations		
Parameter	Unit	Year 2021
pH		6 - 8
Temp	°C	10 - 28
SS	mg/L	215
BOD ₅	mg/L	272
TTM	mg/L	4.1
E. Coli	No./100 ml	1.52 x 10 ⁷ ± 5%
Pollution Reduction		
Parameter	Unit	Year 2021
Condition		FeCl ₃ 20-40 mg/l + Polymer 0-2 mg/l
SS	% removal	70 ±
BOD ₅	% removal	35 ±
E. Coli	% removal	50 ±

2.3.4 Characterisation of Effluent

Sewage entering the primary treatment works will undergo preliminary treatment through 6mm aperture fine screening and grit removal processes. In order to maintain adequate velocities in the tunnels during periods of low flow, seawater will be pumped into the tunnels at various locations. Seawater may be added to the sewage in dry weather at a maximum rate of 1.03m³/s which relates to about 10% in addition to that already discharged from salt water flushing systems. An estimated 25% by volume of total effluent is thus derived from seawater.

2.3.5 Primary Treatment at Stonecutters' Island Sewage Treatment Works

The original treatment concept was predicated on the use of lime to enhance the primary sedimentation process. A study was commissioned during the detailed design to review the chemical treatment facilities at Stonecutters' Island Sewage Treatment Works in which it was recommended that alum and polymer would allow greater flexibility to the plant operators.

Subsequently, an external review of the Project was undertaken which proposed that instead of lime or alum, ferric chloride should be used to enhance the sedimentation process. The change from the use of lime to ferric chloride for enhancing sedimentation and sludge settlement has resulted in changes to the design and materials used for the E&M works at the plant. The permanent (rather than temporary) use of these chemicals, has resulted in the need for fewer sedimentation tanks on account of the increased surface loading rate to the sedimentation tanks.

Changes between the Design Memorandum (December 1993) and the Revised Design Memorandum are:

- Ferric chloride and polymer will be used instead of lime and polymer and its use will continue during Stage II up to the year 2021. Therefore there is no interim design criteria for the year 2003.

- The dosage of ferric chloride will be less (at 20 to 40 mg/l) compared to lime (at 120 to 160 mg/l). However, due to the chemistry of the precipitate formed (less ferric sludge will be formed per kg of chemical used than for lime), there will be a reduction in the amount of ferric sludge generated on a dry-solids basis.
- Although there will be less dry sludge produced, the sludge will settle to a less dense form (2 to 4 percent versus 4 to 7 percent with lime). Therefore, the net total change is an increase in the volume of liquid sludge generated by the facilities.
- TTM concentration will be controlled by the reduction at sources instead of treating at the Stonecutters Island Sewage Treatment Works. Hence, the design criteria for TTM is not set.
- E. coli and ortho-phosphate removal efficiencies will be lower due to the changes in chemical use from lime only to ferric chloride/polymer. Hence, the design criteria for E. coli, and ortho-phosphate reduction have not been established.
- The eight flocculation tanks will remain in permanent service.
- The number of sedimentation tanks used for settling sewage will drop from 54 (62 minus 8 flocculation tanks) to 38 (46 minus 8 flocculation tanks).
- The hydraulic flow through each sedimentation tank will be increased assuming that as many as 4 of the sedimentation tanks are out of service at any one time for maintenance. This will cause the flow to be processed through as few as 34 tanks (46 minus 8 for flocculation minus 4 out of service for maintenance).

2.3.6 Sludge Treatment

Following proposals made previously the Design Memorandum (December 1993) recommended the dewatering of sludge and drying of lime settled sludge, revisions to this concept were as follows:

- dewatering capacity be based upon sludge quantities for the year 2021 arising from ferric chloride dosing of the incoming sewage at the rate of 20-40 mg/l.
- sludge drying plant to be excluded. i.e. dewatering only.
- dewatering technology not be limited to membrane presses.
- plant and site layout to be designed to facilitate future extension to treat a 50% increase in sludge throughput.
- plant operation 24 hours per day, seven days per week.

Using high performance centrifuges (Contract awarded in May 1995) the sludge throughput is reported to be 542 tonne per day with a minimum cake dry solids of 32% based on the dosing of 20 - 40 mg/l of ferric chloride in the primary settlement tanks.

While the volume of sludge generated will be reduced as a result of ferric chloride being adopted, rather than lime, the storage of the sludge has increased from 10,000m³ (lime) to 12,000m³ as a result of the lower solids content in the ferric chloride sludge.

Key changes in the design of the sludge treatment facilities are summarised below:

- Changes in sludge volumes and characteristics arising from the change to ferric chloride settlement;
- Deletion of sludge drying facilities;
- Reduction in minimum sludge cake dry solids to 32%;
- Acceptance of alternative dewatering systems to membrane plate presses. e.g. centrifuges;
- Dewatering trials to be carried out by the contractor to verify dewatering performance on ferric chloride sludge, followed by a design review;
- Sludge cake silo capacity increased to accommodate increased quantities for disposal;
- Building requirements reduced due to deletion of drying plant and reduced space requirements for centrifuges; and
- Dewatering plant to be suitable for a 50% future increase in capacity.

2.3.7

Chemical Dosing Facilities

The chemical dosing facilities comprise a polymer system, a ferric chloride system, a protected water system, and a dilution water system for the polymer. Ferric chloride will be delivered to site in liquid form by barge or tanker whence it will be unloaded, using pumps, to the six storage tanks. Ferric chloride will be fed automatically to the system via the rapid mix chambers.

The implications of the change in the chemical dosing strategy was a subject of a supplementary assessment. The changes in the pollution removal rates are summarised in Table 2.3.

Table 2.3 Comparison of Pollution Removal

Parameter	No Chemical Addition	Chemical Assisted Sedimentation to pH 9.7	Chemical Assisted Sedimentation to pH 10.2	Ferric Chloride 20 - 40 mg/l
BOD	20 - 30%	35%	44%	35%
SS	44 - 50%	65%	76%	70%
TTM	25 - 37%	50%	68%	-
<u>E.Coli</u>	50%	95%	99%	50%
Orthophosphate	10%	50%	75%	-
NH ₃ N	0	0	0	-
TKN	4.3%	12.5%	17.5%	-
Organic N	10%	30%	41%	-

3.1 Introduction

Under the Stage I Scheme, effluent will be collected at a series of preliminary sewage treatment plants in Kowloon and on Hong Kong Island to be subsequently transferred, via tunnels, for treatment to primary standard, at a sewage treatment works on Stonecutters Island. Treated effluent will then be discharged to the Western Dangerous Goods Anchorage Zone via the Stage I Outfall. The main components of this Scheme which represent new works are the Stonecutters Island Main Sewage Treatment Works, the Stage I Outfall, pumping stations at Stonecutters Island and Kwun Tong and the construction of drop shafts at the various preliminary treatment works. Substantial upgrading works will be required to achieve the design standard at existing preliminary treatment works, which are also essential components of the overall scheme.

Once the Ocean Outfall is commissioned, under Stage II of the Scheme, the Stage I Outfall will be used only in emergency situations, for example if the Ocean Outfall is blocked, suffers a failure or is deliberately closed down for maintenance.

The following paragraphs outline the construction methods which were adopted for use in the Environmental Assessments which were conducted for each of the fifteen individual contracts. The construction methods were based on the information provided by the engineering design teams responsible for each Contract at the time of the assessment. It is recognised that most of the Contracts have now been let and that the Contractor may have chosen to adopt an alternative method for constructing individual components of the Scheme. Nonetheless the findings of the assessments which were carried out are still pertinent as they provided the basis for the definition of the Particular Specifications for Environmental Protection which provide the constraints and controls for maintaining environmental quality during the construction phase.

3.2 The Outfall

Essentially the Stage I Outfall begins at an existing structure, referred to as Chamber 15, and terminates at a pair of diffusers, laid on the seabed through which effluent to be discharged to the marine environment as illustrated on Figure 3.1. Modification of Chamber 15 is required as part of the Outfall construction. The Outfall also includes a short conduit connecting Chamber 15 to a drop shaft linked to a deep tunnel. The tunnel terminates in a pair of offshore riser shafts with a final section comprising the pair of diffusers.

The dropshaft entry culvert will be constructed from reinforced concrete using conventional methods, with the upper 5-10m in soft soil. It was assumed that the shaft walls would be supported by sheet piles or diaphragm walls. The soil will be excavated by a hydraulically operated excavator. Excavation through rock will be by drill-and-blast methods and it was assumed that the shaft walls will be unsupported during construction. The shaft superstructure was assumed to be of reinforced concrete construction. Below the ground surface, the shaft is likely to be lined with a precast or concrete liner, cast in-situ along its full depth.

It was presumed that the tunnel would be excavated by conventional tunnel boring machine (TBM) techniques and would be lined with precast or cast-in-situ concrete segments.

The work/staging area for the dropshaft and tunnel will occupy an area of 11,000 m² adjacent to the shaft. Precast concrete lining segments (perhaps 2.5m x 1.5m x 250mm thick) could be cast at an existing off-site facility or at one set up specifically for construction projects of the Stage I Scheme. If a cast-in-situ liner is used, concrete batching could be undertaken at the dropshaft site. In the Environmental Assessment Working Paper it was recognised that the tunnel contractor may choose to have the concrete transported from off-site facilities.

Section 3

The offshore riser shafts will be lined with steel pipe sections along their full length. The shafts will be excavated by conventional reverse circulation drilling techniques, using a jack-up rig, a semi-submersible, a derrick barge or other appropriate means. The method of drilling will enable the contractor to collect drill cuttings at the surface, for ultimate disposal away from the site. It is expected that the upper 30m of soft sediments will need to be stabilized during drilling operations, by use of steel casing, while the remainder of the shaft is likely to be unsupported. Drilling mud is not expected to be required to stabilize the walls of the shaft.

Both the diffuser pipeline and the connection between the two shafts, will probably be fabricated from steel with mortar, concrete and or dielectric coatings to protect against corrosion. The pipeline will be installed in segments up to 50m in length, in which case it was assumed that the segments will be transported by barge, off-loaded to the sea and sunk into position using two or more specially equipped barges.

Excavation of the pipeline trench was assumed to be by conventional techniques such as grab bucket or a trailing suction dredger. Sand, gravel and rock armouring will be placed over the diffuser, probably using a barge and grab buckets. It was assumed that following conventional practice dredging of any marine deposits defined as being contaminated would be undertaken using sealed grab dredgers and would be disposed of at the East Shau Chau Contaminated Mud Pits.

The 24 risers located along the diffuser pipeline will be constructed from the same material as the pipeline. Each riser will be connected to and installed with a 50m long pipeline segment. The protective dome on top of each riser manifold will be constructed using Cross Linked High Density Polyethylene (HDPEX), or similar material. The head structures on each of the 3.25m diameter riser shafts will be protected by reinforced concrete structures.

A work/staging area of about 12,000 m² will be required for the offshore work, including fabrication and storage of diffuser pipeline sections and risers, tunnel lining segments for the offshore riser shafts, and offshore riser head structures.

Casting and storage of tunnel lining segments and concrete protection structures, fabrication and welding of miscellaneous components, and assembly of various components, including application of protective coatings, may also be carried out.

Use of marine access was recommended for the import to and export of materials and components of the Outfall as it would reduce congestion on local roads at Stonecutters Island and would minimise the on-site impacts associated with for example batching of concrete.

Components of the detailed design which have the effect of reducing environmental impacts include the adoption of a driven tunnel rather than an immersed tube tunnel as proposed in the Preliminary Design. Construction of the latter would have had a more significant impact on the marine environment for a longer period of time. The substantial reduction in the requirement for concrete and casting basins is of a great benefit because it not only minimises marine pollution, but reduces the impacts on land-based sensitive receivers (both adjacent to the casting yards and through the reduction in traffic associated with this work). Furthermore, the substantially reduced dredging requirements of the present design is of environmental benefit in terms of the smaller burden placed on disposal sites, the impacts on the quality of receiving waters and at disposal sites and the consequential reduction in marine traffic involved in the spoil disposal.

3.3 The Production Shafts

Excavation of production shafts will be necessary to provide access to the tunnelling works. These production shafts are located at Tseung Kwan O, Chai Wan, To Kwa Wan and Kwun Tong where the following activities will be undertaken:

- (i) construction of guide walls and installation of diaphragm walls to rockhead around the shaft perimeter, to give an internal diameter of 10.0 metres;
- (ii) excavation in soil within the diaphragm walls or sheet piling down to rockhead;
- (iii) grouting at the rock/soil interface to control water inflows at the toe of the diaphragm walls or sheet piling as required, and to construct a reinforced, in situ concrete, ring beam to secure the toe of the support; and
- (iv) excavation in rock by drill and blast, down to the final overall depth, installing primary rock support consisting of rock dowels, welded wire mesh and shotcrete, as required. All vertical surfaces will have welded wire or chainlink mesh as a minimum precaution against falling rock. The minimum internal diameter is 8.0 metres.

At Tsing Yi, construction of the shaft will be similar to the outline given above, except that the rock is at or within a few metres of the surface. At the Stage I Outfall site the rock is sufficiently shallow to permit sheet piling to be a viable means of soft ground support. Other activities required for the production/drop shaft will be similar to those outlined above.

For the advance works at the Kwun Tong pumping station only soil excavation will be required. Construction activities include:

- (i) construction of guide walls and installation of diaphragm walls to rockhead around the shaft perimeter to give an overall internal diameter of 13.0 metres;
- (ii) excavation in soil within the diaphragm walls to a depth of 22.5 metres;
- (iii) excavation and lining of the connecting adit to the Kwun Tong pumping station production shaft/riser;
- (iv) installation of a drainage layer and casting of the reinforced concrete in situ, first stage base slab, with weep holes to relieve groundwater pressure prior to completion of the pumping station internal structure.

Measures to minimise the environmental impacts associated with excavation of the production shafts include:

- (i) the adoption of diaphragm walls for support in soil (except for the Stage I Outfall drop shaft) to minimise the impact on groundwater levels;
- (ii) the installation of diaphragm walls, which is beneficial in terms of noise because it avoids the need for percussive driving of sheet piles; and
- (iii) the adoption of soil and rock support measures to minimise the risk of ground loss and surface settlement, which also effectively reduces the risk of damage to any adjacent structures and utilities.

Environmental control measures which have also been incorporated into the detailed design include, but are not limited to, restricting blasting to daylight hours, controlling vibration and control of airborne dust levels arising from general construction works and specifically from drilling and vehicle movements on-site.

3.4 The Transfer Tunnels

The engineering objectives of the transfer system for conveyance of effluent to its ultimate destination at Stonecutters Island may be summarised as follows:

- (i) the conveyors were designed to avoid the build-up of sediments;
- (ii) economic design was optimised and limiting flow velocities were established to ensure re-scouring is achieved daily;
- (iii) the design life is of the order of 100 years on a minimum maintenance basis; and
- (iv) provision of access and any in-built facilities required for emergency pumping out in the unlikely event that this is required.

The tunnels have been designed to take account of the addition of seawater under the most restrictive flow conditions when the capacity to transport sediment is least. Such an occurrence is expected under minimum average dry weather flow (ADWF) during the dry season. This contribution of seawater is estimated to be 25% of the daily transport capacity. Design considerations include the potential effects of seawater addition on internal surface linings, including corrosion and marine growths.

To achieve re-scouring in the conveyance system, the criteria adopted require to a velocity of 1.3m/s at peak daily flow and 0.75m/s at ADWF. These conservative design parameters were proposed in the Preliminary Engineering Review and are considered by the engineering design teams to be adequate to achieve their objective. To prevent a build-up of gas and air in the soffit, the tunnels were designed with a negative gradient of 0.2%.

In the engineering design, initial consideration was given to measures minimising environmental impacts associated with the overall Scheme, and include the employment of tunnel boring machines (TBM) for the major part of tunnel excavation. Not only will this construction method reduce the disturbance caused by tunnelling, but it will also ensure that noise and vibration associated with the excavation will not be detected above ground level.

As the tunnels will maintain at least 30 metres of rock cover, the risks of ground loss and surface settlement are reduced and the potential for damage to overlying structures or utilities or the need for restrictions on future developments above the tunnels, is obviated.

Tunnels will be driven from Chai Wan and Tseung Kwan O to Kwun Tong using a TBM. An erection chamber for the TBM will initially be excavated at the base of the production shaft by the drill and blast method. This activity is scheduled to take a period of 2 months to complete, at both Chai Wan and Tseung Kwan O. Rock dowels, welded wire mesh and shotcrete will then be installed as required, to provide primary rock support. As the TBM drives proceed, primary rock support comprising rock dowels, welded wire mesh and steel ribs and lagging will be provided as required.

The tunnel drive between Chai Wan and Kwun Tong is scheduled to take place over a period of 12 months, with the tunnel drive between Tseung Kwan O and Kwun Tong, programmed over a 13 month period.

Depending upon the quality of the rock encountered, it may be necessary to grout areas of poor quality rock face to control seepage and inflow of groundwater. Once the tunnels have been driven, concrete pipes will be installed over a seven month period. To expedite this activity and to meet the programme requirements, installation of pipes will be carried out from both ends of the tunnel. Either concrete or grout will be used to backfill between the pipe and the tunnel wall, which is expected to be completed within a period of 2 months.

The short (197m) section of tunnel between Chai Wan Sewage Treatment Works (STW) and the Chai Wan production shaft will also be backfilled and grouted. Construction methods employed for the transfer tunnel systems, will ensure no significant noise impacts at ground level. The depth at which the works will be carried out also contributes to this aim. A fundamental design concept is that at least 30m of rock cover will be provided over the tunnels. In addition to this method of tunnelling adopted and the depth to which the tunnels are to be excavated will be such that any vibration at above-ground structures or utilities will be imperceptible.

Air quality impacts arising within the tunnel will mostly be due to exhausting of gases and replenishment of air. Ventilation within the tunnels is of particular concern with respect to the generation of silica dust and the emissions of radon gas. As sections of the tunnels (and part of the shafts) will be excavated through granite, the potential exists for high levels of these substances to be released to the internal atmosphere. Workers will be permitted to work within the tunnels only for lengths of time conforming to the Labour Department Regulations. Limits on silica dust levels (with respect to the health and safety of workers) and the requirements for monitoring air quality were specified within all relevant Contract Documents. It is unlikely there will be any adverse environmental impact associated with the venting of air from the tunnels.

Water quality impacts associated with the construction of the transfer tunnels mainly relate to ingress of groundwater. All efforts will be made to prevent intrusion of seawater because this raises several problems at the workface. Grouting of the rock face will be carried out where necessary, to control excessive ingress of water which might impede progress, risk groundwater lowering and associated settlement damage, or prejudice the long-term durability or operation of the tunnels. Excavated rock and spoil, contaminated grouts and drilling muds will be brought to the surface and will require appropriate disposal. It should be noted that spoil generation rates are greater when TBM's are used compared with the drill and blast techniques. The fraction of rock is also smaller, thus requiring more stringent dust control measures to be applied.

3.5

The Preliminary Treatment Works

The basis of the design criteria for the various Preliminary Treatment Works within the scheme is given in the report "Preliminary Treatment Plants - Final Report on Process Design", February 1994, and for the Tseung Kwan O Outfall Pumping Station in the SSDS Design Memorandum, December 1993.

The objectives of the Preliminary Treatment Works are to remove grit and other heavy particles and fine screenings from the sewage prior to entering the tunnel systems for onward conveyance to Stonecutters Island for primary treatment. Degritting is considered essential to prevent siltation in the deep tunnels which would affect the hydraulic performance of the conveyance system, increase the potential for overflow discharges to the harbour and create the need for maintenance of the system.

Although fine screening of the sewage is not an essential process, it is nonetheless recognised that considerable benefits can be accrued from the removal of rags and debris from the effluent. The main benefit of fine screening will become apparent during the infrequent events when sewage cannot be accommodated within the tunnel conveyance system, as a result of seasonal high flows or because of some malfunction in the system. During such times, effluent will have to be discharged to Victoria Harbour. Screens with 6 mm apertures will be provided at all of the Preliminary Treatment Works concerned.

Section 3

Upgrading of the existing Preliminary Treatment Works will involve similar activities at each site, although the scale of the works will vary depending upon the present facilities and their state of repair. Activities which will be required at individual sites includes:

- (i) demolition of parts of existing plants
- (ii) piling for new foundations
- (iii) reinforced concrete construction
- (iv) new building construction
- (v) site road and drainage construction
- (vi) mechanical and electrical installation

Sites which require major up-grading work include Chai Wan, Kwun Tong and To Kwa Wan. Construction works at these sites are programmed to be completed within a 12 to 18 month period. Works at the other sites should be completed within a period of 12 months, although the actual schedules will be governed by the time required to fabricate, transport, install and commission the mechanical equipment. Details of the construction programmes are given in Appendix B.

The following principles will be applied to the upgrading of the preliminary treatment works:

- (i) all flows to the tunnels will be given full treatment, and standby treatment units will be provided in each case to enable one duty unit to be removed from service for maintenance or repair;
- (ii) excess flows which may have to be discharged to the Harbour will also be given preliminary treatment; and
- (iii) if possible the current nominal capacity of the existing works will be maintained, even if these exceed the adopted SSDS design flows.

The sequence of operations at the Preliminary Treatment Works is mechanically raked coarse bar screens, pumping (screw or centrifugal), mechanically raked fine bar screens and grit removal in detritors. While screening of the effluent is not essential with regard to the hydraulic performance of the conveyance systems, the removal of rags and debris prior to the effluent entering the tunnels will undoubtedly be beneficial. Operations at the Stonecutters Island Treatment Works will also be simpler if these materials are removed. The main benefit will, however, manifest during periodic events when effluent cannot be accommodated in the tunnel system due to high seasonal flows or following malfunction within the system.

Grit removal using detritors is recommended, because they are simple to operate and not dependant on mechanical equipment. Detritors are often constructed with an integral grit and washer/separator which consists of a reciprocating rake classifier installed on an inclined ramp constructed alongside the tank. Grit is scraped by a rotating mechanism from the detritor floor into a pit at one side of the tank. The reciprocating mechanism gradually lifts the grit along the ramp, washing it as it travels. Organics are returned to the detritor by means of a return pump. The final product is a relatively clean grit, containing little free water, which is suitable for direct disposal into a container and thus onward disposal at a landfill site.

At Tseung Kwan O the system presently in use is one where the grit is removed from the detritor side pits by a pump, the grit slurry being removed from the tank and sent back to a grit handling system. Handling of screenings is an unpleasant operation which may generate odours and result in complaints from operatives. It was therefore recommended that screen washing systems are installed at this Preliminary Treatment Works, subject to a detailed evaluation of their performance.

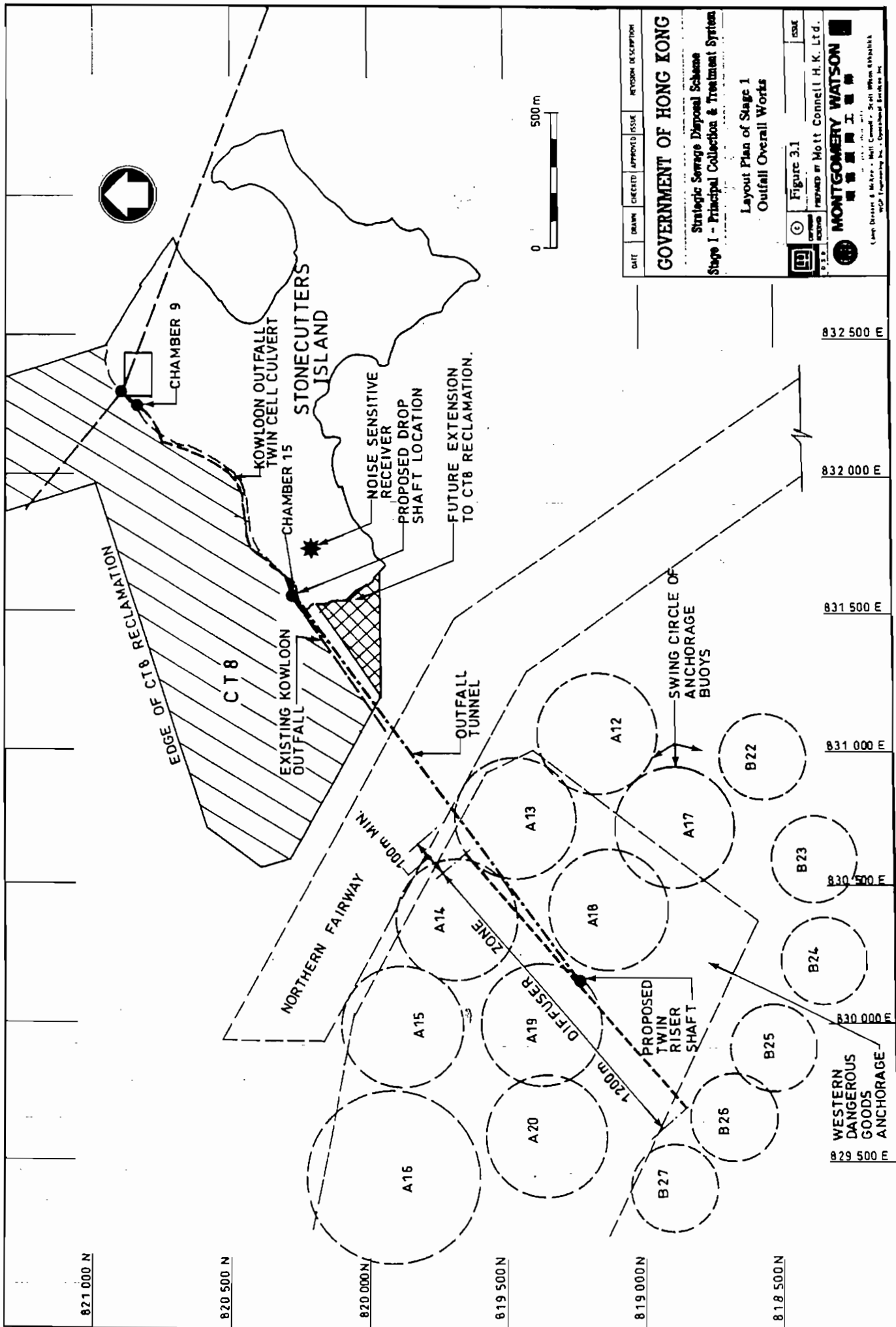
Only the plants at Shau Kei Wan and Kwai Chung do not require augmentation to the works. However, at Shau Kei Wan the screenings handling system is considered to be unacceptable and required replacement.

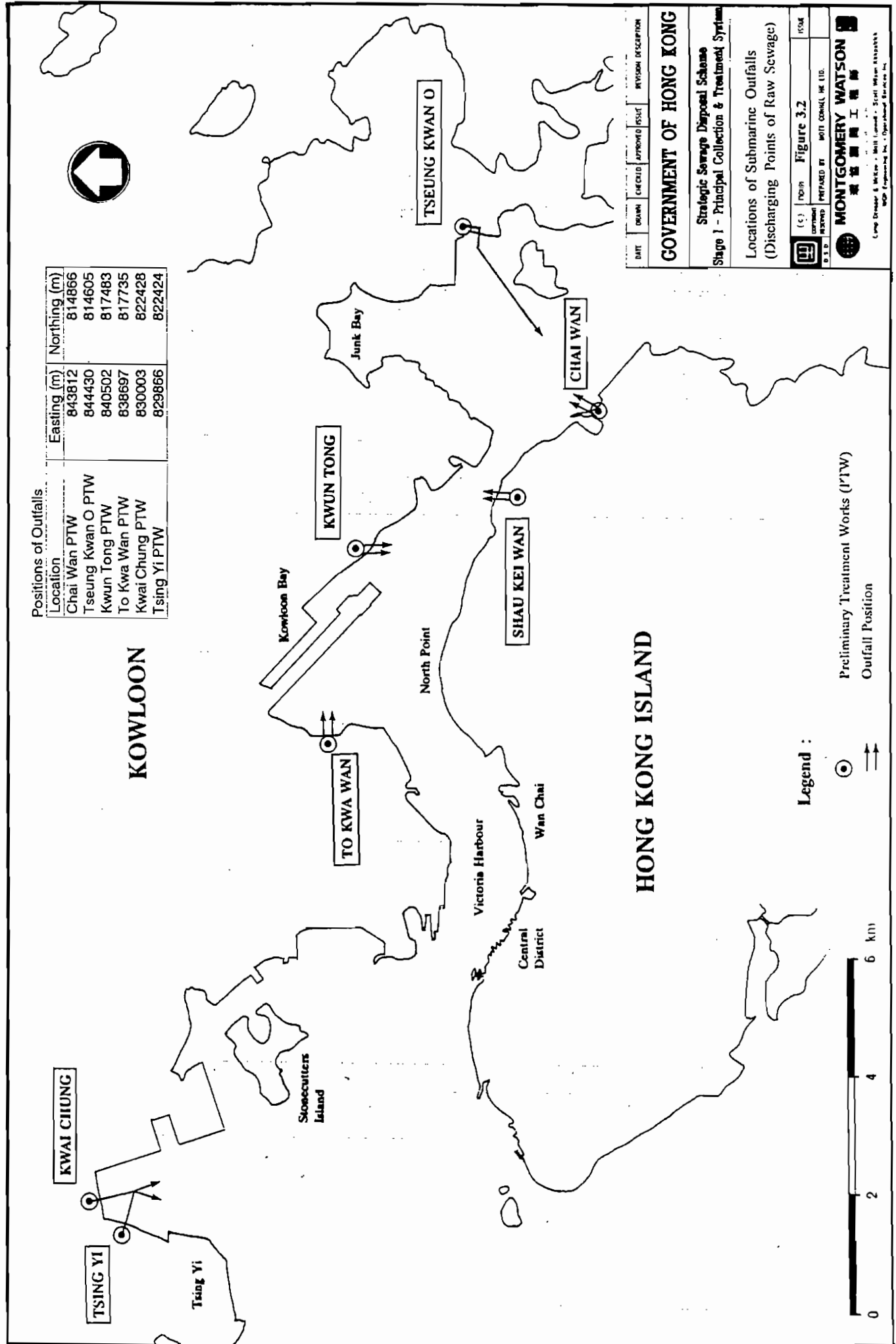
As the up-grading activities at the Preliminary Treatment Works will be carried out while the plants are operational, pollution control measures are particularly relevant to this work. Due to the close proximity of some of the work sites to sensitive receivers, specific attention will be given to reduction of noise and dust levels generated through the execution of the Contract. Emphasis has been placed on the continuous operation of the Preliminary Treatment Works during the construction phase. However, there will be occasions when effluent may need to be discharged without first being screened. EPD will be notified in advance of such events with the works being scheduled to occur during periods of low night-time flow (to minimise the impact on the receiving water quality). Discharge locations are shown on Figure 3.2.

At sites where major modifications to existing works are required to upgrade the levels of treatment to the design standard, temporary works will be constructed to allow inflows be redirected around the works area while maintaining effective treatment and plant operation. Potential environmental impacts associated with this component of the overall scheme include elevated dust levels and noise impacts, temporary discharges of unscreened effluent, disruption of local traffic and noise and air quality due to construction vehicles, especially during the demolition phases.

Drop shafts are required at each of the preliminary treatment works to transfer screened flows from the catchment area to the tunnels. Construction techniques will be similar to those described previously for the production shafts. Indeed, in some cases the drop shafts will be provided by modification of the production shafts when the latter have served their purpose of providing access for the tunnelling work.

Layout plans of new preliminary treatment works are included in Appendix J.





DATE	DRAWN	CHECKED	APPROVED	ISSUE	REVISION DESCRIPTION
GOVERNMENT OF HONG KONG					
Strategic Sewerage Disposal Scheme					
Stage 1 - Principal Collection & Treatment System					
Locations of Submarine Outfalls (Discharging Points of Raw Sewage)					
(S)	NO. 10	Figure 3.2		ISOM	
DESIGNED	PREPARED BY	MOTT MACDONALD HK LTD.		MONTGOMERY WATSON	
D.R.D.	蒙 麥 堅 尼 工 程 師 (Civil Engineer & Marine - Soil Control) - Soil Marine Specialist MOTT MacDonald Inc. - Operational Services Inc.				

ENVIRONMENTAL BASELINE, STANDARDS AND LEGISLATIVE CONTROLS

4.1 Noise

Legislative Control

Noise control is implemented through the Noise Control Ordinance (NCO), Cap. 400, its regulations and three Technical Memoranda (TMs). Two of the TM's apply to construction noise and the third to non-construction noise. The NCO provides the method for defining Noise Sensitive Receivers (NSR's), in addition to imposing stringent controls on construction works carried out close to any identified NSR.

The Technical Memorandum on "Noise from Construction Work other than Percussive Piling (TM1)" is particularly pertinent to the construction stages of this project. This Technical Memorandum details permissible levels for construction noise and provides the method for calculating noise impacts. No work using powered mechanical equipment is allowed during any defined restricted period unless a Construction Noise Permit (CNP) has been obtained by the Contractor. Area Sensitivity Ratings (ASR's) were assigned, for each site, using the method specified in the TM which takes account of surrounding land uses as well as the type of dwelling. Basic Noise Levels (BNLs) are ascribed according to the Area Sensitivity Rating (ASR) as shown in Table 4.1.

Table 4.1 Area Sensitivity Rating

Type of Area Containing Noise Sensitive Receiver	Degree to which NSR is affected by Influencing Factors		
	Not Affected	Indirectly Affected	Directly Affected
(i) rural area, including country parks or village type developments	A	B	B
(ii) low density residential area consisting of low-rise or isolated high-rise developments	A	B	C
(iii) urban area	B	C	C
(iv) area other than those above	B	B	C

Acceptable Noise Levels (ANLs) for construction works are calculated from the BNLs following corrections for the duration of the CNP and for multiple site situations. For the SSDS the ANLs are assumed to be the same as the BNLs and are provided for reference for each ASR in Table 4.2.

Table 4.2 Acceptable Noise Levels for Construction

Time Period	Acceptable Noise Level dB(A)		
	ASR A	ASR B	ASR C
Period 1 All days during the evening (1900 - 2300 hours), and general holidays (including Sundays) during the daytime and evening (0700 - 2300 hours)	60	65	70
Period 2 All days during the night time (2300 - 0700 hours)	45	50	55

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Furthermore, the maximum noise level recommended by EPD should not exceed 75 dB(A) at any sensitive receiver during periods not restricted under the NCO. This criterion has been included in the Particular Specification Clauses, Section 26A Environmental Protection.

With regard to the particular case of schools, it should be noted that in EPD's "Practice Note ProPECC N2/93," it is recommended that the maximum noise levels should be 70 dB(A) for those periods not restricted under the NCO, with a further reduction of 5 dB(A) during examinations. Under this Practice Note the equivalent maximum level at dwellings is 75 dB(A).

The special requirements for percussive piling are set out in the Technical Memorandum on "Noise from Percussive Piling (TM2)" for working under a permit system. Construction noise permits are required for percussive piling and determination of the permitted hours of operation and other conditions where necessary. Percussive piling is prohibited during the restricted periods unless specifically exempted. Acceptable Noise Levels (ANLs) are provided in TM2 for buildings with various types of windows or ventilation systems. The ANLs are given in Table 4.3 below.

Table 4.3 Acceptable Noise Levels for Percussive Piling

NSR Window Type or Means of Ventilation		ANL (dB(A))
(i)	NSR (or part of NSR) with no windows or other openings.	100
(ii)	NSR with central air conditioning system.	90
(iii)	NSR with windows or other openings but without central air conditioning system.	85

For NSR's which are hospitals, medical clinics, educational institutions, courts of law or other receptors which are considered to be particularly sensitive to noise, a further reduction of 10dB(A) shall be applied to the ANLs given in Table 4.3.

In addition to the foregoing, subsidiary regulations control noise levels emanating from hand held percussive breakers and air compressors and require compliance with the relevant noise emission standards and the fitting of Noise Emission Labels.

When the sewage disposal facilities are operational, they will be controlled according to the "Technical Memorandum for the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites" (TM3). These are provided in Table 4.4 below.

Table 4.4 Acceptable Noise Levels for Operation

Time Period	ASR A	ASR B	ASR C
Day (0700 to 1900 hours)	60	65	70
Evening (1900 to 2300 hours)			
Night (2300 to 0700 hours)	50	55	60

In addition to the foregoing criteria, the design limits provided in the "Hong Kong Planning Standards and Guidelines (HKPSG)" for operational noise are the ambient background noise levels or ANL minus 5 dB(A) whichever is the lower.

Existing Noise Levels

Existing background noise levels at the nearest NSR before the commencement of construction activities were defined by baseline monitoring. Detailed results of the baseline monitoring carried out by the resident site staff prior to construction are given in Appendix C with a summary of the results provided in Table 4.5.

Table 4.5 Existing Background Noise Levels at NSRs, dB(A)

Location	Existing Background Noise Levels, dB(A)		
	0700 - 1900	1900 - 2300	2300 - 0700
Stonecutters Island STW	64.5	57.4	55.7
Stage 1 Outfall	-	-	-
Chai Wan	-	66.5	61.7
Shau Kei Wan	-	-	-
Tseung Kwan O	-	60.3	58.1
Kwun Tong	-	63.2	57.5
To Kwa Wan	-	60.0	58.8
Kwai Chung	-	-	-
Tsing Yi	-	61.2	59.1

The noise levels provided in Table 4.5 were used to define the ambient background noise levels for the environmental assessment of the operational phase of the Stage I Scheme.

4.2

Air QualityLegislative Control

Air quality is regulated through the Air Pollution Control Ordinance, 1983 Cap. 311, which provides, inter alia, statutory Air Quality Objectives for each Air Control Zone (ACZs). ACZ's have been declared for the whole of the Territory, and the associated AQO's are provided as Table 4.6.

Table 4.6 Hong Kong Air Quality Objectives

Pollutant	Concentration $\mu\text{g}/\text{m}^3$ (i) Averaging Time				
	1 Hour (ii)	8 Hours (iii)	24 Hours (iii)	3 Months (iv)	1 Year (iv)
Sulphur Dioxide	800		350		80
Total Suspended Particulates (v)			260		80
Respirable Suspended Particulates (v)			180		55
Nitrogen Dioxide	300		150		80
Carbon Monoxide	30000	10000			
Photochemical Oxidants (as ozone (vi))	240				
Lead				1.5	
(i) - Measured at 298°K (25°C) and 101.325 KPa (one atmosphere). (ii) - Not to be exceeded more than three times per year. (iii) - Not to be exceeded more than once per year. (iv) - Arithmetic means. (v) - Respirable Suspended Particulates means suspended particulates in air with a nominal aerodynamic diameter of 10 micrometers and smaller. (vi) - Photochemical oxidants are determined by measurements of ozone only.					

Specified Processes which are named under the Air Pollution Control Ordinance have specific controls attached and include, inter alia, concrete batching and rock crushing. Although the latter is unlikely for any of the Construction Contracts it is likely that concrete batching facilities will be required at different stages of the construction phase. It should be noted that the Contractor will require a special licence before he can operate any concrete batching plant. EPD also recommend that a maximum hourly level of 500 $\mu\text{g}/\text{m}^3$ suspended particulates should not be exceeded at the boundary of any construction site.

The operational phase of the project will also be subject to air pollution control by other legislation which includes the Air Pollution Control (Furnaces, Oven and Chimneys) (Installation and Alteration) Regulations (Jan 1989) and Air Pollution Control (Fuel Restriction) Regulations (Aug 1990). The Contractors attention is also drawn to the "Code of Good Practices for the Operation of Liquid Fuel - Fired Commercial, Industrial and Domestic Appliances (Mar 90)."

The proposed fuel storage facility at Stonecutters Island will be classified as a Specified Process under amendments to the Air Pollution Control Ordinance under the Category of "Organic Chemical Works". A licence may be required from the EPD prior to its operation.

The odour nuisance guidelines from EPD have been quoted as:

"The recommended criterion is the odour nuisance threshold of the identified odorous gas in the aerial emissions, which is taken to be 5 times the odour detection threshold of the gas. This odour nuisance threshold is then used to compare with the predicted concentrations of the odorous gas at any receptors outside the plant, which are based on an average time of about 5 seconds, for the purpose of determining the likelihood of an odour nuisance."

Existing Air Quality

Existing background 1-hr TSP levels measurements at the designated air quality monitoring stations were carried out prior to the commencement of the construction activities. The averaged background 1-hr TSP levels are summarised in Table 4.7 and the detailed results of air quality monitoring at each construction areas are tabulated in Appendix D(3). From the results of air quality monitoring, it shows that 1-hr TSP levels are below the target level of 500 $\mu\text{g}/\text{m}^3$ EPD have recommended.

Table 4.7 Baseline 1-hr TSP Monitoring Results

TSP ($\mu\text{g}/\text{m}^3$)	Kwun Tong	Tsing Yi	To Kwa Wan	Chai Wan	SCI Outfall	Tseung Kwan O
Average	48	44	44	36	30	25
Minimum	18	7	9	12	10	10
Maximum	94	92	157	77	69	54

Due to the unavailability of High Volume Samplers, the baseline air quality (24-hr TSP) measurements were not undertaken before the commencement of the construction works. Therefore, the 24-hr TSP data for the months of July 1994 and August 1994 at the monitoring stations in Kwun Tong, Sham Shui Po, Kwai Chung and Mongkok were obtained from EPD and were adopted for general reference in this study. The 24-hr TSP measurements data were included in Appendix D(3). The overall average and minimum and maximum ranges of 24-hr TSP levels were summarised in Table 4.8.

Table 4.8 Baseline 24-hr TSP Monitoring Results

TSP $\mu\text{g}/\text{m}^3$	Kwun Tong	Sham Shui Po	Kwai Chung	Mongkok
Average	94.5	84.7	66.9	142.3
Minimum	39.3	52.1	32.4	70.3
Maximum	177.7	156.3	129.9	276.7

The overall 24-hr TSP level measurements recorded at the 4 monitoring stations for the months of July and August 1994 were found to be lower than the target level of $260 \mu\text{g}/\text{m}^3$, except that recorded at Mongkok on 3rd August 1994.

4.3

Water QualityLegislative Control

Marine water quality in Hong Kong is governed by the 1980 Water Pollution Control Ordinance (Cap 358) (WPCO). Territorial waters have been subdivided into Water Control Zones (WCZ) and each zone has been assigned a series of Water Quality Objectives (WQOs) depending on the beneficial uses of the receiving waters. The WCZ most pertinent to the Stage I Scheme, once operational, is the Western Buffer Zone. During construction, WCZ's which are applicable include, Victoria Harbour and the Western Buffer Water Control Zones. Changes to ambient conditions in Victoria Harbour, Western Buffer and Southern Waters following implementation of the Stage I Scheme were assessed as part of this Study. Water quality objectives for these WCZ's are given on Table 4.9.

Table 4.9 Summary of Water Quality Objectives and their Applicability

Parameter	Water Quality Objective	Part or Parts of Zone		
		Victoria Harbour (Phase One)	Western Buffer	Southern Waters
A. Aesthetic Appearance	(a) There should be no objectionable odours or discolouration of the water.	Whole zone	Whole zone	Whole zone
	(b) Tarry residues, floating wood, articles made of glass, plastic, rubber or of any other substances should be absent.	Whole zone	Whole zone	Whole zone
	(c) Mineral oil should not be visible on the surface. Surfactants should not give rise to a lasting foam.	Whole zone	Whole zone	Whole zone
	(d) There should be no recognisable sewage-derived debris.	Whole zone	Whole zone	Whole zone
	(e) Floating, submerged and semi-submerged objects of a size likely to interfere with the free movement of vessels, or cause damage to vessels, should be absent	Whole zone	Whole zone	Whole zone
	(f) The water should not contain substances which settle to form objectionable deposits.	Whole zone	Whole zone	Whole zone

Table 4.9 Summary of Water Quality Objectives and their Applicability (Cont'd)

Parameter	Water Quality Objective	Part or Parts of Zone		
		Victoria Harbour (Phase One)	Western Buffer	Southern Waters
B. Bacteria	<p>(a) The level of <i>Escherichia coli</i> should not exceed 610 per 100 mL, calculated as the geometric mean of all samples collected in a calendar year.</p> <p>(b) The level of <i>Escherichia coli</i> should not exceed 180 per 100 mL, calculated as the geometric mean of all samples collected from March to October inclusive in 1 calendar year. Samples should be taken at least 3 times in 1 calendar month at intervals of between 3 and 14 days.</p> <p>(c) The level of <i>Escherichia coli</i> should be less than 1 per 100 mL, calculated as the geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.</p> <p>(d) The level of <i>Escherichia coli</i> should not exceed 1 000 per 100 mL calculated as the geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.</p>	Inland waters	<p>Secondary Contact Recreation Subzones and Fish Culture Subzones Bathing Beach Subzones</p> <p>Water Gathering Ground Subzones</p> <p>Other inland waters</p>	Whole zone
C. Colour	Human activity should not cause the colour of water to exceed 50 Hazen units.	Inland waters	Water Gathering Ground Subzones Other inland waters	Whole zone
D. Dissolved Oxygen	<p>(a) The level of dissolved oxygen should not fall below 4 mg per litre for 90% of the sampling occasions during the whole year; values should be calculated as the annual water column average (see Note). In addition, the concentration of dissolved oxygen should not be less than 2 mg per litre within 2m of the seabed for 90% of the sampling occasions during the whole year.</p> <p>(b) The levels of dissolved oxygen should not be less than 4 mg per litre.</p>	<p>Marine waters</p> <p>Inland waters</p>	<p>Marine waters excepting Fish Culture subzones</p> <p>Fish Culture Subzones</p>	Whole zone
E. pH	<p>(a) The pH of the water should be within the range of 6.5-8.5 units. In addition, human activity should not cause the natural pH range to be extended by more than 0.2 unit.</p> <p>(b) Human activity should not cause the pH of the water to exceed the range of 6.0-9.0 units.</p>	<p>Marine waters</p> <p>Inland waters</p>	<p>Marine waters</p> <p>Water Gathering Ground Subzones Other inland waters</p>	Whole zone
F. Temperature	Human activity should not cause the daily temperature range to change by more than 2.0°C.	Whole zone	Whole zone	Whole zone
G. Salinity	Human activity should not cause the salinity level to change by more than 10%.	Whole zone	Whole zone	Whole zone

Note: Expressed normally as the arithmetic mean of at least 3 measurements at 1 m below surface, mid depth and 1m above the seabed. However in water of a depth of 5m or less the mean shall be that of 2 measurements (1m below surface and 1m above seabed) and in water of less than 3m the 1m below surface sample only shall apply.

In 1990 an amendment to the Ordinance was enacted which essentially provided a mechanism for setting effluent standards. These are included in the Technical Memorandum, "Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (TM) (WPCO Cap 358, S.21)."

The recently published Practice Note for Professional Persons ProPECC PN1/94 "Construction Site Drainage" is also pertinent for the prevention of water pollution during the construction phase for this Project.

Oil and fuel spills to coastal waters are controlled separately under the Shipping and Port Control Ordinance (Cap. 313) (SPCO) and are the responsibility of the Marine Department. The SPCO prohibits pollution of the sea by oil from land-based or marine sources in addition to the dumping of refuse and general littering from vessels or port-based operations.

Marine dumping of dredged spoil and excavated material unsuitable for land reclamation is controlled under the Dumping at Sea Act 1974 (Overseas Territories) Order 1975 which also prohibits dumping at sea without a licence.

Works Branch Technical Circular No. 22/92 covers the disposal of dredged mud, whether contaminated or uncontaminated, in the disposal grounds defined by Government. Classification of the level of contamination is defined in EPD's Technical Circular No 1-1-92. The EPD control the disposal of marine deposits at sea through a licencing system. This process also requires confirmatory sediment quality testing so that the method of disposal can be defined.

Existing Water Quality

Existing water quality in the Western Buffer and Victoria Harbour Water Control Zones are influenced by pollution from industrial and domestic sources. Existing water quality data are presented for Victoria Harbour and the Western Buffer Water Control Zones in Table 4.10 and indicate generally poor conditions especially with respect to DO (bottom layer) and total nitrogen which is well in excess of the relevant water quality objectives.

Table 4.10 Existing Water Quality of Victoria Harbour and Western Buffer Zone

Station (i)	VM1	VM3	VM6	VM12	VM13	VM14	WM2	WM4
Surface Temperature	22.8	22.9	22.8	22.8	22.7	22.9	23.0	23.3
Bottom Temperature	21.9	22.6	22.2	22.2	22.5	22.7	22.2	22.6
Surface Salinity (ppt)	30.8	30.7	30.3	30.1	29.3	28.6	28.9	29.7
Bottom Salinity (ppt)	32.9	31.2	31.6	32.4	31.1	30.0	32.4	32.4
Surface D.O. (% saturation)	80.0	70.0	74.0	72.0	72.0	73.0	97.0	90.0
Bottom D.O. (% saturation)	68.0	60.0	54.0	61.0	57.0	66.0	82.0	82.0
pH Value	8.1	8.1	8.1	8.1	8.1	8.2	8.2	8.2
Secchi disc (m)	2.1	1.9	1.5	1.5	1.2	1.5	1.6	1.4
Turbidity (NTU)	5.2	4.8	6.2	7.8	7.8	5.8	9.5	10.3
Suspended Solids (mg/L)	6.5	5.8	7.1	9.3	10.0	9.1	12.0	10.8
BOD (mg/L)	0.9	0.9	0.9	0.8	1.1	0.8	0.6	0.5
Inorganic N (mg/L)	0.46	0.62	0.54	0.52	0.65	0.49	0.30	0.34
Total N (mg/L)	0.85	0.97	0.88	0.86	1.01	0.85	0.60	0.67
PO4-P (mg/L)	0.05	0.06	0.06	0.06	0.07	0.05	0.04	0.04

Table 4.10 Existing Water Quality of Victoria Harbour and Western Buffer Zone (Cont'd)

Station (i)	VM1	VM3	VM6	VM12	VM13	VM14	WM2	WM4
Total P (mg/L)	0.11	0.12	0.11	0.11	0.13	0.11	0.07	0.08
Chlorophyll - a (ug/L)	0.58	0.79	0.59	0.64	0.71	0.61	0.74	0.61
<i>E. Coli</i> (No./100mL)	8260	1080	3660	3170	10900	1280	77	134

- Note: 1. Data are extracted from Marine Water Quality in Hong Kong for 1993, published by Environmental Protection Department
 2. Stations are named as those in the above report.
 3. Data presented are annual arithmetic means except for *E. coli* data which are geometric means.
 4. Except as specified, data presented are depth-averaged data.

4.4 Waste Disposal

The Waste Disposal Ordinance 1980 (Cap. 354) provides the statutory framework for the management of all wastes in Hong Kong by requiring the comprehensive planning for collection and disposal of wastes, including construction wastes. Disposal of screenings, sludge and grit from the individual treatment works will also be disposed of according to this Ordinance.

4.5 Vibration

Although no statutory controls are presently placed on vibration, the Civil Aviation Department, the Mines Division of the Civil Engineering Department and the British Forces may all require limitations, in terms of peak particle velocity, to protect sensitive calibration and monitoring equipment, industrial or residential developments in close proximity to construction work sites.

4.6 Visual Impact

In Chapter 9 of the "Hong Kong Planning Standards and Guidelines (HKPSG) 1990," sewage treatment works, pumping stations and related facilities are all identified as causes of visual intrusion on their surroundings. Recommendations made therein, will be taken into account when assessing the visual impact of the overall Scheme, individual components such as the Stonecutters Island Sewage Treatment Works and any relevant construction phases.

4.7 Other Legislation

The Buildings Ordinance (Cap. 123) provides for control over the design of oil storage facilities which are regulated by the Fire Services Department. This is particularly relevant at Stonecutters Island in connection with the provision of sludge treatment facilities.

5.1 Noise5.1.1 Construction Phase :

Equipment, plant and methods of construction adopted for each activity undertaken at individual work sites were defined. Sensitive receivers were identified through site visits, which were repeated throughout the Study process. The location of each NSR are shown on Figures 6.1 to 6.9. The relatively long construction period at many of the sites in the urban area which are in close proximity to sensitive receivers is a particular concern. A specific problem was raised at Shau Kei Wan in connection with a school which is located only 20m from the Preliminary Treatment Works.

The number of residents who could potentially be affected by construction of components of the Stage I Scheme were estimated by visiting each site. These are summarised in Table 5.1.

Table 5.1 Number of Potential Noise Sensitive Receivers at Each Site

Location	Number of Potential NSR (People Number)
Stonecutters Island Sewage Treatment Works	40
Outfall (Chamber 15)	20
Chai Wan	4,500
Shau Kei Wan	700
Tseung Kwan O	2,000
Kwun Tong	5,500
To Kwa Wan	3,000
Kwai Chung	2,000
Tsing Yi	1,900

As the Stage I Scheme is being constructed under fifteen individual contracts of varying duration, the assessments were initially carried out for each component of the individual contracts using information available at that time. Where simultaneous activities are programmed at a particular site, the cumulative noise levels were calculated in order to assess the combined impacts at each sensitive receiver.

Predicted noise levels were estimated using the method detailed in the Technical Memorandum "Noise from Construction Work other than Percussive Piling, EPD 1989" and Technical Memorandum, "Noise from Percussive Piling, EPD 1991."

Equipment schedules and noise calculation sheets are provided in Appendix C.1, along with any additional assumptions which were made for individual cases.

Section 5

5.1.2 Operation Phase :

Once the Stage I Scheme has been commissioned the main sources of noise will include pumps and motors at the pumping stations, control units, ventilation fans and the mechanical equipment for moving plant, equipment and waste around the sites. As the Sewage Treatment Works at Stonecutters Island is a single fixed noise source a "noise budget" was applied to each of the main components of the works to ensure compliance with the overall Acceptable Noise Level prescribed for this site. At all other sites, all items of equipment which could generate noise were also identified and a cumulative assessment was carried out to determine the extent of any mitigation measures which may be required.

Reference was made to Technical Memorandum 3 "Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites (TM3)." However the "Hong Kong Planning and Standards Guidelines (HKPSG)" are also relevant because they state the planning criteria for operational noise levels is 5 dB(A) less than the ANL for the particular situation or the background level, whichever is the lower.

5.2 Air Quality

5.2.1 Construction Phase :

During construction airborne dust is the major pollutant of general concern, with vehicle exhausts becoming significant at a site specific level. Sources of airborne dust include initial site clearing works, demolition of existing facilities, retrofitting new equipment and plant, construction of the production/drop shafts, blasting, excavating, stockpiling, vehicle movements on unpaved surfaces and haul roads, and concrete batching.

It was agreed at the start of the Study that no air quality modelling would be carried out. Instead, estimates of key quantities were computed on a monthly basis and compared with those used in the modelling for the Preliminary Design. It should be stressed that the results were presented in the EIA for the Preliminary Design only as maximum values, these were then referred to as percentages of 1 hr or 24 hr AQO's. For the present study the sensitive receivers are in some instances different to those adopted for use in the Preliminary Design EIA, due to changes in land use in the intervening period. However, such changes are incorporated in this latest assessment process to take full account of the present situation. Details of the air quality assessments are contained within Appendix D.

Wherever possible it is recommended that marine transport is used to reduce the overall impacts of fugitive dust and vehicle emissions.

5.2.2 Operation Phase :

Once the Stage 1 Scheme is operational, potential impacts in terms of air quality relate primarily to odour generation and secondarily to fugitive dust emissions from the chemical dosing facilities.

Potential sources of odour include

- (i) all preliminary treatment works
 - screens buildings
 - grit buildings
 - detritors
 - aerated grit channels
- (ii) Kwun Tong Pumping Station
 - wet wells
 - discharge channels

- (iii) Stonecutters Island Sewage Treatment Works
 - wet wells discharge channels of pumping stations
 - influent channel of sedimentation tanks
 - sludge treatment facilities
 - sludge collection and disposal facilities
 - sedimentation tanks (depending upon which chemical is used to enhance the sedimentation process)

The major odorous gas from the above sources is hydrogen sulphide. At Stonecutters Island and Kwun Tong, all components considered to be hydrogen sulphide sources were assessed both individually and in cumulative terms to determine the odour impacts at corresponding sensitive receivers.

The preliminary odour assessments which were carried out indicated that mitigation measures will be necessary for the majority of the works comprising the SSDS Stage I Scheme. Proposed mitigation measures were then incorporated into the detailed design under the corresponding contracts and special particular specification clauses were recommended.

Emission rates of hydrogen sulphide of the aforementioned components of the Scheme were estimated principally from the results of hydrogen sulphide sampling surveys which were commissioned specifically for this purpose. The model used for estimating the hydrogen sulphide concentrations at sensitive receivers was the Industrial Source Complex - Short Term (ISCST). The meteorological data for the ISCST model were derived from long term monitoring records at relevant weather stations and were provided by the Royal Observatory for use in this Study.

The modelling results were compared against the odour nuisance threshold, which is taken to be 5 times the odour detection threshold of hydrogen sulphide (0.5 ppb) averaged over a period of 5 seconds.

The preliminary assessment identified that mitigation measures will be necessary for most of the components of the Stage I Scheme. Proposed mitigation measures were then incorporated into the designs of corresponding contracts. The revised designs were further assessed by interpreting model results, to determine if further mitigation measures were required.

Fugitive dust emissions at Stonecutters Island were assessed using the Fugitive Dust Model (FDM). Input data included the location of sensitive receivers, physical characteristics of the dust particles and meteorological data.

5.3 Water Quality

5.3.1 Construction Phase :

Water quality impacts of the construction phase are primarily confined to those connected with the marine works for the outfall tunnel and diffuser sections. Sediment losses during dredging, oxygen depletion as a result of anaerobic compounds being released from the sediments, release of nutrients into the water column as a result of solubilisation of the hitherto bound substances, off-site transportation of sediments and the impacts on sensitive receivers were all assessed.

Other issues which were considered as part of the construction phase assessment, include the potential for uncontrolled runoff into water courses or marine waters. Particular attention was given to areas where bituminous materials are likely to be used.

As the preliminary treatment works will be remain in service while upgrading works are being carried out, effluent will infrequently be discharged into the receiving waters without pretreatment for short periods of time. Restrictions have been placed through the Conditions of Contract to minimise the impacts on receiving water quality.

Section 5

5.3.2 Operation Phase :

Following the implementation of the Stage I Scheme the quality of the receiving water will essentially depend upon the loads discharged into the water body which relate to the level of pollution removal. Removal of pollutant loads prior to discharge to the maritime environment depend on both the nature and the dosage of chemicals used to enhance the sedimentation process. Assessments were carried out using the results of mathematical modelling studies to examine the effects on receiving water quality if lime or ferric chloride were used to enhance the sedimentation process. The findings are reported in Appendix L and are summarised in Section 7.

5.4 Waste Disposal

5.4.1 Construction Phase :

During construction of the Stage I Scheme an estimated 0.53Mm³ of spoil will be generated as a result of excavating the shafts and tunnels for the Stage I Scheme with an additional 1.8Mm³ of marine mud dredged over a period of 6 months. Details of the waste arisings are given in Appendix E.

All dredged material will be disposed of in accordance with the requirements of EPD and the Fill Management Committee (FMC). Excavation for the tunnels will take place through granite to the west and volcanic tuff to the east. While disposal of such material is at the Contractor's discretion, it has been generally recommended that, wherever practical, a policy of waste minimisation should be adopted. The final use will depend upon the actual timing of waste arisings and the requirement for such materials of this type at the particular time.

Initially grab samples of marine deposits along the alignment of the trench for the diffuser were collected to determine disposal, and any special dredging requirements. As some of these marine deposits were classified as being contaminated, a detailed vibrocore survey was carried out to define the extent of the contamination. The results of the sediment sampling programme are contained within the Sediment Quality Report which is provided in Appendix F. The definition of the quality of spoil and the disposal methods for marine deposits are given in Works Branch Technical Circular No.22/92 and EPD Technical Circular No. 1-1-92. Marine spoil will either be disposed of to the Contaminated Mud Pits to the east of Sha Chau or to the disposal ground at Ninepins.

5.4.2 Operation Phase :

When all the facilities have been commissioned, the only significant solid wastes arising at the Preliminary Treatment Works will be grit and screenings. Disposal facilities for these materials are included in the upgrading of the treatment works and methods to minimise the impacts have been included in the contracts for each of the sites. At Stonecutters Island the main source of waste is sludge which will be disposed of to landfill via barge.

5.5 Vibration

5.5.1 Construction Phase :

Potential vibration problems were considered by identifying sensitive equipment, facilities, and properties in close proximity to each individual work site and determining the nature of the likely construction works. The Mines Division of the Civil Engineering Department and the Civil Aviation Department provided advice with regard to vibration levels which would be acceptable, in terms of peak particle velocities. These have been included in the Particular Specification for Environmental Protection clauses in each contract. Details of the issues considered in terms of vibration for this Project are summarised in Appendix G.

5.5.2 Operation Phase :

Following the commissioning of the Stage I Scheme the operation of pumps and motors may cause vibration. While it has been previously accepted that this will not present a threat to the health of residents located near to such facilities account has been taken of the possible nuisance factor, especially at night time. It should also be noted that this issue has been taken into account in the Specification of Electrical and Mechanical Equipment for the various Contracts, in which restrictions on vibration limits have been defined.

5.6 Visual and Landscape Issues

5.6.1 Construction Phase :

Visual impacts during construction were considered in terms of the relatively short term change in land uses, the proximity of sensitive receivers and the predominant landscape features in the area. The findings of the visual and landscape assessments carried out for the Preliminary Design have been updated in terms of the present context.

5.6.2 Operation Phase :

Both visual and landscape impacts of the new facilities have been considered. The sewage treatment works at Stonecutters Island constitutes the most significant change to the landscape associated with the Stage I Scheme with visual impacts perceived from land, sea and air. However, all of the sites were considered in terms of the relative value of the existing landscape, the degree of change as a result of the Stage I Scheme, the key features of the landscape at present and the proximity and nature of sensitive receptors. Details of assessments of the visual impacts and the landscape issues are given in Appendix H.

CONSTRUCTION PHASE ASSESSMENT

6.1 Introduction

The assessments contained herein are based on the findings presented in the Environmental Assessment Working Papers for each Contract. The layout-plans of construction sites and sensitive receivers are illustrated on Figures 6.1 to 6.9. Details of Construction methods, duration, plant likely to be employed, number of personnel engaged on site and any pollution control facilities which are incorporated with the design or construction methods were provided by the Engineering design team responsible for individual activities. Where the Contracts were to be let as Design, Construct and Operate (DCO) the design team provided either an outline design to enable the potential construction phase impacts to be predicted. The construction phase assessments considered all activities carried out at individual sites and the cumulative impacts of more than one activity/Contract being carried out at any given time.

6.2 Stonecutters Island Treatment Works6.2.1 Description of the Construction Works

The new Stonecutters Island Sewage Treatment Works (SISTW) is the single largest development in the entire Stage I Scheme. The main construction activities at the site will be :

- Construction of a production/riser shaft to connect with the underlying tunnel transfer system.
- Construction of a production/drop shaft to connect to the Stage I Outfall.
- Installation of a pumping station, sedimentation tanks (involving piling) and sludge treatment, collection and disposal facilities.
- Provision of Chemical Dosing Facilities.

6.2.2 Noise

At the commencement of this Project an Area Sensitivity Rating (ASR) of "A" was ascribed to Stonecutters Island to reflect the existing rural setting of this site. However, following consultations with EPD it was agreed that as the land use of the area surrounding the STW is rapidly changing, an ASR of "B" is now more appropriate at this site. Previously Stonecutters Island was a rural location isolated from the mainland. Since the West Kowloon reclamation connected Stonecutters to the mainland in 1993 the new land uses include CT8 and the Nava. basin which is currently being constructed as well as the Permanent Site for Mid Stream Operations at Stonecutters Island which is scheduled to be constructed in the near future. About 40 people will potentially be affected at this site.

The noise levels at NSR1 during the construction phase of the SSDS Stage 1 Scheme are summarised in Table 6.1.

Table 6.1 Cumulative Construction Noise Level - Stonecutters Island

Time	Construction Activities	Predicted Maximum Noise Levels at NSR, dB(A)	Mitigation Requirements
20/6/1994 - 27/2/1995	A	66	-
28/2/1995 - 9/4/1995	A, C	70	-
10/4/1995 - 1/5/1995	A, C, D	75	-
2 5/1995 - 5/5/1995	A, C, D, E	76	1 dB reduction

Table 6.1 Cumulative Construction Noise Level - Stonecutters Island (Cont'd)

Time	Construction Activities	Predicted Maximum Noise Levels at NSR, dB(A)	Mitigation Requirements
6/5/1995 - 2/7/1996	C, D, E	76	1 dB reduction
3/7/1996 - 19/2/1997	D, E	75	-
20/2/1997 - 20/5/1997	B, D, E	75	-
21/5/1997 - 27/5/1997	D, E	75	-
28/5/1997 - 26/6/1997	E	69	-

Key : A - diaphragm walls for SCI main pumping station
 B - riser shaft
 C - sedimentation tanks civil works
 D - Stonecutters Island STW buildings, main pumping station and site development
 E - sludge treatment facilities

The maximum cumulative noise level at the nearest NSR (NSR1), is expected to be 76 dB(A) during the construction phase of SSDS Stage 1 Scheme. The main sources of noise are the provision of the buildings, site development and main pumping station (Contract DC/93/16). It was assumed that all items of plant would be employed on-site at any given time and it may thus be concluded that this worst case scenario would be unlikely to occur.

On the basis of the assumption that no night time or holiday working will be required and the working hours are confined to 0700-1900 hrs, no mitigation measures will be required.

During the period when piling for the sedimentation tanks and the piling for the pumping station overlap, forecast maximum noise level at NSR1 is 84 dB(A) if Diado piles are used. In the latter event the Contractor will require to obtain a Construction Noise Permit prior to commencing any percussive piling.

6.2.3

Air Quality

Sources of dust include earth moving, transport of materials and personnel to, from and around the site, concrete batching, erosion of stockpiled materials and excavation for the buildings, trenches and service ducts.

The results of the air quality modelling carried out as part of the EIA of the Preliminary Design concluded that dust levels generated by construction works at Stonecutters Island were unlikely to cause concern. Assuming a worst case scenario involving 168 trucks for the export of spoil and import of concrete, and a spoil excavation rate of 21000m³ (March 1993 according to the programme given therein), predicted TSP levels at the three closest sensitive receivers were 89, 42 and 36 µg/m³ respectively.

Comparison of these predicted TSP levels with the AQO's indicate that it is unlikely the air quality standards will be breached, assuming good site practices are maintained.

6.2.4 Water Quality

Key issues pertaining to water quality have been identified as follows:

- (a) uncontrolled runoff of surface water contaminated with oil, grease, bentonite slurry, sediments or chemicals used in the finishing processes for the buildings;
- (b) discharge of washwaters from the vehicle wheel and body washing facility;
- (c) washout water from any concrete batching plant; and
- (d) the disposal of effluent from the construction workforce.

Assuming good site practices are established and maintained potential impacts on water quality are expected to be relatively minor.

It was recommended that all surface water runoff should be channelled through perimeter drains provided at Stonecutters Island. Sediment and grease traps should be installed at frequent intervals in the drainage system and should be cleaned out at frequent intervals to ensure their efficiency. Cognisance was also given to the Practice Note ProPECC PN 1/94 "Construction Site Drainage" at all of the sites.

All water from the vehicle wheel and body washing facility should meet the standards set in the Technical Memorandum on Standards for Effluents (TM), prior to disposal. Any treatment which may be necessary to achieve the Standards should be carried out on-site. Criteria which are most relevant for this Contract include those relating to suspended solids in addition to oil and grease.

For the protection of water quality, it was recommended that the Contractors provide dedicated works areas for, inter alia, the following activities:

- (a) the application of protective coatings or finishings to construction materials;
- (b) bentonite mixing;
- (c) concrete batching;
- (d) mixing of fertilisers or other materials used in the landscaping works; and
- (e) fuel storage, refuelling or vehicle maintenance.

A dedicated drainage system around all these works areas for the collection and containment of any materials or spillages was a stated requirement in the Contract, and it was recommended that spent materials or spillages should either be reused or containerised and disposed of off-site in a manner which is acceptable to the Director of Environmental Protection.

All process waters, including washout water from any concrete batching plant employed on-site or water used for testing the structures and fittings should be disposed of to the foul sewer in accordance with the provisions of the TM. Wheel washing facilities have been provided at Stonecutters Island and disposal of wastewater will be required in accordance with the requirements of the ProPECC PN1/94.

All domestic effluent will be disposed of via the foul sewers, which were provided under the installation of the RSS facilities.

6.2.5 Waste Disposal

Waste arisings at this site will include domestic effluent and solid wastes from the labour force, silts and sediment from the vehicle and wheel washing facilities, excavated spoil including rock and earth, bentonite contaminated spoil and general construction rubble.

Quantities of putrescible solid waste, grease and sediments all requiring disposal will be very minor compared to the spoil generation for excavation activities. Spoil generation rates for both rock and soil are included in Table 6.2.

Table 6.2 A Summary of Spoil Generation Rates

Construction Activity	Production Shaft	Pumping Station
Slurry contaminated wastes	1,100 m ³	9,300 m ³
Excavation in Soil	2,500 m ³	70,000 m ³
Excavation in Rock	160 m ³	1,000 m ³

Each Contractor will be required to dispose of inert construction waste material which could be used for reclamation or land formation in a public dumping area as specified by the Director of Civil Engineering Services.

In view of the amount of traffic generated at Stonecutters Island (Container Terminal No. 8 as well as SSDS), and the potential congestion of local roads, it was recommended that the use of barges for the disposal of spoil is considered.

Any construction material which is unsuitable for land formation will be disposed of at a designated landfill site along with putrescible solid wastes, sediments, grits and grease. Such wastes need to be collected, containerised and disposed of to landfill at regular intervals for the avoidance of nuisance.

Domestic effluent from the labour force should be disposed of via the foul sewerage and sewage treatment plant which were installed under the first Contract.

6.2.6

Vibration

Although no statutory controls are presently placed on vibration, the Civil Aviation Department, the Mines Division of the Civil Engineering Department and the British Forces may all require limitations on the peak particle velocity (ppv) to protect sensitive calibration and monitoring equipment, industrial or residential developments in close proximity to construction work sites.

Sensitive receptors identified include the Civil Aviation Department's (CAD) Non Directional Beacon (NDB) on Stonecutters Island and the communication and calibration equipment operated by the British Forces (BF).

Discussions with both BF and CAD during the Preliminary Design phase revealed that neither of these two sensitive receivers are likely to be adversely affected by the construction activities associated with this Contract. Further discussions with CAD have been held in connection with the specific works at Stonecutters Island required for the execution of the Stage I Outfall Contract. Monitoring requirements were detailed by CAD in their letter of 17th February 1994 (Ref (42) in AS/WKS/650) and are included in Section 9.

CAD also advised that the use of large electric welding machines or any other equipment which could interfere with the radiated NDB signal shall be prohibited at Stonecutters Island.

On the basis of the available information it was anticipated that vibration will be a minor issue for the works carried out at Stonecutters Island Sewage Treatment Works. It was nonetheless recommended that the Contractor consults with the CAD to ensure that the equipment he proposes to use on-site will have no adverse impact on the operation of the aforementioned facility.

6.2.7

Visual Impact and Landscape Issues

Areas which are most likely to be affected by the construction works on Stonecutters Island will be restricted to existing and proposed facilities located on the northern facing slopes surrounding Stonecutters Island Harbour.

Existing facilities comprise training and administrative buildings to the east, with workshops, stores and residential dwellings to the south. Some other residential dwellings are scattered over the hill side to the east of the harbour. Visual intrusion of the construction works at Stonecutters Island will be minor if viewed in the context of the other developments in the middle distance.

6.2.8 Summary of Potential Impacts

A summary of potential impacts arising from various construction activities is given in Table 6.3.

Table 6.3 Summary of Potential Impacts - Stonecutters Island Sewage Treatment Works

Works	Noise	Air Quality	Water Quality	Waste	Vibration	Visual and Landscape
Piling	***	**	*	*	**	**
Construction of buildings and site development	**	**	***	***	**	**
Construction of production/riser shaft and main pumping station	***	**	**	**	**	**

key : ****- very severe; ***- moderate severity; **- minor impact; *- insignificant

6.3 The Stage I Outfall

6.3.1 Description of the Works

The works are to take place off the south west of Stonecutters Island, under part of Container Terminal 8, the Northern Fairway and the Western Dangerous Goods Anchorage. Major works will involve:

- Modifications to existing Chamber 15, at the western side of the Island.
- Construction of a drop shaft on the Island.
- Construction of a culvert to connect Chamber 15 to the drop shaft.
- Construction of a lined tunnel from the drop shaft to a point some 1.8km offshore.
- Construction of twin riser shafts at the off-shore end of the tunnel.
- Laying of two horizontal diffusers, over 600 metres, in an excavated seabed trench, at the end of the riser shafts.

Containerised facilities were provided for 20 resident site staff (RSS) at the Chamber 15 works, with a septic tank to accommodate sewage flows from up to 100 workers. At this remote site the difficulties involved in making a connection to existing foul sewerage are too great and therefore it was proposed that a septic tank would provide the most practical solution for disposal of effluent.

Section 6

6.3.2 Noise

For the purpose of the noise impact assessment, the most onerous Area Sensitivity Rating (ASR) of "A" was originally used to describe the general environment of the site, in order to reflect the present tranquil situation of Stonecutters Island. In the latter part of the Project it was agreed that an ASR "B" would be appropriate as the area is already under development.

The nearest Noise Sensitive Receiver (NSR) is about 350 metres away, at the Armed Forces' Married Quarters. The number of occupants at this location was estimated to be 20.

The relatively small scale of the works required for establishing the RSS facilities will not have any significant effect on this nearest NSR especially considering the attenuation over distance.

Based on knowledge of the noise levels typically emitted from equipment and vehicles during such construction work, the effects at the nearest NSR were computed for the various stages of the programme for the construction of the outfall. The results are summarised in Table 6.4 below, in terms of both single activities and the cumulative effects of activities which are likely to be carried out simultaneously.

Table 6.4 Predicted noise levels at the nearest NSR associated with construction work for the Stage I Outfall, Stonecutters Island

	Impact of Single Activity at NSR dB(A)	Maximum Cumulative Impact at NSR dB(A)	Mitigation Requirements, (Duration, Months) dB(A)
Land Based			
1. Works around dropshaft			
a. Sheet piling	72	72	-
b. Soil excavation	63	63	-
c. Rock excavation	74	74	-
d. Modifications to Chamber 15	62	71	-
e. Line dropshaft	67	68	-
2. a. Construct tunnel (24 hrs)	71	71	21(13)
3. a. Fabricate diffusers pipelines assumes on-site fabrication	62	71	-
Marine Based			
2. Works around the outfall diffuser zone			
a. Drill construct offshore riser shafts	51	71	-
b. Dredge for diffuser pipelines	51	68	-
c. Install diffuser pipelines	47	71	-
d. Backfill trench	47	71	-

The results indicate that cumulative noise levels are likely to exceed the specified limits at all times controlled by the NCO Technical Memorandum, unless mitigation measures are applied. As it is anticipated that round-the clock working will be undertaken at this site, mitigation measures will therefore be necessary.

The use of specially silenced equipment can achieve significant reductions in noise levels, in the order of 15 dB(A), however measures in addition to this will be required to satisfy the NCO limits. For construction work at the drop shaft, activities will be confined to the period (between 0700 - 1900 hours) which is not controlled under the NCO. For the tunnelling, the contractor will need to provide a noise enclosure around the shaft entrance and spoil handling area if the intention is to carry out these activities

24 hours per day. The enclosure should be designed such that it can be opened during the daytime to allow the noisy activity of spoil removal to take place.

The Contractor will be required to demonstrate that the relevant noise control limits can be achieved within the programming constraints.

6.3.3 Air Quality

The modelling which was carried out for the Preliminary Design EIA, in 1992, predicted that airborne dust levels produced by the construction works were unlikely to be an issue for concern. Based on the worst case situation, the estimated concentrations of Total Suspended Solids (TSP), at the nearest sensitive receivers, were well within the levels specified under the APCO Air Quality Objectives. For the Detailed Design, the spoil excavation rates and, hence, number of vehicle movements per day, are substantially reduced. Therefore, despite the nearest sensitive receiver now being some 100m closer to the site than originally predicted in the Preliminary Design Study, it is surmised that the previous conclusion is still valid.

Nevertheless, the major sources of potential problems have been identified, as shown in Table 6.5 and recommendations have been given that all practicable steps should be taken to minimise the production of airborne dust, including the use of marine transport to reduce the number of vehicle movements.

Table 6.5 Construction of the Stage I Outfall: Summary of main potential sources of airborne dust

Activity	Potential Impact
Excavation of Drop Shaft and Entry Culvert Excavation Tunnel.	<p>Excavation works will generate approximately 75,000 m³ of spoil (mostly granite).</p> <p>Stockpiling of spoil and the loading and offsite disposal. If a worst case scenario is assumed and the actual excavation of the tunnel is completed in the shortest possible time (say about 30 linear m excavated/day, resulting in three month's construction) the spoil generation rates are still considerably less than assumed in the modelling study undertaken as part of the Preliminary Design. However, the tunnel will be driven by a TBM which will generate a much finer spoil than drill and blast techniques, potentially requiring more dust suppression measures to be applied when stockpiling and handling the material.</p> <p>It should be noted that excavation of the tunnel is not the only activity which will be undertaken during the programmed period and consideration must also be given to simultaneous activities which could contribute to overall airborne dust levels.</p> <p>It should also be noted that as the tunnel will be driven through granite, the potential exists for high levels of silica dust along with a build-up of radon gas within the tunnel. Adequate ventilation will be required to reduce the levels of silica dust in the internal air of the tunnel and to achieve sufficient exchanges of air to dissipate the radon gas.</p>

Table 6.5 Construction of the Stage I Outfall: Summary of main potential sources of airborne dust (Cont'd)

Activity	Potential Impact
Tunnel Lining	While it is recognised that the method of lining will ultimately be decided by the Contractor, it is understood that a precast lining is currently favoured by the design team. There are many engineering advantages in adopting this method, including the fact the liner can be placed in the tunnel while the TBM continues excavation. The potential impacts associated with this activity are the above ground sources of dust which are generated as the segments are precast. If the casting basins are located on Stonecutters Island, the Contractor will be required to obtain a licence before batching can commence. All batching facilities will require fugitive dust controls.
Offshore Riser Shaft	Construction of the shaft will have little impact on air quality, spoil generation estimated at only 4,000m ³ . Excavated material will be saturated (in a slurry) and will be disposed of immediately to landfill. Lining will be steel with 500m ³ of grout required to fill the annulus between the shaft wall and liner.
Dredging	Dredging will have negligible impact on ambient air quality
Pipelaying	Construction per se will have negligible impact, although fabrication (if coating steel pipework with cement or concrete) of the pipe could generate high levels of dust.
Backfilling	On-site impacts will be negligible in terms of air quality, but the method of winning fill could have adverse impacts depending on the source. As this is presently unknown, the Contractor will be required to demonstrate that the method of winning and transporting fill material will have minimal impact on the environment.
Fabrication of individual components, transportation to site and installations.	Methods of construction and fabrication rest with the Contractor. He will be required to demonstrate that none of the proposed activities will have an unacceptable effect on air quality. This is particularly so if casting basins are used.

6.3.4 Water Quality

Activities with the potential to affect water quality during construction of the Stage I Outfall include, dredging, surface water runoff to watercourses charged with silts, oils and grease, water inflows to the tunnels, land-based activities and disposal of domestic effluents.

Water quality is an issue of major concern during construction of the Outfall largely because of the dredging which will be required for laying the diffusers. Dredging without adequate controls can cause unacceptable risk to receiving water quality and the marine life supported by that water body. Impacts include increased turbidity and suspended solids concentrations in the water column and the potential release of hitherto bound metals, nutrients and organic matter all of which can lead to depletion of the dissolved oxygen content in the water column.

From the site investigations carried out for this Project (reported under cover of a Sediment Quality Study) it was concluded that heavy metal contamination was confined to the top 1m below seabed level. The amount of material which is classified as "contaminated" as defined by the EPD Technical Circular No. 1-1-92, was estimated to be 240,000m³. When dredging and disposal of this material is carried out specific controls will be applied in accordance with the requirements of the Fill Management Committee and EPD.

It has been estimated that 2.6Mm³ of soft clay deposits will be excavated during this period of dredging. Assuming a maximum 5% sediment loss rate during dredging and a six day working week, then the amount of material released to the water column was estimated to be 320 tonne/day. The location of the dredging works is shown on Figure 6.2 which also illustrates the nearest sensitive receivers.

The estimated release rate of sediment to the water column is higher than that previously assumed in the Preliminary Design EIA. This is due to the shortening of the construction programme and the change in the method of construction. Notwithstanding this, it was concluded that assuming strict controls are applied during dredging operations the impacts on water quality in the immediate vicinity of the works could be controlled to acceptable levels.

Dredging plant will be defined by, inter alia, the actual programme requirements but will ultimately be the Contractor's choice. As the depth of the trench is between 15 and 20m in an area where the water depth is about 10m, both trailer suction or grab dredgers could be used. The relative performance of trailer suction dredger versus grab dredgers is summarised in Table 6.6 below.

Table 6.6 Performance of Trailer Suction and Grab Dredgers

Trailer Suction Dredger	Grab Dredger
Main causes of turbidity around the dredger from the use of overflows and discharge from degassing systems.	Main causes of turbidity around the dredger from the use of grabs, and the overflow of material.
Suspended solids concentrations are of the order of 100mg/l except in the immediate vicinity of the dredger.	Suspended solids concentrations in excess of 100mg/l throughout the water column are expected. An increase in the size of grab will result in a corresponding increase in the suspended solids concentration in the water column.
Operational performance variable depending upon the size of dredger with respect to the water depth.	Operational performance variable depending on the duty of care provided.
<u>Note:</u> overflow is not permitted during dredging and, the suspended solids concentrations can be reduced to about 100mg/l near the bottom of the water column.	Use of water tight grabs is reported to reduce the suspended solids loads to the upper part of the water column but increase the concentrations in the bottom waters.
Extensive reworking of material, more likely to release contaminants to receiving waters.	Less reworking or crushing of material cannot be used if sediment has a high water content.
Careful operation can reduce the release rate to <1% of volume being dredged	Careful operation can effectively reduce the sediment losses by >50% especially if sealed and water tight grab dredgers are used.

It should be noted that where dredging of contaminated sediments is undertaken, sealed grab dredgers will be required to minimise the release of material to the water column when lifting.

The low ambient water velocities prevailing in the diffuser zone are not considered to be sufficient to transport the sediment plume any significant distance from the dredging site. It has been concluded that only a very small percentage of fines will be transported away from the dredging zone. It is understood from the Sewage Strategy Study that beneficial uses of "marine life", "navigation and shipping", and "aesthetic" may apply throughout the Victoria Harbour WCZ, together with a limit on inorganic nitrogen of $\leq 0.5\text{mg/l}$ in well flushed areas.

The beneficial use of "domestic/industrial" applies to industrial water intakes for flushing and air conditioning, however there do not appear to be any such facilities within the area of influence of the dredging works. No other sensitive marine uses such as spawning grounds, mariculture zones, or beaches are close to the site (Figure 6.10) and the closest fish culture zone and gazetted beaches are more than 8km and 6km away respectively. This distance indicates that these sensitive will not be adversely impacted by the construction works.

Furthermore, recent surveys have indicated that in the first 10 minutes following dredging, the suspended sediment load in the water column can be reduced by 50%, followed by a further 50% reduction usually within the next 20-30 minutes as a result of deposition. Only the very finest particles will be retained in suspension (plumes) for a long period of time. Therefore, it may be concluded that the impacts of sediment release, per se, during dredging the diffuser zone will be confined to nearfield impacts which can be minimised through application of appropriate mitigation measures.

The associated decrease in dissolved oxygen during dredging was also assessed and the following conclusions drawn:

- grab dredgers could result in more localised oxygen depletion and possible nutrient release in terms of volume but the actual release rates of nutrients may be enhanced by the degree of agitation afforded by suction dredgers, such impacts will be locally confined and may be minimised by, inter alia, reducing the dredging rate, reducing the degree of disturbance;
- oxygen depletion associated with dredging should, nevertheless, be contained well within a 200m radius assuming the conditions specified in the Contract Document to minimise the release of material while lifting marine deposits are adhered to; and
- oxygen depletion can be reduced if suction or closed grab dredgers are used.

Performance criteria and a water quality monitoring programme were incorporated into the "Particular Specification Clauses" of the contract documents to minimise the impacts of dredging on receiving water quality. In the area where contaminated mud has been identified (through detailed sampling and analyses) the use of closed/sealed grabs is required. Environmental Protection measures are provided in Appendix F for reference.

Ingression of water to the tunnel is likely when the tunnel is being driven. Although every effort will be made to minimise this for engineering, as well as environmental and safety reasons, the implication is that wastewaters contaminated by sediments/oils and similar materials will arise and will need to be pumped out of the tunnel for external disposal. Quantities cannot be estimated at this stage, however, it should be noted that this wastewater will require treatment prior to discharge to the foul sewer to ensure compliance with the WPCO Technical Memorandum and the ProPECC PN1/94 "Construction Site Drainage". If necessary, a lagoon will be built to settle-out the solids from the wastewater, possibly using a flocculant. Settling lagoons will be surrounded by bunds or collection and containment systems to avoid overflow into the storm sewers during severe wet weather. Frequent digging-out and disposal of the slurry to landfill will also be required.

Construction of the twin riser shafts will commence two months before the tunnel. Following installation of the liners, the shaft will be capped, thus retaining the volume of water below the cap until such times as a connection to the tunnel is made. When this water is removed via the tunnel, suspended sediments and other construction related materials will also be removed prior to discharge to the foul sewer.

The favoured method of construction for the tunnel liner is to use precast sections and install these as the TBM advances. Potential impacts on water quality therefore relate to the casting of units, spillage or runoff laden with concrete or aggregates from the batching or mixing areas and plants. All wastewaters arising from plant or facilities used for the casting of tunnel lining segments will to be screened prior to discharge in accordance with the requirements of the Water Pollution Control Ordinance, and additional requirements set out the contract documents.

The septic tank which will be installed for treatment of domestic effluent will be maintained in peak operating condition by regular de-sludging to ensure that effluent quality complies with the requirements for Victoria Harbour Water Control Zone.

6.3.5 Waste Disposal

A sediment quality report was prepared for the Government's Fill Management Committee (FMC) along with the proposed disposal schedule. The FMC determined the disposal site in accordance with the Works Branch Technical Circular No. 22/92, "Marine Disposal of Dredged Mud." FMC have advised that for contaminated mud the disposal site which has been allocated is East Sha Chau (240,000m³), with the remaining mud disposed at the Ninepins Spoil Disposal Ground (2.36Mm³).

Adverse impacts of spoil disposal will also be minimised through the contractual specification of appropriate disposal techniques for dredging, transporting and dumping of fill, and for monitoring of water quality at disposal sites.

An estimated 75,000m³ (bulked volume) of spoil will be generated during excavation of the tunnel and dropshaft. Within additional 4,000m³ (bulked volume) generated when the dropshafts are constructed.

The schedule of waste arisings will depend upon the method of construction adopted for the tunnel. Using the TBM method will result in a greater amount of waste generation but over a shorter period of time than for the drill and blast approach. To minimise the congestion on local roads, it was recommended that marine disposal routes are considered as the first option for the export of spoil, and also for the import of concrete, plant and other materials.

It was recommended that any inert construction waste which could be used for reclamation or land formation should be disposed of in a public dumping area (to be specified by CED). Any construction material which is unsuitable for this purpose should be disposed of at a designated landfill site. Domestic and general construction wastes should also be collected, containerised and disposed of to landfill at regular intervals for the avoidance of nuisance.

6.3.6 Vibration

Potentially sensitive receptors include the Civil Aviation Department's (CAD) Non-Directional Beacon and the communication and calibration equipment operated by the British Forces (BF). Discussions with both BF and CAD during the Preliminary Design phase revealed that neither of these two installations are likely to be adversely affected by the construction activities.

Residential dwellings are unlikely to be affected by blasting as there is sufficient distance between source and receptor. Notwithstanding this, the recommendation was made that British Forces were to be advised of the construction schedule and all activities to be undertaken.

6.3.7 Visual Impact and Landscape Issues

The nearest dwelling is located on a hill overlooking the site and much of the construction work associated with the Stage I Outfall will be underground or offshore. Movement of vehicles on, off and around the site could have an adverse impact in terms of visual intrusion. Night time working will be required at this site, and care will need to be taken when positioning the floodlights, so as to avoid glare at the dwellings.

Section 6

6.3.8 Summary of the Potential Impacts

A summary of the potential impacts arising at the Stage 1 Outfall is included in Table 6.7.

Table 6.7 Summary of Potential Impacts - Stage 1 Outfall

Works	Noise	Air Quality	Water Quality	Waste	Vibration	Visual and Landscape
Installation of Office Accommodation	*	*	**	*	*	*
Construction of Drop Shaft and Connecting Adit	***	**	**	*	***	**
Construction of Stage I Outfall	***	***	***	***	*	*

key : ****- very severe; ***- moderate severity; **- minor impact; *- insignificant

6.4 Chai Wan Preliminary Treatment Works

6.4.1 Description of the Construction Works

Major works carried out at the two sites provided at the two sites provided at Chai Wan will:

- Construction of a drop shaft at the northern part of the site;
- Construction of a production shaft, at the southern part involving;
- Tunnel drive to Kwun Tong, by TBM;
- Up-grading of the existing plant to the standard required for the Stage I Scheme.

Containerised resident site staff (RSS) facilities were installed at the commencement of the construction phase at this site.

6.4.2 Noise

For the purpose of ascribing Area Sensitivity Ratings (ASR) according to the NCO Technical Memorandum, the neighbourhood of this site has been divided into two sectors.

The nearest Noise Sensitive Receiver (NSR), a temporary housing area (THA), is some 350 m from the production shaft and 230m from the drop shaft. A residential building, which is 270m from the production shaft and 360m from the drop shaft, is also a NSR. These NSRs are in the sector which has been ascribed an ASR of "C". An estimated 4,500 people could potentially be affected by construction at this site.

There is a primary school located 490 metres away from the preliminary treatment works, where the drop shaft will be constructed, but only 150 metres from where the production shaft will be constructed in the other part of the site.

For installation of the RSS facilities, the predicted noise levels were 61dB(A) and 54dB(A) at the THA and the school, respectively. Therefore compliance with the NCO and the EPD Practice Note Pro PECC PN2/93 should be easily achieved for the activity, without special mitigation measures.

For work associated with the production shaft, noise levels have also been predicted for both single and multiple activities, where relevant;

- rock excavation will be the noisiest activity, producing 80dB(A) at the school, 72dB(A) at the THA and 75 dB(A) at the residential building if pneumatic drills are used, with a decrease of 4dB(A) in the three cases if hydraulic drills are used
- backfilling work, which will include demolition of the diaphragm walls, could generate noise levels of 71dB(A) at the school, 64dB(A) at the THA and 66 dB(A) at the residential building.

The above predictions suggest that even if hydraulic rock drilling equipment is used, considerable noise mitigation measures will be needed with respect to the production shaft activities.

The noise associated with the drop shaft will largely be generated by spoil trucks, loaders and cranes. Levels have been predicted in terms of both single and, where appropriate, multiple activities:

- installation of the guide and diaphragm walls; 60dB(A) at the school, 66dB(A) at the THA and 63 dB(A) at the residential building
- raise bore excavation; 63dB(A) at the school, 69dB(A) at the THA and 65dB(A) at the residential building
- lining of the shaft; 56dB(A) at the school, 63dB(A) at the THA and 59dB(A) at the residential building.

It has been ascertained from site visits that there is no double glazing on the windows at the school and that the windows are opened to provide ventilation.

The findings of the individual activities associated with the construction of the drop shaft, were compared with the limits specified in the NCO and Practice Note Pro PECC PN2/93. The results indicate that no mitigation measures will be required with regard to the school, but for the THA, some mitigation will be needed to achieve reductions of 14 and 8dB(A) respectively when excavation and lining of the tunnels is carried out.

Noise generated directly from the tunnel drive work is expected to be undetectable at ground level, but the ancillary facilities above ground will present a significant source of noise. Noise levels predicated at the NSRs for different activities in the tunnel drive work are as follows:

- TBM chamber excavation; 74dB(A) at the school, 67dB(A) at the THA and 69dB(A) at the residential building
- tunnel drive; 76dB(A) at the school, 69dB(A) at the THA and 71dB(A) at the residential building
- installation of concrete pipes; 71dB(A) at the school, 64dB(A) at the THA and 66dB(A) at the residential building.

Reference to the governing standards indicates that the foregoing results indicate that without mitigation measures, noise generated by tunnelling activities is likely to cause breaches of 11dB(A) at the school during examination periods and 14dB(A) and 16dB(A) at the THA and the residential building respectively during the night time.

A summary of the main noise mitigation requirements for the major activities at the Chai Wan site is shown in Table 6.8 below:

Table 6.8 Prediction of mitigation measures required with respect to the three nearest NSRs, for activities at the Chai Wan site

Time	Construction Activities	Predicted Maximum Noise Levels, dB(A)	Mitigation Requirements
4/1994	Installation of the RSS facilities	61 (THA) 54 (School)	No mitigation measures required
5/8/1994 - 2/3/1995	Construction of production shaft	72 (THA) 80 (School) 75 (Res. Bldg)	reduction up to 20 dB(A) is required
3/1/1995 - 30/4/1997	Construction of dropshaft in the PTW and tunnel	71 (THA) 76 (School) 71 (Res. Bldg)	reduction up to 16 dB(A) is required

From the assessments of simultaneous activities it is apparent that the tunnelling will have the greatest impact on the NSRs. Significant noise sources include the movement of vehicles around the site, and the handling of spoil, which will continue over 24 hrs. Even with silenced equipment it may be necessary to install a noise enclosure around the shaft or restrict the handling of spoil to between 1900 and 2300 hours or to periods which are not controlled by the NCO.

It must also be noted that cumulative noise impacts of the up-grading works at the sewage treatment works with those of the tunnelling, may also need to be assessed, but no definitive time schedule for these works is currently available.

6.4.3 Air Quality

Excavation of the drop shaft and production shaft, stockpiling and removal of waste material associated with these activities together with that from the tunnel driving work are the main sources of air pollution at this site. Air quality impacts associated with up-grading of the sewage treatment works are generally of minor significance although demolition of existing buildings must be carefully controlled to minimise fugitive dust emissions. If concrete batching is to be carried out on site, special controls would need to be applied to this activity to avoid creating an adverse impact on air quality.

It has been estimated that approximately 760m³ of rock and 1,800m³ soft material will be excavated during the construction of the drop shaft. Up to 10 trucks will be required to remove spoil from site on a daily basis. In addition to which up to 15 concrete trucks and 10 general purpose truck movements are expected on a daily basis for the delivery of plant and materials to this site.

The present estimates are relatively similar to those adopted in the Preliminary Design EIA in which 2,500m³ of rock would be excavated with 10 trucks required to remove spoil. These modelling assumptions resulted in a predicted maximum Total Suspended Particulate concentration of only 11µg/m³ at the nearest sensitive receiver, some 450 metres from the work site. On this assumption it is not anticipated that construction of the drop shaft will give rise to any breaches of the AQO at the nearest sensitive receiver.

The production shaft construction will take place some 170 metres from a primary school, which is the nearest sensitive receiver.

By extrapolation of the air quality modelling results given in the Preliminary Design, the rate of excavation of rock (1,400m³/month, cf 2,400m³/month) and the number of vehicles used (8 compared to the previously assumed 10) to remove spoil from site would not cause the AQO to be breached (<11µg/m³TSP). It may thus be surmised that construction of this shaft should not incur breaches of the AQO at the nearest sensitive receiver.

An estimated 48,000m³ of rock will be generated as a result of driving the tunnel, which is equivalent to 5,600m³ per month. On average, 34 truck movements will be required per day with a maximum of 50 per day in extremis for the removal of spoil off-site. In this case, the volumes of spoil are considerably higher than those assumed for the Preliminary Design modelling. Within the tunnels the ventilation system will need to be designed in accordance with Labour Department requirements relating to the number of air changes (which will depend on inter alia the number of workers, the activities taking place and the materials involved). As the tunnel will be driven in part through granite, the release of silicon dust and radon gas are a key concern.

Exhaust gases from the air venting systems are not expected to significantly affect external air quality, although adequate ventilation of the air inside the tunnels will be required for reasons of occupational health as noted above.

In common with all the other sewage treatment works in the Stage I Scheme, the details of the up-grading work will only be available once the Contractor has defined the actual works programme. It is however a fundamental design concept of in this Stage I Scheme that environmental impacts must be reduced as far as practicable, and this will be reflected in the contract for this work.

If concrete batching is carried out on site for any of the activities, the contractor will be made aware of the need to obtain a licence from the EPD and to install the plant so as to maximise screening and distance from sensitive receivers.

6.4.4 Water Quality

Potential water quality impacts mainly relate to runoff which may be charged with sediments, oils or greases. Suppression of dust from stockpiled materials (fine spoil compared to that generated by drill and blast techniques) will need to be carefully controlled to minimise silt laden runoff. A series of simple drains and sediment traps was recommended around stockpiles so that water used for dust suppression can be recycled on-site.

A settling lagoon for waste water slurry generated through the use of the TBM in the tunnels may be required. This waste water/slurry may be contaminated with sediments, oils and possibly spent explosives and will need to be treated before disposal. Construction and management of settling lagoons will need to ensure there is no risk of overflow during periods of high rainfall. Disposal of any settled slurry or mud (which may be difficult to consolidate and may require flocculant) will be at the nearest landfill site. The liquid fraction could be disposed of to the foul sewer in accordance with the Water Pollution Control Ordinance (Technical Memorandum).

6.4.5 Waste Disposal

It is ultimately the Contractor's responsibility to ensure waste is disposed of in accordance with the provisions of the Waste Disposal Ordinance. It was nonetheless recommended that any rock which could be used in reclamation or other construction projects in the Territory should be directed to a public storage site. Any other spoil which is unsuitable for reclamation or land formation will be disposed of at landfill, subject to agreement with the EPD.

Partially dewatered slurry from any setting lagoons which may be constructed on-site will also be disposed of to landfill. Alternative arrangements for the disposal of wastewater/slurry from the tunnels will be required to comply with the Waste Disposal Ordinance, the Water Pollution Control Ordinance and the Technical Memorandum. Domestic effluent will be disposed of via the foul sewer in accordance with the provisions of the Technical Memorandum.

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6.4.6 Vibration

The nearest Civil Aviation Department facility is located some 3 km to the north of the site near the village of A Kung Ngam, which is sufficiently remote to be discounted from further consideration. The production shaft is in close proximity to the industrial developments and thus may require some restrictions to be placed on blasting. The Mines Division have advised that as a general rule a maximum ppv limit of 25 mm/s would be imposed. In cases where utilities or buildings, or their occupants, could be considered to be sensitive to vibration more stringent controls would be imposed by Mines Division in their blasting permits. Restrictions are placed on a case-by-case basis which require the Contractor to provide a detailed works programme, layout and general arrangement plans to Mines Division for their advice on this matter prior to commencing any work involving explosive charges.

A site inspection has not identified any sensitive buildings in close proximity to the works site for construction of the production shaft. However, this will require further confirmation when the Contractor submits his application for a blasting permit. As previously noted the tunnels will be driven at such a depth that there will be no perceivable effects on above-ground structures or utilities.

6.4.7 Visual Impact and Landscape Issues

For construction of the production shaft the various plant will, to a large extent, be concealed from view by the site hoardings, although higher structures such as cranes could be visible above the hoardings. The distance between the work sites and the primary school, in the existing environmental setting, is considered adequate to diminish any perceived visual impact during construction.

Much of the works for the dropshaft will also be sheltered from view by the general site hoardings as well as the standard Drainage Services Department security screen/walls which exist round three sides of the plant. While some items of plant may be visible including drilling rigs and cranes, the distance between the potential sensitive receivers and the works sites, in combination with the surrounding landscape, is considered sufficient to render any visual impacts acceptable.

6.4.8 Summary of Potential Impacts

A summary of the potential impacts arising at Chai Wan is included in Table 6.9.

Table 6.9 Summary of Potential Impacts - Chai Wan

Works	Noise	Air Quality	Water Quality	Waste	Vibration	Visual and Landscape
Installation of Office Accommodation	*	*	*	*	*	*
Construction of Drop Shaft and Connecting Adit	***	**	*	**	**	*
Construction of Stage I Outfall	****	**	*	****	*	*

key : ****- very severe; ***- moderate severity; **- minor impact; *- insignificant

6.5 Shau Kei Wan Preliminary Treatment Works

6.5.1 Description of the Construction Works

Major works required at the existing Preliminary Treatment Works at Shau Kei Wan include:

- Construction of a dropshaft
- Up-grading of the existing facilities to the standard required for the Stage I Scheme.

A resident site staff (RSS) office with services has already been established at the site.

6.5.2 Noise

An Area Sensitivity Rating (ASR) of "B" was adopted to describe the general neighbourhood of this site with reference to the method given in the NCO Technical Memorandum. The part of the site where the drop shaft is to be constructed is only 40 metres from a school which is the nearest Noise Sensitive Receiver (NSR). The nearest residential building is located some 140 metres away with an estimated 700 people potentially affected by works at this site. The activity which is predicted to generate the highest noise levels is excavation through rock and the forecast noise levels are:

- 122 dB(A) at source
- 84 dB(A) after distance attenuation at the school
- 74 dB(A) after distance attenuation at the residential building

A summary of the predicted extent of noise mitigation for various stages of the dropshaft construction work is given in Table 6.10.

Table 6.10 Predicted extent of required noise mitigation during dropshaft construction at Shau Kei Wan

Activity	Noise Impact (Duration of Activity)	Extent of Mitigation Required (dB(A) reduction)			
		School (40m from site)		Residential Buildings (140m from site)	
		Non-exam Period	Exam Period	1900-2300 hrs	2300-0700 hrs
i Guide walls and diaphragm walls	82 (School) 71 (Res. Bldg) (5 weeks)	12	17	6	21
ii Soil Excavation	80 (School) 70 (Res. Bldg) (3 weeks)	10	15	5	20
iii Ring Beam	78 (School) 67 (Res. Bldg) (4 weeks)	8	13	2	17
iv Raise Bore excavation	84 (School) 74 (Res. Bldg) (6 weeks)	14	19	9	24
v Line drop shaft	78 (School) 67 (Res. Bldg) (3 months)	8	13	2	17

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It is apparent that stringent measures will be required to minimise noise to acceptable levels at this site during the construction of the drop shaft. Use of super-silenced equipment alone may not be sufficient to achieve the reduction in noise level required during certain periods of construction. Abatement techniques such as noise enclosures around the shaft area and stockpiles may also need to be considered at this site. Although the duration of this work is relatively short, it should be noted that the disturbances created by the overall Stage I works, especially to the school, will be of significantly longer term and working methods should be planned accordingly.

6.5.3 Air Quality

During construction of the drop shaft fugitive airborne dust problems are likely to arise due to spoil being handled, stockpiled and transported from the site. Material brought onto the site for lining and backfilling is also a potential source of airborne dust.

Estimates of the spoil generation rates and vehicle movements were compared to those used for the Preliminary Design EIA where it was concluded that with only two vehicle movements per day and the relatively short duration of dust generating activities, construction works should not cause elevated dust levels at this site. Although it has been concluded that this earlier assessment may still be valid for the present situation, in view of the very close proximity of the school, it was recommended that dust monitoring is conducted for the duration of the works.

The later stage of up-grading the Preliminary Treatment Plant may also create more environmental nuisance than at other sites because of the close proximity of the school and this was reflected in the mitigation measures proposed for the works at this site in the individual contract documents.

A valuable mitigation measure to reduce impacts of airborne dust would be scheduling of vehicle movements to avoid periods when children are arriving at or leaving the school. More importantly this step would also greatly contribute to road safety of the children and was recommended in the individual Environmental Assessment Working Papers.

6.5.4 Water Quality Assessment

Issues of water pollution arising during the construction of the drop shaft are likely to be minor, involving only drainage and surface run-off, which will usually contain particulate materials such as concrete or grouts. In the event that the Contractor chooses to use concrete batching on-site, strict controls will need to be applied to washing out of the batching plant. The waste waters may need treatment prior to disposal to meet the standards of the WPCO Technical Memorandum as applicable to wastewaters discharging to the foul sewer connecting to a Government Sewage Treatment Plant. Advice provided in the EPD Practice Note ProPECC PN1/94 "Construction Site Drainage" is also relevant in this connection.

While upgrading of the Preliminary Treatment Works is being undertaken the need to discharge unscreened sewage effluent into the Harbour via the outfall shown on Figure 3.2 may occasionally arise. The Contractor will be required to ensure that the works are scheduled such that the impacts associated with such an event are minimised. Before undertaking any such activities the Contractor will be required submit a method statement which will include the proposals for disposing of effluent and will be sent to EPD for comment before approval is granted. It was recommended that the works programme is drawn up to ensure that any overflow is scheduled to occur during periods of low flow (night time) as far as practical.

6.5.5 Waste Disposal

An estimated 2,000m³ of rock will be brought to the surface with a further 710m³ of soil during excavation for the drop shaft. The rock excavation is scheduled to take approximately six weeks with soil excavation taking three weeks. Assuming a 6 day working week, this represents an average spoil removal rate of 55m³ per day for rock and 40m³ for soils.

While the method of disposal will ultimately be the Contractor's responsibility, it is nonetheless recommended that the rock debris is directed to a public storage dump for use in reclamation. The spoil and any other materials which are unsuitable for reclamation should be taken to the nearest landfill site, as directed by the EPD. It is not possible to define the haul roads to be used by the Contractor, but it is recommended that, wherever feasible, the disposal of spoil should be planned such that disruption to the local traffic flows are minimised.

Solid waste arising from the canteen or other similar RSS facilities should be collected, containerised and disposed of to the nearest landfill site as frequently as necessary for the avoidance of nuisance.

A key concern is the management of traffic in connection with the safety of the children from the nearby school. As recommended in the previous sub-section, vehicles for the bulk transport of spoil, and waste should only arrive and leave the site during periods when school children are neither leaving nor arriving at school.

6.5.6 Vibration

Vibration is not expected to be an issue of concern at this site. In the Preliminary Design EIA, it was reported that vibrational stresses on adjacent structures or utilities, may arise through the adoption of raise boring techniques. Advice provided by the Engineering Design Team suggests this is now most unlikely due to the specific alignment and the construction methods that will be adopted.

6.5.7 Visual Impacts and Landscape Issues

Shau Kei Wan is not an area of high landscape value, with the shipyards to the east, and a wholesale fish market due west. Furthermore, the work site is within the existing sewage treatment works, which will minimise potential aesthetic and visual impacts. However, if work continues on-site around the clock, residents of nearby buildings may suffer visual intrusion through the use of floodlighting to allow the works to continue over a 24 hour period. This problem can be minimised by directing the floodlights away from the buildings.

6.5.8 Summary of Potential Impacts

A summary of the potential impacts arising at Shau Kei Wan is included in Table 6.11.

Table 6.11 Summary of Potential Impacts - Shau Kei Wan

Site	Noise	Air Quality	Water Quality	Waste	Vibration	Visual and Landscape
Installation of Office Accommodation (completed)	*** (short term)	**	*	*	*	*
Construction of Drop Shaft and Connecting Adit	****	**	**	***	**	*
Upgrading of the PTW	***	***	*** (short term)	***	*	*

key : ****- very severe; ***- moderate severity; **- minor impact; *- insignificant

6.6 Kwun Tong Preliminary Treatment Works Pumping Station

6.6.1 Description of the Construction Works

At Kwun Tong, the sources of potential construction phase impacts are more complex because multiple activities will be carried out simultaneously for almost the entire duration of the construction period. The situation is exacerbated by the fact that the works will be carried out over a long period of more than two years and in close proximity to residential developments. The up-grading of the existing sewage treatment works will be extensive, with the objective of providing one of the more important focal points in the overall Stage I Scheme, by large scale conversion of a treatment plant which is presently in a poor state of repair.

Major activities will involve:

- construction of a production/riser shaft and a production/drop shaft with installation of pipes and backfilling with concrete.
- construction of a dropshaft in Kwun Tong PTW with installation of pipes and backfilling with concrete.
- tunnel drive to To Kwa Wan, by TBM.
- lining of the tunnel to To Kwa Wan and also the tunnel from Chai Wan.
- up-grading of the existing treatment works, which requires an almost entire re-fitting with considerable civil engineering work.

Resident site staff facilities have been installed to accommodate a projected (RSS) total complement of about 60 persons.

6.6.2 Noise

The Kwun Tong site is located in close proximity to residential properties, however, there is already a high level of background traffic noise and much other noisy, construction work in progress. An Area Sensitivity Rating (ASR) of "C" was therefore adopted for the purpose of the noise assessment. An estimated 5,500 residents could potentially be affected by works carried out at this site.

The works to be carried out in association with the pumping station and tunnel construction will be located in a part of the site where the nearest NSR is some 140 metres away. Table 6.12 provides a summary of the predicted effects at this NSR of each component of this construction work and also the most likely practical effects of being superimposed upon the noise levels from other work which will probably be in progress at the same time.

Table 6.12 Predicted noise levels, at nearest NSR, of work associated with the pumping station and tunnel construction at Kwun Tong

Activity	Noise Impact at NSR Predicted for Single Activity, dB(A)	Maximum Noise Impact at NSR Predicted for Multiple Activities, dB(A)	Mitigation Requirements (Duration, Months) dB(A)
Excavate TBM chamber (0700-1900 hrs)	75	75	-
Drive tunnels Kwun Tong to To Kwa Wan (24 hrs)	76	77	22(9)
CIP tunnel lining (24 hrs)	71	75	20(6)
Guide and diaphragm walls (0700-1900 hrs)	67	77	Mitigation measures for tunnel driving are required
Raise bore (0700-1900 hrs)	69	75	-
Line drop shaft (0700-1900 hrs)	63	74	-
Line shafts (0700-1900 hrs)	71	71	-
P.S. Civil Works (0700-1900 hrs)	66	77	Mitigation measures for tunnel driving are required

Not unexpectedly activities associated with driving the tunnels are predicted to exert the greatest impact on the nearby NSRs. The greatest noise source is not the tunnelling work per se but the associated vehicle movements on, off and around the site and the cranes and the use of other mechanical equipment required to remove spoil from the shafts and the site. It has been concluded that mitigation measures will be required for the entire duration of the works, even during daytime hours. Recommended mitigation measures include the provision of acoustic screens around the shaft and stockpile areas, and restricting certain noisy activities to specific periods during the day. Although it is a fundamental design criterion that spoil will not be removed from the site at night-time, it will still be brought to the surface 24 hours/day.

It should also be noted that pumps and compressors will be required to be operational 24 hours per day. While these sources are unlikely to cause noise impacts which are unacceptable in terms of the NCO limits for daytime work, between 1900 and 0700 hours the limits will certainly be exceeded in the absence of special mitigation measures.

The major work which is required to up-grade the existing sewage treatment plant will be carried out some 180 metres from the nearest NSR. This work overlaps with the shaft and tunnelling construction. As extensive demolition, piling and reconstruction will be required for the up-grading of this plant, it may be anticipated that noise levels could be quite significant for the larger part of this phase. Appropriate mitigation measures will be required to comply with NCO standards.

6.6.3 Air Quality

In view of the many simultaneous activities scheduled to be carried out at this site, the potential exists for high levels of airborne dust to be generated. Key issues to be addressed in controlling the air quality impacts include dust emissions from drilling and blasting, excavation, concrete batching, material handling, and the movement of vehicles around and off site.

The air quality modelling study carried out for the Preliminary Design EIA assumed a worst case scenario which involved 2,700m³ of rock excavation, involving vehicle 27 movements per day. From the results of the study, a maximum projected Total Suspended Particulate (TSP) level of 44µg/m³ was predicted as a result of all the construction works, and thus it was concluded there would be no exceedance of the Government's Air Quality Objectives (AQO). Dust generation is likely to be highest when the tunnel is driven between Kwun Tong and To Kwa Wan. The lining of both the tunnel and the shaft carries the option of concrete batching on-site, which presents another potential source of airborne dust. The design team have estimated that on average, 3,600m³ per month of rock will be excavated from the tunnel. It is estimated that up to 30 trucks (60 movements) will be required to remove the spoil generated through construction of the tunnel and pumping station during this period.

It is apparent that the Preliminary Design prediction, in spite of being an assumed worst case scenario, underestimates the present situation. While the AQO's may not be in danger of being exceeded it is, nonetheless, recommended that all practicable measures to reduce the potential impacts on sensitive receivers should be adopted. Such measures include the use of marine rather than road transport for spoil disposal and material and plant deliveries, importing of ready mix concrete to site and the provision of enclosures around the stockpiled spoil.

The Contractor will be required to obtain a licence from the EPD under the provisions of the APCO before a concrete batching plant can be installed on-site. The location of any batching plant should be carefully chosen to maximise the distance between sensitive receiver and source and will need to be at least 100m from the nearest sensitive receiver.

Based on practical experience elsewhere, it is anticipated that external air quality will not be significantly affected by exhausting the tunnel venting system. However, attention will need to be given to the ventilation system within the tunnels to ensure adequate air exchanges are provided at the working face to achieve the Labour Departments' occupational health standards for silica dust and radon gases.

6.6.4 Water Quality

Although this site is located within an existing sewage treatment works and a sanitary connection has been made to the foul sewer for the disposal of domestic effluent from the RSS, compliance will still be required with the WPCO Technical Memorandum discharges to foul sewers connecting to a Government sewage treatment plant.

Runoff from the site has the potential to be heavily laden with suspended solids, cement, bentonite and possibly with oils, as a consequence of the activities carried out both above and below ground. Furthermore, a vehicle wheel washing facility will be provided on site. Pollution control mechanisms such as oil or sediment traps will be required to ensure compliance with the relevant Technical Memorandum of the WPCO and the EPD Practice Note Pro PECC PN1/94. If concrete or other batching plant is installed or there is a need to apply protective coatings to materials, a dedicated drainage system will be required around these areas for the containment and appropriate disposal of any spillages.

In the EIA Report based on the Preliminary Design it was suggested that tunnel spoil could be used as fill at the adjacent reclamation site. It is now believed that this approach could have unacceptable implications on water quality (and the material is unlikely to be suitable for fill) and this option is therefore not recommended.

While up-grading of the sewage treatment works is being undertaken there will be an occasional need to discharge unscreened effluent into the Harbour. As noted previously, the Contractor will be required, by means of their method statement, to demonstrate that the works programme is designed to reduce the effects of such incidents to an absolute minimum.

6.6.5 Waste Disposal

Construction works at Kwun Tong were estimated to generate 5,000m³ of tunnel spoil, with an additional 5,200m³ of soil and 2,000m³ of rock from excavating the shafts. All of these materials will require disposal involving the use of up to 26 trucks per day.

Other wastes requiring disposal, include general construction wastes and domestic effluent from the site staff. The Contractor will be responsible for the appropriate disposal of all wastes. Spoil from the tunnel will be disposed of by the Contractor. It has been recommended in the Environmental Assessment Working Papers that any spoil which could be used in land formation projects should be directed to a public storage dump. All inert waste which is unsuitable for reclamation and any organic wastes should be correctly disposed of to landfill at a regular frequency to avoid nuisance.

The possibility of disposing of tunnel spoil to the adjacent reclamation area, as suggested in the Preliminary Design EIA, should be no longer considered to be an acceptable option due to the potential water quality impacts as noted above.

6.6.6 Vibration

Sensitive Airfield Surface Detection Equipment is located some 900m from the works site. The Civil Aviation Department has defined a maximum vibrational stress of 1mm/sec at any sensitive receptor. The Contractor will be required to submit working method statements which will ensure this requirement is met for all works carried out at this site.

6.6.7 Visual Impact and Landscape Issues

Potential impacts of the works on the surroundings are considered to be minor when judged in context of the other works in the area.

As spoil removal, tunnel lining and other works will be carried over a 24 hour period the visually obtrusive floodlighting which is likely to be required could cause a significant nuisance to those residents overlooking the site. It was recommended in the Environmental Assessment Working Papers that any floodlighting should be directed away from the residential developments for the reduction of nuisance while work is undertaken during periods of darkness.

6.6.8 Summary of Potential Impacts

A summary of potential impacts arising from construction activities is given in Table 6.13.

Table 6.13 Summary of Potential Impacts - Kwun Tong

Works	Noise	Air Quality	Water Quality	Waste	Vibration	Visual and Landscape
Pumping Station and tunnel construction	***	**	**	***	**	*
Upgrading of existing PTW	***	***	*** (short term)	***	*	*

key : ****- very severe; ***- moderate severity; **- minor impact; *- insignificant

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6.7 To Kwa Wan Preliminary Treatment Works

6.7.1 Description of the Construction Works

Major construction activities at To Kwa Wan are:

- construction of a production shaft, which after completion of the project will be backfilled so that this part of the site can be returned to other uses;
- construction of a drop shaft;
- tunnel drive to Stonecutters Island, by TBM, followed by tunnel lining;
- lining of the tunnel from Kwun Tong; and
- up-grading of the Preliminary Treatment Works, involving demolition and building construction,

The site will also be provided with the usual containerised resident site staff (RSS) facilities.

6.7.2 Noise

This site was ascribed an Area Sensitivity Rating of "B", according to the methodology specified in the Noise Control Ordinance (NCO) Technical Memorandum. The nearest NSR to the production shaft is an established residential area which is located some 96 metres away from the production shaft. Predicted maximum noise level for installation of the containerised offices for the RSS was only 60 dB(A) at the nearest Noise Sensitive Receiver (NSR), which is located some 200 metres away. The total number of people potentially affected by works at this site was estimated to be 3,000. On the basis of the noise calculations undertaken it was identified that installation of these RSS facilities did not require particular noise mitigation measures to be implemented.

The noisiest activity was identified as the excavation of the production shaft with a predicted maximum noise level at the NSR of 84 dB(A). This is primarily due to rock excavation which will last for a period of three months and will require noise reduction of 9dB(A) outside restricted hours. If the works are to be carried out during 1900-2300 hrs and 2300-0700 hrs, further reductions up to 19dB(A) and 34dB(A) respectively are required.

For tunnel and dropshaft construction a summary of predicted noise levels at this NSR and their cumulative effects, is given in Table 6.14.

Table 6.14 Predicted Noise Levels at nearest NSR for construction activities associated with the production shaft, To Kwa Wan site

Activity	Noise Impact at NSR predicted for Single Activity dB(A)	Maximum Noise Impact Multiple Activities dB(A)	Mitigation Requirements dB (Duration, Months)
Excavate TBM erection chamber (24 hrs)	78	78	28(2)
Drive tunnels TKW - SCI (24 hrs)	80	81	31(13)
CIP tunnel lining (24 hrs)	75	81	31(6)
Guide walls and diaphragm walls (0700-1900 hrs)	67	80	Mitigation measures are required for tunnel driving and lining
Soil excavation (0700-1900 hrs)	66	80	Mitigation measures are required for tunnel driving and lining
Ring Beam (0700-1900 hrs)	64	80	Mitigation measures are required for tunnel driving and lining
Raise bore (drop shaft) (0700-1900 hrs)	70	81	Mitigation measures are required for tunnel driving and lining
Line drop shaft (0700-1900 hrs)	64	81	Mitigation measures are required for tunnel driving and lining
Line shafts (backfill) (0700-1900 hrs)	75	75	-

The foregoing results indicate that potential impacts on sensitive receivers are expected to be significant for most of the construction phase. The major concern relates to the above ground activities associated with driving the tunnels which is scheduled to continue through the night. Although spoil disposal will only be permitted during daytime, material will still be brought to the surface over a 24 hour period and stockpiled for disposal during daylight hours. Pumps, generators and ventilation fans will also operate 24 hours per day.

In the Environmental Assessment Working Papers it was recommended that acoustic sheds or enclosures should be constructed around the shaft entrance and stockpiles. These would be opened up between 0700 and 1900 hours to allow spoil to be exported from the site.

Consideration was also given to the type of equipment to be used at this site. For example super-silenced compressors can achieve reductions of between 7 and 15 dB(A) compared to standard equipment which was assumed in the noise modelling for this project to identify a worst case scenario. In the EIA of the Preliminary Design it was stated that part of the site is surrounded by a concrete security wall. However, it should be noted that, although this may assist in noise reduction, it will not be sufficient to achieve the

levels required by the NCO Technical Memorandum.

As no construction details were available at the time of the assessment it was not possible to predict potential noise levels associated with the treatment plant up-grading works. It may be surmised, however, that at this location these could be severe due to their nature and extent. The Contractor will be required to design the works such that the necessary standards are achieved for both piling and non-piling construction works and will be required to limit working hours to between 0700 and 1900 hours.

6.7.3 Air Quality

For the works required at this site it has been estimated that on average 5,200m³ of rock will be excavated on a monthly basis from the tunnel drive to Stonecutters Island. A further 4,500m³ of soil and 640m³ of rock will be excavated over a period of approximately four months in association with construction of the drop shaft.

Up to 60 vehicle movements will be required for disposal of spoil and for the lining materials. A maximum of 20 vehicle movements are also predicted for plant deliveries, although it should be noted that these will not occur every day.

The estimates given above were compared to those used for the air quality modelling study which was part of the EIA for the Preliminary Design. In the earlier study, it was assumed that the worst case in terms of dust generation would be when a total of 3,300m³ of rock was excavated, requiring 14 vehicle movements per day. The model predicted a maximum dust emission rate for this period of 51µg/m²/s which equates to a Total Suspended Particulate (TSP) concentration of 150µg/m³ at the nearest sensitive receiver. Although the model results cannot be directly extrapolated it would be reasonable to assume that with the doubling of the excavation rate and quadrupling of the vehicular movements, fugitive dust emissions could create a significant problem for the majority of the construction phase at this site.

The Contractor may also wish to install concrete batching plant at this site, which will add to the potential airborne dust problems. As previously noted for other sites, before such a facility can be operated, the Contractor will be required to obtain a licence from the EPD. The location of any batching plant should be sheltered if possible, and should be as far from sensitive receptors as is practical (at least 100m if possible).

Construction activities associated with upgrading the Preliminary Treatment Work which could adversely affect ambient air quality include demolition of existing facilities, material handling (including stockpiling and concrete batching) and vehicle movements on, off and around the site.

Due to the scale and the nature of the overall works at this site, it will be imperative to incorporate dust mitigation measures and a monitoring programme into the overall site management.

6.7.4 Water Quality

The potential water quality impacts associated with shaft and tunnel construction are mainly confined to uncontrolled runoff or washout from batching plants entering drainage channels and sewers. When the Preliminary Treatment Works is being upgraded, the need to discharge unscreened effluent into the Harbour will occasionally arise. As previously noted under discussions pertaining to the other sites, it is not possible to quantify the frequency or the extent of these untreated effluent discharges. The Contractor will be required to demonstrate, in his method statement, that phasing of the works will be such that bypassing of the treatment process will be minimised.

It should be noted that if concrete batching or bentonite mixing plants are established on-site or if there is any requirement to apply protective coatings to any materials or dampening of stockpiled materials dedicated drainage systems will be required around such areas to allow spillages to be contained and appropriately disposed of. Although the work site is located within an existing sewage treatment works, all wastewaters will be required to be disposed of according to the provisions of the WPCO Technical Memorandum for connections to foul sewers which connect to a Government Sewage Treatment Works. The provisions of Practice Note ProPECC PN1/94 also apply at this site in connection with site drainage

and disposal of effluent.

6.7.5 Waste Disposal

Spoil generation rates for construction of the transfer tunnel have been estimated to amount to 300m³/month. Further disposal requirements relate to spoil excavated from the drop shaft and wastes associated with general day-to-day construction activities. Disposal of these wastes are responsibility of the individual Contractor, but must be in accordance with the requirements of EPD.

It is recommended that the Contractor should give careful attention to transport for routes and scheduling the disposal of spoil, in order to minimise congestion on local roads.

6.7.6 Vibration

There are no Civil Aviation Department facilities in the vicinity of the site, but industrial and residential dwellings are in close proximity and therefore more stringent vibration controls may be required here than at other sites. Mines Division have advised the general vibration limit of 25mm/s ppv will apply, although this is subject to further confirmation when the Contractor submits his programme and detailed working methods for the construction of the drop shaft and the tunnelling works.

Vibration will not be an issue either during the installation of the RSS facilities or during the upgrading works.

6.7.7 Visual Impact and Landscape Issues

The area had a low sensitivity to visual impacts because of the adjoining industrial uses. In addition to which this site is partially shielded from view by a security fence which will further reduce the visual impact of the construction works.

6.7.8 Summary of Potential Impacts

A summary of potential impacts arising from construction activities is given in Table 6.15.

Table 6.15 Summary of Potential Impacts - To Kwa Wan

Works	Noise	Air Quality	Water Quality	Waste	Vibration	Visual and Landscape
Installation or RSS facilities	*** (short term)	**	*	*	*	*
Construction of production shaft	****	**	**	***	**	*
Construction of tunnel and drop shaft	****	**	**	***	**	*
Upgrading of PTW	***	***	***	*** (short term)	*	*

key : ****- very severe; ***- moderate severity; **- minor impact; *- insignificant

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6.8 Tsing Yi Preliminary Treatment Works

6.8.1 Description of the Construction Works

All construction activities will take place within an existing Preliminary Sewage Treatment Works. Major works to be carried out at the site are:-

- Construction of the production/drop shaft.
- Driving of tunnels between Tsing Yi and Stonecutters Island (by TBM) and between Tsing Yi and Kwai Chung (by drill and blast)
- Lining of the tunnels.
- Up-grading of the existing preliminary treatment facilities in order to achieve the Stage I project design standards.

Containerised resident site staff (RSS) facilities will be located immediately to the west of the existing aerated grit channel. Road access to the site is also provided.

6.8.2 Noise

The noise sensitive receiver (NSR) which is nearest to the facilities is some 120m away from the production/drop shaft in an area which has been assigned an ASR of "B". An estimated 1,900 people could potentially be affected by construction works at this site.

The perceived noise level associated with construction of the site staff facilities was predicted to be 62dB(A) and thus fully complies with the BNL limit of 65dB(A) given the NCO Technical Memorandum.

During the excavation of the production shaft, the predicted maximum noise level at the NSR is 81 dB(A). This is primarily due to rock excavation which will last for five months. Construction activities which will have the longest duration are the driving and lining of the two tunnels. A summary of predicted noise levels of single and cumulative activities at this NSR is given in Table 6.16 with further details on the time periods involved, in Appendix C(1).

Table 6.16 Predicted noise levels at nearest NSR for construction activities at the Tsing Yi site

Activity	Noise Impact at NSR Predicted for Single Activities dB(A)	Maximum Noise Impact at NSR Predicted for Multiple Activities dB(A)	Mitigation Requirements, dB (Duration, months)
Excavate TBM chamber	76	76	26(2)
Drive tunnels TY - SCI	78	81	31(9)
Drive tunnels TY - KC drill and blast	78	81	31(7)
CIP tunnel lining TY - SCI (option)	73	73	23(6)
CIP tunnel lining TY - KC (mandatory)	73	79	29(2)
Line shafts	73	73	23(3)

Not unexpectedly driving the tunnels (both by TBM and drill and blast) will have the greatest impact, with the surface activities of loaders and cranes generating the highest sound power levels. From Table 6.16 it is apparent that for the majority of the construction phase of this site, noise mitigation measures will be required to permit even daytime working. When more than one activity is being carried out at this site, a reduction of 6dB(A) will be required during daytime hours, a 16dB(A) reduction between 1900 and 2300 hours and 31 dB(A) between 2300 and 0700 hours. Such mitigation measures will need to be applied extensively at source, and may include super-silenced equipment, provision of acoustic sheds or noise enclosures round the spoil mucking out area.

For the duration of the upgrading works there will be an overlap with the tunnel construction works. From the details given in Table 6.16 it may be surmised that mitigation measures will be required to permit work even during periods not controlled under the NCO.

The noise impact due to modification of these treatment works cannot be predicted until more programming details and equipment schedules are available once the Contractor has submitted his detailed working methods. It may, however, be surmised that the impacts could be considerable, especially during periods when piling is carried out on-site.

A noise monitoring programme will be required for the duration of the construction works at this site.

6.8.3

Air Quality Assessment

Construction of the access road may cause a temporary local elevation in airborne dust levels, but considering the short duration and minor extent of the work, it is believed that there will be no significant dust problem at the nearest sensitive receivers.

In the EIA of the Preliminary Design, it was assumed that the month when construction activities would generate most dust would be June 1993 (based on the programme available when the EIA of the Preliminary Design was undertaken). During this period an estimated 3,600m³ of rock was assumed to excavated with nearly 45m³ of concrete imported onto site in ready mix form. A daily emission rate of 40µg/m²/s was used as input to the models which resulted in a predicted Total Suspended Solids (TSP) level of 28µg/m³ at the nearest sensitive receiver. Thus it was concluded there would be no exceedance of the APCO Air Quality Objectives.

The Detailed Design data indicates that the average monthly excavation rate will now be increased to 5,400m³ of rock, as a result of the tunnel drive from Tsing Yi to Stonecutters Island. Furthermore, an estimated 30 spoil disposal vehicles and 25 vehicle movements will be associated with import of plant and materials to site. Other dust generating activities include the driving of the tunnels between Tsing Yi and Kwai Chung (drill and blast) which is programmed to overlap with the tunnel drive to Stonecutters Island for a period of almost four months. Air quality impacts of backfilling the production shaft are dependent upon the method of mixing concrete. If concrete is batched on-site it could cause fugitive dust problems. However, if brought onto site in ready mix form, potential impacts are associated only with the increased vehicle movements.

It may be concluded that, potential emission rates may be almost twice those previously assumed in the Preliminary Design EIA. Nevertheless, this should not be a serious issue assuming proper controls on construction methods are exercised.

Due to the large scale of work required at this site, incorporation of mitigation measures in the overall design and construction methods will be required to ensure the APCO Air Quality Objectives are not exceeded. To ensure correct application of these measures, an airborne dust monitoring programme will undertaken as described in Section 9.

Section 6

6.8.4 Water Quality

Water quality issues associated with construction at this site are expected to be minor. Nevertheless, measures will be required to control runoff from the site area and the washout of any batching plants. If concrete batching or bentonite mixing plants are established on-site, or if there is any requirement to apply protective coatings to any construction materials, then areas will be provided for these facilities with dedicated drainage collection systems. All liquid waste arising on-site will be discharged to the foul sewer in accordance with the provisions of the TM and the Practice Note, ProPECC PN1/94 on Construction Site Drainage. Any necessary treatment, such as settlement of solids, will be provided by the Contractor.

6.8.5 Waste Disposal

Waste disposal issues will be similar to those of the other sites and the Contractor will be required to dispose of these waste materials in accordance within the guidelines set by EPD.

6.8.6 Vibration

The nearest Civil Aviation Department facility is the Outer Beacon which is located some 2 km from this site to the south of the Nam Wan Kok Oil Depot. It is not anticipated that the drilling and blasting, or the employment of a TBM for will have any impact on this beacon. An upper vibration limit of 25 mm/s is generally imposed by Mines Division in connection with blasting at such sites. Prior to commencing any of the works, Mines Division will require full details of the Contractor's method statement, the construction programme and any other information which may be necessary to finalise their requirements. It may however be assumed that, vibration should not be an issue of concern at this site.

6.8.7 Visual Impact and Landscape Issues

The site is within an area of low sensitivity where construction works are not expected have an unacceptable visual impact on adjoining land uses. Residents of the Cheung Ching Housing Estate are prevented viewing this site due to a 5m high retaining wall to the north and a 10m high wall with tree planting to the west. The wider views to and from the Rambler Channel are limited and in view of the fact that there are container depots in close proximity it may be concluded that the works will not detract from their surroundings.

6.8.8 Summary of Potential Impacts

A summary of the extent of the potential impacts identified at Tsing Yi are given in Table 6.17.

Table 6.17 Summary of Potential Impacts - Tsing Yi

Activity	Noise	Air	Water	Waste	Vibration	Visual
Installation of RSS facilities	**	*	*	*	*	*
Production/Drop Shaft	***	**	*	**	*	*
Tunnel between SCI and TY	***	***	**	***	*	*
Tunnel between KC and TY	***	***	**	***	*	*
Upgrading of PTW	***	***	** intermittent	***	*	*

key : *** Severe/Moderate ** Minor * Negligible

6.9 Tseung Kwan O Preliminary Treatment Works

6.9.1 Description of the Construction Works

The construction activities will be located within the existing Tseung Kwan O Pumping Station. The major works include:

- establishment of containerised resident site staff (RSS) facilities;
- construction of a production/drop shaft;
- installation of drop and riser pipes in shafts, to be backfilled with concrete;
- driving of the tunnels to Kwun Tong, by a TBM;
- lining of the tunnels; and
- up-grading of the existing preliminary facilities in order to achieve the Stage 1 project design standards.

6.9.2 Noise

A recent survey of this area was undertaken which confirmed that the nearest NSR is still more than 2km away and out of the line of vision of this site. An Area Sensitivity Rating of "B" has been ascribed to this site in view of the proximity of the Tseung Kwan O New Town.

On account of the large distance between the RSS facilities and the nearest sensitive receiver, the installation of the RSS facilities was not expected to give rise to elevated noise levels. Although handling of the 24 containers for sample storage may cause high levels of noise in close proximity to the site, in the order of 112 dB(A), as a result of using a 30 tonne crane, the attenuation over distance will ensure that effects are negligible at the nearest Noise Sensitive Receiver (NSR).

Examination of noise levels for each activity undertaken in connection with the construction of the production/drop shaft indicates that rock excavation and the associated vehicle movements will cause the highest noise. The maximum level predicted at the nearest NSR is 55 dB(A), for 20% of the production/drop shaft construction period. Reference to the Acceptable Noise Levels (ANL) for such areas, with a sensitivity rating of "B", indicates that the use of either hydraulic or pneumatic drills will require noise reduction measures for the two months when rock excavation takes place between 1900 and 2300 hours.

Noise levels at source and at the NSRs have been predicted for excavation of the TBM chamber and the tunnel. According to the construction programme there are no other noisy activities scheduled for this stage of work and, thus, cumulative impact assessments were not required to be carried out. Reference to the NCO Technical Memorandum indicates that noise levels at the nearest sensitive receiver will easily achieve the required standard, except in the event that work is carried out between 2300 and 0700 hours. In such cases, a reduction of upto 1 dB(A) would be theoretically required, but in practice it would prove difficult to identify the Tseung Kwan O site as the offending noise source.

A summary of the predicted noise for the various activities and extent of mitigation required is given in Table 6.18.

Table 6.18 Predicted Noise Levels and Mitigation Measures for Tseung Kwan O Tunnelling Activities

Activity	Maximum Predicted Noise Level dB(A)	Mitigation Measures Required
i (a) excavation of TBM chamber	(a) 49 dB(A)	(a) none
(b) tunnel drives to Kwun Tong	(b) 51 dB(A)	(b) between 2300 and 0700 hours
ii installation of pipes	46 dB(A)	none
iii line shafts	46 dB(A)	none

Although the potential impacts from the demolition and reconstruction of the switchgear building may be significant at source, the nearest sensitive receiver is at considerable distance and shielded from view by local topography. It may be assumed therefore that distance will serve to attenuate the impacts on NSR's from these works.

6.9.3

Air Quality

Movement of containers and vehicles around the site during establishment of the RSS facilities, may create local and short term elevations in levels of airborne dust on-site. Due to the distance between the source and receptor this activity will have a negligible impact at the nearest sensitive receivers.

Dust generating activities at the production/drop shaft area include the excavation works and vehicle movements associated with haulage of spoil off site and import of concrete onto the site.

Input data adopted in the Preliminary Design air quality modelling study assumed the most severe situation would arise between January and December 1996 when an estimated 5,000m³ of rock would be excavated each month involving 27 vehicle trips/day. The engineering design team have now identified that rock excavation will take place over a two month period, with approximately 1300m³ of spoil removed per month. About 15 trucks will be employed in the removal of this spoil from site during excavation, about half the number previously assumed in the modelling study.

Furthermore, comparison of the two sets of data indicate that the modelling assumptions adopted for the Preliminary Design EIA were very conservative. Predicted dust levels corresponding to an emission rate of 38 µg/s/m² represents a more severe situation than anticipated for the present scenario. The considerable distance between the work site and the nearest sensitive receiver will also be of benefit in minimising dust problems.

When the TBM chamber is being excavated and the tunnel driven, elevated airborne dust levels may arise from spoil muck out, stockpiling of spoil and materials, concrete batching (if carried out on-site) and vehicle movements on, off and around the site. In connection with this work, an estimated 88,000m³ of rock will be brought to the surface over the period between July 1995 and July 1996, which relates to a monthly excavation rate of 9,500m³ (bulk volume). It has been assumed that up to 50 spoil trucks movements/day will be engaged in the off-site disposal of spoil.

Comparison of the input data with that used in the Preliminary Design EIA modelling studies would suggest the dust generating potential of this tunnelling stage is almost twice that previously assumed. However, the distance between the dust source and the nearest sensitive receiver will, again, be of benefit and it may therefore be concluded that, assuming the proposed mitigation measures are adopted, air quality is not likely to be a serious issue in this stage of the works.

It is unlikely that local air quality will be affected by exhausting of the tunnel ventilation system. However, the need for this ventilation requirements have been emphasised for occupational health reasons, because of potential build up of radon and silica in internal area in the western section of the tunnel which will be driven through granite.

Measures designed to minimise dust generation rates, and to mitigate the impacts of construction are included in Section 8.

6.9.4 Water Quality

Water pollution associated with construction work is a minor issue at Tseung Kwan O and is primarily confined to the appropriate disposal of effluent to foul sewer and site drainage. The standards to be achieved are those set out in the Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters. Perimeter drains will be required to prevent any contaminated runoff being released to drainage courses and ultimately into Tseung Kwan O in accordance with the recommendations made in the Practice Note Pro PECC PN1/94. Although the water used for rock drilling might be heavily charged with sediments, the quantities of this wastewater are likely to be small. However, discharge of untreated wash-waters from batching plants, for example, could have an adverse impact on receiving water quality.

If settling lagoons are provided for wastewater generated within the tunnels, these will need to have pollution prevention measures incorporated into their design, including bunding to a suitable height, to prevent overflow during periods of heavy rainfall. Settlement may be enhanced using a flocculant, and the resulting supernatant disposed of to the inlet of the treatment works in accordance with the Technical Memorandum mentioned above.

When the treatment facilities are being up-graded there may be short periods when overflow of untreated effluent into Tseung Kwan O will be unavoidable. As in the case of other sites, the Contractor will be required, in his Method Statement, to demonstrate effective measures will be taken to minimise such impacts.

6.9.5 Waste Disposal

The significant waste disposal issues are the same as for all other sites and pertain to general construction waste and spoil, which may be mixed with concrete or bentonite.

Key quantities of spoil estimated for each construction activity are as follows:

Production/Drop Shaft:

Diaphragm wall excavation	1600 m ³
Excavation in soil	3600 m ³
Excavation in rock	2600 m ³

TBM Tunnel Drive Tseung Kwan O to Kwun Tong

Excavation in rock	88,000 m ³
--------------------	-----------------------

Waste arising at Tseung Kwan O will therefore, mostly, be produced by excavation of the transfer tunnel. On average an estimated 9,500m³ of rock (bulk volume) will be brought to the surface at Tseung Kwan O each month. Although disposal of spoil will be the Contractor's responsibility, any material which could be used in land formation or general construction works will be sent to a public storage dump. Material which is unsuitable for reclamation, will be directed to the SENT landfill.

6.9.6 Vibration

No vibration sensitive equipment is located in close proximity to the Tseung Kwan O site, nor are there any residential dwellings which could be affected by vibration from blasting.

Section 6

6.9.7 Visual Impacts and Landscape Issues

Topography and the distance between the work site and the nearest sensitive receivers indicate that the visual impact of construction plant operating at this site will be minimal.

6.9.8 Summary of Potential Impacts

A summary of potential impacts arising from construction activities is given in Table 6.19.

Table 6.19 Summary of Potential Impacts - Tseung Kwan O

Activity	Noise	Air	Water	Waste	Vibration	Visual
Installation of RSS facilities	*	*	*	*	*	*
Construction of Production Shaft	***	*	*	**	*	*
Construction of tunnels	**	**	****	****	*	*
Upgrading of PTW	**	**	*** (short term)	***	*	*

key : *** Severe/Moderate ** Minor * Negligible

6.10 Kwai Chung Preliminary Treatment Works

6.10.1 Description of the Construction Works

The works are to be carried out at the Kwai Chung Preliminary Treatment Works which was under construction at the time of the assessment. The major activities include:

- construction of the drop shaft; involving installation of diaphragm walls to rockhead, excavation through soil and rock then concrete lining;
- excavation of the connecting adit from the main tunnel, by drill and blast, with bore raising through rock to final depth;
- installation of concrete pipes, with concrete or grout backfill, to finish the internal size in the rock portion;
- construction of a concrete de-aeration chamber within the large diameter portion of the shaft; and
- construction of a vortex chamber and connecting culvert at the shaft top.

Containerised facilities, offices, and toilets will be provided for the resident site staff (RSS) to the extreme east of the site.

6.10.2 Noise

The site is surrounded by heavy industry and the MTL Container Terminal. The nearest Noise Sensitive Receiver (NSR) is some 600 metres away. As a result of these surroundings and other influencing factors, the area has been assigned the least onerous Area Sensitivity Rating (ASR) of "C". An estimated 2,000 people could potentially be affected by construction activities at this site.

The establishment of the RSS facilities will have no significant noise impact on their surroundings.

A summary of predicted noise levels during the drop shaft construction stages is provided in Table 6.20 as follows:

Table 6.20 Predicted noise levels at the nearest NSR for drop shaft construction at the Kwai Chung site

Activity	Noise Impact at NSR Predicted for Single Activity dB(A)	Maximum Noise Impact at NSR Predicted for Multiple Activities dB(A)	Mitigation Requirements, dB (Duration, Months)
Guide walls and diaphragm walls	59	59	4dB during 2300-0700 hrs
Soil excavation	57	57	2dB during 2300-0700 hrs
Ring beam	55	55	-
Raised bore	61	61	6dB during 2300-0700 hrs
Sink and line	55	55	-

From the results provided in Table 6.20 it is evident that even during periods when multiple activities are carried out at this site, no mitigation measures will be necessary to permit work during daytime or between 1900 and 2300 hours. Mitigation measures will, however, be required if work is to be carried out between 2300 and 0700 hours.

6.10.3 Air Quality

The soft ground excavation will generate an estimated 1,740m³ of spoil with an additional 830m³ of rock excavation over a three month period. Air quality issues pertaining to construction of the drop shaft mainly relate to stockpiling, handling and transfer of these materials on and off site and the possible requirement to batch concrete for lining the drop shaft. An estimated 10 vehicle movements will be associated with removal of spoil, 15 for concrete, and 10 for plant and materials, at this site.

The anticipated quantities of spoil and, hence, vehicle movements, have therefore increased since the EIA for the Preliminary Design when predicted production rates were only 300m³ per month. Nevertheless, local conditions and the 600m distance between the source and the sensitive receivers suggest that the ASR's will not be adversely affected by fugitive dust emissions. Fugitive dust emissions can be easily controlled through good working practices, which are discussed in Section 8. It may thus be surmised that air quality will not be an issue of concern at this site, although monitoring at the boundary of the site during the entire construction period is recommended.

6.10.4 Water Quality

Water quality impacts may arise from washout of any concrete batching plants, site runoff which could include particulate matter or oil from above ground construction activities. Ultimate discharge of these wastewaters will be into the Rambler Channel. The effect on existing water quality will be insignificant and impacts can be controlled by the inclusion of pollution prevention facilities in accordance with the Practice Note on Construction Site Drainage, Pro PECC PN1/94.

Domestic effluent from the workforce, estimated to number 20, will be disposed of via the foul sewer in accordance with the requirements of the WPCO Technical Memorandum.

Section 6

6.10.5 Waste Disposal

In addition to the soil and rock which will be excavated during the initial phase of construction of the drop shaft, as quantified in Section 6.10.3 above, other waste disposal issues relate to grouts, bentonite contaminated material, waste concrete and general construction wastes. As in the case of other sites, reusable material will be directed to a public storage dump while the remainder will be sent to landfill in accordance with EPD requirements. It is recommended that wherever possible, materials should be reused and recycled on site to reduce both disposal requirements and vehicle movements associated their disposal.

6.10.6 Vibration

Vibration stresses associated with activities at this site and the surrounding land uses have been assessed, and the conclusion drawn that vibration is a minor issue.

6.10.7 Visual Impacts and Landscape Issues

In the EIA which was carried out for the Preliminary Design in 1992, it was concluded that despite the surroundings, the prominence of the site with respect to the wider perspective of the Rambler Channel would require specific mitigation measures to be applied. From site visits, recorded by photography during this present assessment, it is the consultant's opinion that the landscape quality of this site has been overstated in the earlier study. The visual impacts associated with construction works at this site are considered to be minor in the context of their surroundings.

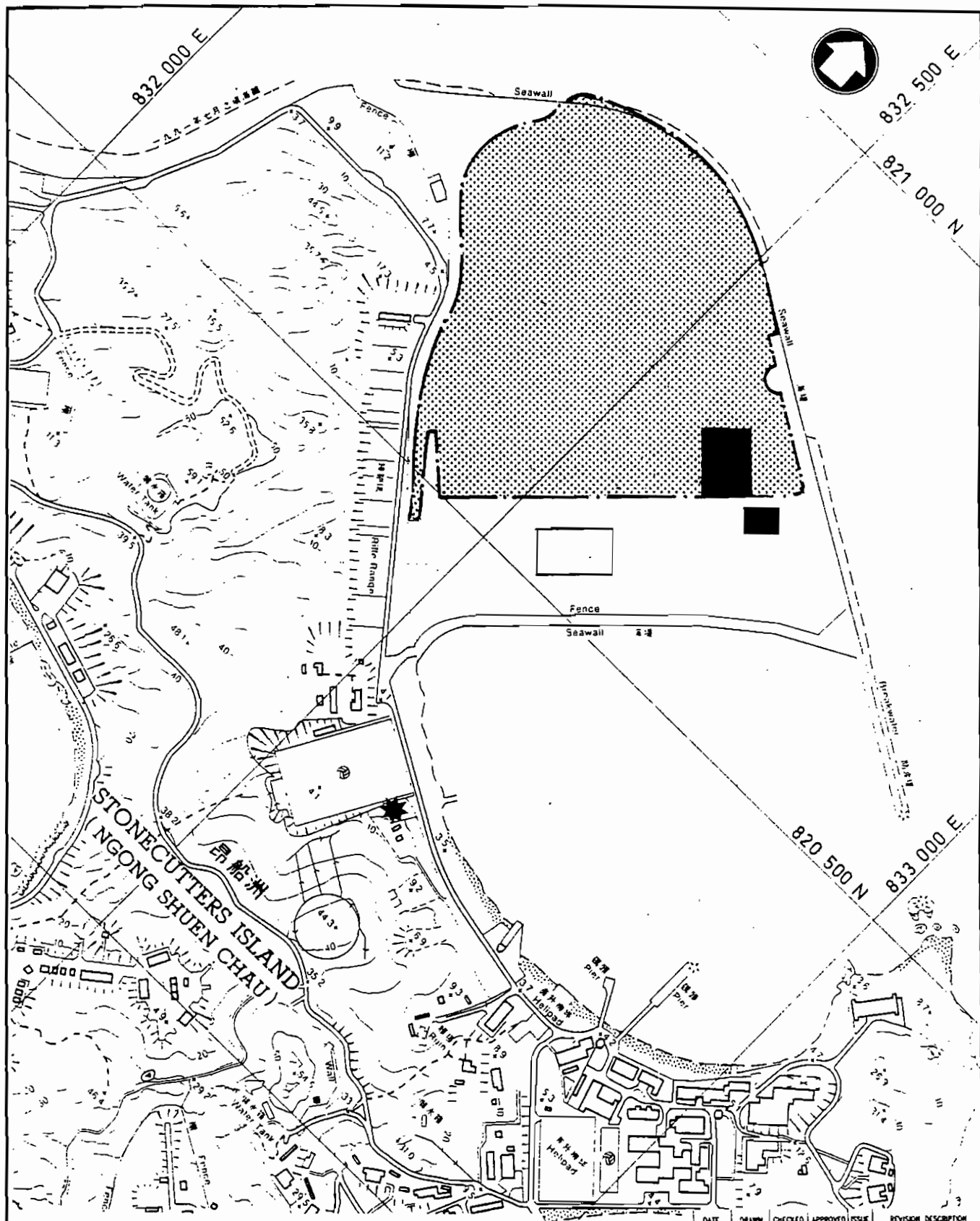
6.10.8 Summary of Potential Impacts

A summary of the potential impacts which could arise as a result of activities at Kwai Chung are given in Table 6.21 below.




Table 6.21 Summary of Potential Impacts - Kwai Chung

Activity	Noise	Air	Water	Waste	Vibration	Visual
Installation of RSS facilities	*	*	*	*	*	*
Drop Shaft	***	**	*	*	*	*


key : *** Severe/Moderate ** Minor * Negligible



Legend:

-  Location of Temporary Site Office for Resident Site Staff (RSS)
-  Works Area
-  Noise Sensitive Receiver

metres 100 0 200



GOVERNMENT OF HONG KONG

Strategic Sewage Disposal Scheme
Stage I - Principal Collection & Treatment System

Layout Plan of Construction
Works Area in Stonecutters Island
Sewage Treatment Works

Figure 6.1

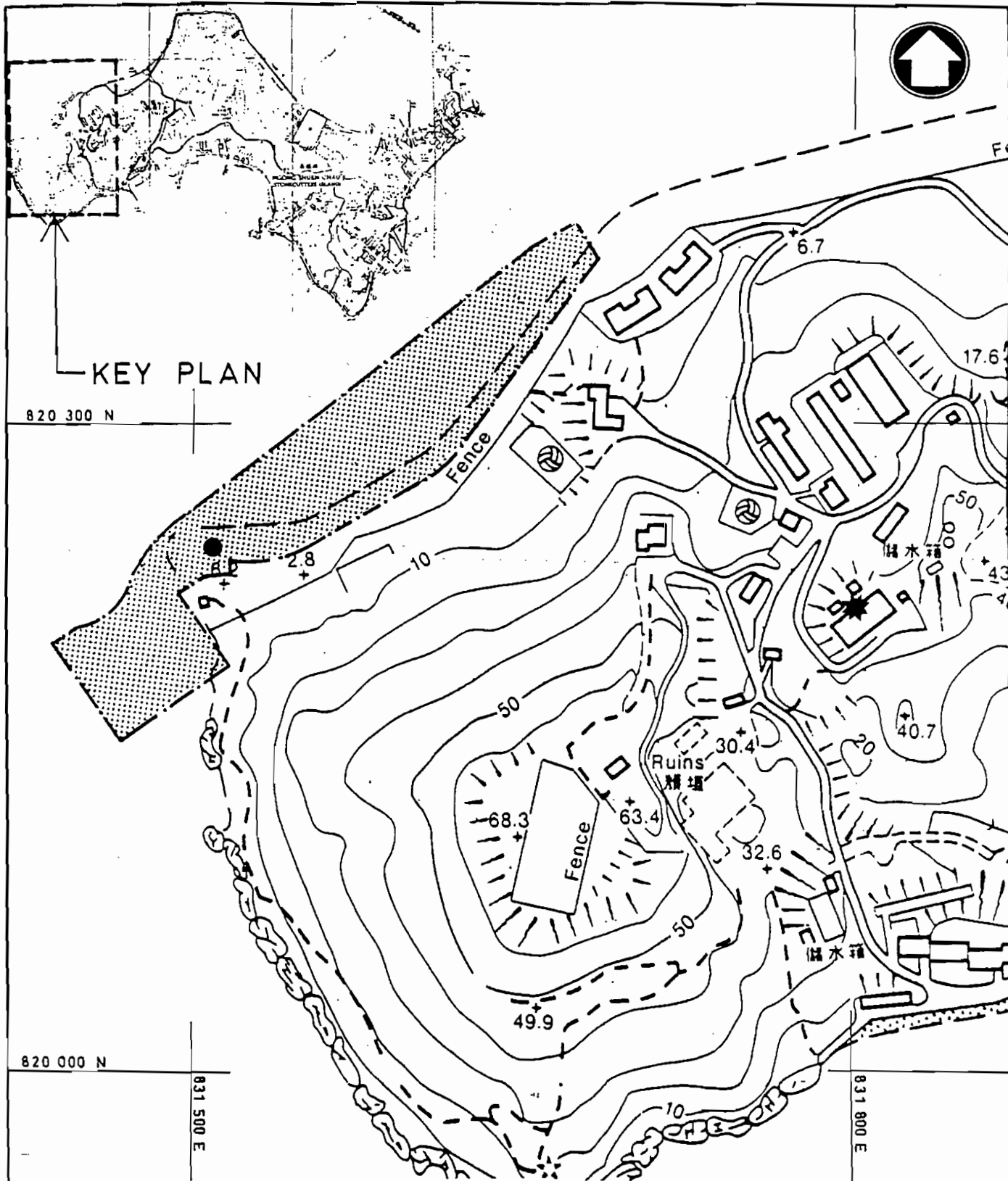


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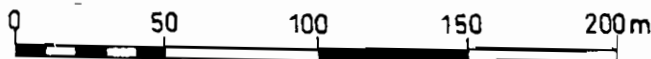
Location of Production Shaft/
Drop Shaft



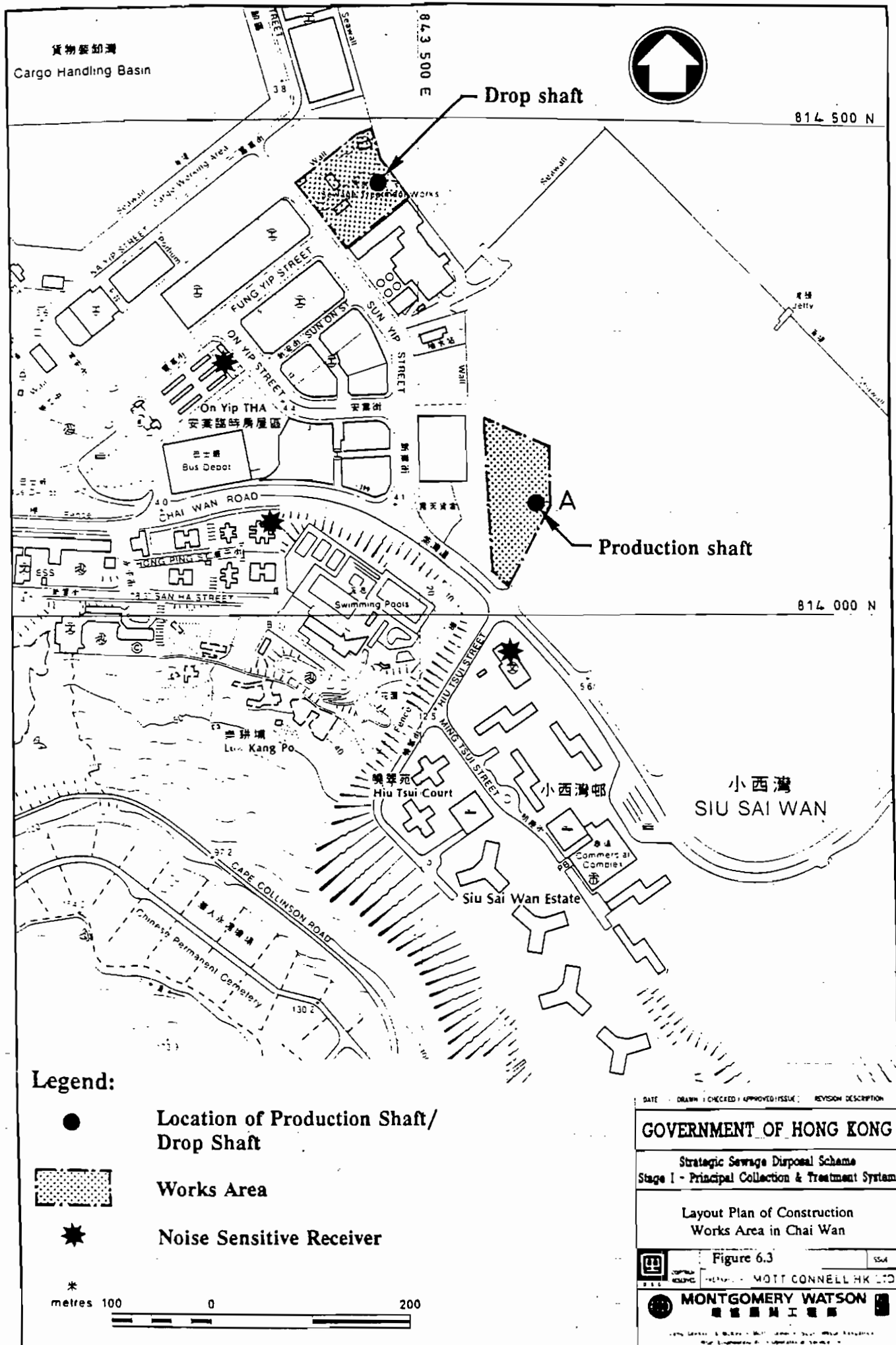
Works Area

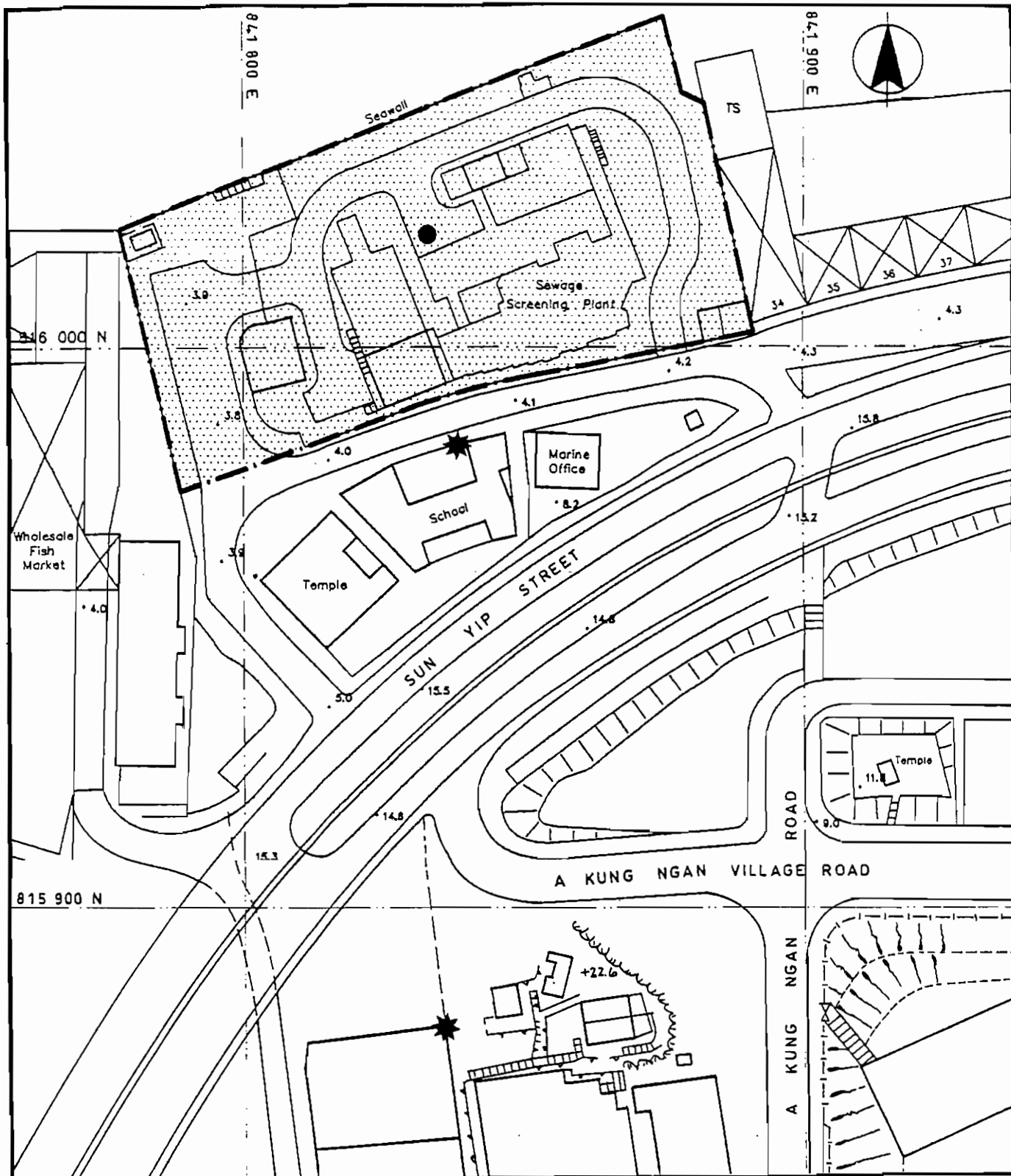


Noise Sensitive Receiver



DATE	DRAWN	CHECKED	APPROVED/ISSUE	REVISION DESCRIPTION
GOVERNMENT OF HONG KONG				
Strategic Sewage Disposal Scheme Stage 1 - Principal Collection & Treatment System				
Layout Plan of Construction Works Area at Stage 1 Outfall				
Figure 6.2				15/04
PREPARED BY: WOT CONNEL HE LTD.				
MONTGOMERY WATSON 環境顧問工程				
Landscape & Marine - Hill Country - Soil Conservation WOT Engineering Inc. - Corporation Services Inc.				





Legend:



Location of Production Shaft/
Drop Shaft



Works Area



Noise Sensitive Receiver



GOVERNMENT OF HONG KONG

Strategic Sewage Disposal Scheme
Stage 1 - Principal Collection & Treatment System

Layout Plan of Construction
Works Area in Shau Kei Wan



Figure 6.4

ISSUE

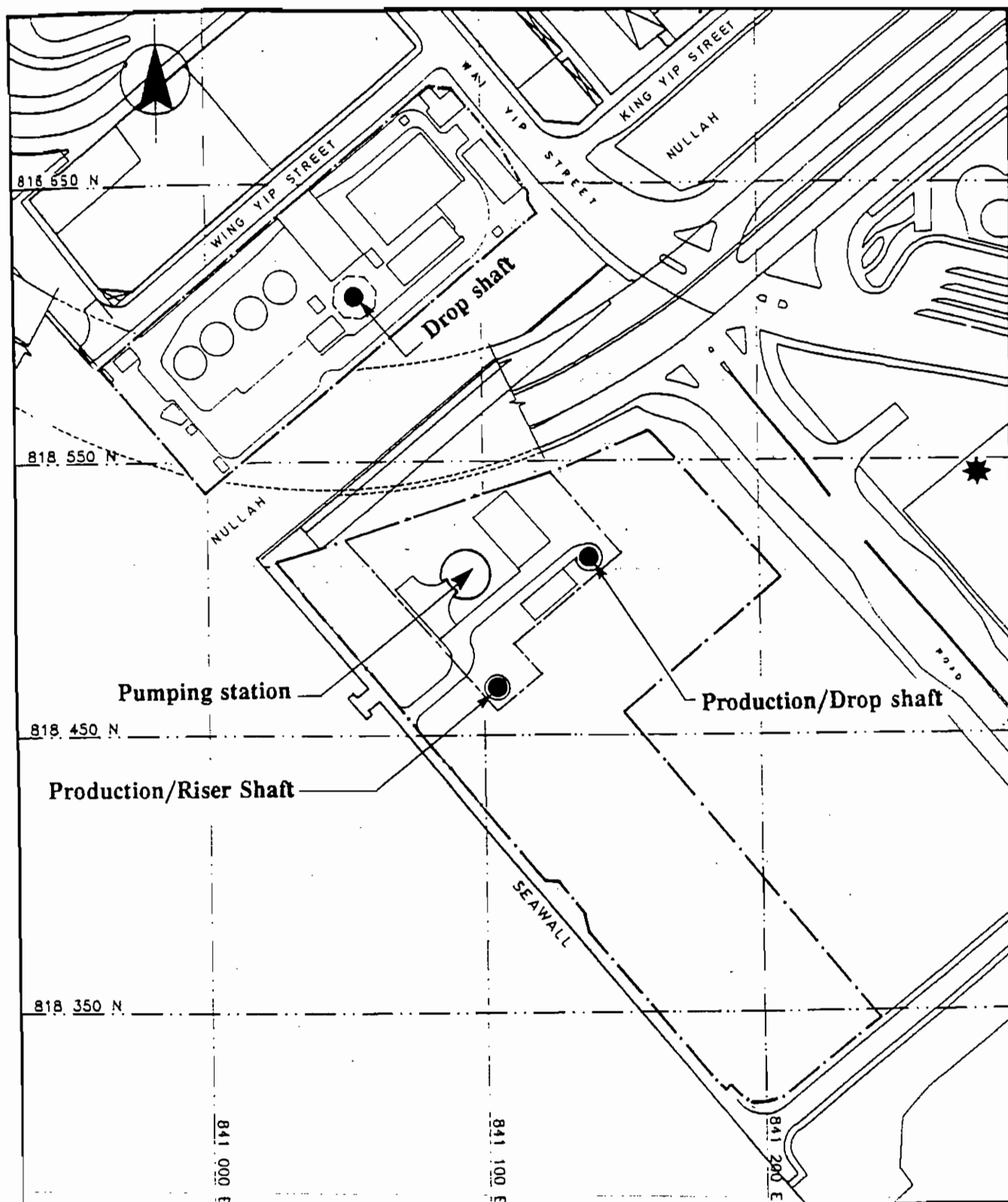
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Camp Dresser & McKee • Mott MacDonald • Scott Wilson Associates
MGP Engineering Inc. • International Services Inc.



Legend:

- Location of Production Shaft/
Drop Shaft
- ▤ Works Area
- ★ Noise Sensitive Receiver

20 0 20 40 60 m

GOVERNMENT OF HONG KONG

Strategic Sewage Disposal Scheme
Stage I - Principal Collection & Treatment System

Layout Plan of Construction
Works Area in Kwun Tong

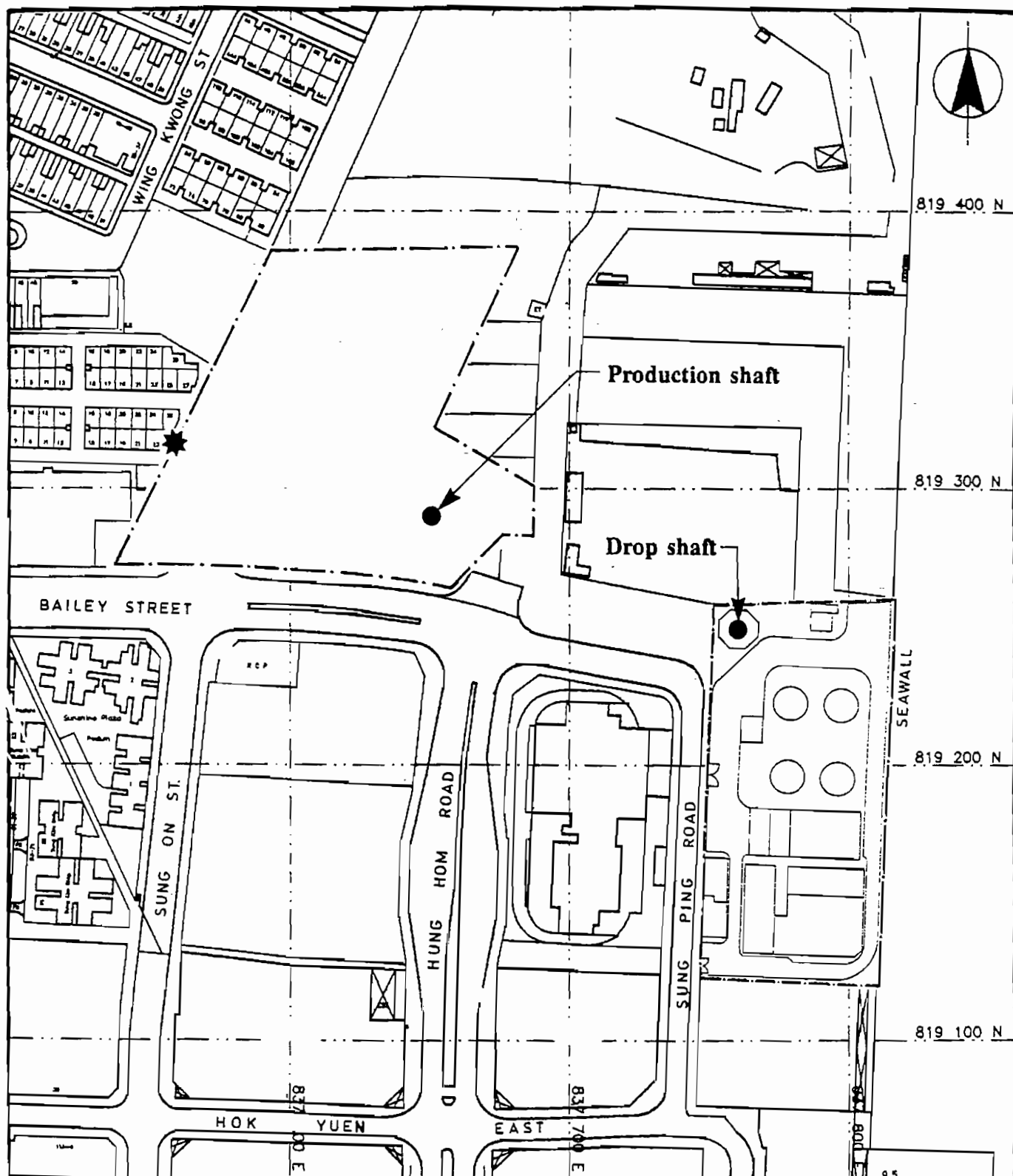


Figure 6.5

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Legend:

- Location of Production Shaft/
Drop Shaft
- Works Area
- ★ Noise Sensitive Receiver

GOVERNMENT OF HONG KONG

Strategic Sewage Disposal Scheme

Stage I - Principal Collection & Treatment System

Layout Plan of Construction Works Area in To Kwa Wan

Figure 6.6

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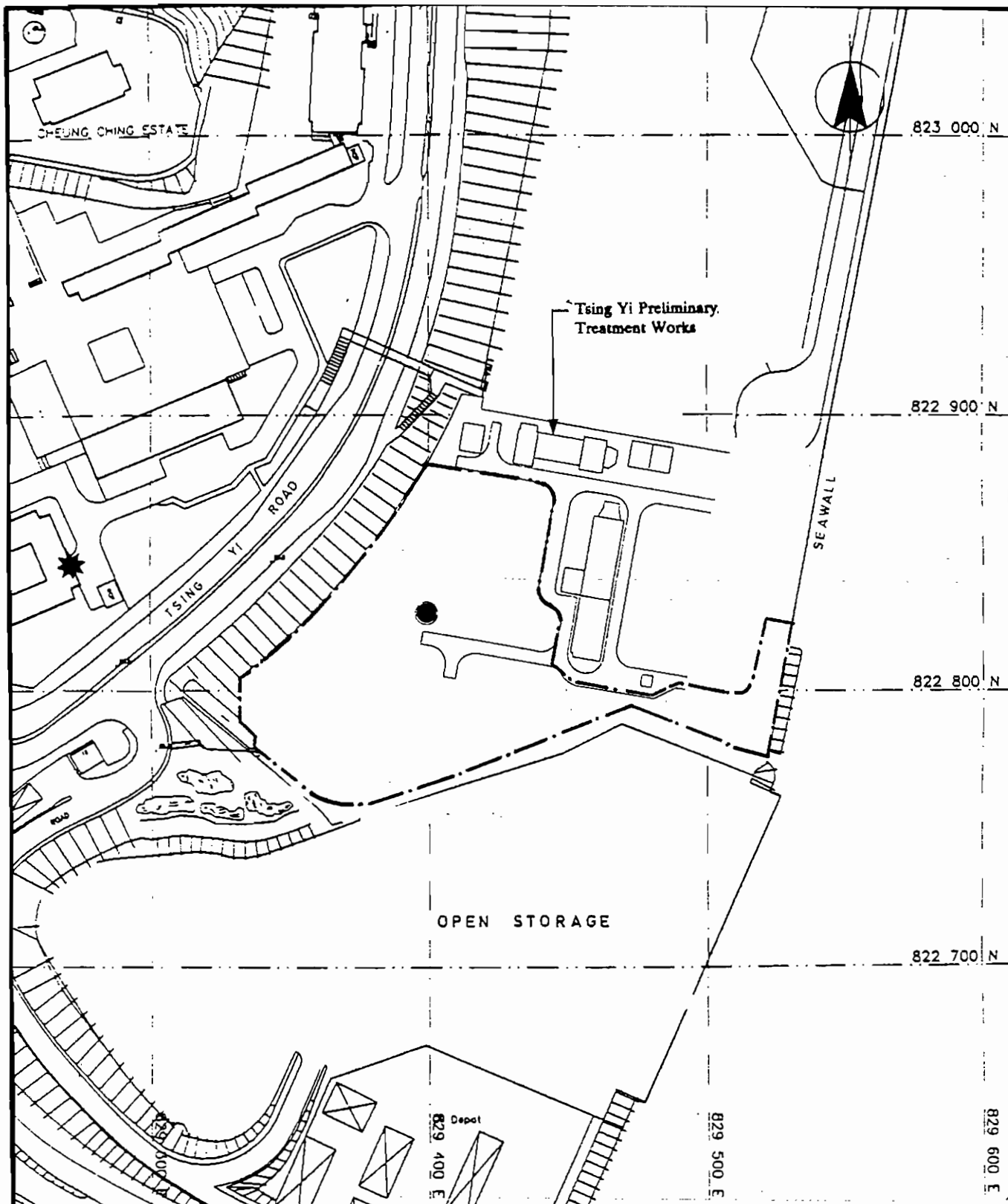
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WGP Western & MidAm • Mobil Council • Shell Business Analyst •
WGP Engineering, Inc. • Operational Services Inc



Legend:

- Location of Production Shaft/
Drop Shaft
- Works Area
- ★ Noise Sensitive Receiver

GOVERNMENT OF HONG KONG

**Strategic Sewage Disposal Scheme
Stage 1 - Principal Collection & Treatment System**

Layout Plan of Construction
Works Area in Tsing Yi



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Figure 6.7

ISSUE

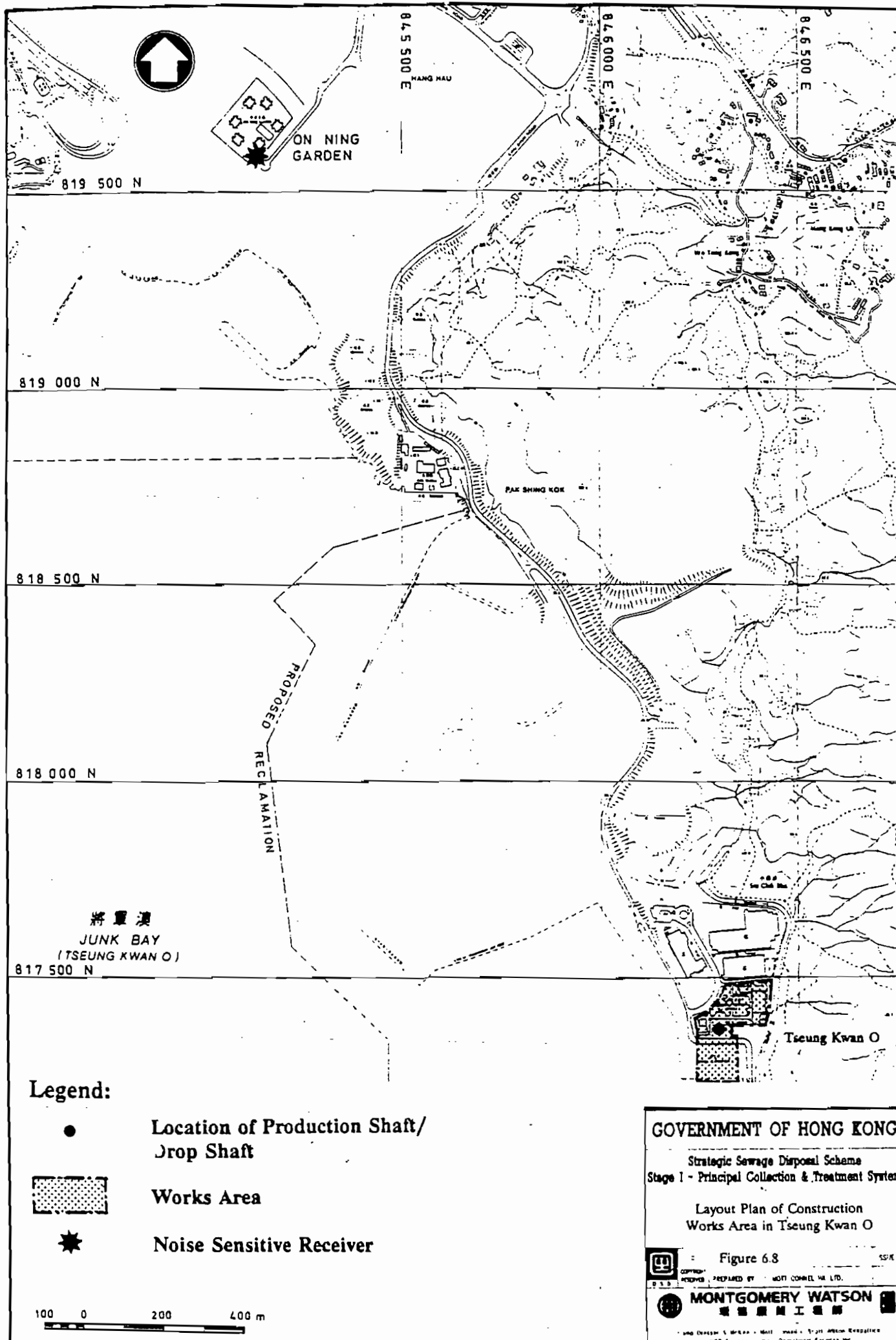
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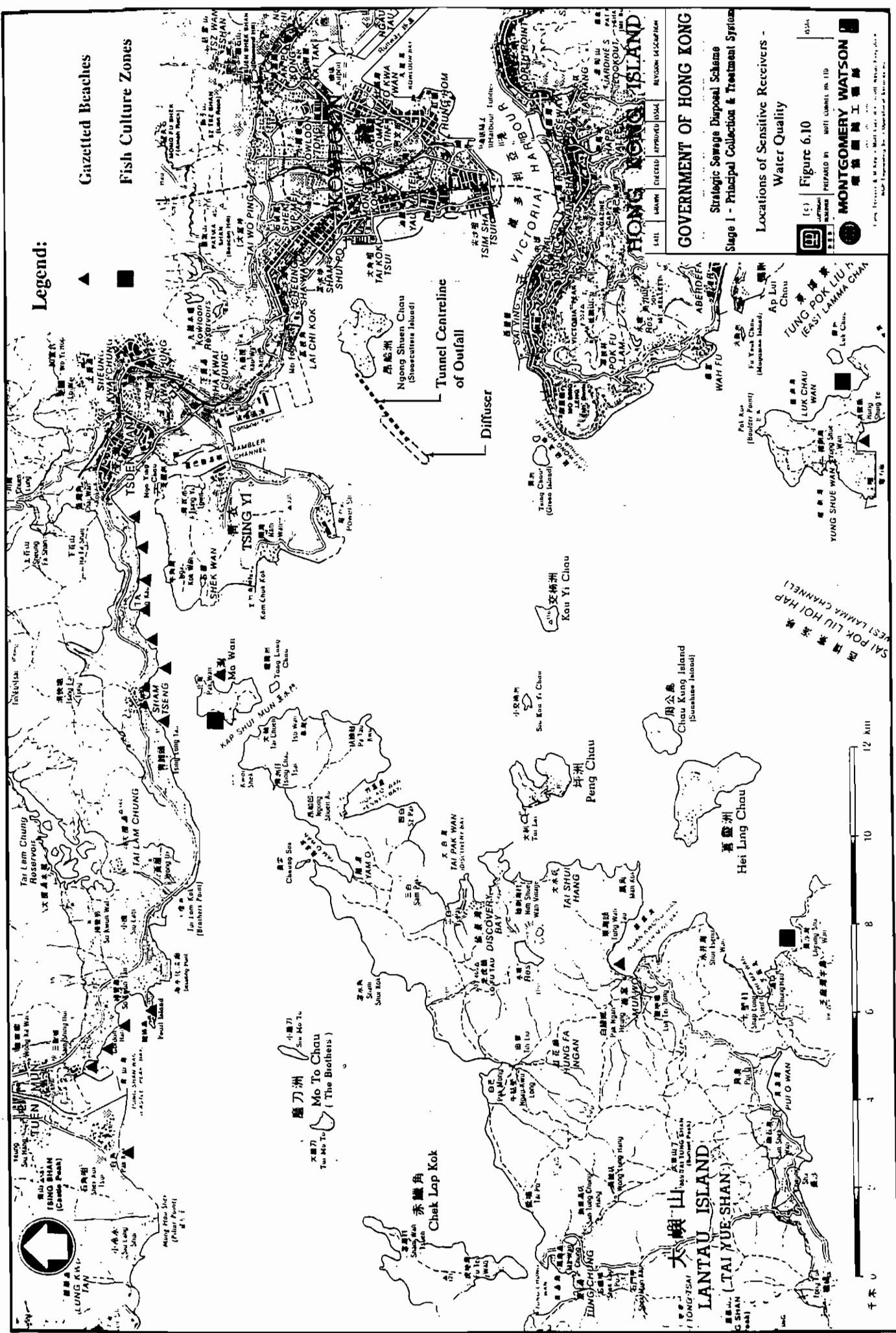


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MWP Engineering Inc. - Operational Services Inc.

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OPERATIONAL PHASE ASSESSMENT

7.1 Introduction

At Stonecutters Island Sewage Treatment Works the level of treatment provided is based on primary sedimentation. The Initial Design Memorandum, 1993, was predicated upon the addition of lime to enhance the sedimentation process. The subsequent decision to base the treatment process on ferric chloride rather than lime required a reappraisal of the impacts associated with the operational phase of the Stage I Scheme, particularly in connection with the noise and odour control facilities previously recommended and future water quality.

The findings of the operational assessments are provided in the following sections with further details provided in the relevant Appendices. The findings of the operational assessments based on lime, ferric chloride and ferric sulphate (where information is available) treatment scenarios are given in the following paragraphs.

7.2 Air Quality

Once the Stage I Scheme has been commissioned air quality issues will be confined to odour generation at the pumping stations at Kwun Tong and Stonecutters Island (Tseung Kwan O is a remote pumping station where retention times of sewage will be very much less than at either of the aforementioned), preliminary treatment works, sludge collection and disposal systems and the sedimentation tanks at Stonecutters Island.

Fugitive dust emissions may also be an issue in connection with the handling and storage of chemicals for the sedimentation process at SCISTW. The aforementioned issues were evaluated through the application and interpretation of the ISCST model for odours and the Fugitive Dust Model (FDM) for the chemical handling and storage facilities.

7.2.1 Odour Modelling Assessment

Hydrogen sulphide (H_2S) was identified as the main odorous gas associated with the Stage I Scheme, at the sources identified in Table 7.1 below:

Table 7.1 Sources of Hydrogen Sulphide

Type	Sources	Present in
Screening Buildings	sewage, screenings	All PTW's
Detritors (Aerated Grit Channels)	sewage	All PTW's
Grit Skip Buildings	grit	All PTW's
Gravity Culverts	sewage	Pumping Stations
Wet Wells	sewage	Pumping Stations & PTW's
Sedimentation Tanks	sewage	Stonecutters Island STW
Sludge Treatment Facilities	sludge	Stonecutters Island STW

Layout plans identifying the location of all odour sources at each site are included in Section H of Appendix D1. From these plans it can be observed that the most complex sites in terms of defining the odour potential are Stonecutters Island and Kwun Tong which require cumulative assessments of all sources of odours. It should be also noted that while the drop shafts and distribution chambers are odour sources, the design is now such that these will all be covered and no odours will escape directly.

Section 7

Release of H_2S from the Stage I Scheme is the primary concern on account of the odour threshold level, the proximity of the preliminary treatment works and pumping stations to existing sensitive receivers and the conditions expected to prevail within the conveyance system.

The assessment methodology is based on the same model (ISCST) as that used in the EIA of the Preliminary Design. Fundamental differences in the approach are that the average time for the estimation of hydrogen sulphide should be 5 seconds, rather than 5 minutes, in accordance with EPD's requirements.

In addition to which while the adoption of worst case meteorological data is appropriate for preliminary design it is misleading when specifying the pollution control facilities and odour control equipment required. Therefore, as agreed with EPD, the Royal Observatory data for 1993 was reviewed and the actual worst case scenario and the frequency of its occurrence, were defined and used in the present assessments.

Contrary to the findings of the Preliminary Design EIA the wet wells and drop shafts of the SSDS Stage I Scheme, preliminary treatment works (PTW's) were also considered to be significant sources of odour and were included in the assessment of the Detailed Design.

The mass flux of H_2S provides the emission rate of H_2S and permits the scale of the problem to be defined. Estimates of emission rates and factors for sources which are open to the atmosphere are very subjective and require a degree of caution to be applied, and there is still no consensus on for example the preferred equations (from different researchers such as Pomeroy, Thistlethwaite) to be adopted, the amount of sulphide present in available form or the degree of inhibition by metals (variable quantities from industrial effluent).

Domestic effluent naturally contains about 1 - 3 mg/l of sulphide and with the predominant use of seawater for flushing in Hong Kong and the inclusion of industrial wastewaters will increase the levels in the effluent. The amount of available H_2S was initially estimated by considering the sulphide flux in the walls of the tunnel systems. Slime will inevitably form on the walls of the conveyance tunnels and thus the sulphide flux and concentration in the liquid were estimated (from wall slimes) by Thistlethwaite and Pomeroy's equations as follows:

Using Thistlethwaite's equation to determine the sulphide flux:

$$G = 5.2 \times 10^{-4} V [BOD5]^{0.8} \times [SO_4]^{0.4} \times 1.139^{(T-20)}$$

(G: Sulphide flux in g/m^2hr , V: Water Velocity in m/s, [BOD5]: BOD5 in mg/l, [SO₄]: Sulphate concentration in mg/l, T: Temperature in °C)

Sulphide generation in tunnel sections was estimated by Pomeroy's equation (Ref 1) as follows:

$$Cs = 4 \times G(1+0.4D) \times t/D$$

(Cs: sulphide concentration in mg/l, D: Sewer diameter in m, t: Retention time in hour)

Details of the calculations used are summarised in Appendix D1 (Section A) with the results summarised in Table 7.2 below.

Ref 1 Technical Standing Committee on Hydrogen Sulphide Corrosion in Sewage Works; 1989: Hydrogen Sulphide Control Manual, Monograph 2, Melbourne and Metropolitan

Table 7.2 Estimated Hydrogen Sulphide Concentrations in Sewage (mg/l)

Temp (C)	20	20	20	Maximum
Location flow	1997 ADWF	2011 ADWF	2021 ADWF	
Kwun Tong Pumping Station Wet Well	0.31	0.30	0.29	0.31
Kwun Tong Pumping Station Drop Shaft	0.36	0.38	0.38	0.38
Stonecutter's Island Main Pumping Station	0.37	0.41	0.42	0.42
Stonecutter's Island (NWK) Pumping Station	0.02	0.02	0.02	0.02

Free Surface Flows - Channels and Culverts

A detailed literature search revealed a paucity of information relating to the emission rates of H₂S gas from sewage. Research appears to have focused upon odour levels or H₂S concentrations for different components of conveyance and treatment systems. In order to use the ISCST model the strength of the source needs to be defined in terms of mass per second. Application of equations used to estimate rate of corrosion in partially filled sewers have been applied to evaluate the emission rates in flowing channels directly:

$$\phi = 0.7 (SV)^{3/8} [H_2S] \quad (\text{Ref 2})$$

where :

(ϕ : hydrogen sulphide flux in gram per sq. meter hour, S: total energy head gradient, V: velocity of sewage, [H₂S]: hydrogen sulphide molecule concentration in sewage)

It should be noted that with the exception of the wet wells at the pumping station, screenings and sludge processing facilities all other odour sources can be considered to behave as open channel flow. Thus for the aforementioned the equation given above can be applied to estimate their emission rates.

Overflow channels of the NWKPS and discharge channels of the SCIMPS and KTPS may be significant sources of hydrogen sulphide. The emission rates for these channels were estimated using the same equations as for the open channels. The wet well of the NWKPS is similar to an open channel and its emission rate can also be estimated by the same method. The results are summarised in Table 7.3.

Table 7.3 Emission Rates of Channels

Location	(SV) ^{3/8}	[H ₂ S] in sewage (mg/l)	Sewage Surface Area (m ²)	Emission rate (µg/s)
SCIMPS Discharge Channel(s)	0.0096 - 0.0329	0.42	452	800
KTPS Connecting Culvert	0.06	0.38	200	887
NWKPS Wet Well	0.002225	0.02	228	28
NWKPS Overflow Channel	0.041818	0.02	31	5

Ref 2 ASCE; 1989 Sulphide in Wastewater Collection and Treatment Systems pp 86-88; American Society of Civil Engineers : New York

The emissions from the NWKPS wet well and the NWKPS overflow channel are relatively low because the hydrogen sulphide concentration in the influent is expected to be very low (0.02mg/l) due to the short distance between the NWKPTW and the NWKPS.

Pumping Station Wet Wells

The emission rates for open channels cannot be applied to wet wells. Site monitoring has therefore been carried out to estimate the hydrogen sulphide flux across the sewage surface in the wet well of Cheung Sha Wan Pumping Station. The maximum value estimated is 20 μ g/sq.m-s (refer to Appendix D1 (Section C) for details). This value can be used to estimate the maximum amount of H₂S emission from the wet wells in KTPS and SCIMPS. The results are summarised in Table 7.4.

Table 7.4 Emission Rates of Pumping Station Wet Wells

Location	Flux (μ g/m ² s)	Sewage Surface Area (m ²)	Emission Rate (μ g/s)
Kwun Tong Pumping Station Wet Well	20	96.6	1932
Stonecutter's Island Main Pumping Station Wet Well	20	190	3800

The wet well in Cheung Sha Wan Pumping Station is force ventilated and the hydrogen sulphide flux would have been smaller if there was no forced ventilation. The wet wells in KTPS and SCIMPS are not expected to be ventilated except prior to man access, and therefore the emission rates estimated in Table 7.4 are considered to be conservative.

Screening Processes

During the H₂S monitoring work in the existing Kwun Tong PTW and To Kwa Wan PTW, several monitoring points were located around buildings related to screening processes. The results and the emission rates are summarised in Table 7.5.

Table 7.5 Hydrogen Sulphide Concentrations and Emission Rates from Screening Plant

Location	Concentration	Emission Interpreted	Remark
Kwun Tong PTW - Coarse Screening Chamber	0.218ppm (avg) 0.8 ppm (max)	2012 μ g/s (avg) 7005 μ g/s (max)	Not enclosed; Inlet chamber for screw pumps was included.
Kwun Tong PTW - Fine Screen (Drum Type)	0.99ppm (avg) 3.2 ppm (max)	N/A	The screen was in a poor condition. Sewage vapour presented around the screen
Kwun Tong PTW - Screenings Dewatering Building	1.54ppm (avg) 3.1 ppm (max)	N/A	The plant was in a very poor condition. The floor was flooded by sewage.
To Kwa Wan PTW - Coarse Screen Building	0.017ppm (avg) 0.15 ppm (max)	1156 μ g/s (avg) 10408 μ g/s (max)	Roofed
To Kwa Wan PTW - Fine Screen Building	0.012ppm (avg) 0.1 ppm (max)	N/A	Enclosed building with natural ventilation by louvres around the building
To Kwa Wan PTW - Screening Dewatering House ventilation outlets	0.051ppm (avg) 0.2 ppm (max)	N/A	Enclosed building with forced ventilation

Table 7.6 Estimated Hydrogen Sulphide Emissions from Screening and Grit Skip Buildings

Location		Length (m)	Width (m)	Height (m)	Volume (cu.m)	Air Change (Per Hour)	Air Flow Rate (cu.m/s)	Concentration (ppm)	Emission (ug/s)
Chai Wan PTW	Coarse Screen Building	9.50	9.00	6.50	556	6	0.93	1.5	1931
	Fine Screen Building	23.05	15.50	8.85	3162	6	5.27	1.5	10988
	Grit Skip Building	4.00	4.00	4.05	65	6	0.11	1.5	225
Shau Kei Wan PTW	Coarse Screen Building	10.75	7.30	6.70	526	6	0.88	1.5	1827
	Fine Screen Building	22.50	21.00	7.00	3308	6	5.51	1.5	11494
	Coarse Screen Building	31.50	9.00	6.75	1914	6	3.19	1.5	6650
Tseung Kwan O PTW	Fine Screen Building	20.00	18.60	5.25	4833	6	8.05	1.5	16794
	Grit Skip Building	7.00	4.30	6.75	266	6	0.44	1.5	926
	Coarse Screen Building	23.26	12.50	6.75	1963	6	3.27	1.5	6820
Kwun Tong PTW	Fine Screen Building	6.48	14.95	9.95	3385	6	5.64	1.5	11763
	Grit Skip Building	12.00	7.00	6.50	546	6	0.91	1.5	1897
	Coarse Screen Building	13.50	10.50	6.50	921	6	1.54	1.5	3202
To Kwa Wan PTW	Fine Screen Building	24.45	16.75	6.50					
	Grit Skip Building	7.00	16.75	7.80					
	Coarse Screen Building	7.00	16.75	8.80	4608	6	7.68	1.5	16014
Tsing Yi PTW	Fine Screen Building	9.20	7.60	6.00	420	6	0.70	1.5	1458
	Grit Skip Building	12.50	7.00	11.60	1015	6	1.69	1.5	3527
	Coarse Screen Building	19.83	7.05	5.00					
Tsing Yi PTW	Fine Screen Building	12.70	10.90	7.50					
	Grit Skip Building	10.00	10.60	5.00	2267	6	3.78	1.5	7878

The maximum emission rate of the coarse screening component of the existing Kwun Tong PTW has been estimated to be 7005 $\mu\text{g/s}$ based on the odour monitoring which was undertaken specifically for this Project. Detailed calculations for the estimation of emissions are listed in Appendix D1 (Section C). Works at this plant will comprise enclosure of the coarse screens, but the equipment will not be changed. The ventilation rate of the enclosure was estimated to be 3.27 cu.m/s . Assuming that the emission rate from the equipment remains the same, the maximum hydrogen sulphide concentration of air emitted from the ventilation outlet of the proposed enclosure will be 1.5 ppm.

The new coarse screens at To Kwa Wan PTW will be set up in a new location in front of the inlet chamber for the screw pump. The emissions from the existing coarse screens at To Kwa Wan are therefore not suitable for estimating the emissions from the corresponding new screens.

The estimated maximum hydrogen sulphide concentration of air emitted from the new coarse screen building of Kwun Tong PTW, which is 1.5 ppm, is higher than those listed in Table 7.5 except for the concentration of fine screen and screenings dewatering building in the existing Kwun Tong PTW, which are particularly high because of poor conditions and are considered not suitable for using as references. It is reasonable to assume that the hydrogen sulphide concentration of air emitted from all screening plants (both coarse and fine screening plants and grit skip buildings) is 1.5 ppm and the emissions thus derived are summarised in Table 7.6.

Detritors

The detritors in the existing To Kwa Wan PTW were monitored and the H_2S flux from the surface was estimated to be 4.76 $\mu\text{g/s}$ (Refer to Appendix D1 (Section C) for details). This value was used to estimate the emissions from all the uncovered detritors in each of the PTW's. Subsequently the design of the detritors has been modified such that all of these facilities are now covered and therefore do not release hydrogen sulphide to the atmosphere.

The grit traps at Shau Kei Wan PTW will be located within the building housing the fine screens and thus the (single) emission is also the total source.

Aerated Grit Channels

The aerated grit channels in the existing Kwun Tong PTW were monitored and the H_2S flux from the surface was estimated to be 30.76 $\mu\text{g/s}$ (Refer to Appendix D1 for details). This value will be used for the aerated grit channels in Tsing Yi PTW.

Screenings from Preliminary Treatment Works

Hydrogen sulphide concentrations of screenings were monitored as part of the baseline studies for this Project, and the results are summarised in Table 7.7.

Table 7.7 Hydrogen Sulphide Concentration (ppm) of Fine Screening Residual

Location	Date	Time	Air Temperature (°C)	Concentration
Kwun Tong PTW	27/9/94	14:44	28.8	0.00
Kwun Tong PTW	27/9/94	14:46	28.8	0.10
Kwun Tong PTW	28/9/94	13:13	28.8	0.20
To Kwa Wan PTW	3/10/94	14:52	28.4	0.00

The H₂S levels shown are surprisingly low in spite of the strong intensity of odour level at the vicinities of screening residuals. The containers used to collect screening residuals is closed and therefore this component does not release emissions to the atmosphere.

Sludge Treatment Facilities

Sludge Treatment Facilities were initially considered separately under the auspices of the design and construct Contract pertaining to these facilities. Within that Contract the Contractor was required to demonstrate that the sludge treatment facilities would be designed such that they will neither cause an odour impact at the site boundary nor will they contribute to the overall odour level.

Using details now provided by the Contractor (engaged to design and construct these facilities) the H₂S concentrations at various locations of the Sludge Treatment Facilities have been estimated and are included in the overall odour budget. The foul air flow rates and H₂S concentrations at various locations of the Sludge Treatment Facilities have been estimated and summarised in Table 7.8.

Table 7.8 Hydrogen Sulphide Concentrations at the Sludge Treatment Facilities

Location	H ₂ S Concentration, ppm	Foul Air Generation Rate, m ³ /hr	Air Generation Rate and H ₂ S Contration after Dilution, m ³ /hr (ppm)	H ₂ S Emission Rate, µg/s
Sludge Holding Tank (each tank)	50	10	625 (0.8)	193
Centrifuges/ Conveyor	4.03	1570	1670 (9.6)	6190
Centrate Sump	97	100		
Dewatered Cake Silos	5	70	70 (5)	135

Sludge Handling and Disposal Facilities

The sludge cake will be disposed via the Sludge Handling and Disposal Facilities in sealed containers. The only location where the sludge cake is exposed to the atmosphere is at the loading ports under the sludge cake silos. The H₂S emission rate for each of these loading ports has been estimated to be 6.883 µg/s (refer to Appendix D1 (Section D) for details).

Sedimentation Tanks

Generation of odours from the sedimentation tanks is a more complex issue than the other components of the Stage I Scheme as the odours change both in nature and character depending upon the treatment process applied. For the scenario where the chemically enhanced sedimentation process was based on lime it was concluded that H_2S generation would not be a problem as the elevation in pH would inhibit the release of hydrogen sulphide gas.

The modification of the chemical dosing strategy from one based on lime to a strategy based on ferric chloride or ferric sulphate required a reappraisal of this assumption and a reassessment of the cumulative odour generated at Stonecutters Island Sewage Treatment Works.

The concentration of H_2S gas from wastewater in the Influent Channel of the Sedimentation Tanks was estimated to be 0.33 mg/l (refer to Appendix D1). It was surmised that a considerable amount of H_2S will be removed at this point of the works as a result of aeration. From the literature it has been identified that if effluent is adequately aerated then up to 80% of the dissolved sulphide can be oxidised thereby reducing the problem of odour generation (Ref 3).

Typical design criteria for odour control using aeration include a detention time of 10 - 15 minutes with air supplied at a rate of 0.09 - 0.35 $m^3/min-m$ (Ref 4). The detention time and air supply rate of the Influent Channel are 3 minutes and 0.47 $m^3/min-m$ respectively. Although the detention time is acknowledged to be short compared to the typical design criterion for odour control, it is reasonable to assume that at least 25% of the dissolved H_2S will be removed by this method. Therefore, the H_2S concentration at the Influent Channel was estimated to be $0.33 \times (100 - 25) / 100 = 0.25$ mg/l.

The rapid mix chambers are located downstream of the influent channel where ferric chloride or ferric sulphide will be introduced to the system. The amount of dissolved H_2S removed by either of these two chemicals depends on the dosage applied. The mechanisms involved when dissolved iron is introduced to the system include the combination of iron with sulphides to form highly insoluble iron salts such as smythite (Fe_3S_4), pyrite (FeS), and marcasite (FeS_2). Partly soluble compounds such as pyrrhotite (Fe_7S_8) and ferric sulphide (Fe_2S_3) can also be formed. By precipitating insoluble forms of sulphide, hydrogen sulphide is also removed due to a shift in its dissociation equilibrium thereby reducing the generation of odours.

Reference has been made to the in-situ tests detailed by Weber and Albu (Ref 5) which demonstrated the percentage removal of hydrogen sulphide increases with the dosage applied. The following results were reported:

FeCl ₃ Dosing Rate:	Average % sulphide reduced
21.6 gal/day or 4 mg/l	4.8
50 gal/day or 9 mg/l	11.5
77 gal/day or 14 mg/l	27.1
100 gal/day or 18 mg/l	38.7
150 gal/day or 28 mg/l	58.8

Ref 3 WALTRIP, G.D. AND SNYDNER, E.G. (1985); Elimination of odor at six major wastewater treatment plants; p.57; J. Water Pollut. Control Fed. as quoted in WATER ENVIRONMENT FEDERATION (1992); Design of Municipal Wastewater Treatment Plants; p.507; Water Environment Federation; Virginia.

Ref 4 WATER ENVIRONMENT FEDERATION (1992); Design of Municipal Wastewater Treatment Plants; p.438; Water Environment Federation; Virginia.

Ref 5 WEBER, M. AND ALBU, J. (1995); "Chemicals in Combination" in Water Environment and Technology, October 1995; pp. 56-61.

In the Revised Design Memorandum, 1995, it was stated that ferric chloride will be added to the Rapid Mix Chambers at a concentration of 20 mg/l to 40 mg/l. Assuming the average concentration of ferric chloride applied is 30 mg/l, then on the basis of the foregoing results it may be surmised that the percentage hydrogen sulphide removal rate will be of the order of 60%.

Although no comparable data have been found in the literature survey in connection with the addition of ferric sulphate, it was promulgated that if a 60% removal rate of hydrogen sulphide from the sedimentation tanks would permit compliance with the odour criterion, then laboratory trials would be recommended to determine the actual dosage of ferric sulphate required.

On this basis the H_2S concentration of effluent of the Rapid Mix Chambers was estimated to be $0.25 \times (100-60) / 100 = 0.099$ mg/l. The H_2S concentrations of sewage in the main distribution channels, the flocculation tanks and the sedimentation tanks, which are downstream of the Rapid Mix Chambers, were estimated to be 0.099 mg/l if ferric chloride is added to enhance the sedimentation process. The emission flux are estimated base on this estimated value and illustrated in Table 7.9.

Table 7.9 H_2S Emission Rates of the Sedimentation Tanks - Ferric Chloride Treatment Scenario

Location	H_2S Concentration, mg/l	(SV) ^{3/8}	H_2S Emission Flux, $\mu g/m^2-s$
Flocculation Tank	0.099	0.00374	0.072
Main Distribution Channel	0.099	0.00839	0.162
Sedimentation Tank	0.099	0.00019	0.004

An odour control system was included as a requirement in the Contract Document (DE/93/19) for the sedimentation tanks. Air collected from the influent channel of the sedimentation tanks, where hydrogen sulphide will be removed by aeration, will be treated by the odour control system. The hydrogen sulphide emission rate of the odour control unit has been estimated to be 69.5 $\mu g/s$ (refer to Appendix D1 (Section C) for details).

Summary of Hydrogen Sulphide Sources

The results of the hydrogen sulphide emission rates measured are summarised in Table 7.10 below.

Table 7.10 Summary of Hydrogen Sulphide Emission (Without Deodorisation) in $\mu g/s$

Location	Chai Wan	Shau Kei Wan	Tseung Kwan O	Kwun Tong	To Kwa Wan	Tsing Yi	Stonecutters Island
Coarse Screens Buildings	1931	1827	6650	6820	3202	3527	N/A
Fine Screens Buildings	10988	11494	16794	11763	16014	7878	N/A
Grit Skip Buildings	225	N/A	926	1897	1458	N/A	N/A
Aerated Grit Channels	N/A	N/A	N/A	N/A	N/A	1738	N/A
Pumping Station Wet Wells	N/A	N/A	N/A	2819	N/A	N/A	4607
Sedimentation Tanks - Influent	N/A	N/A	N/A	N/A	N/A	N/A	6950

Table 7.10 Summary of Hydrogen Sulphide Emission (Without Deodorisation) in $\mu\text{g/s}$ (Cont'd)

Location	Chai Wan	Shau Kei Wan	Tseung Kwan O	Kwun Tong	To Kwa Wan	Tsing Yi	Stonecutters Island
Sedimentation Tanks - Flocculation Tanks, Main Distribution Channels and Sedimentation Tanks (for Ferric Chloride or Ferric Sulphate Treatment Scenarios)	N/A	N/A	N/A	N/A	N/A	N/A	621
Sludge Treatment Facilities	N/A	N/A	N/A	N/A	N/A	N/A	7723
Sludge Handling and Disposal Facilities	N/A	N/A	N/A	N/A	N/A	N/A	28
Total	13144	13321	24370	23299	20674	13143	19929 (19308 for lime treatment scenario)

Odour Nuisance

According to Special Supplement No.5 to the Hong Kong Government Gazette, dated 21 January 1994, Section 5.1, any domestic premises, hotel, hostel, hospital, clinic, nursery, temporary housing accommodation, school, educational institution, office, factory, shop, shopping centre, place of public worship, library, court of law, sports stadium or performing arts centre shall be considered to be an odour sensitive receiver.

For each of the sites investigated in connection with future odour generation, existing sensitive receivers were identified and the following information was used as input data to the ISCST (Version 2.11) model to evaluate potential odour nuisance.

- location of sensitive receivers;
- meteorological data including wind speed, wind direction, mixing height, atmospheric stability and temperature;
- source data identifying the location, source characteristics, emission rates and emission characteristics.

Source strengths were input to the model as $\mu\text{g H}_2\text{S}$ per second. Using a conversion factor of 72 provides the number of odour units predicted. The predicted odour units before mitigation are illustrated at each location on Figures 7.1 - 7.7. It should be noted that the distances between source and receptors have in some cases changed between the Preliminary and Detailed Design Stages.

The 5 odour unit limit will be significantly exceeded at all the seven sites implying that substantial reductions in odours will be required through the application of deodorisation techniques.

Details of Mitigation Measures

The following mitigation measures have been incorporated into the corresponding Contracts for the facilities listed below:

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(a) Chai Wan PTW, Shau Kei Wan PTW, Tseung Kwan O PTW, Kwun Tong PTW & To Kwa Wan PTW

Covers are required for the detritors. Deodorisation units, capable of reducing H_2S concentration from 0.5-3 ppm down to 0.005 ppm, will be installed downstream of the extraction fans of all screens buildings and grit skip buildings.

H_2S concentration of extracted air from those buildings is not expected to exceed 5 ppb (0.005 ppm = 5 ppb) after deodorisation. This is equivalent to 10 odour units and will be reduced to less than 5 odour units at sensitive receivers outside the boundaries after dilution.

(b) Tsing Yi PTW

Deodorisation unit with same specifications as given in (a) above will also be installed to treat the air extracted from the coarse and fine screens buildings and the two aerated grit channels.

(c) Kwun Tong Pumping Station

Deodorisation units with 99% hydrogen sulphide removal efficiency will be installed at the connecting culvert and the wet well. H_2S emissions (after deodorisation) from the connecting culvert and wet well were estimated to be 11.3 $\mu g/s$ and 8.9 $\mu g/s$ respectively.

(d) Stonecutters Island Sewage Treatment Works

- Northwest Kowloon Pumping Station

The influent at this pumping station is not expected to be septic since it will have been aerated in the Stonecutters' Island PTW about 250m upstream. No odour mitigation measures will be required for this pumping station.

- Stonecutters Island Main Pumping Station and Sedimentation Tanks Influent Channel

Deodorisation units with 99% H_2S removal efficiency shall be installed. H_2S emissions (after deodorisation) from the wet well of SCIMPS and the Influent Channel of the Sedimentation Tanks were estimated to be 27 $\mu g/s$ and 69.5 $\mu g/s$ respectively.

- Sedimentation Tanks - Flocculation Tanks, Main Distribution Channels and Sedimentation Tanks

Ferric chloride or sulphate will be dosed upstream of these facilities. The dosage prescribed in the Revised Design Memorandum, 1995, for ferric chloride is between 20-40 mg/l. The chemical dosing facilities are capable of increasing the dosing rate to 60 mg/l. As noted previously, dissolved iron will combine with sulphide to form highly insoluble iron salts and will precipitate out in the sludge as insoluble forms of sulphide.

- Sludge Treatment Facilities

Locally mounted activated carbon odour control units will be installed at all sludge tanks and sludge cake silos. A central activated carbon odour control unit will be installed to treat the foul air extracted from the centrifuge centrate and solids discharge ports, all transfer conveyors and the centrate sump. The H_2S removal efficiencies of all the carbon odour control units will be 99%.

- Sludge Handling and Disposal Facilities

Although there will be some exposure of the sludge cake to the atmosphere during the filling process, both the areal extent of the exposed cake, and the potential odour emissions from this source will be relatively insignificant compared to other components of the SCISTW. Therefore, no mitigation measures are recommended for these facilities.

Odour removal requirements are listed in Table 7.11 from which it may be observed that except for North West Kowloon Pumping Station, all preliminary treatment works and pumping stations need substantial odour removal to attain the 5 O.U. limit at odour sensitive receivers. Furthermore, all forced ventilation systems at each of the PTW's need up to 99% of odour removal and all detritors need to be covered.

Table 7.11 Summary of Deodorization Units Details

Location	Buildings/Equipment	H ₂ S Removal Requirements (by activated carbon unless otherwise stated)	For New Buildings or for Existing Facilities
Stonecutters Island Sewage Treatment Works	SCIMPS	99% removal	New Buildings
	Influent Channel of Sedimentation Tanks	99% removal	New Facilities
	Flocculation Tanks, Main Distribution Channels and Sedimentation Tanks (Ferric Chloride or Ferric Sulphate Treatment Scenarios)	about 60% removal (assuming concentration of ferric chloride is 30 mg/l, dose of ferric sulphate not determined as yet)	New Facilities
	Sludge Treatment Facilities (including raw sludge and sludge cake holding tanks, centrifuge centrate and solids discharge ports, all transfer conveyors and the centrate sump)	99% removal	New Facilities
Chai Wan PTW	Fine Screens Building Coarse Screens Building Grit Skip Buildings	3 ppm to be reduced to 0.005 ppm	New Buildings
Shau Kei Wan PTW	Coarse Screens Building Fine Screens Building	3 ppm to be reduced to 0.005 ppm	New Buildings
Tseung Kwan O PTW	Grit Skip Buildings Coarse Screens Building	3 ppm to be reduced to 0.005 ppm	New Buildings
	Headworks Buildings	3 ppm to be reduced to 0.005 ppm	Existing Buildings
Kwun Tong PTW	Coarse Screens Building Fine Screens Building Grit Skip Buildings	3 ppm to be reduced to 0.005 ppm	New Buildings
Kwun Tong Pumping Stations	Connecting Culvert Wet Well	99% removal	New Facilities
To Kwa Wan PTW	Coarse Screens Building Fine Screens Building Grit Skip Buildings	3 ppm to be reduced to 0.005 ppm	New Buildings
Tsing Yi	Coarse Screens Building Fine Screens Building	3 ppm to be reduced to 0.005 ppm	New Buildings
	Aerated Grit Channels	3 ppm to be reduced to 0.005 ppm	Existing Aerated Grit Channels

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All deodorization plants will consist of prefilter sections and chemical impregnated activated carbon sections.

The humid air in Hong Kong might reduce the removal efficiency of the impregnated activated carbon, and should be taken into account when designing deodorization plants.

The predicted odour levels (by ISCST model) at the nearest sensitive receivers with mitigation measures at all site are summarised in Table 7.12.

Table 7.12 Predicted Odour Levels at Nearest Sensitive Receivers (with Mitigation Measures)

Location	Odour Levels at Nearest Sensitive Receivers (odour units)	Remark
Chai Wan	1.0	-
Shau Kei Wan	0.7	-
Tseung Kwan O	0.1	-
Kwun Tong	2.3	-
To Kwa Wan	1.1	-
Tsing Yi	1.4	-
Stonecutter's Island Sewage Treatment Works	1	Lime Treatment Scenario
	7.2	Ferric Chloride or Sulphate Treatment Scenarios (Dosing equivalent to 30 mg/l ferric chloride)

By considering the Lime Treatment Scenario, the odour levels at all the nearest sensitive receivers are estimated to be lower than the 5 odour unit limit if the mitigation measures are incorporated. If ferric chloride or sulphate removes 60% of hydrogen sulphide (ie ferric chloride dosed at 30 mg/l), the odour level at the nearest sensitive receiver at Stonecutters Island is estimated to be 7 which is self evidently in excess of the criterion specified.

A sensitivity test was carried out to determine the optimum dosage of ferric chloride which is required to achieve the odour criterion. These sensitivity tests were performed to estimate odour levels at the nearest sensitive receivers at Stonecutters Island assuming ferric chloride was added at between 30 mg/l to 40 mg/l (refer to Appendix D1 (Section I) for details).

<u>Dosing Rate (mg/l)</u>	<u>Odour Level at the Receiver (Odour Units)</u>
31	6.7
32	6.4
33	6.1
34	5.8
35	5.5
36	5.2
37	4.9

The results of the sensitivity test indicate that if the dosing rate is 37 mg/l, the odour level at the nearest sensitive receiver will be below 5 odour units. By extrapolation an estimated 74% reduction in the hydrogen sulphide emissions would thus be required (in the sedimentation tanks) to comply with the odour criterion (cumulative criterion).

However it should be noted that re-examination of the meteorological input of ISCST indicated that when the model predicts the odour levels at the nearest sensitive receiver at Stonecutters Island are higher than 5, the stability classes are generally from D to F. The conversion factors from 1 hour average to 5 second average (assessment criterion) for these stability classes are generally in the order of 10. As a constant conversion factor of 50 was used for all the stability classes, in accordance with the agreed methodology, it may be surmised that the maximum odour levels at the nearest sensitive receiver may have erred on the side of safety.

The models were re-run with all of the mitigation measures included at each site to generate odour contours, which are presented on Figures 7.8 to 7.14. From the results provided it may be concluded that the mitigation measures for odour control provided for the SSDS Stage 1 Scheme are adequate to protect all of the defined sensitive receivers. The addition of ferric chloride as recommended in the Revised Design Memorandum, 1995, would be capable of controlling the H_2S levels downstream of the Rapid Mix Chambers of the Sedimentation Tanks to allow the cumulative criterion to be achieved. For a scenario predicated on ferric sulphate the dose would need to be determined through, inter alia laboratory tests, to ensure at least 60% of hydrogen sulphide would be removed downstream of the Rapid Mix Chambers of the Sedimentation Tanks.

Fugitive Dust

Hydration of lime in the slurry mixer at Stonecutters Island may generate dust but according to the results given in Appendix D2 there will be no adverse impact at the sensitive receivers.

It has been identified in the Revised Design Memorandum, 1995, that ferric chloride will be imported to site in liquid form and is therefore not an issue in this connection.

7.3

Noise

Post construction noise impacts were assessed by calculating sound pressure levels for all equipment at site taking account of any measures such as acoustic louvres, or restrictions on acceptable sound pressure levels for individual items of equipment already incorporated in the Detailed Design. For the SCISTW, operational noise assessments have been assessed for both the Lime Treatment Scenario and Ferric Chloride or Sulphate Treatment Scenarios. An estimate of the number of people potentially affected by the operation of this scheme and the cost of mitigation measures were also made.

Stonecutters Island Sewage Treatment Works

The original operational noise assessments were based on addition of lime to enhance the sedimentation process. The subsequent decision to adopt a strategy based on ferric chloride (or possibly sulphate) required amendments to the items of equipment to be provided at the SCISTW. A supplementary operational noise assessment was thus carried out for the Ferric Chloride or Ferric Sulphate Treatment Scenarios which is detailed in Appendix C3.

As the SCISTW is considered under the HKPSG to be a single fixed noise source all of the components of the Stage I Scheme which could contribute to the overall noise impact at this site were identified and assessed. All Noise Sources within the sewage treatment works are summarised in Table 7.13. The details of the noise assessment are included in Appendix C2 (Appendix C3 for Ferric Chloride or Ferric Sulphate Treatment Scenarios).

Table 7.13 Noise Sources of Stonecutters Island Sewage Treatment Works

Contract No.	Description	Equipment	No. on duty
DE/93/16	Sludge Treatment Facilities	Ventilation Equipment	14
DC/93/16	Stonecutters Island STW Buildings, Main Pumping Station and Site Development	<u>Switchgear & Control Building</u> Air Condition Unit 26 Emergency Generator 1 <u>Administration Building</u> Ventilation Fan 11 A/C Chiller Unit 1	
DC/93/17	Sludge Collection and Disposal	Derrick Lighter 1 Crane 1 Vessel with on-board Gantry Crane 1	
DE/93/17 (Lime Dosing Scenario)	Chemical Dosing Facilities	Fans 4 Unloader 1	
DE/93/17 (Ferric Chloride or Ferric Sulphate Dosing Scenarios)	Chemical Dosing Facilities	Fans Unloading Pumps 4 6	
DE/93/18	Pumping Station E&M Equipment	<u>SCIMPS</u> Indoor equipment:- Main Pump 6 Main Motor 6 Pumpwell Lift 1 Control Centre Lift 1	
		Outdoor equipment:- Motor Hall Extraction Fan 8 Air Cooled Chiller 4 Lift Machine Room Air Extraction Fan 1 Lift Machine Room Ventilation Fan 1 Pumpwell and Motor Hall Extraction Fan 4 Pumpwell Air Supply Fan 8 Toilet Extraction Fan 1 Control Room Air Supply Fan 1	

Table 7.13 Noise Source of Stonecutters Island Sewage Treatment Works (Cont'd)

Contract No.	Description	Equipment	No. on duty
		<u>NWKPS</u> Indoor equipment: Pump Motor Outdoor equipment: Switchgear Building Fan Transformer <u>SCISTW Switchgear Building</u> Indoor equipment: Transformer <u>Sedimentation Tanks</u> Outdoor equipment: Transformer <u>Chemical Dosing Facilities</u> Outdoor equipment: Transformer <u>Sludge Treatment Facilities</u> Outdoor equipment: Transformer	 7 7 1 2 6 4 2 2
DE/93/19 (Lime Dosing Scenario)	Sedimentation Tanks E&M Equipment	<u>Blower Room No. 1</u> Air Blower Centrifugal Pump	 4 2
		<u>Blowers Room No. 2</u> Air Blower	 2
		<u>Blower Room No. 3</u> Air Blower Centrifugal Pump	 2 2
		<u>Blower Room No. 4 and Access Tunnel</u> Air Blower Sludge Pump	 3 17
		<u>Scum Pump Room</u> Scum Pump	 8
		<u>Outdoor Equipment</u> Rapid Mixer Sludge Collector Drive Cross Collector Drive Odour Control Facility Air Conditioning Unit Ventilating Fan	 12 112 26 1 4 16

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Table 7.13 Noise Source of Stonecutters Island Sewage Treatment Works (Cont'd)

Contract No.	Description	Equipment	No. on duty
		<u>Blower Room No. 2</u> Air Blower	2
		<u>Blower Room No. 3</u> Air Blower Centrifugal Pump	2 4
		<u>Blower Room No. 4</u> Air Blower	4
		<u>Blower Room No. 5</u> Air Blower	1
		<u>Access Tunnel</u> Sludge Pump Air Blower Scum Pump	12 3 1
		<u>Scum Pump Room</u> Scum Pump	10
		<u>Outdoor Equipment</u> Rapid Mixer Sludge Collector Drive Cross Collector Drive Odour Control Facility Air Conditioning Unit Ventilating Fan	12 112 26 1 4 16

The cumulative noise levels arising from the operational phase of the proposed sewage treatment works on Stonecutters Island were assessed at the facades of the Noise Sensitive Receivers, NSR1, NSR2 and NSR3 and the results are provided in Tables 7.14a and 7.14b.

Table 7.14a Cumulative Sound Pressure Levels, dBA, at NSRs from the Operational Phase of the Sewage Treatment Works on Stonecutters Island - Lime Treatment Scenario

Contract No.	Description	Predicted Sound Pressure Level, dBA			Standards of Hong Kong Planning Standards and Guidelines, dB(A)
		NSR 1	NSR 2	NSR 3	
(0700 - 2300 hrs)					
DC/93/16	STW Bldgs, MPS & Site Development	40.52	39.34	38.65	
DC/93/17	Sludge Collection and Disposal	52.43	51.55	51.88	
DE/93/16	Sludge Treatment Facilities	42.10	40.93	40.41	
DE/93/17	Chemical Dosing Facilities	50.00	49.20	49.75	
DE/93/18	Pumping Stations E&M Equipment	46.86	45.48	44.32	
DE/93/19	Sedimentation Tanks E&M Equipment	43.59	41.80	39.94	
Cumulative Noise Levels		55.73	54.74	54.82	60(57 for 1900 - 2300 hrs)
(2300-0700 hrs)					
DC/93/16	STW Bldgs, MPS & Site Development	40.52	39.34	38.65	
DC/93/17	Sludge Collection and Disposal	Not Operated	Not Operated	Not Operated	
DE/93/16	Sludge Treatment Facilities	42.10	40.93	40.41	
DE/93/17	Chemical Dosing Facilities	38.13	37.26	37.61	
DE/93/18	Pumping Stations E&M Equipment	46.86	45.48	44.32	
DE/93/19	Sedimentation Tanks E&M Equipment	43.59	41.80	39.94	
Cumulative Noise Levels		50.23	48.85	47.85	50

Table 7.14b Cumulative Sound Pressure Levels, dBA, at NSRs from the Operational Phase of the Sewage Treatment Works on Stonecutters Island - Ferric Chloride or Ferric Sulphate Treatment Scenarios

Contract No.	Description	Predicted Sound Pressure Level, dBA			Standards of Hong Kong Planning Standards and Guidelines, dB(A)
		NSR 1	NSR 2	NSR 3	
(0700 - 2300 hrs)					
DC/93/16	STW Bldgs, MPS & Site Development	40.52	39.34	38.65	
DC/93/17	Sludge Collection and Disposal	52.43	51.55	51.88	
DE/93/16	Sludge Treatment Facilities	40.82	39.60	39.00	
DE/93/17	Chemical Dosing Facilities	39.37	38.52	38.90	
DE/93/18	Pumping Stations E&M Equipment	46.86	45.48	44.32	
DE/93/19	Sedimentation Tanks E&M Equipment	42.48	40.85	39.25	
Cumulative Noise Levels		54.37	53.33	53.27	60(57 for 1900 - 2300 hrs)
(2300-0700 hrs)					
DC/93/16	STW Bldgs, MPS & Site Development	40.52	39.34	38.65	
DC/93/17	Sludge Collection and Disposal	Not Operated	Not Operated	Not Operated	
DE/93/16	Sludge Treatment Facilities	40.82	39.60	39.00	
DE/93/17	Chemical Dosing Facilities	39.37	38.52	38.90	
DE/93/18	Pumping Stations E&M Equipment	46.86	45.48	44.32	
DE/93/19	Sedimentation Tanks E&M Equipment	42.48	40.85	39.25	
Cumulative Noise Levels		50.23	48.85	47.85	50

The operational noise levels for Lime Treatment Scenario are marginally higher than those for Ferric Chloride or Ferric Sulphate Treatment Scenarios.

Preliminary Treatment Works

Equipment schedules for each of the PTW's are given in Appendix C2 along with the proposed modifications to the works. It should be noted that the switching of dosing chemicals from lime to ferric chloride or sulphate will not affect the operational noise of the PTWs. At the preliminary treatment works at Chai Wan items of equipment which are identified defined noise sources are given in Table 7.15:

Table 7.15 Noise Sources of Chai Wan PTW

Contract No.	Description	Equipment	No. on duty
DE/93/15	Upgrading of Existing PTW's	<u>Coarse Screen Building</u>	
		Coarse Screen	2
		<u>Pumping Station</u>	
		Motor	3
		Centrifugal Pump	3
		<u>Fine Screen Building</u>	
		Fine Screen	2
		Screenings Conveyor	1
		Washer Compactor	1
		<u>Outdoor Equipment</u>	
		Coarse Screens Building D/O Unit	3
		Pumping Station Ventilation Fan	2
		Fine Screens Building D/O Unit	2
		Grit Skip Building D/O Unit	1
		Administration Building A/C Unit	2
		Kitchen (Admin. Bldg) Ventilation Fan	1
		Toilet (Admin. Bldg) Ventilation Fan	1
		Workshop Ventilation Fan	3
		Detritor	1
		Grit Classifier	1
		Grit Conveyor	1

The noise levels arising from the operational phase of the new Chai Wan Preliminary Treatment Works at the Temporary Housing Area (THA) and the primary school are summarised in Table 7.16.

Table 7.16 Noise Impacts of Chai Wan PTW

Source Description	Sound Pressure Level at NSR (dB(A))		
	NSR (THA)	NSR (School)	NSR (Res.bldg)
Coarse Screens Building Indoor Equipment	27.49	19.18	22.52
Fine Screens Building Indoor Equipment	37.62	29.87	33.01
Pumping Station Indoor Equipment	49.00	41.31	44.42
Outdoor Equipment	54.10	46.69	49.69
Total (dB(A))	55.3	47.9	50.90

From the results summarised in Table 7.16, outdoor equipment, which mainly consists of ventilation or air-conditioning units, is the major noise source followed by the centrifugal pumps in the pumping station.

At Shau Kei Wan noise sources of noise identified for this assessment are included in Table 7.17:

Table 7.17 Noise Sources of Shau Kei Wan PTW

Contract No.	Description	Equipment	No. on duty
DE/93/15	Upgrading of Existing PTW's	<u>Coarse Screens Building</u>	
		Coarse Screen	1
		<u>Pumping Station</u>	
		Screw Pump	2
		<u>Fine Screens Building</u>	
		Fine Screen	2
		Screenings Conveyor	1
		Grit Conveyor	2
		Common Conveyor	1
		Grit Trap Mixer	1
		Grit Classifier	1
		Washer Compactor	1
		Launder Washer Pump	1
		Air Blower	1
		<u>Outdoor Equipment</u>	
		Coarse Screens Building D/O Unit	1
		Pumping Station Ventilation Fan	4
		Fine Screens Building D/O Unit	2
		MCC A/C Unit	1

The noise levels arising from the operational phase of the new Shau Kei Wan Sewage Treatment at the primary school and the residential building are summarised in Table 7.18.

Table 7.18 Noise Impacts of Shau Kei Wan PTW

Source Description	Sound Pressure Level at NSR (dB(A))	
	NSR (School)	NSR (Residential)
Coarse Screens Building Indoor Equipment	38.31	27.22
Fine Screens Building Indoor Equipment	50.02	36.18
Pumping Station Indoor Equipment	55.35	37.95
Outdoor Equipment	57.46	44.69
Total (dB(A))	60.0	46.1

At Kwun Tong Preliminary Treatment Works (KTPTW) and Kwun Tong Pumping Station (KTPS), the following items of equipment were identified as noise sources and are summarised in Table 7.19 below:

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Table 7.19 Noise Sources at Kwun Tong (PTW & PS)

Contract No.	Description	Equipment	No. on duty
DE/93/15	Upgrading of Existing PTW's	<u>Coarse Screens Building</u>	
		Coarse Screen	3
		<u>Pumping Station (Within PTW)</u>	
		Screw Pump	5
		<u>Fine Screens Building</u>	
		Fine Screen	3
		Screenings Conveyor	2
		Washer Compactor	1
		<u>Outdoor Equipment</u>	
		Coarse Screens Building D/O Unit	2
		Pumping Station (Within PTW) Ventilation Fan	6
		Fine Screens Building D/O Unit	2
		Grit Skip Building D/O Unit	1
		Administration Building A/C Unit	2
		Kitchen (Admin. Bldg) Ventilation Fan	2
		Toilet (Admin. Bldg) Ventilation Fan	1
		Workshop Ventilation Fan	5
		Detritor	3
		Grit Classifier	3
		Detritor Organic Return	3
		Grit Conveyor	4
DE/93/18	Pumping Station E&M Equipment	<u>Wet Well</u>	
		Submersible Centrifugal Pump	5
		<u>Switchgear Building</u>	
		Transformer	2
		Ventilation Fan	4

The cumulative noise levels at the NSR from the operational phase of Kwun Tong Preliminary Treatment Works and Kwun Tong Pumping Station are summarised in Table 7.20.

Table 7.20 Noise Impacts of Kwun Tong PTW and Kwun Tong PS

Source Description	Sound Pressure Level at NSR, dB(A)
Kwun Tong PTW	
Coarse Screen Building Indoor Equipment	26.90
Fine Screen Building Indoor Equipment	40.63
Pumping Station Indoor Equipment	44.85
Outdoor Equipment	54.57
Subtotal	55.21
Kwun Tong Pumping Station	
Wet Well	19.52
Switchgear Building	42.43
Subtotal	42.45
Total	55.40

The results show that the noise standards of Hong Kong Planning Standards and Guidelines can just be achieved.

At To Kwa Wan Preliminary Treatment Works, the following items of equipment have been identified as noise sources and are given in Table 7.21.

Table 7.21 Noise Sources of To Kwa Wan PTW

Contract No.	Description	Equipment	No. on duty
DE/93/15	Upgrading of Existing PTW's	<u>Coarse Screen Building</u>	
		Coarse Screen	1
		<u>Pumping Station</u>	
		Screw Pump	6
		<u>Fine Screens Building</u>	
		Fine Screen	3
		Launder Washer Pump	1
		Washer Compactor	1
		Screenings Conveyor	2
		<u>Outdoor Equipment</u>	
		Coarse Screens Building D/O Unit	2
		Pumping Station Ventilation Fan	7
		Fine Screens Building D/O Unit	2
		Grit Skip Building D/O Unit	1
		Administration Building A/C Unit	2
		Axial Exhaust Fan (Admin. Bldg)	1
		Detritor	3
		Grit Classifier	3
		Grit Conveyor	5

The noise levels arising from the operational phase of the new To Kwa Wan PTW at the residential dwelling are summarised in Table 7.22.

Table 7.22 Noise Impacts of To Kwa Wan PTW

Source Description	Sound Pressure Level at NSR(dB(A))
	NSR (Residential)
Coarse Screens Building Indoor Equipment	21.03
Fine Screens Building Indoor Equipment	27.77
Pumping Station Indoor Equipment	43.91
Outdoor Equipment	46.07
Total (dB(A))	48.2

The predicted noise levels at the NSR do not exceed the noise standards of Hong Kong Planning Standards and Guidelines.

At Tsing Yi Preliminary Treatment Works, the following items of equipment outlined in Table 7.23 have been identified as noise sources:

Table 7.23 Noise Sources at Tsing Yi PTW

Contract No.	Description	Equipment	No. on duty
DE/93/15	Upgrading of Existing PTW's	<u>Coarse Screens Building</u>	
		Coarse Screen	1
		<u>Pumping Station</u>	
		Screw Pump	2
		<u>Fine Screens Building</u>	
		Fine Screen	2
		Screenings/Grit Conveyor	6
		Grit Pump	1
		Grit Classifier	1
		Launder Washer Pump	1
		Washer Compactor	1
		Air Blower	1
		<u>Outdoor Equipment</u>	
		Coarse Screens Building D/O Unit	1
		Fine Screens Building D/O Unit	3
		Fine Screens Building A/C Unit	1
		Pumping Station Ventilation Fan	2

The cumulative noise level at the NSR from the operational phase of Tsing Yi PTW is summarised in Table 7.24.

Table 7.24 Noise Impacts of Tsing Yi PTW at NSR

Source Description	Sound Pressure Level at NSR (dB(A))
Coarse Screens Building Indoor Equipment	25.61
Fine Screens Building Indoor Equipment	44.19
Pumping Station Indoor Equipment	39.63
Outdoor Equipment	48.54
Total (dB(A))	50.30

The predicted noise levels at the NSR do not exceed the noise standards of Hong Kong Planning Standards and Guidelines.

At Tseung Kwan O Preliminary Treatment Works and Pumping Stations, the following items of equipment summarised in Table 7.25 were identified as noise sources:

Table 7.25 Noise Sources at Tseung Kwan O PTW & PS

Contract No.	Description	Equipment	No. on duty
DE/93/15	Upgrading of Existing PTW's	<u>Inlet Pumping Station</u>	
		Main Pump	6
		<u>Coarse Screens Building</u>	
		Coarse Screen	1
		<u>Head Building</u>	
		Fine Screen	3
		Screenings Conveyor	4
		Washer Compactor	1
		<u>Outdoor Equipment</u>	
		Inlet Pumping Station Ventilation Fan	7
		Coarse Screens Building D/O Unit	2
		Headworks Building D/O Unit	2
		Grit Skip Building D/O Unit	2
		Detritor	3
		Grit Classifier	3
DE/93/18	Pumping Stations - E&M Equipment	Detritor Organic Return Pump	3
		Grit Conveyor	3
		Main Motor	2
		Main Pump	2
		Roof Extractor	4
		Transformer	2

The cumulative noise level at the NSR from the operational phase of Tseung Kwan O PTW and PS is summarised in Table 7.26.

Table 7.26 Noise Impacts of Tseung Kwan O PTW and PS

Source Description	Sound Pressure Level at NSR, dB(A)
Tseung Kwan O PTW	32.36
Tseung Kwan O PS	33.33
Total	35.88

The results show that the noise standards of Hong Kong Planning Standards and Guidelines can be achieved.

7.4

Water Quality

Mathematical models from the WAHMO suite were used to examine far field effects of the effluent discharge in terms of future water quality and impacts on sensitive receivers (Refer to Figure 7.15). A series of predictive scenarios were simulated (conducted by EPD for this Study in 1994) based on the assumption that the treatment provided at Stonecutters Island Sewage Treatment Works would be primary sedimentation with the addition of a chemical to enhance the sedimentation process. The scenarios which were tested assumed a baseline, primary sedimentation without addition of chemicals, and two scenarios which assumed different removal rates of individual pollutants.

Model simulations were carried out using the WAHMO model in all cases for four representative tidal conditions : dry season neap tide, dry season spring tide, wet season neap tide and wet season spring tide. Standard values and coefficients for decay, reaction kinetics and dispersion coefficients were applied as appropriate and the pollution loading scenarios and effluent flow rates adopted given in Table 7.27 below. The influent to the SISTW was based on the values given in the Design Memorandum 1993, with pollution reduction factors adopted in the Preliminary Design maintained for this Study. Areas of specific interest in connection with this Project, in terms of future water quality, include Victoria Harbour, the Western Buffer and to a lesser extent the Southern Water Control Zones.

Table 7.27 Loading Scenarios for Modelling Tests (note figures in brackets are pollution reduction factors)

Parameter	SCTSTW Influent (Source DESMO, 1993)	Unassisted Sedimentation	Low Rate Removal Chemically Assisted Sedimentation	High Rate Removal Chemically Assisted Sedimentation
BOD (t/d)	437.5	350 (20%)	284.4 (35%)	245 (44%)
SS (t/d)	347.0	229 (44%)	121.4 (65%)	83.3 (76%)
TTM (t/d)	6.64	4.9 (25%)	3.3 (50%)	2.1 (68%)
E.Coli (no/d)	2.54E17	1.25E17 (50%)	1.3E16 (95%)	2.5E15 (99%)
NH ₃ N (t/d)	33.1	33.1 (0%)	33.1 (0%)	33.1 (0%)
TKN	58.6	56.6 (43%)	51.3 (12.5%)	48.3 (17.5%)
Organic N	25.5	22.9 (10%)	17.8 (30%)	15.0 (41%)

Water quality criteria adopted for this Study include the Water Quality Objectives for the declared Water Control Zones and the Water Quality Criteria, defined in the Preliminary Design EIA upon which the acceptability of the Stage I Scheme was predicated. The Water Quality Test Criteria adopted for this Study are summarised in Table 7.28.

Table 7.28 Water Quality Test Criteria

<u>E.coli</u>	< 1,000/100ml < 20,000/100ml (intakes in Victoria Harbour and the Eastern and Western Buffer Zones)	60%ile 90%ile
Dissolved Oxygen (depth averaged)	> 4mg/l > 2mg/l (intakes in Victoria Harbour and the Eastern and Western Buffer Zones)	90%ile 90%ile
pH	6.5 - 8.5 change < 0.2	100%ile
Suspended Solids	< 30% increase in natural levels	100%ile
Ammonia	< 0.021mg/l	50%ile
Inorganic Nitrogen	< 0.1mg/l (Southern Waters) < 0.3mg/l (Junk Bay) < 0.4mg/l (E & W Buffer Zones) < 0.5mg/l (Victoria Harbour Zone)	50%ile 50%ile 50%ile 50%ile

Initial Dilution

While the Brief called for the delineation of the initial and secondary mixing zones it is important to remember that these are not fixed concepts and are influenced by many factors. It is also important to recognise that the models used to estimate the extent of the impacts of the discharge are the best available tools although they also have limitations inasmuch as they simulate "typical conditions". Furthermore, it must be stressed that the actual effects of the outfall (and the level of treatment provided) will only be able to be accurately determined through the environmental monitoring and auditing of the performance.

Initial dilution can be described as the dilution of a buoyant plume as it rises from the discharge point to the surface. As the effluent rises it entrains seawater at the edge of the plume, thus increasing the width of the wastefield, and decreasing the concentration of pollutants at the edges. Initial dilution of a plume which varies over the tidal cycle, depends on a combination of a variety of factors including water depth, salinity, buoyancy, current speeds and direction and the velocity of the discharge.

Defining the initial dilution required to achieve the design criteria and desired water quality objectives is an important component of the environmental engineering design of the outfall. Using the results of the Initial Dilution Modelling Study (conducted by the Engineering Design Team for the Stage I Outfall, summarised in Appendix L) it is possible to estimate the dilution of the Stage I Outfall different operating conditions.

During the dry season the initial dilution achieved will be between 2 and 4 times that of the commensurate wet season conditions. In the wet season the effects of stratification are clearly demonstrated by the concentration of the wastefield in the lower layer and a smaller initial dilution. By implication the effects of the effluent discharge will affect a larger area during the wet season. During the dry season, initial dilution is shown to be greater than the wet season, with high concentrations of pollutants in close proximity to the outfall. This conclusion concurs with the findings of the EIA for the Preliminary Design.

Mixing Zone

From the results obtained it is apparent that during the wet season the wastefield will be submerged for a longer period of time and the area of attachment will be more extensive. This implies that during the wet season the extent of the area of influence of the outfall (although not necessarily the concentration of pollutants) will be greater than during the dry season. This is relevant when attempting to define the extent of the mixing zone and the potential for surface slick formation. Factors influencing surface slick formation (or grease or floatables) include the level of screening provided and the initial dilution achieved. As noted previously the effluent will be screened to remove gross and fine solids and treated to primary standard prior to discharge. By achieving a high initial dilution the concentration of effluent will be reduced, and the potential for the formation of an oily slick on the surface will be greatly reduced.

It has been reported that when the initial dilution is greater than 400 surface slick formation will be infrequent. If the initial dilution is less than 100 then the potential for slick formation increases. On this basis it is possible that surface slicks could form at various times during the wet season within about 300m of the outfall.

Far Field Effects

From the results provided it is apparent that if the Stage I Scheme is not implemented, TIN, DO, and E.Coli will not comply with the WQO's at the locations provided in Table 7.29.

Table 7.29 Baseline Compliance with WQO's

Location	DO	E.coli	Ammonia	TIN
Mixing Zone	<50% (90%)	100%	100%	compliance
Ma Wan Channel	75% (100%)	100%	100%	non-compliance
West Victoria Harbour	35% (80%)	45%	100%	non-compliance
East Victoria Harbour	45% (50%)	5%	100%	non-compliance
West Lamma Channel (off SE tip of CT10/11)	75% (100%)	100%	100%	compliance
East Lamma Channel	75% (100%)	100%	100%	compliance

Details of the water quality assessments are provided in Appendix L, the following summary provides a concise overview of the results in terms of the water quality parameters examined and the design concept for the Stage I Scheme.

Dissolved Oxygen :

- even with the highest level of treatment provided, the WQO's cannot be achieved in Victoria Harbour, or the Western Buffer.
- significant improvements forecast in the Rambler Channel (station 22) following implementation of Stage I Scheme although the degree of compliance with the WQO's does not vary with the addition of chemicals to enhance the sedimentation process.
- well oxygenated waters will prevail in Southern Water Control Zone which confirms that this water body is not directly influenced by the Stage I Scheme.
- water quality at the fish culture zones is not expected to achieve the WQO's on an annual basis.

BOD :

- general improvements in BOD are forecast as a consequence of implementing the Stage I Scheme, except within the mixing zone (13,8,14,24,25,26,27).
- the most significant reductions in BOD are forecast in eastern Victoria Harbour, and in the Rambler Channel as a direct result of collecting up and treating numerous point sources of pollution.
- reductions in BOD increase as the level of treatment increases although the extent of the improvements depends on the area being considered.

Ammoniacal Nitrogen :

- according to the model predictions even with unassisted sedimentation the 50% compliance with the WQO's can be achieved throughout the study area on an annual basis. It should be noted that at various times of the year, and especially in Victoria Harbour the WQO's will be unlikely to be achieved.
- the level of treatment provided to the effluent prior to discharge has negligible effect on resulting water quality.

Organic Nitrogen :

- small increases in organic nitrogen are forecast in the Western Victoria Harbour for unassisted sedimentation compared to baseline.
- comparison of the model results with the removal rates for various levels of treatment indicate very subtle improvements.

Oxidised Nitrogen :

- the model results indicate that in Victoria Harbour, even assuming unassisted sedimentation is adopted, the WQO's could be achieved on an annual basis.
- In the Southern Waters where the WQO is most stringent the water quality criteria could also be achieved on an annual basis regardless of the level of treatment provided.

Chlorophyll-a

- in most cases the predicted chlorophyll-a concentrations increase in proportion to the level of treatment provided.
- the reason for the increase is possibly due increased clarity in the water column as a result of reducing the unscreened pollution loads discharging into the waters especially in Victoria Harbour.

Suspended Solids :

- full compliance with the WQO's are forecast throughout the entire area regardless of the level of treatment applied.

E.Coli

- despite the significant reductions in bacterial counts in Victoria Harbour the WQO's are not expected to be achieved on an annual basis for any of the treatment scenarios currently being considered.
- however even under the scenario which assumes unassisted sedimentation will be applied to the effluent, the WQO's for E.coli could be achieved on an annual basis in the Rambler Channel.
- with the exception of a local area in the East Lamma Channel (stations 30 and 31) full compliance is forecast in the Southern Water Control Zone. The reasons for non compliance at the aforementioned stations are local effects and are unrelated to the implementation of the Stage I Scheme.
- an increase in the dosage of chemical required to enhance the sedimentation process will be required if the WQO's for bacteria are to be achieved around the outfall (24,25,26,27).

7.5

Visual and Landscape Impacts

Visual impacts of the permanent fixtures of the Stage I Scheme have been considered in connection with their surroundings. At many of the sites the facade of the works will be little altered once the upgrading works required for the Stage-I Scheme are completed. In addition to which the standard DSD security walls which shield many of the sites from view at ground level will be maintained.

Section 7

Construction of the new sewage treatment works and associated facilities at Stonecutters Island will contribute to the transformation of the rural to semi-urban environment. Visual and landscape issues have been carefully considered at all stages of the detailed design in terms of both the permanent fixtures and the aesthetic appearance of the surroundings, with a specialist Landscape Consultant engaged to prepare a detailed Landscape Restoration Plan, illustrated in Figure 7.16.

Development characteristics have been defined from visits to each site as illustrated on plates 1 through 10 and recourse has also been made to the findings of the Preliminary Design. Operational implications on existing users have been addressed by considering the final landform, operational requirements and the findings are summarised in Table 7.30.

Table 7.30 Site Characteristics and Visual Impacts

Site	Development Characteristics	Visual and Landscape Impact
Stonecutters Island	<p>Stonecutters Island Main Pumping Station approximately 50m diameter, 37.5m below ground level with a 20m high superstructure with a flat roof;</p> <p>North West Kowloon Pumping Station approximately 49m x 13m in plan and 5.8m deep. No superstructure at this facility;</p> <p>switchgear building 3 storeys, 44m x 30m in plan</p> <p>administration building 3 storeys, 46m x 26m;</p> <p>control building at NWKPS a 16.5m x 9.5m single storey building with 2 no. 5.5m x 5m transformer bays;</p> <p>transformer compounds, concrete slabs with walls but no roofs;</p> <p>roads, main access will be not less than 7.3m wide and 170mm thick reinforced concrete on 150mm thick sub-base. In entrance area roads will be constructed of concrete blocks;</p> <p>street lighting will provide an illumination level of at least 100 lux (either on columns or as floodlighting on buildings);</p> <p>berthing area;</p> <p>sedimentation tanks 10m high covering an area of 33,500m²;</p> <p>sludge collection and disposal, offices, workshops, fuel store, container storage area, seawall moorings;</p> <p>sludge treatment facilities, dewatering and drying plants housed in building 80m x 100m and 16m high. Boiler house may be housed separately. Sludge tanks with odour control units on roofs, fuel storage provided;</p> <p>master landscape plan prepared for this site</p>	<p>master landscape plan formulated to minimise visual and landscape impacts at an early stage of the operations. Residual impacts will be those observed from vantage points, passing marine vessels and from the air when arriving or departing from Chek Lap Kok Airport. Visual impacts are considered to be minor in connection with the development of this area for commercial uses.</p>
Stage I Outfall	<p>dropshaft entry culvert comprises a covered conduit 30m long ranging in size from 4.5m square at Chamber 15 to 8m wide by 7.5m high at the dropshaft, the shaft superstructure will be +10m PD and will be covered with removable concrete slabs for maintenance access;</p> <p>walls at Chamber 15 to be raised from existing 7mPD to 11mPD.</p>	<p>There will be no visual or landscape impact.</p>
Chai Wan	<p>upgraded PTW, drop shaft located within the existing works, operational access via existing road network, DSD security wall and screens already in place. Production shaft will be backfilled and returned to planned use.</p>	<p>DSD security wall and hoardings presently exist round three sides of the site. Minimal impact</p>
Shau Kei Wan	<p>upgraded PTW, operational access past school 20m from entrance to site; highly visible from adjacent residential dwellings.</p>	<p>landscape value in this area not particularly high with shipyards to the east and a wholesale fishmarket due west.</p>

Table 7.30 Site Characteristics and Visual Impacts (Cont'd)

Site	Development Characteristics	Visual and Landscape Impact
Kwun Tong	upgraded PTW, nearest SR is 200m away.	minimal impact in view of surrounding uses.
To Kwa Wan	upgraded PTW, nearest SR is 200m away.	minimal impact in view of surrounding uses.
Tsing Yi	upgraded PTW obscured from view by hanging bamboo and other dense foliage; operational and maintenance access will be via the existing road	site already obliterated from view by 5m high retaining wall to the north and a 10m high wall with tree planting to the west. Wider views from and to the Rambler Channel are limited by the container depot in close proximity to the site.
Tseung Kwan O	upgraded PTW about 2km from any existing or planned residential development.	impacts are minor when considering the general construction works in this area and the long term industrial and commercial use of the adjacent land.
Kwai Chung	new PTW with landscaping features included in the design.	landscape quality at this site considered to be overstated in Preliminary Design Phase.

7.6

Risk and Hazard Assessment

Risk and hazard assessments were undertaken individually for components of the Stage I Scheme by the Engineering Design teams for discrete contracts and did not form part of the Brief for the Environmental Assessments. Although risk analyses were not included in the Brief to be undertaken as part of the EIA of the Detailed Design, a summary of the risks associated with the Stage I Scheme (as given in the Preliminary Design EIA) is given in Table 7.31.

Table 7.31 Potential Risks Associated with Stage I Scheme

Risk	Analysis/Assessment
Accumulation of toxic and/or explosive gases (H ₂ S) in enclosed spaces	Design includes gas detectors and H ₂ S monitors in confined spaces. Conditions for access to confined spaces will be specified in Operations Manual
Stonecutters Island Sewage Treatment Works	Failure or malfunctioning of the chemical dosing system Basic treatment provided at the works although <u>E.coli</u> counts would be high.
Fugitive Dust from Chemical Dosing Facilities	Design will include enclosure and ventilation systems to minimise fugitive dust emissions.
Storage of Chemicals in Powder Form	Risk of explosions can be minimised through design of storage facilities
Blockages or Siltation in the Tunnels	Designed to prevent siltation even under conditions of low flow and blockages prevented by upgrading of PTW's to include fine screening.

Table 7.31 Potential Risks Associated with Stage I Scheme (Cont'd)

Risk	Analysis/Assessment
Outfall Failure	<p>Emergency overflow included in the overall design. In addition to the dual power supply, standby generators and pumps, the following must be also be considered for all PTW's and SISTW to minimize the impacts when overflow occurs.</p> <ul style="list-style-type: none"> (i) Proper screening to overflow by standby coarse screens; (ii) Bypass extension to avoid discharge into any enclosed bay and typhoon shelter; and (iii) Discharge point below the Low Water Mark. <p>In particular, the requirement of below the Low Water Mark should be taken into account during the design of those new outfalls at seawalls for the replacement of unusable existing outfalls. If site constraints do not permit these to be implemented at particular pumping station, this must be clearly defined.</p>
Failure at Pumping Stations	<p>Standby motors, pumps and other units have been specified in the M&E contract to minimise the risk of failure. Routine inspections and maintenance checks will be required to minimise the risks of failure.</p>
Power Failure	<p>Power to the pumping stations should be from different substations but the event of a power failure is very remote and thus no emergency substation has been included.</p>

7.7

Waste DisposalSludge

Dried sludge will be disposed of the WENT (60%) and SENT (40%) landfills in the New Territories, together with general municipal and industrial refuse and dewatered sludges from other sewage treatment plants and water treatment plants in the territory. The estimated quantities of total wastes and moisture contents to these landfills are summarised in Table 7.32 based on operation of the SISTW at a pH of 9.7 (lime scenario).

Table 7.32 Estimated Year 2021 Landfill Disposal Quantities (Lime Based Scenario)

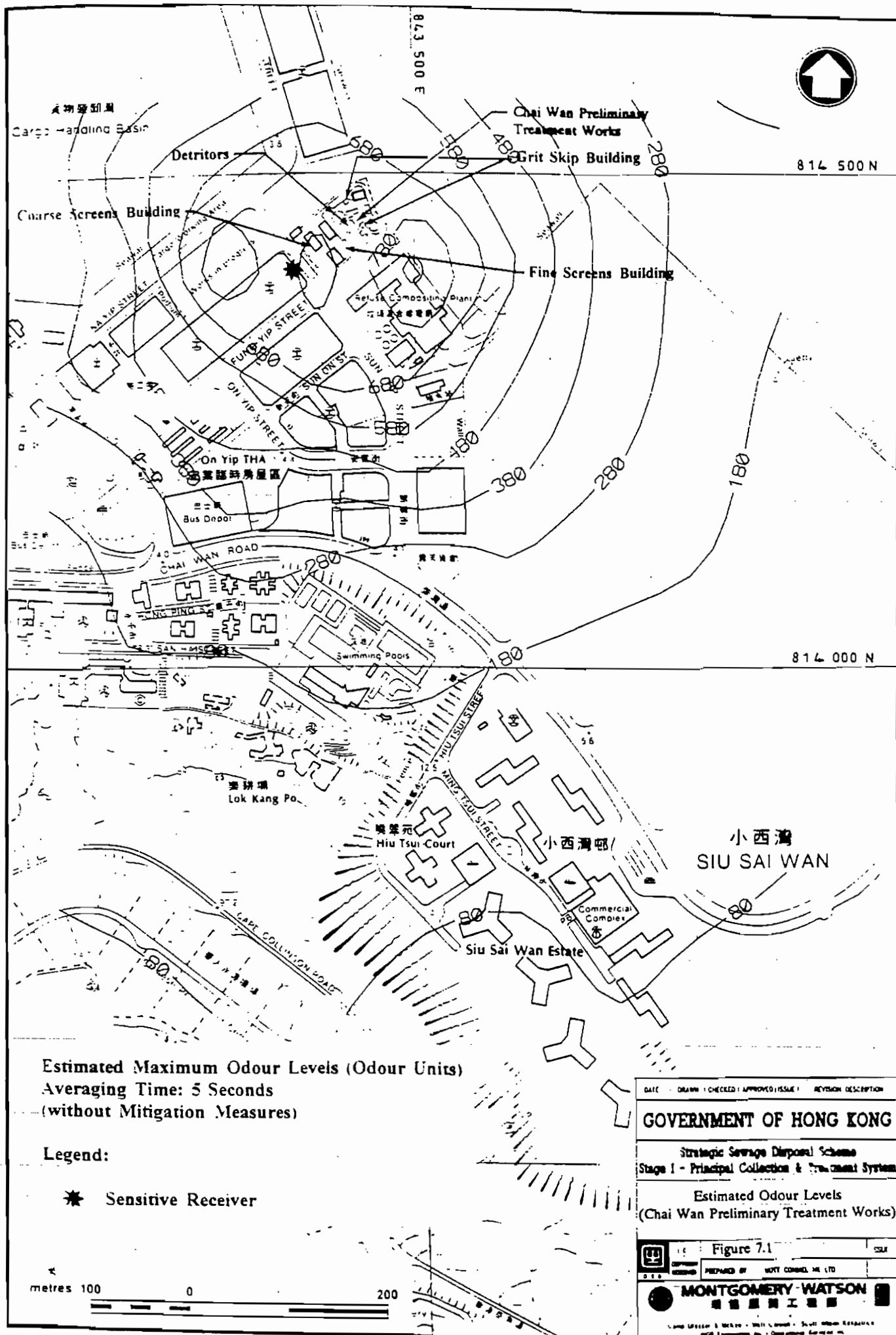
Item	WENT	SENT	TOTAL
Total waste to disposal, t/y	1,930,000	2,630,000	4,560,000
Total wet sludge quantity, t/y	275,000	158,000	433,500
SISTW wet sludge quantity, t/y	114,000	76,000	190,000
Proportion due to SISTW, %			
- of total wet sludge loading	41.5	48.0	43.8
- of total waste loading	5.9	2.9	4.2
Total liquid addition t/y	310,000	204,500	521,500
Moisture in sludge, t/y	130,000	69,000	199,000
Moisture in SISTW sludge, t/y	17,100	11,400	28,500
Proportion due to SISTW, %			
- of total wet sludge loading	13.1	16.5	14.3
- of total waste loading	5.5	5.6	5.5

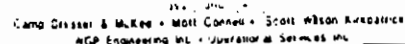
For the sedimentation strategy which is based on addition of ferric chloride there is a reduction in the dry solids cake sludge to 32% resulting in a greater volume of sludge to be disposed of each day. The design throughput for the year 2021 (as above) is 542 tonne of dry solids per day. This equates to between 1264 (non-summer) and 1423 (summer) tonnes wet solids production per day.

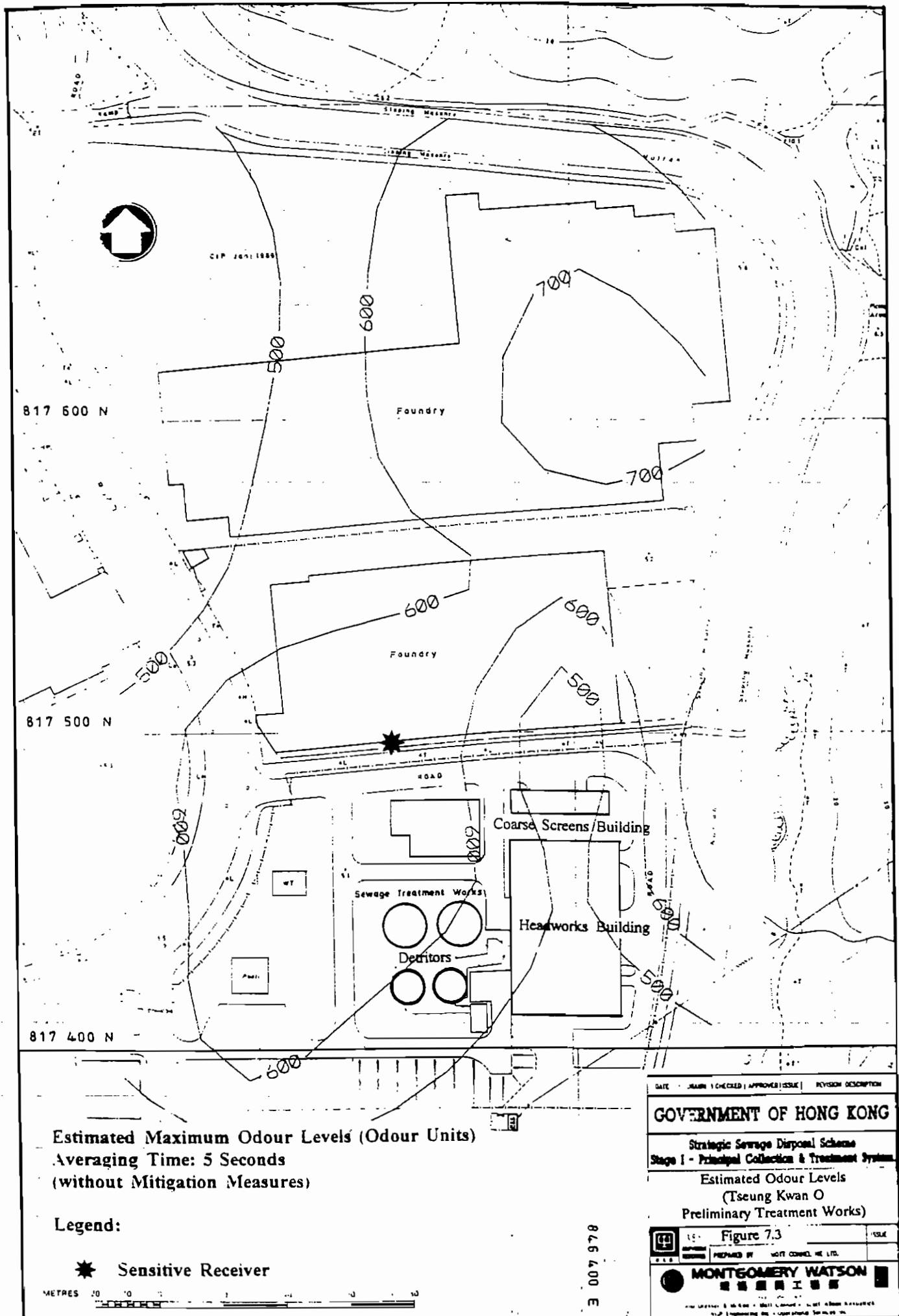
On the basis of these data it may be concluded that the SISTW will be a minor contributor to the total solid waste arisings. Variations in the amount of sludge produced by the SISTW will have little impact on the total amount of wastes discharged to the landfills and hence on the proposed sludge disposal strategy.

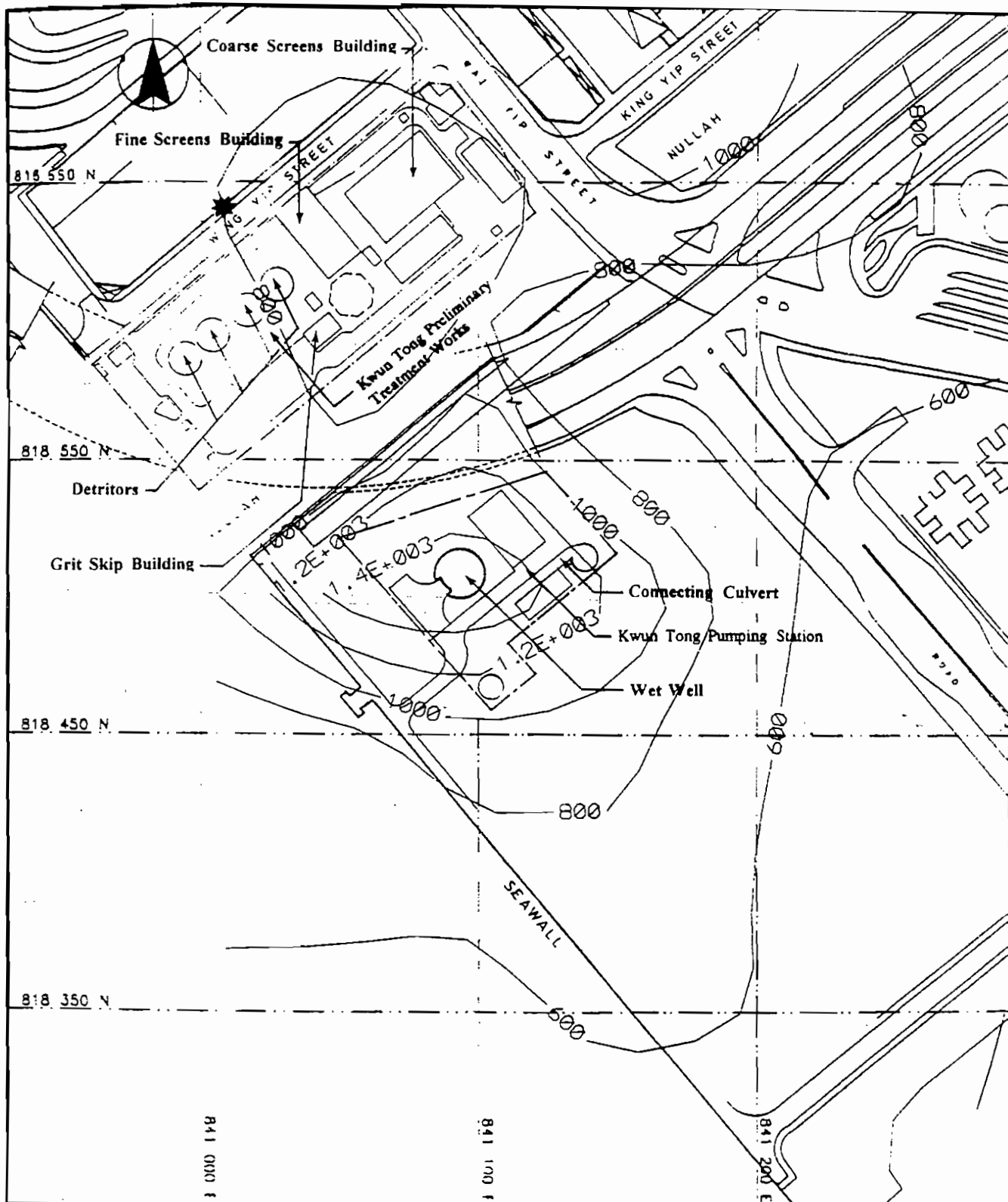
Screenings

Screenings from PTW's will also be disposed of at the aforementioned landfill sites, and while the average question of grit and screenings have not been estimated it is expected that this will form a very small part of the overall daily waste disposal requirements at the landfill sites (refer to waste arisings for 1988 in which 40 tonnes of sewage work screenings were disposed of).









Estimated Maximum Odour Levels (Odour Units)
Averaging Time: 5 Seconds
(without Mitigation Measures)

Legend:

★ Sensitive Receiver

GOVERNMENT OF HONG KONG

Strategic Sewage Disposal Scheme
Stage I - Principal Collection & Treatment System

Estimated Odour Levels
(Kwun Tong Preliminary Treatment Works)



Figure 7.4

COMPASS
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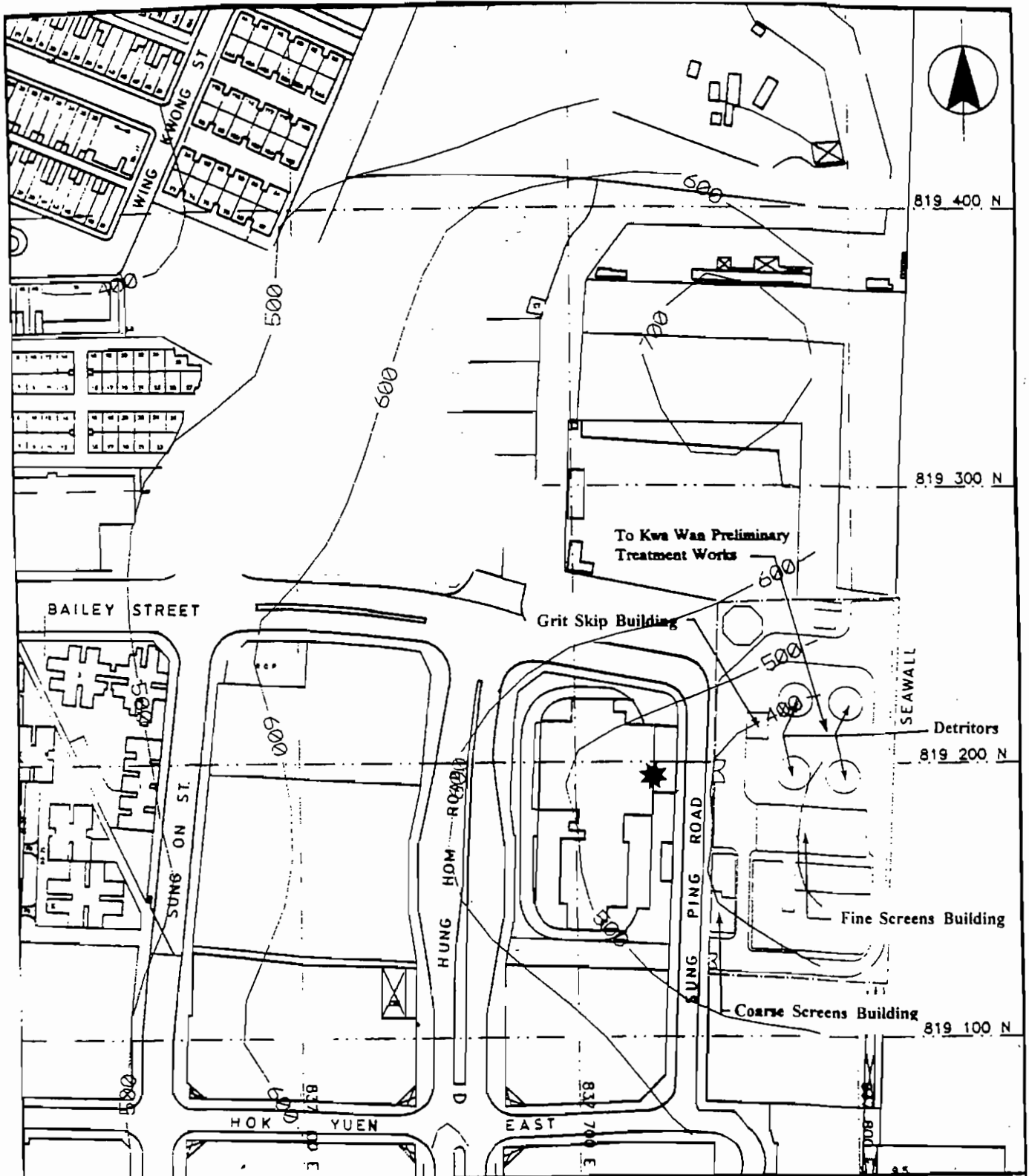
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MONTGOMERY WATSON

環境工程顧問公司

20 0 20 40 60 m



Estimated Maximum Odour Levels (Odour Units)
Averaging Time: 5 Seconds
(without Mitigation Measures)

Legend:

★ Sensitive Receiver

GOVERNMENT OF HONG KONG

Strategic Sewage Disposal Scheme
Stage I - Principal Collection & Treatment System

Estimated Odour Levels
(To Kwa Wan Preliminary Treatment Works)



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Figure 7.5

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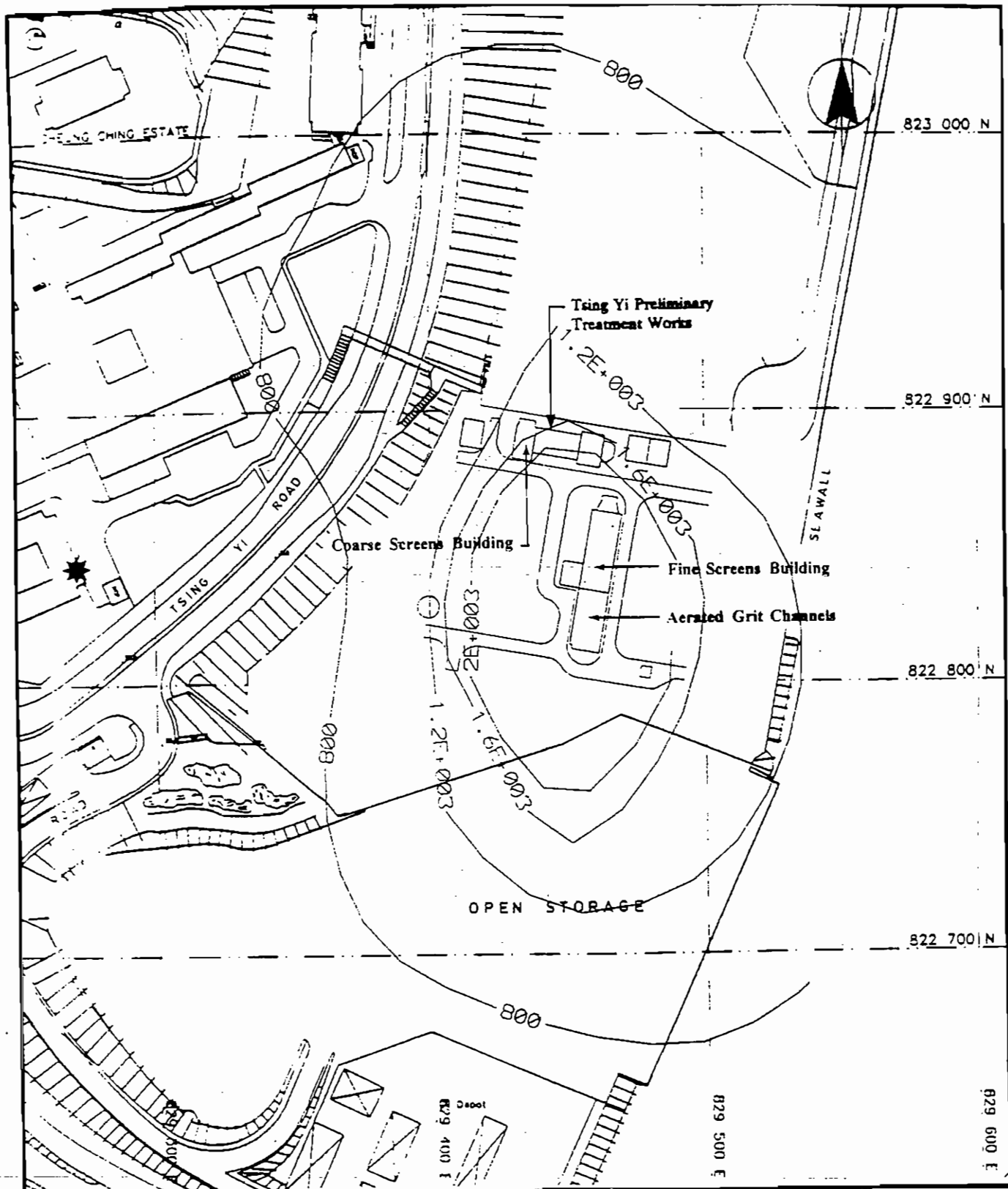
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MONTGOMERY WATSON
環境顧問工程師

Architect & Engineer: Mott MacDonald - South Region Consultants
M&W Engineering Inc. - Operational Services Inc.

20 0 20 40 60m



Estimated Maximum Odour Levels (Odour Units)
 Averaging Time: 5 Seconds
 (without Mitigation Measures)

Legend:

★ Sensitive Receiver

0 20 40 60 m

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Strategic Sewage Disposal Scheme
 Stage I - Principal Collection & Treatment System

Estimated Odour Levels
 (Tsing Yi Preliminary Treatment Works)



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Figure 7.6

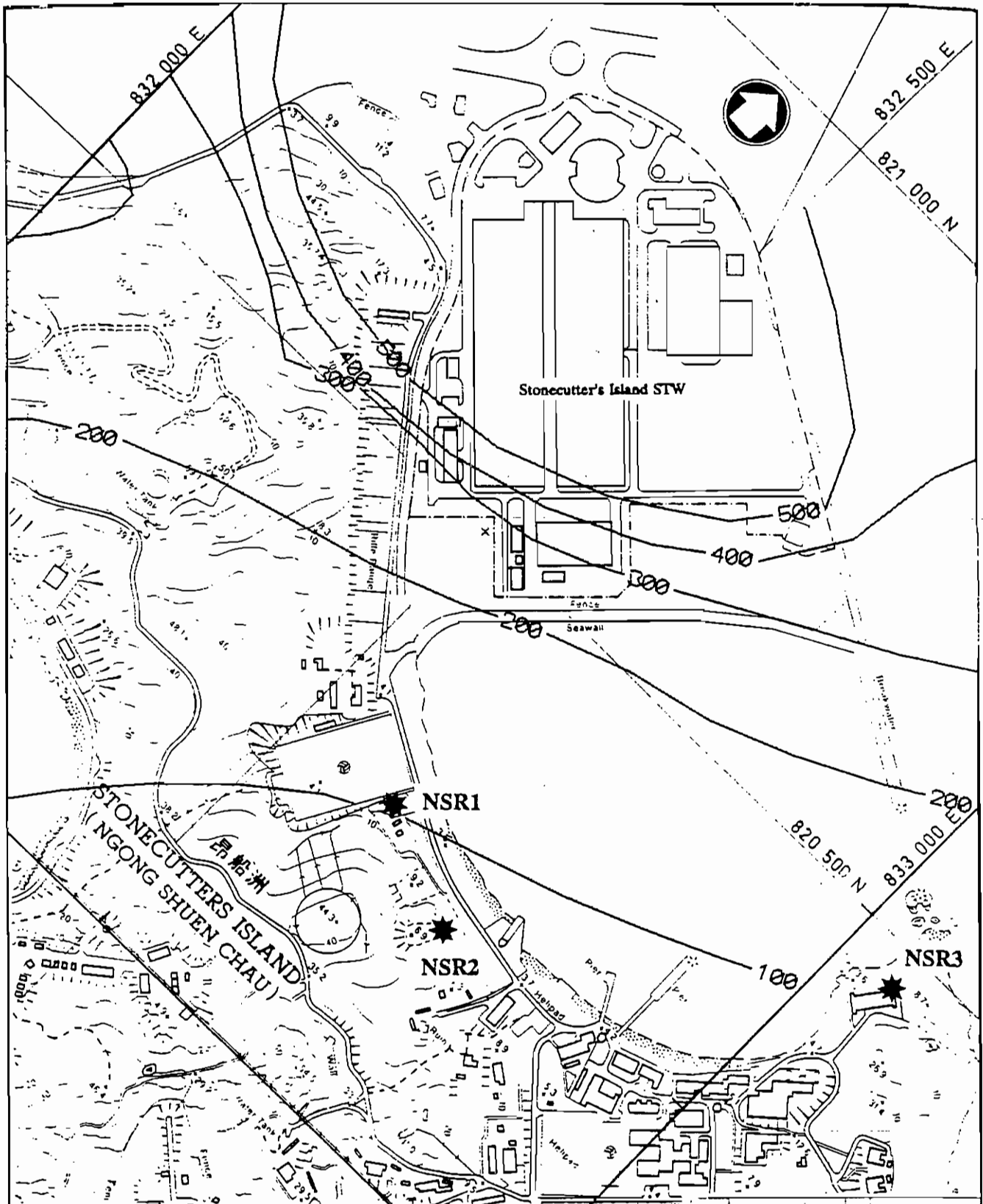
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 MGP Engineering Inc. • Operational Services Inc.



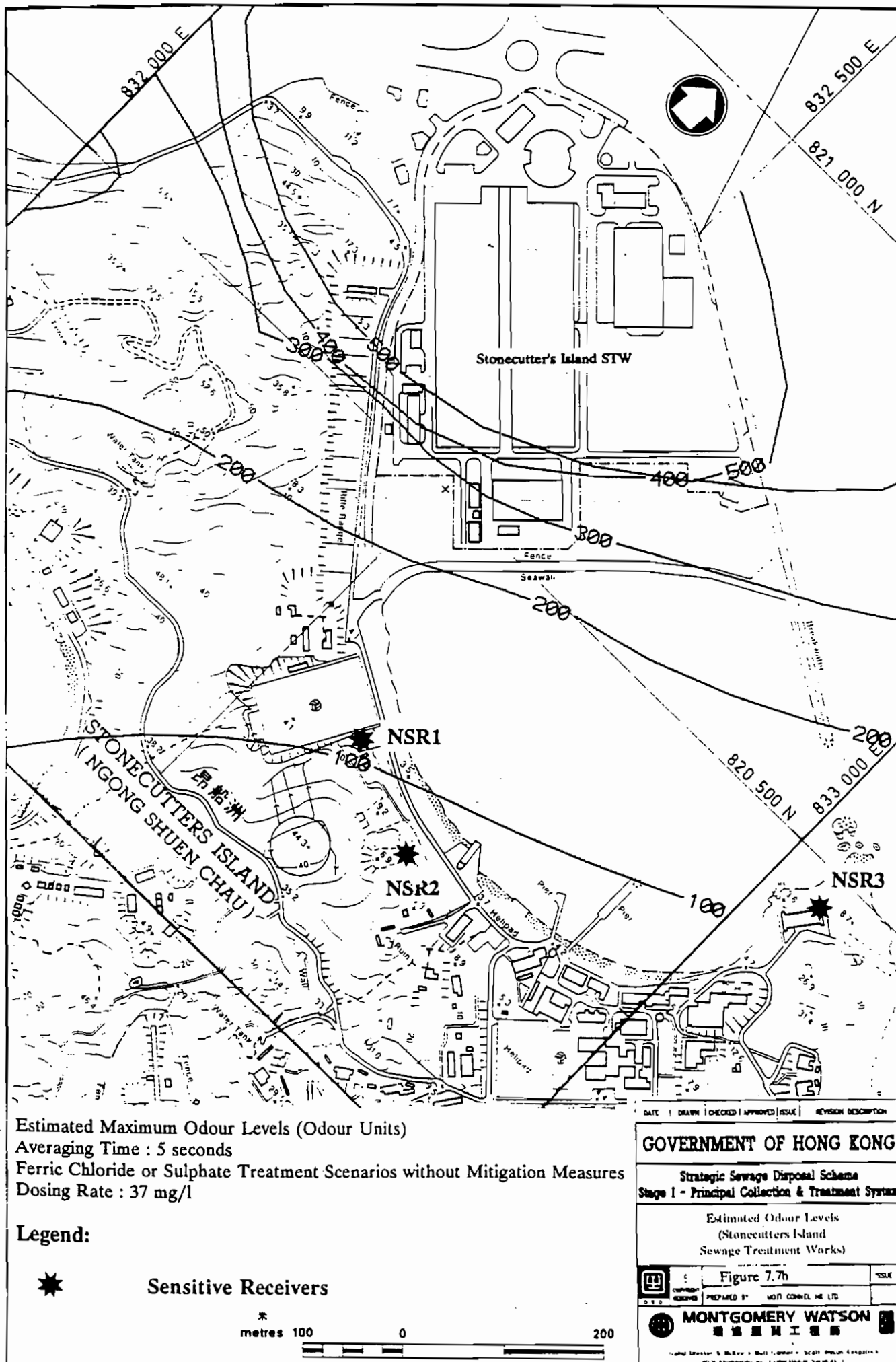
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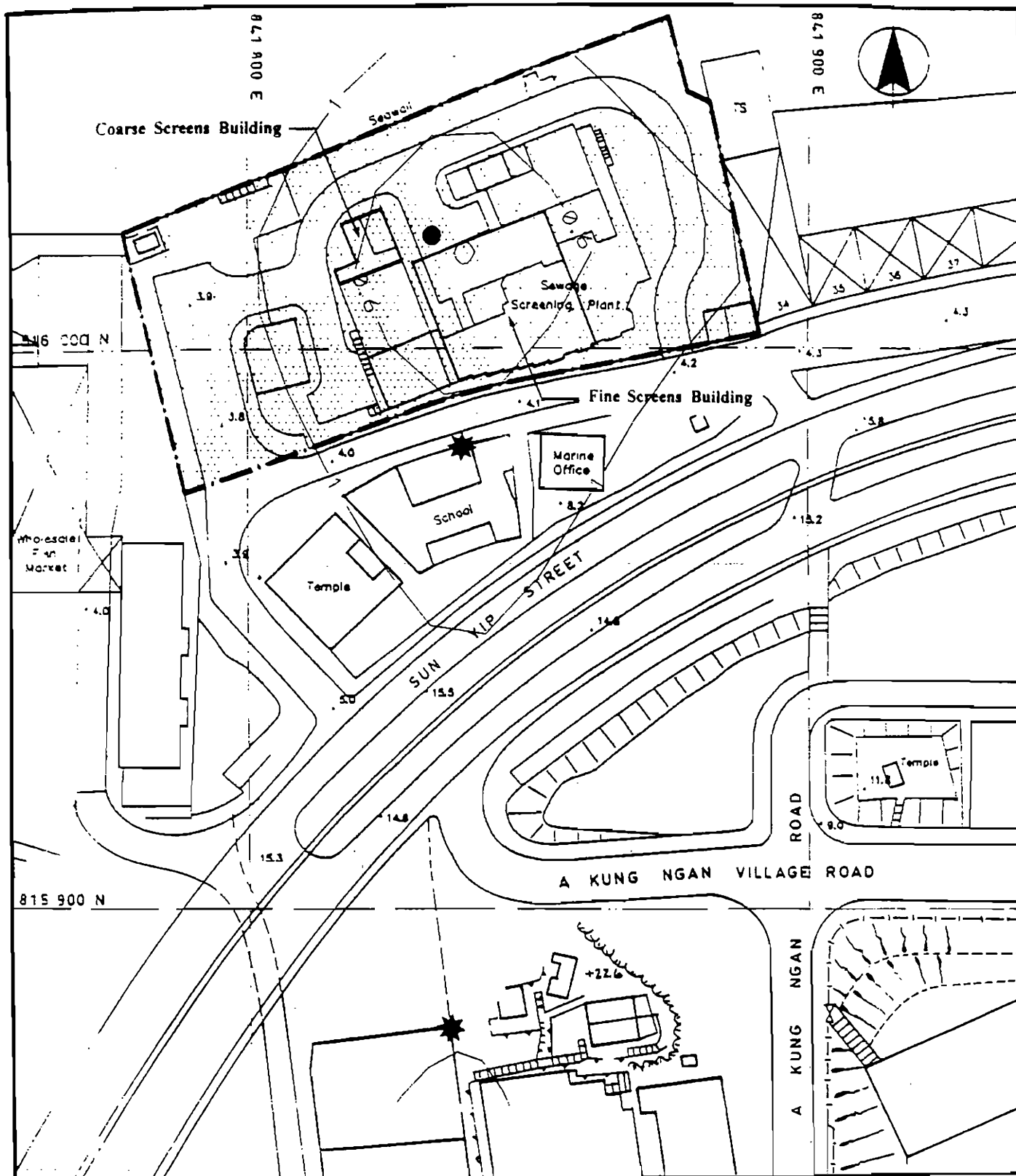


Sensitive Receivers

metres 100 0 200

DATE	DRAWN	CHECKED	APPROVED	ISSUE	REVISION	DESCRIPTION
GOVERNMENT OF HONG KONG						
Strategic Sewage Disposal Scheme						
Stage 1 - Principal Collection & Treatment System						
Estimated Odour Levels (Stonecutters Island Sewage Treatment Works)						
Figure 7.7a						
PREPARED BY: MOTT MACDONALD & CO. LTD.						
MONTGOMERY WATSON 環境顧問工程師						





Estimated Maximum Odour Levels (Odour Units)
Averaging Time: 5 Seconds
(with Mitigation Measures)

Legend:

★ Sensitive Receiver

METRES 20 10 0 10 20 30 40 50 60

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Strategic Sewage Disposal Scheme Stage I - Principal Collection & Treatment System

Estimated Odour Levels
(Shau Kei Wan Preliminary Treatment Works)
with Mitigation Measures



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Figure 7.9

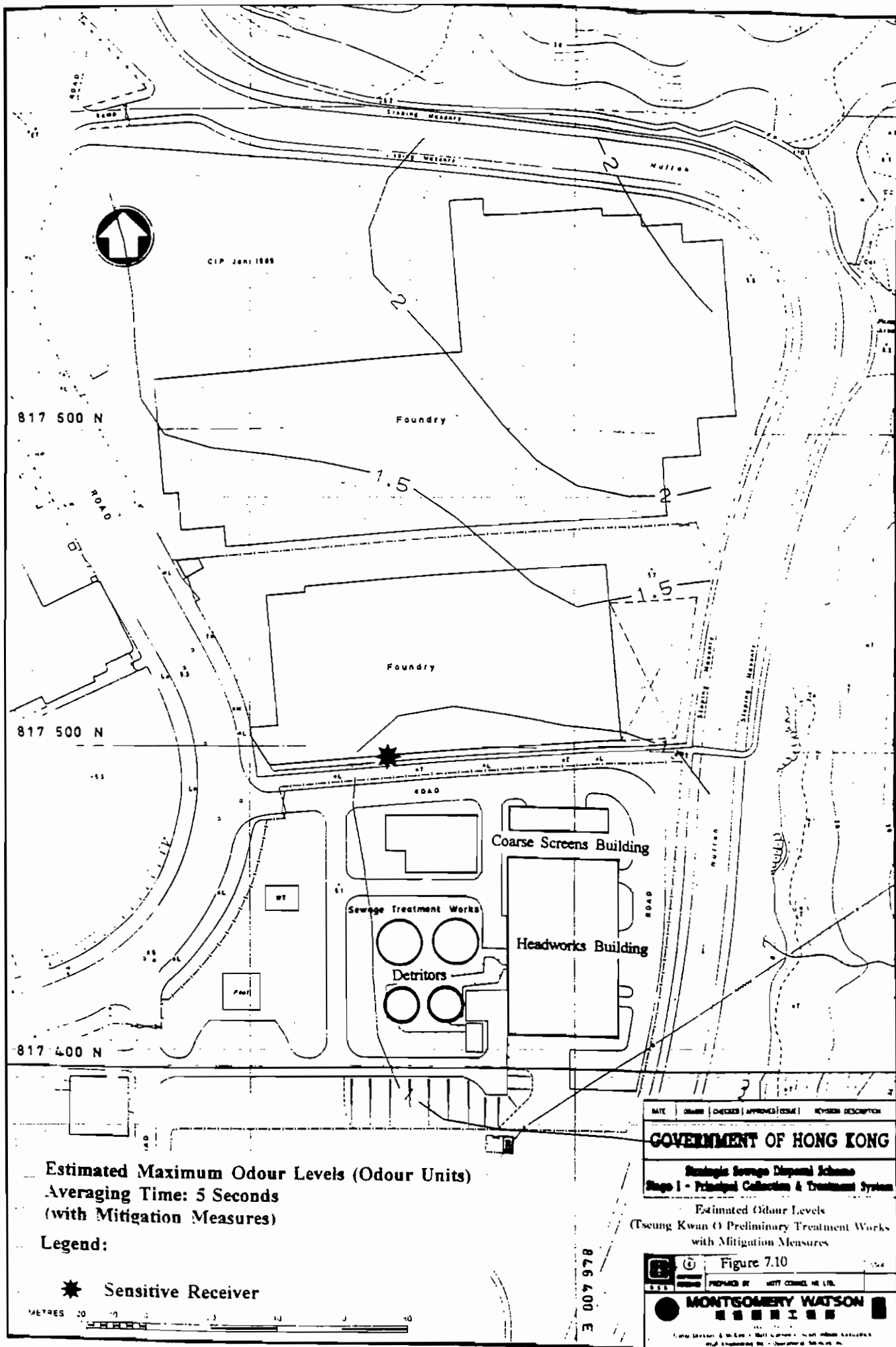
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Camille Glesser & Milton - Moit Corpn - Scott Wilson Associates
MWP Engineering Inc. - Operational Services Inc.



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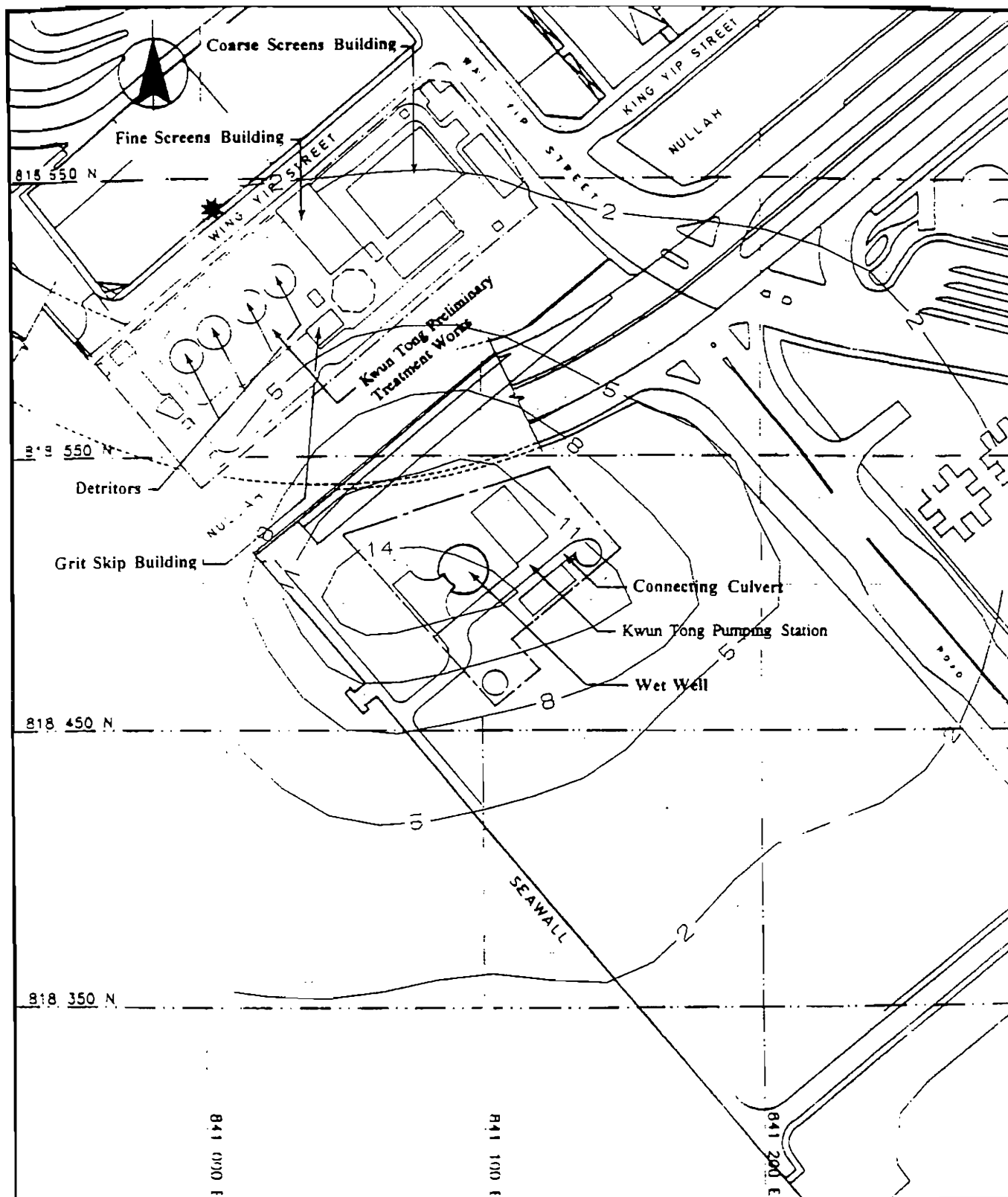
GOVERNMENT OF HONG KONG

Strategic Sewage Disposal Scheme
Stage 1 - Principal Collection & Treatment System

Estimated Odour Levels
 (Tseung Kwan O Preliminary Treatment Works
 with Mitigation Measures)

Figure 7.10

<p>MONTGOMERY WATSON 蒙哥馬利華頓</p>	PREPARED BY: MOTT MACDONALD & CO. LTD. 3007 978 817 400
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Estimated Maximum Odour Levels (Odour Units)
Averaging Time: 5 Seconds
(with Mitigation Measures)

Legend:

★ Sensitive Receiver

20 0 20 40 60 m

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Strategic Sewage Disposal Scheme
Stage 1 - Principal Collection & Treatment System

Estimated Odour Levels
(Kwun Tong Preliminary Treatment Works)
with Mitigation Measures

Figure 7.11

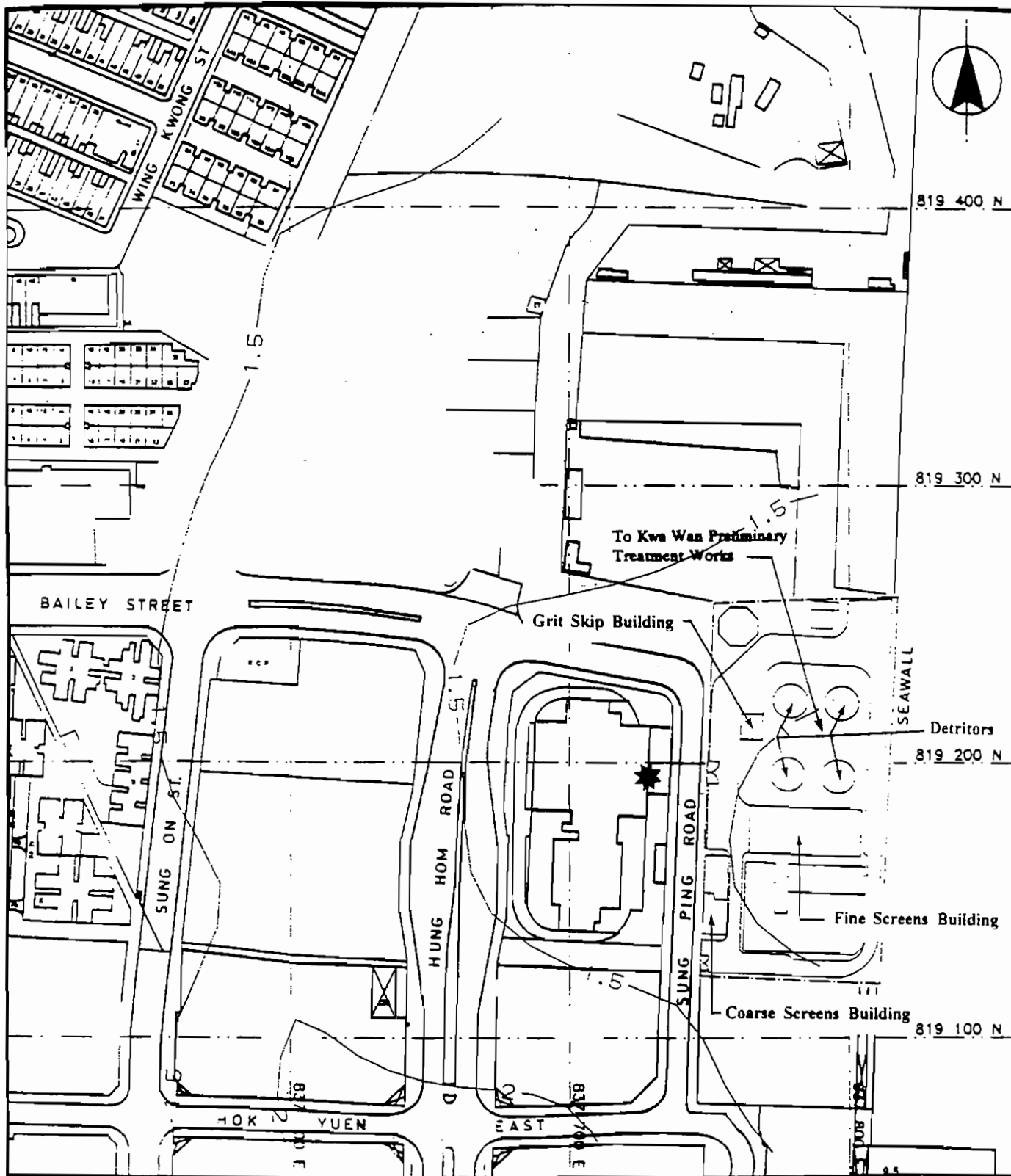


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REVIEW

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Estimated Maximum Odour Levels (Odour Units)
Averaging Time: 5 Seconds
(with Mitigation Measures)

Legend:

★ Sensitive Receiver

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Strategic Sewage Disposal Scheme
Stage I - Principal Collection & Treatment System

Estimated Odour Levels
(To Kwa Wan Preliminary Treatment Works)
with Mitigation Measures



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Figure 7.12

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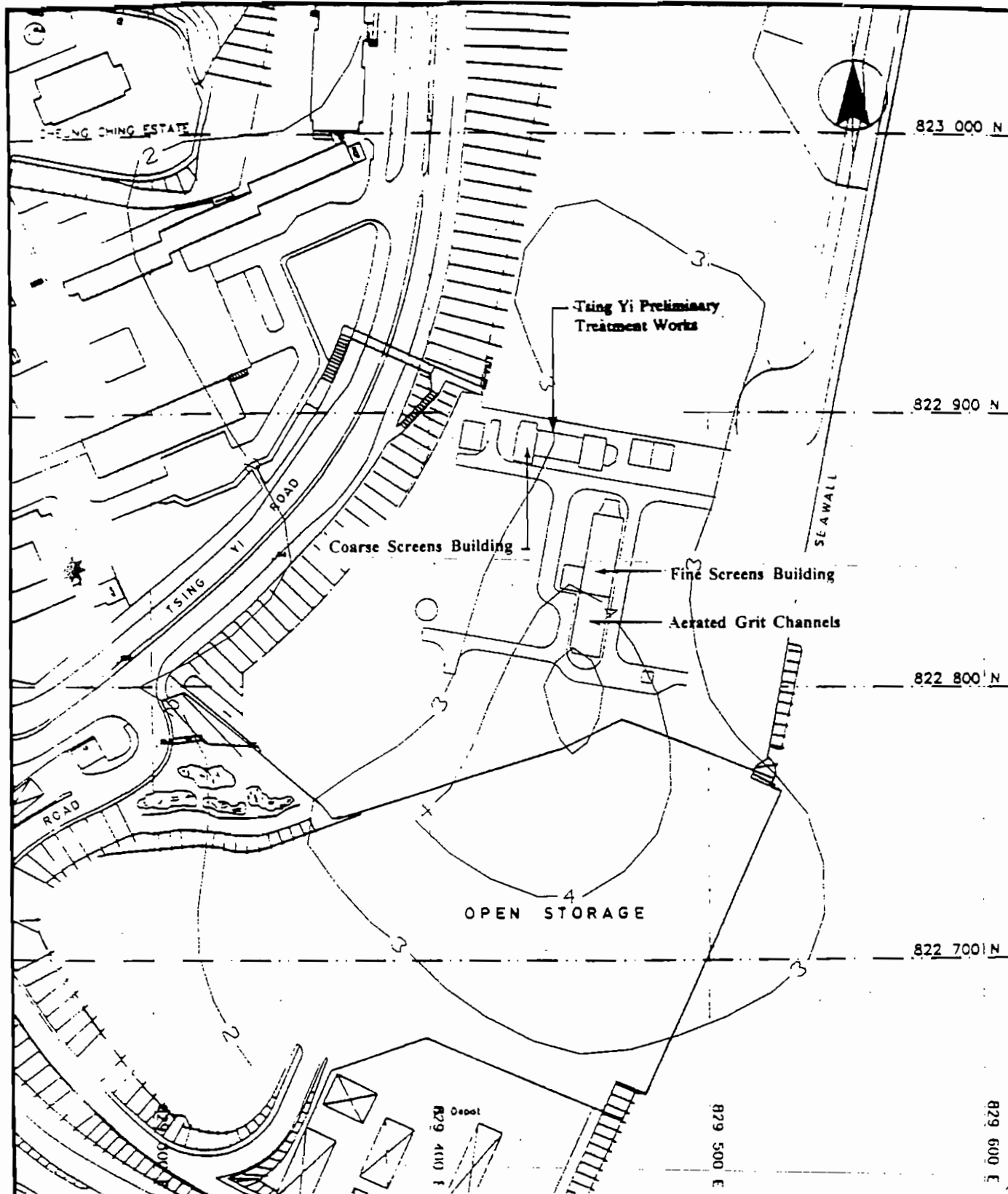
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MONTGOMERY WATSON
環境工程顧問公司

1000 Summer & Market Street, Suite 1000, New York, NY 10010
MCS Engineering Inc., 1000 Summer & Market Street

20 0 20 40 60 m



Estimated Maximum Odour Levels (Odour Units)
 Averaging Time: 5 Seconds
 (with Mitigation Measures)

Legend:

★ Sensitive Receiver

GOVERNMENT OF HONG KONG

Strategic Sewage Disposal Scheme
 Stage I - Principal Collection & Treatment System

Estimated Odour Levels
 (Tsing Yi Preliminary Treatment Works)
 with Mitigation Measures



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Figure 7.13

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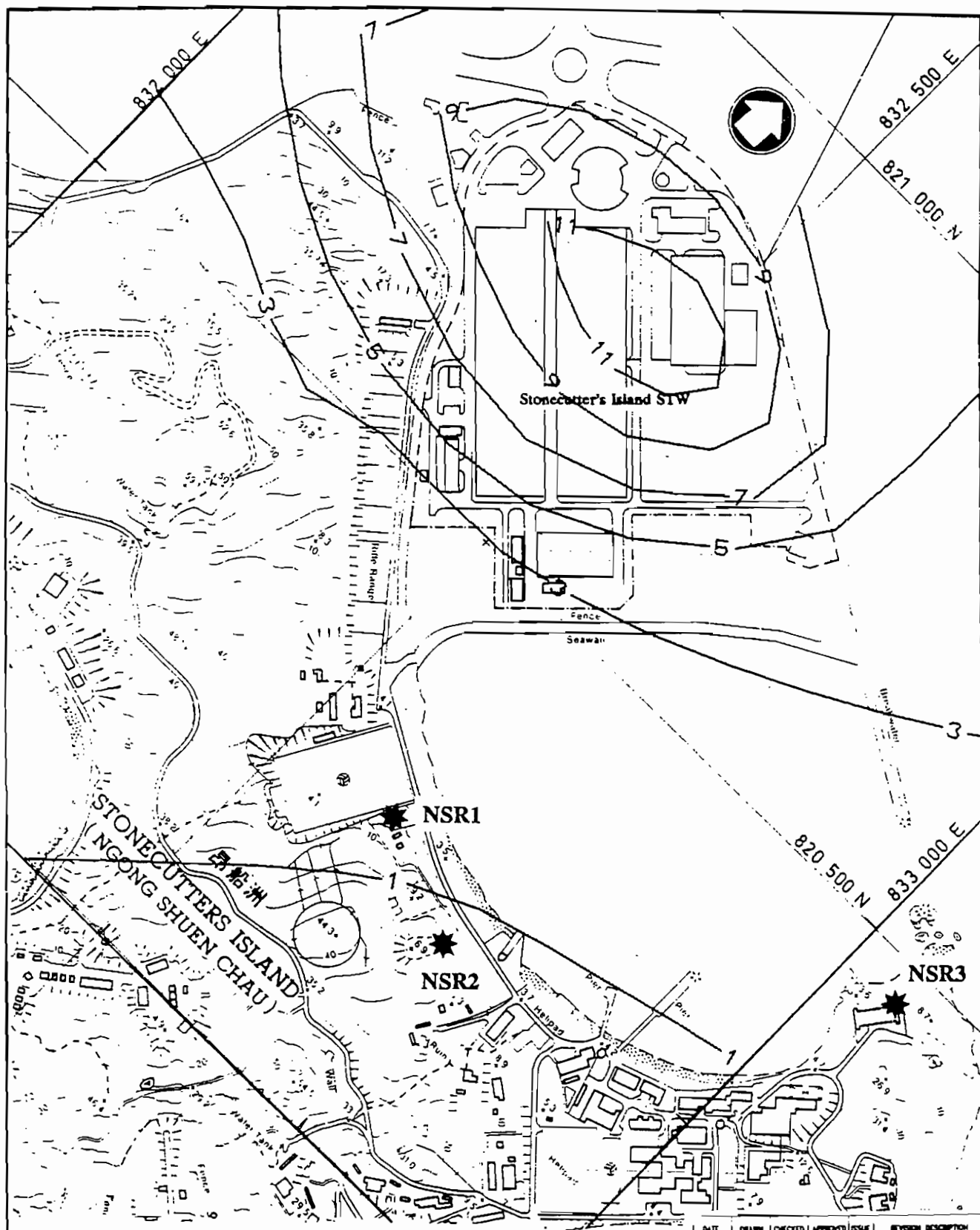
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Lamp Director & McKee • Mott MacDonald • Scott Wilson Associates
 MGP Engineering Inc. • Operational Services Inc.

0 20 40 50m



Estimated Maximum Odour Levels (Odour Units)
 Averaging Time : 5 seconds
 Lime Treatment Scenario with Mitigation Measures

Legend:



Sensitive Receivers

metres 100 0 200

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GOVERNMENT OF HONG KONG

Strategic Sewage Disposal Scheme
 Stage 1 - Principal Collection & Treatment System

Estimated Odour Levels
 (Stonecutters Island
 Sewage Treatment Works)
 with Mitigation Measures

Figure 7.14a



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1. Other Station & Works - Main Control - Staff Room & Reception
 Staff Engineers & Supervisors

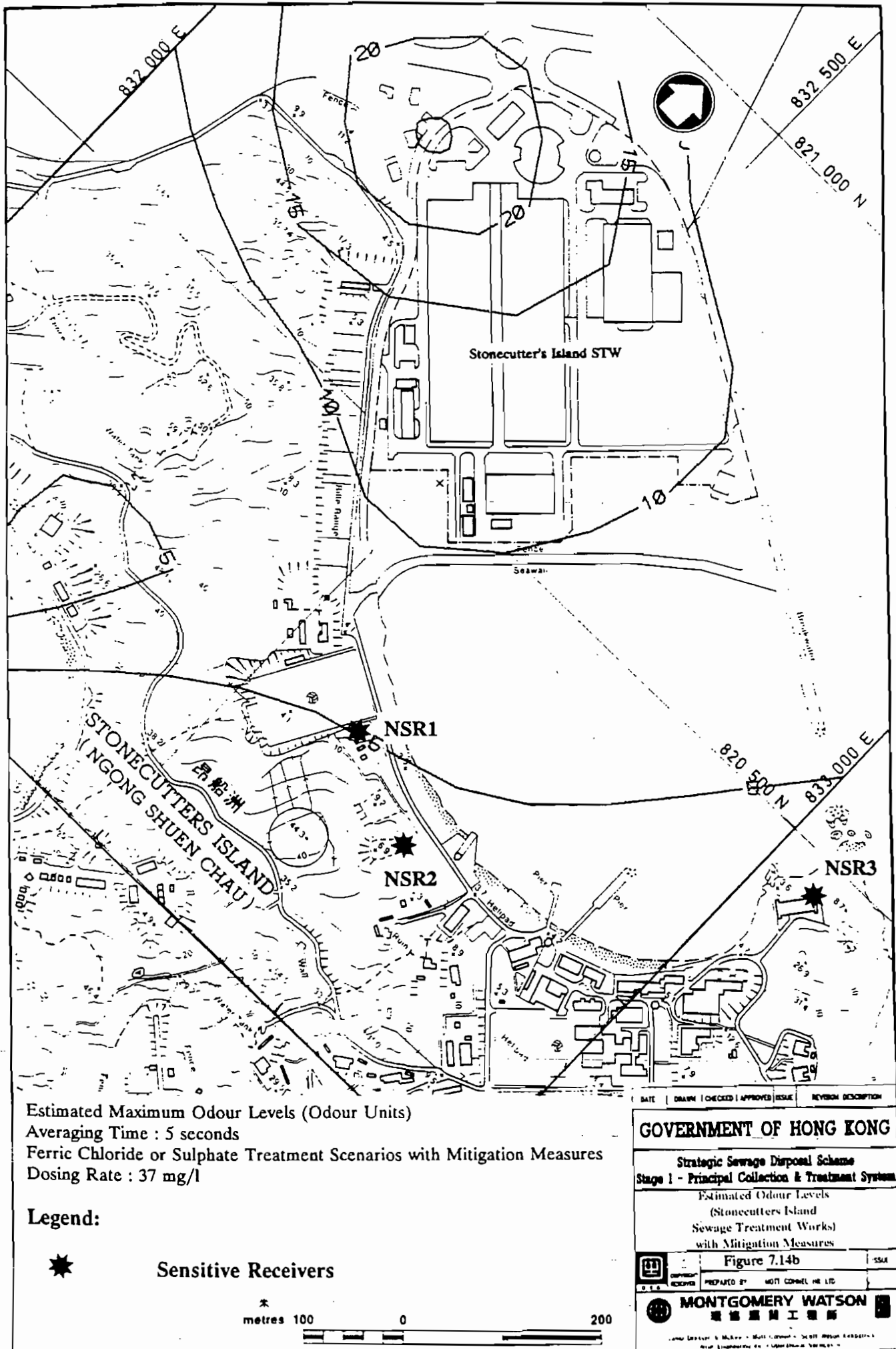
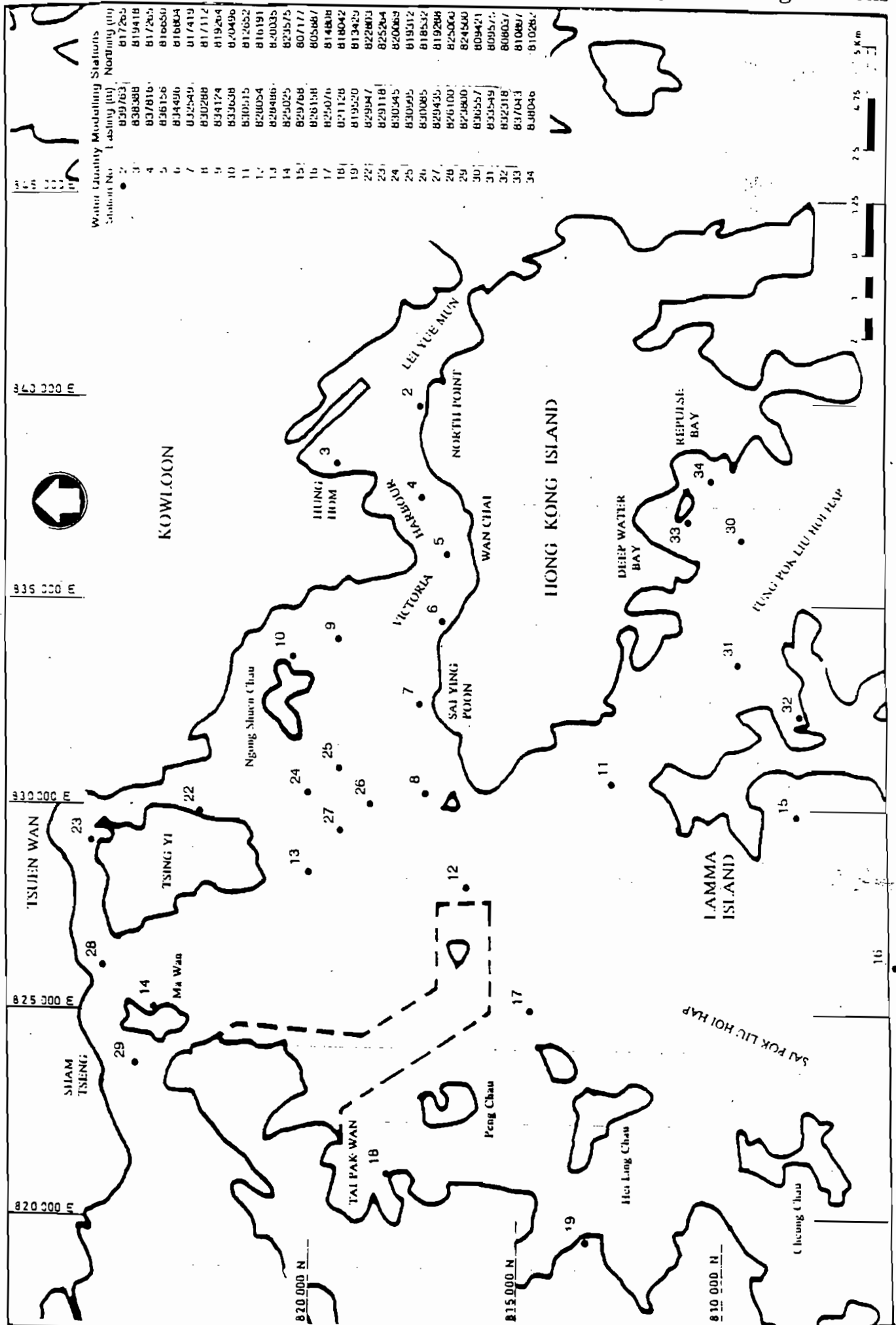


Figure 7.15

Water Quality Modelling Stations



Heavy standard trees - 183
Light standard trees - 79
Ground cover/shrubs/palmes/
bamboo/climbers - 10000 m²
Whip planting - 4800 m²
Gross area - 2977 m²
Non trafficked hard landscape
maintenance strip - 1300 m²
Hard landscape areas - 3250 m²
Special paving (Entrance & administrative
buildings area) - 11825 m²
Site boundary

- Heavy standard trees - 183
Light standard trees - 79
Ground cover/shrubs/palm/
bamboo/climbers - 10000 m²
Whip planting - 4800 m²
Gross area - 2977 m²
Non trafficked hard landscape
maintenance strip - 1300 m²
Hard landscape areas - 3250 m²
Special paving (Entrance & administrative
buildings area) - 11825 m²
Site boundary

PROPOSED SPECIES LIST TO INCLUDE
SELECTION FROM THE FOLLOWING
TREES (HEAVY/LIGHT STANDARDS):

- Acacia confusa*
Albizia lebbek
Aleurites moluccana
Bauhinia blakeana
Cassia siamea
Celtis sinensis
Ficus microcarpa
Litsea nymphaeala
Sapinum discolor
Shefflera actophylla
Schinia
Pinus mastoniana

VIP MIXES:

- Acacia confusa
Cinnamomum camphora
Celtis sinensis
Crotona religiosa
Ficus microcarpa
Sapium discolor
Shefflera actinophylla
Schima superba

GROUND COVER/SHRUBS/BAMBOO/CUMBIERY

- Acalypha wilkesiana*
Aglaia odorata
Bambusa sp.
Catharanthus roseus
Ficus pumila
Isodora helix
Libibicus roosa-sinensis
Lydrangea sp.
pomea sp.
Melastoma sanguineum
Mussaenda pubescens
Wodalia trilobata

NAME	ADDRESS	TELEPHONE	DATE
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GOVERNMENT OF HONG KONG

Strategic Sewage Disposal Scheme

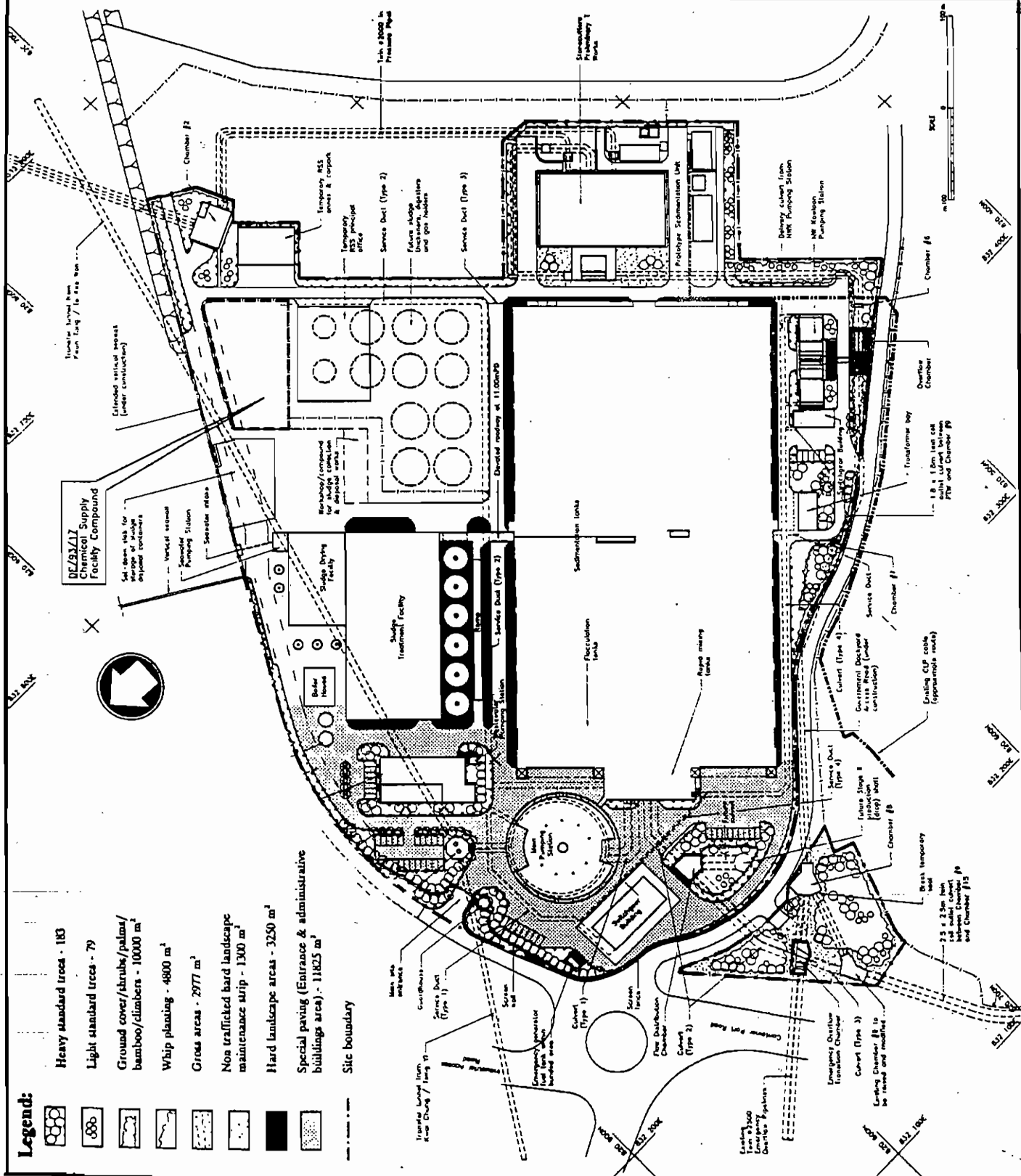
Landscaping Proposed Layout

Figure 7.16

Figure 7.16

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Lump Summed & McGraw-Hill Chemical - Soil Science Department



MITIGATION MEASURES

8.1 Introduction

The stated aim of the SSDS Stage 1 Scheme is to reduce the environmental impact of general construction and wherever practical to incorporate environmental control measures into the detailed design. The following sections outline a series of measures which aim to achieve the overall reduction in environmental impact associated with the SSDS Stage 1 Scheme. Particular Specification Clauses for environmental protection and for the minimisation of adverse impacts were included in all contract documents and are summarised in Appendix I.

8.2 Construction Phase8.2.1 Noise

All Contractors will be required to give due regard to the proposals set out in the Practical Guide for the Reduction of Noise from Construction Works" EPD 1989 when designing their method statement. Site specific mitigation measures with an indication of associated costs are summarised in Table 8.1.

Table 8.1 Summary of Noise Mitigation Measures - Construction

Location	Mitigation Measures Proposed	Number of People Affected at any Given Time	Order of Cost of Mitigation Measures	Estimated Residual Impacts at Nearest NSR
Stonecutters Island Sewage Treatment Works	<p>(a) Construction of Diaphragm Walls for Stonecutters Island Main Pumping Station:-</p> <p>Proposed noise reduction methods include, but are not limited to, the following:</p> <ul style="list-style-type: none"> (i) removal of spoil and transfer of materials around the site should be undertaken only during day-time; (ii) use of acoustic screens between the noise source and sensitive receiver; (iii) use of acoustic shielding for individual items of powered or mechanical plant to achieve noise reduction at source; and (iv) employment of quieter techniques and, where practical, silenced and supersilenced items of plant. 	40	No mitigation measures are required.	66 dB(A), which is less than the recommended level from EPD for 0700-1900 hours.
	<p>(b) Transfer System from Kwun Tong to Stonecutters Island and from Kwai Chung to Stonecutters Island:-</p> <p>A series of measures are proposed herein which aim to reduce general levels of noise emanating from the construction sites :</p> <ul style="list-style-type: none"> i) stockpiling of spoil and removal of such material should be carried out only during daytime hours; ii) excavation of shafts should be carried out only during daytime; iii) drilling and blasting should be restricted to daytime hours; iv) restriction on the sound power levels of drilling equipment; v) employment of acoustic screens to reduce the perceived impact between source and potentially sensitive receptors; and vi) employment of quiet techniques including but not limited to silenced and supersilenced equipment. 	40	\$370,000	49 dB(A)

Table 8.1 Summary of Noise Mitigation Measures - Construction (Cont'd)

Location	Mitigation Measures Proposed	Number of People Affected at any Given Time	Order of Cost of Mitigation Measures	Estimated Residual Impacts at Nearest NSR
Stonecutters Island Sewerage Treatment Works (Cont'd)	<p>Work is expected to be carried out 24 hours/day at individual sites. Noise sources include spoil removal and handling pumps and compressors. On account of the high sound power levels generated by such equipment and the extent of the mitigation required, the Contractor should consider the provision of a noise enclosure around major noise sources.</p> <p>(c) Buildings, Main Pumping Station and Site Development:-</p> <p>As many construction activities will be carried out at Stonecutters Island at the same time, the overall aim will be to provide a series of measures which should achieve a reduction in overall noise levels during this period. All measures proposed herein could easily be incorporated into the Contractors working methods.</p> <p>Proposed noise reduction methods for this Contract include the following:</p> <ul style="list-style-type: none"> (i) use of acoustic shielding for individual items of powered or mechanical plant to achieve noise reduction at source; (ii) employment of quieter techniques and, where practical, silenced and supersilenced items of plant. <p>(d) Sludge Treatment Facilities:-</p> <p>These should include, but are not limited to, the following:</p> <ul style="list-style-type: none"> (i) removal of spoil and transfer of materials around the site should be undertaken only during day-time; (ii) use of acoustic screens between the noise source and sensitive receiver; (iii) use of acoustic shielding for individual items of powered or mechanical plant to achieve noise reduction at source; and (iv) employment of quieter techniques and, where practical, silenced and supersilenced items of plant. 	40	No mitigation measures are required as no work is anticipated between 1900-2300 hours or 2300-0700 hours.	75 dB(A), which is less than the recommended level from EPD for 0700-1900 hours.
Outfall (Chamber 15)	<p>(a) Excavation of Production Shafts and Pumping Station Foundations:-</p> <p>General measures to achieve an overall reduction in noise levels include, but are not restricted to the following:</p> <ul style="list-style-type: none"> (i) stockpiling and removal of spoil from site only during daytime hours; (ii) excavation of spoil during daytime hours; (iii) drilling and blasting only during daytime hours; (iv) use of acoustic screenings to reduce perceived impact between source and receptor; (v) adoption of quieter techniques and the employment of silenced and supersilenced equipment where practicable; (vi) arrangement of working hours. 	20	No mitigation measures are required.	74 dB(A), which is less than the recommended level from EPD for 0700-1900 hours.

Table 8.1 Summary of Noise Mitigation Measures - Construction (Cont'd)

Location	Mitigation Measures Proposed	Number of People Affected at any Given Time	Order of Cost of Mitigation Measures	Estimated Residual Impacts at Nearest NSR
Outfall (Chamber 15) (Cont'd)	<p>If the standards are to be met, noise mitigation measures in the form of a barrier between the noise source and the nearest sensitive receptor will be required most probably around the perimeter of the shaft.</p> <p>(b) Stage I Outfall:-</p> <p>Proposed noise reduction methods include, but are not limited to, the following:</p> <ul style="list-style-type: none"> (i) removal of spoil and transfer of materials around the site should be undertaken only during day-time; (ii) provision of an acoustic enclosure around the dropshaft to reduce the impact associated with lining; (iii) works carried out of the dropshaft site during 0700-1900 hours (iv) provision of an acoustic enclosure around the tunnel shaft and spoil reception area to permit work to continue between 1900 and 0700 hours (v) use of acoustic shielding for individual items of powered or mechanical plant to achieve noise reduction at source; and (vi) employment of quieter techniques and, where practical, silenced and supersilenced items of plant. <p>The Contractor will be required to give due regard to the proposals set out in the "Practical Guide for the Reduction of Noise from Construction Works" EPD 1989 when designing his method statement. It should be noted that significant reductions in sound power levels can be achieved, and thus impacts, through the use of supersilenced plant for example a reduction of up to 15 dB(A) could be achieved through the use of supersilenced compressors. Such items are also frequently used in Hong Kong.</p>	20	\$2,000,000	50 dB(A)
Chai Wan	<p>(a) Excavation of Production Shafts and Pumping Station Foundations:-</p> <p>General measures to achieve an overall reduction in noise levels include, but are not restricted to the following:</p> <ul style="list-style-type: none"> (i) stockpiling and removal of spoil from site only during daytime hours; (ii) excavation of spoil during daytime hours; (iii) drilling and blasting only during daytime hours; (iv) use of acoustic screenings to reduce perceived impact between source and receptor; (v) adoption of quieter techniques and the employment of silenced and supersilenced equipment where practicable; (vi) arrangement of working hours. <p>Noise reduction measures will be required around the perimeter of the production shaft when rock drilling is undertaken.</p>	24 classes of students, about 700 dwellings 4,500 people approximately	\$200,000	70 dB(A), which is less than the recommended level from EPD for 0700-1900 hours.

Table 8.1 Summary of Noise Mitigation Measures - Construction (Cont'd)

Location	Mitigation Measures Proposed	Number of People Affected at any Given Time	Order of Cost of Mitigation Measures	Estimated Residual Impacts at Nearest NSR
Chai Wan (Cont'd)	<p>(b) Transfer System from Chai Wan to Kwun Tong and Tseung Kwan O to Kwun Tong:-</p> <p>General mitigation measures which will be required for the reduction in overall noise levels at all sites include:</p> <ul style="list-style-type: none"> (i) stockpiling and removal of spoil from site during daytime hours only; (ii) excavation of spoil during daytime hours; (iii) drilling and blasting during daytime hours only; (iv) use of acoustic screenings to reduce perceived impact between source and receptor; (v) adoption of quieter techniques and the employment of silenced and supersilenced equipment wherever practical; and (vi) preclusion of raised bore techniques for sinking shafts. <p>In the event that spoil handling must (for programming reasons) be carried out 24 hr/day the Contractor may be required to provide noise enclosures particularly around any noise source, over the spoil conveyors and at the production shafts.</p> <p>No mitigation measures are required for the construction of the drop shaft.</p> <p>Mitigation measures for works at the production shaft, may include</p> <ul style="list-style-type: none"> (i) at source noise reduction measures such as erection of noise enclosure around the actual works and spoil handling areas; (ii) use of marine facilities for disposal of spoil, import of materials etc; (iii) provision of secondary glazing and air conditioning at the school (taking account of the overall length of time work will be carried out at this site - although which Contractor should be responsible for providing this is open to debate). <p>(c) Upgrading Existing Preliminary Treatment Works:-</p> <p>Proposed noise reduction methods include, but are not limited to, the following:</p> <ul style="list-style-type: none"> (i) transfer of materials around the site should be undertaken only during day-time; (ii) use of acoustic screens between the noise source and sensitive receiver; (iii) use of acoustic shielding for individual items of powered or mechanical plant to achieve noise reduction at source; (iv) employment of quieter techniques and, where practical, silenced and supersilenced items of plant. 	Same as above	\$1,000,000	65dB(A) at school, 51dB(A) at Temporary Housing Area.

Table 8.1 Summary of Noise Mitigation Measures - Construction (Cont'd)

Location	Mitigation Measures Proposed	Number of People Affected at any Given Time	Order of Cost of Mitigation Measures	Estimated Residual Impacts at Nearest NSR
Shau Kei Wan	<p>(a) Transfer System from Chai Wan to Kwun Tong and Tseung Kwan O to Kwun Tong:-</p> <p>General mitigation measures which will be required for the reduction in overall noise levels at all sites include:</p> <ul style="list-style-type: none"> (i) stockpiling and removal of spoil from site during daytime hours only; (ii) excavation of spoil during daytime hours; (iii) drilling and blasting during daytime hours only; (iv) use of acoustic screenings to reduce perceived impact between source and receptor; (v) adoption of quieter techniques and the employment of silenced and supersilenced equipment wherever practical; and (vi) preclusion of raised bore techniques for sinking shafts. <p>In the event that spoil handling must (for programming reasons) be carried out 24 hr/day the Contractor may be required to provide noise enclosures particularly around any noise source, over the spoil conveyors and at the production shafts.</p> <p>Mitigation measures may include</p> <ul style="list-style-type: none"> (i) rescheduling of construction works to fit in with the school holidays (although this is not likely to be able to be accommodated within the overall works programme); (ii) at source noise reduction measures such as erection of noise enclosures around the shaft and spoil handling areas; (iii) provision of secondary glazing and air conditioning at the school (taking account of the overall length of time work will be carried out at this site under various contracts). <p>(b) Upgrading Existing Preliminary Treatment Works:-</p> <p>Proposed noise reduction methods include, but are not limited to, the following:</p> <ul style="list-style-type: none"> (i) transfer of materials around the site should be undertaken only during day-time; (ii) use of acoustic screens between the noise source and sensitive receiver; (iii) use of acoustic shielding for individual items of powered or mechanical plant to achieve noise reduction at source; (iv) employment of quieter techniques and, where practical, silenced and supersilenced items of plant. 	6 classes of students, about 88 dwellings, 700 people approximately	\$350,000	64dB(A) for school, 54dB(A) for the residential building.

Table 8.1 Summary of Noise Mitigation Measures - Construction (Cont'd)

Location	Mitigation Measures Proposed	Number of People Affected at any Given Time	Order of Cost of Mitigation Measures	Estimated Residual Impacts at Nearest NSR
Kwun Tong	<p>(a) Excavation of Production Shafts and Pumping Station Foundations:-</p> <p>General measures to achieve an overall reduction in noise levels include, but are not restricted to the following:</p> <ul style="list-style-type: none"> (i) stockpiling and removal of spoil from site only during daytime hours; (ii) excavation of spoil during daytime hours; (iii) drilling and blasting only during daytime hours; (iv) use of acoustic screenings to reduce perceived impact between source and receptor; (v) adoption of quieter techniques and the employment of silenced and supersilenced equipment where practicable; (vi) arrangement of working hours. <p>At Kwun Tong noise mitigation measures will be required for the full extent of the works period. Acoustic shields constructed around the perimeter of the production shafts and working areas will serve to reduce noise levels.</p>	about 1100 residential dwellings, 5500 people approximately	\$320,000	65dB(A), which is less than the recommended level from EPD for 0700-1900 hours.
	<p>(b) Transfer System from Chai Wan to Kwun Tong and Tseung Kwan O to Kwun Tong:-</p> <p>General mitigation measures which will be required for the reduction in overall noise levels at all sites include:</p> <ul style="list-style-type: none"> (i) stockpiling and removal of spoil from site during daytime hours only; (ii) excavation of spoil during daytime hours; (iii) drilling and blasting during daytime hours only; (iv) use of acoustic screenings to reduce perceived impact between source and receptor; (v) adoption of quieter techniques and the employment of silenced and supersilenced equipment wherever practical; and (vi) preclusion of raised bore techniques for sinking shafts. <p>In the event that spoil handling must (for programming reasons) be carried out 24 hr/day the Contractor may be required to provide noise enclosures particularly around any noise source, over the spoil conveyors.</p> <p>Mitigation measures will be required only when work is carried out between 2300 and 0700 hours.</p>	Same as above	\$400,000	Refer to (c) below

Table 8.1 Summary of Noise Mitigation Measures - Construction (Cont'd)

Location	Mitigation Measures Proposed	Number of People Affected at any Given Time	Order of Cost of Mitigation Measures	Estimated Residual Impacts at Nearest NSR
Kwun Tong (Cont'd)	<p>(c) Transfer System from Kwun Tong to Stonecutters Island and from Kwai Chung to Stonecutters Island:-</p> <p>A series of measures are proposed herein which aim to reduce general levels of noise emanating from the construction sites :</p> <ul style="list-style-type: none"> i) stockpiling of spoil and removal of such material should be carried out only during daytime hours; ii) excavation of shafts should be carried out only during periods not restricted under the NCO; iii) drilling and blasting should be confined to periods not restricted under the NCO; iv) restriction on the sound power levels of drilling equipment; v) employment of acoustic screens to reduce the perceived impact between source and potentially sensitive receptors; and vi) employment of quiet techniques including but not limited to silenced and supersilenced equipment. <p>Work is expected to be carried out 24 hours/day. Noise sources include spoil removal and handling pumps and compressors. On account of the high sound power levels generated by such equipment and the extent of the mitigation required, the Contractor should consider the provision of a noise enclosure around major noise sources.</p> <p>In addition to the foregoing in view of the need for mucking out at night, a full noise enclosure over the shaft and conveyor, may be required. Spoil handling should only be carried out during periods not restricted under the NCO, and thus spoil brought to the surface at other times should be stored within an enclosure and only handled during normal hours.</p> <p>(d) Upgrading Existing Preliminary Treatment Works:-</p> <p>Proposed noise reduction methods include, but are not limited to, the following:</p> <ul style="list-style-type: none"> (i) transfer of materials around the site should be undertaken only during day-time; (ii) use of acoustic screens between the noise source and sensitive receiver; (iii) use of acoustic shielding for individual items of powered or mechanical plant to achieve noise reduction at source; (iv) employment of quieter techniques and, where practical, silenced and supersilenced items of plant. 	Same as above	\$2,000,000	55dB(A)

Table 8.1 Summary of Noise Mitigation Measures - Construction (Cont'd)

Location	Mitigation Measures Proposed	Number of People Affected at any Given Time	Order of Cost of Mitigation Measures	Estimated Residual Impacts at Nearest NSR
To Kwa Wan	<p>(a) Excavation of Production Shafts and Pumping Station Foundations:-</p> <p>General measures to achieve an overall reduction in noise levels include, but are not restricted to the following :</p> <ul style="list-style-type: none"> (i) stockpiling and removal of spoil from site only during daytime hours; (ii) excavation of spoil during daytime hours; (iii) drilling and blasting only during daytime hours; (iv) use of acoustic screenings to reduce perceived impact between source and receptor; (v) adoption of quieter techniques and the employment of silenced and supersilenced equipment where practicable; (vi) arrangement of working hours. <p>At To Kwa Wan where the predicted noise levels are in the range of 74-84 dB(A) at the nearest NSR even for daytime working, special attention will need to be given to reducing noise levels especially when rock excavation is undertaken. An obvious solution would be to relocate the production shaft site to increase the distance between the noise and receptor. This is however not feasible and barriers between the source and receptor provide a practical solution to reducing perceived noise levels.</p>	<p>about 600 dwellings,</p> <p>3000 people approximately</p>	\$460,000	74dB(A), which is less than the recommended level from EPD for 0700-1900 hours.
	<p>(b) Transfer System from Kwun Tong to Stonecutters Island and from Kwai Chung to Stonecutters Island:-</p> <p>A series of measures are proposed herein which aim to reduce general levels of noise emanating from the construction sites :</p> <ul style="list-style-type: none"> i) stockpiling of spoil and removal of such material should be carried out only during daytime hours; ii) excavation of shafts should be carried out only during daytime; iii) drilling and blasting should be restricted to daytime hours; iv) restriction on the sound power levels of drilling equipment; v) employment of acoustic screens to reduce the perceived impact between source and potentially sensitive receptors; and vi) employment of quiet techniques including but not limited to silenced and supersilenced equipment. 	<p>about 600 dwellings,</p> <p>3000 people approximately</p>	\$2,000,000	50 dB(A)

Table 8.1 Summary of Noise Mitigation Measures - Construction (Cont'd)

Location	Mitigation Measures Proposed	Number of People Affected at any Given Time	Order of Cost of Mitigation Measures	Estimated Residual Impacts at Nearest NSR
To Kwa Wan (Cont'd)	<p>Work is expected to be carried out 24 hours/day. Noise sources include spoil removal and handling pumps and compressors. On account of the high sound power levels generated by such equipment and the extent of the mitigation required, the Contractor should consider the provision of a noise enclosure around major noise sources.</p> <p>In addition to the foregoing in view of the need for mucking out at night, a full noise enclosure over the shaft and conveyor, may be required. Spoil handling should only be carried out during periods not restricted under the NCO, and thus spoil brought to the surface at other times should be stored within an enclosure and only handled during normal hours.</p> <p>(c) Upgrading Existing Preliminary Treatment Works:-</p> <p>Proposed noise reduction methods include, but are not limited to, the following:</p> <ul style="list-style-type: none"> (i) transfer of materials around the site should be undertaken only during day-time; (ii) use of acoustic screens between the noise source and sensitive receiver; (iii) use of acoustic shielding for individual items of powered or mechanical plant to achieve noise reduction at source; (iv) employment of quieter techniques and, where practical, silenced and supersilenced items of plant. 			
Tsing Yi	<p>(a) Excavation of Production Shafts and Pumping Station Foundations:-</p> <p>General measures to achieve an overall reduction in noise levels include, but are not restricted to the following :</p> <ul style="list-style-type: none"> (i) stockpiling and removal of spoil from site only during daytime hours; (ii) excavation of spoil during daytime hours; (iii) drilling and blasting only during daytime hours; (iv) use of acoustic screenings to reduce perceived impact between source and receptor; (v) adoption of quieter techniques and the employment of silenced and supersilenced equipment where practicable; (vi) arrangement of working hours. <p>As the predicted noise levels are more than 6 dB(A) greater than the permitted daytime noise level for construction activities, noise barriers will need to be erected around the immediate works area. The Contractor will be required to demonstrate his methods comply with the standards set and any proposed noise mitigation measures will achieve the necessary reduction in noise levels.</p>	about 380 residential dwellings, 1900 people approximately	\$1,300,000	50 dB(A)

Table 8.1 Summary of Noise Mitigation Measures - Construction (Cont'd)

Location	Mitigation Measures Proposed	Number of People Affected at any Given Time	Order of Cost of Mitigation Measures	Estimated Residual Impacts at Nearest NSR
Tsing Yi (Cont'd)	<p>(b) Transfer System from Kwun Tong to Stonecutters Island and from Kwai Chung to Stonecutters Island:-</p> <p>A series of measures are proposed herein which aim to reduce general levels of noise emanating from the construction sites :</p> <ul style="list-style-type: none"> i) stockpiling of spoil and removal of such material should be carried out only during daytime hours; ii) excavation of shafts should be carried out only during daytime; iii) drilling and blasting should be restricted to daytime hours; iv) restriction on the sound power levels of drilling equipment; v) employment of acoustic screens to reduce the perceived impact between source and potentially sensitive receptors; and vi) employment of quiet techniques including but not limited to silenced and supersilenced equipment. <p>Work is expected to be carried out 24 hours/day. Noise sources include spoil removal and handling pumps and compressors. On account of the high sound power levels generated by such equipment and the extent of the mitigation required, the Contractor should consider the provision of a noise enclosure around major noise sources.</p> <p>In addition to the foregoing in view of the need for mucking out at night, a full noise enclosure over the shaft and conveyor, may be required. Spoil handling should only be carried out during periods not restricted under the NCO, and thus spoil brought to the surface at other times should be stored within an enclosure and only handled during normal hours.</p> <p>(c) Upgrading Existing Preliminary Treatment Works:-</p> <p>Proposed noise reduction methods include, but are not limited to, the following:</p> <ul style="list-style-type: none"> (i) transfer of materials around the site should be undertaken only during day-time; (ii) use of acoustic screens between the noise source and sensitive receiver; (iii) use of acoustic shielding for individual items of powered or mechanical plant to achieve noise reduction at source; (iv) employment of quieter techniques and, where practical, silenced and supersilenced items of plant. 	Same as above	\$2,500,000	50dB(A)

Table 8.1 Summary of Noise Mitigation Measures - Construction (Cont'd)

Location	Mitigation Measures Proposed	Number of People Affected at any Given Time	Order of Cost of Mitigation Measures	Estimated Residual Impacts at Nearest NSR
Kwai Chung	<p>(a) Transfer System from Kwun Tong to Stonecutters Island and from Kwai Chung to Stonecutters Island:-</p> <p>A series of measures are proposed herein which aim to reduce general levels of noise emanating from the construction sites :</p> <ul style="list-style-type: none"> i) stockpiling of spoil and removal of such material should be carried out only during daytime hours; ii) excavation of shafts should be carried out only during daytime; iii) drilling and blasting should be restricted to daytime hours; iv) restriction on the sound power levels of drilling equipment; v) employment of acoustic screens to reduce the perceived impact between source and potentially sensitive receptors; and vi) employment of quiet techniques including but not limited to silenced and supersilenced equipment. <p>(b) Upgrading Existing Preliminary Treatment Works:-</p> <p>Proposed noise reduction methods include, but are not limited to, the following:</p> <ul style="list-style-type: none"> (i) transfer of materials around the site should be undertaken only during day-time; (ii) use of acoustic screens between the noise source and sensitive receiver; (iii) use of acoustic shielding for individual items of powered or mechanical plant to achieve noise reduction at source; (iv) employment of quieter techniques and, where practical, silenced and supersilenced items of plant. 	about 390 residential dwellings, 2000 people approximately	No mitigation measures are required	61dB(A), which is less than the recommended level from EPD for 0700-1900 hours.
Tseung Kwan O	<p>(a) Excavation of Production Shafts and Pumping Station Foundations:-</p> <p>General measures to achieve an overall reduction in noise levels include, but are not restricted to the following:</p> <ul style="list-style-type: none"> (i) stockpiling and removal of spoil from site only during daytime hours; (ii) excavation of spoil during daytime hours; (iii) drilling and blasting only during daytime hours; (iv) use of acoustic screenings to reduce perceived impact between source and receptor; (v) adoption of quieter techniques and the employment of silenced and supersilenced equipment where practicable; (vi) arrangement of working hours/ 	about 400 residential dwellings, 2000 people approximately	No noise mitigation measure is required	55 dB(A), which is less than the recommended level from EPD for 0700-1900 hours.

Table 8.1 Summary of Noise Mitigation Measures - Construction (Cont'd)

Location	Mitigation Measures Proposed	Number of People Affected at any Given Time	Order of Cost of Mitigation Measures	Estimated Residual Impacts at Nearest NSR
	<p>(b) Transfer System from Chai Wan to Kwun Tong and Tseung Kwan O to Kwun Tong:-</p> <p>General mitigation measures which will be required for the reduction in overall noise levels at all sites include:</p> <ul style="list-style-type: none"> (i) stockpiling of spoil and removal from site during daytime hours only; (ii) excavation of spoil during daytime hours; (iii) drilling and blasting during daytime hours only; (iv) use of acoustic screenings to reduce perceived impact between source and receptor; (v) adoption of quieter techniques and the employment of silenced and supersilenced equipment wherever practical; and (vi) preclusion of raised bore techniques for sinking shafts. <p>Mitigation measures will be required only for Period II working and will be defined when the need for working during this period is established.</p> <p>(c) Upgrading Existing Preliminary Treatment Works:-</p> <p>Proposed noise reduction methods include, but are not limited to, the following:</p> <ul style="list-style-type: none"> (i) transfer of materials around the site should be undertaken only during day-time; (ii) use of acoustic screens between the noise source and sensitive receiver; (iii) use of acoustic shielding for individual items of powered or mechanical plant to achieve noise reduction at source; (iv) employment of quieter techniques and, where practical, silenced and supersilenced items of plant. 	Same as above.	No noise mitigation measure is required.	51dB(A), estimated from a worst case scenario which is unlikely to happen.

8.2.2 Air Quality

The major air quality impact during the construction phase of the SSDS Stage 1 Scheme will be the elevated dust levels at the site boundaries and sensitive receivers. The mitigation measures proposed for all of the work sites minimise dust generation and include, but are not limited to:-

- (a) restriction of maximum vehicular traffic speeds to 8 m/hour on all roads around the site;
- (b) where vehicle movements exceed 100/day over a distance greater than 100m flexible paving must be provided;
- (c) aggregate and dusty materials which are stockpiled or stored must be enclosed on three sides, with the walls extending 2m beyond the front of the pile;
- (d) dusty loads being transported to, from and around the site must be covered with tarpaulins fitted at least 300mm over the edges;
- (e) the use of the vehicle wheel and body washing facilities, which have been supplied at all the sites, will be mandatory before vehicles use the public highway;
- (f) use of high level alarms on cement storage silos to prevent overfilling;
- (g) use of filter vents for cement silos, weigh hoppers and dry mixers;
- (h) monitoring of all construction activities which have the potential to cause elevated dust levels;

- (i) provision of adequate ventilation within the tunnels to protect the health of the workforce;
- (j) the distance between any concrete batching facility and the nearest sensitive receiver should be at least 100m and should be maximised wherever practical taking account of local conditions; and
- (k) marine access is recommended as far as possible to reduce the vehicular traffic to, from and in the vicinity of the site.

Watering of sites, especially when chemical wetting agents are involved, can create additional problems of sediment laden runoff discharging from the sites to the receiving water bodies. It is therefore recommended that surfaces are dampened using water which can be collected and reused for minimising dust wherever practical.

8.2.3 Water Quality

The following measures which aim to minimise water pollution impacts of construction on streams, water courses and receiving water bodies have been proposed for application at all relevant sites:

- (a) surface runoff
 - (i) perimeter drains connecting to the foul sewer and containing sediment traps, control of offsite discharge of sediment laden surface waters to receiving waters, streams or drainage channels;
 - (ii) baffle silt traps may need to be incorporated into surface water drainage system; and
 - (iii) water used to minimise fugitive dust emissions from stockpiled material should be kept to a minimum and wherever possible recycled and reused on-site.
- (b) concrete batching plants and other mixing plant
 - (i) limiting the sizes of concrete batching facilities is recommended to reduce the volume of water used in washing out the batching facilities it will also be beneficial in reducing fugitive dust emission levels; and
 - (ii) a bund should be provided around any concrete batching or other mixing plants to collect and contain any spillages which can then be treated and disposed of.
- (c) dedicated drainage systems
 - (i) perimeter drains should be provided to collect and contain any spillages from concrete batching plants, bentonite mixing, fuel storage, vehicle maintenance or areas where finishings or coatings are applied to materials; and
 - (ii) spent material and spillages should be contained and disposed of appropriately for the avoidance of nuisance.
- (d) tunnel driving
 - (i) any waste water pumped out from the tunnels, which will be charged with spoil, grout, oils and greases shall be pretreated, as required, to achieve the standards set in the TM prior to disposal via the foul sewer;
 - (ii) waste water arising from tunnelling operations may need to be treated to remove the solids contents, possibly by using a settling lagoon or sediment traps. The semi-solid slurry will need to be disposed of to a landfill site and the liquid fraction disposed via the foul sewer for treatment at the appropriate sewage treatment works; and
 - (iii) if settling lagoons are provided they will need to be designed to avoid overflow, especially during storm events, and shall be dug out regularly.

- (e) other effluents
 - (i) all domestic effluents shall be disposed of via proper connections to existing foul sewers;
 - (ii) any liquid used to dampen stockpiled material should be collected and recycled on site, so reducing the water budget and disposal requirements.
- (f) dredging (outfall construction)
 - (i) working methods should aim to reduce the potential for sediment resuspension and thus transport and deposition away from the immediate works site;
 - (ii) reduction of suspended solids in the water column can be affected by prohibiting overflow from hydraulic dredgers, and used by specifying methods and performance requirements in the relevant Contract;
 - (iii) all contaminated mud will be removed using sealed grabs and shall be disposed of at the contaminated spoil disposal pits at East Sha Chau.
- (g) temporary discharge of untreated effluent

For the upgrading of existing preliminary treatment works the Contractors will be required to submit method statements to the Engineer demonstrating that all practical methods have been adopted to avoid discharges of untreated sewage. In the event that such discharges are unavoidable the Contractor will be required:

- (i) to arrange his work programme so that the period of discharge is as short as possible, and takes place during a period of low flow;
- (ii) EPD should be notified in advance and wherever practical the event should be scheduled to occur during periods of low night time flow to minimise the impact on the receiving water quality.
- (iii) Discharge of untreated effluent should not exceed 24 hours. Location of untreated sewage discharges are shown on Figure 3.2.

8.2.4 Waste Disposal

Measures to reduce the on-site and off-site impacts of spoil disposal include restriction of spoil disposal to daytime hours, although consideration may need to be given to the traffic management implications. Consideration should also be given to using marine access wherever possible for the removal of spoil and the import of plant and machinery to the site. Not only would such an arrangement reduce potential impacts on air quality and noise but would also serve to alleviate the traffic congestion, which is a particular concern at Kwun Tong and Stonecutters Island.

The Contractor should aim to minimise the amount of waste generated on-site wherever possible. In particular he should recycle and reuse, materials wherever practical; he should also clean and reuse fuels, oil and bentonite, wherever possible, thereby minimising disposal requirements.

8.2.5 Vibration

The Contractor should ensure that his working methods do not create vibrational stresses by controlling the size of charges used when blasting and by restricting of the use of equipment such as large electric welding machinery, which could interfere with the radiated signals at CAD facilities.

The choice of plant and equipment employed by the Contractors will play a large part in determining the extent of any vibrational stress experienced. Application of boring techniques is recommended for the excavation of shafts rather than drill and blast excavation because it will reduce the potential for vibrational stress on surrounding structures or utilities and are thus recommended.

As previously identified, it is not anticipated that vibration from the TBM tunnel drives will be detectable at ground surface and thus no specific mitigation measures will be required in this connection.

8.2.6 Visual Impacts and Landscape Issues

The necessity of undertaking the works in an unobtrusive manner presents difficulties at most of the sites and will require hoardings and general screenings placed around the perimeter. Substantial screens erected around the sites will eliminate the visually obtrusive general construction site debris. Although hoardings are useful at ground level, they will do little to alleviate the visual intrusion for residents overlooking construction sites.

Organisation and rationalisation of traffic entering and leaving the site (ie avoidance of queue formation or congestion) will minimise the perceived visual intrusion of the works sites especially those in residential areas. The recommendation to use marine transport where possible is also supported in this connection.

Planting of trees in advance is strongly recommended at Stonecutters Island as it will hasten the implementation of the long term landscaping programme while providing short term ground coverage and landscape protection.

Security walling or fencing will also be required at Stonecutters Island as a permanent feature. In view of the contribution of this feature to the overall perspective of the Harbour, detailed consideration was given to providing an aesthetically appealing contribution to the seascape through the Landscape Master Plan which was architecturally conceived to harmonise all the components of the sewage treatment works with their particular function.

To reduce the level of glare and visual intrusion flood lighting should be restricted to those areas where work is being undertaken (it should be noted that this does not include restrictions to security lighting).

8.3 Operational Phase

8.3.1 Noise

Stonecutters Island Sewage Treatment Works (SCISTW)

Compliance with the following specifications will be required to achieve the standards set:

(a) SCISTW Switchgear & Control Building

- (i) The sound pressure level 1 metre from each of the 26 (maximum number) outdoor air condition units shall not exceed 70 dB(A).
- (ii) The sound pressure level 1 metre from the external wall of the emergency generator room shall not exceed 75 dB(A).

(b) SCISTW Administration Building

- (i) The sound pressure level 1 metre from the following ventilation equipment shall not exceed 75dB(A):-

<u>Ventilation Equipment</u>	<u>No.</u>
Roof Extraction Fan	7
Office Air Supply Fan	1
Kitchens Exhaust Fan	1
Toilets Exhaust Fan	1
G/F Locker Room Exhaust Fan	1

- (ii) The sound power level of the chiller unit shall not exceed 90 dB(A).

(c) Sludge Treatment Facilities Building

- (i) The sound pressure level 1 metre from each of the 10 (maximum number) ventilation fans shall not exceed 75 dB(A).
- (ii) The sound pressure level 1 metre from the external wall of the building shall not exceed 70 dB(A).

(d) Unloading Facilities for Chemical Dosing Facilities

- (i) The sound power level of the unloader shall not exceed 109 dB(A).
- (ii) The unloader shall be in operation only during 0700-2300 hours.

(e) Chemical Dosing Facilities Building

- (i) The sound power level of the 4 (maximum number) A/C or ventilation units shall not exceed 90 dB(A).
- (ii) The sound pressure level 1 metre from the external wall of the building shall not exceed 65 dB(A).

(f) Stonecutter's Island Main Pumping Station (SCIMPS)

- (i) The sound pressure level around the periphery of the building roof shall not exceed 65dB(A).

Alternatively, the above can be replaced by specifying the sound power level of each of the following ventilation equipment to be less than 90dB(A):-

Ventilation Equipment	No.
Motor Hall Extraction Fan	8
Air Cooled Chiller	4
Lift Machine Room Air Extraction Fan	1
Lift Machine Room Ventilation Fan	1
Pumpwell and Motor Hall Extraction Fan	4
Toilet Extraction Fan	1
Control Room Air Supply Fan	1

- (ii) The sound pressure level 1 metre from the external wall shall not exceed 60dB(A). this can be replaced by the following specifications:-

- Acoustic Louvres
Maximum area : 24.00 sq.m
Minimum Transmission Loss (TL):

Frequency	63	125	250	500	1000	2000	4000	8000
Minimum TL	7	8	11	12	15	16	12	11

- Roller gate of main entrance shall be made of galvanised steel (minimum thickness is 1.2mm) and shall be shut during normal operation.
- Doors of the motor hall shall be made of hardwood with thickness not less than 43mm.

- (iii) The sound pressure level 1 metre from the intake louvres of pumpwell air supply fans shall not exceed 75 dB(A).
- (g) North West Kowloon Pumping Station (NWKPS)
- (i) One ventilation fan with sound pressure level of 75 dB(A) 1 metre from the equipment is allowed for NWKPS Switchgear Building.
- (h) Properties of E&M Equipment for Blower Room No. 1, 2 & 3 and Scum Pump Rooms in SCISTW Sedimentation Tanks

- (i) Acoustic louvres
Minimum Transmission loss (TL):

Frequency	63	125	250	500	1000	2000	4000	8000
Minimum TL	7	8	11	12	15	16	12	11

- (ii) Acoustic panels for doors
Minimum Transmission loss (TL) & minimum absorption coefficients:

Frequency	63	125	250	500	1000	2000	4000	8000
Minimum Ab. Coeff	0.71	0.89	0.95	0.95	0.95	0.95	0.93	0.74
Minimum TL	26	19	29	40	52	56	56	57

- (iii) Areas of concrete, louvres and acoustic panels for plant rooms (m²)

Location	Area of Concrete	Area of Louvre	Area of Acoustic Panel (Door)	Total Area
Blower Room 1	1571	8	7	1586
Blower Room 2	392	12	7	411
Blower Room 3	743	15	21	779
Scum Pump Room	141	1	10	152

(iv) Sound pressure levels of indoor equipment (1m) for DE/93/19

Frequency	Air Blower (dB(A))	Sludge Pump (dB(A))	Scum Pump (dB(A))
63	69	39	46
125	83	50	57
250	73	59	66
500	76	65	72
1000	75	71	78
2000	71	69	76
4000	67	65	72
8000	62	57	64

(i) Sound Pressure Levels of Outdoor Equipment of SCISTW Sedimentation Tanks

Maximum sound pressure levels of outdoor equipment are listed in the following:

Equipment	Sound Pressure Level (1m) (dB(A))
Rapid Mixer	80
Sludge Collector Drive	50
Cross Collector Drive	50
Odour Control Facility	70
Air Conditioning Unit	65
Ventilation Fan	70

Chai Wan Preliminary Treatment Works

The specifications provided in Table 8.2 are required to ensure compliance with the standards set.

Table 8.2 Maximum Number and Sound Power Levels of Ventilation Equipment of Chai Wan PTW

Equipment	Maximum Number in Operation	Maximum Sound Power Level, dB(A)
Coarse Screens Building D/O Unit	3	90
Fine Screens Building D/O Unit	2	100
Grit Skip Building D/O Unit	1	90
Pumping Station Ventilation Fan	2	95
Workshop Ventilation Fan	3	90
Administration Building Air-Conditioning Unit	2	90
Kitchen Exhaust Fan	1	90
Toilet Exhaust Fan	1	90

Shau Kei Wan Preliminary Treatment Works

To ensure compliance with the standards set compliance with the requirement given in Table 8.3 will be required.

Table 8.3 Maximum Numbers and Sound Power Levels of Ventilation Equipment of Shau Kei Wan PTW

Equipment	Maximum Number	Maximum Sound Power Level, dB(A)
Coarse Screens Building D/O Unit	1	80
Fine Screens Building D/O Unit	2	80
Pumping Station Ventilation Fan	4	80
MCC Room A/C Unit	1	90

In addition, compliance with the sound pressure levels one metre from external walls of plant room is a requirement stipulated in the Contracts. Details are summarised in Table 8.4.

Table 8.4 Required Sound Pressure Levels of Building Walls - Shau Kei Wan PTW

Plant Room	Sound Pressure Level 1m from External Wall dB(A)
Fine Screens Building	55
Pumping Station	65

Kwun Tong Preliminary Treatment Works

Compliance with the following specifications will be required to achieve the standards set.

- (a) The permitted items of plant and noise levels of equipment are listed in Table 8.5.

Table 8.5 Maximum Numbers and Sound Power Levels of Ventilation Equipment of Kwun Tong PTW

Equipment	Maximum Number in Operation	Maximum Sound Power Level, dB(A)
Coarse Screens Building D/O Unit	2	90
Fine Screens Building D/O Unit	2	100
Grit Skip Building D/O Unit	1	95
Pumping Station Ventilation Fan	6	95
Workshop Ventilation Fan	5	90
Administration Building A/C Unit	2	90
Kitchen Exhaust Fan	2	90
Toilet Exhaust Fan	1	90

- (b) The sound pressure level one metre from the external wall of screw pump building needs to be reduced to 75dB(A) or less.

Kwun Tong Pumping Station

The sound pressure level one metre from the four ventilation fans, of the switchgear building of Kwun Tong Pumping Station, shall not exceed 70dB(A).

To Kwa Wan Preliminary Treatment Works

The acoustic design specifications for this plant are stated in Table 8.6.

Table 8.6 Maximum Number and Sound Power Levels of Ventilation Equipment of To Kwa Wan PTW

Equipment	Maximum Number in Operation	Maximum Sound Power Level, dB(A)
Coarse Screens Building D/O Unit	2	80
Fine Screens Building D/O Unit	2	80
Grit Skip Building	1	80
Pumping Station Ventilation Fan	7	90
Administration Building A/C Unit	2	80
Axial Fan (Admin. Bldg)	1	80

In addition, compliance with the sound pressure levels one metre from external walls of plant room is required. The details are summarised in Table 8.7.

Table 8.7 Required Sound Pressure Levels of Building Walls - To Kwa Wan PTW

Plant Room	Sound Pressure Level 1m from External Wall, dB(A)
Fire Screens Building	55
Pumping Station	75

Tsing Yi Preliminary Treatment Works

The maximum numbers of plant and the sound power levels which are required to achieve the standards set are given in Table 8.8.

Table 8.8 Maximum Number and Sound Power Levels of Ventilation Equipment of Tsing Yi PTW

Equipment	Maximum Number in Operation	Maximum Sound Power Level, dB(A)
Coarse Screens Building D/O Unit	1	85
Fine Screens Building D/O Unit	3	85
Fine Screens Building A/C Unit	1	80
Pumping Station Ventilation Fan	2	90

In addition, the sound pressure levels one metre from external walls of the screw pump room shall be less than 70dB(A).

8.3.2 Odour

A summary of details of deodorization units required is listed in Table 8.9

Table 8.9 Deodorisation Units Details

Location	Mitigation Measures Required	Deodorisation Requirements		
		Buildings	H ₂ S Removal Required	For New Buildings or Existing Facilities
Chai Wan PTW	(i)	Fine Screens Building Coarse Screens Building Grit Skip Buildings	3 ppm to 0.005 ppm	New Buildings
Shau Kei Wan PTW	(i)	Coarse Screens Building Fine Screens Building	3 ppm to 0.005 ppm	New Buildings
Tseung Wan O PTW	(i)	Grit Skip Buildings Coarse Screens Building Headworks Buildings	3 ppm to 0.005 ppm 3 ppm to 0.005 ppm	New Buildings Existing Buildings
Kwun Tong PTW	(i)	Coarse Screens Building Fine Screens Building Grit Skip Buildings	3 ppm to 0.005 ppm	New Buildings
Kwun Tong Pumping Station	(i)	Connecting Culvert Wet Well	99% removal	New Facilities
To Kwa Wan PTW	(i)	Coarse Screens Building Fine Screens Building Grit Skip Buildings	3 ppm to 0.005 ppm	New Buildings
Tsing Yi PTW	(i) + (ii)	Coarse Screens Building Fine Screens Building Aerated Grit Channels	3 ppm to 0.005 ppm 3 ppm to 0.005 ppm	New Buildings Existing Aerated Grit Channels

Table 8.9 Deodorisation Units Details (Cont'd)

Location	Mitigation Measures Required	Deodorisation Requirements		
		Buildings	H ₂ S Removal Required	For New Buildings or Existing Facilities
Stonecutters Island		SCIMPS	99 % removal	New Buildings
		Influent Channel of Sedimentation Tanks	99 % removal	New Facilities
		Flocculation Tanks, Main Distribution Channels and Sedimentation Tanks (Ferric Chloride)	about 60% removal if dosage applied is 30mg/l	New Facilities
		Sludge Treatment Facilities (including raw sludge and sludge cake holding tanks, centrifuge centrate and solids discharge ports, all transfer conveyors and the centrate sump)	99 % removal	New Facilities

Notes: (i) Covers are required for the detritors. Deodorisation units, capable of reducing hydrogen sulphide concentration from 0.5-3 ppm down to 0.005 ppm, will be installed downstream of the extraction fans of all screens buildings and grit skip buildings.

Hydrogen sulphide concentration of extracted air from those buildings is not expected to exceed 5 ppb (0.005 ppm = 5 ppb) after deodorisation. This is equivalent to 10 odour units and will be reduced to less than 5 odour units at sensitive receivers outside the boundaries after dilution.

- (ii) A deodorisation unit with same specifications will also be installed to treat the air extracted from the two aerated grit channels.

All deodorization plants will consist of prefilter sections and chemical impregnated activated carbon sections.

9.1 NoiseConstruction Phase

Noise monitoring of all construction works associated with the Stage I Scheme is a prerequisite of the environmental control plan. These monitoring proposals are made to ensure that the Contractors working methods do not generate noise levels which exceed the predefined limits or which cause an unacceptable elevation in background noise levels or adverse impacts at the sensitive receivers.

A detailed Environmental Monitoring and Audit Manual was issued under separate cover for the Construction Phase of the Stage I Scheme which contains full details of the monitoring and audit requirements for construction of the Stage I Scheme. The following sections provide the guidelines for the formulation of the monitoring and audit plan.

Baseline noise monitoring should be undertaken for at least two weeks with measurements taken everyday at the nearest noise sensitive receiver. This should comprise three Leq (5 and 30 minute) measurements on each monitoring day.

Impact noise monitoring should be performed throughout the Contract at the same location. For construction during normal working (unrestricted) hours (0700-1900 hours) impact monitoring should comprise Leq (30 minute) taken twice per week. Impact monitoring for construction outside normal working (restricted) hours (1900 - 0700 hours) should comprise Leq (5 minute) taken twice per day, once in each of the restricted periods, unless complaints are received. In such a case more frequent measurements will be necessary. It should be noted the precise programme for impact monitoring can only be determined when actual details of the Contractor's programme for construction are available.

Where monitoring shows an excessive noise level, the Contractor should take necessary steps to ensure that his actions are not contributing to the excess.

The Engineer should be kept informed of any mitigation measures taken, and written reports and proposals for action should be passed to the Engineer by the Contractor whenever monitoring shows an excessive noise levels occur.

Table 9.1 shows a proposed plan of action which may be required in the event that noise levels exceed those specified.

Table 9.1 Construction Noise Action Plan

Event	Action	
	Engineer	Contractor
When a complaint is received	<ul style="list-style-type: none"> o Notify Contractor o Conduct measurement o Investigate noisy operations 	-
When more than one complaint is received within a 2 weeks period	<ul style="list-style-type: none"> o Notify Contractor o Analyse investigation o Require Contractor to propose measures to reduce the noise o Increase monitoring frequency to check mitigation effectiveness 	<ul style="list-style-type: none"> o Submit noise mitigation proposals to Engineer o Implement noise mitigation measures
<p>75 dB(A) exceeded between 0700 - 1900 hrs on normal weekdays</p> <p>60 dB(A) exceeded between 0700 - 2300 hrs on holidays and 1900 - 2300 hrs on other days</p> <p>45 dB(A) exceeded between 2300 - 0700 hrs of next day</p> <p>75 dB(A) at residential dwellings, 70 dB(A) exceeded at schools during periods not restricted under the NCO (65 dB(A) during examinations) under EPD Practice Note Pro PECC PN/2/93</p>	<ul style="list-style-type: none"> o Notify Contractor o Require Contractor to implement mitigation measures o Increase monitoring frequency to check mitigation effectiveness 	<ul style="list-style-type: none"> o Submit noise mitigation proposals to the Engineer o Implement mitigation measures o Prove to Engineer effectiveness of measures applied

Noise monitoring requirements were also specified in Particular Specification Clauses for Environmental Protection, Section 26A.05 Noise Monitoring, 26.06 "Compliance audit reporting" and 26A.07 "Action on detection of excessive level" and included in each of the individual Contract Documents.

Operational Phase

Confirmatory monitoring and auditing is also required to ensure that the materials and design provided will achieve the standards set and will include monitoring of pumps, extraction and ventilation fans and motors which could have an impact at sensitive receivers. Should any complaints be received by EPD the plant manager of the facility concerned should be informed immediately and should review the operational procedures and thoroughly check plant and equipment to ensure compliance with the Noise Control Ordinance.

A Post Project Monitoring and Audit Manual has been issued which provides details of the recommended monitoring and audit requirements for the Stage I Scheme.

9.2 Air QualityConstruction Phase

Air quality monitoring and action plans are essential if the aim of reducing ambient TSP levels arising at each of the work sites is to be achieved. Dust monitoring stations for baseline and impact monitoring should be established at the land boundary of the site. TSP baseline monitoring should be carried out for at least two weeks with measurements taken every day prior to the start of the construction to establish a representative 24-hour TSP background level. Readings should be taken three times daily for two weeks for 1-hour TSP.

Impact monitoring of 1 hour TSP levels should also be carried out at the site boundary. The programme for impact monitoring will only be able to be defined when the Contractor's detailed works programme becomes available. The monitoring proposals should be updated to reflect any changes in the programme as work progresses. As a guide, 1-hour samples should be taken on three in every six days at the site boundary near to any activities likely to cause significant dust impacts and 24 hour samples taken close to sensitive receivers at least once every six weeks.

Where the monitoring data collected at the site boundary reveals a deterioration in air quality (i.e. the trigger, action or target levels are exceeded) the Contractor will be required to take any necessary additional steps to ensure that his actions are not contributing to the deterioration.

Table 9.2 provides general proposals for trigger, action and target levels to prevent deterioration in air quality at the site boundary which are being proposed for all Contracts which comprise the Stage I Scheme.

Table 9.2 Trigger, Action and Target Levels for Dust

TSP Monitoring Parameter in $\mu\text{g}/\text{m}^3$	Location	TSP level in $\mu\text{g}/\text{m}^3$		
		Trigger	Action	Target
1-hour TSP level	Site Boundary	30% above baseline	average of trigger and target levels	500
24-hour TSP level	Air Sensitive Receivers	30% above baseline	average of trigger and target levels	AQO(260)

Table 9.3 shows a proposed action plan should any of the trigger, action or target levels be exceeded.

Table 9.3 Proposed Action Plan for Dust

Event	Action	
	Engineer	Contractor
Trigger level exceeded for one sample	Repeat measurement as soon as possible	Identify source.
Trigger level exceeded for more than one consecutive sample	Repeat measurements as soon as possible Notify contractor and EPD immediately	Identify source and impose necessary mitigation measures
Action level exceeded for one sample	Repeat measurement as soon as possible Notify contractor EPD immediately	Identify source and impose necessary mitigation measures
Action level exceeded for more than one consecutive sample	Daily monitoring to be imposed Notify contractor and EPD immediately Require contractor to make additional proposals for dust suppression	Identify source Review plant and equipment and working procedures Submit proposals for reducing dust to Engineer Implement remedial action to dust emission immediately Notify Engineer of action taken
Target level exceeded for one sample	Daily monitoring is to be imposed Notify Contractor and EPD immediately Require Contractor to make additional proposals for dust suppression Provide investigation report which should be sent to EPD as soon as possible	Identify source Review plant and equipment and working procedures Submit proposals for reducing dust to Engineer Implement remedial action to reduce the dust emission immediately Notify Engineer of action taken Provide investigation report

Table 9.3 Proposed Action Plan for Dust (Cont'd)

Event	Action	
	Engineer	Contractor
Target level exceeded for more than one consecutive sample	<p>Daily monitoring is to be imposed immediately</p> <p>Notify contractor and EPD immediately</p> <p>Require Contractor to make additional proposals and to take immediate steps to reduce dust, and to provide report for such instance to the EPD as soon as possible</p>	<p>Identify source</p> <p>Review plant and equipment and working procedures</p> <p>Submit proposals for reducing dust to Engineer</p> <p>Implement dust suppression measures to reduce dust immediately</p> <p>Notify Engineer of action taken</p> <p>Provide investigation report which should include the findings and suggestions to prevent such exceedance happening again</p> <p>Stop the relevant portion of work as necessary as determined by the Engineer</p>

Operational Phase

It is recommended that upon completion of the Stage I works, a comprehensive environmental audit is undertaken to confirm that the odour control systems are operating to the design standards and the filters at the chemical dosing facilities are conforming to the standards set. Full details of the proposed Post Project Monitoring and Audit Requirements are provided in a separate manual. A summary of these requirements is given in the following paragraphs.

Monitoring of emissions and odour levels will be required to confirm that the odour control units which are installed achieve the standards set for the site boundary.

The monitoring programme will be undertaken to ensure:

- (i) the cumulative odour threshold limit at the site boundary will not exceed 2 odour units; and
- (ii) the TSP level does not exceed 500 $\mu\text{g}/\text{m}^3$ at the site boundary (if chemicals are imported to site in powder form).

If valid complaints are received in connection with mal odours arising from any of the facilities the plant manager should review operating procedures and implement remedial action. A review of the performance of the plant and plant maintenance should be carried out if a large number of complaints are received.

Odour Monitoring

Odour compliance monitoring will be required to verify the performance of the odour control facilities at all the sites. The suggested monitoring requirements are:

- (i) olfactometry method should be adopted;
- (ii) compliance monitoring shall be carried out for three one hour periods on three consecutive days after the commissioning of the Stage 1 Scheme;
- (iii) impact monitoring shall be carried out when the odour impacts are expected to be highest (e.g. during summer, low flow conditions and stable wind conditions);
- (iv) baseline monitoring shall be carried out in the same manner prior to commissioning of the Stage 1 Scheme at all the sites;
- (v) sampling of air shall be carried out at spots where odour is expected to be the strongest, persistent, and/or which are nearest to the sensitive receivers;
- (vi) informal monitoring by odour patrol using his olfactory sense shall be carried out in addition to formal monitoring; and
- (vii) the target level is defined as 2 odour units at the site boundary.

All details relating to the proposed odour monitoring programme were included in the Post Project Monitoring and Audit Manual.

9.3

Water Quality

Construction Phase

During the construction phase, water quality monitoring programmes are essential to confirm the Contractors working methods are not contributing to an unacceptable deterioration in receiving water quality. The Contractor must schedule and design his works such that he:

- (i) minimises disturbance to the seabed while dredging;
- (ii) minimises losses of dredged material during lifting and transportation of fill or dredged material;
- (iii) prevents discharge of fill or dredged material at any location other than that approved by the DEP;
- (iv) prevents the unacceptable reduction in dissolved oxygen levels due to the dredging or backfilling;
- (v) prevents release of excessive suspended solids to the water column.

The Contractor must establish a series of monitoring stations with each station having a defined (measured) target limit for turbidity defined by the Engineer.

Water quality monitoring must be carried out to define the Baseline Conditions prior to the commencement of the marine works under the Contract. The Engineer will then establish the 'Baseline' conditions by insitu measurement of dissolved oxygen concentration (mg/l) (DO) and dissolved oxygen saturation (%) (DOS) and temperature (degrees Celsius). Water samples will be taken for immediate on site measurement of turbidity (NTU) and laboratory analysis of suspended solids (mg/l).

Baseline monitoring must be carried out at all Designated Monitoring Stations for a period of four consecutive weeks within a period of six weeks prior to the commencement of the marine works on four days of each week. Monitoring shall be undertaken at each station on the mid-flood and mid-ebb tides at three depths, namely one metre below the water surface (upper), mid water depth (middle) and one metre above the seabed (lower).

The baseline results control station monitoring results and WQO shall form the basis for calculating the trigger, action and target levels (TAT) to be used in impact monitoring.

During the course of the works impact monitoring shall be undertaken on three working days per week at each designated monitoring Station. The interval between each sampling series (mid ebb and mid flood) will not be less than 36 hours where two sets of turbidity, DO, DOS and temperature levels shall be measured and water samples for suspended solids taken at each depth. Where the difference in value between the first and second reading of each set is more than 25% the readings shall be discarded and further readings shall be taken.

If the monitoring data of Turbidity or Suspended Solids or Dissolved Oxygen show a deteriorating trend or where TAT levels for any of these three parameters are exceeded, the Contractor shall take action in accordance with an Action Plan which shall be submitted to and agreed by the Engineer.

The Designated Monitoring Stations will be defined for each individual component of the Marine Works to be undertaken during the execution of this Contract.

Action on detecting a deterioration in water quality shall include all necessary steps taken by the Contractor to stem the deterioration and reestablish the status quo. The steps taken will include but not be limited to :-

- (a) checking of all marine plant and equipment;
- (b) maintenance or replacement of any marine plant or equipment contributing to the deterioration;
- (c) checking and maintenance of all silt screens; and
- (d) review of all working methods.

The general procedures to avoid pollution during dredging works include the requirement that the Contractor shall design his working methods and use equipment that shall minimise the risk of silt and other contaminants being released into the water column or deposited in other than designated locations.

Marine Mud

The Contractor shall ensure that all marine mud, contaminated marine mud and unsuitable material is disposed of at the approved locations. He will be required to ensure accurate positioning of vessels before discharge and will be required to submit and agree proposals with the Engineer for accurate positional control at disposal sites before commencing dredging. All disposal in designated marine dumping grounds shall be in accordance with the conditions of a licence issued by the DEP under the Dumping at Sea Act (Overseas Territories) Order 1975. Floatable and contaminated materials (as defined by the DEP) will not be acceptable at marine dumping grounds and will require other methods of disposal.

The Engineer may monitor any vessel transporting material to ensure that loss of material does not take place during transportation. The Contractor is to provide all reasonable assistance to the Engineer for this purpose and shall design his methods of working to minimise pollution and shall provide both experienced personnel and suitable training to ensure that these methods are implemented.

Water quality monitoring at disposal sites will be required to ensure the working methods do not adversely affect local water quality.

The Water Quality Monitoring equipment will be provided from the RSS centralised monitoring equipment stores as required and shall include dissolved oxygen and temperature measuring equipment, turbidity measuring equipment, water depth detector and global positioning system.

Baseline monitoring shall be carried out for the various water quality parameters which shall be established prior to the commencement of the dumping or dredging operation. The Contractor shall establish the Baseline conditions by measuring turbidity, dissolved oxygen concentration, dissolved oxygen saturation at all designated monitoring stations on four sampling days per week at mid flood and mid ebb for one week prior to the commencement of the operation. All measurements shall be taken in situ and at three water depths namely 1m below water surface, mid depth and 1m above the seabed.

During the course of the operation monitoring shall be undertaken three days a week. Monitoring at each designated monitoring station shall be undertaken on a working day. The interval between each series (mid ebb and mid flood) of sampling shall not be less than 36 hours. The value of turbidity, DO and DOS shall be determined. Two measurements at each depth of each station shall be taken. Where the difference in value between the first and second reading of each set is more than 25% of the value of the first reading the readings shall be discarded and further readings shall be taken.

Should the monitoring programme record levels of turbidity or dissolved oxygen which are indicative of a deteriorating situation in the opinion of the DEP, further monitoring may be required.

An action plan for water quality monitoring has been drawn up and is included as Table 9.4.

Table 9.4 Action Plan for Water Quality Monitoring

Event	Action by	
	Engineer	Contractor
Monitoring results on a single occasion indicate unacceptable water quality.	Notifies Contractor.	Acknowledges verbally.
Monitoring results on two consecutive occasions indicate unacceptable conditions.	Notifies Contractor. Requires deployment of Contractor's existing plant and methods to be adjusted to meet WQR. Increases monitoring frequency to daily.	Reviews plant and working methods. Submits remedial proposals to Engineer for written approval. Implements remedial action immediately on receipt of approval.
Monitoring results on three or more consecutive occasions indicate unacceptable conditions.	Notifies Contractor and Environmental Protection Department. Requires Contractor to deploy alternative or additional plant and/or methods to meet WQR. Continues to monitor on a daily basis and takes water samples to confirm suspended solids concentrations.	Reviews plant and methods. Submits proposals for alternative or additional plant and/or methods to Engineer for written approval. Implements remedial actions immediately on receipt of approval.

Table 9.4 Action Plan for Water Quality Monitoring (Cont'd)

Event	Action by	
	Engineer	Contractor
Monitoring results indicate persistently unacceptable conditions.	<p>Notifies Contractor and Environmental Protection Department in writing. If approved remedial measures have not been implemented, Engineer directs Contractor to cease related works or parts of works until approved measures have been implemented and plant and methods made to comply with the required approvals.</p> <p>Continues to monitor on a daily basis and takes water samples to confirm suspended solids concentrations.</p>	Implements approved remediation measures and ensures compliance of plant and methods.

Benthic Biota

Monitoring of the effectiveness of operations at the contaminated mud disposal sites is part of an ongoing Project at East Sha Chau. Previously monitoring studies were also carried out at Waglan Island to identify the impacts of disposal of mud on water quality and the benthic communities. This may be considered further in strategic terms although it was not recommended as part of this SSDS Stage I Study on account of the short time span of the dredging operations.

Operational Phase

Details of the proposed Post Project Monitoring and Audit requirements are given under cover of a separate Manual and are based on the following recommendations:

- (a) monitoring of the hydraulic performance of the outfall which may be undertaken by regularly recording the water levels in Chamber 15 and Chamber 9 and correlating this data with the discharge rate through the outfalls;
- (b) water quality monitoring of the receiving waters to confirm that the water quality standards to which the diffusers are designed are being achieved; and
- (c) monitoring of sediment deposition rates around the diffusers to determine accretion rates and to define any maintenance dredging requirements.

Once the Stage I Outfall is commissioned environmental audits will be required. Audits should focus upon the determining whether the design objectives/discharge consents are being achieved, and will provide feedback to assist in the advancement of the Stage II system.

Monitoring of the hydraulic performance of the outfall could be undertaken by installing instrumentation of the headworks.

Recent developed methods of methods of measuring, throughout the water column, suspended solids, dissolved oxygen and water temperature and salinity provide a powerful monitoring tool which could be applied during the post-construction monitoring of the outfall plume dispersion.

Suspended solids are measured using a vessel-mounted acoustic doppler current profiler (ADCP). The method of converting acoustic backscatter intensity to solids concentrations in mg/l was developed in Hong Kong and has been used extensively throughout the Territory to monitor the primary effects of dredging and disposal of dredged material. The ADCP is capable of measuring solids concentrations over depth increment of as little as 0.10m from about 2 metres below the water surface to near seabed level. Water current speed direction are also measured at the same depth intervals and a full profile of data is obtained at intervals of about 2 seconds. The speed at which the survey boat is sailed thus determines the horizontal spacing of data points which at a sailing speed of 2m/sec is 4 metres.

Water temperature and salinity data and observations of dissolved oxygen are collected using a towed multi-sensor streamer which can be deployed at the same time as the ADCP. The sensor spacing can be varied to suit the water depth and to requirements of the monitoring. Typically, 6 sets of sensors are used which, in 10 metres of water, would provide continuous data profiles at depth increments of about 1.5 metres.

All of the data can be monitored while being collected, enabling the operators to track material in suspension with ease. During an 8-hour period of monitoring, approximately 5 million independent observations of solids content can be made (in 10 metres of water) together with a similar number of observations of water temperature and salinity and dissolved oxygen.

The acoustic method of suspended solids measurement has recently been applied in a quantitative manner to the measurement of discharges from the NWNT sewage outfall. There are significant calibration problems and difficulties association with laterally variable proportions of organic material and natural sediment. However, it is likely that the method can be used in a semi-quantitative manner and it can certainly be used to monitor and it can certainly be used to monitor non-quantitatively, the dispersion of an outfall plume.

The peak discharge rate (yr. 2006) of 38.8 m³ is expected to have an initial solids concentration of about 105 mg/l without treatment and 36mg/l with treatment. The natural solids concentration in the Western Harbour varies seasonally and tidally within the range of 5-25 mg/l the solids concentration and thus the discharge will be readily detectable. It is expected that the plume development could be monitored confidently up to the point where the solids concentration has reduced to about 5% over local background levels.

Other water quality parameters including total nitrogen (and the aerates thereof), BOD, chlorophyll-z and *E.coli* should be routinely measured, by collecting samples of marine water at surface and bottom layers of the water column at specified locations to be agreed with the Director of Environmental Protection.

Monitoring of sediment deposition round the diffusers could be undertaken using inter alia side scan sonar techniques at regular intervals.

9.4

Vibration

Monitoring requirements were detailed by CAD in their letter of 17th February (Ref (42) in AS/WKS/650) to ensure the operational capability of the Non Directional Beacon at Stonecutters Island is unaffected by the construction works associated with Construction of the Stage 1 Outfall. CAD have advised their monitoring requirements are as follows:

"During the work period, the vibration stress as measured on the floor of the 'SC' non directional beacon equipment room shall not exceed a peak particle velocity of 1mm/sec. In this connection, the building contractor shall provide a vibrograph capable of operation to satisfy the following criteria to enable CAD to monitor the vibration stress during the work period:-

- (a) The sensitivity of the vibrograph shall be adjustable within the PPV range of interest from 0.2 mm/sec to 1.2 mm/sec.
- (b) When the vibrograph detects a vibration stress exceeding a preset level, it should automatically generate an alarm signal and provide a print out of the event at the HKTI Watchkeeper Position at 5/F of the Airport Passenger Terminal Building for remote logging/monitoring purposes. The remote monitoring/control signals shall be transmitted through private telephone wires to be supplied by the contractor. The remote monitoring equipment at the Airport shall be equipped with a microcomputer and a printer to provide a printout of each event exceeding the preset alarm level."

9.5

Environmental Complaints

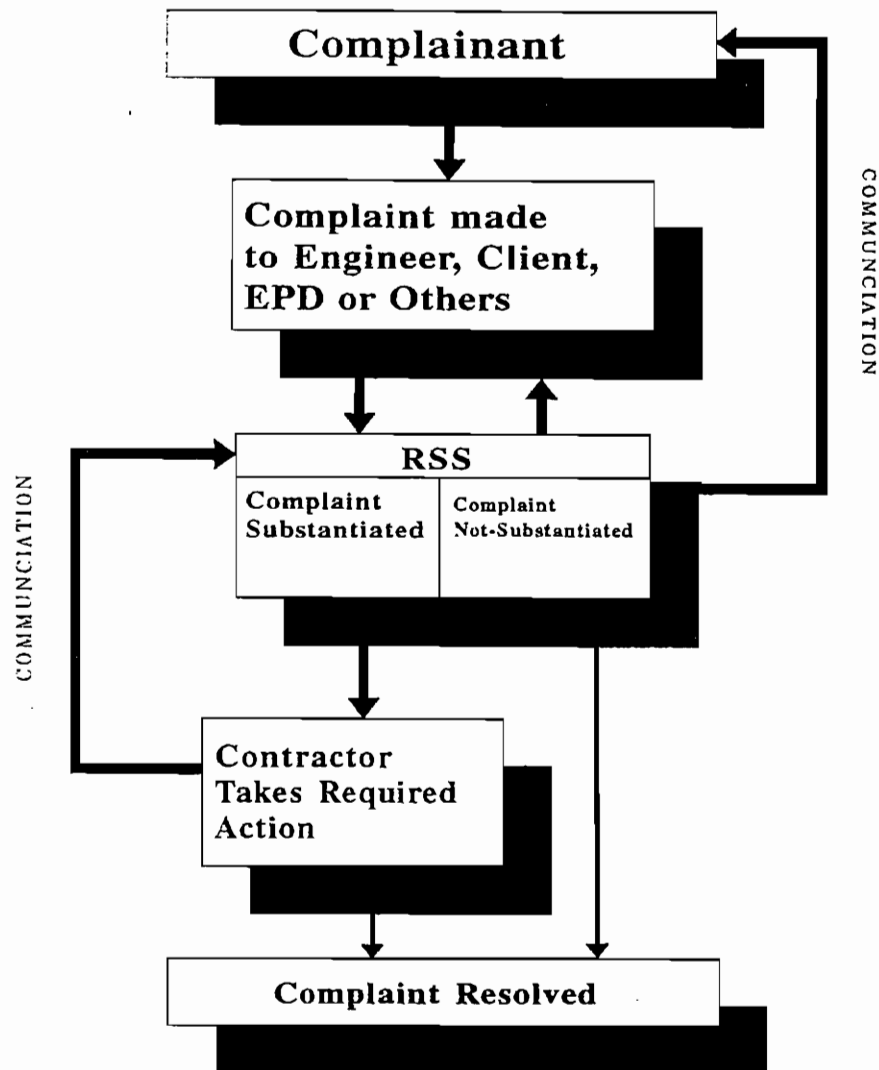
Sensitive receivers in the vicinity of the work sites associated with the Stage I Scheme may occasionally perceive impacts associate with construction activities. This may result in a complaint informing the Client or the RSS of the situation. The following guidelines detail a means by which the RSS could deal with any complaints as efficiently as possible.

- (a) all environmental complaints should be received by the CE/PD or SRE, and immediately passed to the RSS. Complaints to the SRE will be dealt with by bilingual staff;
- (b) the complaint should be immediately logged by the RSS, and an interim reply made to the complainant. Details should also sent to DSD, EPD and other relevant parties;
- (c) the RSS should immediately commence procedures for substantiating the validity of the complaint. An initial investigation should be made of the referred environmental parameter at the source of the complaint. If appropriate, monitoring should also be undertaken or increased to measure the impact from construction activities, with reference to the appropriate trigger, action and target levels;
- (d) any action should be taken in accordance with the relevant action plan;
- (e) if action is required by the Contractor he should inform the RSS of all steps taken, including any action and remedial work. Written reports and proposals should be also passed to the RSS by the Contractor;
- (f) monitoring by the RSS should continue, to ensure that the Contractor's remediation measures are effective, and until the situation is resolved; and
- (g) liaison should continue between the SRE and all relevant parties until the situation is resolved.

All complaints should be classified in each monthly Environmental Monitoring and Audit Reports detailing the complainant, validity of each complaint, action required, how it has been resolved, and correspondence between all parties.

DSD, EPD and other relevant parties should fully informed of each step.

Figure 9.1 identifies the sequence of actions, responsibilities, personnel and communication pathways involved in resolving any complaint.



DATE	DRAWN	CHECKED	APPROVED	ISSUE	REVISION DESCRIPTION

GOVERNMENT OF HONG KONG

Strategic Sewage Disposal Scheme
Stage I - Principal Collection & Treatment System

Flow Chart for Environmental Complaints

		Figure 9.1	ISSUE
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CONCLUSIONS

On the basis of the foregoing assessments the following conclusions have been drawn:

- (1) Without the implementation of this Environmental Improvement Scheme marine and bathing beach water quality will continue to decline.
- (2) The overall objective of providing a short term improvement in water quality in Victoria Harbour, with minimal impact on the existing environment during construction, can be achieved if the mitigation measures described herein are adopted.
- (3) Particular Specification Clauses and Special Particular Specification Clauses were specifically developed for inclusion in each of the fifteen Contract Documents. These specifications will ensure that environmental standards and legislation are complied with during and following construction.
- (4) All specifications are feasible and practical and will offer a high degree of environmental protection during the construction and implementation of the Stage I Scheme.
- (5) Stringent monitoring of all construction activities will be required to ensure that all environmental standards and guidelines recommended herein are adhered to.
- (6) Post project monitoring and audit of the Stage I Scheme will be required to ensure the design concepts and criteria are achieved. This is particularly pertinent in connection with the Stage I Outfall and the odour control facilities especially at Stonecutters Island Sewage Treatment Works.

Water Quality

- (7) The most severe impacts on water quality during construction will arise as a consequence of the marine works. These may be mitigated to a level which is acceptable in terms of receiving water quality except in the immediate vicinity of the dredgers.
- (8) Other water quality issues pertain to the collection and disposal of drill water arising from construction which will also be minimised through good working practices in accordance with the conditions included in the Contract Documents.
- (9) Interpretation of the results of the modelling studies indicates that significant benefits can be accrued from the implementation of the Stage I Scheme especially in the Rambler Channel and under certain conditions in Victoria Harbour.
- (10) The levels of lime or ferric chloride currently being considered are not able to elevate dissolved oxygen concentrations to the extent that the WQO's could be achieved.
- (11) The most significant reductions in BOD are forecast in eastern Victoria Harbour, and in the Rambler Channel as a direct result of collecting and treating numerous point sources of pollution.
- (12) The treatment provided at SISTW has little effect on the removal of ammonia. By implication the addition of ferric chloride or the lowest level of lime would permit at least 50% compliance with the WQO's on an annual basis although during the wet season on the neap tide the WQO's for ammonia will be exceeded especially in Victoria Harbour.
- (13) The model results suggest that the WQO's for oxidised nitrogen could be achieved even in Victoria Harbour even without the addition of chemicals to enhance the sedimentation process.
- (14) Elevations in chlorophyll-a may be expected possibly due to increased clarity in the water column as a result of reducing the unscreened pollution loads discharging into the waters especially in Victoria Harbour.

Section 10

- (15) Full compliance with the WQO's for suspended solids is forecast throughout the entire area regardless of the level of treatment applied.
- (16) Despite the significant reductions in bacterial counts in Victoria Harbour full compliance with the WQO's would not be achieved even with a 99% removal of the bacterial pollution load.

Air Quality

- (17) Impacts relating to fugitive dust releases during construction may be controlled through good working practices, even at Stonecutters Island where many activities will be carried out concurrently.
- (18) Mitigation measures will be required to reduce the hydrogen sulphide emissions at the Stonecutters Island Sewage Treatment and all preliminary treatment works once the Stage I Scheme is operational. Odour control requirements were included in all pertinent Contracts to ensure that the E&M designs of all equipment comply with the guidelines provided by EPD. The cost of installing these mitigation measures is HK\$27M (Contract Prices) which is only a fraction of the HK\$5.4 billion estimated cost for completion for the construction of the Stage I Scheme.
- (19) If a lime based treatment scenario is adopted, ammonia may create a localised odour nuisance in the sludge press room where the air will be directed through activated carbon before being emitted to the atmosphere. All other odour reduction requirements specified in the individual Contract documents will ensure compliance with the criterion set.
- (20) If the treatment scenario is based on ferric chloride a reduction of 60% of the hydrogen sulphide emissions downstream of the Rapid Mix Chamber will be required to achieve the odour criteria (in cumulative terms). This reduction can be achieved through the application of ferric chloride at the concentration currently proposed in the Revised Design Memorandum.
- (21) If the treatment scenario is to be based on ferric sulphate, trials (including laboratory tests) will be required to determine the dosage of ferric sulphate which would remove at least 60% of hydrogen sulphide downstream of the Rapid Mix Chambers.

Noise

- (22) Noise generated during construction of the Stage I Scheme will impose severe restrictions in working practices at specific locations. All of the imposed time constraints can be incorporated within the construction programme to achieve the overall aim of reducing the impact of these works on their environment. The estimated total cost of these temporary mitigation measures is HK\$1.5M (1995 prices).
- (23) Once operational, mitigation measures will be required at all sites except Tseung Kwan O Preliminary Treatment Works and Pumping Station. Acoustic design specifications were included in all pertinent Contracts to ensure that equipment and building design would comply with the HKPSG regardless of the chemical treatment scenario adopted at Stonecutters Island Sewage Treatment Works. The estimated overall cost of installing these permanent mitigation measures is HK\$13M (1995 prices).

Waste Disposal

- (24) During construction the main sources of solid waste will be spoil from driving the tunnels (88,000m³ of rock at Tseung Kwan O, 48,000m³ of rock at Chai Wan and 78,000m³ of rock from driving the outfall tunnel) and marine muds (2.6Mm³ in total of which less than 10% is contaminated) from dredging the trench for the outfall. It was recommended that construction materials should be re-used, wherever possible, to minimise the waste disposal requirements.
- (25) Use of marine transport to dispose of waste material would significantly reduce the number of vehicles of the road network and was recommended at all relevant sites.

- (26) Once operational the main sources of waste are screenings from the Preliminary Treatment Works and sludge from the Stonecutters Island Sewage Treatment Works. For the lime based scenario an average of 520 tonne per day of wet sludge will be disposed of to landfill. If the sedimentation strategy is based on ferric chloride, for the same time horizon (2021) an estimated 542 tonne of dry solids will be generated per day which equates to approximately 1700 tonnes of sludge requiring off-site disposal per day. The substantial increase in the quantity of sludge requiring disposal is due to the reduction in dry solids content achieved with ferric chloride.

Visual

- (27) Visual impacts will not be an issue of particular concern at any of the works sites during construction. A detailed master plan has been developed for the Stonecutters Island which will significantly enhance the landscape value of this site once the works have been commissioned.

Vibration

- (28) Vibration will not be an issue during either construction of the collection system or the operation of the new facilities.

Risk of Failure

- (29) The risk of failure of the whole system is so remote as it would require all of the pumping stations and the SISTW to malfunction together. Periods when maintenance works need to be carried out should be scheduled for during night time hours, when the flows are lowest.
- (30) Incorporation of the safety measures will ensure that the potential downtime at any facility will be minimal.