HONG KONG GOVERNMENT
DRAINAGE SERVICES DEPARTMENT

Agreement No. CE 28/93
CENTRAL, WESTERN & WAN CHAI WEST SEWERAGE

REVISED FINAL
EM&A MANUAL

May 1997

MAUNSELL CONSULTANTS ASIA LTD
in association with
ATKINS HASWELL

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FOR :

MAUNSELL CONSULTANTS ASIA LIMITED
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1 INTRODUCTION

1 INTRODUCTION

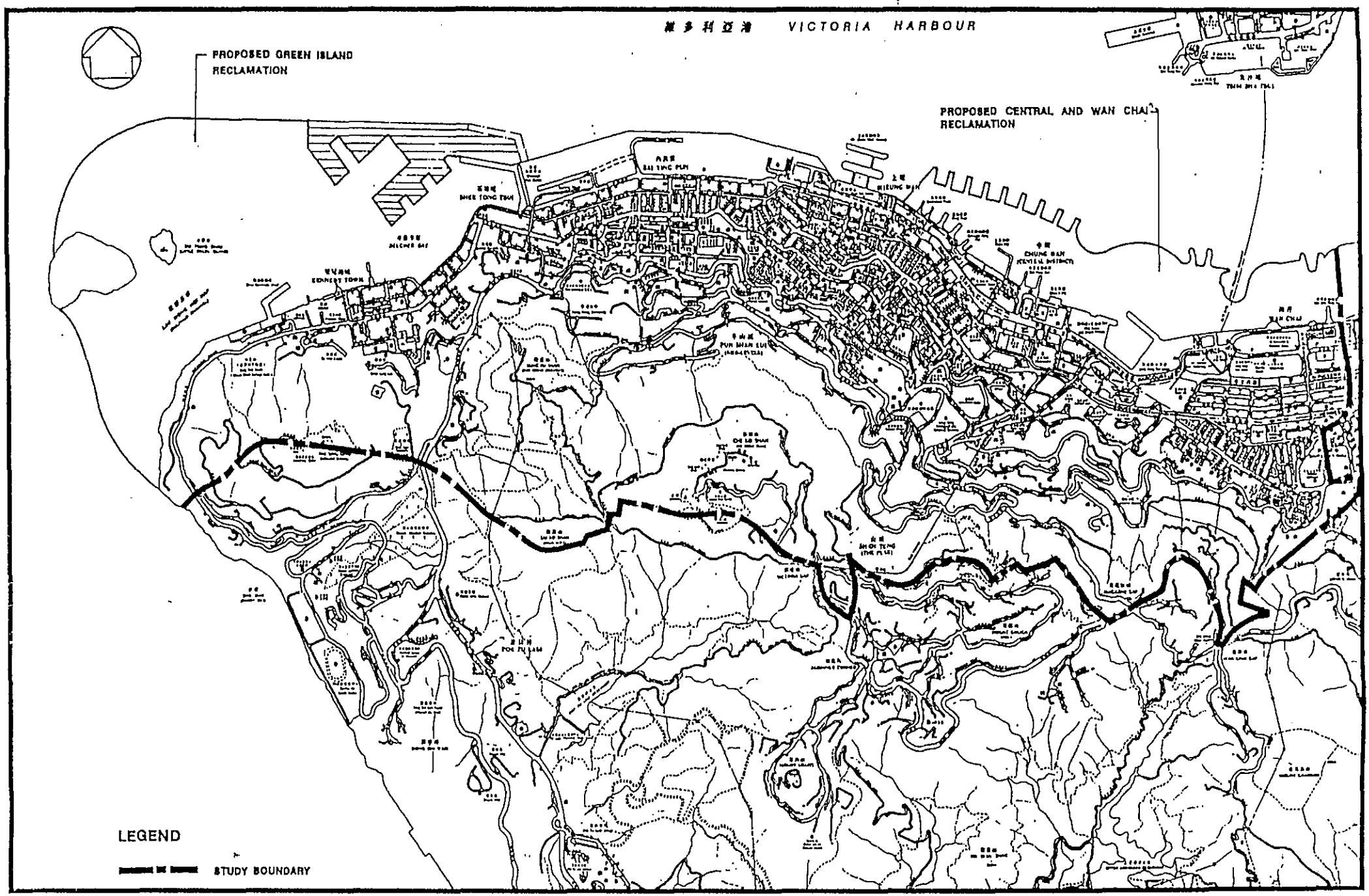
1.1 Purpose and Structure of This Document

This Manual outlines the monitoring and audit programme to be undertaken for the construction and operation of the Central, Western, and Wan Chai West Sewerage project. It provides systematic procedures for environmental monitoring and checking of the construction and operation impacts of the project.

1.2 Project Site and Landuses

The study area [Figure 1.1] includes the western part of Wan Chai District, together with the urban area to the west including Central District, Sheung Wan, Sai Ying Pun, and Kennedy Town. It also includes Victoria Peak, Mid-Levels, Mount Kellett, Mt Gough and Mount Davis. The major works in the project consist of:

- Construction of two trunk sewers: Central and Wan Chai East trunk sewers which will involve the construction of:
  - 3.5 km of trunk sewer with hydraulic diameters between 1050 mm to 1800 mm to collect and transfer flow from Western and Central districts to Central Screening Plant, and
  - 2.3 km of trunk sewer with hydraulic diameters between 1200 mm to 1800 mm to collect and transfer flow to Wan Chai East Screening Plant
- Construction of approximately 31.2 km of interceptor and reticulation sewers and installation of about 1540 numbers of manholes in the study area to connect to the above trunk sewers. Depending on locations, the diameters of the pipelines will be between 225 mm and 1650 mm;
- Construction of a new pumping station at the existing Central Screening Plant;
- Construction of a new pumping station and screening plant facilities at Wan Chai East Screening Plant.



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STUDY AREA
FIGURE 1.1

2 ENVIRONMENTAL ASSESSMENT STUDIES

2 ENVIRONMENTAL ASSESSMENT STUDIES

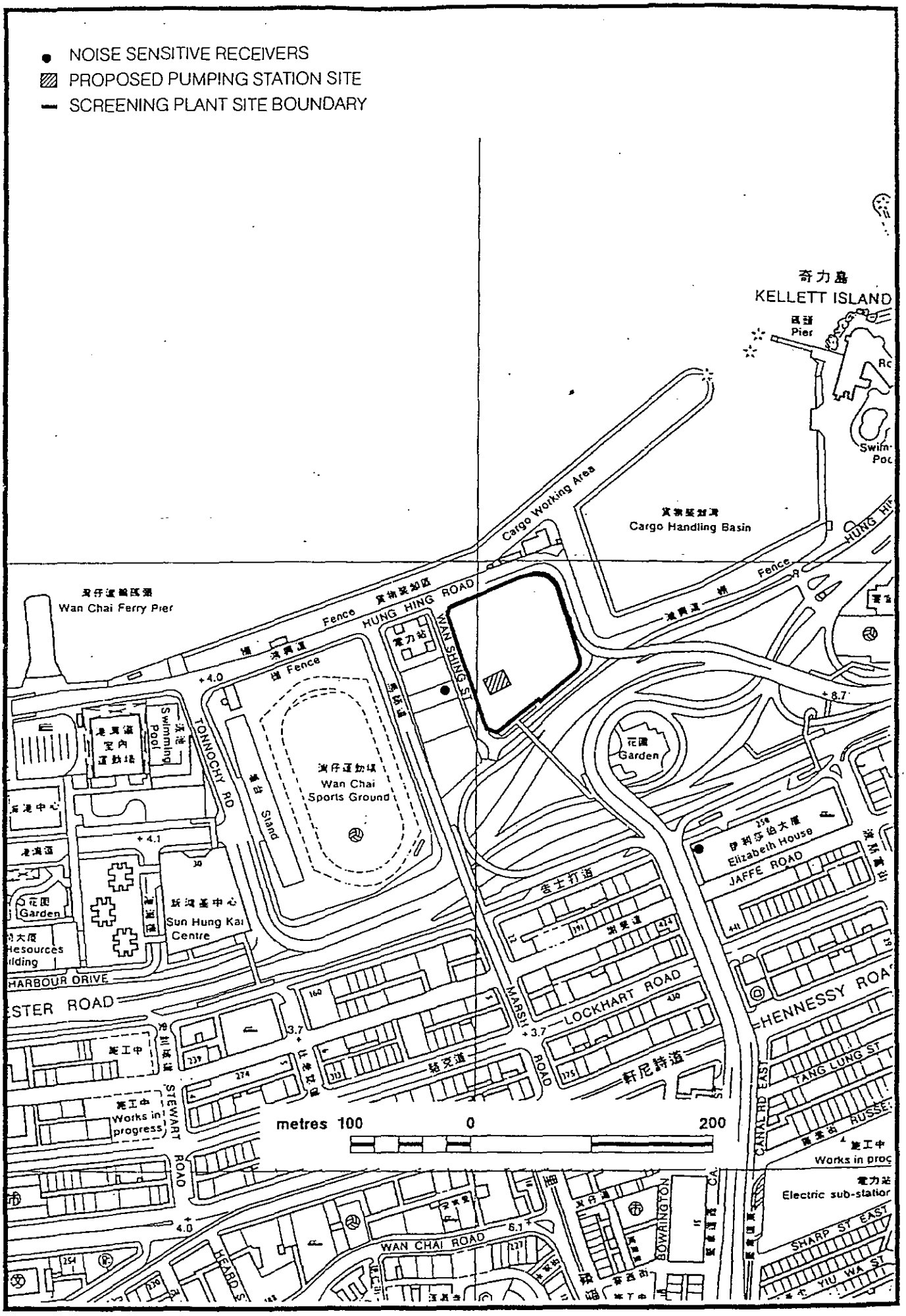
2.1 Sensitive Receivers

At the Wan Chai East Screening Plant, the Royal Society for the Prevention of Cruelty to Animals, Hong Kong should be used as the monitoring station to measure dust and piling noise impacts and the residential blocks of Elizabeth House for the general construction noise impact impacts from the plant upgrading activities [Figure 2.1].

At the Central Screening plant, the Sheung Wan Fire Station should be used as the monitoring station for measurement of dust and noise impacts resulting from the construction activities [Figure 2.2].

For construction of the trunk sewer, potential sensitive receivers (SRs) are listed in Table 2.1. Their locations are presented in Figures 2.3 and 2.4.

Specific SRs have not been identified at this stage for the reticulation/interception sewers. This is partly due to the minor nature of much of the sewer works, the need for confirmation of the sewer alignments during detailed design and the construction programme during the construction stage. It is recommended that an EM&A Manual be produced at the commencement of the construction stage for this work.



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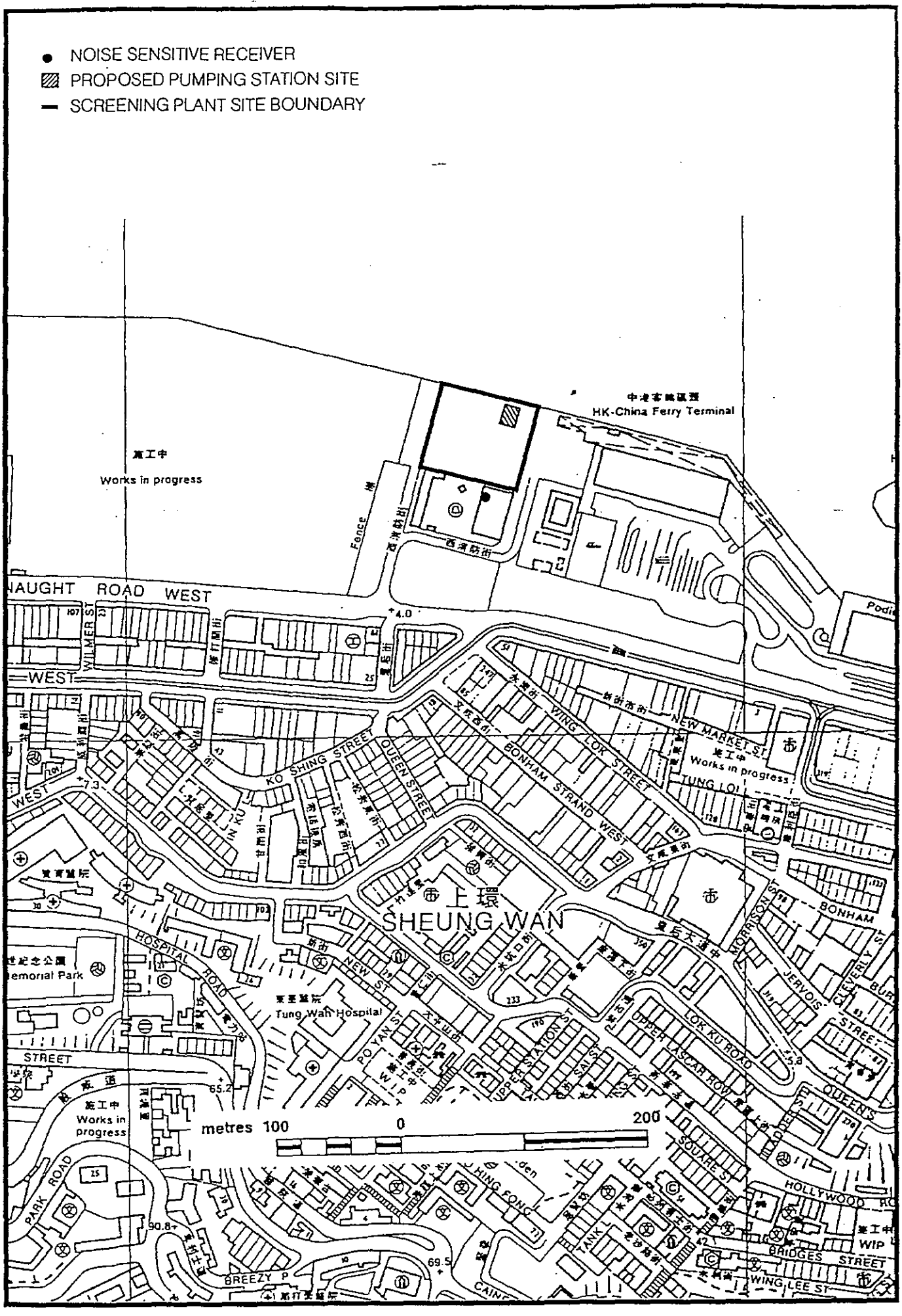
LOCATION OF WAN CHAI PUMPING STATION
FIGURE 2.1



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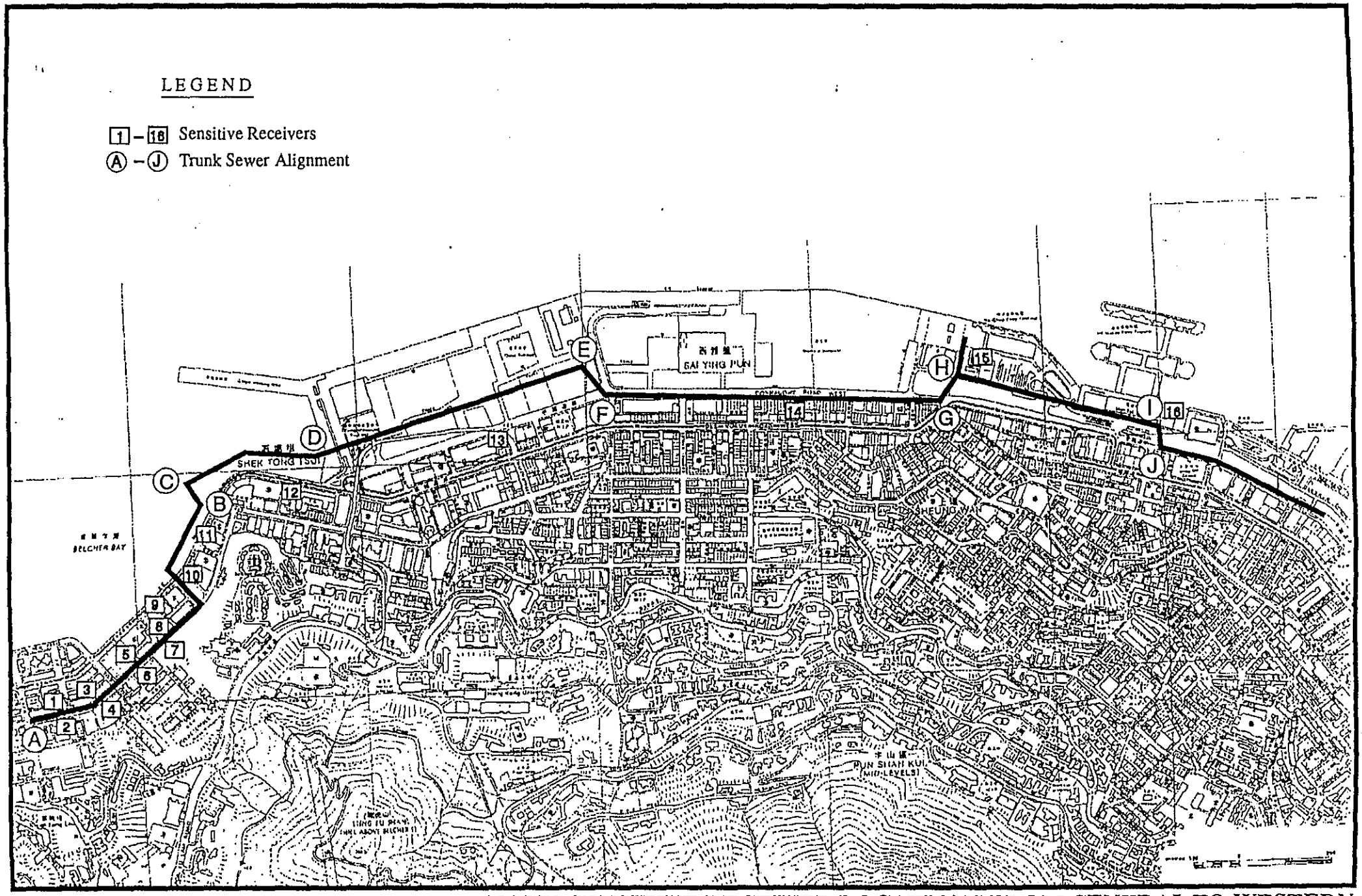
LOCATION OF CENTRAL PUMPING STATION
FIGURE 2.2



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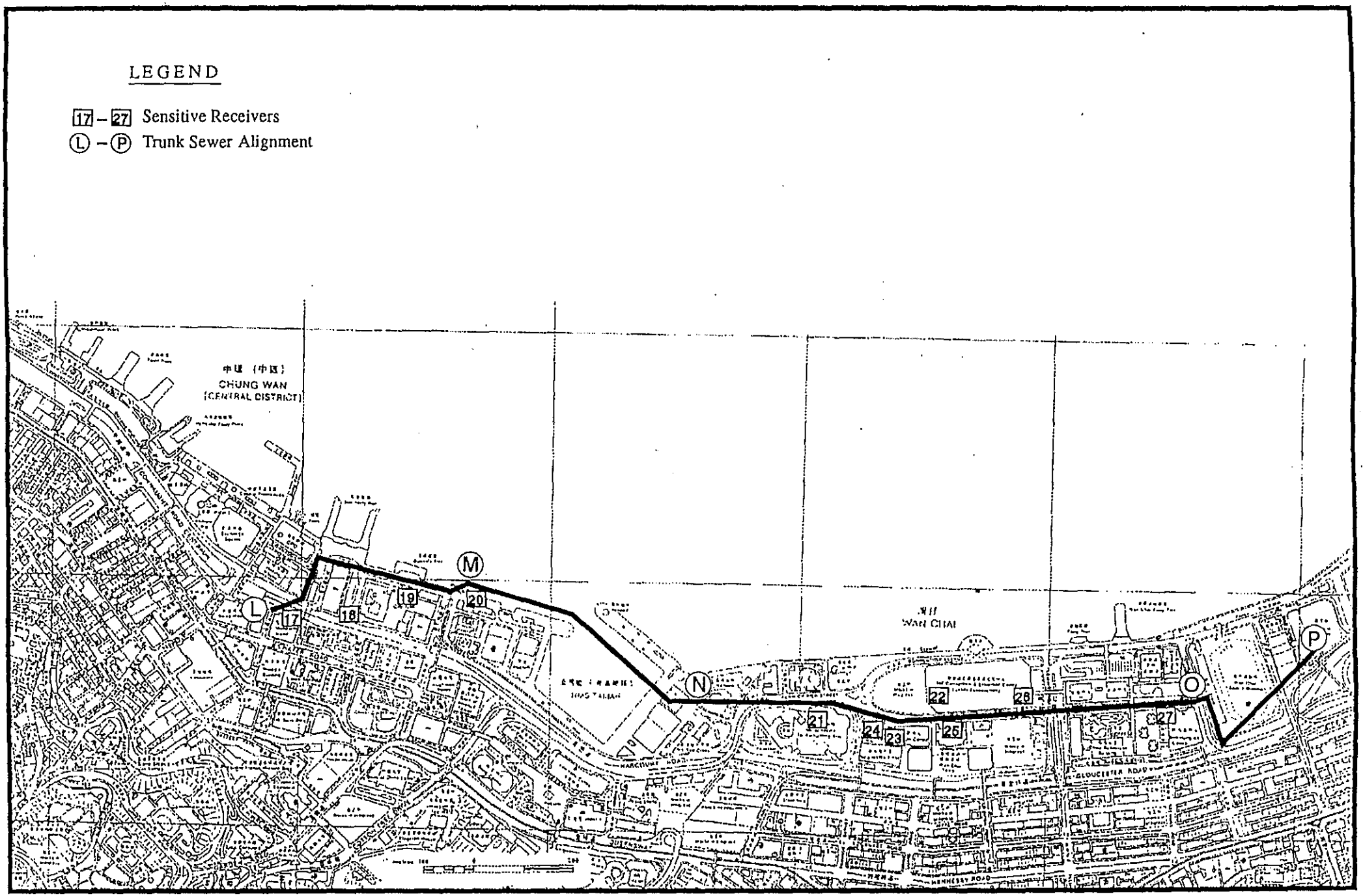
NOISE SENSITIVE RECEIVER LOCATIONS FROM CENTRAL TO WESTERN

FIGURE 2.3



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NOISE SENSITIVE RECEIVER LOCATIONS FROM CENTRAL TO WAN CHAI

FIGURE 2.4

Table 2.1 Noise Sensitive Receivers

Alignment Section	Identification	Noise Sensitive Receiver
A B	1	Nos. 71-111 (west side Belcher's Street)
	2	Nos. 46-86 (east side Belcher's Street)
	3	Nos 37-61 (west side Belcher's Street)
	4	Nos. 26-42 (east side Belcher's Street)
	5	Nos. 15-35 (west side Belcher's Street)
	6	Nos. 16-26 (east side Belcher's Street)
	7	Welfare Centre (opp. Holland Street)
	8	7-11 Belcher's Street
	9	Sai Chung Street (west)
	10	Sai Chung Street (east), Belcher Court
	11	Buildings west of Kennedy Town Praya (eg Chester Court)
C E	12	Buildings south of Kennedy Town Praya (eg Nos. 430-458)
	13	Buildings south of Connaught Road West (eg Nos 168-187)
F H	14	Buildings south of Connaught Road West (eg Nos. 1-158)
	15	Fire Station
H J	16	Shun Tak Centre (Victoria Hotel)
L M	17	Mandarin Hotel
	18	Municipal Library
	19	City Hall
M N	20	Blake Block, HMS Tamar
N O	21	HK Academy for Performing Arts
	22	Grand Hyatt Hotel
	23	YMCA, Harbour Road
	24	HK Arts Centre
	25	District Court, Harbour Road
	26	New World Harbour View Hotel
	27	Residential Block A, Harbour Road

2.2 Findings of Environmental Study

2.2.1 Scope of the EIA Study

Impacts have been assessed in terms of the negative effect on existing or planned SRs in the vicinity of construction and operation sites. They include:

- Construction Impacts
  - noise impacts on identified noise sensitive receivers (NSRs) caused by construction equipment
  - dust emission caused by construction activities
  - qualitative cumulative dust impact from relevant projects in the study area
  - impact of discharging construction wastewater
  - handling and disposal of excavated spoil including contaminated soil
- Operational Impacts
  - odour emissions from pumping stations and screening plants
  - noise from two pumping stations and screening plants
  - water quality due to discharges from the two screening plants

2.2.2 Findings and Conclusions of the EIA

Overall, it is concluded that environmental impacts can either be small or can be mitigated to an extent where the impacts on sensitive receivers would be acceptable, with the exception of construction noise generated at an 'open cut' alignment along Belcher's Street because of very close proximity to the NSRs. However, because it is envisaged that construction works will be undertaken in lengths of approximately 50 m and for a short duration, a limited number of NSRs would be affected at one time and for a short duration.

A summary of environmental impacts is provided in Table 2.2.

Table 2.2 Summary of Environmental Impacts

Parameter		Potential Impact	Significant Residual Impacts After Mitigation	Further Work
Construction Phase	Dust	Dust impact from general construction activity, this should be controllable within acceptable levels.	None	None
	Noise	Trunk Sewer Alignment Noise impacts on SRs can be mitigated to acceptable levels except at Belcher's Street section. Screening Plant Noise impacts on SRs can be mitigated to acceptable levels. Reticulation/Interception Sewers No quantitative assessment due to the lack of definite sewer alignment information.	Significant noise impact on SRs along Belcher's Street. No evening and night-time work should be carried out. None	To re-examine/confirm noise impact assessment and consider mitigation measures in details. None To re-examine/confirm noise impact assessment and consider mitigation measures in details
	Water	No significant impact as construction work will be land based.	None	None
	Solid Wastes	Proper spoil handling and disposal procedures should be adopted depending upon the outcome of soil analysis.	None	To determine spoil disposal options based upon results of soil sampling and analysis when information becomes available
Operational Phase	Noise	None	None	None
	Odour	Odour emission from the proposed new pumping stations can be mitigated to acceptable levels.	Odour can still be emitted from existing facilities (except for the pumping stations).	To verify the prediction and design odour control system for both existing and proposed facilities together.
	Water	Initial step to improve water quality in Victoria Harbour	Interim solution before the implementation of SSDS Stage III/IV	Commission SSDS Stage III/IV

2.3 Environmental Mitigation Measures

2.3.1 Air Quality

Dust

- Use of regular watering, with complete coverage to reduce dust emissions from unpaved areas;
- Regular cleaning of pavements and roads in surrounding areas will help minimise the transfer of dust by vehicle movements;
- Use of enclosures around the main activities to contain spreading of dust;
- Establishment and frequent use of vehicle wheel and body washing stations at site exits, where practical;
- Tarpaulins over soil transferred in lorries to and from the work area.

Odour

- For Existing Facilities: Full enclosure of all conveyor belts, inlets, drum screens and other exposed odour sources, eg. channels. Exhaust air should be ducted to odour removal equipment;
- For New Facilities: New buildings housing sewerage treatment plant should be effectively isolated from external ambient air and should be provided with a ventilation system capable of a minimum 5 air changes per hour. Exhaust air should be ducted to odour removal equipment.

All contained odorous emissions should be routed to a centralised odour treatment unit. The odour removal efficiencies should be at least 98% for the Central and 97% for the Wan Chai East screening plants. The exhaust stacks of both plants should be elevated at least 10 m above ground level and be located as far from the SRs as is possible. The exit velocity should be at least 8 m per second. Alternative arrangements may be developed but these must provide an equivalent or better level of odour reduction.

In addition, good housekeeping measures should be implemented, including *inter alia,* floor sweeping, regular hosing down and cleaning. A single type of container should be utilised for both screenings and grits. The container should have a sliding top cover to prevent the escape of odours and infiltration of rain water.

2.3.2 Noise

General noise control include the following :

- Use of acoustic barriers/shields to enclose, partially enclose noisy activities and to screen the receivers from direct line of site from construction activities. A purpose-built barrier normally can achieve reductions of 5 - 10 dB(A);

- Use of silenced equipment;
- Carefully planning the construction programme through:
  - Restriction of times at which concrete breaking and/or piling is carried out
  - Minimisation of surface construction and underground excavation work during evening and night-time periods;
- Observation of school hours: noisy operations such as concrete breaking, excavation plant operation, and/or piling should be avoided near the existing schools during teaching or exam hours;
- Placing of noisy equipment and the conducting of activities as far from SRs as is practical and turning off of idling equipment;
- Proper plant and equipment maintenance.

2.3.3 Water

- Silt traps and sedimentation tanks should be provided at construction sites and wastewater (site run-off) should be channelled to the basins. Regular maintenance of the sediment traps, eg. digging out, should be carried out to ensure their efficiency;
- Measures to intercept rainwater run-off onto the work sites should be provided so that it will not flow across the sites;
- Processing water should be re-used. Prior to its discharge, it should be channelled to the sedimentation tanks;
- Bentonite should be stored in silos prior to use. To prevent possible release during application, earth bunds should be constructed around the areas where diaphragm walling is being installed. Any release of bentonite should then be contained within the bunded area and remain available for recycling;
- Excavation of open-cut and cover trenches should be avoided during monsoon or rainy seasons if possible. Measures should be taken to minimise the flow of rainwater into trenches. Trenches should be dug and backfilled in short sections. Water pumped from the trenches should be channelled to sedimentation tanks prior to its discharge into storm drains;
- Sewage arising from construction sites should be collected and treated prior to discharge.

3 PROJECT ORGANISATION AND PROGRAMME

3 PROJECT ORGANISATION AND PROGRAMME

3.1 Internal Organisation of the Project Team

Environmental work, including monitoring, data analysis, proposed mitigation measures and the writing of reports, will be undertaken by an Environmental Team (ET) employed by the Contractor. A Environmental Checker, independent to the Contractor, should be employed directly by the Project Management Team and approved by Government. They shall:

- Conduct regular site inspection;
- Audit all monthly monitoring reports prepared by the ET;
- Liaise with EPD with respect to findings of the monthly reports and on all contentious issues;
- Liaise with the Engineer Representative (ER) in respect of the ET's performance;
- In the event of non-compliance of action and/or limit levels, the Environmental Checker should undertake action specified in the section 4.3, Action Plan.

Figure 3.1 illustrates the recommended organisational structure.

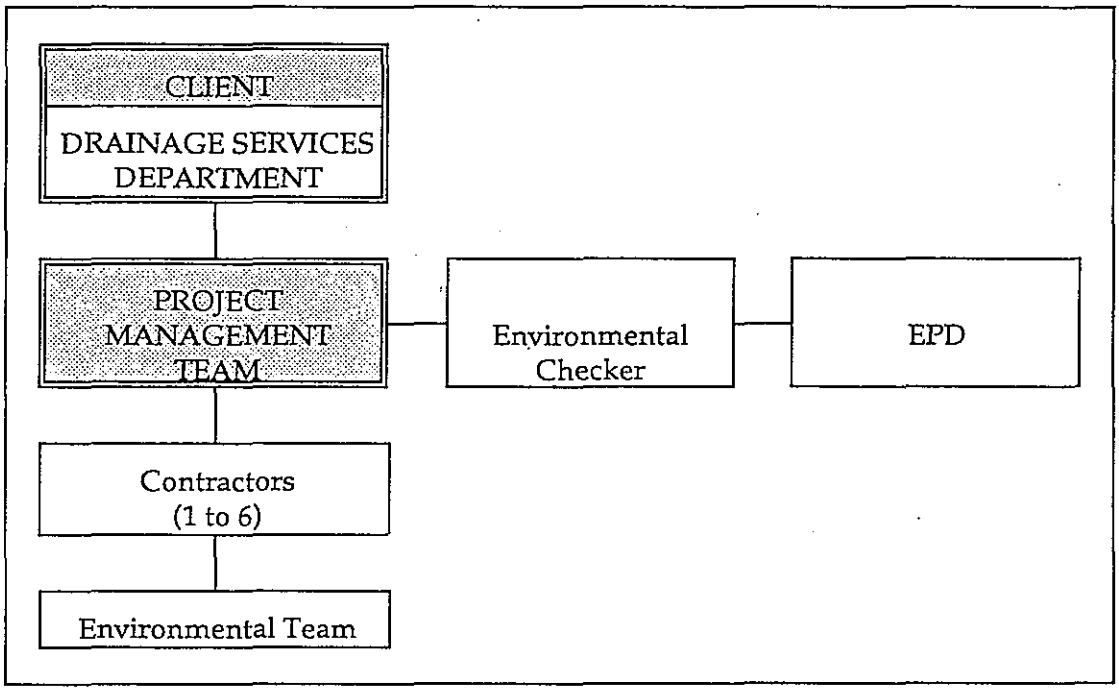


Figure 3.1 Organisation Structure

3.2 Lines of External Communication Regarding Environmental Issues

The existing EPD complaint hotline should be utilised and any complaints received should then be passed on to the ET who should investigate and discuss with the project manager.

3.3 Project Programme

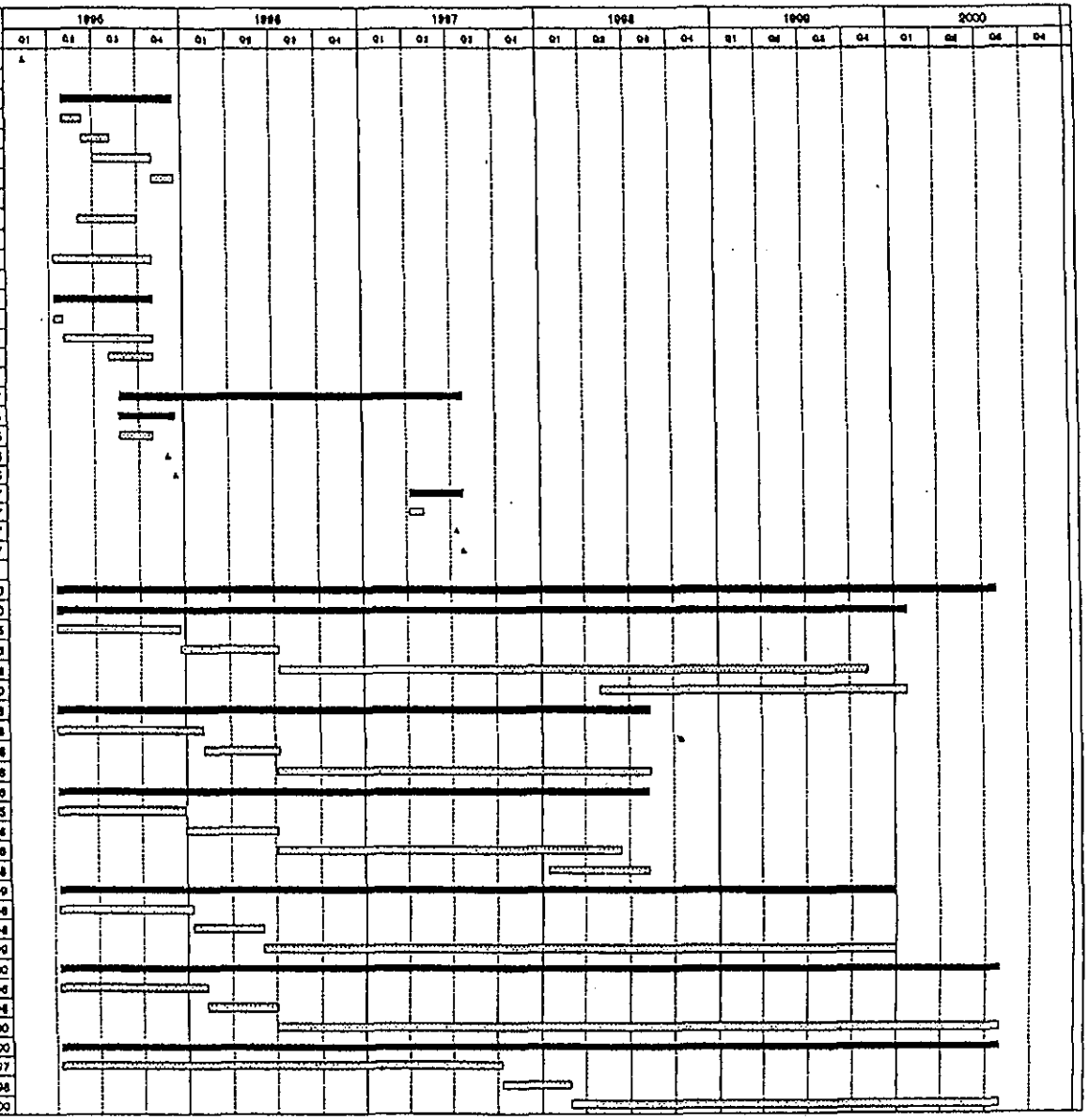
The project summary programme is given in Figure 3.2. It outlines the programme for site investigations, design and construction phases and other particular programme issues.

The programme indicates that altogether there will be six contractors involved in the overall construction of this project, namely one for trunk sewer, two for screening plants and pumping station, three for interception sewers. Although the construction work will take place between 1996 and 2000, commencement and duration of each contract will be different and project specific. This means that the monitoring work and the programme should consider the various construction activities at one time. The most intensive construction will occur in the first three years when the construction of the trunk sewers, pumping stations, screening plants and interception sewers will take place all over the study areas. For the final year, the construction work shall be limited to the interception sewer areas.

Central, Western and Wan Chai West Sewerage

Design and Construction Stages - Summary Programme

Task Name	Start Date	End Date
COMMENCE DETAILED DESIGN	10 Feb 1996	10 Feb 1996
SITE INVESTIGATIONS	29 Apr 1996	15 Dec 1995
Phase I Investigation	29 Apr 1996	7 Jun 1996
Phase I Report	8 Jun 1996	8 Aug 1996
Phase II Investigation	1 Jul 1996	31 Oct 1996
Phase II Report	1 Nov 1996	15 Dec 1996
UTILITY INVESTIGATION&REPORT	1 Jun 1996	30 Sep 1996
CONFIRM LAND REQ.& ACQUISIT.	10 Apr 1996	31 Oct 1996
MODELLING	10 Apr 1996	31 Oct 1996
Updating STC28 Records	10 Apr 1996	28 Apr 1996
Update Modelling	1 May 1996	31 Oct 1996
Confirm sewer sizes/alignment	1 Aug 1996	31 Oct 1996
FUNDING	31 Aug 1996	27 Jul 1997
CONTRACTS CN1,CN2,CN3,CN4&CN5	31 Aug 1996	14 Dec 1996
Prepare Cost Estimate	31 Aug 1996	28 Oct 1996
PWSC Approval for Upg.to Cat A	29 Nov 1996	29 Nov 1996
FC approval	15 Dec 1996	15 Dec 1996
CONTRACTS CN4 & CN5	7 Apr 1997	27 Jul 1997
Prepare Cost Estimate	7 Apr 1997	6 May 1997
PWSC Approval for Upg.to Cat A	14 Jul 1997	14 Jul 1997
FC Approval	28 Jul 1997	28 Jul 1997
DESIGN/CONTRACT/CONSTN STAGE	10 Apr 1996	31 Jul 2000
CONTRACT CN1-TRUNK SEWERS	10 Apr 1996	28 Jan 2000
Detailed Design/Contract docu.	10 Apr 1996	21 Dec 1996
Gazetting & Tendering	22 Dec 1996	9 Jul 1996
Construction	10 Jul 1996	7 Nov 1998
Commissioning	1 May 1998	28 Jan 2000
CN2-P.STN & SCNG PLANT(CIVIL)	10 Apr 1996	13 Aug 1998
Detailed Design/Contract Docum	10 Apr 1996	4 Feb 1996
Gazetting & Tendering	5 Feb 1996	5 Jul 1996
Construction	5 Jul 1996	13 Aug 1998
CN3-P.STN & SCNG PLANT(E&M)	10 Apr 1996	10 Aug 1998
Detailed Design/Contract Docum	10 Apr 1996	28 Dec 1996
Gazetting & Tendering	29 Dec 1996	5 Jul 1996
Construction	5 Jul 1996	13 Jun 1998
Commissioning	15 Jun 1998	10 Aug 1998
CN4-CENTRAL INT/RETIC -UPPER	10 Apr 1996	31 Dec 1999
Detailed Design/Contract Docum	10 Apr 1996	11 Jan 1996
Gazetting & Tendering	12 Jan 1996	3 Jun 1996
Construction	3 Jun 1996	31 Dec 1999
CN5-WAN CHAI INT/RETIC -UPPER	10 Apr 1996	31 Jul 2000
Detailed Design/Contract Docum	10 Apr 1996	5 Feb 1996
Gazetting & Tendering	5 Feb 1996	1 Jul 1996
Construction	1 Jul 1996	31 Jul 2000
CN6-INT/RETIC SEWER-LOWER	10 Apr 1996	31 Jul 2000
Detailed Design/Contract Docu.	10 Apr 1996	10 Oct 1997
Gazetting & Tendering	11 Oct 1997	28 Feb 1998
Construction	28 Feb 1998	31 Jul 2000



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SUMMARY PROGRAMME

FIGURE 3.2

4 ENVIRONMENTAL STANDARDS

4 ENVIRONMENTAL STANDARDS AND ACTION PLANS

4.1 General Environmental Performance Requirements

4.1.1 Air and Noise

The following general environmental performance requirements/standards (as summarised in Table 4.1) that should be imposed for the construction and operation of the project:

- To comply with TSP levels of 500 μgm^{-3} (1-hour) and/or 260 μgm^{-3} (24-hour) established for the Air Quality Objectives (AQOs);
- To comply with 2 odour units at the boundaries of two screening plants;
- To comply with and observe the Noise Control Ordinance (NCO) and its subsidiary regulations in force in Hong Kong:
  - Construction noise of daytime (0700-1900 hours) during weekday (Monday to Saturday) outside the restricted hours should be restricted to 75 dB(A) at the nearest noise sensitive SRs, except at the school which should be limited to 70 dB(A) during normal teaching hours and/or 65 dB(A) during examinations. Evening (1900-2300 hours) and nighttime (2300-0700 hours) noise limits from Monday to Saturday, and all day during public holidays (including Sunday) should comply with appropriate acceptable noise limits (ANLs) for relevant area of sensitivity ratings (ASRs), as described in Technical Memorandum (TM) Noise from Construction Work other than Percussive Piling.
  - Percussive piling activity and noise levels should comply with the requirements specified in the TM on Noise from Percussive Piling under the NCO.
  - Operational noise at the nearest SRs of the two screening plants should not exceed appropriate ANLs of relevant ASR specified in the TM for the Assessment of Noise from Places other than Construction Sites, domestic Premises or Public Place under the NCO.

Table 4.1 Summary of Environmental Performance Requirements

Parameter		Location	Limit	Note
Air	Construction TSP	Srs	500 μgm^{-3} (1hr) 260 μgm^{-3} (24hr)	--
	Operation Odour	Site boundaries of two Screening Plants	2 odour units	
Noise	Construction $L_{Aeq(30\ mins)}$ (0700-1900), excluding Public holidays & Sundays	SRs in close proximity to the pipeline alignments	75 dB(A) 70 dB(A) 65 dB(A)	Excluding schools During school teaching hours During school exams
	$L_{Aeq(5\ mins)}$ (1900-0700), and whole days for public holidays including Sundays		ANLs	TM for assessment of construction noise
	Operation $L_{Aeq\ (30\ min)}$	SRs in close proximity to the Screening Plants	ANLs	TM for assessment of operational noise

4.1.2 Soil

Hong Kong currently has no criteria of its own for assessing land contamination. However, a standard approach [Table 4.2] has been developed in the Netherlands (Dutch criteria) and this system is recognised by EPD. However, the standard to be selected for contaminated soil assessment should be approved by EPD.

Table 4.2 Selected Dutch Values for Judging Significance of Soil Contamination

Parameter	Reference Values (mg kg^{-1})		
	A	B	C
Cadmium	1	5	20
Chromium	100	250	800
Copper	50	100	500
Lead	50	150	600
Mercury	0.5	2	10
Zinc	200	500	3000
Nickel	50	100	500

Note: The A value is the normal background level, the B value is that 'delimiting value for soil having potential for harmful effects on human health or the environment and requiring further investigation'; and the C value delimits 'heavy pollution and requirement for remedial action'.

4.2 Action and Limit Level

The basic method of recording any changes in environmental conditions during the construction for this project is through monitoring of air and noise. It has become a common practice to apply a range of environmental limits termed Action and Limit Levels to provide a framework for the interpretation of monitoring results. Tables 4.3 and 4.4 are the action and limit levels for air quality and noise respectively.

Table 4.3 Action and Limit Levels for Air Quality

Parameters	Action	Limit
24 Hour TSP Level in µg/m•	For baseline level < 108 µg/m, Action level = average of baseline level plus 30% and Limit level For baseline level > 108 µg/m and baseline level < 154 µg/m, Action level =200µg/m For baseline level > 154 µg/m, Action level = 130% of baseline level	260 µg/m^3
1 Hour TSP Level in µg/m•	For baseline level < 154 µg/m, Action level = average of baseline level plus 30% and Limit level For baseline level > 154 µg/m and baseline level < 269 µg/m , Action level =350µg/m For baseline level > 269 µg/m, Action level = 130% of baseline level	500 µg/m^3

Table 4.4 Action and Limit Levels for Noise

Time Period	Action	Limit
0700-1900 hrs on normal weekdays	When one documented complaint is received	75* dB(A)
0700-2300 hrs on holidays and 1900 2300 hrs on all other days		60/65/70** dB(A)
2300-0700 hrs of next day		45/50/55** dB(A)

* reduced to 70 dB(A) for schools and 65 dB(A) during school examination periods.
** to be selected based on Area Sensitivity Rating

4.3 Action Plan

When exceedances of action and limit levels occur, action has to be undertaken to control environmental impacts to acceptable levels. Tables 4.5 and 4.6 summarise the event and action plans for air quality and noise respectively.

Table 4.5 Event/Action Plan for Air Quality

EVENT	ACTION		
	ET	ER	CONTRACTOR
ACTION LEVEL			
Exceedance for one sample	1. Identify source 2. Inform ER 3. Repeat measurement to confirm finding 4. Increase monitoring frequency to daily	1. Notify Contractor 2. Check monitoring data and Contractor's working methods	1. Rectify any unacceptable practice 2. Amend working methods if appropriate
Exceedance for two or more consecutive samples	1. Identify source 2. Inform ER 3. Repeat measurements to confirm findings 4. Increase monitoring frequency to daily 5.Discuss with ER for remedial actions required 6.If exceedance continues, arrange meeting with ER 7.If exceedance stops, cease additional monitoring	1. Confirm receipt of notification of failure in writing 2. Notify Contractor 3. Check monitoring data and Contractor's working methods 4. Discuss with Environmental Supervisor and Contractor on potential remedial actions 5.Ensure remedial actions properly implemented	1. Submit proposals for remedial actions to ER within 3 working days of notification 2. Implement the agreed proposals 3. Amend proposal if appropriate
LIMIT LEVEL			
Exceedance for one sample	1. Identify source 2. Inform ER and EPD 3. Repeat measurement to confirm finding 4. Increase monitoring frequency to daily 5. Assess effectiveness of Contractor's remedial actions and keep EPD and ER informed of the results	1. Confirm receipt of notification of failure in writing 2. Notify Contractor 3. Check monitoring data and Contractor's working methods 4. Discuss with ET Leader and Contractor potential remedial actions 5. Ensure remedial actions properly implemented	1. Take immediate action to avoid further exceedance 2. Submit proposals for remedial actions to ER within 3 working days of notification 3. Implement the agreed proposals 4. Amend proposal if appropriate
Exceedance for two or more consecutive samples	1. Identify source 2. Inform ER and EPD the causes & actions taken for the exceedances 3. Repeat measurement to confirm findings 4. Increase monitoring frequency to daily 5. Investigate the causes of exceedance 6. Arrange meeting with EPD and ER to discuss the remedial actions to be taken 7. Assess effectiveness of Contractor's remedial actions and keep EPD and ER informed of the results 8. If exceedance stops, cease additional monitoring	1. Confirm receipt of notification of failure in writing 2. Notify Contractor 3. Carry out analysis of Contractor's working procedures to determine possible mitigation to be implemented 4. Discuss amongst ET Leader and the Contractor potential remedial actions 5. Review Contractor's remedial actions whenever necessary to assure their effectiveness 6. If exceedance continues, consider what portion of the work is responsible and instruct the Contractor to stop that portion of work until the exceedance is abated	1. Take immediate action to avoid further exceedance 2. Submit proposals for remedial actions to ER within 3 working days of notification 3. Implement the agreed proposals 4. Resubmit proposals if problem still not under control 5. Stop the relevant portion of works as determined by the ER until the exceedance is abated

Table 4.6 Action Plan for Construction Noise

Event	Action	
	ET Leader or ER	Contractor
Action Level	1. Notify Contractor 2. Analyse investigation 3. Require Contractor to propose measures for the analysed noise problem 4. Increase monitoring frequency to check mitigation effectiveness	1. Submit noise mitigation proposal to ET Leader/ ER 2. Implement noise mitigation proposals
Limit Level	1. Notify Contractor 2. Notify EPD 3. Require Contractor to implement mitigation measures . Increase monitoring frequency to check mitigation effectiveness	1. Implement mitigation measures 2. Prove to ET Leader and ER effectiveness of measures applied.

5 ENVIRONMENTAL MONITORING REQUIREMENTS

5 ENVIRONMENTAL MONITORING REQUIREMENTS

5.1 Monitoring Methodology

5.1.1 Air Quality

24-hour TSP will be sampled by drawing air through a pre-conditioned, pre-weighed filter inside the high volume sampler at a controlled flow rate. After 24 hours of sampling the filter paper, with retained particulates, would be collected and returned to the laboratory for drying in a desiccator, followed by accurate weighing. TSP levels are calculated from the ratio of mass of particulates retained on the filter paper to the total volume of air sampled. All equipment and procedures will follow USEPA Standard Method described in 40, CFR, Part 50. Sample collection filters will comprise of glass fibre, quartz fibre or teflon fibres in order to minimise sample degradation.

For 1-hour TSP, a portable dust meter will be used. TSP measurement is based on the principle of light scattering. The meter shall be factory calibrated against a known opacity and will be calibrated in the field, each time, prior to deployment, against known standards provided by the manufacturer.

Weather condition, including the wind speeds and directions should also be monitored.

5.1.2 Noise Monitoring

Noise levels should be determined by carrying out measurements at the monitoring locations. Where a measurement is to be undertaken outside of a building, the assessment point would normally be positioned at 1 m from the sensitive facade, but may be re-positioned at any other point considered appropriate by EPD. Where a measurement is to be made of noise being received at a place other than a building, the assessment point would be at a position 1.2 m above the ground in the free-field.

5.2 Equipment

5.2.1 Air Quality

For air quality monitoring, the following or similar equipment should be used a high volume sampler as referenced in the USEPA Standard Method 40, CFR Part 50.

Portable dust meters should be available to perform air monitoring where necessary.

5.2.2 Noise

Noise should be monitored using Bruel and Kjaer modular precision sound level meter type 2231, with statistical analysis module BE 7101 or other suitable instruments which comply with the International Electrotechnical Commission Publications 651:1979 (Type 1) and 804:1985 (Type 1) specification.

5.3 Calibration

All monitoring equipment will be maintained in calibration at all times. Re-calibration will be carried out in accordance with requirements stated in this Manual or that recommended by the manufacturers, whichever is more stringent.

5.3.1 TSP Monitoring

The flow rate of each high volume sampler with mass flow controller will be calibrated using an orifice calibrator. Initial five point calibration will be conducted upon installation and prior to commissioning. One point flow rate calibration will be carried out every two months. Five point calibration will be carried out initially and every six months thereafter.

The portable dust meters will be calibrated against gravimetric standards every 2 months. A calibration check against a known standard will be carried out on each occasion the meter is used.

5.3.2 Noise Monitoring

The sound level meters will be calibrated using a Bruel and Kjaer Sound Level Calibrator Type 4230, or other similar equipment, prior to and after each set of measurements. The results of the calibration will be recorded on the field data form. The measurement is discarded if the calibrations before and after do not agree to within 1 d(A), then repeated until the calibrations before and after agree to within 1 d(A). An annual calibration check will be carried out by the manufacturer.

5.4 Monitoring Requirements

5.4.1 Baseline Monitoring

Air Quality

Ambient dust levels of both 1-hour and 24-hour TSP should be measured daily for two weeks at the site boundaries of two screening plants. The monitoring should be undertaken prior to commencement of construction work.

Noise

Baseline noise monitoring of $L_{Aeq\ (30\ min)}$ for daytime (0700-1900), $L_{Aeq\ (5\ min)}$ during restricted hours (1900-0700), L_{10} and L_{90} should be carried out. The monitoring stations should include one receiver closest to each screening plant and one receiver along No. 46-87 Belcher's Street. The monitoring should be undertaken daily for two weeks.

Soil Analysis for Contamination

Prior to excavation, soil samples should be taken at the two screening plant.

Central Screening Plant: A single borehole to be drilled in the south eastern corner 1 m from the proposed pumping station construction site boundaries. Soil samples should be taken immediately above the water table, and then once every 5 m to a depth of - 20 mPD where a final sample will be taken. This will allow the sampling of fill material, marine deposits and alluvium. A sample of the top layers of the marine deposits should be taken. These occur at approximately -10 mPD.

Wan Chai East Screening Plant: A single borehole to be drilled 1m inside, and half way along, the eastern boundary of the proposed pumping station. Soil sampling will be as for the Central Screening Plant. A sample of the top layers of the marine deposits should be taken. These occur approximately between -3 mPD and -5 mPD.

Depending upon the contractors' spoil handling proposals and if off-site disposal of spoil is required, spoil samples at some of the reclamation and manhole/shaft sites may be required for analysis of contamination. The reasons for contamination analysis is explained in Appendix A.

Recommended analysis parameters should include cadmium, chromium, copper, lead, mercury, nickel and zinc

5.4.2 Compliance Monitoring during Construction

Dust

Continuous 24-hour TSP should be monitored at the screening plants during the major construction work (eg. civil and earth work). Monitoring frequency should be once every six days.

Occasional dust monitoring for 1-hour TSP using portable dust meter should be undertaken when complaints are received or major dust generating activities taking place at other work sites.

Noise

For construction compliance monitoring, measurements of $L_{Aeq\ (30\ min)}$ during day-time (0700-1900) on normal weekdays should be undertaken at closest affected and selected receivers once per week. These locations should include one NSR for each screening plant and one NSR along Nos 46-87 Belcher's Street at any time. Three consecutive measurements of $L_{Aeq\ (5\ min)}$ should be carried out on a weekly basis when evening and/or night time work is taking place.

Regular compliance monitoring will not be necessary along the trunk sewer alignments (except for Bechler's Street) as well as reticulation and interception sewer alignments. However, monitoring and/ or investigation will be required when complaints are received.

5.4.3 Compliance Monitoring during Operation

Odour

Odour patrol monitoring at two screening plants should be undertaken daily for six months. The odour detected should be classified as follows:

- Slight — Implying the odour is barely noticeable and unlikely to cause offence;
- Noticeable — Implying a noticeable odour from the sewer, but not necessarily offensive;
- Strong — Implying that the odour may cause offence.

Odour panel test should be conducted when complaints are received. The method used should be approved by EPD.

Noise

Measurement of $L_{Aeq\ (30\ min)}$ should be undertaken at the closest receivers around the two screening plants. Frequency of monitoring should be once per week for four weeks, initially to confirm the compliance of the noise performance requirement.

5.4.4 Summary of Monitoring Requirements

A summary of the monitoring programme for both baseline and compliance is presented in Table 5.1.

As the construction sites will move along the sewer alignments, except for the two screening plant sites, the monitoring location for the trunk sewer work along Belcher's Street will have to change from time to time to match with construction activities.

5.5 Data Recording

Standard pro-formas should be used for recording field data. The data should then be input into a computerised database. This will serve as a systematic method of recording and storing data. In the event of complaints or evidence of unacceptable environmental impacts being obtained from the monitoring results, these data should be easy to reference.

Monitoring staff should record observations and events on the data forms to allow later interpretation of the results obtained.

Table 5.1 Environmental Monitoring Requirements

Monitoring Requirement	Period	Parameter	Location	Frequency	Additional Requirements	Limit
Air	Baseline prior to Construction	TSP (1-hour and 24-hour)	Site boundary of screening plants	Daily x 2 weeks	-	-
	Construction	TSP (24-hour)	Site boundary of screening plants	Every 6 days	More frequent monitoring required if deterioration occurs	500 μgm^{-3} (1-hr)(i) 260 μgm^{-3} (24-hr)
		TSP (1-hour)		Complaints received	Occasional *ad hoc* monitoring using portable dust meter at other work sites	
	Operation	Odour patrol	Site boundary	Daily for 6 months	To be determined after completion of the first 6 months	2 ou (100% compliance requirement)
		Odour panel		-	Once complaint received	
Noise	Baseline	L_{Aeq} 5 min, L_{Aeq} 30 min L_{10} & L_{90}	1 NSR for each Screening Plant 1 NSR along Nos 46-86 Belcher's Street at any time	Daily x 2 weeks	-	-
	Construction	L_{Aeq} 30 min (0700-1900) L_{Aeq} 5 min (1900-0700) and whole days for public holidays including Sundays		Weekly	More frequent monitoring required if deteriorating situation occurs	0700-1900(i): 75 dB(A) 70 dB(A): school teaching 65 dB(A) school exam 1900-0700 & Public Holidays: ANLs
	Operation	L_{Aeq} 30 min	SRs close to the screening plant, or site boundary	Weekly x 4	-	ANLs
Soil/Spoil	Prior to Construction	Heavy metals: Cd, Cr, Cu, Pb, Hg, Zn, & Ni subject to approval by EPD	Screening Plants, Manholes/ shafts Reclamation	Once prior to excavation	-	To be confirmed with EPD

(i) Non-statutory limits

6 ENVIRONMENTAL AUDIT

6 ENVIRONMENTAL AUDIT

6.1 Audit Requirements

The purpose of an environmental audit is to:

- Establish the degree of compliance of the facility with statutory limits and guidelines for environmental quality objectives;
- Review changes in measured parameters since commissioning of the construction and operation to detect deterioration in performance or to record improvements;
- Examine management practice and its efficacy in achieving environmental protection;
- Recommend improvements to the system and its operation in the event that performance is unsatisfactory.

6.2 Reporting

During construction, monthly environmental monitoring and audit reports should be submitted. The report should include:

- Executive Summary - A brief summary of the main points of the report;
- Monitoring Methodology - monitoring equipment calibration schedule, locations, duration and frequency;
- Monitoring results - monitoring parameters, data, time and location as well as environmental conditions during the time of monitoring taking place;
- Audit Results - summary of the number of TAT level exceedances during the month. Review of pollution sources and working procedures in the event of non-compliance; action taken in the event of non-compliance and follow up procedures to earlier non-compliance actions. List of active construction noise permits;
- Complaints Handling - complaint received, location of complaints, action plan and follow-up procedures;
- Appropriate drawings/tables of monitoring locations, SR locations, calibration certificates from a HOKLAS accredited laboratory, environmental monitoring results, schedule of monitoring for the next month and construction noise permits etc.

During operation, it is suggested that the first audit should be undertaken during the initial operation stage after completion of environmental performance monitoring (eg, six months after commissioning), and second audit at the end of first year. Further audit frequencies should be determined based on findings of the first two audits.

7 ENVIRONMENTAL COMPLAINTS RESPONSE PROCEDURES

7 ENVIRONMENTAL COMPLAINTS RESPONSE PROCEDURES

7.1 Environmental Complaints Response Procedures

An on-site complaint hotline should be set up. When complaints are received, ET should undertake immediate action. The following complaint handling procedures are recommended:

- Investigation of the complaint to determine its validity, and to assess whether the source of the problem was an isolated incident or due to recurring works activities;
- If valid and due to works, identifying mitigation measures;
- Undertaking additional monitoring and audit to verify the situation where necessary;
- Notify the complainant, the Client and the Project Manager of the results of the investigation.

7.2 Complaint Response Action Plan

Experience has shown that complaints received are generally based on the complainants perception of the environmental situation. Verification of complaints following the above outlined procedures is therefore advisable prior to undertaking any remedial action.

Depending on the severity of the complaint, individual complaint cases may be referred to the Project Manager and then to the Construction Manager. The Project Manager with the ET leader will be responsible for determining the appropriate mitigation measures required. Both the project and the ETs will follow up on the implementation of mitigation measures.

7.3 Complaint Response Audit Follow-up Procedures

Notify complainants of results of complaint investigation. Audit response procedures to ensure that any valid reason for complaint does not recur.

8 CONCLUSION

8 CONCLUSION

This Manual outlines environmental and audit work for the construction and operation of the project.

It is recommended that the ET should submit a more detailed EM&A Manual to EPD prior to the commencement of the monitoring work at the beginning of the construction stage. This will resolve certain outstanding issues such as TAT levels, selection of monitoring stations and duration and can be specifically related to the construction programme.

APPENDIX A
SCREENING PLANT GROUND CONTAMINATION INVESTIGATION

1 INTRODUCTION

1.1 General

As part of the Central, Western and Wan Chai West sewerage project, the Central and Wan Chai East Screening Plants will each require the construction of a new pumping station to convey sewage from the proposed trunk sewer to ground level for treatment. The construction of each pumping station will involve excavation to a depth of up to 40 m (for diaphragm walling) resulting in the generation of approximately 34,800 m^3 spoil, equivalent to 35% of the total.

Each of the proposed construction sites is in very close proximity to existing main raw sewage inlets and existing screening process areas. It is therefore considered possible that the soil to be excavated could have become contaminated by leakage or spillage of raw sewage from these areas. Both of the screening plants have been constructed on reclaimed land. Marine deposits beneath the reclamation fill material may also have been contaminated in the past to some degree as a result of previously uncontrolled discharge of effluent into Victoria Harbour.

Investigation is therefore required to confirm the presence and degree of any persistent inorganic contamination, rather than any biological or organic material which may be present. This is in order that spoil generated during the construction phase of the new pumping stations could be appropriately disposed of. The proposed layouts showing pumping station construction sites for both Central and Wan Chai East Screening Plants are shown in Figures A-1 and A-2 respectively.

1.2 Sewage Characteristics

Sewage can contain a wide range of metals and other elements in varying - and sometimes very high - concentrations. The precise chemical forms in which the metals and other elements are present vary, but frequently the metals are chemically combined with solid matter present in the sewage. The sewage received by Central and Wan Chai East Screening Plants is predominantly domestic in nature and is therefore not expected to be exposed to exceptional heavy metal concentrations as experienced by screening plants serving more heavily industrialised areas.

2 SITE DESCRIPTIONS

2.1 Central Screening Plant

A site walk-over revealed that the whole site was concreted over and that there was no visible evidence of any contamination. The proposed location for the pumping station was currently occupied by administration buildings and thus inaccessible. The Consultants were informed by resident staff that an existing pipeline leading from the existing pumping station inlet and running immediately in front of the administration buildings was an emergency overflow outfall to Victoria Harbour. Otherwise all the sewage pipelines were as indicated on Figure A-1.

Raw sewage arrives at the main inlet at approximately 16 m below ground level before being raised by screw pumps for screening. The southern edge of the proposed location of the new pumping station is approximately 3 to 4 m distant from the existing pumping station. There is therefore a possibility that contamination of the proposed site may have taken place.

The Central Screening Plant is constructed on land reclaimed from Victoria Harbour. A borehole investigation undertaken close to the site revealed that the fill material used for the reclamation extends to approximately -10 mPD and consists of silty sand with gravel. Marine deposits are from -10 mPD to -15 mPD and alluvium is below the marine deposits, to a depth of approximately -24 mPD.

The water table is expected to be found between 1 to 1.5 m below ground level at both sites.

2.2 Wan Chai East Screening Plant

A site visit revealed that the majority of the site was either tarmacked or concreted over, though a considerable amount of vegetation had been planted around the periphery of the site for aesthetic and screening purposes. Once again no evidence of surface contamination was found and the below ground pipeline layout was as indicated on Figure C-2, except for minor drains servicing the site's own sewage requirements. These minor drains are not considered to be a significant potential source of contamination.

The majority of the proposed pumping station site falls outside the existing screening plant site boundary to the west. However, the existing inlet chamber into which the main sewer empties and the coarse screens which treat the raw sewage are only 10 m to the east of the proposed pumping station site and as such could pose a potential source of contamination. The inlet sewer is approximately 6 m below ground level.

Wan Chai East Screening Plant is also constructed on land that has been reclaimed from Victoria Harbour. Fill material extends to approximately -3 mPD (8 m below ground level). Below this, extending to -15 mPD, are marine deposits, and below this alluvium extends to -29 mPD.

3 PROPOSED INVESTIGATION

3.1 Investigation Guidelines

Preliminary screening of raw sewage removes up to 60 - 70% of the suspended matter present and this may contain a wide range of metals and other elements in varying concentrations. The ICRCL 23/79 document 'Redevelopment of Contaminated Land: Notes on Sewage Works and Farms' states that a survey for the presence of toxic elements will usually be required when sites are redeveloped or undergo a change of use. It is possible that accidental contamination of areas within the works may have occurred during plant operation.

3.2 Sampling Sites

UK DD175 recommends a minimum number of sampling points for a given site area. The smallest site area quoted is 0.5 ha, for which a recommended minimum of 15 sampling points should be established. In comparison to typical contaminated land investigations the two sites are very small at 400 m^2. Interpolating from the quoted minimum number of sampling points produces a figure of 1.2 samples for each site. ICRCL 23/79 recommends sampling a site suspected of contamination on a grid basis, with grid intervals of 10 - 15 m for smaller sites.

EPD recommends a minimum grid spacing of 18 m for a site of 1 ha. This translates to a maximum of 60 sampling sites for a 1 ha site which is equivalent to 2.4 sampling points for 400 m^2.

3.3 Sample Depth

As can be seen the recommendations for the number and depths of samples to be taken at each trial pit or borehole vary to some extent, though all state that the final number of sampling sites selected should reflect the degree of accuracy required and the likelihood of finding contamination based on the preliminary investigation. ICRCL 23/79 and EPD are similar in that they both require a near surface sample and do not specify a maximum number of samples, only a graduation of depths. UK DD175 recommends a sample within 200 mm of the surface, a sample at the greatest depth of interest and a sample of random depth between these two extremes.

3.5 Proposed Sampling

With regard to the design of the sampling strategy several factors have been taken into consideration:

- Surface areas to be excavated at the two plants are small;
- There is no known history of contaminative land use prior to the commissioning of the screening plants. Both sites are currently concreted over and no evidence of surface contamination was seen;
- It is unlikely that fill material used in the original land reclamation would be a source of contamination. Contamination, if any, would be caused by leakage of pipes;
- Contamination, if any, could also be found in the marine deposits due to previous uncontrolled discharge of effluents. The pollutant loading, if any, of remaining in-situ marine deposits is not known;
- The water table is expected to be within 1.5 m of ground level at both of the sites, therefore any pollutants less dense than sea water are likely to be found above this.

Thus the contamination, if any, would occur from fill material at water table level to the layer of the marine deposit. In light of this, and the above mentioned sampling

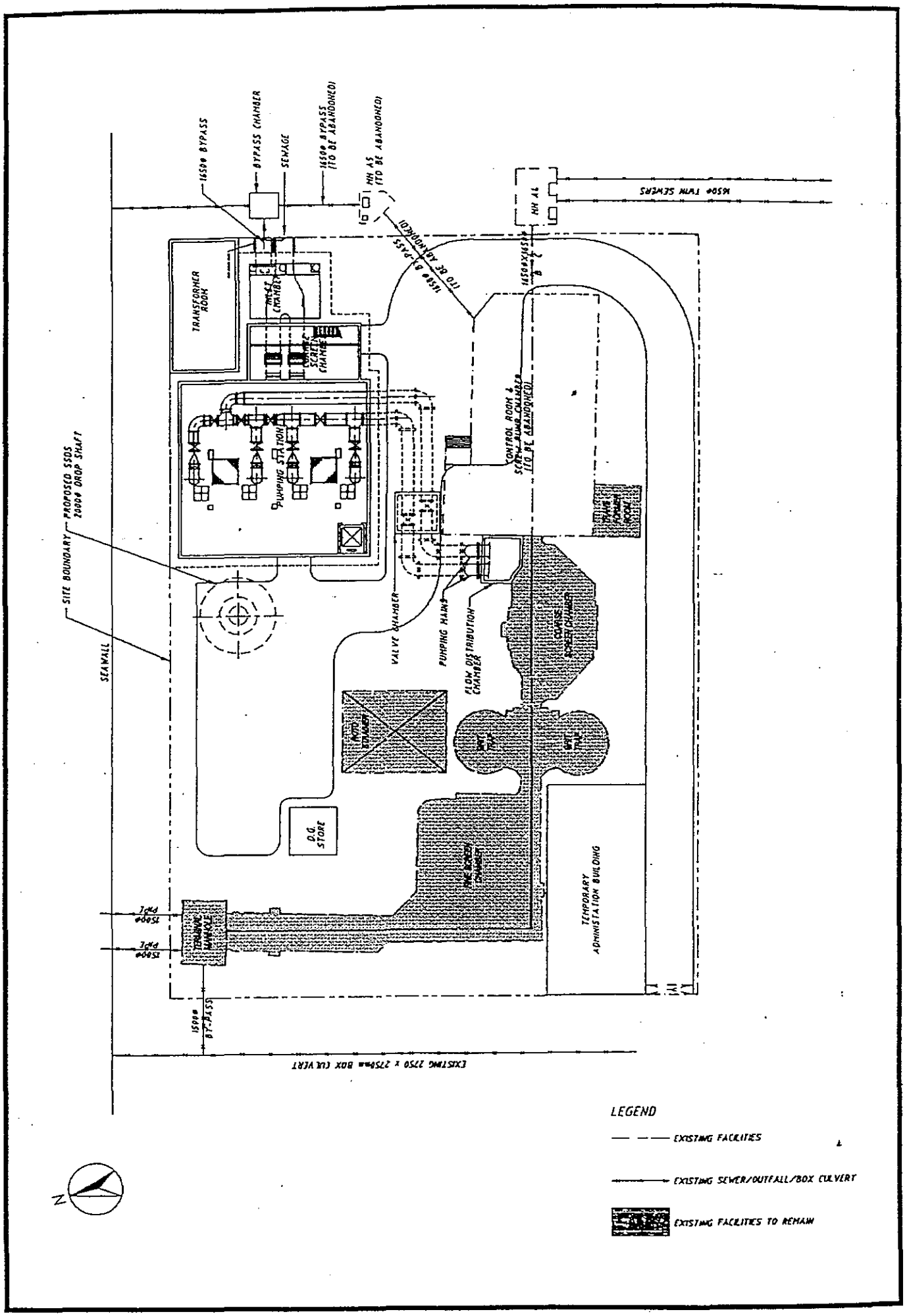
recommendations, the following is proposed:

Central Screening Plant

A single borehole to be drilled in the south eastern corner 1m from the proposed pumping station construction site boundaries. This will optimise proximity to the existing screw pumping station and emergency overflow outfall. Soil samples should be taken immediately above the water table, and then once every 5 m to a depth of - 20 mPD where a final sample will be taken. This will allow the sampling of fill material, marine deposits and alluvium. A sample of the top layers of the marine deposits should be taken. These occur at approximately -10 mPD.

Wan Chai East Screening Plant

A single borehole to be drilled 1m inside, and half way along, the eastern boundary of the proposed pumping station. This will provide proximity to the existing trunk sewer inlet which is a potential source of contamination. Soil sampling will be as for Central Screening Plant. A sample of the top layers of the marine deposits should be taken. These occur approximately between -3 mPD and -5 mPD.



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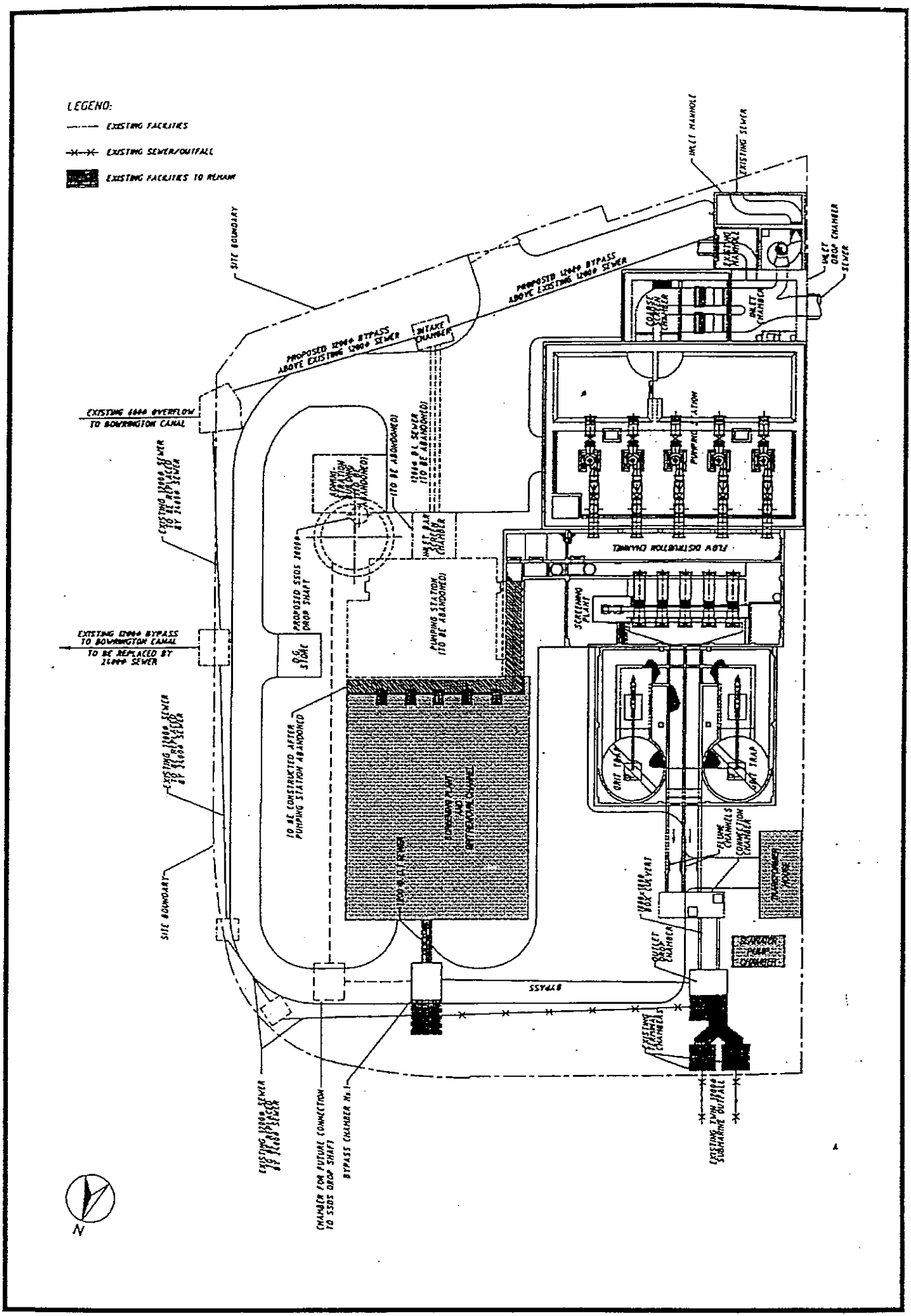
CENTRAL SCREENING PLANT
PROPOSED LAYOUT
FIGURE A-1



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WAN CHAI EAST SCREENING PLANT PROPOSED LAYOUT
FIGURE A-2