FINAL REPORT



ARCO CHINA INC

# Natural Gas Supply to Black Point Power Station: Submarine Pipeline for Hong Kong Territorial Waters, Gas Receiving Station and Related Facilities: *Environmental Impact Assessment*

March 1994

**ERM Hong Kong**
5, 10 & 11/F Hecny Tower
9 Chatham Road, Tsimshatsui
Kowloon, Hong Kong
Telephone 722 9700
Facsimile 723 5660

ERM

FINAL REPORT

ARCO CHINA INC

# Natural Gas Supply to Black Point Power Station: Submarine Pipeline for Hong Kong Territorial Waters, Gas Receiving Station and Related Facilities: *Environmental Impact Assessment*

March 1994

Reference C1119 and C1136

For and on behalf of ERM Hong Kong

Approved by: A M Lauste

Position: ASSOCIATE

Date: 11th March 1994

# *SUMMARY*

## 1 *INTRODUCTION*

In November, 1992, ARCO and its partners, China National Offshore Oil Co and KUPEC, signed an agreement with Castle Peak Power Company Ltd (CAPCO) for the supply of natural gas from the Yacheng Gas Field in the South China Sea.

ARCO China Ltd commissioned ERM Hong Kong to carry out an Environmental Impact Assessment (EIA) for the Submarine pipeline for the Hong Kong territorial waters, the gas receiving station (GRS) and its related facilities.

Two separate EIAs were undertaken, one focusing on the Gas Pipeline within Hong Kong territorial waters and the other on the GRS and its related facilities. This report combines the two EIAs into one report and a summary of findings from the two studies is presented below.

## 2 *THE GAS PIPELINE - HONG KONG TERRITORIAL WATERS*

### 2.1 *WATER*

Given the high and variable concentrations of suspended solids (SS) in Urmston Road, the dredging/post trenching activities will not significantly affect local suspended solid levels. Whichever method is selected, the increases in SS levels at the Water Sensitive Receivers will be within the natural variation range and are therefore not envisaged to have unacceptable impacts on the WSRs. A water quality monitoring programme to be under taken during the works is outlined to confirm these findings.

There will be no discharges into Hong Kong waters during the precommissioning and commissioning stage. Similarly, for the operational stage, no effluent discharge is anticipated from the pipeline system.

### 2.2 *WASTE*

Results of sediment sampling in the Outer Deep Bay Borrow Area indicate that the marine sediment is uncontaminated and therefore should be acceptable for disposal at the gazetted marine dump sites at South Cheung Chau and East of Ninepins.

The operation of the pipeline is not envisaged to produce any waste arisings; condensate will arise from the plant rather than the pipeline.

## 2.3 *ECOLOGY*

All species (with the exception of the Chinese White Dolphin) identified in the Black Point area are commonly found in marine habitats elsewhere in Hong Kong and therefore the marine ecology in these waters is of no special ecological value. The fisheries resource in these waters is not considered important in view of the low number of species found and their moderate fisheries productivities. Therefore, the limited losses of benthic marine life associated with the construction works is anticipated to exert only a localised impact on the marine environment, and will not result in any significant disturbance to the marine ecosystem and fisheries resource of Hong Kong. The most significant potential impact upon the marine ecology of the area is the possible disturbance to the Chinese White Dolphin. However, construction of the proposed pipeline will be a temporary impact and is therefore considered unlikely to adversely affect the Dolphin.

## 2.4 *NOISE*

Noise levels at the two principal settlements in the area, Lung Kwu Sheung Tan and Tsang Tsui associated with the construction activities of the ARCO pipeline for a "worst case scenario", will meet with the statutory noise criteria. The construction activities will be barely perceptible at the nearest noise sensitive receivers, and it is considered that no specific noise controls or monitoring will be required for the construction or operation of the works.

# 3 *GAS RECEIVING STATION AND ITS RELATED FACILITIES*

## 3.1 *AIR*

The construction and operation of the GRS will not pose significant air quality impacts to the surrounding area as the GRS is located at a remote site far from any ASRs.

The Fugitive Dust Model (FDM) was used to predict the level of dust from the construction site to the surrounding area. The predicted worst case 1-hour dust concentrations at the nearest ASRs at Lung Kwu Sheung Tan will fall within the 1-hour TSP limit and the 24-hour AQO for TSP. Appropriate mitigation measures and good on-site management practice should keep the dust impact to a minimum.

The Industrial Source Complex Short Term Version (ISCST2) model was used to predict the pollutant concentrations from the potential sources of emission during the operational phase. Modelling results indicate that no significant air quality impacts are expected from the operation of the GRS.

## 3.2 WASTE

With good construction practice and management whereby waste arising will be stored, transported and disposed of using approved methods, no significant adverse environmental impacts are envisioned. Inert wastes from construction could be used as fill material at reclamation sites. Other land sourced construction wastes unsuitable for reclamation or land formation will be disposed of to WENT Landfill, whilst chemical wastes will be disposed of to the Chemical Waste Treatment Centre at Tsing Yi. Recycling of construction wastes should be carried out wherever feasible to conserve resources and landfill capacity.

During the operation of the GRS, only small quantities of waste will result from the day to day activities of the station. With the correct storage, transport and disposal procedures, none of the waste arisings are expected to result in any adverse environmental impacts.

## 3.3 WATER

Water quality impacts from the construction of the GRS will be similar to typical land based construction activities which involve construction runoff litter and debris, spillages and domestic sewage. These are unlikely to cause significant water quality impacts on the surrounding water if proper site management and good construction practices are implemented. Therefore, minimal water quality impacts are expected.

The operation of the GRS is not envisaged to cause any major effluent discharge. Drainage from the plant will be diverted to the treatment plants at the new Large Thermal Power Station nearby for subsequent treatment prior to discharge . All effluent from the GRS will have to comply with the Technical Memorandum prior to discharge.

## 3.4 NOISE

The nearest village settlements in the area are relatively remote from the GRS and as there is a substantial screening effect due to topographical features in the area, noise impact during both the construction and operation phase of the project will not be significant. The future relocation of village settlements should ensure that there will also be no noise constraints during the decommissioning of the GRS.

CONTENTS

*PART B*

| | |
|---|---|
| AFD | Agriculture and Fisheries Department |
| ALMOB | Automatic Lean Mixture Overboard |
| ANL | Acceptable Noise Levels |
| AQOs | Air Quality Objectives |
| ASR | Area Sensitive Rating |
| ASRs | Air Sensitive Receptors |
| BOD | Biochemical Oxygen Demand |
| CAPCO | Castle Peak Power Company Ltd |
| CED | Civil Engineering Department |
| CLP | China Light and Power Ltd |
| CNP | Construction Noise Permit |
| CO | Carbon Monoxide |
| COD | Chemical Oxygen Demand |
| CPPS | Castle Peak Power Station |
| CWTC | Chemical Waste Treatment Centre |
| DB | Deep Bay |
| DEP | Director of Environmental Protection Department |
| DO | Dissolved Oxygen |
| EIA | Environmental Impact Assessment |
| EM&A | Environmental Monitoring and Audit |
| EPD | Environmental Protection Department |
| ESD | Emergency Shut Down |
| FDM | Fugitive Dust Model |
| FMC | Fill Management Committee |
| GRS | Gas Receiving Station |
| HC | Hydrocarbons |
| HKPSG | Hong Kong Planning Standard and Guidelines |
| ISCST2 | Industrial Source Complex Short Term Version 2 |
| LB | Lay barge |
| LTPS | Large Thermal Power Station |
| MAOP | Maximum Allowable Operating Pressure |
| NCO | Noise Control Ordinance |
| $NO_x$ | Nitrogen Oxides |
| NSRs | Noise Sensitive Receivers |
| PADS | Ports and Airport Developments |
| PD | Principal Datum |
| PSD | Process Shut Down |
| SDV | Shutdown isolation valve |
| $SO_2$ | Sulphur Dioxide |
| SS | Suspended Solids |
| SSSI | Site of Special Scientific Interests |
| SWL | Sound Power Level |
| TM | Technical Memorandum |
| TMPD | Tuen Mun Port Development |
| TSP | Total Suspended Particulate |
| USEPA | US Environmental Protection Agency |
| WCZ | Water Control Zone |
| WENT | West New Territories |
| WPCO | Water Pollution Control Ordinance |
| WQO | Water Quality Objectives |
| WSRs | Water Sensitive Receivers |
| WWFN | World Wide Fund for Nature |

# 1 INTRODUCTION

## 1.1 BACKGROUND TO THE STUDY

In November, 1992, ARCO and its partners, China National Offshore Oil Co and KUPEC, signed an agreement with Castle Peak Power Company Ltd (CAPCO) for the supply of natural gas from the Yacheng Gas Field in the South China Sea. The gas will be used to fire Phase I of the Large Thermal Power Station (LTPS) at Black Point which is currently being constructed and is scheduled for commissioning in 1996 and 1997. In addition, gas will also be supplied to the Castle Peak 'B' Power Station where existing coal fired units will be replaced with gas fired units. The natural gas will be delivered via a 778 km pipeline from the Yacheng 13-1 Wellhead Platform to a Gas Receiving Station (GRS) at the Black Point site as illustrated in *Figure 1.1a.*

ARCO China Ltd commissioned ERM Hong Kong to carry out an Environmental Impact Assessment (EIA) for the Submarine pipeline for the Hong Kong territorial waters, the gas receiving station and its related facilities.

The EIA were carried out in two stages with environmental issues relating to the submarine pipeline being assessed in the Stage 1 EIA and issues relating to the GRS were addressed at a later stage. The following draft EIAs have been submitted to EPD for comment:

- EIA for the Natural Gas Supply to Black Point Power Station Submarine Pipeline - Hong Kong Territorial Waters (ERM Hong Kong, July 93);

- EIA for the Hong Kong Gas Receiving Station and its related facilities at Black Point (ERM Hong Kong, September 93).

A separate EIA for the pipeline section within China waters has been undertaken by the Chinese. Risk assessment study was carried out by others to address the risk levels associated with the developments.

This report combines the two EIAs on the pipeline and GRS prepared by ERM Hong Kong into a single report to cover all environmental issues mentioned in the Study Brief as given in *Annex I.* Response to comments on the two draft reports are given in *Annex II.*

## 1.2 PURPOSE OF THE STUDY

The purpose of this EIA study is to minimize pollution, environmental disturbances and nuisances arising from the construction, operation and decommissioning of the natural gas submarine pipeline within Hong Kong Waters, the on-shore gas receiving station at Black Point and the related facilities (referred to as "the project" thereafter) by providing information on

the nature and extent of the potential environmental impacts. This information will contribute to decisions on:

- the acceptability of any adverse environmental consequences that are likely to arise from the construction, operation and decommissioning of the project; and

- the design, construction, operation and decommissioning of the project.

## 1.3 *OBJECTIVES OF THE STUDY*

The objectives of the EIA Study are:

a) to describe the project and the requirements for its development;

b) to identify and describe the elements of the community and the environment likely to affect/be affected by the project;

c) to identify, predict and evaluate the net environmental impacts and cumulative effects likely to arise from the construction, operation and decommissioning of the project in relation to the existing and planned community, the beneficial uses of the areas concerned and the neighbouring land uses;

d) to identify and specify methods, measures and standards to be included in the detailed design which may be necessary to mitigate the impacts to acceptable levels;

e) to recommend the environmental monitoring and audit requirements necessary to ensure the effectiveness of the environmental protection measures adopted; and

f) to identify additional studies where necessary to fulfil the objectives or requirements of this EIA study.

## 1.4 *STRUCTURE OF THE REPORT*

This report is organised into two independent sections. Part A addresses the gas pipeline for the Hong Kong Territorial waters while the EIA for the gas receiving station is discussed in Part B.

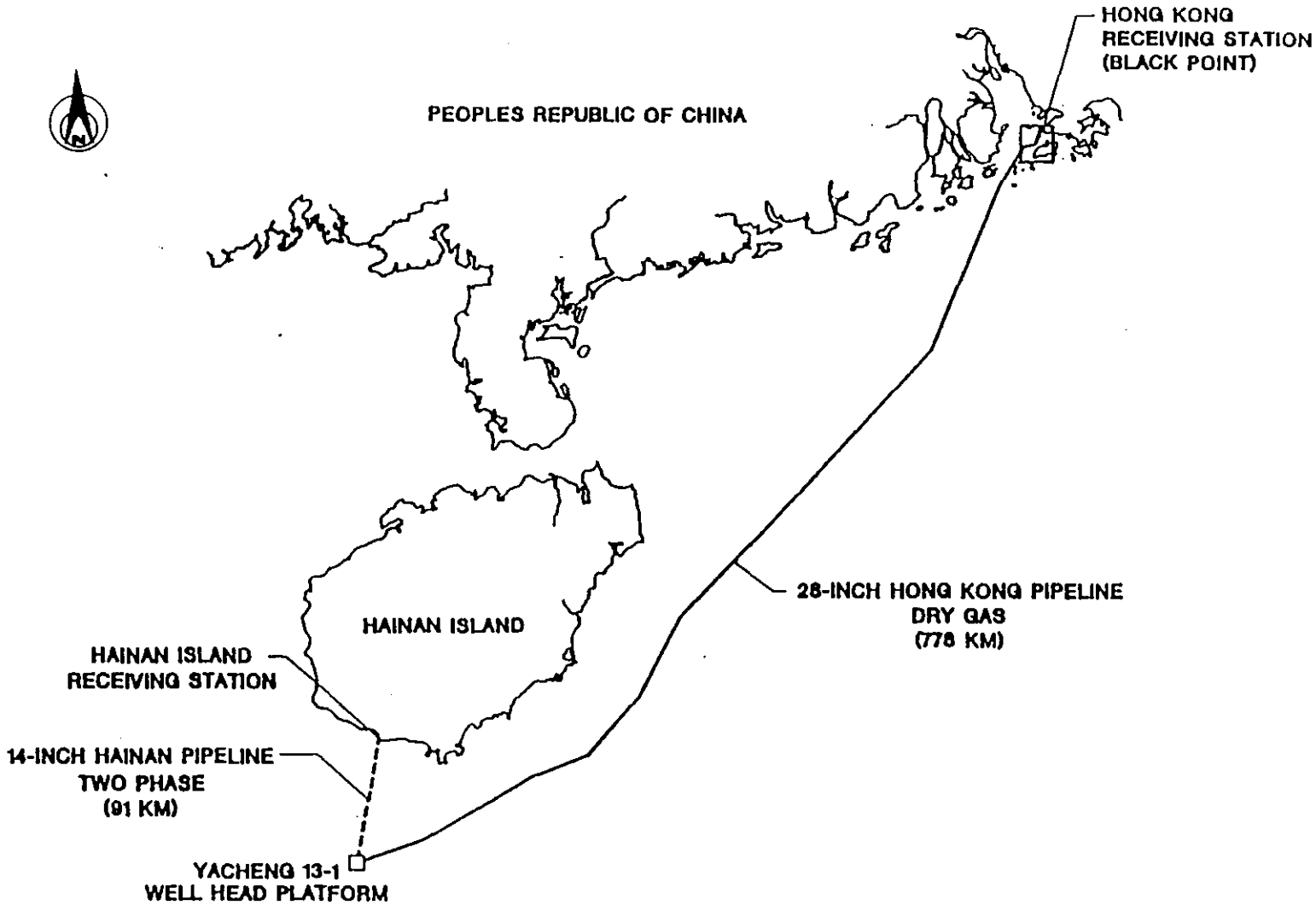



Figure 1.1a

Overview of Pipeline Route

ERM Hong Kong

11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

ERM

# PART A

Natural Gas Supply to Black Point Power Station Submarine Pipeline – Hong Kong Territorial Waters: *Environmental Impact Assessment*

CONTENTS

# A1 INTRODUCTION

This EIA study assess the potential environmental impacts involved for the section of the pipeline within Hong Kong Territorial waters; the study area is shown in *Figure A1.1b* and covers a 5km section of the pipeline corridor.

This EIA is organised into 6 sections. Following this introductory section, the subsequent sections are as follows:

Section A2 describes the proposed project, its surrounding land uses and the pipeline project programme;

Section A3 describes the work associated with pipeline installation and discusses the environmental impacts on water quality and marine ecology, and from noise and waste during the construction phase;

Section A4 gives details of the commissioning and operation of the gas pipeline and associated environmental impacts on water quality, and marine ecology and from noise and waste.

Section A5 covers the environmental monitoring and audit requirements necessary to ensure the effectiveness of the environmental protection measures adopted.

Section A6 summarises the environmental impacts associated with the construction and operation of the pipeline.

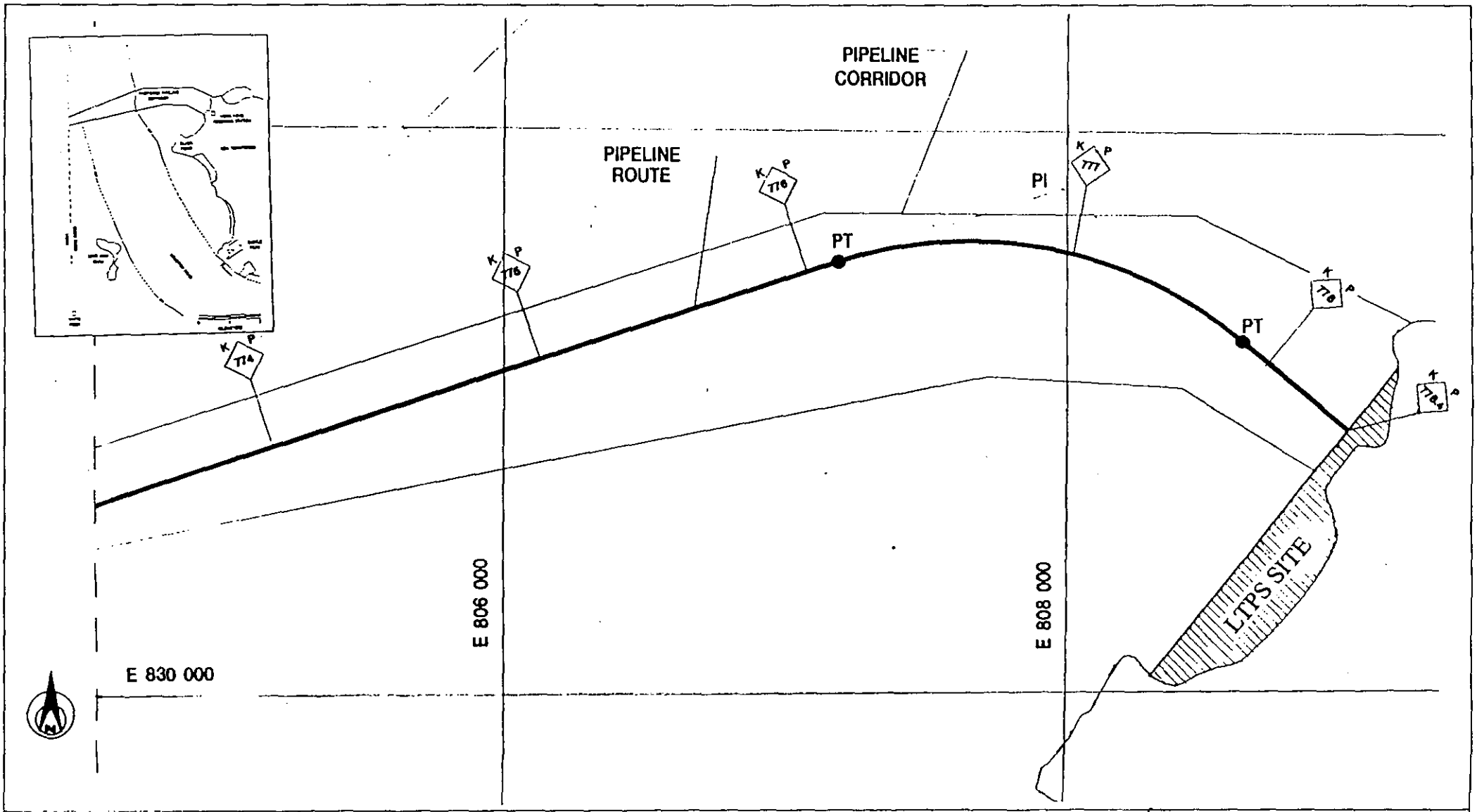



Figure A1.1b

Proposed Pipeline Alignment within Hong Kong Waters

ERM Hong Kong

11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

ERM

## A2 PROJECT DESCRIPTION, PROGRAMME AND SURROUNDING LANDUSES

### A2.1 DESCRIPTION OF THE PROJECT

The project will be a part of the Yacheng Gas Development Programme which consists of the following:

- the installation of a drilling platform and one processing platform at 60 miles south of Hainan Island;
- a dry gas pipeline to Hong Kong;
- a gas/condensate pipeline to Hainan Island; and
- a dry gas receiving station at Black Point (Hong Kong).

This study examines the 5km section of the 778 km pipeline within Hong Kong waters. The 711mm (28 inch) outside diameter pipeline with thickness of 17.12mm will be covered by an average 100mm (4 in) nominal thickness of reinforced concrete. The pipeline will deliver 19.03 MMSCMD of natural gas.

### A2.2 EXISTING AND FUTURE LANDUSE

The pipeline passes through the Outer Deep Bay borrow pit which was the former borrow area for the Tin Shui Wai development. The area is currently used as a dumping ground for uncontaminated marine mud and alluvial clays from the Port and Airport Development Study (PADS) Projects.

The pipeline traverses the Shekou to Hong Kong marine traffic lane, for which maintenance dredging is required between Shekou and the middle of Deep Bay. The pipeline corridor also lies within the gazetted dredging area for CLP.

*Figure A2.2a* delineates the boundaries of the borrow pits in the Deep Bay area and the surrounding landuses.

### A2.3 PROJECT PROGRAMME

The design of the project began in early April 1992. The tender for construction of the gas pipeline was issued for bid in June 1993 and planned to be finalised and awarded by January 1994. Installation of the pipeline will commence shortly thereafter and the section within Hong Kong waters will take around 4 months and is scheduled to be completed by September 1994. Precommissioning will take around 184 days to complete. A summary of the project schedule is presented in *Figure A2.3a*.

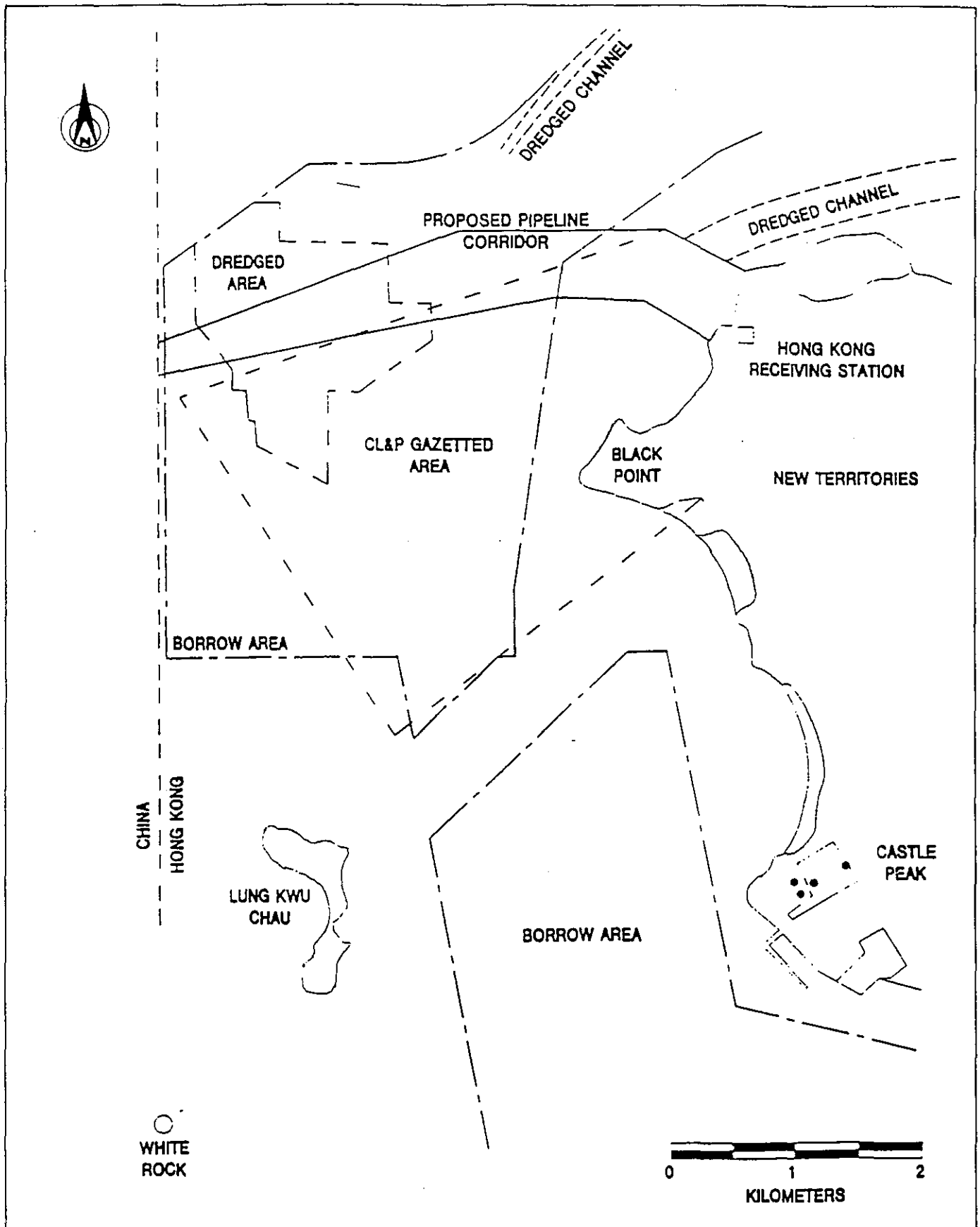



Figure A2.2a

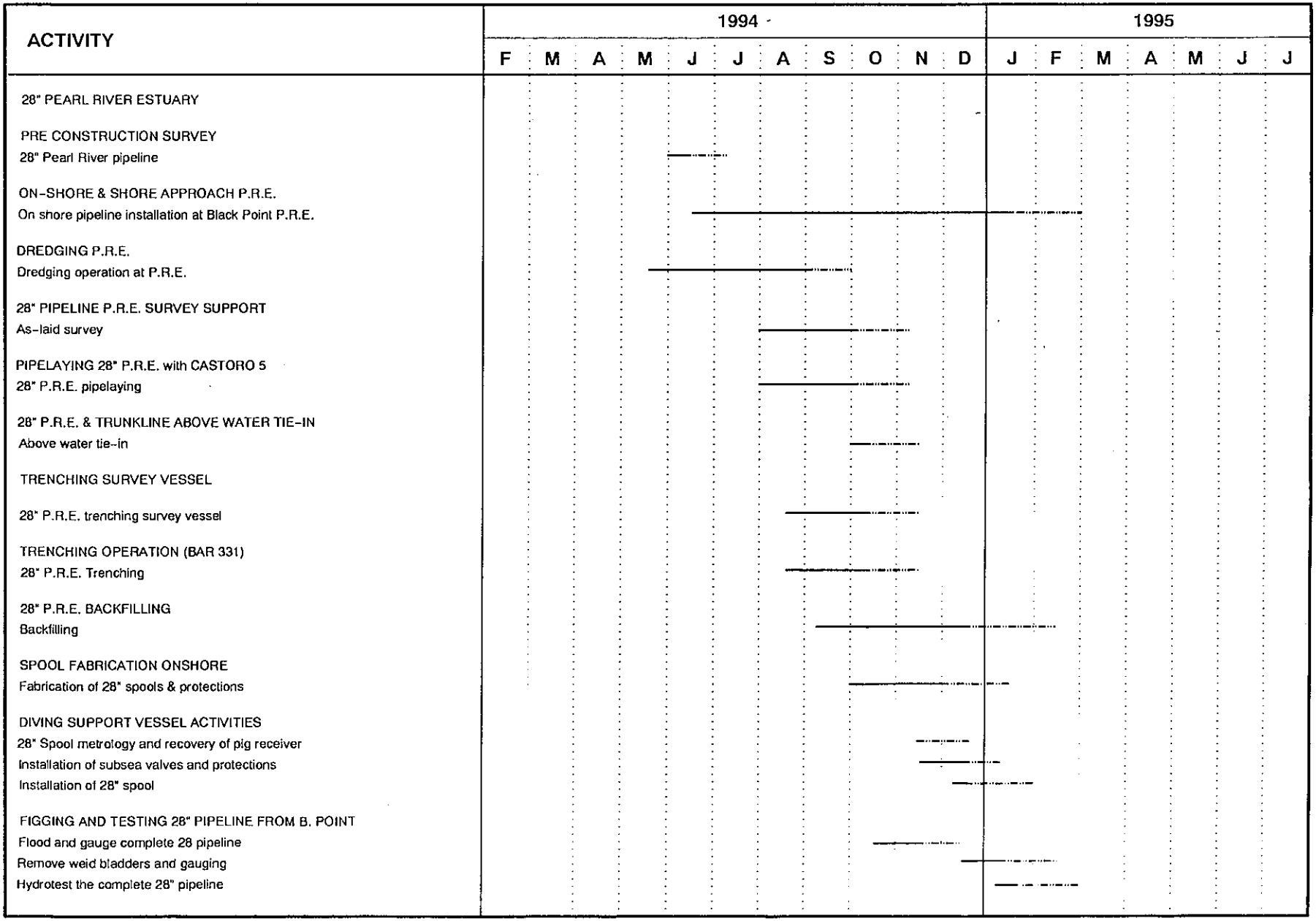
Landuses in the Area of the Pipeline Route

ERM Hong Kong

11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

ERM

*Figure 2.3a Schedule for Pipeline Installation in the Pearl River Esturary*



## A3 CONSTRUCTION PHASE

This section presents a summary of the pipeline installation works and then examines the associated environmental impacts in relation to water, waste, ecology and noise.

### A3.1 PIPELINE INSTALLATION

Around 75 km of the pipeline will be laid from Black Point and subsequently tied–in to the rest of the previously laid pipeline. While details of pipeline installation have not yet been finalised, typical operations will involve the following:

- Pretrenching
- Pipelaying
- Post trenching
- Backfilling

Depending on the final decision on the installation method, pipeline installation can involve either pure pretrenching by conventional dredging; pure post trenching by mechanical pipeline trenching devices such as ploughing or by jetting or fluidisation; or a combination of both.

ARCO has confirmed that there will be no marine blasting.

#### A3.1.1 *Pretrenching*

Pretrenching will be necessary to ensure a smooth pipeline pull in/launch profile, traditional methods of dredging can be employed for this work. Access dredging may also be required for the lay barge. The selection of the dredging equipment will be determined by a number of factors such as availability, water depth, volume of material to be dredged, location of dredged material disposal, time available for vessel to remain at the channel, construction schedule and costs.

Review of preliminary method statements indicated the use of cutter suction dredgers, and trailing suction hopper dredgers. The consultants consider that this may not be an ideal solution in view of the water currents and very significant sediment transport through Urmston Road. The trench will be dredged approximately perpendicular to the predominant current direction and the speed of the current, particularly as the ebb tide would make it difficult for trailers and perhaps impossible for cutters to work. In addition, the trench would take some time to dredge unless several dredgers were to be used. It is quite conceivable that a single dredger, or even several, would be unable to maintain a sufficiently high rate of progress to counter sedimentation in the trench.

We have assumed that, if a dredged trench solution is to be adopted, it will be dredged using one or more trailers. However, there would inevitably be some difficulties associated with working in the very shallow waters at the western end of the Hong Kong corridor and in the shallow approaches to Black Point. Other methods such as the grab and bucket dredgers may have to be used in these areas.

Assuming trench slopes of 1:10 and a nominal bottom width of 10 metres gives a total volume of 1,237,500$m^3$. It is likely that the volume of dredged material will be less as a trench slope of 1:5 will be employed for areas other than the non-borrow area. In addition, the pure trenching approach will unlikely be employed. ARCO have stated dredged material should be limited to less than 500,000$m^3$ of material.

A brief description of the different types of dredgers and its advantages and disadvantages are presented in *Annex III(a)*.

### *A3.1.2 Pipelaying*

A single lay barge (LB) will be employed for pipelaying. The pipelaying process will consist of pipepulling for the shore approach, the conventional pipelay and the tow method. For the shore approach, and the conventional pipelay, the lay vessels will moor at a distance from the shore and will require a certain anchorage spread for the pipelaying barge. The region for the construction anchor zones for the lay barge across the Urmston Road and the shore approach is illustrated in *Figure A3.1a*.

- The Shore Approach

  Pipelaying in water depths of less than 5.0m involve pipe pulling operations. There are two commonly used construction techniques for installing the shore approach section, namely, onshore pull or offshore pull. A typical shore approach construction configuration is given in *Figure A3.1b*.

  The onshore pull method is the most common method of providing a land to sea pipeline transition with minimal civil work. This involves pipepulling ashore by land winches from a moored lay vessel. This is considered more appropriate for Hong Kong due to the space limitations at the land site.

  The offshore pull involves the fabrication of the shore approach pipe while onshore, thus requiring a larger shore construction area than the onshore method. Pipes are pulled from shore by a moored lay vessel or pull barge.

  Details of the two shore approach methods are presented in *Annex III(b)*, and the construction requirements associated with each method are outlined in *Table A3.1a*.

*Table A3.1a Construction Requirements for Onshore Approach*

| ACTIVITY | OFFSHORE PULL | ONSHORE PULL |
|---|---|---|
| Provision for vehicular access | yes | yes |
| Site Preparation | Approx 200m$^2$ x 70m | approx 50m x 50m |
| Winch base and back anchor | no | yes |
| Hold back winch | yes | no |
| Pipe storage area | yes | no[1] |
| String fabrication and storage area | yes | no[1] |
| Pipe welding, NDT, and field jointing | yes | no[1] |
| Site offices | yes | yes |

Note:

1) These items will be required if there is an onshore section of pipeline to be installed.
2) Length is a function of site area and length of pipe strings.

Source: ARCO China Inc.

- Conventional Pipelay

The conventional pipelaying will require a minimum water depth of about 5.0m to operate. Offshore pipeline installation by a lay barge is considered to be suitable for both the deep and shallow Hong Kong waters. The lay barge is basically a floating pipeline welding installation facility, where pipeline are made up and simultaneously laid on the seabed. A typical pipelaying configuration during the laying operation by a lay barge is presented in *Figure A3.1c*. Details of a typical lay vessel are given in the *Annex III(c)*.

Based on a 24-hour continuous operation, the pipelaying process is expected to proceed at a rate of 0.75 - 1.5km per day.

- Tow methods

The tow method could be employed for the section of the Urmston Road which falls in the marine traffic lane. The tow methods are used mostly for short pipeline section. Three primary tow techniques which will be considered are as follows:

*Bottom Tow*

With the bottom tow method, the pipeline is towed along the seabed by a tow vessel. A second vessel monitors the behaviour of the pipe by picking up signals from transmitters on the carrier pipe. *Figure A3.1d* is an illustration of the bottom tow method.

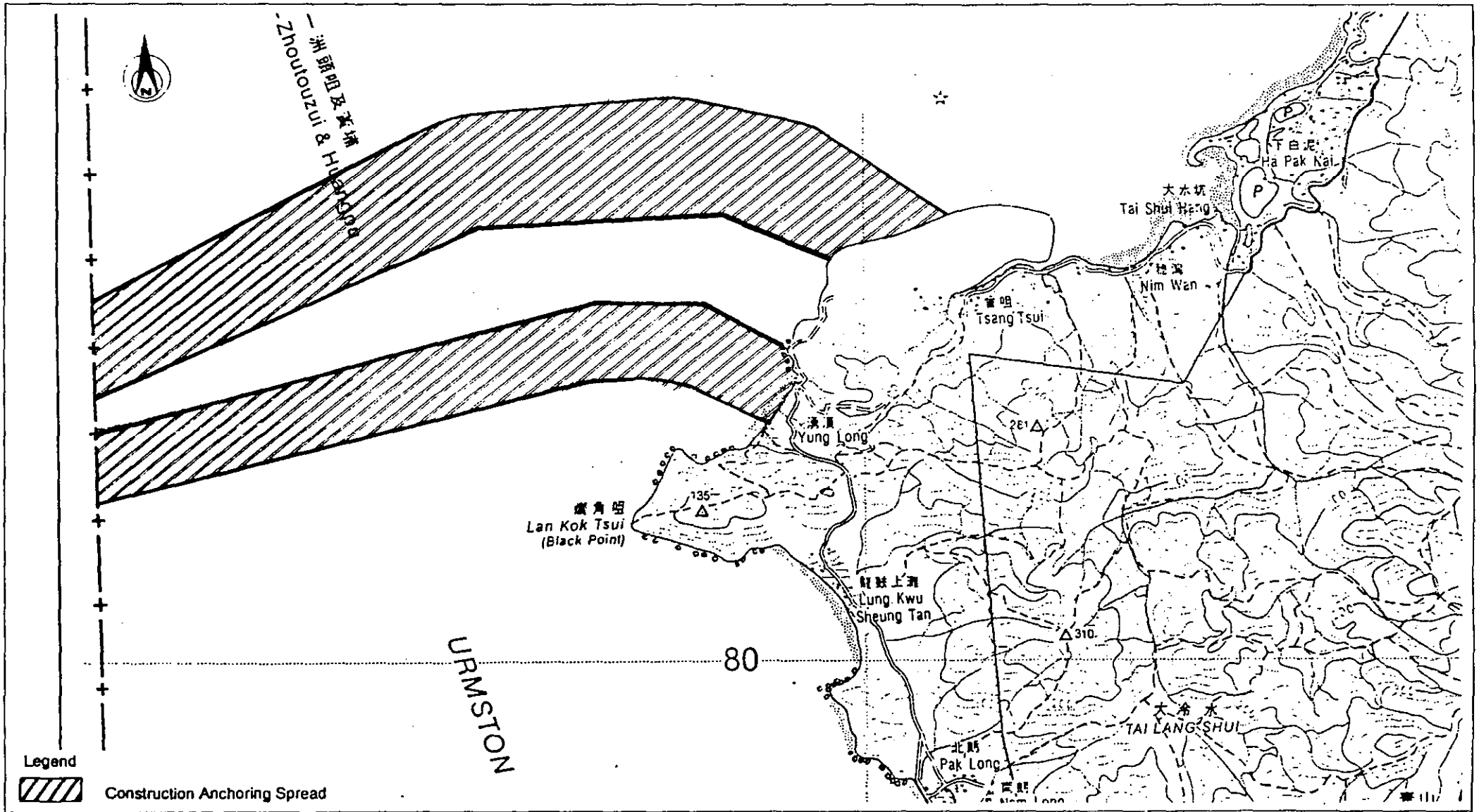



Figure A3.1a

Construction Anchoring Zone

ERM Hong Kong

11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

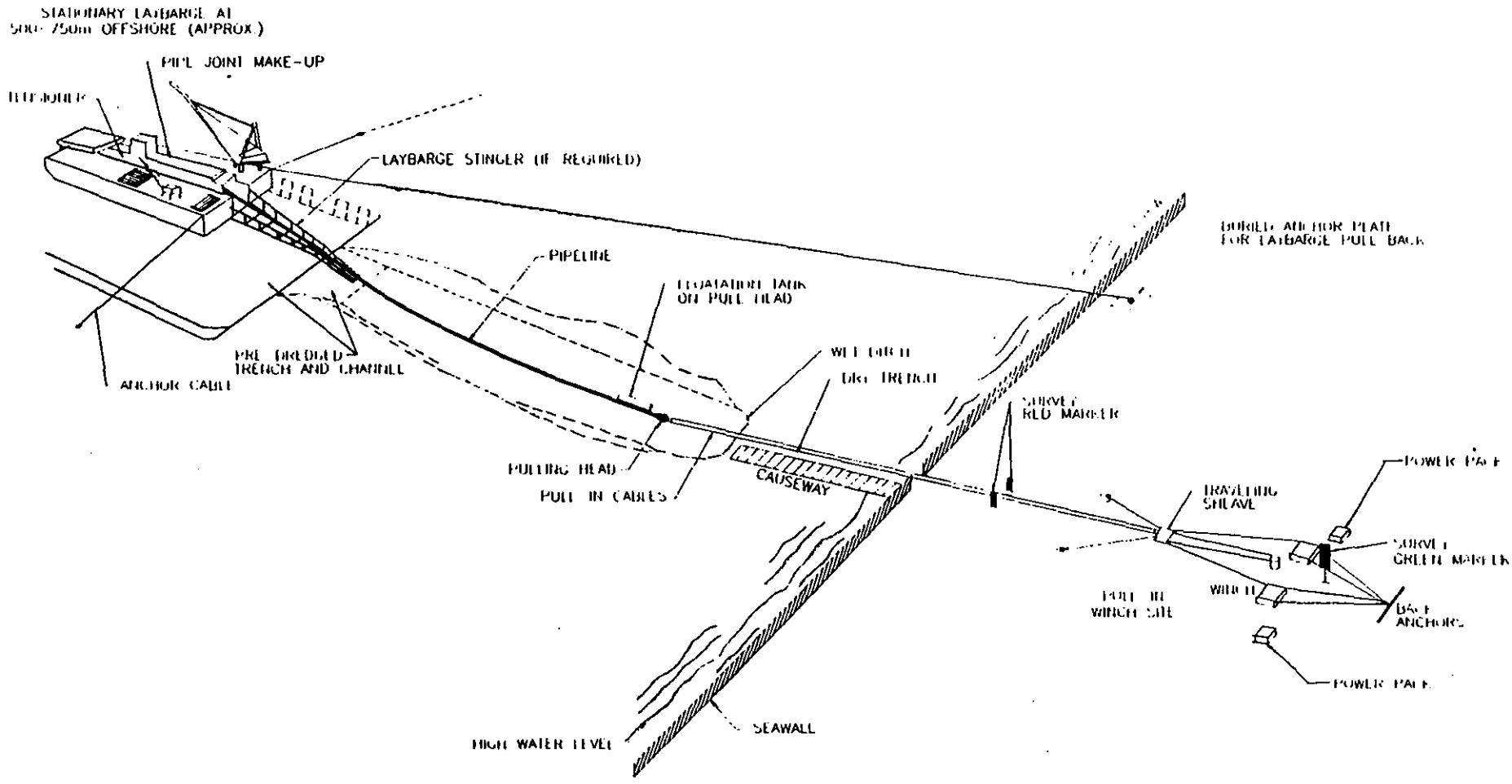



Figure A3.1b

Typical Shore Approach Construction Configuration

ERM Hong Kong

11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

ERM

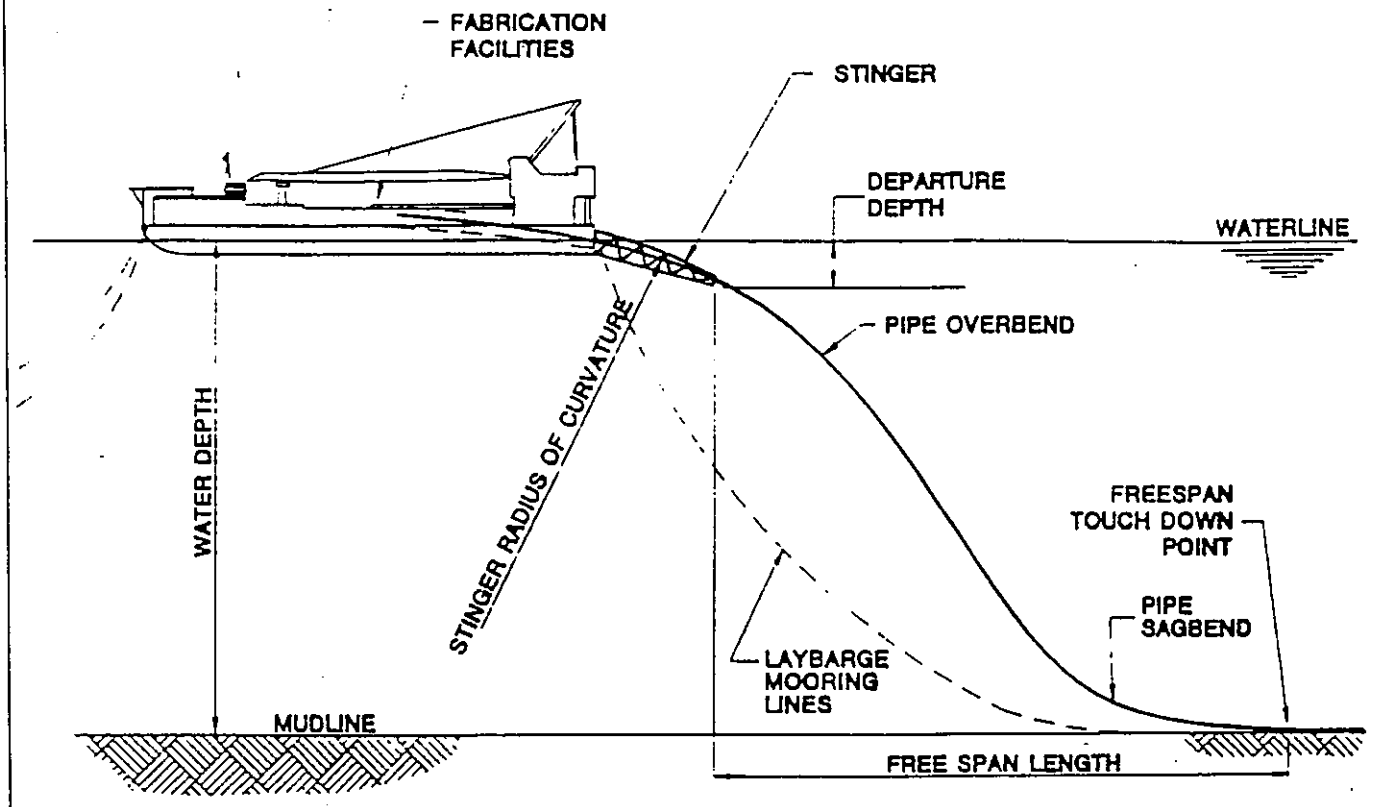


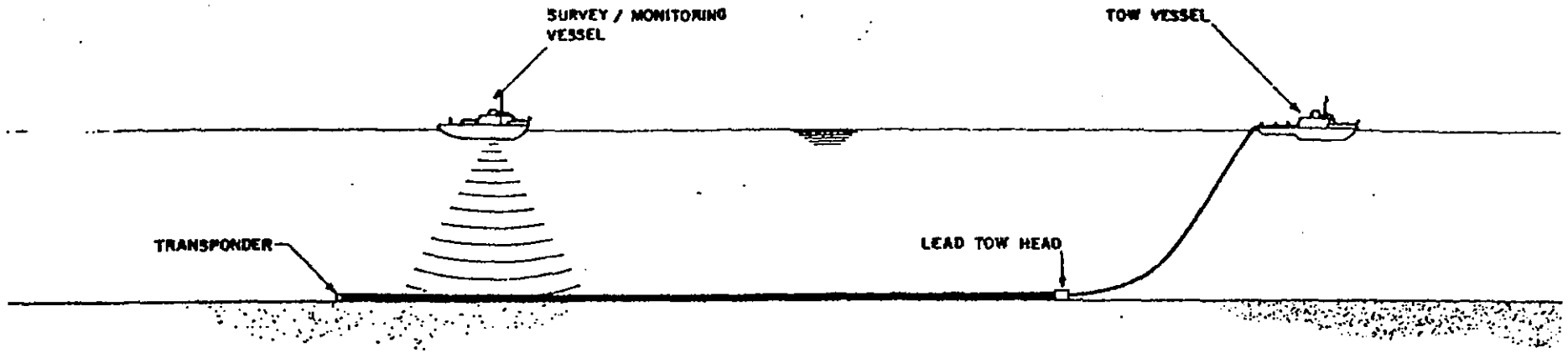

Figure A3.1c

Typical Configuration During Pipelaying

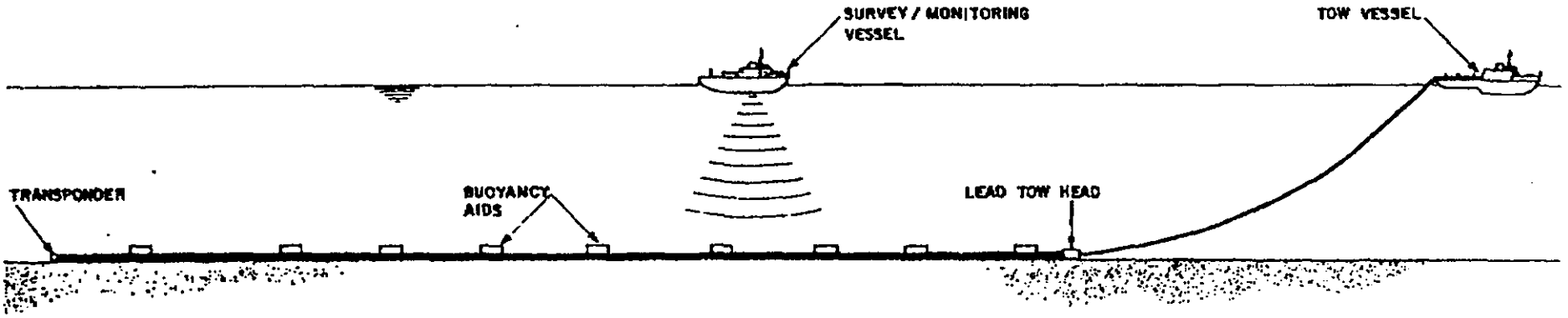
ERM Hong Kong

11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

ERM




BOTTOM TOW WITHOUT BUOYANCY




BOTTOM TOW WITH BUOYANCY

Figure A3.1d On Bottom Tow

ERM Hong Kong

11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

ERM

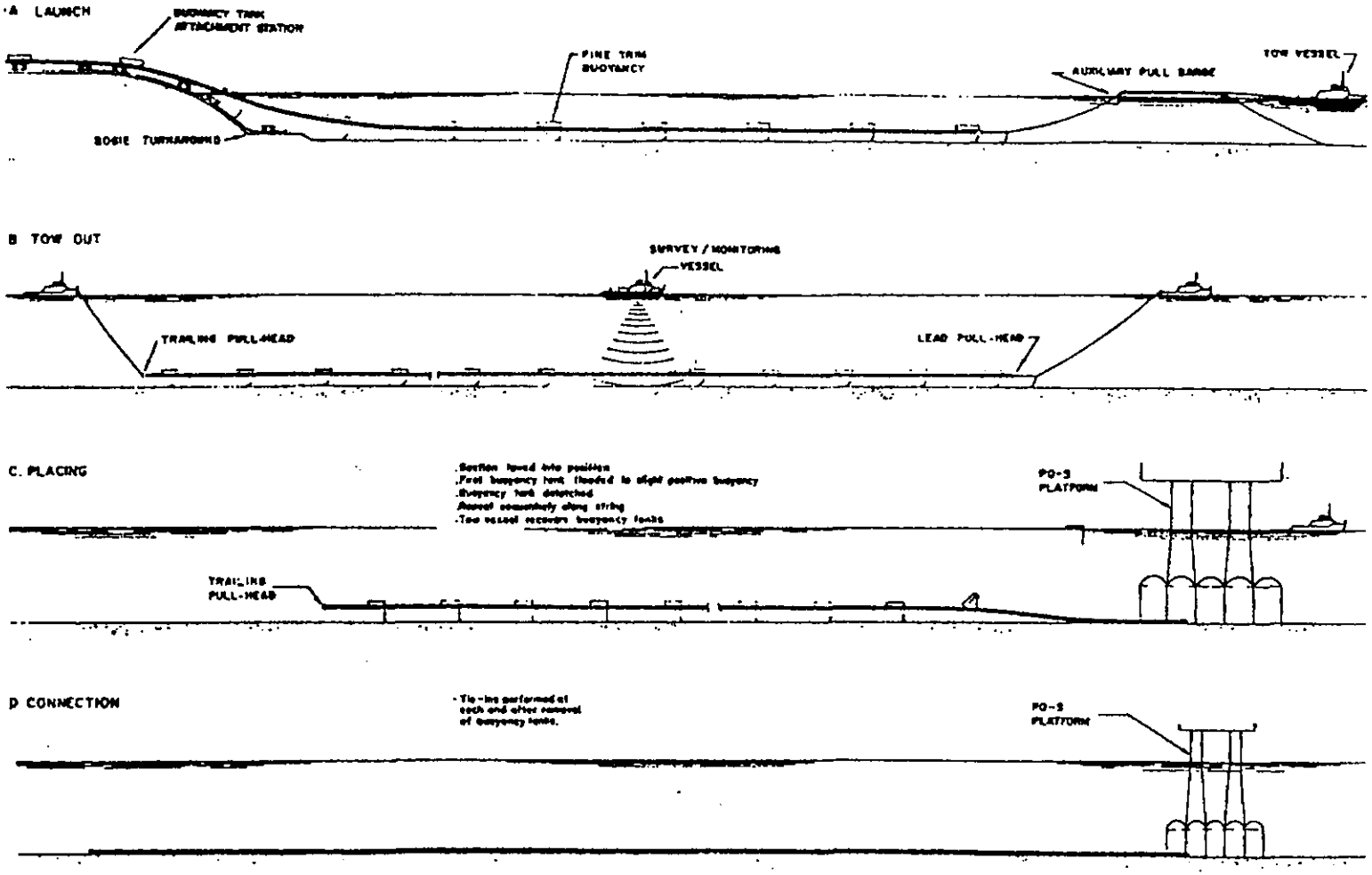



Figure A3.1e Off Bottom Tow

ERM Hong Kong

11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

ERM

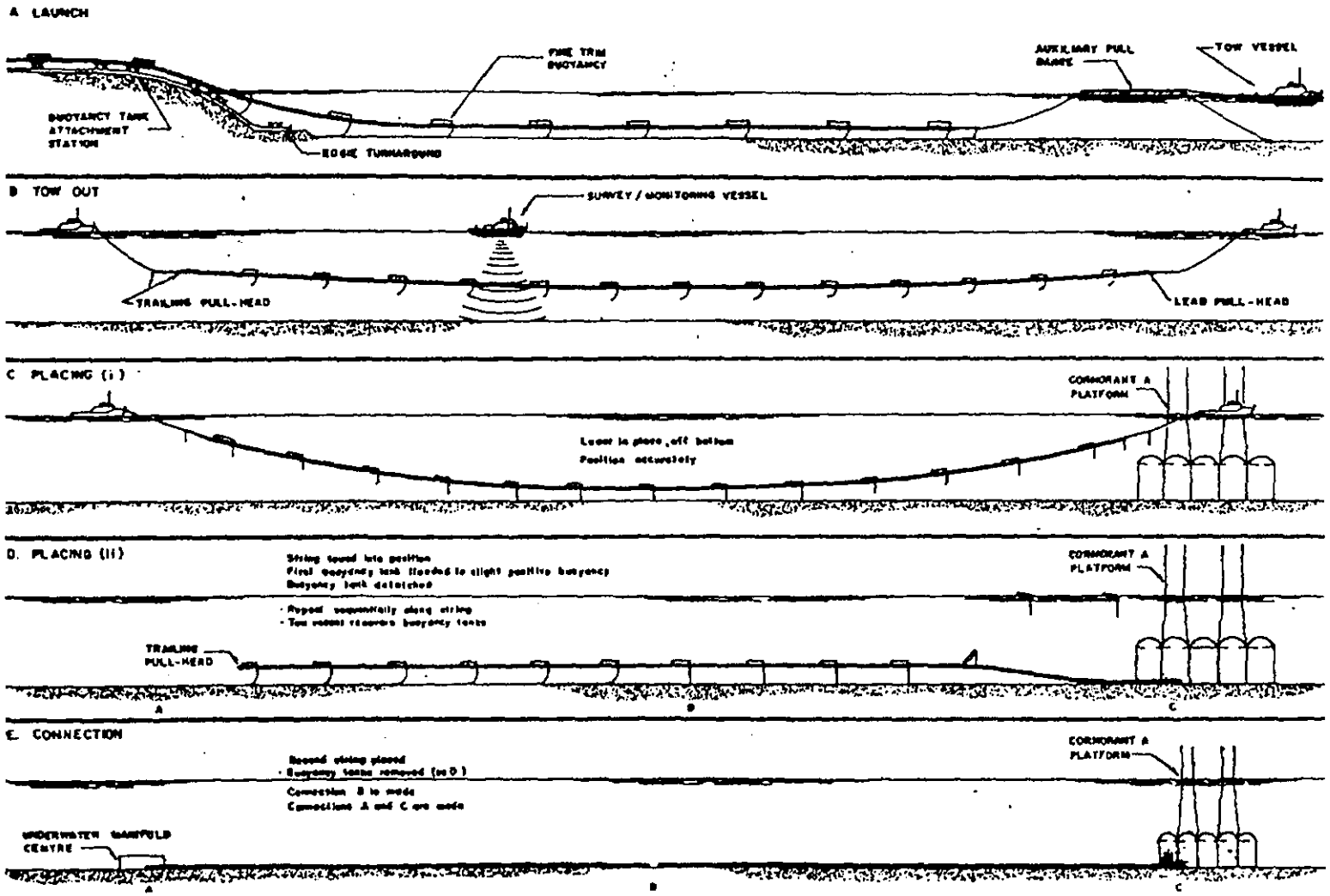



Figure A3.1f Mid Depth Tow

ERM Hong Kong

11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

ERM

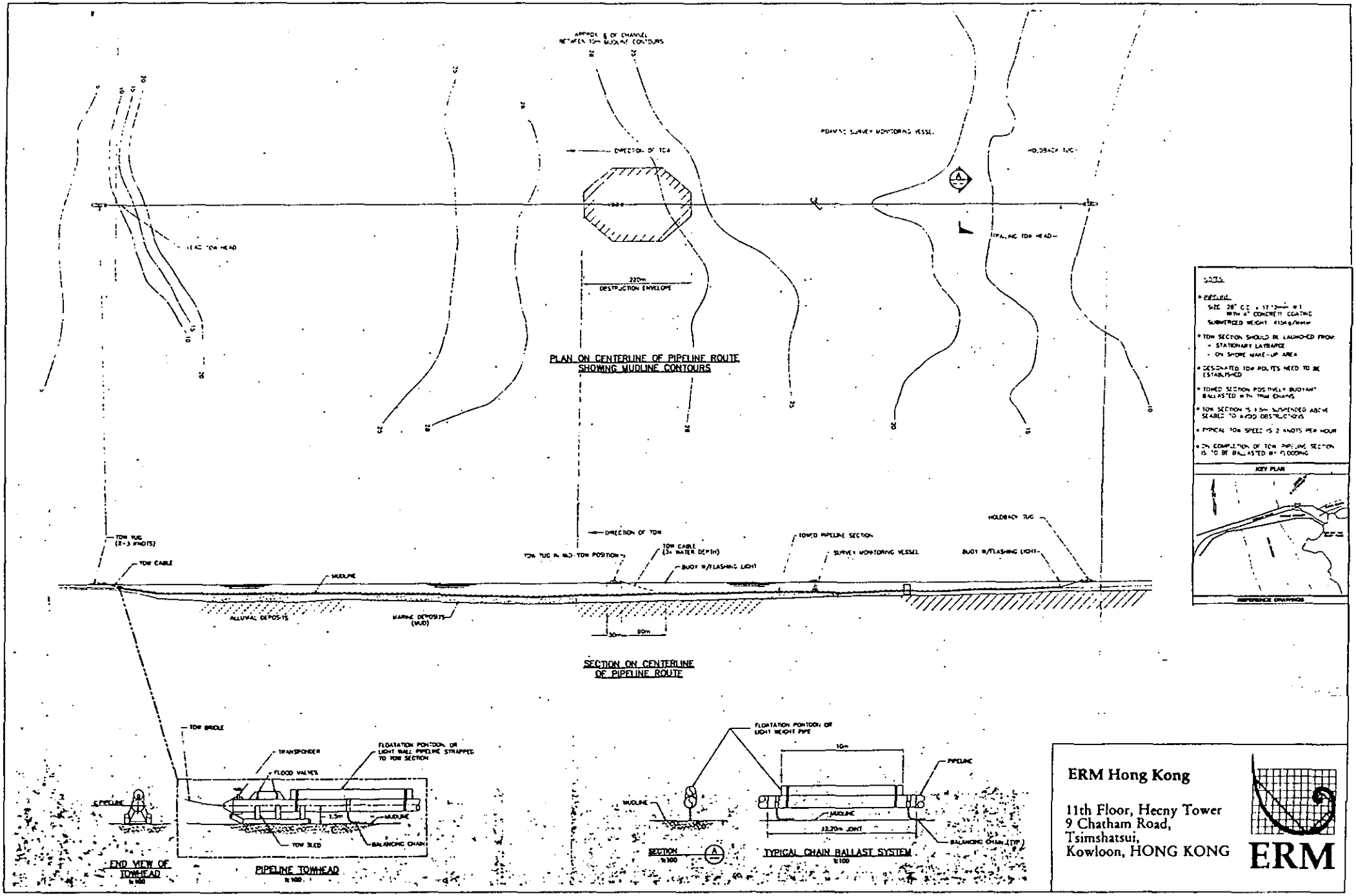



Figure A3.1g Urmston Road Channel Typical Near Bottom Tow Obstruction Envelope

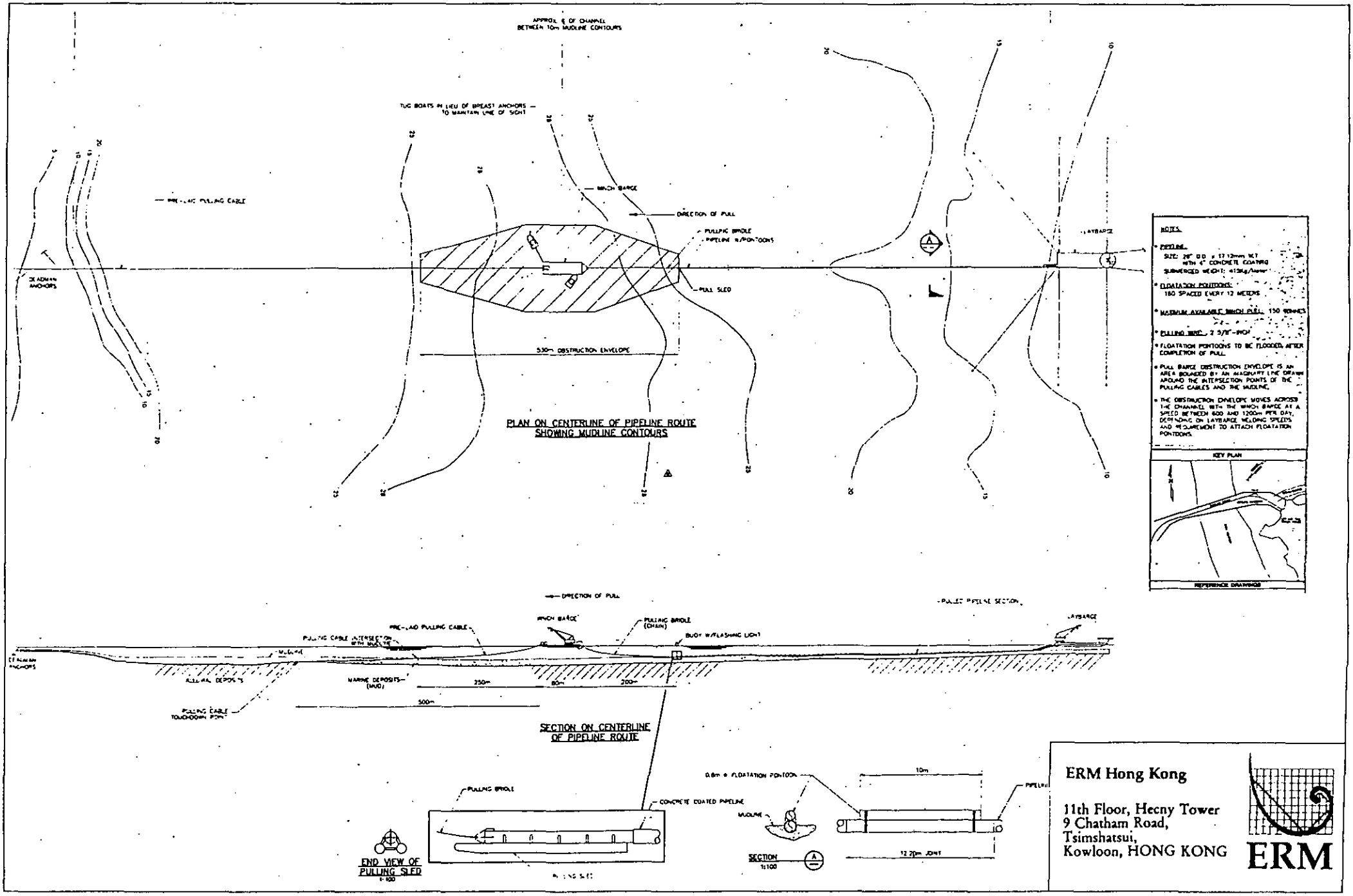



Figure A3.1h Urmston Road Channel Typical Pullbarge Obstruction Envelope Alternative 1

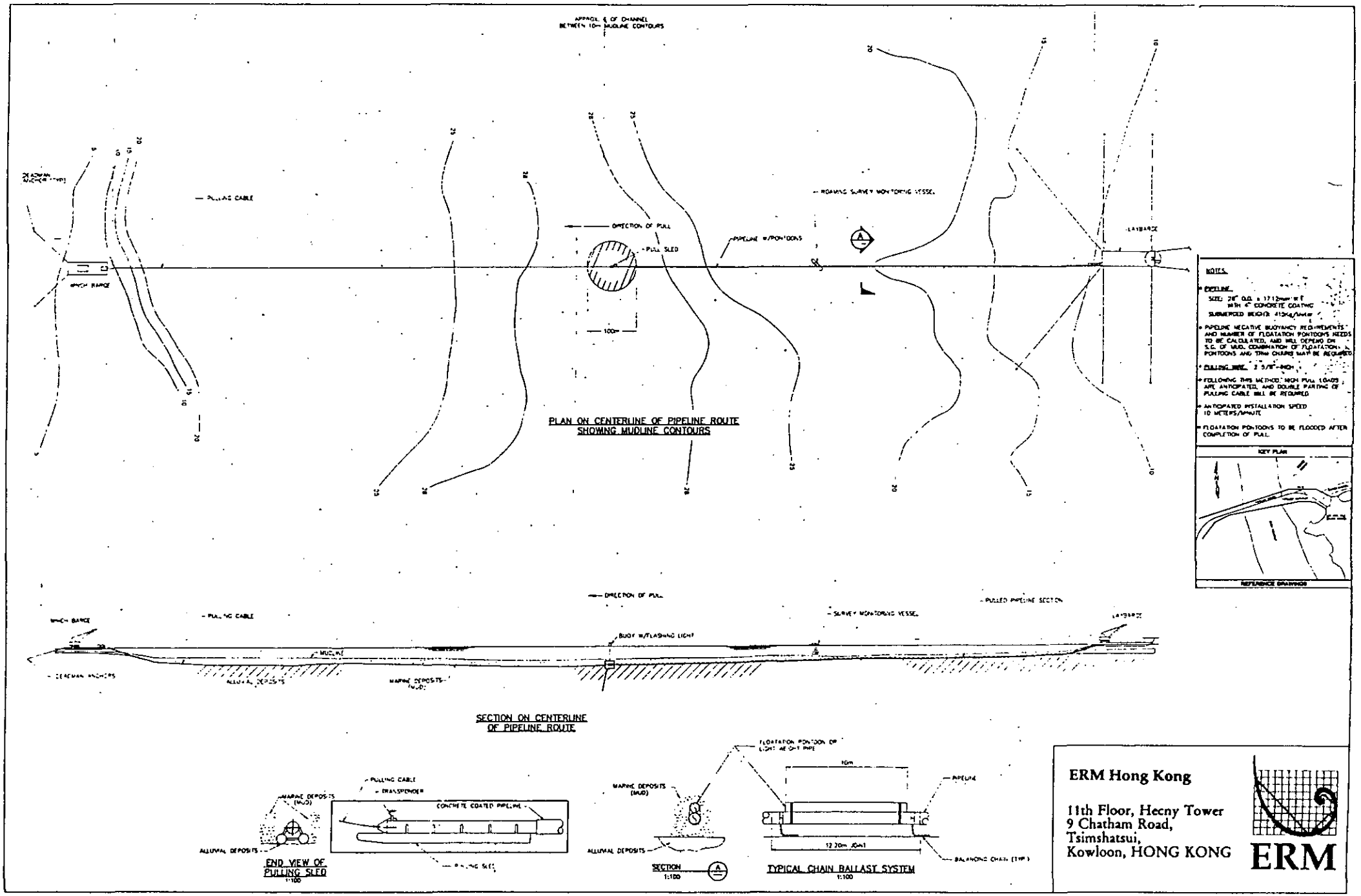
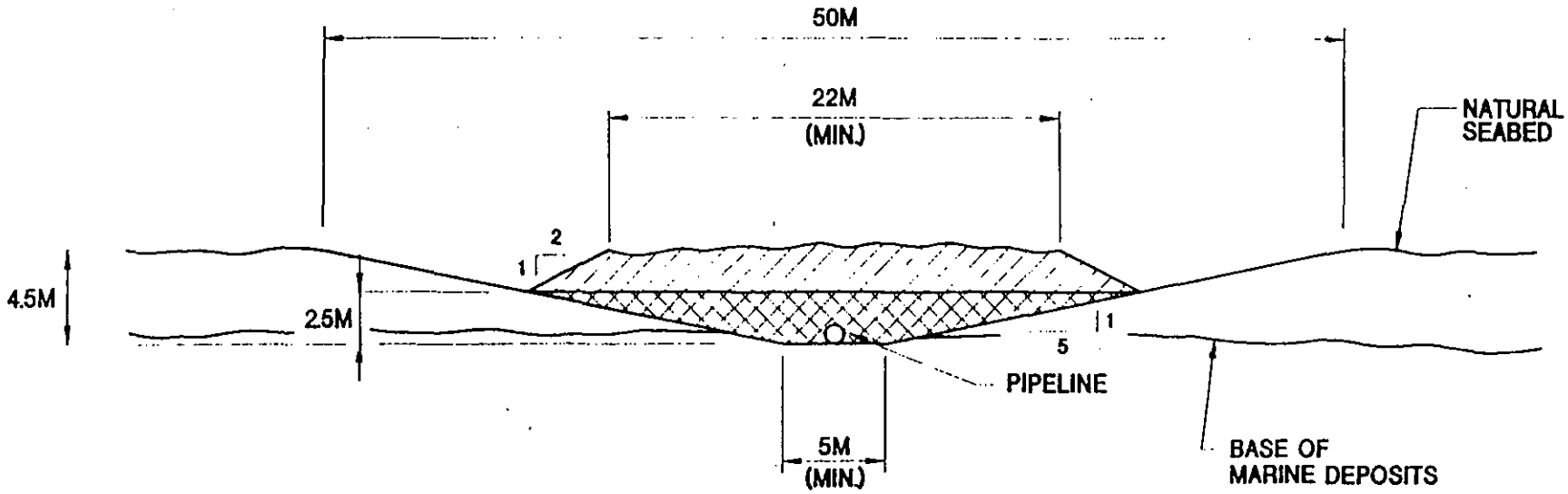



Figure A3.1i Urmston Road Channel Typical Pullbarge Obstruction Envelope Alternative 2




KEY

TOP LAYER OF BACKFILL

BOTTOM LAYER OF BACKFILL

Figure A3.1j

Urmston Road Channel Pipeline Protection

ERM Hong Kong

11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

ERM

*Off-Bottom Tow*

In the off-bottom tow method, the pipeline is made slightly positively buoyant. Chains are then added to increase the weight so that the pipe itself floats a short distance from the bottom, but the chains trail on the seabed.

Since the system is now floating, an additional vessel may be required at the trailing end of the line to provide control and stability. An illustration of the off-bottom tow is presented in *Figure A3.1e.*

*Mid Depth Tow*

The pipeline and rigging design for this method is similar to the off-bottom technique, the difference lies in the fact that the ends of the pipeline are pulled upwards so that the line adopts a catenary shape. The tow vessel and the hold-back vessel support the submerged weight of the system and apply horizontal forces to ensure that the curvature of the pipeline is kept within satisfactory limits. An illustration of the mid depth tow is given in *Figure A3.1f.*

Each of these methods relies on the use of tugs to physically tow the pipeline from a shore based make up site, where the line is welded up into the desired pipe length, to the position of installation. One major advantage of the tow method is that extensive areas for anchoring spread will not be required. Thus resulting in limited disruption to local marine traffic. *Figures A3.1g-i* show the extent of the construction envelope.

### *A3.1.3 Post Trenching*

Post trenching is carried out subsequent to pipelaying installation to sink the pipeline to the desired depth in the seabed. Most recent developments on post trenching include mechanical pipeline trenching, jetting or fluidization. Details of the different post trenching techniques are given in *Annex III(d).*

As these post trenching methods are relatively new in Hong Kong, there is limited information available on the post-trenching methods which might be used and therefore the volumes of material which are likely to be displaced each working day cannot be determined with great accuracy.

- Post-trenching by ploughs or other similar mechanical pipeline trenching devices

  Of the several different types of mechanical post trenching methods which are available, towed ploughs are likely to be the most suitable because of the very soft seabed conditions which would make this method productive whilst hindering self-propelled ploughs. Ploughing involves pulling a `plough' under and around the pipeline forming a furrow for lowering the pipeline. The 'plough' cuts a trench with a side

slope matching the angle of repose of the soil. This slope controls the volume of soil to be removed and the quality of the soil (i.e. the density and the shear strength) greatly influences the magnitude of the required pull force. Based on the indicative data provided by J.P. Kenny, the plough would make two passes to achieve burial. Each pass would be undertaken at a rate of 600–1,200 metres per day, displacing about 3,800–7,600m$^3$ of mud over a working period of 15 hours.

- Post-trenching by jetting or fluidisation

  The soil conditions are not suited to fluidisation which is generally only applied to granular soils. The consultants have therefore assumed that burial will be achieved by jetting. Jetting will be accomplished by means of high pressure high velocity water jetted through nozzles cutting and emulsifying the sea bottom material with sea water. Air is injected hydropneumatically lifting the soil from the trench to allow the pipeline to sink to the desired depth. The disturbed sediments/particles then settle along the sea bottom and the air will rise to the surface. As with ploughing, 600–1,200 metres of advance per day is assumed over a 15 hour working period, involving the displacement of 8,100–16,200m$^3$ of mud. This is equivalent to forming a trench 4.5 metres deep and 3.0 metres wide. However, it should be noted that it would not be possible to form a trench with these dimensions; our assumption is based on progressive displacement and partial burial of the pipe accompanied by a continual sloughing of the 'trench' slopes.

During post trenching, marine mud removed from the path of the jet sled or the `plough' is deposited along the side of the pipe route. Disposal of trenched material is not necessary.

### *A3.1.4 Back Filling*

The trench will have to be reinstated after installation of the pipeline and the pipeline protected with a cover layer sufficient to resist damage by dredging anchors or fishing activities.

It is estimated that about 300,000m$^3$ of backfill material will be needed for the 5km pipeline section. While the size, type and grade of material are not known at this stage, backfill material expected to be imported is sand, gravel and rock. An illustration of the pipeline protection system is shown in *Figure A3.1j*.

Backfilling of the trench onshore and in the intertidal zones will be performed by landbased equipment.

## A3.2 WATER QUALITY

### A3.2.1 Introduction

The ARCO submarine pipeline route is located on the outer rim of Deep Bay. Deep Bay is an area of predominantly estuarine water and intertidal mudflats with a main drainage channel running through its centre in a north easterly direction. It is a shallow estuary with an average depth of 2.9m and the seabed is relatively flat. The proposed pipeline corridor falls in the deeper water (with average depth of 13m) of Deep Bay by the Urmston Road.

Under the Water Pollution Control Ordinance, Hong Kong waters are subdivided into 10 Water Control Zones (WCZ). Each Water Control Zone has a designated set of statutory Water Quality Objectives (WQO). Deep Bay falls within the Deep Bay Water Control Zone. To protect the marine waters in the Deep Bay area, marine activities in the region shall not cause a deterioration in water quality and must be in compliance with the Deep Bay WQO's. These are outlined in *Table A3.2a.*

### A3.2.2 Baseline Conditions

*Existing Water Quality*

In the Deep Bay region, water quality is largely controlled by the fluvial input from the Pearl River, Shenzhen and Yuen Long Rivers, coupled with the ocean currents of the South China Sea. Consequently the shallow waters of Deep Bay are turbid and suspended sediment levels are very variable. This estuarine mixing zone of saline and fresh waters produces wide salinity variations with depth, location and time. A stratified salinity profile is prominent during the summer in Deep Bay when river flows are at their highest and the surface salinity falls to its lowest value.

The water quality in the region is well documented by the EPD marine water quality monitoring programme, and from CLP monitoring results as part of the EIA study for the proposed LTPS at Black Point. Monitoring stations are located in the immediate vicinity of the proposed Black Point Power Station reclamation site off Black Point. A summary of both EPD and CLP Data (for 1990) are given in *Table A3.2b.*

*TableA3.2a Summary of Water Quality Objectives for Deep Bay*

| Water Quality Parameters | | Objective | Sub-zone |
|---|---|---|---|
| Offensive odour, tints and colours | - | not to be present | whole zone |
| Visible foam, oil grease, scum, litter | - | not to be present | whole zone |
| E. coli | - | annual geometric mean not to exceed 610/100 mL | secondary contact recreation subzone |
| D O within 2m of bottom | - | not less than 2 mg/L for 90% samples | outer marine subzone except mariculture subzone |
| Depth average D O | - | not less than 4 mg/L for 90% samples | outer marine subzone except mariculture subzone |
| D I at 1 m below surface | - | not less than 4 mg/L for 90% samples | inner marine subzone except mariculture subzone |
| | - | not less than 5 mg/L for 90% samples | mariculture subzone |
| pH | - | to be in the range 6.5 - 8.5, change due to waste discharge not to exceed 0.2 | whole zone except bathing beaches |
| Salinity | - | change due to waste discharge not to exceed 10% of natural ambient level | whole zone |
| Temperature change | - | change due to waste discharge not exceed 2°C | whole zone |
| Suspended solids | - | waste discharge not to raise the natural ambient level by 30% nor accumulation of suspended solids | whole zone |
| Toxicant producing significant toxic effect | - | not to be present | whole zone |
| Ammonia | - | annual mean not to exceed 0.021 mg/L calculated as unionised form | whole zone |
| Nutrients | - | quantity shall not cause excessive algal growth | whole zone |
| | - | annual mean depth average inorganic nitrogen not to exceed 0.7 mg/L | inner marine subzone |
| | - | annual mean depth average inorganic nitrogen not to exceed 0.5 mg/L | outer marine subzone |

In general, the water quality for Outer Deep Bay is fairly good with determinands such as BOD, COD, phenols, E. Coli and DO meeting the WQO. As stated earlier, suspended solids (SS) levels and the associated turbidity are very variable due to the Pearl River and Deep Bay catchment inputs, with SS ranging from 2.5 - 91 mg/l recorded. The low transparency levels in Deep Bay show the silty condition of this waterbody. Toxic metal contamination is low in this location. The SS levels in the Deep Bay borrow area where the pipeline traverses is discussed in greater detail below.

*The Natural Sediment Regime*

Any assessment of the potential primary impacts of the pipeline burial operation must be made in the context of the natural movement of sediment in Urmston Road. The area is characterised by the one of the highest and most variable suspended sediment concentration in Hong Kong. The sediment transport across the proposed pipeline corridor is substantial.

Near-surface currents reach a maximum of about 1.75 m/sec during the later stages of the ebb tide. Maximum currents during the flood tide are understood to be of the order of 0.75 m/sec. For the purposes of this assessment, we assume an average current speed of 0.75 m/sec during the ebb tide and 0.30 m/sec during the flood tide. If an average water depth of 13 metres is assumed along the 5,000 metre pipeline corridor, the average water flow can be taken as 48,750 $m^3$/sec and 19,500 $m^3$/sec during the ebb and flood tides respectively.

Suspended solids concentrations are extremely variable and are known to exceed 1,000 mg/l on occasions. For the most part, the highest concentrations are in the lower part of the water column. The SS levels as presented in *Table A3.2c*, were measured in water samples taken near the Deep Bay Borrow Pit during the ebb tides on May 23rd 1993.

Very high concentrations can, however, occur throughout the water column, particularly during the passage of the salt wedge. Observations made last year using an Acoustic Doppler Current Profiler showed concentrations of several hundred mg/l as the salt wedge passed through a transect extending across Urmston Road immediately north of the pits [1].

[1] Source: Report on Surveys and Dumping Experiments Undertaken in the Redundant Marine Borrow Pits off Black Point in Urmston Road. Final Report to GEO/CED under Fill Management Study Phase II, February, 1993, 2 vols, Binnie Consultants Limited.

Table A3.2b
Marine Water Quality off the LTPS Site at Black Point

| Parameter/Determinands in mg/l unless otherwise specified | Outer Deep Bay | | | |
|---|---|---|---|---|
| | EPD's 1990 Monitoring Results | CLP EIA Monitoring Results | | |
| | | Oct 1990 | Nov 1990 | Dec 1990 |
| pH (pH units) | m 8.3<br>r 7.9 – 8.6 | 7.8 | 8.1 | 8.2 |
| temperature °C | m 23.4(S) 24.3 (B)<br>r (15–30) (15–30) | 23 | 21.3 | 19 |
| Colour (Lovibond Units)* | 5.22 (NTU) | 3.4 (NTU) | 0.6 (NTU) | 0.7 (NTU) |
| Suspended Solids | m 20<br>r 2.5 – 91 | 7.7 | 2 | 2 |
| BOD | m 1.2<br>r 0.2 – 5.4 | 1 | <1 | 1 |
| COD | n.r. | n.d. | n.d. | n.d. |
| Oil & Grease | n.. | 0.2 | 0.07 | 1 |
| Iron | n.r. | 0.43 | 0.091 | 0.068 |
| Boron | n.r. | n.d. | n.d. | n.d. |
| Barium | n.r. | n.d. | n.d. | n.d. |
| Mercury | n.r. | n.d. | n.d. | n.d. |
| Cadmium | n.r. | <0.00005 | <0.00005 | 0.00013 |
| Other toxic metals individually | n.r. | see below | see below | see below |
| Total toxic metals | n.r. | see below | see below | see below |
| Cyanide | n.r. | n.d. | n.d. | n.d. |
| Phenols | n.r. | n.d. | n.d. | n.d. |
| Sulphide | n.r. | <0.01 | <0.01 | n.d. |
| Total residual chlorine | n.r. | <0.01 | <0.1 | n.d. |
| Total nitrogen | m 1.1<br>r 0.6 – 2.3 | 0.23 | 0.77 | n.d. |
| Total phosphorus | m 0.13<br>r 0.03 – 0.4 | 0.21 | 0.25 | n.d. |
| Surfactants (total) | n.r. | 0.01 | <0.05 | n.d. |
| E. Coli (count/100ml) | m 25<br>r 0– 470 | 300 | 200 | 200 |
| Calcium | n.r. | 334 | 371 | 380 |
| Sulphate | n.r. | 2200 | 2300 | 2310 |
| Dissolved Oxygen | m 7.2<br>r 6.3 – 8.7 | 7.7 | 7.8 | 8.3 |
| Salinity (g/kg) | m 19<br>r 8 – 29 | 29 | 27 | 28 |
| Ammonia (as N) | n.r. | 0.02 | 0.46 | n.d. |
| Chromium | n.r. | 0.00009 | 0.0015 | 0.0014 |
| Copper | n.r. | <0.005 | <0.005 | <0.005 |
| Lead | n.r. | 0.0007 | 0.00038 | 0.00066 |
| Nickel | n.r. | <0.005 | <0.005 | <0.005 |
| Zinc | n.r. | 0.0083 | 0.0054 | 0.0049 |
| Arsenic | n.r. | <0.001 | <0.001 | <0.001 |
| Manganese | n.r. | 0.029 | 0.038 | 0.020 |
| Selenium | n.r. | <0.001 | <0.001 | <0.001 |

Note: m – mean , r – range, n.r. – not recorded

*Table A3.2c Suspended Solids Concentration near the Deep Bay Borrow Pit*

| Depth below surface, metres | Suspended solids, mg/l |
|---|---|
| 6 | 11 |
| 11 | 46 |
| 14 | 58 |
| 17 | 306 |
| 19 | 438 |

Note: Each of the above concentrations was derived from a total of 12 solid determinations on water samples.

Source: Dredging Research Limited

As a very approximate indication of the sediment transport, an average concentration of 100 mg/l has been assumed. When combined with the typical current velocities derived above, the rate of natural sediment transport across the pipeline corridor can be estimated to be 4.87 and 1.95 tonnes/sec on the ebb and flood tides respectively. The rate of sediment transport is clearly very substantial.

*Sediment Quality*

The gas pipeline will approach Black Point from the west and traverse the marine borrow area used as fill material for land formation for the Tin Shui Wai Development. The borrow area comprises a series of dredged pits, some of which extend to about -44 mPD. During the Tin Shui Wai project, some of the pits were backfilled, or partially backfilled, using overburden dredged from adjacent pits and from a second borrow area located inside Deep Bay. The backfill comprises a mixture of trailer and grab dredged marine muds and alluvial clays. Sediment analysis were undertaken during the New Airport Master Plan Study for the Deep Bay Marine Borrow Area where the pipeline crosses. Sediment analyses as presented in *Table A3.2d* indicates that the sediment quality at the Deep Bay Borrow Area are classified as uncontaminated. For the marine mud at the Chek Lap Kok airport reclamation area, consultation with the Fill Management Committee (FMC) indicated that the marine mud from the Chek Lap Kok area is considered "clean" and is being used as backfill for the Outer Deep Bay and Urmston Road borrow area. Sediment analyses around the Black Point shore area indicates that the sediment is classified as Class B, i.e., moderately contaminated. It is noted that of the 82 samples taken in the Black Point area, only 5 samples were considered to have exceeded the concentration of only one metallic species, that is, lead. In addition, these sediments are confined to the upper layer (0.1 - 2m depth) which will have been removed during dredging for the Large Thermal Power Plant site.

*Figure A3.2a* shows the sediment sampling area for the Marine Borrow Area and the LTPS site. Although only a relatively small area of the pipeline corridor has been sampled, the extensive area around the pipeline corridor

that were sampled should give a true representation of the sediment condition in the pipeline corridor.

*Table A3.2d Sediment Analysis of Marine Mud at Deep Bay Marine Borrow Area*

| Parameter | Concentration as mg/Kg dry weight mean (range) | Class A Classification* |
|---|---|---|
| | Deep Bay Marine Borrow Area | |
| Copper | 17 (7–33) | 0–54 |
| Cadmium | 0.6 (0.5–0.9) | 0.0–0.9 |
| Chromium | 19 (14–23) | 0–49 |
| Nickel | 20 (16–24) | 0–34 |
| Lead | 47 (39–55) | 0–64 |
| Zinc | 70 (53–92) | 0–140 |
| Mercury | 0.14 (0.05–0.46) | 0.0–0.7 |

Note: * Classification of Dredged Sediments for Marine Disposal – Technical Circular No (TC) No 1–1–92

Source: New Airport Master Plan Study.

*Water Sensitive Receivers*

Water Sensitive Receivers (WSRs) are defined in the Hong Kong Planning Standards and Guidelines and are generally beaches, mariculture zones, Site of Special Scientific Interest (SSSIs), etc . The nearest WSRs that could potentially be affected by the installation of the submarine pipeline are identified below:

- Deep Bay Mariculture Zone and Leased Oyster Bed – approximately 2km to the North East
- Pak Nai SSSI – around 5 km to the North East
- Lung Kwu Chau, Tree Island and Sha Chau SSSI – about 3km to the South
- Non gazetted bathing beaches, namely, Lung Kwu Upper and Lung Kwu Lower – approximately 2km and 4km to the South East respectively
- Cooling Water Intakes of Castle Peak Power Station – the route comes within the 5 km `sensitive zone' radius implemented by CLP, being about 4km from the CPPS.

The locations of the WSRs in the Outer Deep Bay area are shown in *Figure A3.2b.*

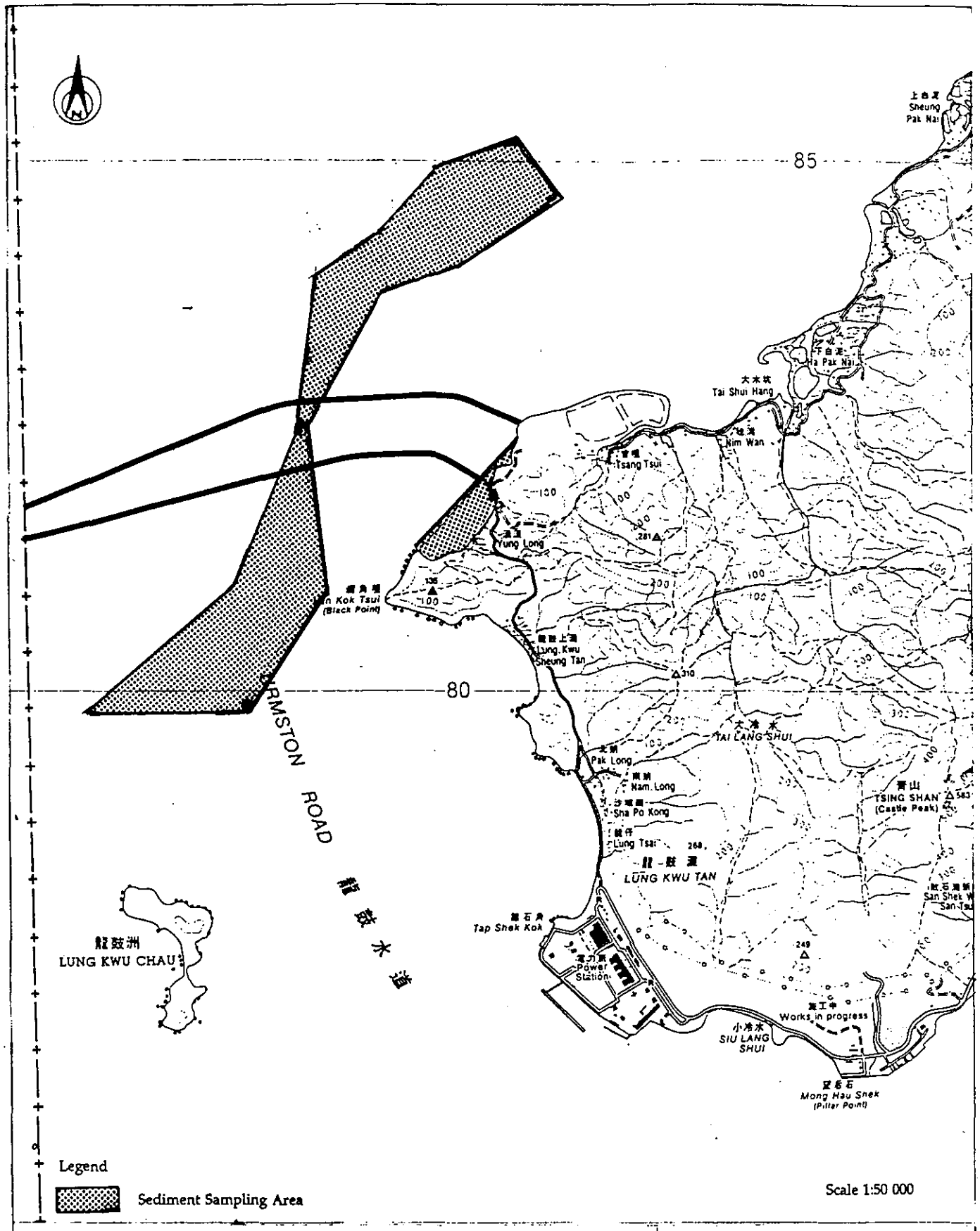



Figure A3.2a

Sediment Sampling Area

ERM Hong Kong

11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

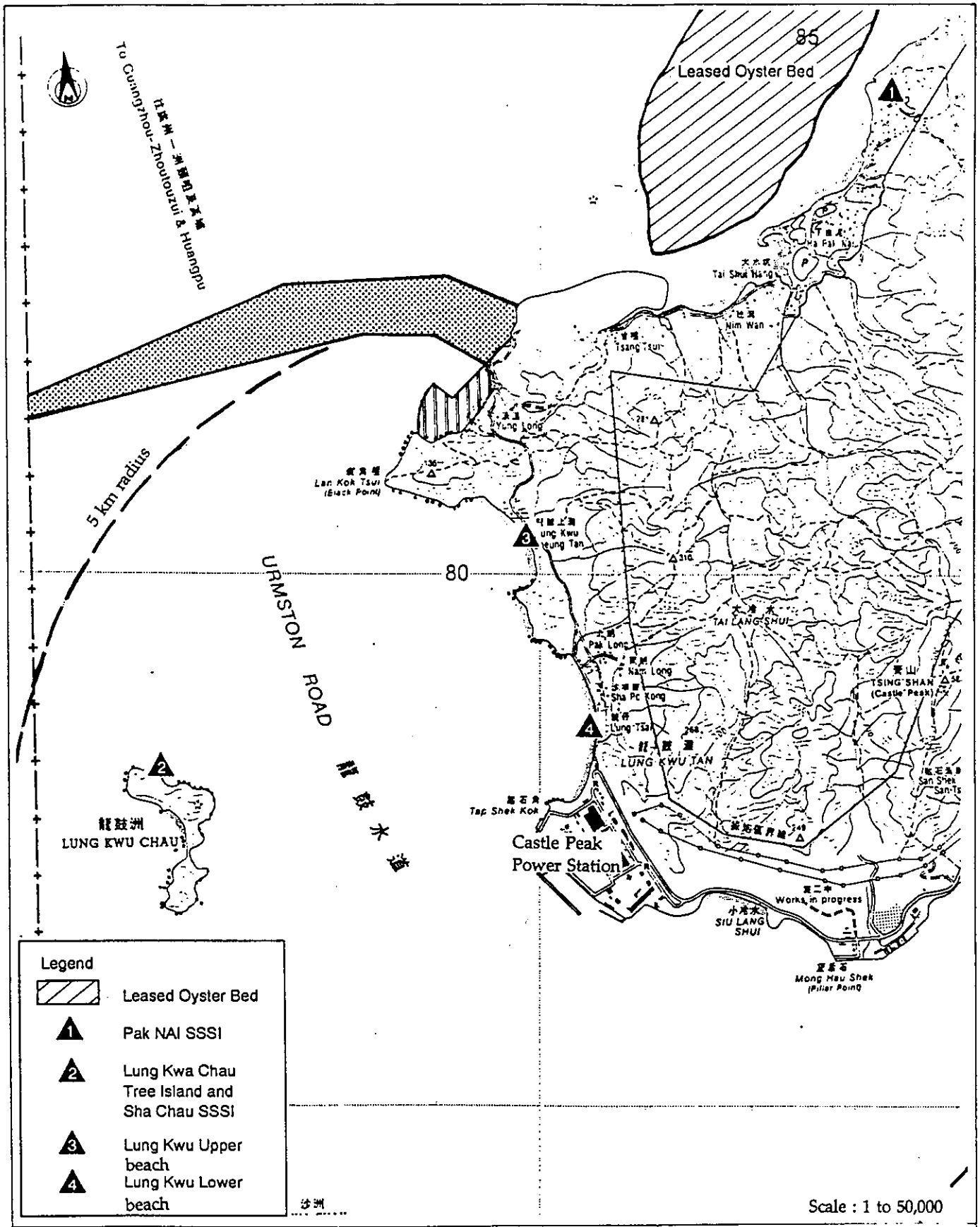



Figure A3.2b

Water Sensitive Receivers

ERM Hong Kong

11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

ERM

*A3.2.3* *Assessment Criteria*

Water quality impacts from the pipeline construction works within the proposed pipeline corridor will be assessed with respect to the Deep Bay WQO, and in relation to the baseline data collated from the EPD and CLP's monitoring records. The Deep Bay WQO of most relevance during the pipeline installation will be the suspended solids (SS) and the dissolved oxygen DO level parameters. Marine activities during the pipeline installation must not cause the natural ambient SS level to be raised by more than 30% nor give rise to accumulation of SS. Requirements for DO levels vary for the different areas of Deep Bay, with the most stringent applying to the mariculture subzone where DO levels should not be less than 5 mg/l for 90% of the samples. DO levels for other areas have to be above 2mg/l at the sea bottom and above 4mg/l at depth average.

For the purpose of this assessment, the consultants assumed that the length of the pipeline across Urmston Road to Black Point is 5,000 metres and that the pipe is to be placed to a depth of 4.5 metres.

*A3.2.4* *Review of Previous Relevant Studies*

There have been a number of recent developments in the Deep Bay area which involve marine activities such as dredging and reclamation work for which sediment and metal dispersion modelling have been undertaken. These include the EIA of the Tin Shui Wai Development – Land Preparation Aspects 1985; the EIA for CLP's Proposed LTPS at Black Point 1992; and the New Airport Master Plan – EA of Construction Impacts 1991. *Figure A3.2c.* shows the study area.

Some general observations regarding the likely behaviour of sediment carried into suspension and thus the potential for impacts to occur can be made based on knowledge of background conditions, and on sediment and metal dispersion modelling results obtained from similar studies in the area.

- Tin Shui Wai Development 1985. EIA of Land Preparation Aspects.

The effect of sediment deposition in waters around the Outer Deep Bay borrow area was extensively studied. A mathematical model (SPOIL) was constructed to allow predictions of movement and subsequent settlement of released material during dredging activities. Results from the SPOIL model have shown that suspended sediment settles out relatively rapidly. Adjacent to the dredger, the natural SS concentrations are greatly increased, and outside the immediate vicinity of the dredger the natural concentrations are doubled. The major component of the concentrations distant from the dredger is the residual build up due to continuous dredging.

The study concluded that while dredging in Outer Deep Bay might generate 50 mm per annum deposition it was unlikely to cause problems for biota dwelling near coastal areas. The critical rate of burial of Deep Bay oysters was estimated to be 50 mm/yr, while a rate of less than 5 mm/yr was

thought to be negligible [1]. According to the study, the Deep Bay mariculture subzone and Pak Nai SSSI would not be significantly affected by high particulate loadings as coarse sand would probably settle near the source while fines would be flushed southwards by moderately strong water currents induced during ebb tides. While dredging away from the oyster beds is preferable the study indicated that any of the feasible dredging methods could be carried out without substantial impact to the Hong Kong oyster beds.

- EIA of the Proposed LTPS at Black Point: Initial Assessment Report 1992.

As part of the EIA for CLP's LTPS at Black Point – hydraulic and water quality modelling was undertaken by Hydraulics Research Ltd. The size of the sediment plume generated by dredging activities was estimated using a simplified Gaussian plume model and predictions of sediment movement determined under different conditions of tide. The results indicated that the concentration of SS in the plume would on average be 2.5 mg/l on the flood tide and 1.6 mg/l on the ebb tide due to the strong tidal currents in the Black Point area. It is likely that the sediment plume from dredging activities will approach Outer Deep Bay during the flood tide. When these SS levels are related to the ambient conditions in Outer Deep Bay, it is noted that higher SS levels from dredging will be acceptable.

- New Airport Master Plan. EA of Construction Impacts 1991.

Deep Bay is designated as the borrow and spoil disposal area for the new airport at Chek Lap Kok and associated infrastructure projects. Potential impacts arising from dredging activities and spoil disposal operations in the region were simulated using sediment dispersion, transport and deposition models. The study indicated that sediment resuspended in the water column will be dispersed over a large area at low concentrations within a few tidal ranges. Exceedance of the natural background levels will only occur in the workplace vicinity where the marine sediment is disturbed.

The simulations of dumping at Deep Bay indicated no significant movement of the sediment plume or areas of increased deposition in the vicinity of oyster beds. Similarly, dredging for marine mud in the southern part of the Deep Bay borrow area was predicted to result in 2mg/l increase in the upper layer with up to 8mg/l at the peak of the ebb tide. For the lower layer, the corresponding increases would reach 25mg/l. For the northern end of the Deep Bay borrow area, a similar effect is anticipated with a maximum increase in the upper layer at the peak of the ebb tide of 12mg/l. At the oyster bed, the predictions of the sediment transport model indicated that there will be increases in suspended solids concentrations for part of the tidal cycle. However, this is considered insignificant when compared to the natural variation in the Deep Bay Area.

[1] R. A. Bowler, 1985, Coastal Pollution due to land formation – a case history. Polmet 85 – Pollution in the Urban Environment.

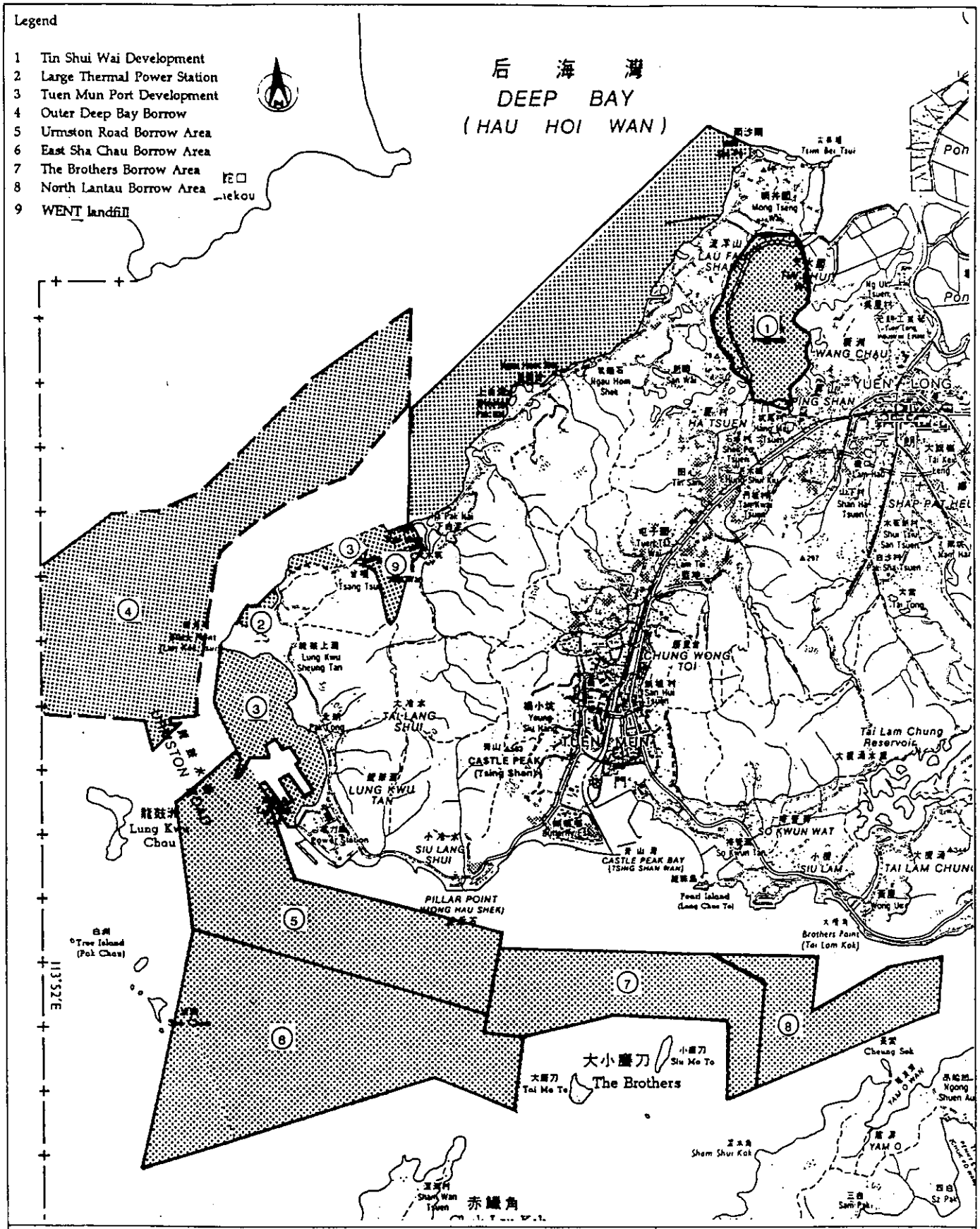



Figure A3.2c

Study Area for Previous Relevant Studies

ERM Hong Kong

11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

ERM

Simulation of simultaneous dredging and dumping at Deep Bay and the Brothers borrow area indicated that no adverse effects on the oyster bed are expected. In general, concentration increases of less than 10mg/l are anticipated with over 10mg/l increases being experienced over a small area of the oyster beds for part of the tidal cycle which in comparison with the natural ambient range is insignificant.

Impacts were assessed mostly in relation to the Castle Peak Power Station (CPPS) cooling water intake as this was considered the key sensitive receiver in the area, where suspended solids concentrations must not exceed 150 mg/l within a 5km radius from the intake. The impact of dredging in the Deep Bay Borrow Area is predicted to be small. The SS concentration resulting from planned dredging operations would be within the tolerable threshold limit set at the CPPS intake. For spoil disposal in Outer Deep Bay, the study revealed that impacts are likely to be greatest during the wet season spring tide operations. However, it is not anticipated to cause any exceedance of the maximum level at the CPPS intake.

Dredging activities at the Airport site will result in a sediment plume in the southwesterly direction along the coast towards Tai O. SS concentration contours indicate that the disturbed sediment would be carried into the 5km zone but the power station intake will not be within the 0–2.5mg/l contour.

The New Airport Master Plan concluded that the effects of dredging, borrowing and disposal operations will not cause deterioration of water quality at the WSR beyond tolerable limits. Predicted impacts are generally within the range which would be experienced under ambient conditions. A restriction on sand winning at Urmston Road and Deep Bay during the peak of the ebb tide would minimise the potential adverse effects at the power station.

### A3.2.5 *Potential Sources of Impacts*

Disturbance to marine mud and the water column is inevitable during the various stages of the pipeline installation. However, it is envisaged that the major source of impact will be from the dredging and post trenching operations whereby the degree of disturbance is the greatest. Impacts on water quality from disturbance of the marine muds may arise from the following:

- physical effects such as the suspension of solids in the water column, leading to a reduction in light penetration and increased retention of heat.

- chemical effects resulting from the release of sediment constituents such as toxic metals and complex organic compounds or material that has an oxygen demand.

The level of oxygen saturation is of particular concern as a number of effects produced by sediment suspension combine to lower it. Reduced light penetration reduces photosynthesis and thus the rate at which oxygen is

produced in the water column. Similarly, the increase in solids in the water column results in more energy from sunlight being retained, which increases the temperature. This also acts against oxygen levels as oxygen is more soluble in colder water. Furthermore, reduced primary production reduces the uptake of nutrients from the water column.

In both cases the extent of impact is related to the amount of material put into suspension. This is a function of the quantity and nature of the sediment, and the method of dredging. Chemical effects are also a function of the degree of sediment contamination. Potential physical and chemical effects are further considered below.

- **Physical Effects**

  Physical effects will depend on the amount of material put into suspension during dredging/post trenching activities. This will depend, in part, on the trenching technique applied as discussed in *Section A3.1.*

  As far as we are aware, the amount of sediment released to the water column when ploughs or jetting systems are used for burial has not been measured. There are numerous measures of the amount of sediment released by conventional dredging plant but, of course, considerable care should be exercised when using such published measurements because of numerous potential differences between the conditions in which the measurements were undertaken and the conditions at the site in question. These include :

  - soil type,
  - the detailed design of the dredger and the manner in which it operates,
  - the hydrodynamic conditions.

  Trailer dredgers can, when working carefully, without overflowing or the use of Automatic Lean Mixture OverBoard (ALMOB) systems and in a quiet hydrodynamic environment with reasonable water depths, work relatively cleanly. In such conditions, they may put less than 5 kg of sediment into suspension for each cubic metre dredged. As conditions become less favourable, the amount of sediment which is lost will rise. For the ARCO pipeline, because of the strong currents, sometimes shallow water and because the use of ALMOB is likely to be necessary for economic working, losses are likely to be of the order of 50 kg/$m^3$. A medium to large trailer dredger is likely to load at a rate of about 1.5 $m^3$ of in situ mud per second and the near-field rate of loss of sediment may thus be of the order of 75 kg/sec whilst it is actually dredging. The actual overall rate of loss will depend on the number of dredgers which are required to maintain a rate of progress compatible with programme requirements. This in turn will depend on the distance to the disposal area and the rate at which natural sediment accumulates in the trench. Assuming disposal to South Cheung Chau, this would require a trailer to make about three to four round trips each day, irrespective of its size.

The loss of sediment when post-trenching by ploughing is likely to be somewhat greater despite the fact that slurrified sediment will not be discharged at a high level in the water column. We have intuitively assumed a near-field loss of 75kg/m$^3$. Based on a worse case production estimate of displacing 7,600m$^3$ over a working period of 15 hours, a rate of loss of about 10.6kg/sec is predicted.

In the case of jetting, the loss of sediment is likely to be substantial when viewed in terms of kg/m$^3$ because the mud will be largely slurrified by the action of the jets and then discharged adjacent to the trench by the educators. A loss of as much as 50% is conceivable although much of this is unlikely to travel any great distance because it will be discharged very close to the seabed and, even though slurrified, will contain a large proportion of small lumps. Based on a 1,200 metres rate of advance per day over a 15 hour working period, 16,200 m$^3$ of mud will be displaced. If the loss is as much as 50% and the seabed density is taken to be 1,450kg/m$^3$, then the rate of loss will be 108kg/sec.

An estimated rates of natural sediment movement as discussed earlier in Section A3.2.2 - *The Natural Sediment Regime* and sediment loss during trenching are summarised in *Table A3.2e.*

*Table A3.2e* *Loss of Sediment into the Water Column from Natural Sediment Transport and Trenching*

| Transport/loss situation | Amount of sediment loss, kg/sec |
|---|---|
| Natural Sediment Transport, flood tide | 1,950 |
| Natural Sediment Transport, ebb tide | 4,875 |
| Trailer Dredging (One dredger) | 75 |
| Ploughing | 10.6 |
| Jetting | 108 |

These are broad estimates but it is quite clear that the rate of loss of sediment to the water column during trenching is between one and two orders of magnitude lower than the natural rate of sediment transport across the pipeline corridor. This constitutes an insignificant amount and that the trenching operations will have a negligible effect on the suspended sediment regime in Urmston Road. However, three other factors also need to be taken into account; the actual density of the seabed, the degree to which the sediment source is focused and the probable transport distance of the sediment.

The losses which have been assumed are based on the usual near-surface mud density of 1,450kg/m$^3$. However, the mud in the pits is unlikely to have a density as great as this when bottom-dumping from trailer dredgers. A density of 1,350kg/m$^3$ may be more realistic, in which case the losses may be reduced by approximately 25%.

In all three cases, the sediment will be released from a moving source. A trailer would work over as long a length of the trench as possible in order to maximise efficiency. Ploughing and jetting will take place over a distance of 1,500 metres, perhaps more, during the course of a working day. The sediment loss will therefore be well distributed, rather than focused at a point.

Much of the sediment will comprise very small lumps of mud. Only a small proportion is likely to be completely desegregated and this material will probably form flocs. It is therefore probable that a large proportion will settle within a few hundred metres of the pipeline. The estimated losses thus represent the near-field loss and the degree of far-field loss is likely to be less. The degree of desegregation of the sediment is likely to be greatest in the case of material lost by dredging and by jetting.

Based on the above discussion, the consultants therefore conclude that the trenching operations are not likely to have a significant effect on the suspended solids levels in the Urmston Road area. For the range of disturbance anticipated, the effects will be greatest in the case of dry-season operations using a jetting method and smallest when using a plough in the wet season.

- **Chemical Effects**

  Also of concern regarding water quality is the potential for toxic metal release from the sediments. Sediment analyses from New Airport Master Plan Study as shown in *Table A3.2d* indicates that the marine mud in the Deep Bay Borrow area where the pipeline corridor passes are essentially uncontaminated, as is the spoil from Chek Lap Kok that is used for backfilling the borrow pit. Mobilisation and release of toxic metals into the surrounding water column will therefore not be significant.

*A3.2.6* *Significance of Impacts*

*Cumulative water quality impacts from other dredging activities*

There are a number of ongoing or forthcoming developments in the Deep Bay area where dredging or backfilling activities will take place. These include the new Chek Lap Kok Airport, the Large Thermal Power Station (LTPS), the WENT landfill, Tuen Mun Port and borrow area in the Deep Bay area. It is likely that dredging works with the exception of the new Chek Lap Kok Airport projects will be completed before the ARCO submarine pipeline installation commences.

- LTPS

  The ongoing dredging work for the LTPS site commenced in March 1993 and is expected to be completed by July 1993. As the plant will be gas-fired, dredging of the access channel and turning basin for bulk coal carriers will not be necessary. Thus, dredging work for the LTPS site is most likely to be completed when the pipeline installation commences.

- WENT landfill and the Tuen Mun Port

  The WENT landfill is operational and the access channel and turning basin for the Island East Transfer Station (IETS) barge is being dredged. Therefore, dredging work should not coincide with the pipelaying schedule. Work for the Tuen Mun Port development is expected to start in 1995. Thus, marine dredging will not be concurrent with the pipeline installation.

- Borrow areas

  Backfilling at the Outer Deep Bay and Urmston Road borrow area are ongoing. These borrow areas have a total capacity of 20Mm$^3$ and are currently filled to about 11Mm$^3$. Backfilling is anticipated to be complete by the end of the year.

  The Inner Deep Bay borrow area is currently being filled with uncontaminated dredged mud from East Sha Chau. Backfilling is expected to be complete in 2 months. Based on this programme schedule, dumping at these borrow areas will not coincide with the pipelaying programme.

- Chek Lap Kok airport

  Dredging for the Chek Lap Kok Airport is most likely to have the greatest potential to increase particulate loading near these marine dredging areas as massive volumes of sediment (91M$^3$) will be removed over a three year period. It is likely that dredging for the airport will coincide with the current pipeline programme as dredging work is expected to last till end of 1994.

*Impacts on Water Sensitive Receivers*

The proposed pipeline installation will involve relatively small scale work as compared with the dredging activities for the airport projects. In addition, pipeline installation is envisaged to take around 4 months. Dredging/post trenching work will therefore be completed within a short duration. Based on the findings from-sediment plume simulations of various dredging and dumping operations in the Deep Bay area and the consultant's estimate of the sediment loss from the various operations in the region, the consultants conclude the potential water quality impacts from the pipeline installation will be within the natural ambient variation and therefore should not pose any problems to the WSRs.

- Mariculture Zone and the Leased Oyster Bed

  The Deep Bay oyster bed is approximately 2km from the pipeline corridor. Pipeline installation activity is not anticipated to be significant. As reported in the New Airport Master Plan, dredging and dumping activities in outer Deep Bay will generally result in maximum SS concentrations of less than 10mg/l at the oyster bed, with over 10mg/l

increases being experienced in a small area only within the oyster bed for part of the tidal cycle. Sediment release from the pipeline installation may cumulatively add to the SS levels, however, this is anticipated to be within the natural ambient range for the oyster.

- SSSI - Pak Nai, Lung Kwu Chau, Tree Island and Sha Chau

  The SSSIs are relatively far away (over 3km) from the pipeline corridor. It is envisaged that a fine portion of sediment will be experienced at the SSSIs during pipeline installation. This increase in SS levels is not considered likely to affect the birds or terrestrial life at the SSSIs.

- Non gazetted bathing beaches - Lung Kwu Upper and Lower

  Water quality impacts on bathing beaches will be on the aesthetics aspects. However, given the short duration of the pipe installation, this will only be temporary and will return to normal soon after installation work ceases. No unacceptable impacts are therefore anticipated at the beaches.

- Castle Peak Power Station (CPPS) cooling water intake

  The pipeline corridor falls within the 5km radius of the Castle Peak Cooling Water intake where SS levels must not exceed 150mg/l. Previous sediment modelling indicates that concurrent dredging/dumping activities at the Chek Lap Kok, Deep Bay and Urmston Road borrow areas will not cause an exceedance of the maximum level at the CPPS water intake. It is expected that similar or smaller scale of impacts will result from the pipeline installation and therefore should not cause unacceptable impacts at the CPPS.

### *A3.2.7 Mitigation Measures*

Although the pipeline installation work is not expected to result in a significant rise in suspended solids levels and the release of toxic metals, it is important that appropriate measures be undertaken to ensure that impacts can be kept to a minimum. The following mitigation measures have been identified and are discussed below.

*Dredging of Marine Mud*

Depending on the type of dredgers to be employed, attention to the dredging methods will be necessary. Measures to minimise pollution should include the following:

- cutterheads of suction dredgers should be suitable for the material being excavated and should be designed to minimise overbreak and sedimentation around the cutter

- Automatic Lean Mixture Overboard (ALMOB) is prohibited in dredging operations.

- mechanical grabs if used should be designed and maintained to avoid spillage and should seal tightly while being lifted

- all vessels should be sized such that adequate clearance is maintained between vessels and the sea bed at all states of the tide to ensure that turbidity is not generated by turbulence from vessel movement or propeller wash

- all pipe leakages should be repaired promptly and plant should not be operated with leaking pipes

- the Works should cause no visible foam, oil, grease, scum, litter or other objectionable matter to be present on the water within the Site or dumping grounds

- loading of barges and hoppers should be controlled to prevent splashing of dredged material to the surrounding water and barges or hoppers should not be filled to a level which will cause overflowing of material or polluted water during loading or transportation.

- pipeline installation work shall comply with the requirements stipulated by the Marine Department as presented in *Annex IV.*

- special measures shall be taken during transportation and disposal of the dredged material. These are discussed in *Section A3.3.4.*

These are no specific mitigation measures for ploughing and jetting operations due to the simplicity of its operation. Good operation practice is the principal mitigation measure; principally concerns operation at the required speed and required depth below the sea bed.

*Landbased Construction Activities*

Pipeline installation work will involve mainly marine activities. However, the onshore/offshore pipepulling and commissioning work will involve some shorebased activities. Special measures shall be undertaken to minimise water quality impacts:

- Disposal of any solid materials, litter or wastes to marine waters should be avoided

- All chemical stores shall be contained such that spills are not allowed to gain access to water bodies.

- All fuel tanks should be provided with locks and be sited on sealed areas within bunds of a capacity of 110% of the tank size.

- Chemical toilets or septic tanks with appropriate desludging arrangements will be required to handle the sewage from the on-site construction workforce.

*Water Quality Monitoring*

It is recommended that during the pipeline installation, a water quality monitoring programme be conducted in order to detect any deterioration of water quality. The proposed water quality monitoring programme is discussed in *Section A5.1*, with details on baseline and work phase monitoring, and the recommended locations of control and monitoring stations. An action plan which outlines details of appropriate responsibilities by relevant parties in the event of exceedance of the recommended level which is based on the Deep Bay WQO is also included.

### *A3.2.8 Conclusions*

Sediment losses during pipeline burial were estimated for different trenching techniques and compared with the natural sediment regime. Given the high and variable concentrations of SS in the Urmston Road, the dredging/post trenching activities will have a minimal effect on local suspended solids concentrations particularly during the wet season when natural concentrations are highest.

With the great distance of the pipeline corridor from the WSRs, the nearest being the oyster bed that is around 2km away, potential increases in SS levels will be within the natural variation range and are therefore not envisaged to result in any unacceptable impacts on the WSRs.

## *A3.3 WASTE MANAGEMENT*

### *A3.3.1 Introduction*

The construction of the proposed submarine pipeline will involve the dredging of a trench on the seabed and the laying of segments of pipe into this trench. Waste from the pipeline installation will therefore arise from the dredging and excavation works which will require disposal.

The nature of the waste arisings and their disposal method requirements are examined in this section.

### *A3.3.2 Marine Sediments*

Sediment quality data is available from the sediment sampling and analysis programme conducted for the New Airport Masterplan EIA. Site investigations for potential borrow areas included sediment sampling in the Outer Deep Bay Borrow Area. The samples were analysed for heavy metals and the results of this analysis are summarised in *Table A3.2d*. These sediments are generally uncontaminated by toxic metals reflecting the location away from immediate sources of industrial pollution. Some contamination, however, in the form of E. coli is present. It is considered that this arises from the Pillar Point Sewage Screening Plant outfall and the raw and lightly treated sewage flows into Deep Bay.

The sediments are classified according to their level of contamination by toxic metals as stipulated in the EPD Technical Circular No. 1-1-92, *Classification of Dredged Sediments for Marine Disposal.* The contamination levels presented in the Technical Circular serve as criteria for determining the disposal requirements of the dredged sediments. Definition of the classification is as follows:

Class A – Uncontaminated material, for which no special dredging, transport or disposal methods are required beyond those which would normally be applied for the purpose of ensuring compliance with EPD's Water Quality Objectives, or for protection of sensitive receptors near the dredging or disposal areas.

Class B – Moderately contaminated material, which requires special care during dredging and transport, and which must be disposed of in a manner which minimizes the loss of pollutants either into solution or by resuspension.

Class C – Seriously contaminated material, which must be dredged and transported with great care, which cannot be dumped in the gazetted marine disposal grounds and which must be effectively isolated from the environment upon final disposal.

It should be noted that for sediments to be identified within a particular class, only the concentration of one metallic species need be exceeded.

The results of the sediment quality analysis indicate the sediments in the Deep Bay borrow area are classified as Class A and therefore confirms these sediments are uncontaminated. In addition, the Fill Management Committee (FMC) has confirmed that dredged material from the New Airport Project to be used as backfill for the borrow pits are considered 'clean' and therefore should not be contaminated.

As discussed previously in *Section A3.2.2*, sediment quality data is also available from the area adjacent to the Black Point shore for the proposed LTPS site. It was found that 5 of the 82 samples from the Black Point area are moderately contaminated; classified as Class B. However, the concentration of only one metallic species was exceeded ie lead. In addition, this contamination is restricted to the upper part of the sediment profile and is therefore unlikely to represent substantial volume. These sediments will be removed under dredging for the LTPS site formation prior to the pipeline installation.

The area is subject to rapid sedimentation and therefore additional contaminated sediment may be deposited between the time of the LTPS dredging and the pipeline dredging. With the recent clean up of pollutant loads into Deep Bay under the Deep Bay Integrated Environmental Management Plan, further sediment contamination is unlikely.

Although no specific sediment sampling and analysis has been conducted for this project, it is considered likely that the sediments to be dredged for the proposed pipeline route are uncontaminated.

### A3.3.3 *Potential Sources of Impact*

Dredging works for the pipeline installation will generate approximately 300,000 $m^3$ (in any case, less than 500,000 $m^3$) of marine sediment requiring disposal. These muds are not deemed suitable for disposal at landfill or public land based dumping areas due to their moisture content and potential level of contaminants, and will therefore be disposed of at sea in designated marine dumping sites. No further dredging work is envisioned once the trench construction is completed and therefore there would be no further requirement for marine sediment disposal.

### A3.3.4 *Transportation and Disposal of Material*

In order to minimise any potential adverse effects from marine disposal, the Hong Kong Government has allocated gazetted marine disposal areas which are allocated by the FMC and the Director of Environmental Protection, depending on the level of contamination of the spoil to be disposed of and their quantity.

In addition, the contractor must satisfy the appropriate authorities that the contamination levels of the muds have been analysed and recorded. Knowledge of the levels of contaminants present would be required prior to the commencement of the pipeline dredging and subsequent sediment disposal to ensure that the correct dredging, handling and disposal procedures are followed. Specific dredging procedures which are required to minimise any potential water quality impacts are discussed in the Water Quality Section.

The dredged muds will be loaded onto barge and transported to designated disposal sites depending on their level of contaminants. It will be the contractors responsibility to ensure that all dredging and disposal methods are in compliance with the guidelines specified in the Works Branch Technical Circular No. 22/92. The contractor will be required to supply the barge(s) for removal and disposal of these muds.

The number and sizes of barges employed by the Contractor will depend largely on the dredging schedule and operation plan. It will also be dependent on the turnaround time for the barges between loading, transporting, depositing of the muds and returning to the dredging area. Hence, the designation of the disposal sites may have an effect on the dredging plan, the capacities and the number of barges utilised.

*Transportation Options*

There are three possible methods of transportation. These are hydraulic transport, transport by hopper or by barge. For grab dredgers, transportation of material can either be by barge or by its own hold if a

self-propelled grab dredger is used. Barge transport is one of the most common methods of transporting dredged material and barges can be self propelled or towed by tug. Potential sources of impacts which may arise during the transportation of material are the loss of dredged material from leakages via the bottom doors, valves and split discharging mechanisms, and spillages overboard can occur from overloaded barges.

The following measures can be adopted to minimise the above potential impacts:

- Bottom openings of barges to be fitted with tight fitting seals to prevent leakage of material. Excess material should be cleaned from the decks and exposed fittings of barges and hopper dredgers before the vessel is moved.

- Monitoring of the barge loading can ensure that loss of material does not take place during transportation. Transport barges or vessels shall be equipped with automatic self monitoring devices as specified by the DEP.

*Disposal Options*

The following three alternatives have been identified for the disposal of dredged materials:

- Gazetted marine dumping grounds

  There are currently three existing gazetted marine disposal grounds: South of Cheung Chau (80Mm$^3$), East of Ninepins (3.7Mm$^3$) and Mirs Bay (9Mm$^3$). However, in view of recent environmental concerns, the Civil Engineering Department have decided that dumping is no longer permitted at the Mirs Bay site. Under the terms of the Works Branch Technical Circular No. 22/92, for disposal of mud less than 500,000 m$^3$, the Director of Environmental Protection is the authority for the licensing and statutory control of the marine disposal of dredged mud.

- Redundant Marine Borrow Areas

  A possible alternative would be to deposit the dredged sediments in the existing worked out borrow pits within the Outer Deep Bay and Urmston Road Areas as the use of the disposal sites south of Cheung Chau and East of Ninepins would incur greater expense and longer travel times. However, these Borrow Areas have been allocated for the PADS projects and therefore the capacity for disposal may not be available at these sites.

- Use as fill material

  Dredged marine material can possibly be utilised as fill material. However, it is envisaged that the dredged material will be mostly clay and silt which are not suitable for fill and therefore reuse of dredged material is not considered an appropriate option.

*Method of Disposal*

Marine discharge can be through the bottom of a barge by various methods such as bottom opening doors, bottom valves, horizontal sliding doors and split hulls. Material is released downwards in each case. A grab or suction pump may also be used for marine discharge. With a volume of less than 500,000 $m^3$ of dredged material, application for marine disposal will be required from the EPD. The contractor shall ensure that dumping takes place only at approved locations and automatic marine positioning recorders are to be used to ensure accurate positioning of the barge prior to discharge.

### *A3.3.5 Evaluation of Impacts*

The results of sediment sampling in the Deep Bay area indicate that the marine sediments are uncontaminated and as such will not require special disposal provisions. The dredged material is therefore not a problem and is suitable for conventional disposal at a gazetted dumping ground. Consultation with the FMC has confirmed that adequate capacity is available for disposal at the gazetted marine dumping sites at South Cheung Chau or East Ninepins.

Potential impacts arising during the transportation of dredged material may be minimised with the adoption of the mitigation measures stated in *Section A3.3.4*. It is therefore anticipated that no significant impacts will result from the dredging, transport and disposal of the marine sediments.

## *A3.4 MARINE ECOLOGY*

### *A3.4.1 Introduction*

Marine ecology in the area of the proposed pipeline off Black Point consists of semi-tropical marine and estuarine biota. The pipeline route lies within the transition area between the predominantly marine waters of Hong Kong and the freshwater discharge from the Pearl River. The marine life in the Deep Bay waters is less diverse compared to the more typical marine habitats in central and eastern regions of Hong Kong, although shell and fin-fisheries remain quite productive.

A marine ecological survey was undertaken for the Large Thermal Power Station (LTPS) development at Black Point. Field studies have included benthic and fish surveys, providing data on marine biotic composition and abundance. In addition, a number of environmental assessments have been conducted for several major development projects in the western New Territories and provide ecological information of relevance to this study. These studies include the Tuen Mun Port Development, the Tin Shui Wai Development and the New Airport Master Plan. The findings from these ecological surveys are summarised below, in particular the identification of any species or habitats of ecological importance which might be affected by construction of the pipeline. The potential impacts that construction activities may have on the local marine ecology will then be assessed.

A3.4.2 *Existing Ecological Environment*

*Benthic Biota*

Marine benthic surveys for the LTPS were conducted with grabs and bottom trawling nets. The benthic biota consisted primarily of soft, muddy bottom species and at least 3 diverse marine communities were collected. The biota was dominated by urchin, turritella snails, worms and crabs, and appear similar to those reported from near the Castle Peak Power Station and from more easterly portions of Deep Bay. The benthic species identified from the seafloor around Black Point are as shown in *Annex V(a)*.

*Marine Mammals*

The Chinese White (Pearl River) Dolphin, *Sotalia Chinensis*, has been observed during marine surveys of Urmston Road and Deep Bay. A dolphin-sighting record programme [1] organised by the World Wide Fund for Nature (WWFN) indicates these sightings are generally in the Ma Wan-Brothers Channel, Urmston Road and Deep Bay, north of Black Point. Based on information compiled by the WWFN and the Agriculture and Fisheries Department (AFD), the dolphin appears to be a coastal/estuarine dolphin rather than a "true" river dolphin (restricted to freshwater habitats) and can use much of the coastal waters of Hong Kong. Little is known of the dolphin's habitat requirements, although sightings show a high concentration in the western New Territories. This may either be a food chain preference or the need for periodic freshwater (eg removal of marine/freshwater parasites), or for more turbid waters (avoidance of predators).

*Marine Resources*

*Mariculture Zones*

The closest oyster beds to the proposed pipeline corridor occur at the boundary of the Deep Bay Mariculture Subzone, as shown in *Figure A3.2b*, at a distance of just under 2km to the north east. There are no Fish Culture Zones in Deep Bay; the nearest Fish Culture Zone is at Ma Wan, approximately 20 km from Black Point.

*Fisheries*

Fish surveys for the LTPS were conducted on the north western and southern sides of Black Point, in water depths of 5-25m. Various species of jellyfish, crabs, shrimps and fish were found. All demersal and pelagic species recorded are species commonly found in the coastal waters of Hong Kong. The fish and macro-invertebrate species found in the demersal and pelagic fish surveys, together with their general abundance, are shown in *Annex V(b)* and *V(c)* respectively.

[1] World Wide Fund for Nature (1991) Various reported sightings submitted to and compiled by WWFN for the period Nov. 1990 to Feb. 1991.

Consultation with the AFD has provided information on fishing activities. A survey conducted in 1991 on fishing craft up to 15m in length indicated that 65 boats out of a total of 202 boats from Castle Peak, San Pui, Lau Fau Shan and Sham Wan fished the Black Point area. The vessels spent on average 32% of their time in the 1 687 ha area off Black Point and represent the main fishing activity in this area.

Larger vessels also fish in the area but only limited data is available. It is known that some 70 larger vessels, mainly shrimp trawlers, but also some stern (otterboard), hang, and pair trawlers fish the Deep Bay, Pearl Estuary and North Lantau areas. According to the AFD, the larger fleets in the Black Point area represent a small percentage of the total fleet in Hong Kong. The majority of fishing activities occur outside Hong Kong waters, with less than 10% of fishing grounds in Hong Kong waters.

*Important Ecological Areas*

The nearest sites of marine ecological importance are the beach areas of Lung Kwu Sheung Tan and Lung Kwu Tan on the shore of Urmston Road, at a distance of approximately 2 km and 4 km respectively to the south-east of the proposed pipeline corridor. It is believed that the two sandy beaches are the only breeding areas in Hong Kong for two species of King Crabs: *Tachypleas tridentatus* and *Tachypleas gigas.*

### *A3.4.3 Potential Sources of Impact*

Construction methods involved in the pipeline installation may affect the local marine ecology; of particular concern are potential impacts arising from dredging, jetting and ploughing. These activities and other methods likely to be employed are discussed below.

*Dredging of marine sediment*

It is estimated that approximately 300,000$m^3$ (less than a total of 500,000$m^3$) of marine sediment will be excavated for trench construction. Dredging of marine sediment will inevitably remove or bury the benthic biota in the immediate work areas and cause disturbance to marine biota in the surrounding area through dispersal of suspended sediments. In addition, the disturbance of sediments will result in an increase in suspended solids concentrations and hence turbidity of the sea water. This in turn will reduce sunlight penetration into the water, thus lowering the rate of photosynthesis of phytoplankton (primary productivity).

*Pipelaying*

An anchor spread of 1250m radius around the lay barge could be required and this will extend outside of the pipeline corridor. The anchor spread may therefore obstruct fishing activities in the area, such as bottom trawler nets for shrimp fishing.

*Post Trenching*

Jetting or ploughing of the sea bottom material will break up the sea bed and may destroy benthic biota in the work areas. As for dredging activities, similar ecological impacts may arise from the disturbance of the marine sediments; resulting from increased suspended solids concentrations and possibly reducing light penetration.

*Back filling*

The placing of fill may cause disturbance to marine biota through dispersal of suspended sediments.

Aside from the direct loss of benthic biota and disturbances to marine biota and habitats both within and adjacent to the work areas, underwater noises, movements of propellers and submerged equipments, and induced currents from vessels will also contribute to impacts on the local marine ecology.

### *A3.4.4 Evaluation Criteria*

The marine ecological impact is assessed using the following criteria:

*Statutory Requirements and Guidelines*

The Mariculture Subzone of the Deep Bay Water Control Zone was designated in order to protect the oyster beds. The water quality in this recognised mariculture area is governed by the Deep Bay Water Quality Objectives, which specifies the maximum levels of suspended solids and E. Coli, and minimum levels of dissolved oxygen.

In view of the environmental significance and sensitive nature of Deep Bay, the Deep Bay Guidelines for Dredging, Reclamation and Drainage Works (ERL (Asia) Ltd 1991) were established to assist with planning, designing, building and monitoring future projects so as to ensure that any impacts on Deep Bay are within acceptable limits. Given the proposed pipe alignment transverses the outer Deep Bay area, recommendations in the Guidelines should be considered during the pipeline installation.

The Chinese White Dolphin is designated protected under the Wild Animals Protection (Cap 170) Ordinance 1980 and the "Bonn" Convention on the Conservation of Migratory Species of Wild Animals.

*Commercial Value of Fisheries*

Information provided by AFD indicate the level of fisheries production in the Black Point area. The fisheries catch, for craft under 15 metres, amounts to 3.1% of the total catch from the 202 boats which fish out of the ports identified in *Section A3.4.2*. The value of the catch in 1991 was considered to be around HK$ 573 000, representing 0.06% of the territories total fisheries production. The value of more general `biota' or communities that serve to support the commercially valuable species must also be considered.

*Rarity of Individual Species and Communities*

This is often used as an indication of ecological significance or importance. Rarity may be officially recognised through regulatory protection, such as for marine mammals, including dolphins. The Chinese White Dolphin is a rare species of cetacean and should be considered as a threatened or endangered species. It should be noted that habitat conservation has been recognised as important as individual preservation.

### *A3.4.5 Evaluation of Impacts*

*Benthic Biota*

Dredging of marine sediment will result in the direct loss of benthic biota and disturbances to the marine biota and habitats in the surrounding area. However, the muddy seafloor ecology has already been disturbed by activities from a number of marine borrow areas and other dredging operations in the Black Point area. These borrow areas and dredging operations are shown in *Figure A2.2a*. The Outer Deep Bay Borrow Area to the west of Black Point has been extensively exploited. The area has been partly backfilled with a mixture of dredged marine muds and alluvial clays, with water depth ranging from 14–42m. The existing benthic community is therefore likely to be limited as the natural seabed has been destroyed. Since a large proportion of the proposed pipeline corridor will therefore transverse through areas which have either been worked out or which are likely to be worked in the near future, the potential impact on the benthic biota has been minimized.

As reported in *Section A3.3.2*, the results of sediment sampling data from the area have indicated that marine sediments are classified as uncontaminated with toxic metal concentrations falling within the Class A level. Dredging works for the pipeline therefore will not result in the release of toxic substances into the marine environment. It is considered that dredging will involve the disturbance and distribution of largely inert material already contained within the ecosystem. Surveys of the marine ecology of the waters have revealed that both species diversity and species numbers of benthos are low. The benthic species noted are typical of benthic communities in the western area of Hong Kong and hence the loss is not anticipated to be significant.

*Fisheries and Mariculture*

The annual fish catch in the Black Point area accounts for approximately only 0.06% of the territories total fisheries production in 1991. In view of the low biomass of fish found during fish surveys and the moderate commercial fisheries productivities in the Deep Bay area, the fisheries resource in the Black Point area is unlikely to be important. Therefore, the impact on fish communities is not considered significant.

The AFD have identified pair, stern and shrimp trawlers to be the vessel types likely to be most affected by obstruction to their line of fishing from the laybarge anchoring. The extent of this interference will depend on whether the obstruction could be avoided without a considerable change in direction. However, the pipelaying for Hong Kong waters will take a maximum of two weeks for the laybarge operation. During this time, the laying operations will progress along the route; thus disturbance in any one area will be very short lived and is not expected to hinder fishing operations in the area. After installation of the pipeline, the pipeline and associated rock armour protection will be located below the level of the seabed, thereby minimising interference with fishing activities.

Marine impacts on the oyster beds of the Mariculture Subzone in Outer Deep Bay are anticipated to be minimal during the construction phase considering the distance of this area from the proposed pipeline corridor. However, it has been suggested that there may be an anti-clockwise water circulation in Deep Bay during the daily tidal change and therefore indirect impacts, such as the dispersion of suspended sediment to the area may result. The effect of dredging activities in the Outer Deep Bay Borrow Area was extensively studied in the Tin Shui Wai Development EIA of Land Preparation Aspects. The study concluded that the Deep Bay Mariculture Subzone would not be significantly affected by high particulate loadings as coarse sand would probably settle near the source and fines would be flushed southwards by moderately strong water currents induced during ebb tides. The study indicated that any of the feasible dredging methods could be carried out without substantial impact to the oyster beds. The impact of dredging in the Deep Bay area is therefore not expected to be significant. Exceedance of the natural background suspended solids concentrations should only occur in the immediate vicinity where the marine sediment is disturbed.

*Marine Mammals*

Construction and related activities within the marine environment, such as noise from dredging and jetting, and marine traffic movement may disturb sensitive marine mammals such as the Chinese White Dolphin.

If preliminary sighting results are taken as representative, they suggest that the dolphin is more likely to be affected by developments at Chek Lap Kok than at the North Western New Territories. [1] The ecological requirements of the Dolphin are not well understood at present and therefore the effects of construction activities and vessel traffic cannot be fully assessed. However, construction activities will be confined to within the pipeline corridor and therefore the pipeline installation is considered unlikely to have a significant impact on the normal movements of the Dolphin, and should not adversely influence the Dolphin's relationship with its habitat.

[1] Scott Wilson Kirkpatrick, ERL (Asia) Ltd, Shankland Cox, Wilbur Smith Associates, Tuen Mun Port Development Study, WP No.8 IEA Vol.2: Construction Impacts 1992.

*Important Ecological Areas*

The King Crab breeding sites at Lung Kwu Sheung Tan and Lung Kwu Tan are unlikely to be adversely affected by the pipeline installation works, in view of the considerable distance from the proposed pipeline corridor. The construction activities will be confined to within the pipeline corridor, at a considerable distance (approx 3 km) from the two beaches, and will be of short duration. The Small Kingcrab (*Tachypleus tridentatus)* is found on sandy shores at low tide and the much larger *T. gigas* is sub-littoral. The larvae are found in the intertidal (littoral areas). Therefore, no significant impacts are anticipated to result on the migrating Kingcrab and its larvae since they are restricted to shoreline areas.

In addition, in evaluating the significance of these marine ecological impacts it is necessary to consider possible developments in the area. The PADS developments for Black Point and south Deep Bay have assigned much of the shoreline and shallow seafloor to marine industries. Although the Deep Bay area is assigned to a 2006 timeframe, the planned reclamation development and dredging for maritime service would directly destroy all shallow marine biota and ecology within 400m of the shore. The gazettal of a marine borrow area in Outer Deep Bay will allow deepening of the seafloor to more than 20 m depth, with the loss of most seafloor life and disturbance to open water biota for several years [1]. It is believed that these planned losses and disturbance of the seafloor and intertidal zones, together with associated disturbance increases from maritime traffic, will radically alter the entire shoreline, much of the seafloor, and the open water environment adjacent to the LTPS site at Black Point. However, no marine survey has been conducted to quantify or assess the losses and impacts on marine biota, especially the Chinese White Dolphin.

### *A3.4.6 Mitigation Measures*

The following outlines measures that can be implemented during construction of the proposed pipeline to minimise marine ecological impacts or to compensate for some adverse effects. Since the impacts on marine ecology are principally the result of dredging of the seabed for trench formation and jetting techniques, the mitigation measures recommended will focus on these construction methods.

*Selection of Dredging Method and Equipment*

Dredging and other open water activities will generate increased turbidity. The amount of sediment released into the water column will depend on the method of dredging and equipment employed. The proper selection of appropriate dredging and dewatering methods or treatment can therefore reduce the amount of sediment resuspension, and this in turn will minimise the impact on marine ecology.

[1] ERL (Asia) Ltd, EIA of Proposed LTPS at Black Point Vol 2. Construction Phase 1992.

*Scheduling of Dredging and Jetting*

The direct loss of benthic biota may be somewhat reduced by scheduling the dredging and jetting activities so as to avoid the peak reproductive periods (eg spawning, breeding) which generally occur in Spring or Autumn. Losses following the peak reproductive season would have less adverse effect than losses before the peak season.

The pipe installation programme have been scheduled to avoid the peak reproductive season. Dredging operations within Hong Kong waters will start in mid-May, 1994 with pipe installation operations commencing from the Black Point shore proceeding seawards. Disturbance to the marine waters, which will be short and temporary, is not expected to affect spawning and breeding activities in the area.

*Research Studies Contribution*

A Dolphin monitoring and research programme is planned in relation to the New Airport Development. ARCO/CLP are in regular contact with WWF regarding progress and findings of these studies. This will assist in clarifying and confirming the ecological requirements and distribution of the Dolphin, and hence their ability to respond to the effects of construction works in Deep Bay. Contractors should be advised of the possible presence of dolphins in the area, the need for their protection and should be encouraged to report sightings as a contribution to the research programme.

## *A3.5 NOISE*

### *A3.5.1 Baseline Conditions*

*Introduction*

Most of the noisy construction activities of concern are restricted to the pipeline corridor within the coastal water north of Black Point. The physical context in the vicinity as shown in *Figure A3.5a*. Concurrently with the planned pipeline installation, the area will be undergoing several on-going or planned construction works that will affect significantly the surrounding physical setting and noise environment.

*Ambient Noise Environment*

Two village settlements, Lung Kwu Sheung Tan and Tsang Tsui, contain small clusters of village houses which will be considered in the study. Lung Kwu Sheung Tan is about 1.2 km east of the route corridor and the area remains classified for residential use in the PADS strategy plan.

Tsang Tsui Village is the area about 1.8 km south of the route corridor with scattered residential dwellings and the existing BBC Relay Station that make up a total population of 9 [1].

[1] With reference to the population figure as at 1990 in the Planning Guide Plan No: D/TM1/11.

A 24-hour noise survey [1] was carried out in October/November 1990 at the two locations, which indicated a typically rural and tranquil noise environment not affected by the adjacent noisy construction activities under way at the time (the WENT Landfill construction works, 2km to the East).

The prevailing background noise level in the day, evening and night-time periods at the two NSR locations were taken as the arithmetic mean of the $L_{90}$ measurements in the corresponding time periods:

*Table A3.5a Results of the Noise Survey*

| Location | | $L_{90}$ dB(A) | $L_{eq}$ |
|---|---|---|---|
| NSR1 (Lung Kwu Sheung Tan) | Day | 44 | 56.1 |
| | Evening | 46 | ) 45.3 |
| | Night | 40 | ) |
| NSR2 (Tsang Tsui) | Day | 42 | 56 |
| | Evening | 39 | ) 44.6 |
| | Night | 40 | ) |

The ambient noise pattern in the locality are expected to increase considerably, as a result of several major infrastructure developments in the area.

*Other Works*

Several planned and ongoing infrastructure developments that need to be considered in the study are shown in *Figure A3.3b*.

The proposed pipe route connects ashore at a reclaimed site developed for the Black Point Power Station. The site formation and foundation works of the power station development project is currently underway and it is unlikely to coincide with the gas pipe installation.

Opening of the South Access Road for general traffic and in particular refuse truck hauling to the WENT landfill at Nim Wan, will directly increase the noise levels at Lung Kwu Sheung Tan along the Southern Access Road. Operation of the WENT landfill itself will also contribute to an increase in the background noise level at Tsang Tsui.

Ports and special industrial developments are planned for the Tuen Mun Port Development under the PADS scheme to form a large reclaimed area south of Black Point. However, construction works for the Development will only start in 1995 after the completion of the gas pipeline installation.

[1] EIA of the Proposed 6000MW Thermal Power Station at Black Point by ERL, November 1992.

*Sensitive Receivers*

The pipeline corridor will be isolated from any immediate residential areas by the natural topographic envelope. The village population distributions in the 1990 record of Planning Department at Nim Wan, Tsang Kok and Tsang Tsui collectively is 204, and the total at Yung Long and Lung Kwu Sheung Tan is 64. As part of the WENT landfill development, the villages of Nim Wan and Tsang Kok have been relocated, and Tsang Tsui will shortly be relocated. And to make provision for the Tuen Mun Port Development, Lung Kwu Sheung Tan is also planned for relocation. For the purpose of this assessment, Lung Kwu Sheung Tan at about 1.2 km east of the site, and Tsang Tsui village at about 1.8 km to the south, will be considered as the two nearest noise sensitive receivers.

### A3.5.2 *Noise Criteria*

For general construction works, noise emission during restricted working hours is controlled legally by the application of a construction noise permit, under the provisions of the Noise Control Ordinance, and enacted in accordance with the procedures stipulated in the "Technical Memorandum" on noise from construction work other than percussive piling (TM).

Noise restrictions are imposed during evenings (1900–2300) and night-time (2300–0700) and Sundays and Public Holidays. A construction noise permit (CNP) is required from EPD who will assess the application in accordance with the TM. Acceptable Noise Levels (ANL) have been stipulated, assuming no correction for the duration of the CNP or multiple site situation, which must not be exceeded and these are given in the following table:

*Table A3.5b Acceptable Noise Levels (ANL) for General Construction Work*

| Time Period | ASR | | |
|---|---|---|---|
| | A | B | C |
| All days during the evening (1900 to 2300 hours), and general holidays (including Sundays) during the day-time and evening (0700 to 2300 hours) | 60 | 65 | 70 |
| All days during the night-time (2300 to 0700 hours) | 45 | 50 | 55 |

From the study of the surrounding noise environment it is considered that the Area Sensitivity Rating (ASR) for the designated NSRs should be "A", and the corresponding ANLs for general construction work are 60 dB(A) at all evenings and daytimes of public holidays, and 45 dB(A) for the night-time.

No allowance has been made for any change in the ASR in future years due to other on-going and planned developments in the area.

Although there is at this time no statutory criteria for control of construction noise during the daytime hours of normal days (0700–1900 Monday–

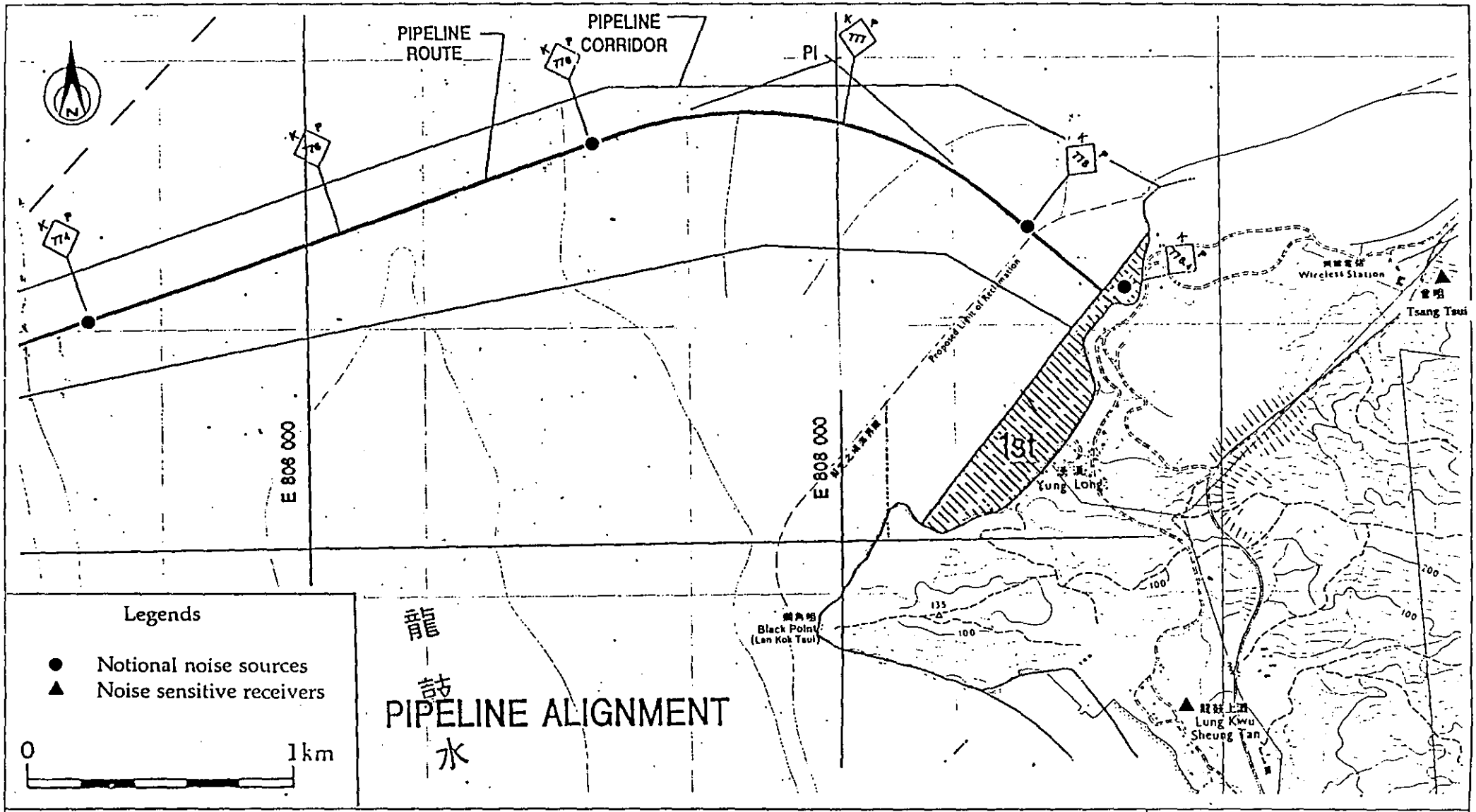



Figure A3.5a

Locations of the Notional Noise Sources and the Receivers

ERM Hong Kong

11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

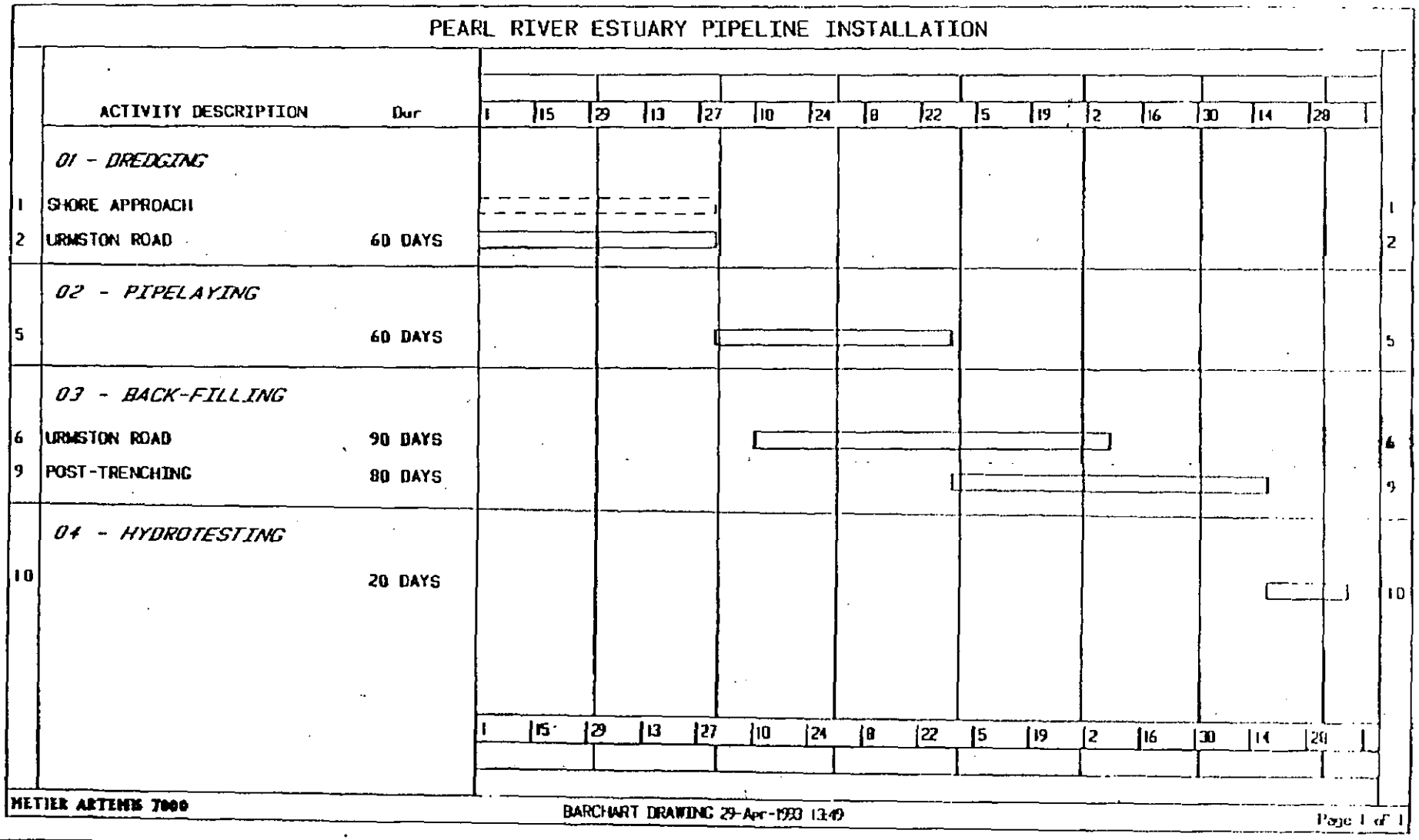



Figure A3.5b

Preliminary Pipeline Installation Programme

ERM Hong Kong

11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

Saturday inclusive), the study will be based on guidelines in HKPSG for developments in rural area to avoid consistent 10 dB(A) exceedance above the prevailing background.

On the advice of EPD, the criteria have been set on the basis of 10 dB(A) above the arithmetic average of 30-minutes $L_{eq}$ measured values over the 12 hour (0700-1800 hrs) daytime period. It will be very difficult to estimate the cumulative noise effect on the future background noise levels due to the ongoing works in the vicinity. Based on the noise survey results at the end of 1990, the day time noise criteria are taken for the assessment as 66 dB(A) at Lung Kwu Sheung Tan and at Tsang Tsui.

*Table A3.5c Recommended Noise Criteria*

| Period | Noise Criteria |
|---|---|
| Evenings and Holidays | 60 dB(A) |
| Night time | 45 dB(A) |
| Day time | 66 dB(A) |

### *A3.5.3 Potential Sources of Impact*

At the time of the study, the installation contract for the pipeline was still under bidding and being considered by the Developer. The actual construction methods are not definitive, and the assessment will need to consider the possible techniques and also the assumptions on the methods likely to be adopted.

*Pretrenching* - Dredging is expected to be carried out by one large and one medium dredger for about two months. Different types of dredger are considered suitable, such as grab, cutter suction, bucket and trailer dredgers. The dredgers will be operating alternatively, for dredging and transporting of spoil for disposal, and it is assumed that there is one dredger operating as stationary and continuously at a time.

*Pipelaying* - A lay barge, a tug boat and two winches with power packs will be employed.

*Backfilling* - it is assumed that a medium size rock dumping vessel will be used.

*Posttrenching* - Jetting and ploughing are the two techniques most likely to be employed for the process. Generally, the trenching rigs will be working on the seabed and towed by the working barge along the pipe route. Jetting air and water will be supplied by an air compressor and a water pump on the barge.

*Commissioning* - the noisiest operation during commissioning is likely to be the operation of 10 large air compressors mounted temporarily onshore for dewatering of the internal pipe walls.

### A3.5.4 *Evaluation of the Impacts*

Exact prediction of construction noise quality is not practical, as it will vary in intensity and character, much dependent on the location and period of time, as well as the variations in the many different activities and types of plants involved. The approach of the study is by analysing all the activities involved, and by modelling the major noise emissions in a logical way.

A "worse-case" approach will be adopted, continuous construction works will be assumed in the evaluation. Works are assumed to progress in the off-shore direction, and are broken down in monthly periods in accordance with the installation programme in *Figure A3.5b*. Noise emissions are modelled at four notional work points, these are one no-shore work point, and three points on the pipe route numbered "KP 778", "KP 776", and "KP 774", as shown in *Figure A3.5a*.

*Analysis of the Noise Sources*

A sound power level (SWL) inventory (*Table A3.5d*) that characterizes the noise emission from the major construction activities identified is prepared in accordance with the TM.

*Table A3.5d Source Sound Power Level*

| Operation | Equipment and SWL in dB(A) | No. of Equipment | Assumed SWL |
|---|---|---|---|
| Pre-trenching | Cutter suction dredger (104) or<br>Trailing suction hopper dredger, (109), or<br>Grab dredger (112), or<br>Chain bucket dredger (118) | 1 | 118 dB(A) |
| Pipelaying (Marine) | Lay barge (104), and<br>Tug boat (110), and | 1<br>1 | 111 dB(A) |
| Pipelaying (On-shore) | Electric Winch (95), and<br>Power pack (100) | 2<br>2 | 104 dB(A) |
| Backfilling | Dump vessel (104), and<br>Tug boat (110) | 1<br>1 | 111 dB(A) |
| Post-trenching (Jetting) | Working barge (110), and<br>Air compressor (109), and<br>Water pump (103) | 1<br>1<br>1 | 113 dB(A) |
| Commissioning | Air compressors (109) | 10 | 119 dB(A) |

*Site Analysis*

The noise evaluation is in general in accordance with the TM procedures, however, as the distance range of the study is in excess of 300m, the following adjustments will be included with regard to standard acoustical principles and practices:

- Barrier attenuation – a correction of 0 dB, -5 dB, or -10 dB are taken in the TM depending on whether the noise source is completely unscreened,

partially screened or completely screened respectively. It is considered that the barrier correction taken from the "Calculation of Road Traffic Noise" derived on the basis of the Maekawa curves will give more accurate results for the study.

- Ground absorption – soft ground absorption which can be significant for long separation distances are not included as the noise propagation is mostly over reflection water surface, and is likely to be less significant than the barrier attenuation.

- Atmospheric air absorption – the correction will be dependent on noise frequency and climatic conditions, conservative correction based on the CONCAWE [1] report will be used. Analysis showed that the most important frequencies for construction noise are 500 Hz, 1 kHz and 2 kHz. The correction used is therefore derived as the logarithmic average of the corrections for each of these frequencies.

Analysis of the effects of the above noise attenuations have been carried out regarding the locations of the 2 NSRs and the 4 notional work points, taking into account the topographic features. As a result, the total noise corrections applicable to each corresponding source – receiver path are prepared as in *Table A3.5e* below:

*Table A3.5e* *Total Source – Receiver Noise Corrections*

| Total Noise Correction, dB(A) | | | | |
|---|---|---|---|---|
| **Receiver Locations** | **Source Locations** | | | |
| | **On-shore** | **KP 778** | **KP 776** | **KP 774** |
| Lung Kwu Sheung Tan | -107 | -110 | -114 | -126 |
| Tsang Tsui | -81 | -85 | -101 | -115 |

*Evaluation of Impacts*

The results of the analysis of the noise sources (ie SWL in *Table A3.5d*) and the site conditions (ie the total noise corrections in *Table A3.5e*) are used to predict the construction noise levels in accordance with the installation programme (*Figure A3.5b*). The results of the noise prediction at Lung Kwu Sheung Tan and Tsang Tsui, due to the pipeline installation works within the 7-month period are presented in *Table A3.5f*.

[1] The Propagation of Noise from Petroleum and Protrochemical Complexes to neighbouring communities. Nov 1977 and April 1981.

*Table A3.5f Results of the Noise Predictions*

| Period | Works | Location | Source SWL dB(A) | Total Correction dB(A) | Noise Contributor dB(A) | Predicted Noise Level dB(A) |
|---|---|---|---|---|---|---|
| **Noise Prediction at Lung Kwu Sheung Tan** | | | | | | |
| 1st Month | Dredging | KP778 to KP776 | 118 | -110 to -114 | Neg | Neg |
| 2nd Month | Dredging | KP776 to KP774 | 118 | -114 to -126 | Neg | Neg |
| 3rd Month | Pipelaying (marine) | KP778 to KP776 | 111 | -110 to -114 | Neg | Neg |
| | Pipelaying (onshore) | onshore | 104 | -107 | Neg | |
| | Backfilling | KP778 | 111 | -110 | Neg | |
| 4th Month | Pipelaying (marine) | KP776 to KP774 | 111 | -114 to -126 | Neg | Neg |
| | Pipelaying (onshore) | onshore | 104 | -107 | Neg | |
| | Backfilling | KP776 | 111 | -114 | Neg | |
| 5th Month | Backfilling | KP774 | 111 | -126 | Neg | Neg |
| | Post-trenching | KP778 to KP776 | 113 | -110 to -114 | Neg | |
| 6th Month | Post-trenching | KP776 to KP774 | 113 | -114 to -126 | Neg | Neg |
| 7th Month | Dewatering | onshore | 119 | -117 | 12 | 12 |
| **Noise Prediction at Tsang Tsui** | | | | | | |
| 1st Month | Dredging | KP778 to KP776 | 118 | -85 to -101 | 33 to 17 | 33 to 17 |
| 2nd Month | Dredging | KP776 to KP774 | 118 | -101 to -115 | 17 to Neg | 17 to Neg |
| 3rd Month | Pipelaying (marine) | KP778 to KP776 | 111 | -85 to -101 | 26 to 10 | 30 to 28 |
| | Pipelaying (onshore) | onshore | 104 | -81 | 23 | |
| | Backfilling | KP778 | 111 | -85 | 26 | |
| 4th Month | Pipelaying (marine) | KP776 to KP774 | 111 | -101 to -115 | 10 to Neg | 23 |
| | Pipelaying (onshore) | onshore | 104 | -81 | 23 | |
| | Backfilling | KP776 | 111 | -101 | 10 | |
| 5th Month | Backfilling | KP774 | 111 | -115 | Neg | 28 to 18 |
| | Post-trenching | KP778 to KP776 | 113 | -85 to -101 | 28 to 18 | |
| 6th Month | Post-trenching | KP776 to KP774 | 113 | -101 to -115 | 12 to Neg | 12 to Neg |
| 7th Month | Dewatering | onshore | 119 | -81 | 38 | 38 |

Comparing the predicted noise levels and the recommended noise criteria in *Table A3.5c*, it is concluded that noise emission associated with the construction activities of the ARCO pipeline, in its "worst case scenario", will meet with the noise criteria recommended. The construction activities will mostly be imperceptible at the nearest noise sensitive receivers, and it is considered that no specific noise constraint and monitoring is identified to be required for the works.

## A4 COMMISSIONING AND OPERATIONAL PHASE

### A4.1 INTRODUCTION

This section presents a summary of the precommissioning, operational and maintenance requirements of the proposed ARCO submarine pipeline and the associated environmental impacts in relation to water, waste, and ecology.

### A4.2 PRECOMMISSIONING AND COMMISSIONING

In general, pipeline precommissioning and commissioning operations consist of the following stages:

- Post Pipelay Operation - Pipeline Flooding and System Pressure Test;
- Post Tie-in Operation - Pipeline Cleaning, Dewatering and System Hydrotest;
- Commissioning Operation - Nitrogen Purging and Introduction of Hydrocarbon Gas

The precommissioning and commissioning process will take around 184 days (exclusive of weather/mechanical downtime or other contingency). Details of the different stage of commissioning are discussed below:

#### A4.2.1 *Post Pipelay Operations*

- Pipeline Flooding and Gauging

  Pipeline Flooding is normally carried out as soon as possible after the completion of the pipelay. The pipeline can either be flooded from shore to subsea or subsea to shore. The flooding pig train normally consists of bi-directional pigs including cleaning pigs and a pig fitted with a gauge pig. The cleaning pigs are used for removal of minor surface rust and millscale on the pipewall while the gauging pig is to determine if the pipeline is free of gross deformations in cross sections. Visco-elastic gels may be used to enhance the efficiency of mechanical pigs by preventing build up of debris in front of the pig. Approximately 27000m$^3$ of water is required to the flood pipe section with in the Pearl River Estuary.

#### A4.2.2 *Post Tie-In Operations*

Post tie-in operations will involve system hydrostatic testing, dewatering and drying.

- System Pressure Test

  The pipeline will be tested at 1.25 times the maximum allowable operating pressure and the test pressure must be held for a minimum of 24 hours. Approximately 3,500m$^3$ of treated water is required for the

hydrostatic test pressurization. Water is discharged at platform during depressurization.

- Pipeline Dewatering

  Dewatering is the most critical operation as the efficiency of the dewatering operation will determine the time required for drying. Large air compressors will be employed. Due to the length of the completed pipeline, it is most practical to mount the driving air compressors onshore and discharge the treated water at the platform. Approximately 276000$m^3$ of treated water must be discharged at the platform.

- Drying

  All free water must be removed from the pipeline prior to operation to prevent formation of corrosive products. There are a number of drying methods such as methanol/glycol swabbing; dry air drying; vacuum drying; or a combination of these techniques. Vacuum drying is considered most suitable for this application provided vacuum drying plants can be sited at both ends of the pipeline. Vacuum drying removes free water from a pipeline by reducing the pressure such that the water evaporates at ambient temperature. Hydrocarbon gas can be introduced directly upon completion of drying operations due to the very low air content of the pipeline. The drying process will expel about 160$m^3$ of residual water as water vapour from both ends of the pipeline.

### *A4.2.3 Commissioning*

Nitrogen purging may be carried out as a contingency operation to prevent the ingress of air and/or air borne water in the pipeline. However, if hydrocarbon gas is available immediately after completion of the vacuum drying operations, nitrogen purge/fill will not be required.

According on the current programme, hydrocarbon gas will be available immediately after drying and nitrogen purge/fill is not necessary.

The pipeline is ready for operation with introduction of hydrocarbons after the above preparation procedures.

### *A4.2.4 Seawater and Chemical Requirements*

Seawater will need to be treated for all precommissioning operations. The seawater will be filtered to remove suspended solids and treated with typical water treatment chemicals, namely, polymeric amines (corrosion inhibitor), ammonium bisulfite (oxygen scavenger), sodium hypochlorite (biocide). *Table A4.2a* – outline the seawater requirements for different stages of the precommissioning. Preliminary estimation of the chemical dosage for the seawater is given in *Table A4.2b*.

*Table A4.2a Seawater Requirements for Precommissioning Operations*

| Operations | Volume of treated seawater ($m^3$) |
|---|---|
| Flooding | 27000 |
| System Hydrotesting | 3500 |
| Calliper Pigging (if required) | 276000 |
| **Total** | **306500** |

*Table A4.2b Estimated Chemical Dosage Requirements*

| Chemical Treatment | Typical Chemicals | Dosage |
|---|---|---|
| Corrosion Inhibition | Polymeric amines | 200 ppm |
| Oxygen Scavenger | Ammonium bisulfite | 150 ppm |
| Biocide | Sodium hypochlorite | 200 ppm |

## A4.3 OPERATION AND MAINTENANCE

The submarine gas pipeline will be used to transport dry hydrocarbon gas from the Yacheng platform to Black Point. During operation, no hydrocarbon slug is anticipated to be discharged at any point of the system.

A remotely operated vehicle may be employed for the non-invasive survey several times throughout the operating period of the pipeline to visually check for exposure or damage. Other runs to determine the internal condition may be carried out by the magnetic anomaly Intelligent Pig. Subsequent runs may be required to detect any internal corrosion problems. In the absence of any problems, no specific maintenance is needed.

The ARCO's operation philosophy in terms of environmental objectives are presented in *Annex VI*.

## A4.4 WATER QUALITY

There will be no discharge into Hong Kong waters during the precommissioning and commissioning stage. Treated seawater will be used for flooding, hydrotesting, and cleaning of the pipeline. The operation will be carried out onshore from the Hong Kong end and water will be discharged at the platform. In view that no discharge will take place in the Hong Kong waters, no impacts on water quality are expected.

When in operation, the pipeline will deliver natural gas to the gas receiving station at Black Point. No effluent discharge is anticipated from the pipeline system.

## *A4.5* *WASTE*

The pipeline is not envisaged to produce any waste.

## *A4.6* *NOISE*

No operational noise is anticipated from the operation of the gas pipeline. Noise during commissioning is covered under *Section A3.5.*

## *A4.7* *ECOLOGY*

The trench will be reinstated with engineering backfill to protect the pipeline. The pipeline will be covered to stand all natural conditions such that no erosion of the top layer due to current or wave action may occur. It will also be protected by a layer with sufficient resistance against damage by dredging anchors or fishing activities.

Fishing activities which may be interrupted during the pipeline installation will return to normal. With the high sediment deposition rate in the Pearl River estuarine area, the seabed will be restored to its natural profile within a short period.

Minimal disturbance to the seabed will result from operation of the gas pipeline as no specific maintenance is envisaged.

## A5 ENVIRONMENTAL MONITORING AND AUDITING

This section outlines the environmental monitoring recommendations for the construction phase of the ARCO submarine pipeline in the Urmston Road and formulates the environmental audit requirements for assessing the effectiveness of the mitigatory measures employed. An Environmental Monitoring and Audit Manual is recommended and requirements for this outlined. Water quality monitoring is recommended during the construction phase and environmental monitoring is not considered necessary during the operational phase.

### A5.1 WATER QUALITY MONITORING REQUIREMENTS

Water quality monitoring is required as a check on the compliance with the Deep Bay Water Quality Objectives and to ensure that mitigation measures, which have been designed for, are implemented and operating effectively.

Baseline monitoring is required to be carried out prior to the commencement of construction to establish the surrounding background water quality. Parameters to be measured should include turbidity, suspended solids and dissolved oxygen concentration. *Table A5.1a* defines the various levels for determination of the level of action required by the relevant parties. These levels were based on the WQO requirements which states the following:

- Suspended Solids – Waste discharge not to raise the natural ambient level by 30% nor accumulation of suspended solids

- Dissolved Oxygen Level – not less than 2mg/l for 90% samples within 2m of sea bottom and not less than 4mg/l for 90% samples for depth average.

In the event of an exceedance of a specified level, the appropriate action by the parties involved are clearly defined in *Table A5.1b*. Details of water quality monitoring are given in *Annex VII*.

| Table A5.1a Water Quality Monitoring Requirements | | |
|---|---|---|
| Frequency | Baseline | · 4 sampling days per week for 4 consecutive weeks prior to commencement of dredging, at mid-flood and mid-ebb.<br>· Measurements to be taken at 3 depths. |
| | Work Phase | · 3 days/week; on a working day with intervals between each series of samplings not less than 36 hours.<br>· Measurements to be taken at 3 depths. |
| Monitoring Locations | | Designated monitoring and control stations as indicated in *Figure A5.1a* |
| Trigger Levels | | · Station result greater than 30% above the baseline level for suspended solids; and/or less than 30% below the mean value of the baseline monitoring measurements for dissolved oxygen. |
| Action Levels | | · Station result greater than 30% above the mean value of recorded reading in the same day at the controls station recording for suspended solids; and/or less than 4 mg/litre dissolved oxygen at the surface layer; and/or less than 2mg/litre dissolved oxygen at 2 meters above sea bottom |
| Target Levels | | · Station result persistently (3 times) greater than 30% above maximum recorded reading in same day at the controls station recording for suspended solids; and/or persistently (3 times) less than 4 mg/litre dissolved oxygen at the surface layer; and/or less than 2mg/litre dissolved oxygen at 2 meters above sea bottom |

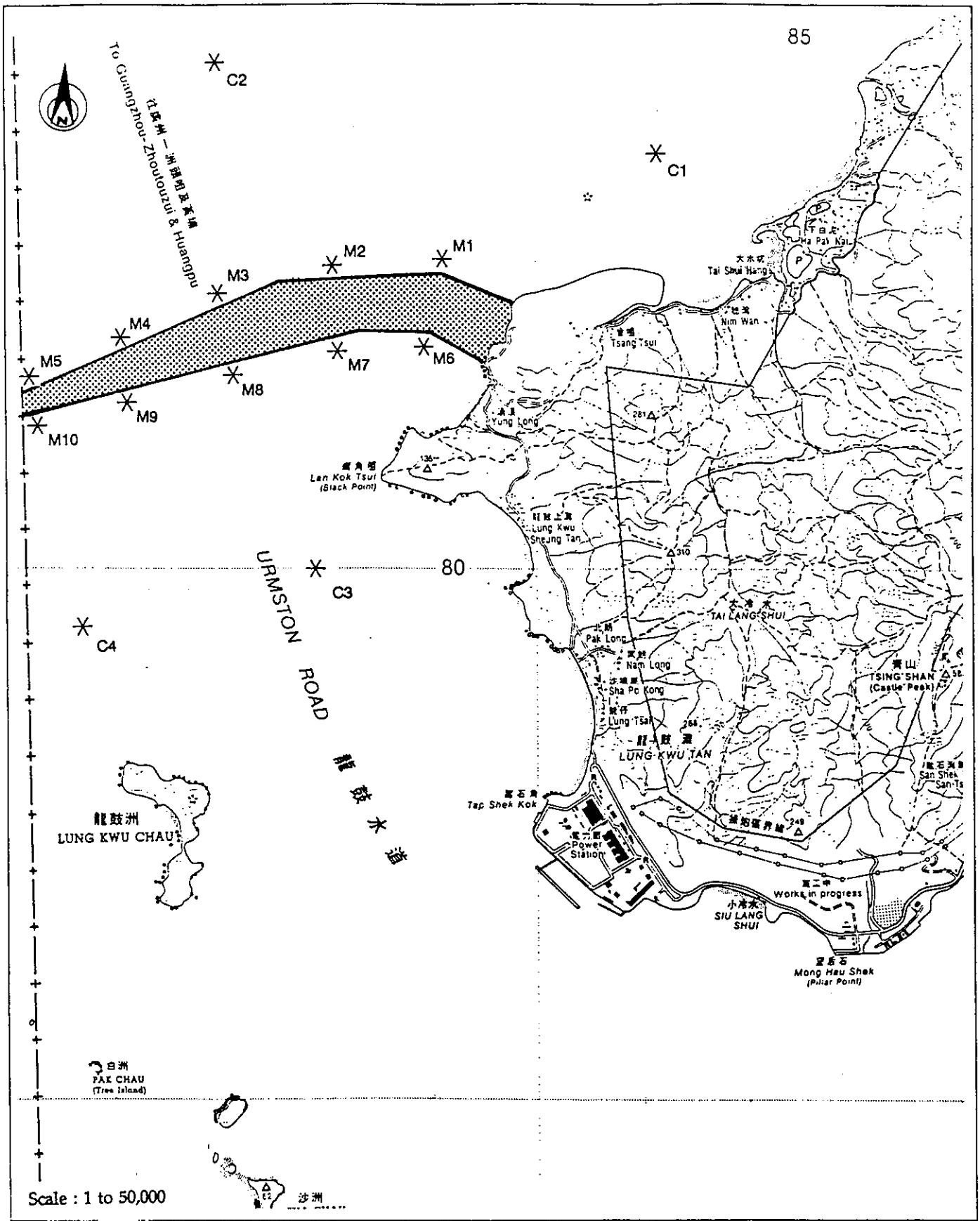



Figure A5.1a

Locations of Water Monitoring and Control Stations

ERM Hong Kong

11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

ERM

*Table A5.1b* *Water Quality - Action Plan*

| Event | Action | |
|---|---|---|
| | Project Proponent/Engineer | Contractor |
| Exceedance of Trigger Level | Notify EPD<br>Evaluate the effectiveness of the contractor's proposed mitigation measures<br>Require contractor to implement the necessary mitigation measures to prevent breaching another level | Repeat measurements as soon as possible to check compliance of water quality parameters with reference to the compliance standards.<br>Notify Project Proponent/Engineer.<br>Review their own plants, equipment and working procedures.<br>Identify source and impose necessary mitigation measures.<br>Recommended mitigation measures include but are not limited to the following:<br>· Rescheduling of dredging activities.<br>· Improved operational and maintenance techniques. |
| Exceedance in Action Level | Notify EPD immediately.<br>Require Contractor to make additional proposals on mitigation measures | Repeat measurements as soon as possible to check compliance of water quality parameters with reference to the compliance standards.<br>Identify source.<br>Review plant and equipment and working procedures.<br>Submit proposals for mitigation measures to Project Proponent/Engineer.<br>Implement remedial action immediately.<br>Notify Project Proponent/Engineer of the action taken. |
| Exceedance of Target Level | Notify EPD immediately.<br>Require Contractor to make additional proposals and to take immediate steps to mitigate situation<br>Provide investigation report which should be sent to EPD as soon as possible. | Repeat measurements as soon as possible to check compliance of water quality parameters with reference to the compliance standards.<br>Daily monitoring is to be imposed.<br>Notify Project Proponent/Engineer.<br>Identify source.<br>Review plant and equipment and working procedures.<br>Submit proposals for mitigation measures to Project Proponent/Engineer.<br>Implement remedial action immediately.<br>Notify Project Proponent/Engineer of the action taken.<br>Provide investigation report which should include the findings and suggestions to prevent such exceedance happening again.<br>If target limits are breached for 3 consecutive measurements, dredging to be suspended until the Authority is convinced that the problem is well under control and that the continuation of dredging operations will be in compliance with DBWQO. |

## A5.2 *CONTINGENCY PLAN*

The following measures shall be undertaken to avoid any unnecessary delay in action or monitoring:

i) Deputy to be appointed in the event of prolonged non-availability of key personnel;

ii) Provision to be made for delay which may affect the monitoring schedule;

iii) Spares to be available in the event of failure or theft of equipment;

iv) Delay monitoring in the event of adverse weather conditions until immediately after adverse conditions;

v) Reschedule monitoring due to any other causes resulting in the failure to carry out the necessary monitoring exercise as scheduled;

vi) Allowance made to provide additional monitoring equipment.

## A5.3 *ENVIRONMENTAL AUDIT REQUIREMENTS*

Project auditing is required to ensure that the proposed developments whilst being constructed and operated will be able to comply with all environmental regulatory requirements, policies and standards.

Environmental auditing should be carried out by an independent body with a view towards reviewing and verifying information available in records developed through the monitoring programme, and to thereby identify specific issues of non-compliance and recommendations to meet them. It is recommended that an audit be carried out on a regular basis to check the effectiveness of the mitigatory measures employed and to review the need for other mitigatory measures.

## A5.4 *ENVIRONMENTAL MONITORING AND AUDIT MANUAL*

An Environmental Monitoring and Audit (EM&A) Manual will be required to provide information, guidance and instruction to environmental site staff undertaking the M&A work. It is recommended that an on-site staff be appointed to monitor environmental performance of the contractor(s) and to ensure that the environmental requirements are met. The EM&A Manual should be submitted to DEP for consideration prior to commencement of baseline monitoring and construction work. Guidelines on the EM&A Manual are given in *Annex VIII*.

Monitoring data should be recorded and stored for ease of reference. An EM&A progress report should be submitted to EPD on a regular basis. The frequency of report submission should be agreed with EPD. The reports should include monitoring data, audit/review of the environmental

monitoring data to identify compliance with regulatory requirements, policies and standards and any remedial works taken/required to mitigate the adverse impacts. Format and guidelines of the EM&A Progress Report are given in *Annex VIII*.

## A6 CONCLUSIONS

This section presents a summary of the environmental impacts associated with the construction and operational phase of the ARCO submarine pipeline for the Hong Kong territorial waters in relation to water, waste, and ecology. A summary of mitigation measures are given in *Annex IX.*

### A6.1 WATER

Sediment loss during pipeline installation were estimated for different trenching techniques and compared with the natural sediment regime. Given the high and variable concentrations of SS in Urmston Road, the dredging/post trenching activities will have a minimal effect on local suspended solids concentrations particularly during the wet season when natural concentration are highest.

With the great distance of the pipeline corridor from the WSRs, the nearest being the oyster bed that is around 2km away, potential increases in SS levels will be within the natural variation range and are therefore not envisaged to have any unacceptable impacts on the WSRs.

There will be no discharge into Hong Kong waters during the precommissioning and commissioning stage. Similarly, for the operational stage, no effluent discharge is anticipated from the pipeline system.

### A6.2 WASTE

Results of sediment sampling in the Outer Deep Bay Borrow Area indicate that the marine sediment is uncontaminated, classified as Class A material in accordance with the EPD Technical Circular No. 1-1-92, for which no special dredging, transport or disposal methods are required. It is likely that the dredged material will be allocated to the gazetted marine dump sites at South Cheung Chau and East of Ninepins. Further consultation with the DEP is necessary to confirm the final disposal location.

The operation of the pipeline is not envisaged to produce any waste.

### A6.3 ECOLOGY

The direct loss of benthic communities and disturbance to the marine biota cannot be avoided but will be minimised by the mitigation measures recommended in the report. However, no rare or unique species or species of significant ecological or scientific interest are known or have been reported in the Black Point area, apart from the Chinese White Dolphin which has been sighted around Black Point. All other species identified are commonly found in marine habitats elsewhere in Hong Kong and therefore the marine ecology in these waters is not of special ecological value. The fisheries resource in these waters is considered unlikely to be important in view of the low number of species found and their moderate commercial

value. Therefore, the loss of benthic and fish species is anticipated to exert only a localised impact on the marine environment, and is unlikely to result in any significant disturbance to the marine ecosystem and fisheries resource of Hong Kong.

The most significant potential impact upon the marine ecology of the area is the possible disturbance of known habitats for the Chinese White Dolphin. The proposed PADS developments for waterfront industry and the associated increase in maritime traffic may have adverse impacts upon the use of these waters by the dolphin. However, construction of the proposed pipeline will be a temporary impact and minor in comparison to the scale of the PADS development. The pipe installation is therefore considered unlikely to adversely affect the Dolphin.

*A6.4* *NOISE*

The predicted noise levels at Lung Kwu Sheung Tan and Tsang Tsui were estimated. It is concluded that noise emission associated with the construction activities of the ARCO pipeline, in its "worst case scenario", will meet with the noise criteria recommended. The construction activities will mostly be imperceptible at the nearest noise sensitive receivers, and it is considered that no specific noise constraint and monitoring is identified to be required for the works.

# PART B

Hong Kong Gas Receiving Station:
*Environmental Impact Assessment*

CONTENTS

# B1 INTRODUCTION

This EIA study assess the potential environmental impacts involved in the construction, operational and decommissioning of the Hong Kong Gas Receiving Station (GRS) and its related facilities at Black Point. The location of the GRS is shown in *Figure B1.1a*.

The report is organised as follows:

Section B2 describes the proposed development, its operation, the surrounding landuse and the overall construction programme;

Sections B3, B4, B5 and B6 describe the net environmental impacts and cumulative effects on air, waste, water quality and noise during the construction, operation and decommissioning of the GRS. Mitigation measures are recommended to reduce these impacts to acceptable levels;

Section B7 summarises and highlights the environmental impacts associated with the construction and operation of the project.

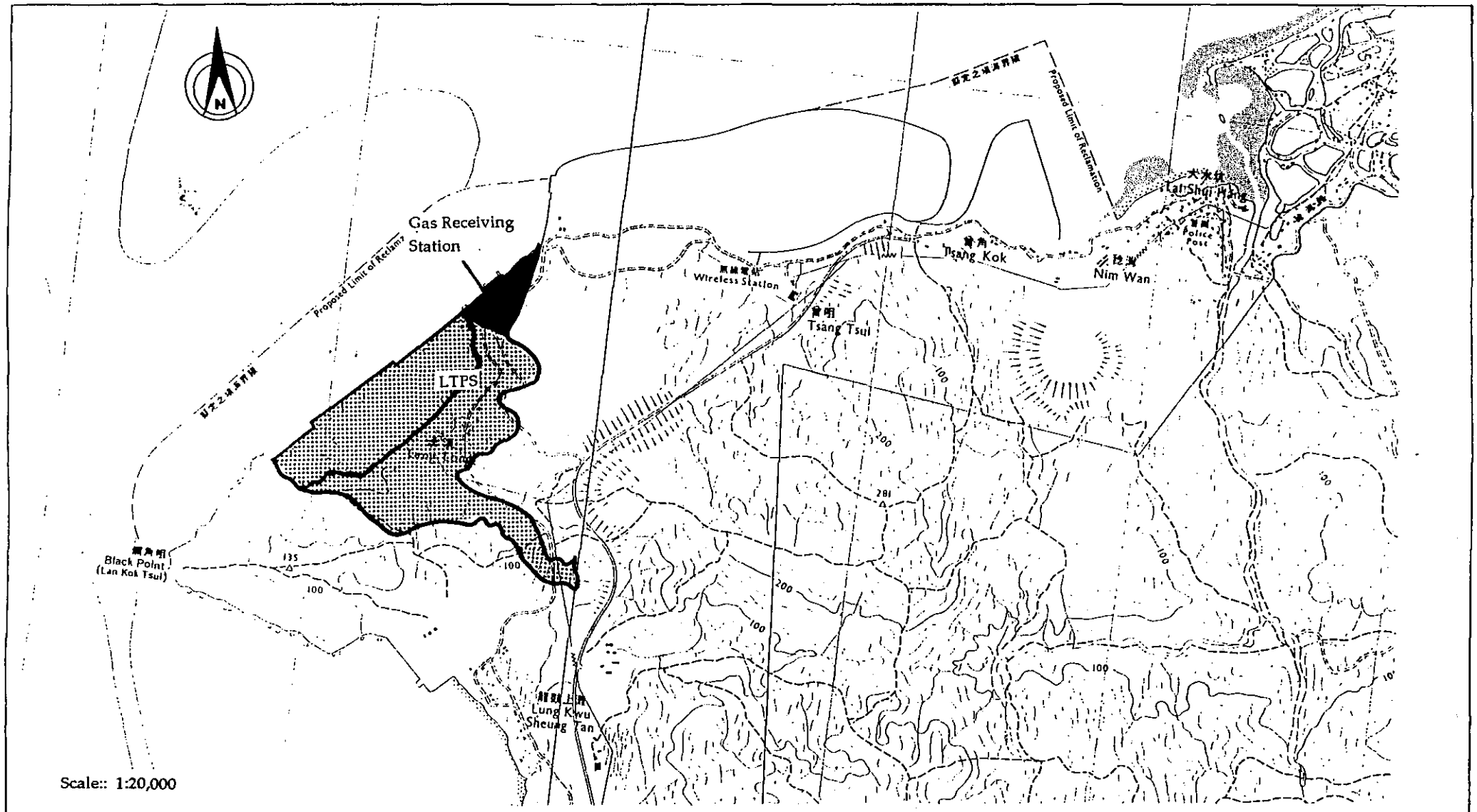



Figure B1.1a

Location of Gas Receiving Station

**ERM Hong Kong**

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

## B2 PROPOSED DEVELOPMENT

### B2.1 SURROUNDING ENVIRONMENT

The proposed GRS is located in the North Western New Territories of Hong Kong by the new LTPS. The geographical setting of the GRS and its surrounding environment is shown in *Figure B2.1a*. To the north-east of Black Point are the WENT landfill, BBC relay station, Tsang Tsui Ash Lagoons and Black Point Borrow Area; to the immediate south is the LTPS while the Castle Peak Power Station (CPPS) is located over 1.5 km to the south.

### B2.2 GENERAL PRINCIPLES

The Hong Kong GRS acts as a receiving and pressure reduction station for transfer of gas to the CLP Black Point and CPPS from the Yacheng Platform in Hainan via a 778 km submarine gas pipeline.

CLP's generation facilities (Castle Peak and/or Black Point) may take gas at a rate up to 19MNm$^3$day$^{-1}$ (714 MMSCFD) for 12 hours followed by no gas requirements for the next 12 hours, 9MNm$^3$day$^{-1}$ (336 MMSCFD average delivery). They require a delivery pressure of 34 - 40 bar (500-600 psig). The GRS provides for peak flow by packing gas into the pipeline during no-flow periods.

The GRS mechanical design is based on a maximum 19MNm$^3$day$^{-1}$ (714 MMSCFD) instantaneous rate. During each 24 hour cycle, the pipeline pressure at the GRS inlet may vary between 50 - 136 bar (740 to 2000 psig). The GRS is designed to deliver gas through two 100% capacity pressure reduction trains while maintaining gas temperature at least 28°C above hydrocarbon dew point. The specification of the gas is presented in *Table B2.2a*. In addition, the gas will be free from trace metals, materials, and dust or other solid or liquid matter, waxes and gums.

High pipeline pressures (over 153 bar (2250 psig)) or low pressures (under 40 bar (600 psig)) will shut down the GRS which means that deliveries to CLP will be immediately terminate.

Facilities to be installed within the GRS are briefly described in the following sections. *Figures B2.2a* and *B2.2b* show the process flow diagram and the proposed plant layout.

## B2.3 DESCRIPTION OF FACILITIES

### B2.3.1 *Inlet Safety Shut-Off Valve (Safety 'Slam-Shut' Isolation Valves)*

The inlet safety shut-off valve is a primary shutdown device in the event of a problem within the GRS or receiving facilities at CLP. It will close automatically within 5 seconds of an Emergency Shut Down (ESD) or Process Shut Down (PSD) condition.

### B2.3.2 *Pig Receiver*

The pig receiver will retrieve arriving pigs used for inspection and cleaning of the pipeline. It is unusual and undesirable for liquids to enter the pipeline and pigging to clean the line is not routine. The pig receiver is designed for normal brush pigs as well as instrumented smart pigs.

*Table B2.2a Specification of Natural Gas*

| | |
|---|---|
| Gas flow rate<br>Maximum (in volume units at 36.8MJ/$m^3$, (970 BTU/scf)) | 19MNm$^3$ per day/12 hours<br>(714MMSCFD/12 hours) |
| Delivery pressure | 40 bar (600 psig) maximum<br>34 bar (500 psig) minimum |
| Delivery temperature | Not less than 18.3°C and at least 28°C over hydrocarbon dew point |
| Hydrocarbon dew point | Not over 12.8°C at delivery pressure |
| Carbon dioxide, maximum | 12.0 mole percent |
| Nitrogen, maximum | 2.0 mole percent |
| Total sulphur content as $H_2S$, maximum | 50 ppm by volume |
| Water content maximum | 6.0 lb/mmscf |
| Particles | No particle larger than 40 microns |

### B2.3.3 *Slug Catcher and Filtration*

To assure complete protection for the GRS, a slug catcher with liquids holding, handling and disposal capability will be installed. No liquids are expected under normal conditions due to dehydration and hydrocarbon dew point control on the offshore platform and therefore a small slug catcher will be installed (31.8$m^3$, (200 barrels)). Any slug catcher liquids recovered will be transferred to the slop receiver where liquids are stored and evacuated by vacuum truck for disposal.

A high liquid level in the slug catcher will shut down the Hong Kong facility. Controls on high level will be triplicated and require a vote of two out of three to activate a shutdown.

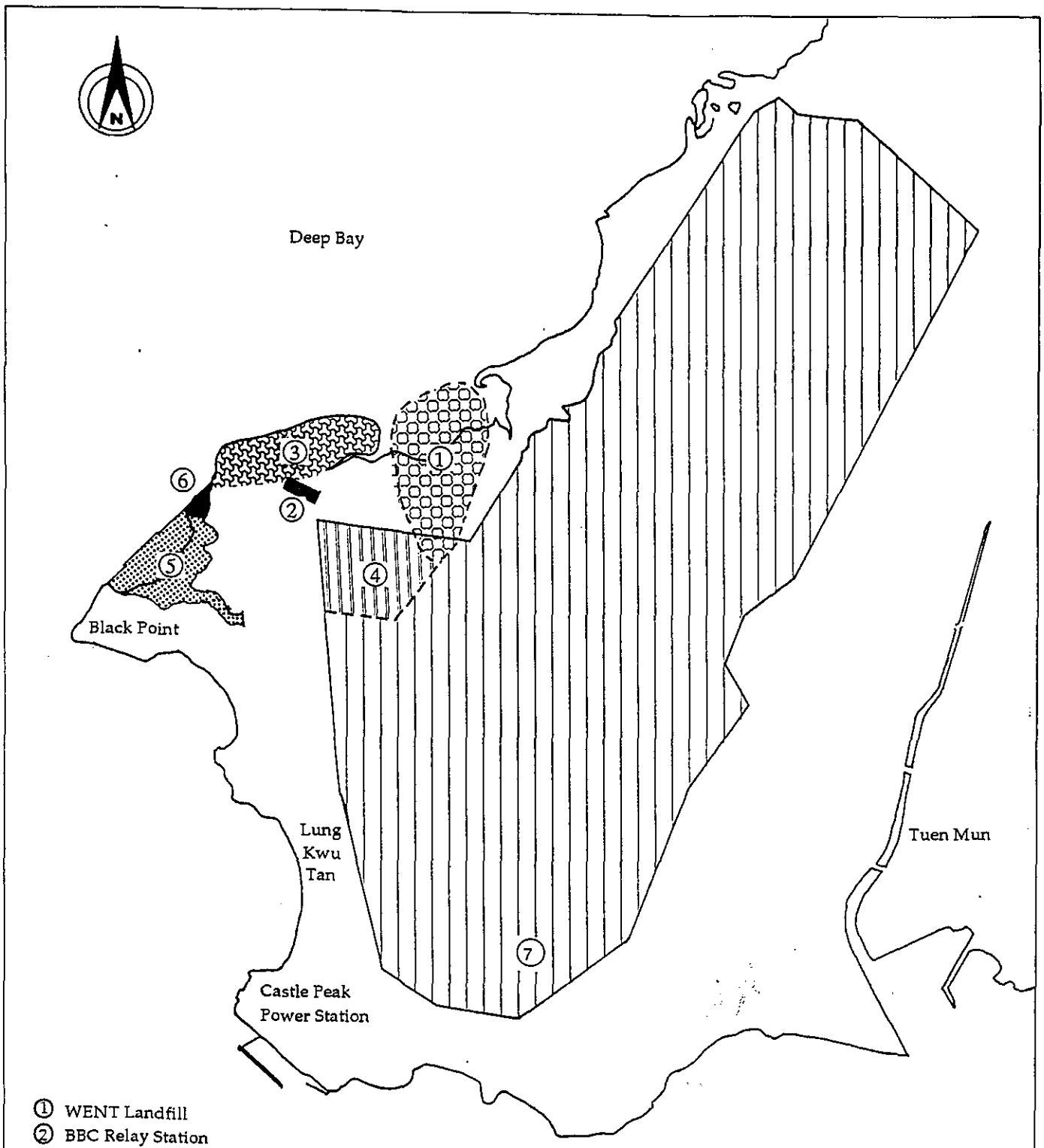



Figure B2.1a

Surrounding Environment

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

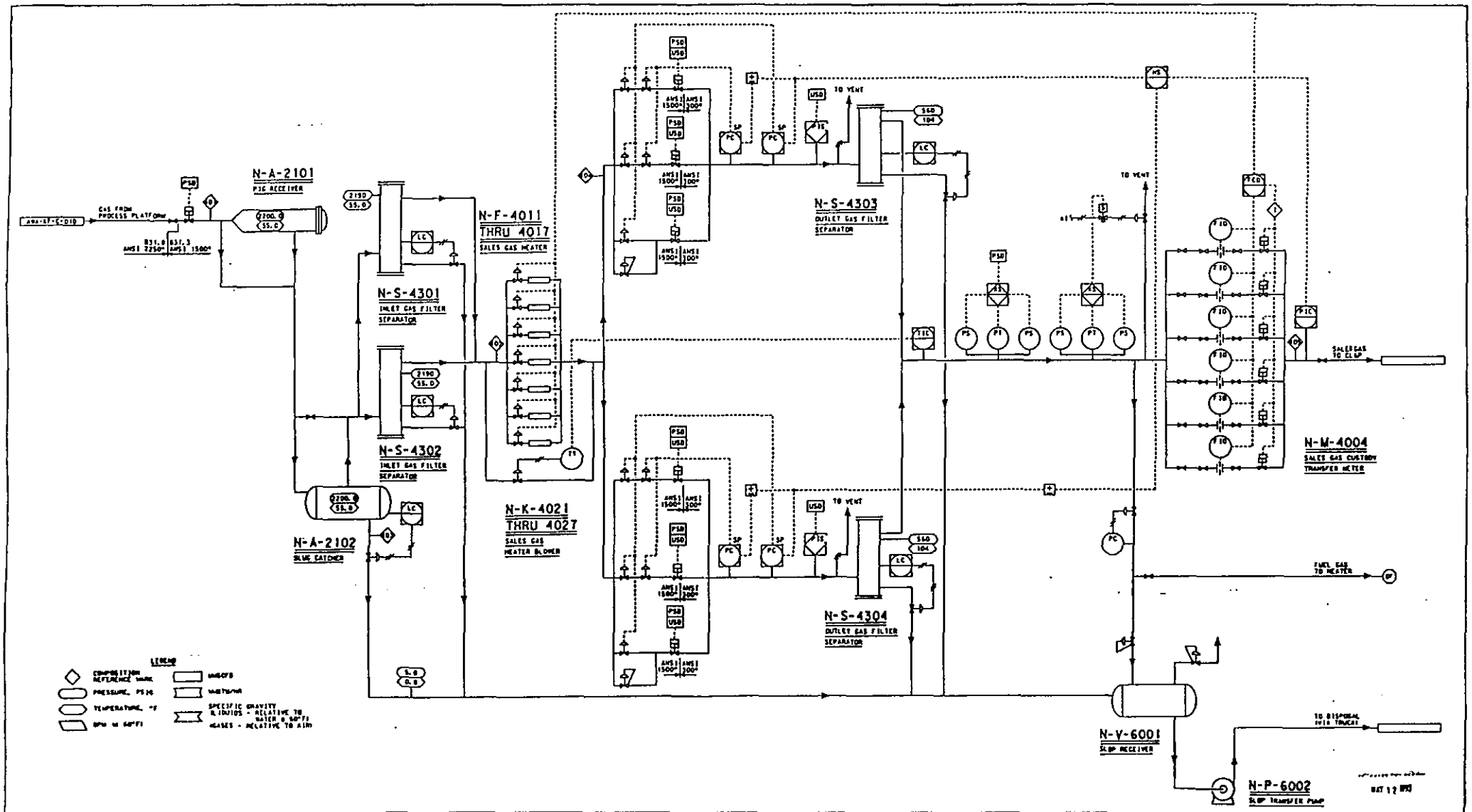



Figure B2.2a

Process Flow Diagram

**ERM Hong Kong**

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

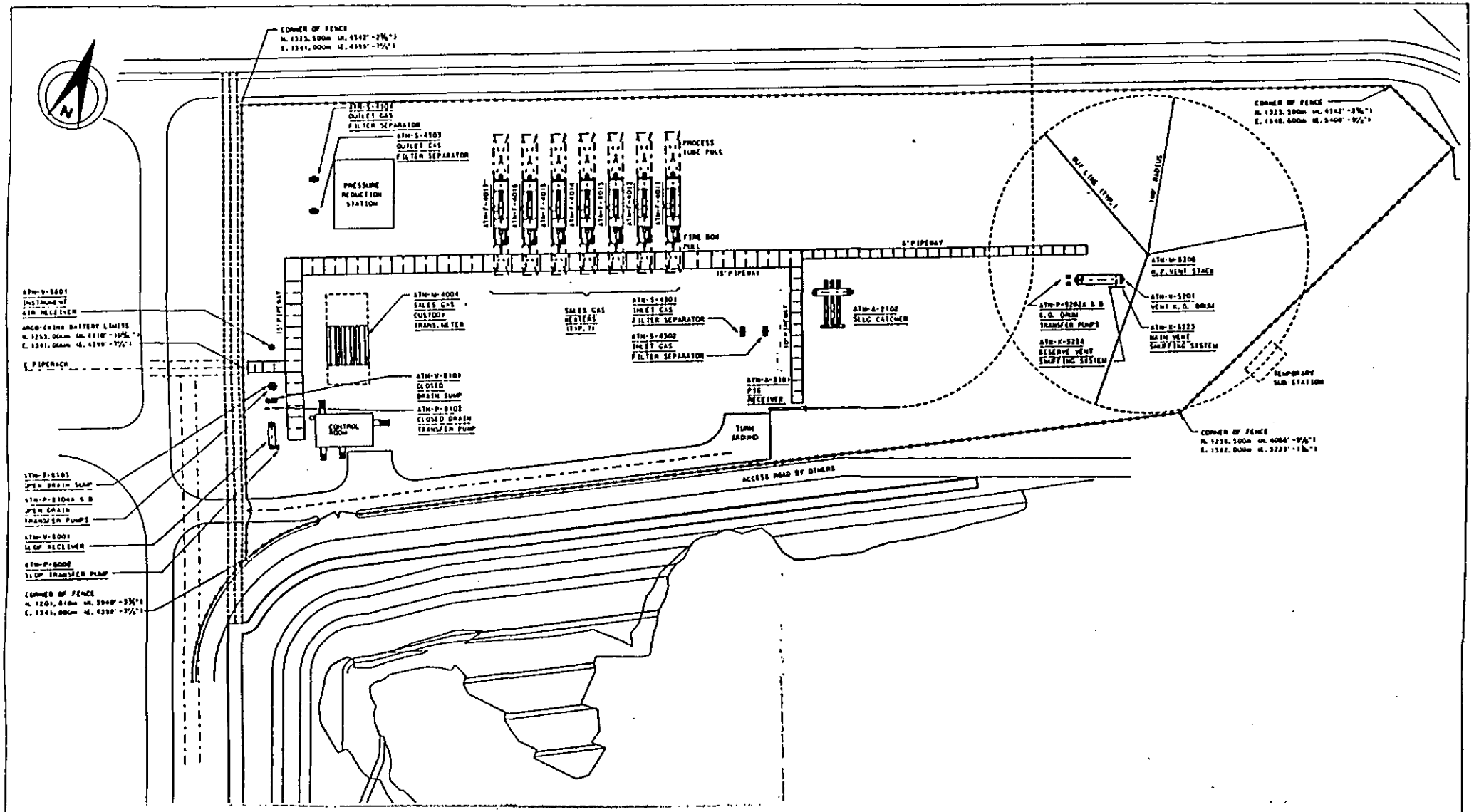



Figure B2.2b

Plant Layout

**ERM Hong Kong**

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

### B2.3.4 *Inlet Filters/Separators*

Separated gas from the slug catcher will be filtered in parallel 100% inlet filter/separators. These remove the last traces of liquid mist and solid particles.

These separators use replaceable high efficiency coalescing cartridges for removal of 99 percent of particles over 3 microns. Mist carryover and solids collected by brush pigging are captured.

### B2.3.5 *Gas Heaters*

CLP requires the gas to be delivered at 28°C or more, above the hydrocarbon dew point of about 12.8°C. Seven water bath gas heaters warm the gas from the filter/separators to 76.7°C to offset the Joule-Thompson effect which cools the gas through the pressure reducing station letdown valves. At full capacity, five water-bath heaters are in operation and two are on standby. Bath temperature is maintained at 87.8°C at all times in the heaters by individual burner control systems. Gas flow through individual heaters is controlled by open/close inlet block valves. As the gas demand increases, inlet block valves to the heaters are opened in sequence.

### B2.3.6 *Pressure Reduction Stations*

Two parallel pressure reduction stations, each of 100% capacity, regulate delivery pressure to 37 - 40 bar (540-590 psig). The system can maintain delivery near 40 bar (600 psig) in support of the Castle Peak pipeline. Each station consists of two 50% 14" pressure control valves equipped with high-speed-actuators. Each is followed by a 14" monitoring (tracking) valve and an 18" SDV (shutdown valve) to prevent overpressure by their fast closure times. In addition, night-time self-contained pressure regulators provide standby fuel for the waterbath heater.

### B2.3.7 *Outlet Filter/Separators*

Outlet filter/separators will remove any condensate formed during the pressure letdown. No liquids are formed normally if the heating system is operating properly. There are 3-micron coalescing filter elements which are identical to those in the inlet filter/separators.

### B2.3.8 *Gas Transfer Meter*

Metering Facilities will measure the gas flow to CLP. Six parallel meter runs will be installed. Five are required for maximum flow and one is a spare. These will be opened in sequence as the gas flow increases and closed in reverse order.

Flow will totalized on two independent metering computers with redundant transmitters. Flow signals will be transmitted to CLP. A composite sampler will gather samples for gas chromatography testing.

*B2.3.9* *Drain/slop oil system*

Both open drain and closed drain systems will be installed in the GRS area. The open drain will collect wastewater from the process equipment area and drain it to the open drain sump. Wastewater will be transferred to the CLP open drain system via lift pumps.

The closed drain system will collect high pressure hydrocarbon wastes and drain it to the closed drain sump where the liquids will be pumped to the slop receiver for storage and disposal. Vapours are vented to atmosphere through a flame arrestor.

*B2.3.10* *Overpressure/Emergency Shutdown*

Overpressure protection of the piping at CLP to 50 bar (740 psig) maximum allowable operating pressure (MAOP) will be provided by multiple levels of protection including two independent overpressure/emergency ShutDown isolation valve (SDV) systems.

*B2.3.11* *Vent Stack*

The elevated Vent Stack will safely dispose of blowdown gas, PSD releases, and blowdown gas from the pipeline. In addition, a very small continuous flow of purge gas at 10scfm will maintain a slight positive pressure to prevent oxygen from accumulating in the venting system. This stack will be 54.5m (180 ft) high and 711 mm (28") in diameter. A carbon dioxide snuffing system will be installed to extinguish fires in case the vent stack is ignited by lightning, static electricity or other causes. This system is designed for maximum delivery rate venting lasting 3 seconds. The height limits radiation from an accidental ignition to a person on the ground to 9569J/sm$^2$ (3000 BTU/hr/sq.ft) for under 5 seconds.

*B2.4* *DEVELOPMENT PROGRAMME*

Site formation work for the GRS will be undertaken by CLP and the site will be handed over to ARCO by April 1994. Installation of the pipeline will commence shortly afterwards and is scheduled to be completed by October 1994. Civil construction work will follow thereafter and mechanical completion is tentatively scheduled for June 1995. Supply of gas will tie-in with the commercial operation of the power station and which is expected to be January, 1996.

The GRS development will be in phase with LTPS. Site formation work for the LTPS will be largely complete by March 1994. Building erection and equipment installation for the LTPS will coincide with construction work for GRS. Dredging work for WENT was completed and site preparation work for the landfill is also underway. Construction work will be completed when construction for the GRS commences.

## B3 AIR

### B3.1 BASELINE CONDITIONS

#### B3.1.1 Existing Air Quality

The GRS will be located at the northern part of the LTPS in an area remote from any urban developments.

The air quality of the area is likely to be affected by the operation of the CPPS under south-easterly winds and gaseous emissions from vehicles associated with the operation of the WENT landfill. It has been estimated that about 300 truck deliveries per day will pass through Lung Kwu Sheung Tan. Exhaust emissions from trucks associated with the operation of the landfill will not cause significant increase to the background air pollution level in the surrounding area.

*Table B3.1a* gives the air quality monitoring results from a CLP monitoring station at Lung Kwu Tan/Black Point. It is clear that the existing $NO_2$ and $SO_2$ levels are well within the respective Air Quality Objectives (AQOs).

*Table B3.1a Summary of $SO_2$ and $NO_2$ Monitoring Results ($\mu g\ m^{-3}$)*

| Years | Lung Kwu Tan/Black Point | |
|---|---|---|
| | $SO_2$ | $NO_2$ |
| Annual average concentrations | | |
| AQOs | 80 | 80 |
| 1991 | 12 | 18 |
| 1992 | 19 | 15 |
| Annual daily maximum concentrations | | |
| AQOs | 350 | 150 |
| 1991 | 59 (May) | 60 (Jun) |
| 1992 | 153 (Dec) | 56 (Jan) |
| Annual hourly maximum concentrations | | |
| AQOs | 800 | 300 |
| 1991 | 291 (Feb) | 201 (Jun) |
| 1992 | 288 (Jan) | 155 (Sept) |

Note: (1) Month of occurrence in brackets.
(2) ERM Hong Kong, EIA of the Proposed 6000 MW Thermal Power Station at Black Point: KIA, Final Report, Part B – Rigorous Frequency Analysis, Tables B3.4a and B3.4b.

### B3.1.2 *Future Air Quality*

During the operation of the GRS, the air quality of the Lung Kwu Sheung Tan will be affected by emissions from the LTPS or the CPPS under north-westerly winds or south-easterly winds respectively. With south-westerly winds, Tsang Tsui is likely to be influenced by pollution from both LTPS and CPPS and industrial developments in the Black Point area. Furthermore, emissions from vehicles generated along future road networks and industrial developments in the Black Point area will also contribute to the overall air quality of the area.

The assumed future air quality at Lung Kwu Tan area and Ha Pak Nai has been estimated in the LTPS Air Quality Key Issue Assessment as shown in *Table B3.1b*. Results at Lung Kwu Tan and Ha Pak Nai should be representative of that at Lung Kwu Sheung Tan and Tsang Tsui. The future air quality at Lung Kwu Tan and Ha Pak Nai were estimated under 8 m $s^{-1}$. The potential air quality impacts from Tuen Mun Port Development have also been included in the estimation of the future background air quality.

However under lower wind speeds, the air quality of the study area is likely to be more influenced by low level air pollution sources in the area. Due to the limited number of committed low level air pollution sources in the Ha Pak Nai and Lung Kwu Tan areas (*see Figure B2.1a*), the likely future air quality of the areas under lower wind speeds is expected to be good and well below the estimated future background air quality as shown in *Table B3.1b*.

It should be noted that the future background air quality were estimated without impacts from the existing Castle Peak Power Station and the proposed LTPS at Black Point.

*Table B3.1b Assumed Future Background $SO_2$ and $NO_2$ levels*

| Receptors | Percentage of hourly AQO | |
|---|---|---|
| | $SO_2$ | $NO_2$ |
| Ha Pak Nai | 3 | 2 |
| Lung Kwu Tan\Black Point | 1 | 3 |

Source: ERM Hong Kong, EIA of the Proposed 6,000 MW Thermal Power Station Stack Emissions Key Issue Assessment, Table 3.4d, Part B – Rigorous Frequency Analysis, 1993.

### B3.1.3 *Air Sensitive Receptors (ASRs)*

The nearest ASRs to the GRS were identified in accordance with the Hong Kong Planning Standards and Guidelines (HKPSG) and are shown in *Figure B3.1a*.

Within 2 km of the GRS there are a number of scattered villages, notably Yung Long, Tsang Tsui and Lung Kwu Tan. The houses at Yung Long have already been resumed as a result of the construction of the LTPS.

Tsang Tsui about 1.2 km from the GRS is the nearest ASR to the GRS. Small clusters of village houses and the BBC Relay Station are in the Tsang Tsui area and is reported to have a population of about nine.

Lung Kwu Sheung Tan is located about 1.6 km south of the GRS and is separated by the Black Point Ridge. Lung Kwu Sheung Tan will be sheltered by the Black Point Ridge of 100m high from the emissions of the GRS. It is recommended in the Tuen Mun Port Development Study that the villagers in Lung Kwu Sheung Tan should be relocated as a result of the Tuen Mun Port Development.

## B3.2 *CONSTRUCTION IMPACTS*

Construction of the GRS will generate significant amounts of dust if uncontrolled. The potential sources of dust are vehicle movements on unpaved roads, excavation, stockpiling and concrete batching. Due to the limited numbers of diesel powered plant and equipment which will be used on site, impacts from exhaust emissions are likely to be insignificant.

### B3.2.1 *Potential Impacts due to Dust*

The main sources of dust to be associated with the construction of the GRS are:

- *Site Formation:* Most of the site formation and reclamation work will be carried out as part of the construction of the LTPS. The level of excavation works required during the construction of the GRS will probably be very limited and will not cause significant dust impacts to the surrounding area.

- *Stockpiling*: As it is expected that the level of excavation works will be limited, no significant quantity of aggregate will be stored on the works site.

- *Concrete batching:* No concrete batching is expected to be undertaken on the site as most of the construction, after site formation, will be steel work and installation of the plant equipment. However, if a concrete batching plant of capacity greater than 50 tonnes per day is installed on site, the operation will be required to comply with the licensing requirements under the Specified Process Regulation,

- *Vehicle movements on unpaved haul road*: Due to the size of the works area the number of vehicle movements that will be generated from construction works is expected to be limited and will not cause significant dust impacts to the area.

### B3.2.2 *Evaluation Criteria*

The limits of ambient dust levels are laid down in the Hong Kong Air Quality Objectives (HKAQO) as shown in *Table B3.2a*. The objectives for dust are based on two averaging periods of 24 hours and one year.

*Table B3.2a* ***Hong Kong Air Quality Objectives***

| Pollutant | Concentration in micrograms per cubic metre *(i)* | | | |
|---|---|---|---|---|
| | Averaging Time | | | |
| | 1 Hour *(ii)* | 8 Hours *(iii)* | 24 Hours *(iii)* | 1 Year *(iv)* |
| Sulphur Dioxide | 800 | | 350 | 80 |
| Total Suspended Particulates (TSP) | | | 260 | 80 |
| Respirable (v) Suspended Particulates (RSP) | | | 180 | 55 |
| Nitrogen Dioxide | 300 | | 150 | 80 |
| Carbon Monoxide | 30,000 | 10,000 | | |

Notes:
(i) Measured at 298°K (25°C) and 101.325 kPa (one atmosphere).
(ii) Not to be exceeded more than three times per day.
(iii) Not to be exceeded more than once per year.
(iv) Arithmetic means.
(v) Respirable suspended particulates means suspended particles in air with a nominal aerodynamic diameter of 10 micrometres and smaller.

In addition to these objectives, an hourly TSP limit of 500 $\mu g\ m^{-3}$ is generally used. This limit is not statutory, but has been employed as an evaluation criterion in EIA studies for many construction projects in Hong Kong and has been enforced through contractual clauses.

### B3.2.3 *Assessment Methodology*

*Dispersion Model*

A Gaussian dispersion model, the Fugitive Dust Model (FDM), was used to predict the level of dust transferred from the construction site to the surrounding area.

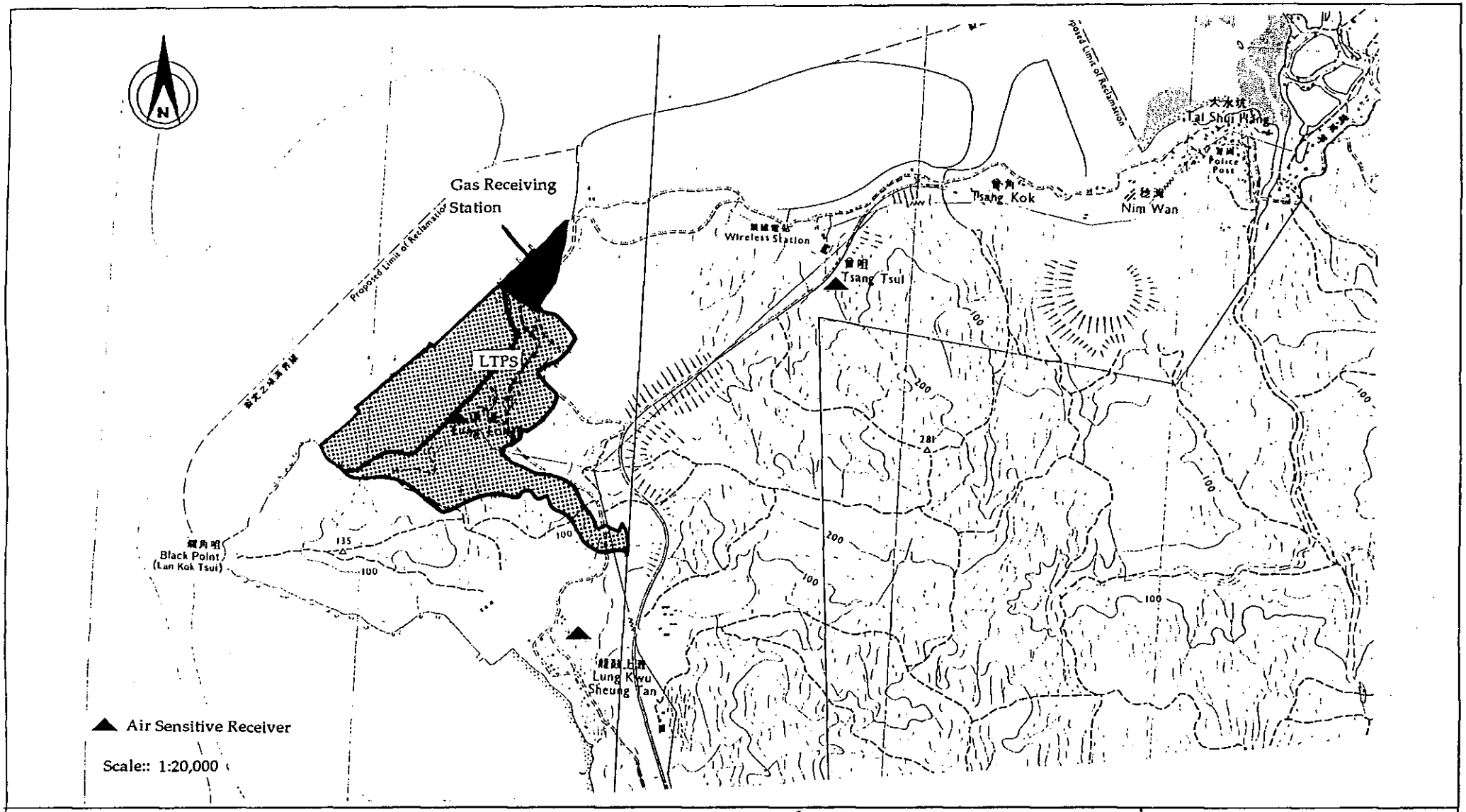



Figure B3.1a

Location of Air Sensitive Receivers

**ERM Hong Kong**

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

It has been assumed that most of the construction work will be carried out during the daytime. Worst-case meteorological conditions of 2 m $s^{-1}$ wind speed under atmospheric stability class 'D' and with the wind blowing directly towards the receptors were used in the modelling exercise.

A particle density of 2,500 kg $m^{-3}$ and one category of particle size (0-30 microns) were adopted in the model run.

The worst case total suspended particulate (TSP) 1-hour dust levels were calculated. Since wind directions and speeds vary significantly throughout the day, a lower 24-hour average dust level at any specific location is likely under the assumed worst case meteorological conditions (ie constant worst case wind direction and speed to a receptor in an hour). The predicted worst case 1-hour dust levels were compared to the hourly TSP limit of 500 $\mu g\ m^{-3}$.

Since the construction of the GRS is likely to be carried out concurrently with the foundation works of the LTPS, their cumulative impacts were also considered in the assessment.

*Emission Rates*

The dust emission rate from construction activities is dependant on the area of the works site and the levels of activities. The potential drift distance of particulates is governed by the emission height, the particle terminal settling velocity and the degree of atmospheric turbulence.

Particles with diameters between 30-100 $\mu m$ are likely to undergo impeded settling. Depending on the atmospheric condition, these particles will probably settle within 100 m of the source of emission. It is generally recognized that dust nuisance to ASRs is mainly caused by particulates with diameter less than or equal to 30 $\mu m$.

A general dust emission rate of $1.16 \times 10^{-4}$ g $m^{-2}$ $s^{-1}$ was used in the dust impacts assessment for general construction activities, in accordance with the *US EPA - Compilation of Air Pollutant Emission Factors, AP-42, 4th Edition, 1985.*

*B3.2.4* *Evaluation of Impacts*

The predicted worst case 1-hour dust concentrations from the construction of the GRS falls to below $300 \mu g m^{-3}$ ( 1-hour average) at 100m from the GRS. The dust impacts from the construction of the GRS at the ASRs, i.e. at Lung Kwu Sheung Tan and Tsang Tsui will be well within the 1-hour limit of 500 $\mu g\ m^{-3}$ acceptable in terms of the 24-hour AQO for TSP.

As the construction of the GRS is likely to be carried out concurrently with the foundation works of the LTPS, the potential cumulative construction impacts may pose a threat to the 24-hour AQO for TSP in the area. From the construction phase EIA of the LTPS at Black Point, the unmitigated dust level at the site boundary from foundation works and vehicle movements

on haul road were predicted to be about 930 $\mu g\ m^{-3}$ and 5,280 $\mu g\ m^{-3}$ under the worst-case scenario. It is noted that, in general, impact will be limited within the construction site and receptors at Lung Kwu Sheung Tan will be protected by the ridge south of the Black Point ridge. Nevertheless, dust suppression measures should be adopted at the works site to reduce the contribution of dust from the construction of the GRS to the surrounding area.

### B3.2.5 *Mitigation Measures*

Although the construction of the GRS alone would not produce unacceptable dust levels, cumulative dust impacts with other concurrent construction activities may produce unacceptable TSP levels when compared with the recommended hourly limit of 500 $\mu g\ m^{-3}$ and the daily AQO of 260 $\mu g\ m^{-3}$. Therefore, it is recommended that the following mitigation measures and good on-site management practice should be adopted during the construction phase of the GRS.

*Vehicle Dust*

- On-site unpaved roads that are frequently used should be regularly compacted and the road surface should be kept clear of loose material. Roadways longer than 100 m and with frequent vehicle movements can be paved with flexible surfacing. Water spraying can also be used to control dust.

- Vehicles should be restricted to designated routes and speed.

- Wheel-wash troughs and hoses should be provided at traffic exits from the site to minimise the quantity of material deposited on public roads.

- Vehicles that have the potential to create dust while transporting materials should have properly fitting side and tail boards. As required by law, materials transported by vehicles need to be covered, with the cover properly secured and extended over the edges of the side and tail boards. The materials should also be dampened if necessary before transportation.

*Concrete Batching*

The Air Pollution Control (Amendment) Ordinance 1993 requires the owners of batching plants with a total silo capacity exceeding 50 tonnes to apply for a licence. The following good on-site management practices for concrete batching should be considered.

- The fugitive emissions from the cement silos should be controlled by bag filters whilst emissions from conveying the product can be reduced by covering the conveyor belt. All conveyors carrying dry cement should be totally enclosed through all stages of the process. Spray systems at aggregate transfer points can further reduce emissions.

- The plant site and ancillary areas should be frequently cleaned and watered to minimise any fugitive dust emissions.

- All vents on cement silos should be fitted with fabric filters using either shaking or pulse-air cleaning mechanisms.

- The filter bags in the cement silo dust collector must be thoroughly shaken after cement is blown into the silo to ensure adequate dust collection capacity for subsequent loading.

- Weigh hoppers of a cement silo should be vented to a suitable fabric filter .

It should be noted that, although there are no plans to install a batching plant on site, if a plant of more than 50 tonnes capacity is required it will have to comply with the above mentioned Ordinance.

*Stockpiling Activities*

If there are extensive stockpiling activities, the following mitigation measures should be considered:

- Stockpiles of sand and aggregate greater than 20 $m^3$ should be enclosed on three sides, with walls extending above the pile and 2 m beyond the front of the pile.

- Water spray facilities should be provided and used both for damping during reception and storage of raw materials.

*Significance of Mitigation Measures*

By adopting the above mitigation measures the following may be assumed :

- a 50% [1] dust suppression from frequent watering during construction activities;

- a 90% [2] dust removal from a controlled concrete batching process; and

- a 70% dust reduction by restricting on-site vehicle speed to 11 kph and by frequent watering or dampening of road surfaces.

With the above mentioned mitigation measures, the dust impacts from the construction of the GRS can be reduced to a very low level.

[1] Jutze, G.A., K. Aetell, Jr., and W. Parker. Investigation of Fugitive Dust-Sources Emissions and Control. Publication No. EPA-450/3-74-046a. June 1974.

[2] USEPA. Compilation of Air Pollutant Emission Factors, AP-42, 4th Edition, 1985.

## B3.3 OPERATIONAL IMPACTS

### B3.3.1 *Sources of Impacts*

During the operation of the GRS, gas is required to be delivered at 50°F, or more, above the hydrocarbon dewpoint of about 55°F. Five water-bath heaters are required at full capacity to warm the gas to the required temperature and two further heaters are required for backup purposes, as shown in *Figure B3.3a*. The potential air pollutants from the heaters are hydrocarbons (HC), sulphur dioxide ($SO_2$), total suspended particulates (TSP), nitrogen oxides ($NO_x$) and carbon monoxide (CO).

For safety purposes, purge gas will be emitted continuously from the high stack throughout the operation of the GRS in order to provide a positive pressure in the gas delivery system. The potential pollutants emitted from the vent system will be hydrocarbons and hydrogen sulphide. Hydrogen sulphide is a major source of odour. Under emergency conditions, gas will be released at high velocity from the high pressure vent in order to reduce pressure within the system. It should be noted that releases from the vent system under emergency conditions will be of short duration (about 5 seconds). Since the HK GRS has been designed for maximum reliability, therefore emergency venting is an extremely rare event. No significant odour impacts or air quality impacts will result from emissions from the vent system under emergency situations. Any emissions during emergency situations will be diluted at quick speed and within short distances from the GRS due to the high emission velocity and short emission duration.

The location of the emission sources are shown in *Figure B3.3a*.

### B3.3.2 *Evaluation Criteria*

Predicted levels of atmospheric pollutants were assessed against the AQOs shown in *Table B3.2a*.

Currently, there is no statutory limit to control hydrocarbon levels. No chronic systemic effects have been reported from occupational exposure of hydrocarbons. The vapour is not irritating to the eyes, nose, or throat [1]. In general, the flammability of hydrocarbons, in this case natural gas, and explosive hazards outweigh the biological effects. At extremely high concentrations (> 1000 ppm) the limiting toxic factor is available oxygen. Minimal oxygen content should be 18% by volume under normal atmospheric pressure.

Typical symptoms and signs of hydrogen sulphide intoxication are most often caused by relatively high concentrations in occupational exposures. *Table B3.3e* shows the established dose-effect relationships for hydrogen sulphide.

[1] Weiss G: Hazardous Chemical Data Book, Noyes Data Corporation, p 568. Park Ridge, New Jersey, 1980.

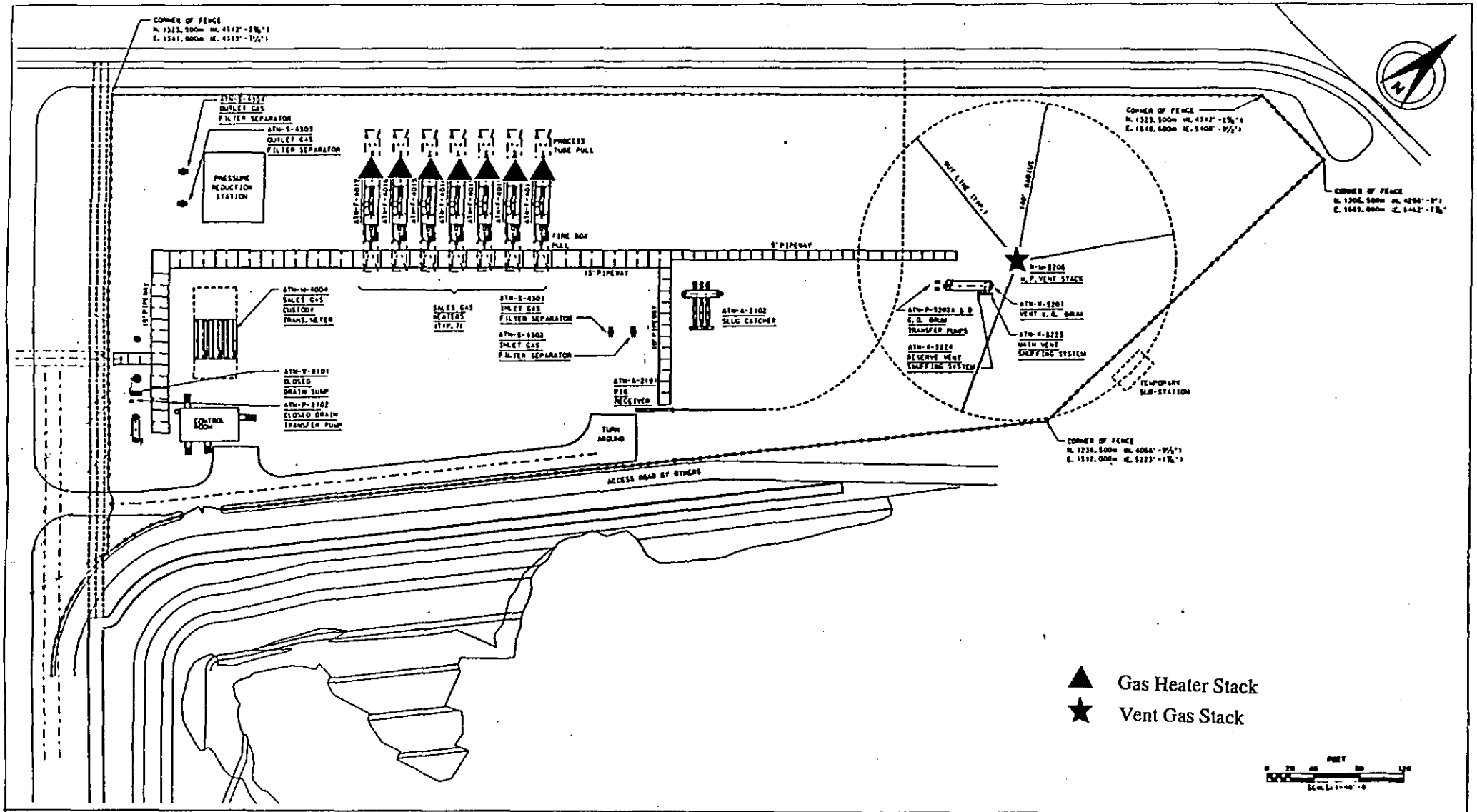



Figure B3.3a

Location of Emission Sources

**ERM Hong Kong**

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

*Table B3.3e Established dose-effect relationships for hydrogen sulphide*

| Hydrogen sulphide concentration (mg $m^{-3}$) | Effect |
|---|---|
| 1400–2800 | Immediate collapse with paralysis of respiration |
| 750–1400 | Strong CNS stimulation, hyperpnoea followed by respiratory arrest |
| 450–750 | Pulmonary oedema with risk of death |
| 210–350 | Loss of olfactory sense |
| 70–140 | Serious eye damage |
| 15–30 | Threshold for eye irritation |

Source: Air Quality Guidelines for Europe, Copenhagen: WHO Regional Office for Europe, 1987.

The lowest-adverse-effect level of hydrogen sulphide is 15 mg $m^{-3}$ when eye irritation is caused [1].

Hydrogen sulphide is also a major source of odour during the operation of the GRS. EPD's recommended 5 odour units over 5-sec averaging time were used in the study to assess the odour impacts at the site boundary. The local conventional odour standard is 2 odour units at the boundary which has been used in a number of odour impacts assessments.

## B3.3.3 *Assessment Methodology*

A Gaussian Dispersion model, Industrial Source Complex (Short Term Version) (ISCST2) was used to predict the pollutant concentrations from the potential sources of emission. The model is capable of considering many individual point sources and has options to allow for stack induced downwash, building effects and buoyancy induced dispersion between sources. The model is approved by the US Environmental Protection Agency (EPA) for simple terrain air quality predictions and has been extensively used in Hong Kong.

*Meteorological Input*

Atmospheric dispersion of pollutants is largely governed by meteorological conditions. Eighteen meteorological conditions were taken as input to the model in order to identify the worst case air quality impacts during the operation of the GRS. The meteorological conditions used are listed in *Table B3.3a*. These are based on the USEPA guidelines for screening purposes.

[1] Air Quality Guidelines for Europe, Copenhagen: WHO. Regional Office for Europe, 1987.

*Table B3.3a Meteorological Conditions*

| Stability Class | Wind Speed (m/s) | Mixing Height (m) |
|---|---|---|
| A | 1, 3 | 1000 |
| B | 1, 3, 5 | 1000 |
| C | 1, 3, 5, 10 | 800 |
| D | 1, 3, 5, 10 | 800 |
| E | 1, 3, 5 | 500 |
| F | 1, 3 | 500 |

*$NO_2/NO_x$ Oxidation Rates*

In accordance with the study on NO oxidation rates carried out by Janssen et al [1], based on power plant plumes on $NO_2/NO_x$ oxidation rate of 20%, was used for receptors at 2 km from the power generation plant. The adopted ozone concentration was 70 $\mu g\ m^{-3}$. Due to uncertainty of the NO to $NO_2$ conversion for non-power plant emission sources, an extra 10% $NO_2/NO_x$ conversion rate was added to the resulting $NO_2$ concentration from the GRS.

*Emission Rates*

The pollutant emission rate for the identified sources are given in *Table B3.3b*. The emission rates were based on information from manufacturers and the USEPA AP42.

The odour emission rate was calculated by multiplying the concentration of hydrogen sulphide of 50 ppmv in the gas and the odour threshold of 0.00047 ppmv [2] and the flow rate from the high pressure stack.

ISCST2 was used to predict the 1-hour odour level and the predicted odour levels were converted to 5 second figures. Correction multipliers to convert predicted hourly figures from 1-hour odour level to 5-sec level were used to account for the effects of human response to odour.

A power-law relationship that relates the ratio of one averaging time to another has been utilized by various environmental agencies to convert hourly figures to 3-minute figures. The relationship is:

$$X_{3\text{-min}} = X_{1\text{-hr}}(t_{1\text{-hr}}/t_{3\text{-min}})^p$$

Where $X_x$ is the concentration under different averaging periods and p is stability dependent (B:0.5; D:0.2; and F:0.167).

[1] Janssen et al, 'A classification of NO oxidation rates in power plant plumes based on atmospheric conditions', Atmospheric Environment Vol. 22, NO. 1, pp 43-53, (1988).

[2] P.N. Cheremisinoff, Industrial Odour Control, 1992.

The converted ISCST 3-min figures tend to underestimate the odour values by a factor of 10 under stability class 'D' and by a factor of 5 for stability class 'E' [1]. It is reasonable to assume that these observed odour levels were based on a rather short averaging time as these levels have been compared to a fluctuating puff model of typical 2-sec averaging time. As an estimate, these two multiplier factors will be used for stability class 'D' and 'F' for converting 3-min results to 5-sec results. Another study [2] recommended that a multiplier of 10 should be used for converting 3-min figures to 5-sec figures for unstable atmospheric conditions.

*Table B3.3c* shows the correction multipliers used in the odour assessment.

*Table B3.3c* ***Factors for converting 1-hr levels to 5-sec levels***

| Stability Class | Conversion factors | | |
|---|---|---|---|
| | 1-hr to 3-min (A)[1] | 3-min to 5-sec (B)[2] | Overall 1-hr to 5-sec (AxB) |
| B | 4.5 | 10 | 45 |
| D | 1.82 | 10 | 18.2 |
| F | 1.65 | 5 | 8.3 |

Notes: (1) From the empirical power-law relationship.
(2) Quoted from the study carried out by Richard et al for stabilities 'D' and 'F' and from the study carried out by Keddie for stability 'B'.

*Cumulative Impacts*

As the GRS will be operated with the LTPS at Black Point, air quality impacts from the LTPS were also considered in the assessment.

## *B3.3.4 Evaluation of Impacts*

*Table B3.3d* shows the predicted worst case 1-hour pollutant concentrations from the gas heaters. The maximum worst case ground level 1-hour pollution concentrations at 50 m from the gas heaters were predicted under unstable atmospheric condition of Stability Class 'C' with 10 m $s^{-1}$ wind speed. Under stable atmospheric condition of Stability Class 'F' and 1 m $s^{-1}$ wind speed, the worst case ground level 1-hour pollutant concentrations were predicted at distances more than 350 m from the heaters.

[1] Richard, A.D., Martha, A.O. and Ned O., *Odour Modelling - Why and How, Recent Developments and Current Practices in Odour Regulations, Controls and Technology. A&WMA, 1991.*

[2] Keddie, A.W.C., *Dispersion of Odours, Odour Control - A Concise Guide, Warren Spring Laboratory, 1980.*

*Table B3.3b* *Emission Data*

| Emission Point | Emission Data | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Emission Height (m) | Cross Section Area ($m_2$) | Stack Diameter (m) | Emission Rate (g/s)[1] HC | $SO_2$ | TSP | $NO_x$ | CO | $H_2S$ | Efflux Velocity (m $s^{-1}$) | Exhaust Temp (K) |
| *Gas Heater* | | | | | | | | | | | |
| Heater No. 1 to No. 5 | 6.09 | 0.64 | 0.9 | 0.0395 | 0.013 | 0.0395 | 1.83 | 0.46 | | 12.7 | 700 |
| *Vent System* | | | | | | | | | | | |
| High Pressure Vent *Continuous Emissions* | 54 | 0.166 | 0.46 | $3.8x10^{-3}$ | | | | | $3.2x10^{-7}$ (Odour emission rate 536.4 o.u $m^3$ $s^{-1}$) | 0.03 | 321.9 |
| High Pressure Vent *Emergency Emissions*[2] | 54 | 0.166 | 0.46 | $1.9x10^{5}$ | | | | | 0.016 (Odour emission rate $26.6x10^{6}$ o.u $m^3$ $s^{-1}$) | 1514 | 321.9 |

Notes: (1) The emission rates are based on design and vendor information and US EPA AP–42 emission factors.
(2) Emergency use only and the emission rate is given as maximum 5 seconds and the duration of the emission is at infrequent interval.

*Table B3.3d* ***Worst case 1-hour pollutant concentrations predicted from the gas heaters ($\mu g\ m^{-3}$)***

| Distance from GRS (m) | Height Above Ground (m) | Meteorological Condition (Stability Class, Wind Speed ($m\ s^{-1}$)) | HC | $SO_2$ | TSP | $NO_2$ | CO |
|---|---|---|---|---|---|---|---|
| At site boundary | glc | D, 5 | 5 | 2 | 5 | 68 | 57 |
| | 10 | D, 5 | 5 | 2 | 5 | 68 | 57 |
| | 20 | F, 3 | 7 | 2 | 7 | 97 | 82 |
| | 30 | F, 1 | 13 | 4 | 13 | 182 | 153 |
| | 40 | F, 1 | 22 | 7 | 22 | 304 | 255 |
| | 50 | F, 1 | 31 | 10 | 31 | 431 | 361 |
| | 60 | F, 1 | 37 | 12 | 37 | 520 | 436 |
| | 70 | F, 1 | 38 | 13 | 38 | 532 | 446 |
| | 80 | F, 1 | 33 | 11 | 33 | 464 | 389 |
| | 90 | E, 1 | 30 | 10 | 30 | 423 | 354 |
| | 100 | E, 1 | 25 | 8 | 25 | 342 | 286 |
| 100 | glc | F, 1 | 4 | 1 | 4 | 54 | 45 |
| | 10 | F, 1 | 5 | 2 | 5 | 67 | 56 |
| | 20 | F, 1 | 8 | 3 | 8 | 106 | 89 |
| | 30 | F, 1 | 12 | 4 | 12 | 167 | 140 |
| | 40 | F, 1 | 17 | 6 | 17 | 240 | 201 |
| | 50 | F, 1 | 22 | 7 | 22 | 309 | 259 |
| | 60 | F, 1 | 26 | 8 | 26 | 354 | 297 |
| | 70 | F, 1 | 26 | 9 | 26 | 360 | 302 |
| | 80 | F, 1 | 24 | 8 | 24 | 327 | 274 |
| | 90 | F, 1 | 22 | 7 | 22 | 306 | 256 |
| | 100 | F, 1 | 19 | 6 | 19 | 259 | 217 |
| 200 | glc | F, 1 | 5 | 2 | 5 | 72 | 61 |
| | 10 | F, 1 | 6 | 2 | 6 | 81 | 68 |
| | 20 | F, 1 | 8 | 3 | 8 | 108 | 91 |
| | 30 | F, 1 | 11 | 3 | 11 | 147 | 123 |
| | 40 | F, 1 | 14 | 5 | 14 | 192 | 161 |
| | 50 | F, 1 | 17 | 5 | 17 | 232 | 194 |
| | 60 | F, 1 | 19 | 6 | 19 | 257 | 215 |
| | 70 | F, 1 | 19 | 6 | 19 | 260 | 218 |
| | 80 | F, 1 | 17 | 6 | 17 | 242 | 203 |
| | 90 | F, 1 | 17 | 5 | 17 | 229 | 192 |
| | 100 | F, 1 | 15 | 5 | 15 | 202 | 169 |
| 300 | glc | F, 1 | 6 | 2 | 6 | 82 | 69 |
| | 10 | F, 1 | 6 | 2 | 6 | 88 | 73 |
| | 20 | F, 1 | 8 | 3 | 8 | 106 | 89 |
| | 30 | F, 1 | 9 | 3 | 9 | 131 | 109 |
| | 40 | F, 1 | 11 | 4 | 11 | 158 | 133 |
| | 50 | F, 1 | 13 | 4 | 13 | 182 | 153 |
| | 60 | F, 1 | 14 | 5 | 14 | 196 | 164 |
| | 70 | F, 1 | 14 | 5 | 14 | 197 | 165 |
| | 80 | F, 1 | 13 | 4 | 13 | 186 | 156 |
| | 90 | F, 1 | 13 | 4 | 13 | 179 | 150 |
| | 100 | F, 1 | 12 | 4 | 12 | 161 | 135 |
| AQO | | | | 800 | 500[1] | 300 | 30,000 |

Note: (1) The 1-hour dust limit of 500 $\mu g\ m^{-3}$ as recommended by EPD.
(2) The GRS boundary is about 200 m from the heaters.

It can be noted from *Table B3.3d* that the proposed GRS will not cause any exceedances of the AQO at ground level. Since the nearest ASR, Tsang Tsui is more than 1 km from GRS, no significant air quality impacts will result at Tsang Tsui due to emissions from the heaters. Worst case ground level hourly $SO_2$ and $NO_2$ levels of less than 2 $\mu g\ m^{-3}$ and 66 $\mu g\ m^{-3}$ respectively were predicted at Tsang Tsui from the gas heaters under stable conditions and low wind speed (stability class F and 1 m $s^{-1}$ wind). High pollutant levels will occur between 40m to 100m above ground within 100m from the GRS. In view of the existing and committed landuses in the Tsang Tsui area as shown in *Figure B2.1a*, no significant air quality impacts and landuse constrain will result from the operation of the GRS.

Maximum 1-hour HC concentration of 0.2 $\mu g\ m^{-3}$ from the vent system was predicted at 150 m from the vent stack (ie still within the GRS). No significant contribution to HC levels in the surrounding area and at the ASRs will result from emissions at the vent system.

Odour ($H_2S$) impacts from the operation of the GRS were predicted and the maximum odour level predicted at 200m from the vent stack is 1.23 of per 5 second which is well below the odour limit of 5 odour unit per 5 second. The maximum predicted level of hydrogen sulphide at 200 m from the vent stack is negligible and well below the lowest-adverse-effect level (15 mg $m^{-3}$).

*Consideration of Background Air Quality*

Under low wind speeds (ie below 5 m $s^{-1}$) the Tsang Tsui area is unlikely to be affected by high level sources such as the proposed LTPS and the existing CPPS. The future background air quality of the Tsang Tsui area is likely to be about 3% and 2% of the hourly AQO for $SO_2$ and $NO_2$ as discussed in *Section B3.1*.

In view of the modelling results, no significant air quality will result from the operation of the GRS to the identified ASRs even when the background air quality of the area is considered. From the GRS alone, it will only take up about 0.3% and 22% of the hourly AQO for $SO_2$ and $NO_2$ respectively at the nearest ASR Tsang Tsui. With the consideration of the likely future background air quality, the air quality at Tsang Tsui will still fall below the AQO.

### B3.3.5 *Mitigation Measures*

The operation of the GRS will not pose significant air quality impacts to the surrounding area. The installation of the heater stacks is required to comply with the Air Pollution Control (Furnaces, Ovens and Chimneys)(Installation and Alteration) Regulations. Although the prediction results show that the operation of the GRS will not cause significant air quality impacts to the area, *Good Engineering Practice* should be adopted in designing the stack height in order to avoid building downwash problems. However, no

building is located within 50m from the heaters within the GRS site in which case building downwash is unlikely to be a problem.

As the existing and committed developments are more than 100m from the GRS, no significant air quality impacts will result at these developments from the operation of the GRS. However, any future proposed landuse within 100m from the GRS should not be higher than 40m in order to avoid plume impingement.

### *B3.4 DECOMMISSIONING IMPACTS*

During demolition of the plant, dust nuisance and exhausts emissions from demolition plant and vehicles associated with the removal of the demolition waste are likely to cause air quality impacts. Due to the limited size of the GRS no significant air quality impacts are expected during the decommissioning as the number of demolition plant and vehicles which will be used on site is limited. However, good on-site management similar to those for the construction of the GRS should be adopted in order to eliminate any contribution of dust to the surrounding area.

### *B3.5 CONCLUSIONS*

It can be concluded that the construction and operation of the GRS will not pose significant air quality impacts to the ASRs as the GRS is located at a remote site far from any ASRs. As the works area of the GRS is limited no significant dust impacts are expected from the decommissioning of the GRS. No monitoring and auditing are required for the construction and operation of the GRS as the predicted air quality impacts are very low.

## B4 WASTE MANAGEMENT

### B4.1 CONSTRUCTION PHASE

#### B4.1.1 Sources of Impacts

Waste arisings from the construction activities will be typical of other land based construction works and will include excavated materials, construction waste, chemical waste and general refuse. They can be divided into distinct categories based on their nature and ultimate disposal sites. These include:

- excavated and inert material suitable for reclamation and fill;
- general construction waste;
- chemical waste; and
- general refuse.

The definitions for each of these categories and the nature of their arisings and potential impacts are discussed in more detail below.

*Excavated Material*

The site may require some small scale excavation work and excavated material which is of an inert nature will most probably be suitable for reuse on-site or elsewhere. It is not likely to have any significant environmental impact and the only likely impacts associated with the excavated material are related to air quality, (specifically dust generation during excavation, stockpiling and transportation).

*Construction Waste*

Waste will arise from a number of different activities carried out by the contractor during construction and maintenance activities and may include:

- wood from formwork;
- equipment and vehicle maintenance parts;
- materials and equipment wrappings; and
- unusable cement/grouting mixes.

Due to the inert nature of most construction waste, disposal is not likely to raise long term environmental concerns. However, the storage and stockpiling of construction waste prior to utilisation on site or disposal can lead to the generation of dust and may be visually intrusive.

The main impacts resulting from the disposal of construction wastes are expected to come from the transportation of these wastes to the various disposal sites. These potential impacts may result in additional noise impacts, possible congestion due to increased traffic loadings and dust and exhaust emissions from the haul vehicles. However, in view of the close

proximity of the GRS to the landfill site and the remoteness of the area, transportation impacts on the local population are likely to be minimal.

*Chemical Waste*

Chemical Waste, as defined under the *Waste Disposal (Chemical Waste)(General) Regulation*, includes any substance being scrap material or unwanted substances specified under *Schedule 1* of the *Waste Disposal Regulations*. A complete list of such substances is provided under these *Regulations*, however substances likely to be generated by land based activities will, for the most part, arise from the maintenance of equipment. Items which may be classified as chemically contaminated should be treated as such. These may include, but may not be limited to the following:

- spent filter cartridges containing heavy metals;
- scrap batteries or spent acid/alkali from their maintenance;
- brake clutch linings containing asbestos materials;
- Used lubricating oil;
- mechanical machining producing spent mineral oils/cleaning fluids; and
- equipment cleaning activities producing spent solvents/solutions which may be halogenated.

Chemical wastes pose serious environmental hazards if not stored and disposed of in an appropriate manner, as outlined in the *Chemical Waste Regulations*. These hazards include:

- adverse effect on water quality from spills;
- odour;
- fire hazards; and
- disruption of sewage treatment works where waste enters the sewage system.

*General Refuse Arising During Construction Period*

General refuse includes any waste that does not fit into any of the categories previously described. Construction sites generate a variety of general refuse requiring disposal. This may include newspapers, food wastes and packaging, waste paper, etc and will generally be disposed of to landfill.

The storage of general refuse has the potential to give rise to adverse environmental impacts including:

- odour if the waste is not collected frequently (daily);
- presence of pests and vermin if the waste storage area is not well maintained and cleaned regularly;
- windblown litter; and
- visual impact.

B4.1.2 *Storage, Collection, Transport and Disposal Options*

*Excavated Material*

The site formation will probably involve small scale excavation work. No on-site re-use is expected and therefore all excavated material will require export from the site.

Prior to export, the material should be stockpiled and excess moisture allowed to drain off. Given the suitability of this material for use as fill in reclamations or nearby developments with a material deficit, the material should be exported to such nearby sites. In accordance with the Civil Engineering Department (CED), disposal of excavated material at marine dumping grounds will not be permitted.

*General Construction Waste*

In accordance with the *New Disposal Arrangements for Construction Waste,* issued in 1992 by the Environmental Protection Department (EPD) and the CED disposal of construction waste can either be at a specified landfill or at a public dumping ground. Depending on the nature of the construction waste generated, surplus material not suitable for reuse on-site will be collected by a waste collector under arrangement with the Contractor and deposited at a suitable public dump or designated landfill. The Contractor should ensure that the necessary waste disposal permits are obtained prior to the collection of the waste.

Construction waste should be separated into two portions, one suitable for public dumping and another for landfilling, at source as far as practicable.

The acceptance criteria of public dumps are stipulated in the WBTC No. 2/93. Dumping licences may be obtained from the CED. Under the licence conditions, public dumps will accept only suitable construction waste, that is, inert building debris, soil, rock and broken concrete. There is no size limitation on the rock and broken concrete. A small amount of timber mixed with otherwise suitable material is permissable.

Intermediate sorting plans are to be established at strategic locations of the territory to receive mixed construction waste.

As for the adjacent WENT Landfill, this site will only receive construction waste with less than 20% inert material by volume in accordance with the specifications. Waste containing more than 20% by volume of inert materials will not accepted for disposal of landfills. However, existing landfills operated by the CED (ie Tseung Kwan O landfill, Shuen Wan Landfill and Pillar Point Valley Landfill) will continue to accept waste containingmore than 20% of inert materials until further notice, likely to be mid 94. Inert materials means soil, rock, asphalt, concrete, brick, cement plaster/mortar, inert building debris, aggregates etc.

Many PADS related contracts, reclamations or other public dumps have a requirement to import fill material from elsewhere. In addition, due to the limited void space at landfills for disposal of domestic and industrial waste in Hong Kong, disposal at these reclamation sites or an approved public dump would be the preferred method of disposal.

As far as possible Contractor should recycle as much of the construction waste on-site, in order to reduce the requirement to import additional materials. In addition, recycling would reduce the collection, transportation and disposal of the construction waste and any associated charges by the transport contractor. At the present time, Government has not implemented a charging policy for the disposal of construction wastes, although it is understood that this is currently under development and may be introduced at landfills in the near future.

*Chemical Waste*

Chemical waste will arise principally as a result of maintenance activities. It is difficult to quantify the amount of chemical waste which will arise these activities since it will be highly dependant on the Contractor's on-site maintenance requirements and the amount of plant utilised.

The Chemical Waste Treatment Centre (CWTC) located at Tsing Yi was commissioned in June 1993 and is the point of disposal for chemical wastes in the territory. The contractor operating the CWTC also operate a marine and land collection service for chemical waste producers. Disposal of chemical wastes in this manner will ensure that environmental and health and safety risks are reduced to a minimum provided that correct storage procedures are instigated on-site and on the marine vessels. At the present time there is no charge for this collection and disposal service, however, there is currently a registration fee of HK$ 200.

The Contractor should contact the EPD and the CWTC operator, who offer a chemical waste collection service and supply the necessary storage facilities for these wastes. Furthermore, the Contractor should contact the EPD to ensure that the handling and disposal methods for the wastes in question are appropriate.

*General Refuse*

General refuse generated on-site should be stored and collected separately from other construction and chemical wastes. The Contractor will be responsible for the removal of waste generated on the site and this may be carried out by a private waste contractor.

Due to the construction programme and the timing of the Government's waste management strategy, general refuse from the site will most likely be transported to WENT Landfill which is now receiving waste.

Waste should be reviewed from the site daily to minimise any potential odour impacts and the presence of pests, vermin and other scavengers and to prevent unsightly accumulation of waste.

### B4.1.3 *Mitigation Measures*

The previous sections detail the potential environmental impacts associated with waste arisings from the construction of the GRS and the recommended storage, transportation and disposal options. This section outlines appropriate mitigation measures to minimise any impact from these waste arisings.

*Segregation of Wastes*

In order to ensure that all waste is disposed of in an appropriate manner, waste should be separated by category, on-site by the contractor. The criteria for sorting solid waste is described in the *New Disposal Arrangements for Construction Waste* issued in 1992 by the EPD and the CED. Waste containing in excess of 20% by volume of inerts should be segregated from waste with a larger proportion of putrescible material.

It is recommended that the Contractor segregate waste materials into inert, non-inert and chemical waste categories from the land based operations and should dispose of them as follows:-

- Inert construction waste material, when deemed suitable for reclamation or land formation, should be disposed of at reclamation sites or public dumping areas.

- Inert material deemed unsuitable for reclamation or land formation and non-inert construction waste and general refuse should be disposed of at a public landfill.

- Chemical waste as defined by *Schedule 1* of the *Waste Regulations (Chemical) 1992*, should be stored and transported using approved methods under the Regulation and the chemical waste disposed of at the CWTC located at Tsing Yi.

The different categories of wastes should be segregated, stored, transported and disposed of in the manner described previously in *Section B4.1.2.*

*Site Practice*

Good site practice will ensure that the on-site impacts discussed previously are minimised. These should include:

- daily collection of general refuse or as often as required;
- regular maintenance and cleaning of waste storage areas; and
- storage of waste in suitable containers/receptacles.

In general, waste generation should be minimized and materials should be recycled as far as practicable to minimize the disposal requirements.

*Storage, Collection and Transportation of Waste*

It is the contractor's responsibility to ensure that only licensed waste collectors, authorised to collect the specific category of waste concerned, are employed and that appropriate measures to minimise windblown litter and dust during transportation are implemented.

The necessary waste disposal permits must be obtained from the appropriate authorities should they be required in accordance with the Waste Disposal Ordinance (Cap 354) and Waste Disposal (Chemical Waste) (General) Regulation (Cap 354).

## B4.2 OPERATIONAL PHASE

### B4.2.1 *Source of Impacts*

During operation of the GRS, waste arisings will typically consist of:

- slop liquids at the slop receiver;
- industrial waste from maintenance activities; and
- general refuse from normal office activities.

In general, the potential impacts from the disposal of waste during operation of the GRS will be the same as the impacts from disposal during the construction phase.

### B4.2.2 *Evaluation of Impacts*

*Liquid hydrocarbons at the Slop Receiver*

Oily water mixtures from the slug catcher and the gas filter separator will be collected at the slop receiver. Under normal conditions, there will be no liquid collected at the slug catcher due to dehydration and hydrocarbon dew point control on the offshore platform. A significant offshore upset could result in the arrival of slugs of liquid at the GRS during pigging operations. Slug flow is unpredictable but will normally arrive directly in front of the pig. Any liquid collected at the slug catcher will be transferred to the slop receiver. Traces of liquid mist and solid particles from the gas that are collected at the filter/separators will be dumped to the slop system. The slop receiver will receive this material once a year (coinciding with the pig run) and will immediately be emptied, with the waste being taken by tanker to the CWTC. Solid particles collected in the filter elements will be retained within them and removed with the filter element when it is changed, initially at about 3 monthly intervals, and approximately yearly intervals after the first year when the pipe has been cleaned of initial particles.

All liquid collected at the slop system, composed of an oil/water mixture, will be evacuated from the slop system by vacuum truck and transported for disposal at the CWTC at Tsing Yi.

Other wastes such as filter cartridges from the filter/separator and lubricating oil from regular maintenance should also be collected and stored in approved containers (200L or 20L) and sent to the CWTC for treatment.

*Industrial Waste from Maintenance Activities*

Industrial waste such as scrap iron from regular maintenance activities, and other scrap materials should be reused as much as possible. This waste may only be disposed of to landfill if it comprises less than 20% inerts.

*General refuse from normal office activities*

There will only be one operator on site. It is estimated that around 1–2 kg of solid waste will arise from the day to day operation of the station.

### B4.2.3 *Storage, Transport and Disposal Options*

General refuse and industrial waste from the GRS could be disposed of to the WENT Landfill, providing that it does not comprise bulky waste nor contain any chemical wastes. The waste would most likely be collected, if possible consolidated with waste from CLP, and jointly disposed of to the WENT Landfill by private waste collector.

Chemical wastes, such as oil/water mixtures from the slop receiver, are expected to be emptied by vacuum truck and transported by a licensed chemical waste collector to the CWTC for treatment.

### B4.2.4 *Mitigation Measures*

Waste management as described previously is not likely to have any significant adverse environmental impacts. No mitigation methods over regular operation practices of adequate collection, temporary storage and disposal of all wastes are warranted.

However, waste generation should be minimised and materials should be reused on-site as far as practicable to minimise the disposal requirement.

## B4.3 *DECOMMISSIONING PHASE*

The decommissioning phase of the GRS will be similar to the construction phase with the exception that large quantities of demolition waste will result. Where possible, consideration should be given to the recycling of reusable material to minimize waste generation. Only non-usable waste should be disposed of to landfill.

## B4.4 *CONCLUSION*

Provided that any waste arising during the construction phase is stored, transported and disposed of using approved methods as described previously, no significant adverse environmental impacts are envisioned.

During the operation of the GRS, only small quantities of waste will result from the day to day operation of the station. Providing the correct storage, transport and disposal procedures are followed, none of the waste arisings are expected to result in any adverse environmental impacts.

It is possible that inert wastes could be used as fill material at reclamation sites, such as the PADS projects. Other land sourced construction wastes unsuitable for reclamation or land formation will be disposed of to WENT

Landfill, whilst chemical wastes should be treated at the CWTC at Tsing Yi, via land or sea transport as appropriate from the construction site. Recycling of construction wastes should be carried out wherever feasible to conserve resources and landfill capacity.

## B5 WATER QUALITY

### B5.1 BASELINE CONDITIONS

*Existing Conditions*

The GRS lies on the coast by the proposed LTPS at Black Point. The marine waters in this part of Hong Kong consist predominantly of estuarine areas and intertidal mudflats with a main drainage channel from the Shenzhen and Yuen Long River running through the Bay in a north easterly direction.

In the Deep Bay region, water quality is largely controlled by the fluvial input from the Pearl River, Shenzhen and Yuen Long Rivers, coupled with the ocean currents of the South China Sea. Consequently the shallow waters of Deep Bay are turbid and suspended sediment levels are very variable. This estuarine mixing zone of saline and fresh waters produces wide salinity variations with depth, location and time. A stratified salinity profile is prominent during the summer in Deep Bay when river flows are at their highest and the surface salinity falls to its lowest value.

The water quality in the region is well documented by the EPD marine water quality monitoring programme and from CLP monitoring results as part of the EIA study for the proposed LTPS at Black Point. Monitoring stations are located in the immediate vicinity of the proposed LTPS reclamation site off Black Point. A summary of both EPD and CLP Data (for 1990) are given in *Table B5.1a*.

In general, the water quality for Outer Deep Bay is fairly good with determinands such as BOD, COD, phenols, E. Coli and DO meeting the WQO. As stated earlier, suspended solids (SS) levels and the associated turbidity are very variable due to the Pearl River and Deep Bay catchment inputs, with SS ranging from 2.5 – 91 mg/L recorded. Toxic metal contamination is low in this location.

Table B5.1a
Marine Water Quality off the GRS

| Parameter/Determinands in mg/L unless otherwise specified | Outer Deep Bay | | | |
|---|---|---|---|---|
| | EPD's 1990 Monitoring Results | CLP EIA Monitoring Results | | |
| | | Oct 1990 | Nov 1990 | Dec 1990 |
| pH (pH units) | m 8.3<br>r 7.9 – 8.6 | 7.8 | 8.1 | 8.2 |
| temperature °C | m 23.4(S) 24.3 (B)<br>r (15–30) (15–30) | 23 | 21.3 | 19 |
| Colour (Lovibond Units)* | 5.22 (NTU) | 3.4 (NTU) | 0.6 (NTU) | 0.7 (NTU) |
| Suspended Solids | m 20<br>r 2.5 – 91 | 7.7 | 2 | 2 |
| BOD | m 1.2<br>r 0.2 – 5.4 | 1 | <1 | 1 |
| COD | n.r. | n.d. | n.d. | n.d. |
| Oil & Grease | n.r. | 0.2 | 0.07 | 1 |
| Iron | n.r. | 0.43 | 0.091 | 0.068 |
| Boron | n.r. | n.d. | n.d. | n.d. |
| Barium | n.r. | n.d. | n.d. | n.d. |
| Mercury | n.r. | n.d. | n.d. | n.d. |
| Cadmium | n.r. | <0.00005 | <0.00005 | 0.00013 |
| Other toxic metals individually | n.r. | see below | see below | see below |
| Total toxic metals | n.r. | see below | see below | see below |
| Cyanide | n.r. | n.d. | n.d. | n.d. |
| Phenols | n.r. | n.d. | n.d. | n.d. |
| Sulphide | n.r. | <0.01 | <0.01 | n.d. |
| Total residual chlorine | n.r. | <0.01 | <0.1 | n.d. |
| Total nitrogen | m 1.1<br>r 0.6 – 2.3 | 0.23 | 0.77 | n.d. |
| Total phosphorus | m 0.13<br>r 0.03 – 0.4 | 0.21 | 0.25 | n.d. |
| Surfactants (total) | n.r. | 0.01 | <0.05 | n.d. |
| E. Coli (count/100ml) | m 25<br>r 0– 470 | 300 | 200 | 200 |
| Calcium | n.r. | 334 | 371 | 380 |
| Sulphate | n.r. | 2200 | 2300 | 2310 |
| Dissolved Oxygen | m 7.2<br>r 6.3 – 8.7 | 7.7 | 7.8 | 8.3 |
| Salinity (g/kg) | m 19<br>r 8 – 29 | 29 | 27 | 28 |
| Ammonia (as N) | n.r. | 0.02 | 0.46 | n.d. |
| Chromium | n.r. | 0.00009 | 0.0015 | 0.0014 |
| Copper | n.r. | <0.005 | <0.005 | <0.005 |
| Lead | n.r. | 0.0007 | 0.00038 | 0.00066 |
| Nickel | n.r. | <0.005 | <0.005 | <0.005 |
| Zinc | n.r. | 0.0083 | 0.0054 | 0.0049 |
| Arsenic | n.r. | <0.001 | <0.001 | <0.001 |
| Manganese | n.r. | 0.029 | 0.038 | 0.020 |
| Selenium | n.r. | <0.001 | <0.001 | <0.001 |

Note: m – mean , r – range, n.r. – not recorded

### B5.1.1 *Future Conditions*

It is expected that the water quality in the area will improve with the implementation of the Livestock Waste Control Scheme and the Water Pollution Control Ordinance (WPCO). Water quality of the inland rivers, such as the Yuen Long River, will improve with the control of discharges into rivers.

### B5.1.2 *Sensitive Receivers*

Water Sensitive Receivers (WSRs) are defined in the HKPSG and are generally beaches, mariculture zones, Sites of Special Scientific Interest (SSSIs), etc . The nearest WSRs that could be affected by the proposed GRS are identified below:

- Deep Bay Mariculture Zone and Leased Oyster Bed – approximately 2 km to the north east;
- Pak Nai SSSI – around 5 km to the north east;
- Lung Kwu Chau, Tree Island and Sha Chau SSSI – about 5 km to the south;
- non-gazetted bathing beaches, namely, Lung Kwu Upper and Lung Kwu Lower – these beaches to the south east are on the other side of the Black Point headland (over 1.5 km and 3 km to the south east respectively); and
- cooling water intakes of CPPS – the station falls on the edge of the 5 km `sensitive zone' radius implemented by CLP.

The locations of the WSRs in the Outer Deep Bay area are shown in *Figure B5.1a*.

In addition, the cooling water intakes of the LTPS, once operational, are identified as WSR for the operational phase assessment.

## B5.2 *CONSTRUCTION IMPACTS*

### B5.2.1 *Source of Impacts*

The proposed GRS site will be formed by CLP and handed over to ARCO. The major sources of water quality impacts that can potentially arise from the construction of GRS will be similar to those of normal construction activities. These will include:

- construction runoff and drainage;
- general construction activities; and
- sewage from on-site construction workforce.

These potential impacts on water quality and their significance are discussed in the following sections.

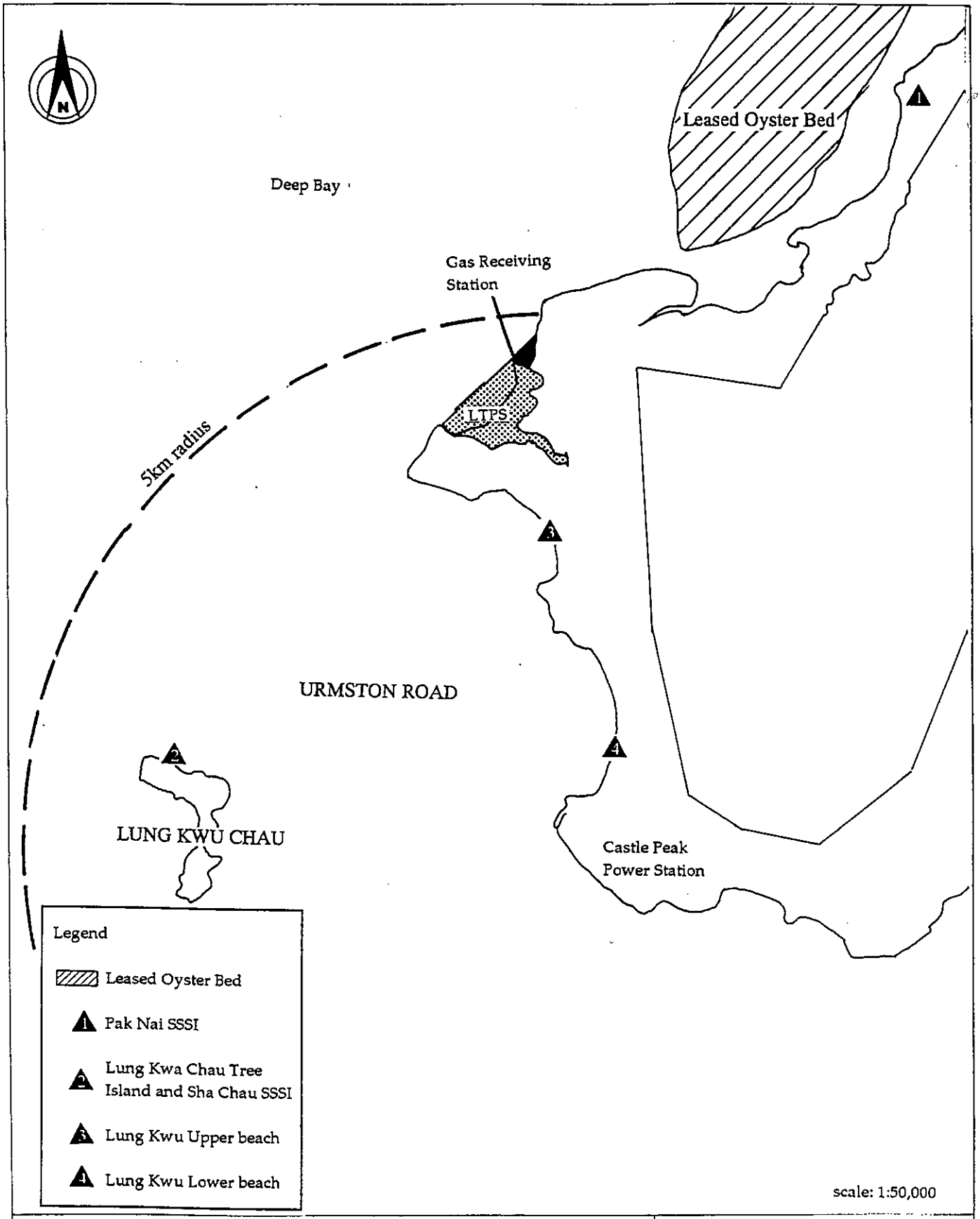



Figure B5.1a

Water Sensitive Receivers

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

*B5.2.2* *Evaluation Criteria*

Under the WPCO, Hong Kong waters are subdivided into 10 Water Control Zones (WCZ). Each WCZ has a designated set of statutory Water Quality Objectives (WQO). Deep Bay falls within the Deep Bay WCZ. To protect the marine waters in the Deep Bay area, effluent discharge in the region must be controlled so as not to cause a deterioration in water quality and must be in compliance with the Deep Bay WQO's.

*B5.2.3* *Evaluation of Impacts*

*Construction runoff and drainage*

Runoff and drainage from construction sites may contain sediments, other SS and contaminants. Potential sources of pollution from site drainage include:

- runoff and erosion from site surfaces, drainage channels, earthworking and stockpiles;
- bentonite slurries and other grouting materials;
- concrete batching plant washout and drainage from dust suppression sprays; and
- fuel and lubricants from construction vehicles.

Construction runoff and drainage may cause both physical and biological effects.

The physical effects may include:

- blockage of drainage channels; and
- increase of SS concentrations in receiving waters.

Possible biological effects which may affect marine life include
- eutrophication caused by the nutrient content of the eroded soil;
- toxicity caused by mixtures of hydrocarbons and grouting materials; and
- reduction in DO levels caused by high SS concentrations.

In view of the close proximity of the GRS to marine waters, it is important that good site management practices be strictly followed to prevent high levels of suspended solids entering surrounding waters. It is unlikely however, that runoff from the construction site will have any significant impact on the water quality of the receiving waters

*General Construction Activities*

On-going site construction activities may cause water pollution from the following:

- debris and rubbish such as packaging, used construction materials and floating refuse; and

- spillages of liquids such as oil, diesel and solvents are likely to affect water quality if they enter surrounding water bodies.

The effects on water quality from construction activities is likely to be minimal. Site boundary security will need to be maintained and good construction practice should be observed to ensure that floating refuse, fuels and solvents do not gain access to the stormwater system in the area.

*Sewage Effluents*

Sewage effluents will arise from sanitary facilities provided for the construction workforce. Based on the scale of the construction work, it is estimated that around 100 workers will be employed. However, this will greatly depend on the construction activities on-site and will vary throughout the construction period. Assuming that each worker produces 55 litres of sewage effluent per day [1], the total sewage effluent discharge would be equivalent to about 5.5 $m^3$ per day for the on site workforce. This amount of sewage will require some form of treatment before discharge.

It is likely that construction workers from the GRS will share the septic tank facilities set up for the existing LTPS site. However, if existing facilities are not available, interim sewage treatment facilities such as chemical toilets and packaged sewage treatment facilities may be necessary to pretreat the sewage before discharging to the adjacent coastal waters.

The Technical Memorandum (TM) standards apply to all sewage effluent discharges. Assuming a site population of 100, a flow rate of approximately 5.5$m^3$ per day is produced, for which the effluent standards, taken from the TM Standards for effluents discharged to the coastal waters of the Deep Bay WCZ, are:

| | |
|---|---|
| Suspended Solids | 30 mg/L |
| Biochemical Oxygen Demand | 20 mg/L |

These standards should be readily achieved with the installation of packaged sewage treatment units.

### B5.2.4 *Mitigation Measures*

Given the great distance from the water sensitive receivers to the GRS site, the construction activities will have minimal impact on the water quality. However, it is important that appropriate measures be implemented to minimise the cumulative impacts associated with other ongoing construction work at the LTPS site. Proper site management is essential to minimise wash-off during rainy seasons and "good housekeeping" practices to ensure that debris and rubbish cannot gain access to nearby stormwater system should be implemented.

[1] Guidelines for the design of small sewage treatment plant, EPD 1990.

The following provides a guideline on the standard measures which should be enforced.

*Site runoff*

All site construction runoff should be controlled and treated to prevent runoff with high level of SS and the following measures may be considered:

- the boundaries of earthworks should be marked and surrounded by dykes or embankments for flood protection as necessary;
- temporary ditches should be provided to facilitate runoff discharge into the appropriate watercourses, via a silt retention pond;
- permanent drainage channels should also incorporate sediment basins or traps and baffles to enhance deposition;
- sediment traps must be regularly cleaned and maintained by the contractor. Daily inspections of such facilities should be required of the Contractor;
- collection of spent bentonite or other grouts in a separate slurry collection system either for reuse or disposal to landfill;
- all traps (temporary or permanent) should also incorporate oil and grease removal facilities;
- all drainage facilities must be adequate for the controlled release of storm flows; and
- minimising of exposed soil areas to reduce the potential for increased siltation and contamination of runoff.

*Debris and Litter*

In order to comply with the aesthetic criteria for the proposed Deep Bay WQO, contractors should ensure that site management is optimised and that any solid materials, litter or wastes should not enter to the surface and marine waters.

*Oils and Solvents*

All fuel tanks and store areas should be provided with locks and be sited on sealed areas, within bunds of a capacity equal to 110% of the storage capacity of the largest tank.

*Sewage*

All polluted water should be treated before discharge. Small integrated treatment units are available which combine grease traps and treatment chambers with aeration and settlement facilities. The treated effluent can

subsequently be discharged to 'storm sewer', providing it complies with the TM. This level of treatment should be readily achieved by standard packaged sewage treatment units.

## B5.3 OPERATIONAL IMPACTS

### B5.3.1 *Introduction*

This section discusses the water quality impact associated with the operation of the GRS and recommends the mitigation measures required to minimise the impact. Water discharge during the commissioning tests are discussed in the draft EIA report for the Submarine Gas Pipeline – Hong Kong Territorial Waters.

### B5.3.2 *Sources of Impacts*

Discharges from the GRS will include the following:

- stormwater runoff;
- drainage from process areas; and
- domestic sewage.

### B5.3.3 *Evaluation Criteria*

The GRS is located by the coastal water of the Deep Bay WCZ and effluent discharges from the plant will be subject to control standards stipulated in the TM.

### B5.3.4 *Evaluation of Impacts*

*Drainage from Process Areas*

Both open drain and closed drain systems will be installed in the GRS site.

The open drain collects wastewater from the process equipment area and drains it to an open sump where the wastewater will be transferred to CLP via a lift pump to undergo oil/water separation treatment prior to discharge to sewer.

The closed drain system collects oily water from the slug catcher and gas filter separator and drains it to the closed drain sump where liquids are pumped to the slop receiver for storage and subsequent disposal. Details of disposal are addressed in *Section B4.2.*

*Stormwater Runoff*

Runoff is essentially uncontaminated from "clean" areas such as the roof of the control station, the pathway, and pavement. It may contain suspended solids and grit, particularly during the initial "first flush" of rainfall

following periods of dry weather. It should be well segregated from the process equipment area and may be discharged to the storm water drain.

*Sewage from Workforce*

The GRS is a simple operation which requires only one operator to be based on site. ARCO estimate a daily sewage generation of 114 litres per day. The sewage will be diverted to the nearby sewage treatment plant within the CLP LTPS.

There are no major effluent discharges from the GRS that are likely to impact on marine water quality. Effluent from the GRS will be diverted to the LTPS for subsequent treatment. In any case, the flow from the GRS is expected to be small and will contribute a small percentage of the overall flow from the LTPS for which an EIA has been carried out and water quality impacts have been fully addressed.

### *B5.3.5 Mitigation Measures*

The operational phase of the proposed GRS is unlikely to result in any water quality impacts provided that appropriate mitigation measures are incorporated into the design of the station. Provided discharges are strictly controlled and meet the standards stipulated in the TM, no adverse impacts on water quality are anticipated.

The following measures have been identified to mitigate potentially significant impacts on water quality as a result of the station operation.

- Stormwater runoff should be well segregated from the runoff from process area. Drainage systems should include traps to collect SS in drainage or runoff (including metals) and interceptors to collect oil and grease.

  This will help to ensure that those substances, prohibited from entering foul sewers and coastal waters as quoted in the TM, are removed from runoff and drainage prior to discharge.

- The efficiency of silt traps and oil interceptors is highly dependent on regular cleaning and maintenance. These installations should be regularly cleaned and maintained in good working order.

  Oily contents of the traps should be collected for reuse, or transferred to an appropriate disposal facility, such as the Government CWTC at Tsing Yi.

- Sewage effluents are required to meet the effluent standards stipulated in the TM. Sewage should be properly directed to the sewage treatment facility at the LTPS for treatment prior to discharge.

## B5.4 DECOMMISSIONING IMPACTS

Decommissioning impacts for the GRS will be similar to the impacts associated with the construction phase of the GRS. With proper site management and good construction practices, no unacceptable impact is anticipated.

## B5.5 CONCLUSIONS

Water quality impacts from the construction of the GRS will be similar to typical land based construction activities which involve construction runoff; litter and debris; and spillages. If proper site management and good construction practices are implemented, it is unlikely that there would be unacceptable water quality impact on the surrounding waters.

The operation of the GRS is not envisaged to have any major effluent discharge. Drainage from the plant will be diverted to the treatment plants at the new LTPS nearby for subsequent treatment prior to discharge . The LTPS has already been subject of an EIA in which water quality impacts were addressed in detail and any water quality impacts upon the marine waters were adequately addressed.

As there are no major effluents from the construction and operation of the GRS, no water quality monitoring is considered necessary.

## B6 NOISE

### B6.1 BASELINE CONDITIONS

The existing environment in the Yung Long area is predominately rural. However, with the construction of the LTPS at Black Point and the operation of the WENT Landfill, the area is undergoing substantial changes in the ambient noise climate. The following sections outline the existing and future noise conditions under which the present noise assessment is carried out.

#### B6.1.1 Existing Conditions

A 24-hour noise survey was carried out in 1990 to assess the background noise level at two locations in the Yung Long area [1]. Results of this indicated that the area was typically rural with tranquil noise environment as shown in *Table B6.1a*.

*Table B6.1a Previous Noise Monitoring Results in the Yung Long Area (1990)*

| Location | Period of Day | $L_{90}$, dB(A) | $L_{eq}$, dB(A) |
|---|---|---|---|
| Lung Kwu Sheung Tan (NSR1) | Day-time | 44 | 56.1 |
| | Evening | 46 | 45.3 |
| | Night-time | 40 | |
| Tsang Tsui (NSR2) | Day-time | 42 | 56 |
| | Evening | 39 | 44.6 |
| | Night-time | 40 | |

However, the area is currently undergoing rapid change as a result of several major construction projects as well as the operation of the WENT Landfill located some 2 km to the east of the site. Existing noise sources in the area include the quarrying works of the Yung Long Borrow Area, the formation works of the LTPS site and offshore noise from the dredging of the WENT Fairway and other associated maritime activities.

#### B6.1.2 Future Conditions

The construction and installation of the GRS is scheduled for April 1994 to April 1995, during which time the site formation and foundation works of the LTPS construction should be completed and may not coincide with the construction of the GRS. However, the construction of the LTPS building infrastructure and other associated works will coincide with GRS project.

Operation of the WENT Landfill and the opening of the landfill access road for general traffic and refuse collection trucks also directly increase the noise levels in the area near the two village settlements.

[1] Environmental Resources Limited, EIA of the Proposed 6000MW Thermal Power Station at Black Point, November 1992.

The reclamation of the proposed Tuen Mun Port Development (TMPD), under PADS, may also commence later in 1995 when the construction of the GRS is completed. However, the TMPD and the operation of the LTPS will being unacceptable changes to the overall noise environment in the area, i.e. from rural to industrial.

### *B6.1.3 Sensitive Receivers*

Within a 2 km radius of the proposed GRS, there were originally several scattered village settlements including Yung Long, Tsang Tsui and Lung Kwu Tan Villages. However, the several village houses at Yung Long have been resumed as a result of the construction of the LTPS.

Tsang Tsui, about 1.2 km from the GRS, contains small clusters of village houses and is reported to still have a population of about nine.

Lung Kwu Sheung Tan is located at about 1.6 km south, separated from the site by a knoll approximately 100 m high. At present, the area remains as village use but is recommended to be relocated as a result of the Tuen Mun Port Development Study.

The latter two villages will be considered for the present assessment and their locations are shown in *Figure B6.1a*.

Due to the predominately rural environmental of the area before the commissioning of the LTPS, the Area Sensitivity Rating (ASR) of the area should be classified as Class 'A'.

## *B6.2 CONSTRUCTION IMPACTS*

### *B6.2.1 Sources of Impacts*

At this stage, items of details of the construction activities including the type and number of construction plant involved in the construction of the GRS have not been finalised. It is however understood that the site will be formed under the LTPS construction contract. Possible construction and installation activities will therefore be limited to the following:

*Site Foundation and Preparation:*

- excavation of trenches, placement of forms and steel, concrete manufacture;
- drilling piles for the construction of heater and vent stack; and
- pavement of site, roadways and drains.

*Erection of Structures:*

- erection and covering of structure; and
- concrete manufacture and aggregate stockpiles.

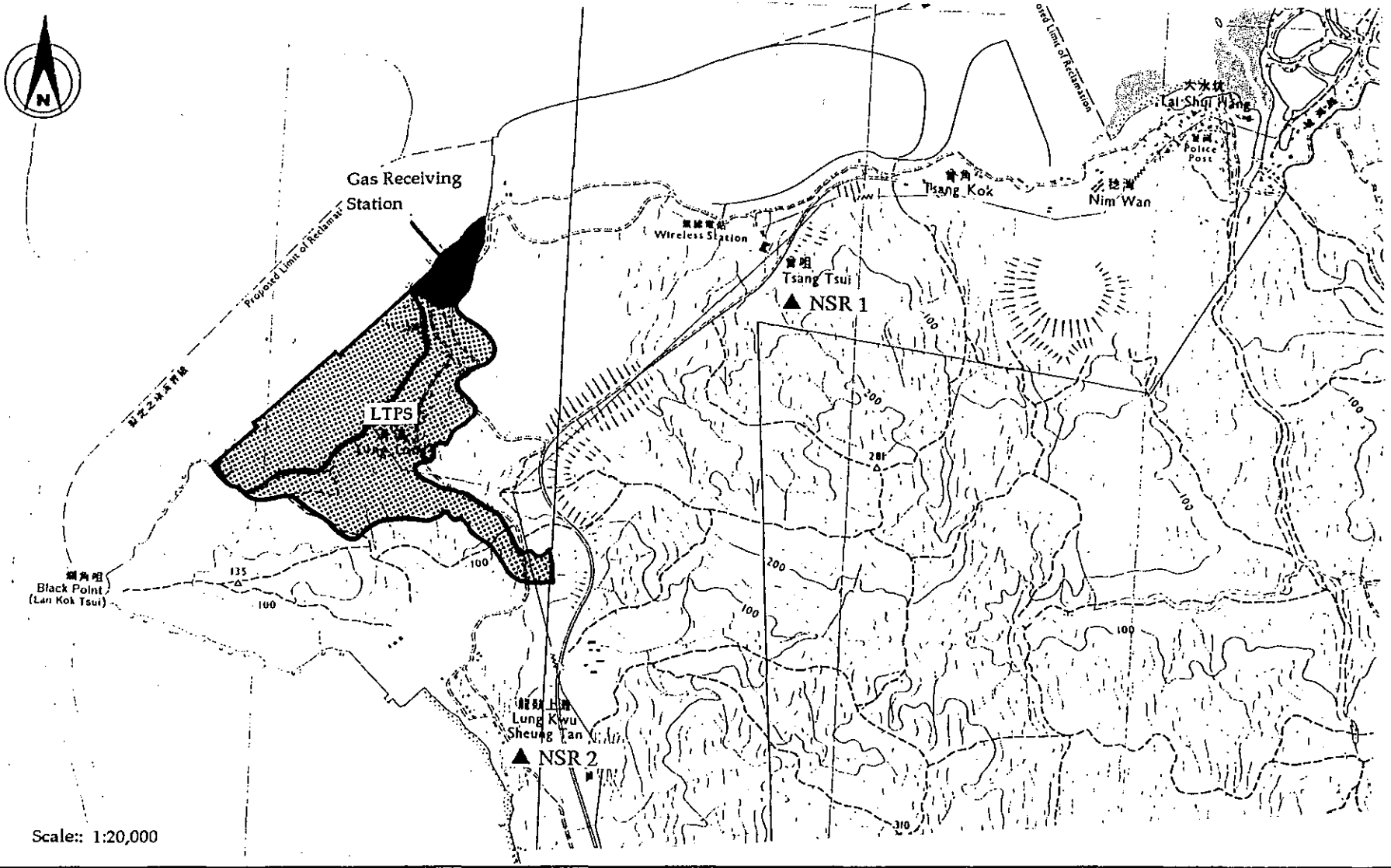



Figure B6.1a

Noise Sensitive Receivers

**ERM Hong Kong**

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

*Installation of Gas Reception Equipment:*

- installation of mechanical and electrical equipment; and
- connection and startup of equipment.

For the purpose of this assessment, a set of typical items of construction equipment for these type of activities was used to estimate potential. See *Table B6.2a.*

*Table B6.2a* ***Possible Powered Mechanical Equipment (PME) Used for Site Foundation and Site Preparation***

| Construction Activities | Assumed Powered Mechanical Equipment | Assumed Number of items of Equipment | Sound Power Level (dB(A)) |
|---|---|---|---|
| Foundation of heater and vent stack | Piling, earth auger | 1 | 114 |
| Site preparation | Excavator | 1 | 112 |
| | Air compressor | 1 | 109 |
| | Generator | 1 | 108 |
| | Lorry | 1 | 112 |
| | Concrete lorry mixer | 1 | 109 |
| | Pneumatic breaker | 1 | 117 |

In addition, the erection and installation of structures and equipment may also noise from non-powered construction activities, e.g. hammering. This is however not controlled under the current legislation.

*B6.2.2* *Evaluation Criteria*

There are at present various sets of Technical Memorandum and regulations under the Noise Control Ordinance (NCO) governing the control of construction noise which are applicable to the construction of the GRS. These regulations are:

- **Technical Memorandum on Noise from Construction Work other than Percussive Piling (TM1)**
- **Technical Memorandum on Noise from Percussive Piling (TM2)**; and
- **Air Compressors and Pneumatic Breakers Regulations (ACPBR).**

*General Construction Noise*

Under the NCO, a *Construction Noise Permit (CNP)* has to be obtained from EPD should construction work be carried out in any of the restricted periods shown in *Table B6.2b.* Day time construction noise in normal weekdays is presently not controlled under the NCO.

As stipulated in the **TM1**, the *Acceptable Noise Levels (ANL)* at 1 m from the facade of the nearest NSRs, for general construction activities within the specified restricted periods, should be lower than those shown in *Table B6.2b*. In addition, the HKPSG states that, for development in rural areas, consistent exceedance of the prevailing background noise level by 10 dB(A) should be avoided.

*Table B6.2b* ***Acceptable Noise Levels for General Construction Work during Restricted Periods***

| Restricted Period | Acceptable Noise Level for ASR 'A' Sensitive Receivers, dB(A) |
|---|---|
| All days during the evening (1900–2300) | 60 |
| General holidays (including Sundays) during the day–time and evening (0700–2300) | 60 |
| All days during the night–time (2300–0700) | 45 |

If the predicted noise levels from general construction work are higher than the specified limits, a CNP for construction within the restricted periods may not be issued by EPD.

*Noise from Percussive Piling*

Under the NCO and the **TM2**, percussive piling is banned for the restricted periods mentioned above and a CNP will have to be applied for from EPD for daytime piling. ANLs at NSRs have also been specified for daytime piling activities as presented in *Table B6.2c*.

*Table B6.2c* ***Acceptable Noise Levels for Percussive Piling***

| Window Type or Means of Ventilation of NSR | Acceptable Noise Level, dB(A) |
|---|---|
| NSR (or part of NSR) with no windows or other openings | 100 |
| NSR with central air conditioning system | 90 |
| NSR with windows or other openings but without central air conditioning system | 85 |

Therefore, predicted piling noise level at Tsang Tsui and Lung Kwu Sheung Tan must be below 85 dB(A) in order to obtain the daytime piling CNP. If there is any exceedance of this specified level, piling operations may only be permitted during non–sensitive hours of the day.

*Noise from Air Compressors and Pneumatic Breakers*

The **ACPBR** under the NCO specifies maximum noise levels permitted for these types of construction equipment. The equipment of concern must be tested using standard measurement procedures and a noise certificate will have to be applied for from EPD and labelled on the equipment during operation.

### *B6.2.3 Evaluation of Impacts*

The methodologies given in the **TM1** and the **TM2** are used to evaluate the impact of construction noise at the nearest Noise Sensitive Receivers (NSRs), Tsang Tsui (NSR1) and Lung Kwu Sheung Tan (NSR2) (see *Figure B6.1a*). *Table B6.2d* presents the predicted noise levels at these NSRs. For simplicity, the barrier correction is taken as -10 dB(A) assuming total screening of the site by the knolls between Yung Long and the two villages.

*Table B6.2d Predicted Noise Levels from Construction Works at the Nearest NSRs*

| Construction Activities | Sound Power Level dB(A) | Approximate Distance from Nearest NSRs (km) | Distance Correction dB(A) | Barrier Correction dB(A) | Facade Correction dB(A) | Predicted Noise Level dB(A) |
|---|---|---|---|---|---|---|
| Piling | 114 | NSR1 1.2 | -70 | -10 | +3 | 37 |
| | | NSR2 1.6 | -72 | -10 | +3 | 35 |
| General Construction | 120 | NSR1 1.2 | -70 | -10 | +3 | 43 |
| | | NSR2 1.6 | -72 | -10 | +3 | 41 |

Under the above 'worst case' assumption, the noise levels at the two nearest NSRs are predicted to be below the NCO and HKPSG criteria for both piling and general construction work. Due to the distance of these NSRs from the site, noise impacts during the construction of the GRS should be insignificant.

In fact the noise climate in the immediate area of Yung Long will be predominately influenced by the construction of the LTPS. According to the EIA study for the LTPS [1], the predicted noise levels at Tsang Tsui and Lung Kwu Sheung Tan during the noisy LTPS construction periods will be 54 and 59 dB(A) during the daytime, and 51 and 54 dB(A) during the night-time, respectively. Therefore, the predicted worst case construction noise from the GRS site is negligible.

Therefore, it can be concluded that noise emissions associated with the construction of the GRS are not significant and no specific constraints or monitoring are required during the construction period.

[1] Environmental Resources Limited, EIA of the Proposed 6000MW Thermal Power Station at Black Point, Vol.2 Construction Impact, 1992

### B6.2.4 *Mitigation Measures*

According to the above assessment, both piling work and general construction activities of the GRS should not pose any impact to the two village settlements in the area. However, the following measures should be considered as far as practicable to protect the construction workforce and other on-site personnel.

- Silenced equipment and quieter methods of construction should be considered. The use of quiet general construction plant can result in a significant reduction to the overall noise intrusion.

- Regular site supervision and maintenance of construction equipment; this can eliminate the generation of unnecessary noise.

## B6.3 *OPERATIONAL IMPACTS*

### B6.3.1 *Sources of Impacts*

The future GRS will contain 7 gas heaters, 2 pressure reduction stations, a control room, a metering room, a vent stack and other associated static facilities. Since there are few mobile operations within the site, only limited noise concerns are expected during the operational phase.

A number of noise sources from the operation of the equipment are identified as follows:

*Transfer Pumps*

These include transfer pumps at the HP Vent K.O. Drum, Open Drain, Slop and Close Drain. The sound pressure level measured at 1 m from these pumps are all 80 dB(A).

*Gas Heater Blowers*

There are a total of seven gas heaters, only five of which will normally be in operation during the day time whilst the other two are standby heaters operating only in emergency. Sound pressure levels for each blower, measured at 1 m from the source, are also approximately 80 dB(A). These heaters will operate at night only to ensure gas and fuel gas are sufficiently warm.

*Control Valves*

Each station consists of two 50% 14" pressure control valves, equipped with high-speed-actuators. Each valve has a sound pressure level of 81 dB(A) at 1 m.

There are also two pilot operated low-flow 2" control valves which maintain gas to the CLP heater pilots during off-times. Each of these valves also has a sound pressure level of 75 dB(A) at 1 m.

*B6.3.2* *Evaluation Criteria*

Relevant noise criteria for assessing the acceptability of industrial noise are laid down in the **NCO** and the **HKPSG**.

According to the **Technical Memorandum for the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Site** under the NCO, the Acceptable Noise Levels (ANL) for ASR 'A' area are shown in *Table B6.3a*. The HKPSG has also laid down noise criteria for fixed sources which states that the noise levels at nearest NSRs for future development should be 5 dB(A) below the appropriate ANL, or the prevailing background noise levels, whichever is lower. In addition, for development in rural area, any noise emitters introducing a consistent excess of 10 dB(A) above the prevailing background ($L_{90}$) should also be avoided.

*Table B6.3a* *Acceptable Noise Levels for Industrial Noise Sources Stipulated under NCO*

| Time Period | ANL for ASR 'A' Area, dB(A) | HKPSG Criteria, dB(A) | | Adopted Criteria for the Present Assessment, dB(A) |
|---|---|---|---|---|
| | | ANL–5 | $L_{90}$ + 10 | |
| Daytime (0700–1900) | 60 | 55 | (NSR1) 54<br>(NSR2) 52 | (NSR1) 54<br>(NSR2) 52 |
| Evening (1900–2300) | 60 | 55 | (NSR1) 56<br>(NSR2) 49 | (NSR1) 55<br>(NSR2) 49 |
| Night–time (2300–0700) | 50 | 45 | (NSR1) 50<br>(NSR2) 50 | (NSR1) 45<br>(NSR2) 45 |

*B6.3.3* *Evaluation of Impacts*

As the nearest NSRs are some 1.2 km and 1.6 km away from the site, detailed prediction of each of the noise sources has not been carried out based on their specific locations within the GRS. Instead, the sound power levels (SWL) of all the identified sources are estimated based on the reported sound pressure level (SPL) data and the following equation:

$$SWL = SPL + 10\log S$$

where, S = the area of the measurement surface, $m^2$

The sound power levels of all the sources are then combined and assumed to locate at the boundary of the site nearest to the NSR to reflect the worst case situation. This method gives the total sound power level for the transfer pumps, heater blowers and control valves of about 106 dB(A) as shown in *Table B6.3b*.

The noise levels at the facades of the two identified NSRs are then calculated based on the standard distance attenuation equation.

SPL = SWL – 20logr – 8

where, r = the distance of NSR from the noise source, m

The results of the calculation are presented in *Table B6.3c*.

*Table B6.3b Estimated Sound Power Levels of Noise Sources*

| Noise Source | Sound Pressure Level at 1m, dB(A) | Estimated Measuring Surface Area, $m^2$ | Sound Power Level of Individual Source, dB(A) | Number of Noise Source | Combined Sound Power Level, dB(A) |
|---|---|---|---|---|---|
| Transfer Pumps | 80 | 33.2 | 95 | 4 | 101 |
| Gas Heater Blowers | 80 | 47.3 | 97 | 5 | 104 |
| Control Valves (14") | 81 | 7.4 | 90 | 2 | 93 |
| Control Valves (2") | 75 | 6.4 | 83 | 2 | 86 |
| | | | | Total | 106 |

*Table B6.3c Predicted Noise Level at NSRs during Station Operation*

| Noise Sensitive Receivers | Total Sound Power Level of GRS, (dB(A)) | Distance of NSRs from site, (m) | Distance Attenuation, (dB(A)) | Facade Correction, (dB(A)) | Predicted Noise Level at NSRs, (dB(A)) |
|---|---|---|---|---|---|
| NSR1 (Tsang Tsui) | 106 | 1,200 | –70 | +3 | 39 |
| NSR2 (Lung Kwu Sheung Tan) | 106 | 1,600 | –72 | +3 | 37 |

Even with no correction for the screening effects of the topographical features in the area, the calculated noise levels at the two NSRs are negligible when compare with the criteria adopted for this assessment.

The predicted noise levels are similar to that of the original EIA Study for the LTPS which estimated a level of 41 dB(A) at Lung Kwu Sheung and 30 dB(A) at Tsang Tsui under the worst case operational scenario.

Therefore, as with the conclusion of the LTPS study, during the operational phase of the GRS, no noise impact is envisaged.

### *B6.3.4 Mitigation Measures*

As no significant noise impacts on the nearest village are envisaged during the operational phase, specific noise mitigation measures and monitoring programmes are not required.

## *B6.4 DECOMMISSIONING IMPACTS*

During the decommissioning of the facility, potential noise impacts will be similar to those for the construction phase. As the area is planned for major industrial and port development, it is not expected that new NSRs will be introduced to the area. In fact, according to the TMPD Study, Lung Kwu Sheung Tan is likely to be relocated at the end of this century. Therefore, significant noise impacts from the demolition of the GRS are not considered to be an issue.

## *B6.5 CONCLUSIONS*

Since the nearest village settlements in the area are relatively remote from the GRS, and there is a substantial screening effect due to the topographical features in the area, noise impacts during both the construction and operational phase of the project will not be significant. In the future, after the relocation of village settlements, there should also be no noise constraints during the decommissioning of the GRS.

## B7 CONCLUSIONS

This section presents a summary of the potential environmental impacts associated with the construction, operational and decommissioning phases of the GRS in relation to air, waste, water, and noise. No monitoring are required as the predicted environmental impacts are very low and should not pose any nuisance or problem to nearby sensitive receivers. A summary of recommended mitigation measures are given in *Annex X*.

*Air*

The construction and operation of the GRS will not pose significant air quality impacts to the surrounding area as the GRS is located at a remote site far from any ASRs.

The Fugitive Dust Model (FDM) was used to predict the level of dust from the construction site to the surrounding area. The predicted worst case 1-hour dust concentrations at the nearest ASRs at Lung Kwu Sheung Tan will fall within the 1-hour TSP limit and the 24-hour AQO for TSP. Appropriate mitigation measures and good on-site management practice should keep the dust impact to a very low level.

The Industrial Source Complex Short Term Version (ISCST2) model was used to predict the pollutant concentrations from the potential sources of emission during the operational phase. Modelling results indicate that no significant air quality impacts are expected from the operation of the GRS.

*Waste*

With good construction practice and management whereby waste arising will be stored, transported and disposed of using approved methods, no significant adverse environmental impacts are envisioned. Inert wastes from construction could be used as fill material at reclamation sites. Other land sourced construction wastes unsuitable for reclamation or land formation will be disposed of to WENT Landfill, whilst chemical wastes will be disposed of to the Chemical Waste Treatment Centre at Tsing Yi. Recycling of construction wastes should be carried out wherever feasible to conserve resources and landfill capacity.

During the operation of the GRS, only small quantities of waste will result from the day to day operation of the station. With the correct storage, transport and disposal procedures, none of the waste arisings are expected to result in any adverse environmental impacts.

*Water*

Water quality impacts from the construction of the GRS will be similar to typical land based construction activities which involve construction runoff litter and debris, spillages and domestic sewage. These are unlikely to cause unacceptable water quality impacts on the surrounding water if proper site management and good construction practices are implemented. Therefore, minimal water quality impacts are expected.

The operation of the GRS is not envisaged to have any major effluent discharge. Drainage from the plant will be diverted to the treatment plants at the new LTPS nearby for subsequent treatment prior to discharge . All effluent from the GRS will have to comply with the TM prior to discharge.

*Noise*

The nearest village settlements in the area are relatively remote from the GRS and as there is a substantial screening effect due to topographical features in the area, noise impact during both the construction and operation phase of the project will not be significant. The future relocation of village settlements should ensure that there will also be no noise constraints during the decommissioning of the GRS.

*Conclusions*

The EIA concluded that the construction, operation and decommissioning phase of the GRS will not result in any unacceptable environmental impacts with respect to air, waste, water, and noise.

Annex I

# Study Brief

**Natural Gas Supply to Black Point Power Station**
**Submarine Pipeline, Receiving Station and The Related Facilities**

**Environmental Impact Assessment (EIA) Study**
**Study Brief**

## 1. Purpose of The EIA Study

The purpose of the EIA study is to minimize pollution, environmental disturbance and nuisance arising from the construction, operation and decommissioning of the natural gas submarine pipeline within Hong Kong waters, the on-shore gas receiving station at Black Point and the related facilities (referred as "the project" thereafter) by providing information on the nature and extent of the potential environmental impacts. This information will contribute to decisions on:

a) the acceptability of any adverse environmental consequences that are likely to arise from the construction, operation and decommissioning of the project; and

b) the design, construction, operation and decommissioning of the project.

## 2. Objectives of the EIA Study

The objectives of the EIA Study are:

a) to describe the project and the requirements for its development;

b) to identify and describe the elements of the community and the environment likely to affect/be affected by the project;

c) to identify, predict and evaluate the net environmental impacts and cumulative effects likely to arise from the construction, operation and decommissioning of the project in relation to the existing and planned community, the beneficial uses of the areas concerned and the neighbouring land uses;

d) to identify and specify methods, measures and standards to be included in the detailed design which may be necessary to mitigate the impacts to an acceptable levels;

e) to recommend the environmental monitoring and audit requirements necessary to ensure the effectiveness of the environmental protection measures adopted; and

f) to identify additional studies where necessary to fulfil the objectives or requirements of this EIA study.

## 3. Study Requirements

### 3.1 General

The EIA shall consist of the following which satisfy the objectives in Section 2:

a) a *Stage 1 EIA Report* on the submarine pipeline covering issues in Section 3.2.1 to enable decisions on the route of the pipeline and the pipeline corridor;

a) a *Stage 2 EIA Report* on the remaining works covering issues in Section 3.2.2 with sufficient reference to the findings in the Stage 1 EIA Report and coverage on the cumulative effects of the entire project;

b) any revisions or supplements to the EIA Reports as required by the Director of Environmental Protection (DEP); and

c) an *Executive Summary*, in both English and Chinese, fully and fairly detailing the findings of the EIA study, but omitting the non-essential technical details. The Executive Summary should at least highlight the major aspects of the project, perceived issues of public concern, recommendations for the implementation and their basis, and the implementation schedule of these recommendations. It is intended that the information presented therein shall assist the Government in undertaking any requirement for public consultation.

### 3.2 Technical Requirements

The study shall include, but not necessarily limited to, water quality, waste/spoil disposal, noise and air quality impact assessment of the construction, commissioning, operation and decommissioning of the project.

The assessment shall also comprise an ecological impact assessment, making particular reference to the maricultural zones and fishing activities in the vicinity of the proposed dredging/trenching work.

#### 3.2.1 Stage 1 EIA Report

The *Stage 1 EIA Report* shall address environmental issues related to the construction and operation of the *submarine pipeline* to enable decisions on the route of the pipeline and the pipeline corridor within Hong Kong waters. The contents of the report shall include, but not necessarily limited to, the following:

a) Route Selection

Outline the key locational requirements of submarine pipeline including factors

of environmental significance. Explain the basis of route selection.

b) Construction

Assess impacts during the construction phase including the mitigation effects of proposed control measures and evaluation of effects on the existing environment. The discussion of impacts should at least include the following considerations:

i) impacts on water quality and marine ecology (including benthic community, fishing activities, and maricultural zones) arising from the dredging/trenching activities;
ii) suitable methods of dredging/trenching, transport and disposal of dredged/excavated materials;
iii) noise arising from marine based activities; and
iv) noise/dust arising from associated land based activities.

c) Operation

Assess impacts during the operation phase including the mitigation effects of proposed control measures and evaluation of effects on the existing environment. The discussion of impacts should at least include the following considerations:

i) impacts arising from the discharge of testing media after pressure test; and
ii) impacts arising from the discharge of cleansing/testing media during maintenance.

### 3.2.2 Stage 2 EIA Report

The *Stage 2 EIA Report* shall address the environmental issues related to the construction, operation and decommissioning of the *remaining works* with sufficient reference to the findings in the Stage 1 EIA Report and coverage on the *cumulative effects* of the entire project. The contents of the report shall include, but not necessarily limited to, the following:

a) Construction

Assess impacts during the construction phase including the mitigation effects of proposed control measures and evaluation of effects on the existing environment. The discussion of impacts should at least include the following considerations:

i) noise/dust arising from construction activities; and
ii) impacts arising from any diversion of water courses.

b) Operation

Assess impacts during the commissioning and operation phase including the mitigation effects of proposed control measures and evaluation of effects on the existing environment. The discussion of impacts should at least include the following considerations:

i) aerial emissions arising from the heat exchange system for the gas receiving station;
ii) air quality impacts (including odour) of the venting of the natural gas during incidents such as system over-pressure or maintenance of pipework; the handling of slug and other drains from the system; and any other air issues identified in the course of this study;
iii) quantity and quality of slug from the pipeline and the disposal of slug;
iv) quantity and quality of effluent(s) arising from the open-drain and closed-drain systems for the receiving station and its disposal; and
v) noise from the operation of other equipment.

c) Decommissioning

Identify all aspects of the project that will likely to cause unacceptable or undesirable environmental impacts during the decommissioning of the project. Develop a board line proposal to mitigate the impacts to an acceptable level.

### 3.2.3 Sensitive Receivers/Receptors

Sensitive receivers/receptors shall be identified for both existing and planned uses in accordance with the Hong Kong Planning Standards and Guidelines (HKPSG). Land uses for construction phase shall comprise those that will be occupied at the time of construction will start for each phase of the works. Land uses for operation phase shall comprise those that are likely to be in place at the completion of construction together with any other committed land uses.

### 3.2.4 Environmental Monitoring and Audit

#### 3.2.4.1 Environmental Monitoring

Identify and recommend environmental monitoring requirements for all construction, post-project and operational phases of the development. These requirements shall include but not be limited to the identification of sensitive receivers, monitoring locations, monitoring parameters and frequencies, monitoring equipment to be used, and any other necessary programmes for baseline monitoring, impact and compliance monitoring, and data management of monitoring results.

### 3.2.4.2 Environmental Audit

Identify and recommend environmental audit requirements for all construction, post-project and operational phases of the development. These requirements shall include but not be limited to:

a) organisation and management structure, and procedures for auditing of the implementation of respective environmental mitigation measures recommended for the detailed design, contract document preparation, construction, post-project operation stages of the development;

b) environmental quality performance limits for compliance auditing for each of the recommended monitoring parameters to ensure compliance with relevant environmental quality objectives, statutory or planning standards, or acceptance criteria recommended by the EIA. These limits shall give indication of a deteriorating environmental quality and shall allow proactive responses to be taken. (The commonly used approach is a set of trigger, action and target levels);

c) organisation and management structure, and procedures for reviewing the monitoring results and auditing the compliance of the monitoring data with the environmental quality performance limits (point (b) above), project contractual and regulatory requirements, and environmental policies and standards;

d) Event/Action plans for impact and compliance monitoring;

e) complaints handling, liaison and consultation procedures; and

f) reporting procedures, report formats and reporting frequency including periodical reports and annual reviews to cover all construction and post-project/operational phases of the development.

**4.2.4.3** Prepare an Environmental Schedule (Manual) which covers the requirements and recommendations in **4.3.4.1** and **4.3.4.2**. The Manual shall also contain a summary list of recommended environmental mitigation measures. This Manual shall be used as a guideline for environmental monitoring and audit during the construction and post-project operational phases. This Manual shall be a stand-alone document and form part of the EIA report.

## 4. Proposed Administration

The assessment shall be conducted by the project proponent and his consultants under the guidance of the Environmental Assessment and Planning Group (EAPG) of the Environmental Protection Department (EPD). EAPG will liaise with other specialist Groups with EPD and relevant Government Departments with regard to the EIA study.

A Study Management Group (SMG), comprises representatives of EPD and relevant Government Departments together with the project proponent and his consultants, may be established by EPD to oversee the EIA study.

The project proponent and his consultants should familiar themselves with the assessment procedures outlined in the EPD's Advice Notes No. 2/92 "Application of the Environmental Impact Assessment Process to Major Private Sector Projects".

In order to maximize community acceptance of complex, high impact and potentially controversial projects, it is the Government's policy to ensure as far as possible that public has access to Government-owned EIA reports. The project proponent are strongly encouraged to follow the approach adopted by the Government. Appendix D at the end of the Advice Note No. 2/92 sets out some guidelines on public access of EIA reports.

## 5. Reporting Requirements

**5.1** The EIA study shall be carried out in two stages as detailed in Section 3.1.

**5.2** The following reports shall be submitted to the DEP:

- 30 copies of the draft EIA reports
- 80 copies of the final EIA reports
- 250 copies of the Executive Summary

The proponent and his consultants shall also supply the Government with such technical notes, working papers, briefs, supporting documents and other relevant inputs as may be required during the study.

- End -

Annex II

# Response to Comments

IIa) Gas Pipeline

IIb) Gas Receiving Station

## Annex IIa) Gas Pipeline

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowlo
Hong Kong
Telephone 722 9700
Facsimile 723 5660

8 December 1993

Regional Assessment Group
Environmental Assessment and Planning Group
Environmental Protection Department
28th Floor, Southorn Centre
130 Hennessy Road
Wanchai
Hong Kong

ERM

*Attn: Mr Yeung Kai Hoi*

Dear Mr Yeung,

*ARCO Submarine Gas Pipeline (HK Territorial Waters) Draft EIA*
*EPD's comments*

We refer to the comments dated 15 November. Please find below the consultant's response:

**General (a)**

Noted. Response to comments on the GRS EIA are being prepared.

**General (c) 3.2.7, 3.4.6**

There are currently no available data on field monitoring or testing of jetting and ploughing. The consultant has therefore made pessimistic assumptions based on the knowledge of the most experienced dredging expert in the Territory, concerning the potential sediment loss based on direct experience on dredging works. The recent Territorial Suspended Solids Survey has illustrated the extremely large volumes of sediment passing Black Point on the ebb tide, only a small part can be attributed to the present dumping operations in the pits which are in turn, considered to be releasing far more sediment than any pipeline trenching work. As our report indicates, therefore, it is not necessary to recommend mitigation measures in order to justify the use of these dredging methods.

Information of the SS levels in the Black Point area are reported in the Report to CED (Contract GC/91/01/PW/7/2/31.34a) : Silt Meter Profiling and Other

Measurement Task 1C. This report is confidential to the client but since a government department is involved. EPD may wish to approach CED for the information.

General (d) Table 5.1a & b

The consultants cannot agree that the background SS levels rarely exceeds 60 mg/l. We understand from the recent Territorial Surveys obtained for CED, there were numerous measurements exceeding 60mg/l.

4.4

CAPCO/ARCO confirmed that the EIA for the pipeline within Chinese waters has been completed and accepted by the relevant parties.

Others

These comments were addressed in the response to comments to EPD dated 29th October 1993.

The EIA report is being finalised and will be forwarded to you shortly.

Yours Sincerely
for ERM Hong Kong

Ralphaelynne Lee
Consultant

cc: Mr C R Blair
Mr Canh Do/Jeffrey Wilburn - ARCO (Fax 713-575-4646)
Mr Peter Shum/K C Ng - CLP (Fax 4411020)

Our ref: C1119/L-1328/RL

**FACSIMILE**

Original copy WILL be sent separately
Total no. of pages including this page: 4

Environmental Protection Department

**TO:** ERM Hong Kong
(Attn.: Mr Steven Laister)

**YOUR REF** : C1119/L-1307/RL (dated 29.10.93)
**YOUR FAX** : 723 5660

**FROM** : DEP
**OUR REF** : (22) in EP 2/N4/31 IV
**TEL No** : 835 1293
**DATE** : 15 November 1993
**OUR FAX** : 591 0558

**Supply of Natural Gas to Black Point Power Station**
**Submarine Gas Pipeline - HK Territorial Waters**

**Response to Comments**

We have the following comments on your response to comments:

General (a)

Please see our "General Comments" on the GRS EIA report (re: our letter to ERM Hong Kong dated 2.11.93 of this series).

General (c); 3.2.7; 3.4.6

The consultants have introduced a number of new dredging methods in the study but gave no details about any previous field testings, monitoring reports and mitigation measures required for these methods (eg. plough & jetting). The response to "General (c)" are inadequate as the references quoted are based on either trailer or grab dredging. The consultants must provide adequate supporting evidences and recommend mitigation measures in order to justify the use of these dredging methods.

General (d); Table 5.1a & b

From our survey data, the background SS level in the surface layer from Pearl River would seldom exceed 60 mg/l in that area. It is therefore reasonable to have an absolute limiting value of 100 mg/l as the TAT level. It is also compatible with the TAT requirements laid down for the dredging and reclamation works for other LTPS related projects.

4.4

Would ARCO/CAPCO please confirm that the EIA for the pipeline within Chinese waters has been completed and accepted by the relevant authority.

Others

There is no response to our additional comments (attached) forwarded to the consultants on 29.9.93.

2. Please let us have your response to the above as soon as possible. As stated in our facsimile message dated 19.10.93, we need your co-operation in order to finalise the report and in turn to advise DLO/TM on the licensing conditions for the laying of the submarine pipeline. Any delay in your part will inevitable reflected in the preparation of the wayleave license.

3. By copy of this facsimile message, would *EMSD, AFD and FMC* please forward their comments on the consultants' response by 20.11.93 the latest.

(Yeung Kai-hoi)
for Director of Environmental Protection

Address: ERM Hong Kong
10 & 11/F, Hency Tower
9 Chatham Road
Tsim Sha Tsui
Kowloon
Attn: Mr Steven Laister (Fax: 723 5660)

cc. ARCO China Inc/Castle Peak Power Co Ltd
6/F, Sham Shui Po Centre
215 Fuk Wah Street
Sham Shui Po
Kowloon
Attn: Mr Peter Shum (Fax: 441 1020)

EMSD
Attn: Mr Kent K Y Fung (Fax: 576 5945)

AFD
Attn: Mr C C Lay (Fax: 814 0018)

FMC, CED
Attn: Mr K Anandasiri (Fax: 714 0214)

DLO/TM
Attn: Miss Grace M C Chung (Fax: 459 0795)

bcc. S(WS)5
AgS(RA)2

# FACSIMILE

Original copy WILL be sent separately
Total no. of pages including this page: 2

Environmental Protection Department

TO: ERM Hong Kong
(Attn.: Mr Steven Laister)

YOUR REF : C1119-L-1126/RL

YOUR FAX : 723 5660

FROM : DEP

OUR REF : ( ) in EP2/N4/31 III

TEL No : 835 1293

DATE : 29 September 1993

OUR FAX : 591 0558

---

**Natural Gas Supply to Balck Point Power Station**
**EIA for the Submarine Pipeline (Hong Kong Territorial Waters)**

Further to our facsimile message dated 1.9.93, we have the following additional comments on the draft EIA report:

3.2.7, P.23

Automatic Lean Mixture Overboard (ALMOB) are prohibited in dredging operations. The second bullet point of this section should be deleted.

E1.4c, Page E4, Appendix E

Please replace the whole section with the following:

"Should the monitoring programme record levels exceed the Trigger/Action/Target (TAT) levels stated in Table 5.1a, immediate mitigation measures should be taken as required by the project manager in accordance with E1.7.

E1.7, Page E4, Appendix E

Please add the following as a new section:

"E1.7 *Mitigation in the event of an exceedance of Trigger/Action/Target (TAT) levels*

In the event of an exceedance of any one of the TAT levels as defined in Table 5.1a, a review of dredging practice should be carried out by the Contractor. This may include a combination of the following:

a) a review of working methods and practices;
b) inspection and maintenance or replacement of any marine plant or equipment contributing to the deterioration;
c) checking the state of maintenance of all silt screens.

The Project Manager shall also review the overall due-diligence management practices by the dredging Contractor. A record of actions taken should be kept and made available for inspection by EPD.

An action plan which outlines details of appropriate responsibilities by relevant parties in the event of exceedance of the recommended level is given in Table 5.1b."

Yours faithfully

(YEUNG Kai Hoi)
for Director of Environmental Protection

bcc. S(WS)5 - Thank you for your advice.

sub-2

## Consultants' Response to Comment

| Item | Government Department | Section | Comments | Consultants Response |
|---|---|---|---|---|
| 1 | EPD | General Comments | a) We have issued a study brief to ARCO, which cover issues wider than the scope of this EIA report. Please advise us when the remaining issues will be addressed and in what format. This should also be clearly stated in the introductory chapter to provide a clear picture of all the issues. Please also include the study brief as one of the appendices to the report for completeness. | As agreed with EPD, the EIA will comprise two reports – 1) for the Submarine Pipeline (Hong Kong territorial Waters; 2) for the Gas Reception Station. The EIA report on the Gas Reception Station was submitted on 22nd September.<br><br>Study brief to be included in the Final Report for the Submarine Pipeline. |
| | | | b) We understand that there will be associated land based activities in the pipeline laying work. These activities should also be described and evaluated in details. | There will be very limited land-based activities for the pipeline installation. These activities involve onshore/offshore pipepulling and commissioning work, and have been described and evaluated in the EIA Report. |
| | | | c) A number of trenching methods (eg. ploughs and jetting in P18 - 19) are mentioned but the report fails to provide supporting materials to justify the estimations of material loss due to these methods. Similarly, supporting materials should also be provided on the ACDP test referred in the last paragraph of P11). | The estimates of material losses as far as possible have been quantified in the text, based on direct experience of dredging work, work methods and sea floor sediments in the Deep Bay Estuary.<br><br>The ACDP work was undertaken during dumping trials in Urmston Road conducted by Dredging Research Limited and Binnie Consultants Ltd. The reference is 'Report on Surveys and Dumping Experiments Undertaken in the Redundant Marine Borrow Pits off Black Point in Urmston Road. Final Report to GEO/CED under Fill Management Study – Phase II. February 1993. 2 Vols, Binnie Consultants Ltd. |

| Item | Government Department | Section | Comments | Consultants Response |
|---|---|---|---|---|
| | | | d) In the report, it is repeatedly (in the last paragraph of P11, 1st paragraph of P13, 3.2.8, 6.1) stated that the natural current carry a high level of SS as compare to the Minimal SS generated by various trenching methods (eg. dredging, jetting). As the Outer Deep Bay borrow/dump site is still in use, a high concentration of SS is generated from various dredging/dumping activities in the area. The relative high SS content might be resulted from the washaway of the newly dumped fine materials. It is therefore preferable to start the trenching work a few months after all the dumping activities have stopped so as to allow the loose surface materials at the dump site be washed away, thus not posing a major problem when the trenching work starts. | Noted, this may be possible dependant upon the final timing of the cessation of works at the Outer Deep Bay borrow/dump site. However even if the two activities overlap, given the very high SS levels that occurs in the area naturally, any cumulative effects from these two sources are unlikely to raise levels significantly. |
| | | Specific Comments | Table 3.2e<br>It appears that the two figures for the flood and ebb tide should be interchanged. | Noted, this is a typing error and the figures for flood and ebb tide have been interchanged. |
| | | | 3.2.7<br>Like other methods (eg trailer suction, grab, cutter suction), mitigation measures for Ploughs and Jetting System should also be provided. | Because of the relative simplicity of these methods (involving insitu mud displacement) compared to the removal and transportation and disposal operations required by dredging work, observation of good operation practice is the principal mitigation measure to be adopted (eg. ensuring ploughs and jets are operating at the required depth below sea bed). |

| Item | Government Department | Section | Comments | Consultants Response |
|---|---|---|---|---|
| | | 3.4.6 | The main water quality concern is the suspension of sediments during the dredging, post-trenching and backfilling activities. The effects of suspension of sediments in the water column will inevitably have an effect on algal production and benthic marine life outside the corridor. Although the effect will be transitory and could be small, the effect can and must be minimized by selection of appropriate trench preparation and filling methods. With respect to this, the report recommends that "appropriate dredging and dewatering methods can reduce the amount of sediment resuspension". It should go on to recommend which method(s) should be selected. It should also take into consideration that at particular parts of the tidal cycle high current flows may spread sediment plumes further and have a greater effect. The possibility of reducing major water quality impact by scheduling the dredging/jetting activities to avoid unfavourable tidal conditions (eg peak flood or ebb) should also be addressed. | The current flows assumed in the assessment of sediment disposal were conservative, and thus "worst case" dispersion effects. The impacts are not expected to be of a scale that would justify limiting the periods of working, which would extend the overall period of construction and hence disturbance to the marine environment. The natural SS levels in the area far exceed the sediment losses predicted from the works, so even at these maximum tidal flow significant SS levels are not anticipated. |
| | | 4.4 | You mention that there will be a large quantity of discharge at the Hainan platform during the pre-commissioning and commissioning stage. Presumably, ARCO will resolve the associated environmental issues with the PRC authority. | The consultants understand that a separate EA has already been prepared for the pipeline related work in Chinese waters. |

| Item | Government Section Department | Comments | Consultants Response |
|---|---|---|---|
| | | 3.3.5<br>The impacts of dumping activities should also be covered as ARCO would need such evaluation to substantiate their application for a dumping license. | The dredged material will be dumped at a gazetted marine dump site of which detailed studies have been undertaken to address impacts of dumping activities. Appropriate mitigation measures are addressed in section 3.3.4 to minimise the impact during transportation and disposal of the material. |
| | | 3.4.2<br>The report mentions that the beaches at Lung Kwu Tan and Lung Kwu Sheung Tan are breeding grounds for Kingcrabs. No mention as to how successful these creatures are in Hong Kong waters. While resuspended solids are unlikely to have any effect on the beaches where the breeding grounds are, will it have any effect on the Kingcrabs migrating to and from the beaches, the success of larvae in the open water or the dispersion of juveniles. | The construction activities will be confined to within the pipeline corridor, at a considerable distance (approx 3 km) from the two beaches, and will be of short duration. The Small Kingcrab (*Tachypleus tridentatus)* is found on sandy shores at low tide and the much larger *T. gigas* is sub-littoral. The larvae are found in the intertidal (littoral areas). Therefore, no significant impacts are anticipated to result on the migrating Kingcrab and its larvae since they are restricted to shoreline areas. |
| | | 3.4.2, 3.4.5 & 3.4.6<br>The effects of the Chinese White Dolphin are mentioned but vague as to the impact on this mammal. This is not surprising as not much is known of its ecology. Studies on the dolphin are ongoing. Any new information that is relevant to the effects of the pipeline should be considered as and when it becomes available. Mitigation measures should be implemented if any adverse effects on the dolphin are deemed likely. | Noted and agreed. Relevant information that becomes available on the ecological requirements of the Dolphin will be considered in the evaluation of potential impacts. This will include the Dolphin monitoring and research programme planned under the New Airport Development. CLP/ARCO are in regular contact with WWF regarding the progress and findings of these studies. |

| Item | Government Section Department | Comments | Consultants Response |
|---|---|---|---|
| | | 5.1<br>The principal effects on the oyster beds in outer Deep Bay should not be overlooked (re: 3.4.2 and 3.4.4). The suspended solids levels at the area should be carefully monitored. An additional monitoring point between M1 and C1 (re: Fig 5.1a) may be prudent with an aim to protect the oyster beds. | An additional monitoring point between M1 and C1 will be recommended. |
| | | Table 5.1a & 5.1b<br>a) An absolute value of SS limit (say, 100mg/l) should be included in Table 5.1a.<br><br>Monitoring clauses to be consistent with Table 5.1a and 5.1b.<br><br>b) Please check the monitoring clauses in Annex 5 against the values and actions in Table 5.1a & 5.1b. | The SS levels as shown in Table 3.2c indicate that the *natural* SS levels far exceed 100mg/l. A 30% above the baseline concentration (as recommended in the Deep Bay Guidelines) is considered a reasonable level.<br><br>Monitoring clauses in Annex to be revised and to be consistent with Table 5.1a and 5.1b. |
| | | 6.3<br>We cannot share the consultants' conclusion concerning the impacts on marine ecology. Although no rare species were found in their ecological survey, great care and mitigation measures should be implemented to avoid excessive impact to the marine ecology. | Our conclusion does not suggest that the work can be carried out without due consideration for the environment. The conclusion is founded on the works being carried out with good operating practices, thereby minimising impacts to marine ecology, so that no significant impacts will result. |
| | | 3.2.7, Page 23<br>Automatic Lean Mixture Overboard (ALMOB) are prohibited in dredging operations.<br>The second bullet point of this section should be deleted. | This is a welcome development in the reduction of dredging impacts and will be deleted accordingly. |

| Item | Government Section Department | Comments | Consultants Response |
|---|---|---|---|
| | | E1.4c, Page E4, Appendix E<br><br>Please replace the whole section with the following:<br><br>"Should the monitoring programme record levels exceed the Trigger/Action/Target (TAT) levels stated in Table 5.1a, immediate mitigation measures should be taken as required by the project manager in accordance with E1.7. | Noted and amendments made. |
| | | E1.7, Page E4, Appendix E<br><br>Please add the following as a new section:<br><br>"E1.7 Mitigation in the events of an exceedance of Trigger/Action/Target (TAT) levels<br><br>In the event of an exceedance of any one of the TAT levels as defined in Table 5.1a, a review of dredging practice should be carried out by the Contractor. This may include a combination of the following:<br><br>a) a review of working methods and practices;<br>b) inspection and maintenance or replacement of any marine plant or equipment contributing to the deterioration;<br>c) checking the state of maintenance of all silt screens.<br><br>The Project Manager shall also review the overall due-diligence management practices by the dredging Contractor. A record of actions taken should be kept and made available for inspection by EPD. | Noted and addition made. |

| Item | Government Department | Section | Comments | Consultants Response |
|---|---|---|---|---|
| | | | An action plan which outlines details of appropriate responsibilities by relevant parties in the event of exceedance of the recommended level is given in Table 5.1.b." | |
| | | Others | Please ensure that the risk aspects of the gas pipeline are satisfactorily resolved with the GasSO, EMSD. | Noted. The consultants understand that these aspects are under discussion with the Departments concerned (see below). |
| 2 | EMSD (GasS0) | | CLP will commission a specialist risk consultant to conduct a one risk assessment study for this submarine pipeline, gas receiving station and the power station to demonstrate the risk levels. CLP, if necessary, will have to incorporate all possible mitigating measures so that the risk levels are within the Government Risk Guidelines. Furthermore, this submarine pipeline is classified as Notifiable Gas Installation (NGI) under the Gas Safety (Gas Supply) Regulations. CLP will have to obtain the construction and use approvals respectively from the Gas Authority before the commencement of construction and commissioning of the pipeline. | Noted. |
| 3 | FMC | | I refer to the draft final report titled "Natural Gas Supply to Black Point Power Station Submarine Pipeline – Hong Kong Waters: Environmental Impact Assessment" dated July 1993. Please be informed that I have no comment on the report. However, I wish to reiterate our concerns that were raised during the meeting held in BLD on 06.05.1993, in that an appropriate working method should be selected so that only minimal dredging is required. Our concerns were stated in my memo in this series dated 01.06.1993 (copy attached), which was a response to DLO/TM's circulation of the minutes of the above meeting. | Noted. Minimal dredging would present the preferred environmental option, although other factors (timing, equipment availability, cost etc etc) may also influence the final selection of the work method. |

| Item | Government Section Department | Comments | Consultants Response |
|---|---|---|---|
| 4 | AFD | a) ERM should be well aware already that AFD describes the area involved as of moderate rather than low fisheries value. Furthermore the proportion of shrimps in commercial catches is such that it is misleading to say they are of low commercial value. | Noted. Text amended to reflect the "moderate" fishery resources in the area. |
| | | b) The extent of the temporary disturbance to fishing from laybarge operations (P.33) is not quantified. If this is to be for the full (74 month) period of pipe laying I assume this issue will be covered in the marine impact assessment. | Noted, however, the pipelaying for Hong Kong waters will take a maximum of two weeks for the laybarge operation. During this time, the laying operations will progress along the route; thus disturbance in any one area will be very short lived and is not expected to hinder fishing operations in the area. |

## Annex IIb) Gas Receiving Station

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong
Telephone 722 9700
Facsimile 723 5660

8 December 1993

Regional Assessment Group
Environmental Assessment and Planning Group
Environmental Protection Department
28th Floor, Southorn Centre
130 Hennessy Road
Wanchai
Hong Kong

*Attn: Mr Yeung Kai Hoi*

Dear Mr Yeung,

*ARCO Gas Receiving Station*
*Response to Comments on Draft EIA*

We refer to the comments from Your Department and other Government Department on the Draft EIA for ARCO Gas Receiving Station. Please find enclosed the consultant's response to the comments. The following Government Departments had no comments:

- Regional Service Department
- Fire Service Department
- Civil Engineering Department (Port Works)
- Marine Department
- District Planning Office/TM & YL
- TDD (Tuen Mun)

An EIA report which will cover both the gas pipeline and gas receiving station is being prepared and will be forwarded to you shortly.

Yours Sincerely
for ERM Hong Kong

Ralphaelynne Lee
Consultant

| | | | |
|---|---|---|---|
| cc: | Mr C R Blair | – | ARCO (Fax 1-713-575-4646) |
| | Mr Cahn DO | – | ARCO |
| | Mr Peter Shum/K C Ng | – | CLP (Fax 4411020) |
| | Mr Vincent Leung | – | RSD (Fax 6021671) |
| | Mr Kwok Jing Keung | – | FSD (Tel 7337746) |
| | Mr David Cook | – | AFD (Fax 8140018) |
| | Mr N Evans | – | FMC (Fax 7140247) |
| | Mr K C Leung | – | CE/Portworks CEO CED (Fax 7140113) |
| | Mr Y K Lee | – | MD (Tel 8582192) |
| | Mr Richard Siu | – | DPO/TM & YL (Tel 4108210) |
| | Mr C Y Yip | – | TDD - Tuen Mun (Tel 4513284) |

Our ref: C1136/L-1352/RL

C1136/EIA.RTC/RL/hl
8 December 1993

*Response to Comments*
*on the Draft EIA Report*
*Hong Kong Gas Receiving Station*

| No. | Department | Reference | Comments | Consultant's Response |
|---|---|---|---|---|
| 1 | EPD | General | The study brief we issued to ARCO covers the submarine pipeline, the gas receiving station and related facilities. Would the consultants please confirm that the environmental issues related to these works have all been covered by the 2 draft EIA reports, i.e. the reports for "Submarine Pipeline" and "Gas receiving station". | The consultants confirm that the two draft EIA reports, i.e. for "Submarine Pipeline" and "Gas Receiving Station" have covered all the environmental issues related to the submarine pipeline, the gas receiving station and related facilities. |
| 2 | | | We suggest that the two EIA reports be combined to form one single document so as to facilitate the subsequent consultation process and to ensure completeness. Similarly, we prefer a single Executive Summary be prepared for this EIA. | Noted. A single Executive Summary will be prepared and the two IEA Reports will be combined as part A and B to form a single document. |
| 3 | | | Mitigation measures have been recommended in various chapters. Please consolidate all these recommendation in one single chapter/appendix to facilitate implementation and enforcement. | Noted. Recommendation for mitigation measures to be given in one single chapter/appendix. |
| 4 | | | Similarly, please consolidate all the monitoring requirements in one single chapter/appendix in the combined final EIA report. | Noted. Monitoring requirements to be given in one single chapter/appendix in the combined final EIA Report. |
| 5 | | Air Quality S.2.3.3, S.2.3.4, S.2.3.7, S.2,3.9 | Please clarify if the slug catcher, filters and separators and the drain/slop oil system are odour sources during their operation and maintenance. If so, their impacts should be assessed in the EIA. | Slug catcher, filters, separaters and the drain/slop oil system are not odour sources during normal operation of the gas receiving station. Localized and temporary odour problem may arise during maintenance of these systems. The odour sources during maintenance would be from mechanical oil and condensate. It is considered that any odour impacts during maintenance will be insignificant and of short duration and will not affect ASRs as these are more than 1 km away from the station. |

| No. | Department | Reference | Comments | Consultant's Response |
|---|---|---|---|---|
| 6 | | Table 3.1b | Could the consultants please specify the EIA documents (including the number of the paragraphs/figures) from which they have derived the background air concentrations? | The future background air quality at Lung Kwu Tan was estimated in the EIA of the Proposed 6,000 MW Thermal Power Station Stack Emissions Key Issue Assessment. Table 3.4d – Part B Rigorous Frequency Analysis. Text will be amended. |
| 7 | | S.3.3.2 | Please note that "2 odour units at the site boundary" is a local conventional standard but not a statutory standard. | Noted. This will be amended to read local conventional standard. |
| 8 | | Table 3.3b | Could the consultants please explain/provide the following: | |
| | | | i) for the gas heaters, extra information, such as the designed rating of the burners and the nominal fuel consumptions, etc. is necessary to facilitate the understanding of the estimation of the emission rates; | The designated rate for the burners is 40 MM Btu/hr of use and the heater is rated at 25 MM Btu/hr. The maximum gas consumption rate is 1097$Nm^3H$ (41,000 SCFH). The fuel gas composition is the same as the gas being sold to CLP (see attached Table 1). |
| | | | ii) for the vent system under the scenario of continuous emissions, please note that the efflux velocity of 0.02 m/s and the estimated odour strength of $H_2S$ of 360.4 o.u. $m^3/s$ are not in agreement with the ones estimated from the purge gas rate of 10 scfm as given in s.2.3.11; and | Noted. The efflux velocity should read 0.03m $s^{-1}$ and the odour strength of $H_2S$ was estimated to be 536.4 ou $m^3$ $s^{-1}$ as the source strength is taken to be 50 ppmv. With this odour strength, the odour unit at 200m from the vent stack will not exceed the 5 odour unit per 5 second. |
| | | | iii) for the vent system under the scenario of emergency emissions, please note that the estimated odour strength of $H_2S$ of $5x10^3$ o.u. $m^3/s$ is also not in agreement with the one estimated from the gas flowrate obtained by multiplying the stack cross-sectional area of 0.166 $m^2$ with the efflux velocity of 1027.3 m/s. | Noted. The efflux velocity should read 1514 m $s^{-1}$ and the odour strength of $H_2S$ was estimated to be $26.6 \times 10^6$ ou $m^3$ $s^{-1}$ for release from the high pressure vent under emergency situation. |

| No. | Department | Reference | Comments | Consultant's Response |
|---|---|---|---|---|
| 9 | | S.3.3.4 | For the non-criterion pollutants (i.e. those without AQOs such as HC and $H_2S$), could the consultants please comment on their health implications? | Noted. The health implications from HC and $H_2S$ will be included in the Final Report. |
| | | | Table 3.3d seems to be for ground level receptors. Could the consultants please confirm that ground level receptors were representatives of the planned/committed land uses at the study area. It will also be useful if the report can also comment on the land use implications of the residual impacts of the gas receiving station. | Noted. Proposed developments within 1 km from the gas receiving station are for industrial uses and it is expected the industrial developments in the area would be low rise. Flagpole receptors with distance away will be texted in the modelling excerise to assess the potential air quality impacts on the planned/committed landuse. |
| 10 | | Table 3.3e | Please elaborate where the figures in table come from. Please note that figures of background air quantity of $S0_2$ and $NO_2$ provided in this table are not in agreement with the ones provided in Table 3.1b-Assumed Future Background $SO_2$ and $NO_2$ Levels. | Noted. This was a typing error and will be corrected. |
| 11 | | S.3.3.5 | The consultants have rightly pointed out that the installation of the heater stacks is required to comply with the Air Pollution Control (Furnaces, Ovens and Chimneys) (Installation and Alteration) Regulations. The endorsement of this EIA report should not in any way be construed as an approval or an indication of approval under the Regulations. | Noted and agreed. |
| 12 | | **Water Quality** S.5.1.1 | Water quality monitoring data for the LTPS reclamation works should be taken into account in assessing the future condition. | Monitoring data for the LTPS reclamation is only available for the water quality parameters of suspended solids and Dissolved Oxygen . It is considered that as these works are temporary, any impacts on water quality will be short-term in nature and localised. There will not influence the future water quality in the area. |
| 13 | | S.5.1.2 | The cooling water intakes of the LTPS should be counted as a WSR. | Noted and agreed. The cooling water intakes if the LTPS will be included as a WSR for the operational phase. |

| No. | Department | Reference | Comments | Consultant's Response |
|---|---|---|---|---|
| 14 | | S.5.2.3, " Construction and runoff and drainage", last para | It is too bold to conclude that the construction runoff will not have any impact on the water quality of the receiving waters. | Noted. However, it is considered that no significant impact on water quality will arise from construction runoff and drainage, assuming good site practices are employed. |
| 15 | | S.5.3.4, " Drainage from Process Water" | Besides sump pit, any discharge to sewers must get a discharge licence from the EPD. The discharge standards should therefore follow the TM. | Noted. All wastewater will be transferred to the CLP LTPS site for treatment prior to discharge to sewer. The discharges from the LTPS were addressed during the Key Issue Assessment and will be required to meet the TM standard. |
| 16 | | S.5.3.4, "Stormwater runoff" | To ensure that the runoff is uncontaminated, all mitigation measures listed in S.5.3.5 must be implemented before the runoff water is discharged into storm water drains. | Noted. |
| 17 | | S.5.3.4, "Sewage from Workforce" | An estimation of 114 litres of sewage per day is too optimistic. It appears that the consultants have forgotten about visitors and maintenance personnels. | It is expected that most visitors will be to the LTPS site and not to the gas receiving station. Thus, the ARCO estimate of sewage generation of 114 litres per day is considered to be reasonable. |
| | | | Although the effluent discharge from the GRS are relatively small, the consultants should also address individual discharges as it would affect the terms of the discharge licence issued by the EPD. | There will be no direct discharge from the GRS. All discharge will be diverted to the LTPS for subsequent discharge. No discharge license will be necessary for the GRS. |
| 18 | | S.5.5, para 1 | The para. should read as: | |
| | | | "Water quality impacts .... and spillages. If proper site management and good construction practices are implemented, it is unlikely that there would be unacceptable water quality impact on the surrounding waters." | Noted and the para. will be amended accordingly. |

| No. | Department | Reference | Comments | Consultant's Response |
|---|---|---|---|---|
| 19 | | **Waste Management** | The following are our general requirements on the disposal of construction waste. Please incorporate them into the report where appropriate:<br><br>"Construction waste should be separated into two portions, one suitable for public dumping and another for landfilling, at source as far as practicable.<br><br>The acceptance criteria of public dumps are stipulated in the WBTC No. 2/93. Dumping licences may be obtained from the CED. Under the licence conditions, public dumps will accept only suitable construction waste, that is, inert building debris, soil, rock and broken concrete. There is no size limitation on the rock and broken concrete. A small amount of timber mixed with otherwise suitable material is permissable.<br><br>Waste containing more than 20% by volume of inert materials will not be accepted for disposal at landfills. However, existing landfills operated by the CED (i.e. Tseung Kwan O landfill, Shuen Wan Landfill and Pillar Point Valley Landfill) will continue to accept waste containing more than 20% of inert materials until further notice, likely to be mid 94. Inert materials means soil, rock, asphalt, concrete, brick, cement plaster/mortar, inert building debris, aggregates etc.<br><br>Intermediate sorting plants are to be established at strategic locations of the territory to receive mixed construction waste.<br><br>In general, waste generation should be minimized and materials should be recycled as far as practicable to minimize the disposal requirements." | Noted and comments on the disposal of construction waste will be incorporated where appropriate into the final report. |

| No. | Department | Reference | Comments | Consultant's Response |
|---|---|---|---|---|
| 20 | | Noise | While we appreciate that the proposed GRS and pipeline are fairly remote from NSRs, there is still a need to provide adequate details in the report to substantiate the operational noise prediction. Would the consultants please provide sound power levels of the equipment in the station and details of their calculations. | Based on the Sound Pressure levels and the size of the equipment, the sound power levels are estimated to be in the range of 81 to 97 dB(A). The predicted noise levels will be presented based on the estimated Sound Power Levels. |
| 21 | Agriculture & Fisheries Department | | While not strictly defined as 'Water Sensitive Receivers' the local capture fisheries resources are nevertheless sensitive to environmental changes. I consider the EIA on the GRS would be more complete if it stated whether there is likely to be any impact from the project on the local fisheries. | Disturbance is over a very small area relative to that available to the local fisheries resources and disturbance of sediment will not exceed the nature range that local fisheries encounter, and thus no significant impacts are anticipated. The landtake impacts are dealt with within the EIA for the power station itself, which pointed out that the natural littoral or rocky habitat to be lost is very limited in both area, and species affected, and would be effectively replaced by the rock wall habitat provided by the power station site. |
| 22 | Civil Engineering Department | | Our only comment on the captioned report concerns Section 4 (Waste Management). We strongly support the constructive use of excavated material, and it should be noted that disposal of such material at marine dumping grounds will not be permitted. | Noted and amendments will be made as necessary in the final report. |

Annex III

# Pipeline Installation Details

IIIa) Dredgers

IIIb) Shore Approach Method

IIIc) Typical Lay Vessel

IIId) Post Trenching Techniques

Annex IIIa) Different Types of Dredgers

**Grab Dredger:**

This is one of the commonest forms of mechanical dredger, comprising a slewing crane which lowers and hoists a grab in and out of the water. Grabs may be either pontoon–mounted or fitted to self–propelled hopper vessels. The former discharge spoil into barges alongside, which then transport material to the dump site. Grabs perform best in soft or loose muds and are ideally suited to working in confined areas.

**Bucket Dredger :**

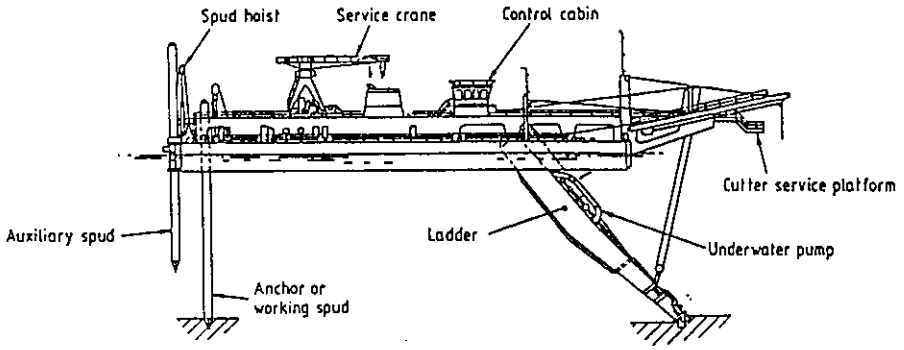
Bucket dredgers are purpose–built vessels, usually pontoon type, which have a central well through which an endless chain of buckets passes carrying excavated material from the seabed up to the top of the bucket and discharges into a chute. When the barge is full the chute arrangement is altered to discharge to another barge while the full barge is taken off to the disposal site.

**Trailer/Cutter Suction Hopper Dredger (TSHD):**

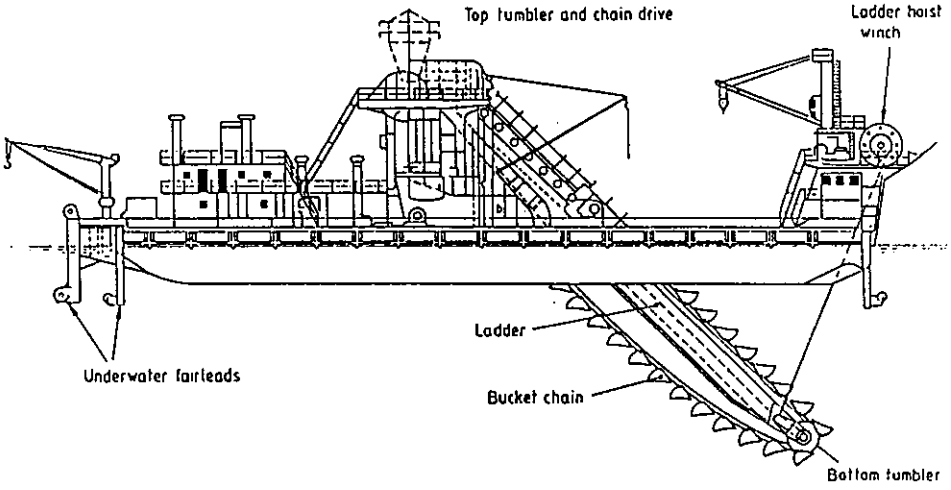
This is a sea–going, self propelled vessel which is equipped with a suction pipe which trails across the seafloor or, in the case of a CSHD, a cutting head. The excavated fluid is discharged into a hopper where the solids settle whilst excess water is discharged via an overflow. This technique, which serves to minimize the water and maximise the solid content of the material transported to the dump site is known as Lean Mixture Overboard (LMOB) and, if used, contributes a large proportion of the solids put into suspension. At disposal grounds, trailer dredgers can discharge their load directly through doors or valves in the bottom of the hull.

Figure III1 present an illustration of the different types of dredgers discussed and an overview of the advantages and disadvantages of the different dredgers are presented in Table III1.

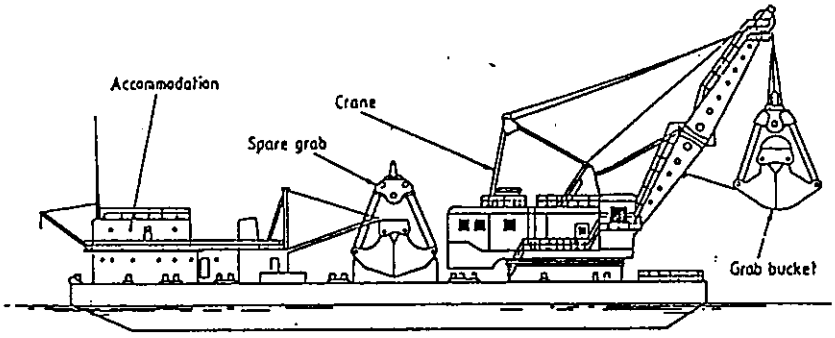
| Table III1 Advantages and Disadvantages of the Different Dredgers | | | |
|---|---|---|---|
| **Dredgers to be used** | **Mode of Operation** | **Advantages** | **Disadvantages** |
| – Bucket<br>– Grab | Mechanical | – relatively little disturbance to material<br>– extraction at near in-situ densities (little disturbance to material as it is removed)<br>– settling basins unnecessary<br>– can be used for wide variety of materials, particularly good for consolidated clays and other hard materials | – significant amount of spillage and leakage<br>– depth of penetration difficult to control, typically +/- 0.3m<br>– slow process, especially if material must be rehandled or transported, increasing project cost |
| – Cutter suction<br>– Trailing suction | Hydraulic | – good control over what is dredged<br>– generally least expensive per $m^3$ removed<br>– if done correctly, low turbidity at dredging site (except for sidecast)<br>– good for larger and more extensive projects | – significant amount of material to deal with<br>– generally at least (4 water: 1 sediment)<br>– requires settling basins, flocculation and filtration<br>– sometimes difficult to separate slurry<br>– high turbidity generation potential if done incorrectly<br>– distance to disposal site should be short (less than 1.5 km) |
| Ref : ERL(Asia) Ltd, 1991, Deep Bay Guidelines for Dredging, Reclamation & Drainage Work | | | |



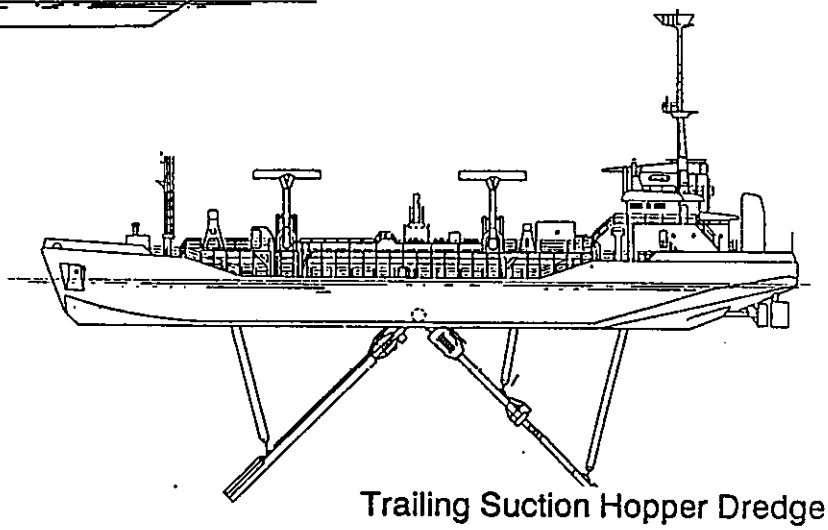

Cutter Suction Dredger




Bucket Chain Dredger




Grab Dredger



Trailing Suction Hopper Dredger

## Annex III Different Types of Dredgers

ERM Hong Kong

11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

ERM

4.1.2 Onshore Preparations and Shore Approach

The extent of onshore work is to a large extent dependent upon the selected method of shore approach installation.

There are two commonly used construction techniques available for installing the shore approach sections. They are:

- Pull ashore by land based winches from a moored lay vessel (onshore pull)
- Pull from shore by a moored lay vessel or pull barge (offshore pull)

Onshore pull

The onshore pull method is illustrated in Figure 4.1, which is potentially more applicable for the Hong Kong pipeline shore approach, because of the likely space limitation in the shore approach area.

This is the most common method of providing a land to sea pipeline transition, requiring a minimum amount of civil works. One or more large capacity winches, rigged with the pulling cable, are situated onshore at the landfall site. The lay vessel moors at a certain distance from the shore as shown in Figure 4.1, given the constraints of draft and anchor spread, to reduce the pull loads. As the vessel moves into position and the mooring operation progresses, welding is initiated and a pipe string is assembled along the welding line of the lay vessel. A pullhead is welded to the end of the string and the winch cable, which has been passed from shore, is connected via a shackle. Tension is applied at the shore based winch and the pipe string is pulled down the stinger (if required) into the suspended section, where curvature is controlled by tension from the winch cable and the deck mounted tensioners. As the pipe joints are progressively added, the pipeline pullhead touches down on the seabed and the winching operation continues until the pullhead reaches shore. It is envisaged that one or more bare joints of pipe is installed immediately behind the pullhead to provide a light leading edge. This

prevents the pullhead from digging into the seabed during the pull and eases the landing of the line on the beach. Once onshore, the pullhead is anchored allowing the lay vessel to lay away in the normal pipelay mode which will be described in Section 4.1.4 The shore winch may still be connected to the pullhead until a sufficient amount of pipe is laid on the seabed, such that there is adequate seabed friction mobilized to resist pipelay tension in the pipeline curve (Figures 4.2, 4.3 and 4.4).

Offshore pull

This method involves the fabrication of the shore approach pipe while onshore, and therefore requires the largest shore construction site. The pipe string, after onshore assembly, is pulled out by a pull or lay vessel moored closely inshore. This approach is more frequently used for the construction of limited length pipelines such as effluent outfalls, but is also applicable if scheduling requires concurrent offshore and shore approach construction, or if separate testing of the shore approach section is required.

The amount of site preparation work is dependent upon the selected method. Onshore preparations for the offshore pull method will require more extensive work than the onshore pull alternative. Construction requirements associated with each method are outlined in Table 4.1.

| ACTIVITY | OFFSHORE PULL | ONSHORE PULL |
|---|---|---|
| provision for vehicular access | yes | yes |
| site preparation | approx 200m** x 70m | approx 50m x 50m |
| winch base and back anchor | no | yes |
| hold back winch | yes | no |
| pipe storage area | yes | no* |
| string fabrication and storage area | yes | no* |
| pipe welding, NDT, and field jointing | yes | no* |
| site offices | yes | yes |

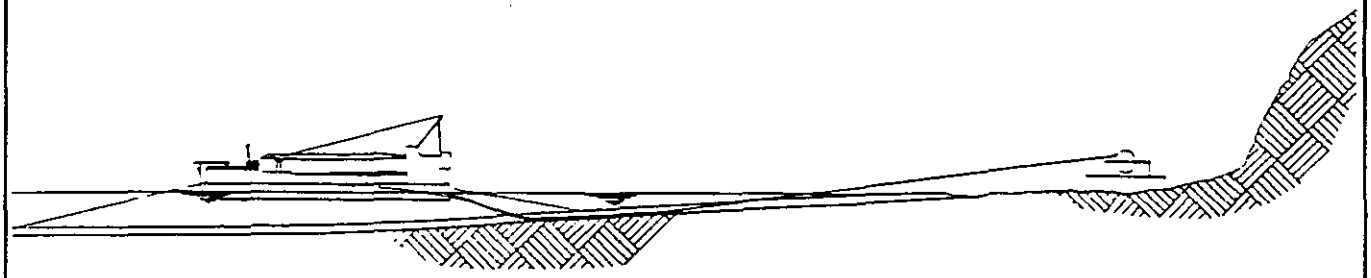
Table 4.1

ONSHORE CONSTRUCTION REQUIREMENTS

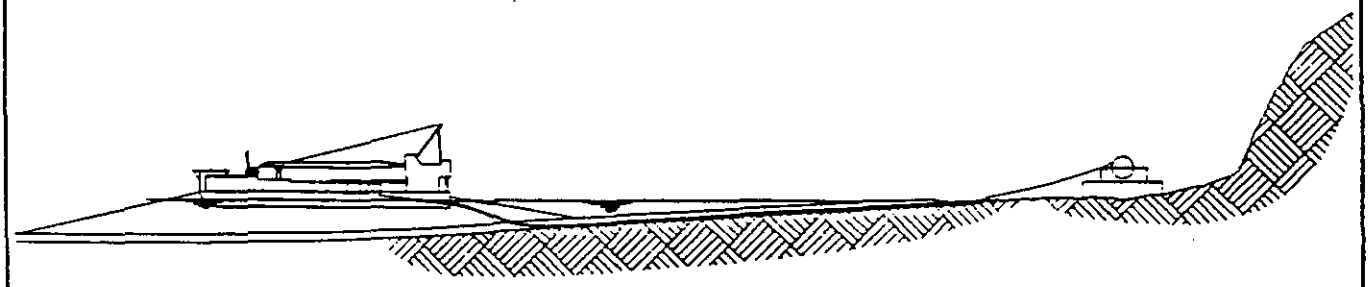
*These items will be required if there is an onshore section of pipeline to be installed

**length is a function of site area and length of pipe strings

PRE-TRENCH PIPELINE ROUTE

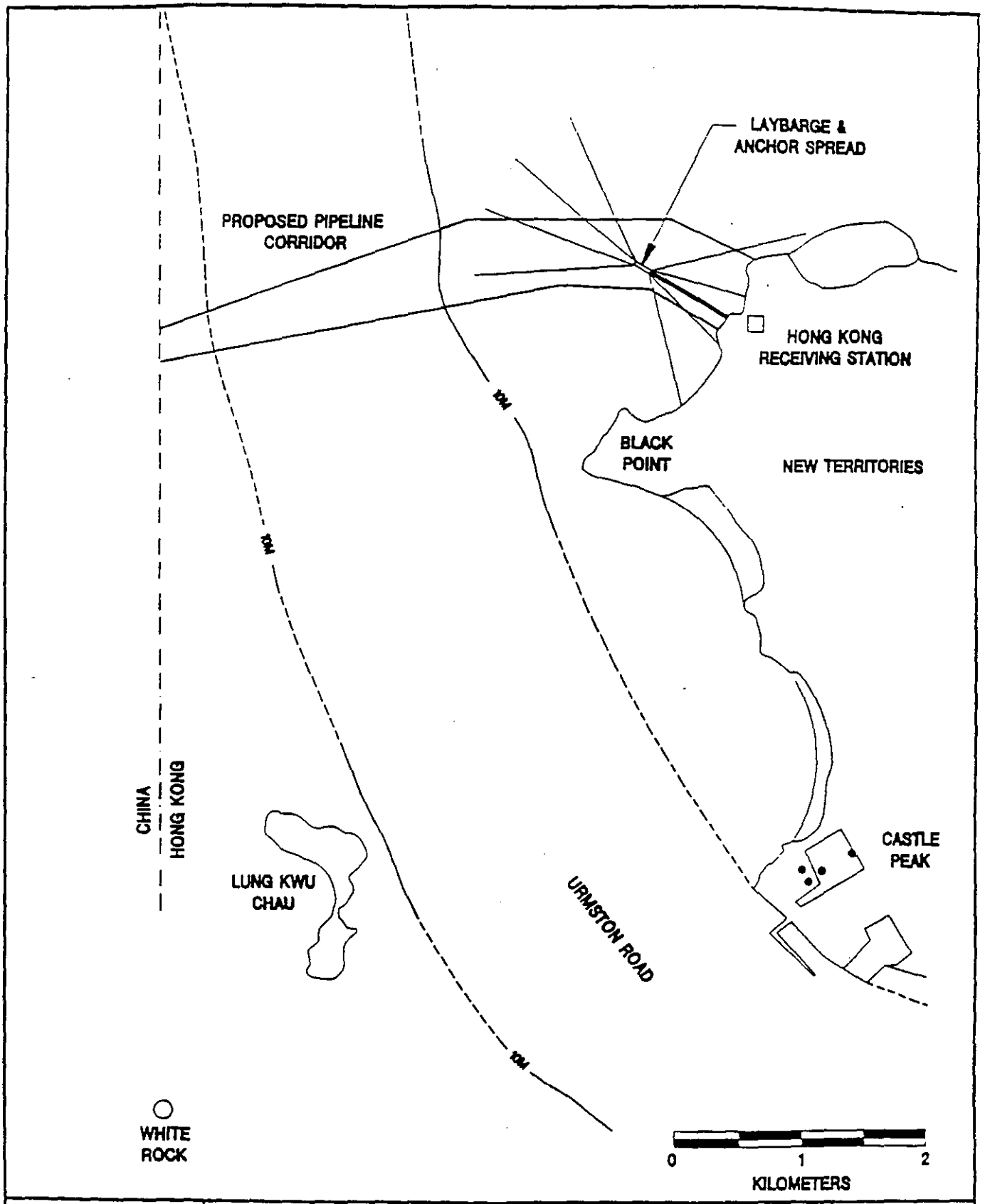


WELD PIPE JOINTS TOGETHER ON LAYBARGE, WHILE PULLING ONSHORE



ANCHOR PIPELINE ONSHORE, AND LAYBARGE LAYS AWAY FROM SHORE

| | | |
|---|---|---|
| J P KENNY JPK | CLIENT<br>ARCO China, Inc.<br>YACHENG 13-1 GAS PROJECT PIPELINES | JOB NO.<br>4957 |
| | ONSHORE PULL METHOD | FIGURE NO.<br>4.1 |




J P KENNY

CLIENT

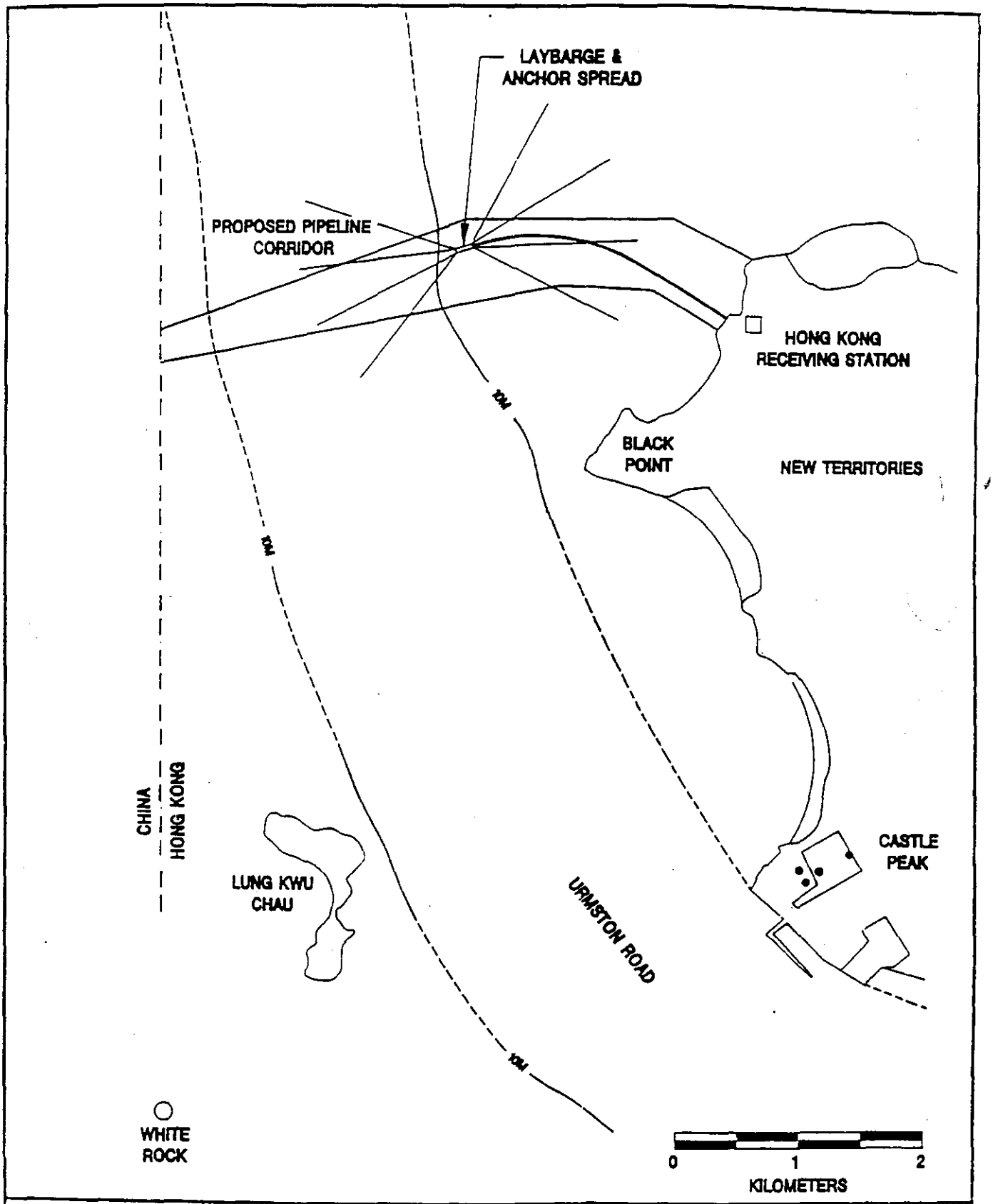
ARCO China, Inc.

YACHENG 13-1 GAS PROJECT PIPELINES

JOB NO. 4957

PIPELINE LAYBARGE INITIAL POSITION

FIGURE NO. 4.2




J P KENNY

CLIENT

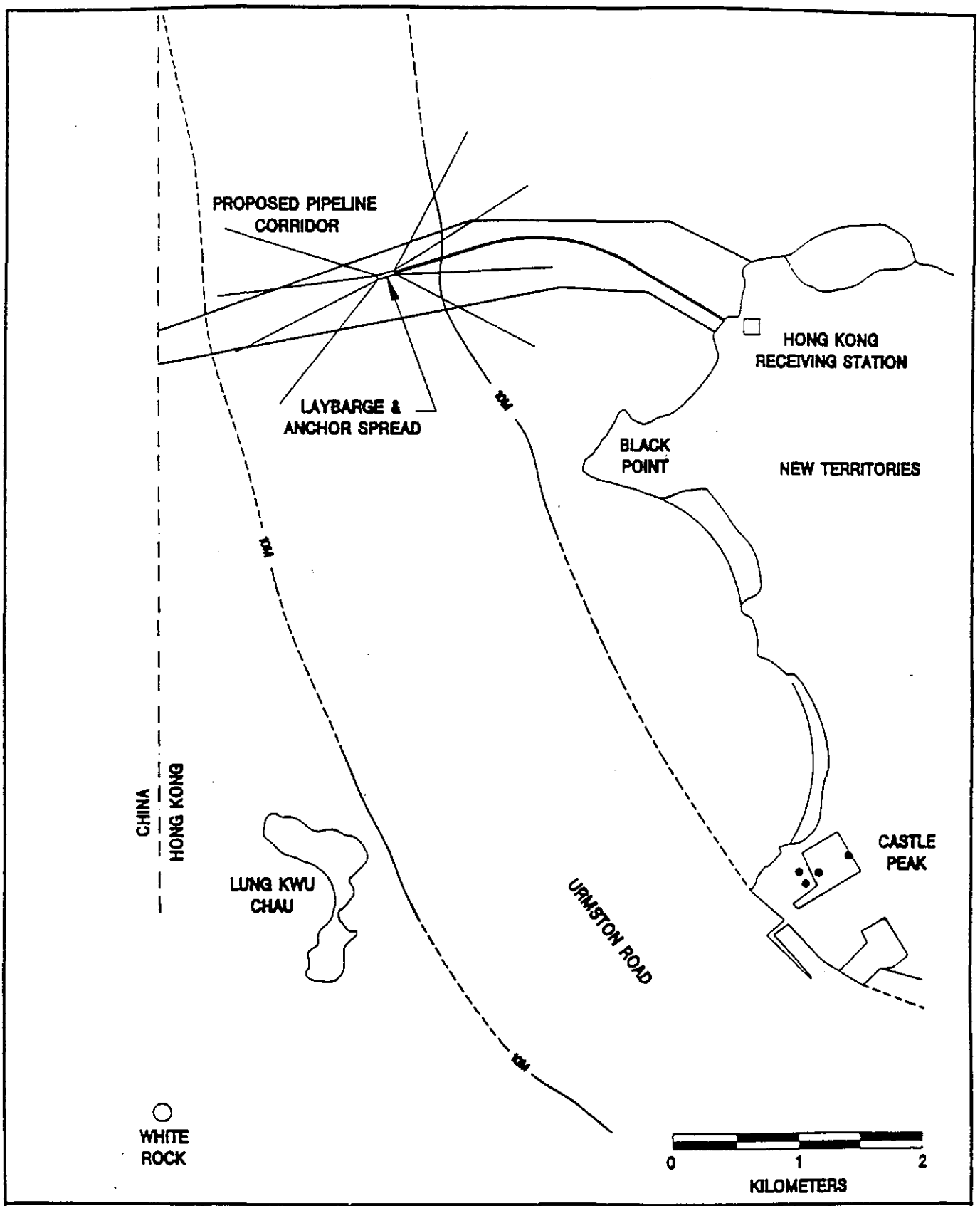
ARCO China, Inc.

YACHENG 13-1 GAS PROJECT PIPELINES

JOB NO. 4957

PIPELINE LAYBARGE POSITION 1

FIGURE NO. 4.3




J P KENNY

CLIENT

ARCO China, Inc.

YACHENG 13-1 GAS PROJECT PIPELINES

JOB NO. 4957

PIPELINE LAYBARGE POSITION 2

FIGURE NO. 4.4

4957070 02/08/93

4.1.4 Pipelay

Once the shore approach has been established the installation of the remaining position of the sub-sea pipeline can be achieved by conventional pipelay. This method is described below:

Offshore pipeline installation by a lay vessel is considered to be suitable for Hong Kong pipeline in both deep and shallow waters. Lay vessels are basically floating pipeline welding and installation facilities, which make up and simultaneously lay a pipeline on the seabed at the desired location. A typical pipeline configuration during the laying operation by a lay barge is illustrated in Figure 4.5. It should be noted that the extremely shallow waters in Hong Kong and PRC waters of the Pearl River Basin may require the use of a specialist vessel for this contract. However it is expected to have the same features as described below.

In general, all lay vessels have the following in common:

- Anchor spread
- Fabrication facilities
- Tensioners
- Stinger

Anchor spread

The primary purpose of the anchor spread is to maintain the lay vessel position so the pipeline can be laid along the prescribed route. The forward movement (pipe pull) is achieved by simultaneously reeling in or paying out the front and rear anchor cables. Lay vessels are normally equipped with 12 or 18 anchors (see also Section 4.3).

Fabrication facilities

Fabrication facilities encompass all pipe handling and pipeline make-up equipment, from offloading of pipe from a pipe haul vessel to the final field joint coating station. Typically, the facilities include the following:

- Craneage
- Pipe storage racks
- Conveyors and rollers to take the pipe joints to the welding stations (firing line)
- Welding units including end-prep machines and pre-heat
- Pipe alignment equipment
- Inspection/Q.A. units
- Field joint coating equipment

Tensioners

Pipe tensioners control the catenary profile of the pipeline during the laying operation, thereby offering control of the sagbend stresses. This is achieved by applying a positive tension to the pipeline on the lay vessel.

Stinger

The stinger is one of the most important features of a lay vessel. Its purpose is to support the pipe in the overbend as it leaves the barge, such that the bending stress is kept at an acceptable level. Basically, stingers are rigid or articulated structures containing roller pipe supports set at a prescribed radius.

A stinger may not be required, due to the shallow water depths of the Hong Kong harbor area.

## 3.2 PLOUGHING

### 3.2.1 Introduction

Plough development has concentrated on methods of locating the Plough Share under or around the pipe and in controlling its direction while leaving basic design principles unchanged. In general, the width and depth of a ploughed trench for a specified pipeline are functions of the type of soil and the pull force exerted. The pipeline plough is normally designed to cut a trench with a side slope matching the natural angle of repose of the soil. This slope controls the volume of soil to be removed which, together with the shear strength and density of the soil, greatly influences the magnitude of the required pull force.

Two main types of plough exist, those which are towed directly by a surface vessel, and those which are self-propelled using a suitably designed subsea traction system, requiring a surface vessel only for monitoring and power supply purposes.

### 3.2.2 Towed Ploughs

Towed ploughs have been used extensively for trenching of pipelines. These ploughs evolved in the mid-1970s from pre-lay trenching systems. The majority of these ploughs have been custom built for one application to suit specific soil conditions and pipe diameters, and hence may not be directly suitable for other applications. A small number of companies, however, specialise in pipeline trenching and have developed towed ploughs which are suitable for trenching a range of pipeline sizes in different soil conditions and water depths.

With the development of post-installation ploughing it has become necessary to ensure that the pipeline will not be damaged during the deployment and trenching operations.

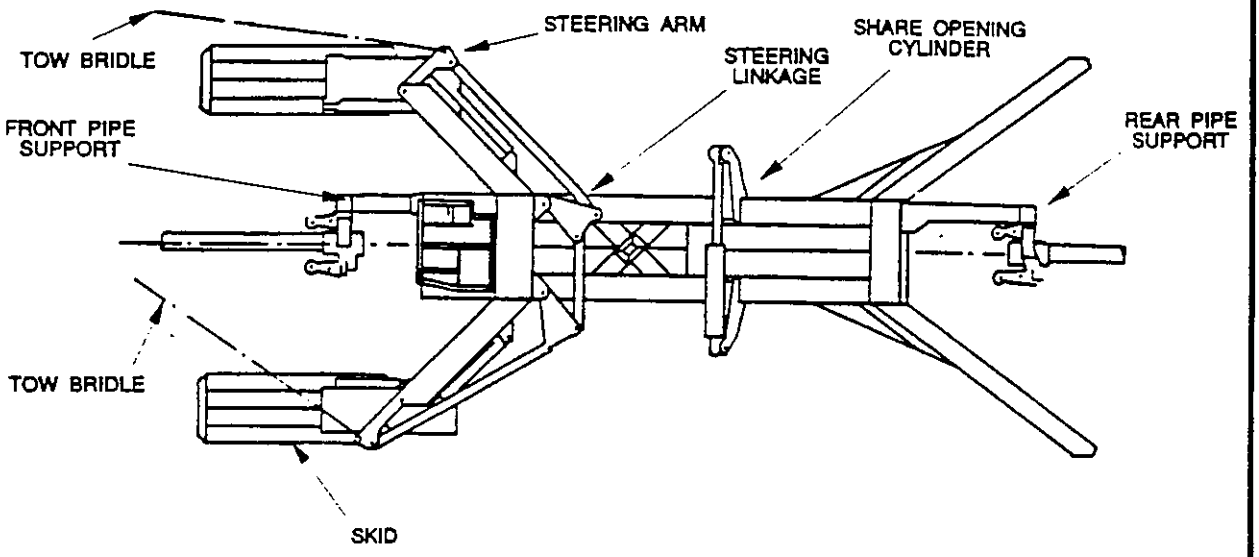
Therefore, all currently available subsea ploughs are fitted with monitoring equipment, in the form of video cameras and/or proximity sensors, which are used to assist the control of forces applied by the plough's rollers to the lines being trenched. There is therefore little likelihood of damage occurring from impact, abrasion or excessive bending during ploughing operations.

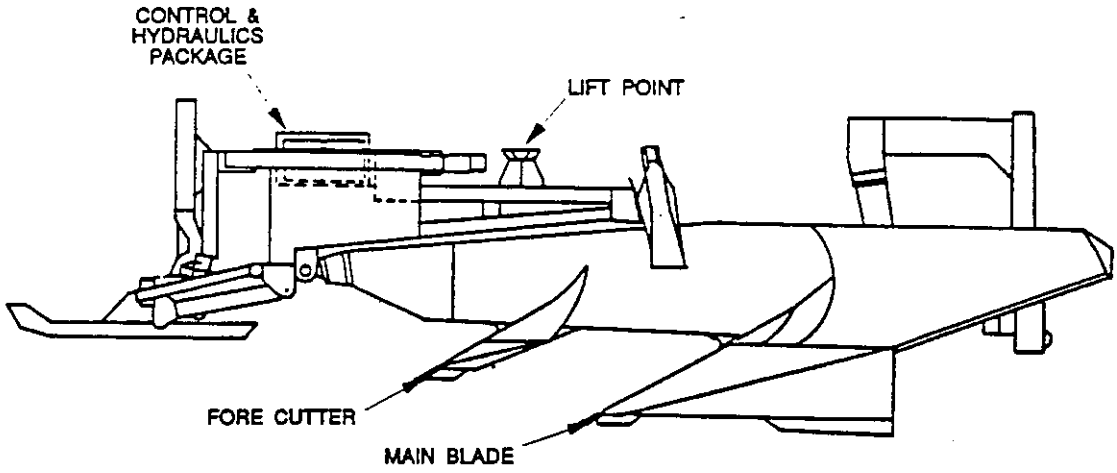
A typical advanced, new generation towed plough is shown in Figure 3.1 and was designed for trenching pipelines of up to 1200mm diameter to depths of 1.8m below natural seabed level. The plough is designed to operate in water depths up to 1000m and produces a 35° vee shaped trench at plough speeds of up to 1000m/hour. The plough features a forecutter that reduces tow forces in non-cohesive materials by the order of 20% and variable skid elevation which enables control of trench depth. The plough is constructed from hollow section, high yield steels to permit extreme pull loads (250t) for minimum plough weight (85t). This low weight allows the plough to be launched and supported from any dynamically positioned monohull vessel fitted with a 100t A-frame at the stern.

The plough geometry maximises the separation distance of front pipe roller support and bridge to allow greater freedom in pitch. This allows the plough to compensate for seabed irregulations that would otherwise be reflected in the trench profile. The plough share is provided with a 600mm box section at its base so that the trench configuration will facilitate lateral movement of hot flowlines rather than vertical excursion up the trench wall.

Modular towed plough systems also exist which have been developed for a variety of subsea burial operations, such as:

- simultaneous lay and burial of cable or umbilical; and
- post-lay burial of cable, umbilical and pipe.




1/10/92

JPK 0119 CDR

J P KENNY

JPK

| | | |
|---|---|---|
| CLIENT: COMPANY STANDARD GUIDELINES | | JOB No. 8150.41 |
| TITLE: TOWED PLOUGH - ADVANCED PIPELINE PLOUGH | | FIG No. 3.1 |

These modular ploughs comprise a control system and a single plough frame to which cable or pipe handling shares are attached according to the task required. The modular ploughs can be configured as cable or pipeline ploughs either on shore or at the worksite, allowing joint trenching operations to be undertaken within a single mobilisation.

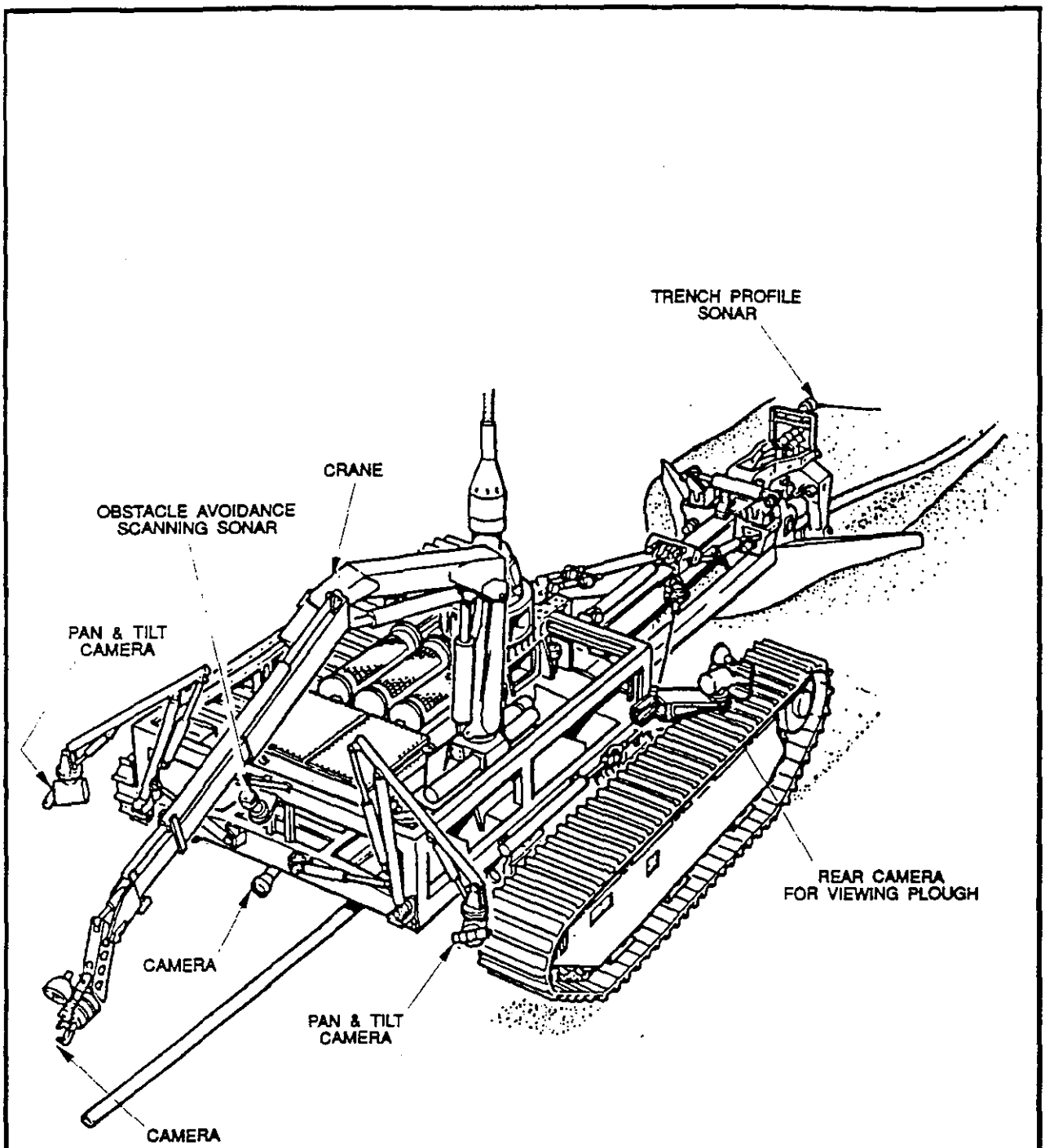
### 3.2.3 Self-Powered Ploughs

The provision of a tow vehicle on the seabed greatly increases the mobility of the machine and provides direct steering capabilities. The benefits become more apparent as operational water depths increase and "soft" steering control from a long tow cable is no longer satisfactory because the tow vessel has to make large deviations from its route to make directional adjustments to the plough. An example of a system used extensively in the North Sea but currently withdrawn from operation is described below in order to outline this trenching method.

The Marine Trenching System, which is shown in Figure 3.2(a), has been used for the trenching and backfill of small diameter flowlines in a wide variety of soil conditions. For trenching pipelines, the vehicle was fitted with an integral high efficiency plough which cut trenches to a depth of between 0.6m and 1.0m.

Engagement with the flowline was effected by separating the plough shares and lifting the flowline into the plough body be means of pipelift rollers [See Figure 3.2(b) (i)]. When closed, the plough fully supports the flowline. The plough has been used to trench flowlines with concrete, epoxy and thermal coatings and with nominal bores of between 3 and 12 inches. The plough also trenched flexible and bundled flowlines.

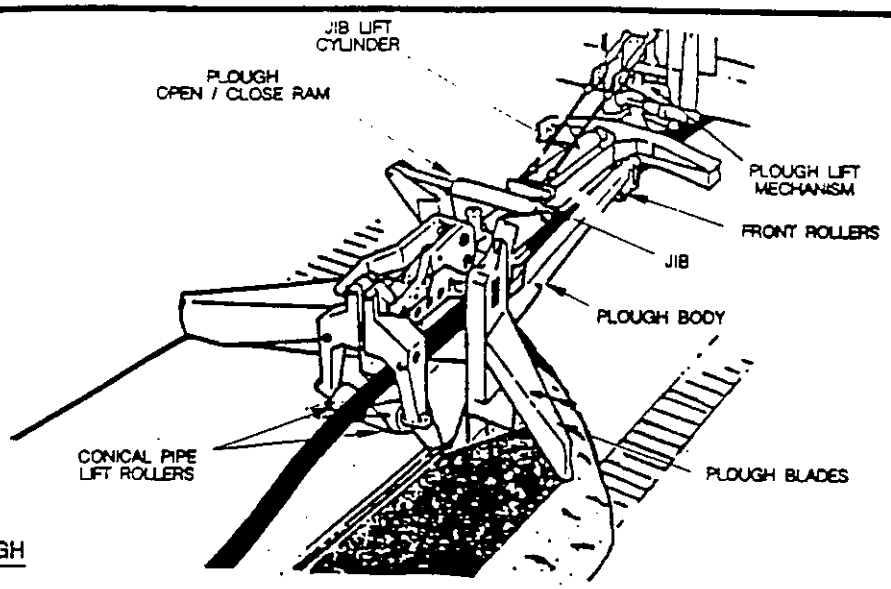
The vehicle was launched using an A-frame structure having a hanging lift frame which was damped for both pitch and



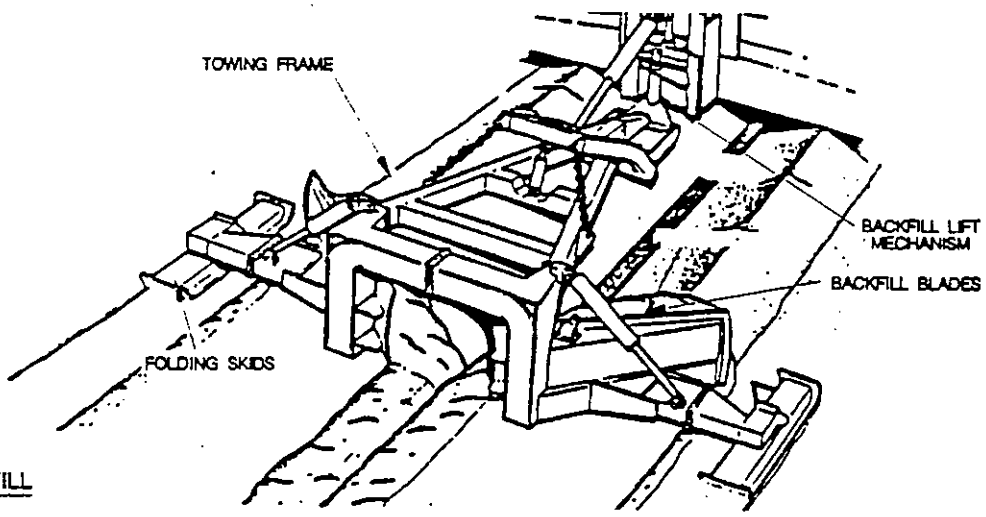

| | | |
|---|---|---|
| J P KENNY JPK | CLIENT: COMPANY STANDARD GUIDELINES | JOB No.: 8150.41 |
| | TITLE: MARINE TRENCHING SYSTEM | FIG No.: 3.2a |

1/10/92

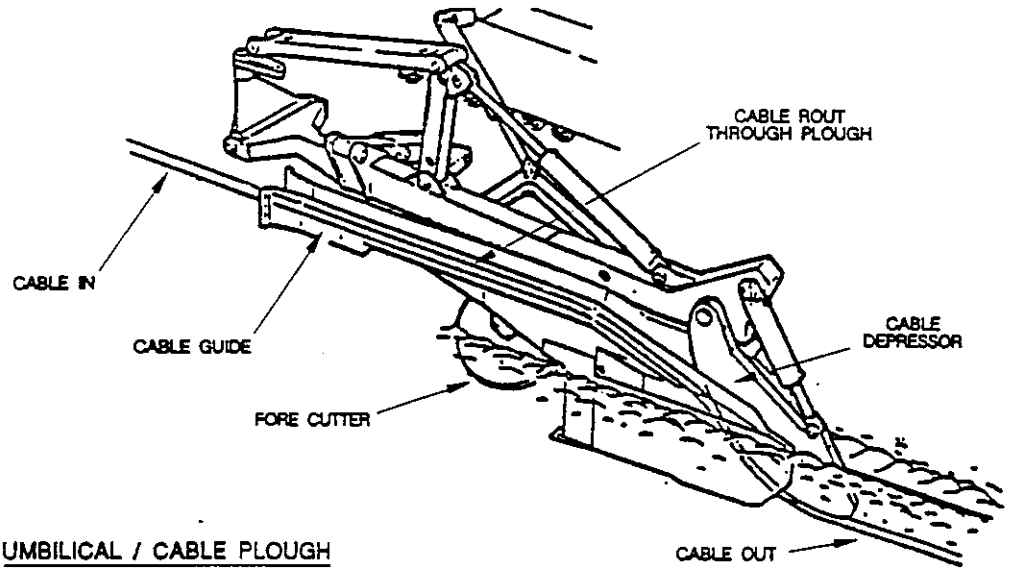
JPK 0120.CDR




FLOWLINE PLOUGH




BACKFILL




UMBILICAL / CABLE PLOUGH

1/10/92

JPK 0121.CDR

| | | |
|---|---|---|
| J P KENNY JPK | CLIENT: COMPANY STANDARD GUIDELINES | JOB No. 8150.41 |
| | TITLE: SELF POWERED PLOUGH - MARINE TRENCHING SYSTEM | FIG No. 3.2b |

roll. The launch and recovery of the vehicle was carried out from a single control area by one operator and could be effected in seas up to 3m.

A trench backfill system was available to infill the trench produced by the flowline plough [See Figure 3.2(b) (ii)]. It was mounted on to the vehicle common tool point and backfill was achieved by recovering the spoil from the lip of the trench during a second pass.

The system was designed and built by UDI in 1982 and trenched over 24 infield flowlines, 11 of which required backfill. The system also installed and buried over 50 umbilical cables in the North Sea [See Figure 3.2(b) (iii)].

## 3.3 MECHANICAL CUTTERS

### 3.3.1 Introduction

Many concepts for mechanical trench cutting machines have been devised for the lowering of offshore pipelines. Preliminary designs were investigated in the early 1970s as an alternative to trenching ploughs. There are three basis concepts used for the cutting tool:

- a wheel or drum with cutting teeth;
- a cutting head or crown which is combined with a suction facility for spoil removal; or
- a cutting chain fitted with buckets and/or teeth.

Wheel or drum cutter mechanical trenchers have been developed, primarily, for the burial of cables and flexible lines. They are ideally suited to cutting through rocky soils and have been mainly used for such areas. This is ideal for rocky conditions but is not suited to sandy soils

where the trench would collapse before the pipe could touch the bottom.

In general, the cutter type of trencher is especially suited to excavating in hard soil conditions. However, some have been devised for softer cohesive and non-cohesive soils.

### 3.3.2 General System Description

It should be noted that of the thirty or forty trench cutter designs conceived for pipeline trenching, only a small number have reached a stage of commercial use or detailed development. They all use a chain cutting technique and all the machines are designed to undercut the pipeline which is held above the cutters to avoid damage. The pipe then falls into the trench behind the cutter.

The mechanical trench cutting systems developed for commercial use consist of a series of mechanical cutters mounted on a tracked vehicle which is propelled along the seabed either by electrically or electro/hydraulically driven crawler tracks. Power and control are supplied from the surface support vessel via an electro/hydraulic umbilical.

Tracked vehicles can experience problems with finding sufficient traction on soft seabeds, or where the bottom is uneven, rocky or steep. As with all track-driven machines, weight is required for traction and the pull force that can be exerted may be limited not by the power of the motor and its transmission system, but by loss of traction. The machines can be fitted with different track widths to adjust for the bearing capacity of the soil.

In soft soil conditions the tracks can be fitted with grousers (a series of vertical plates attached to the track chains) in order to aid vehicle movement and reduce track slippage. Track slippage in soft soils can cause the

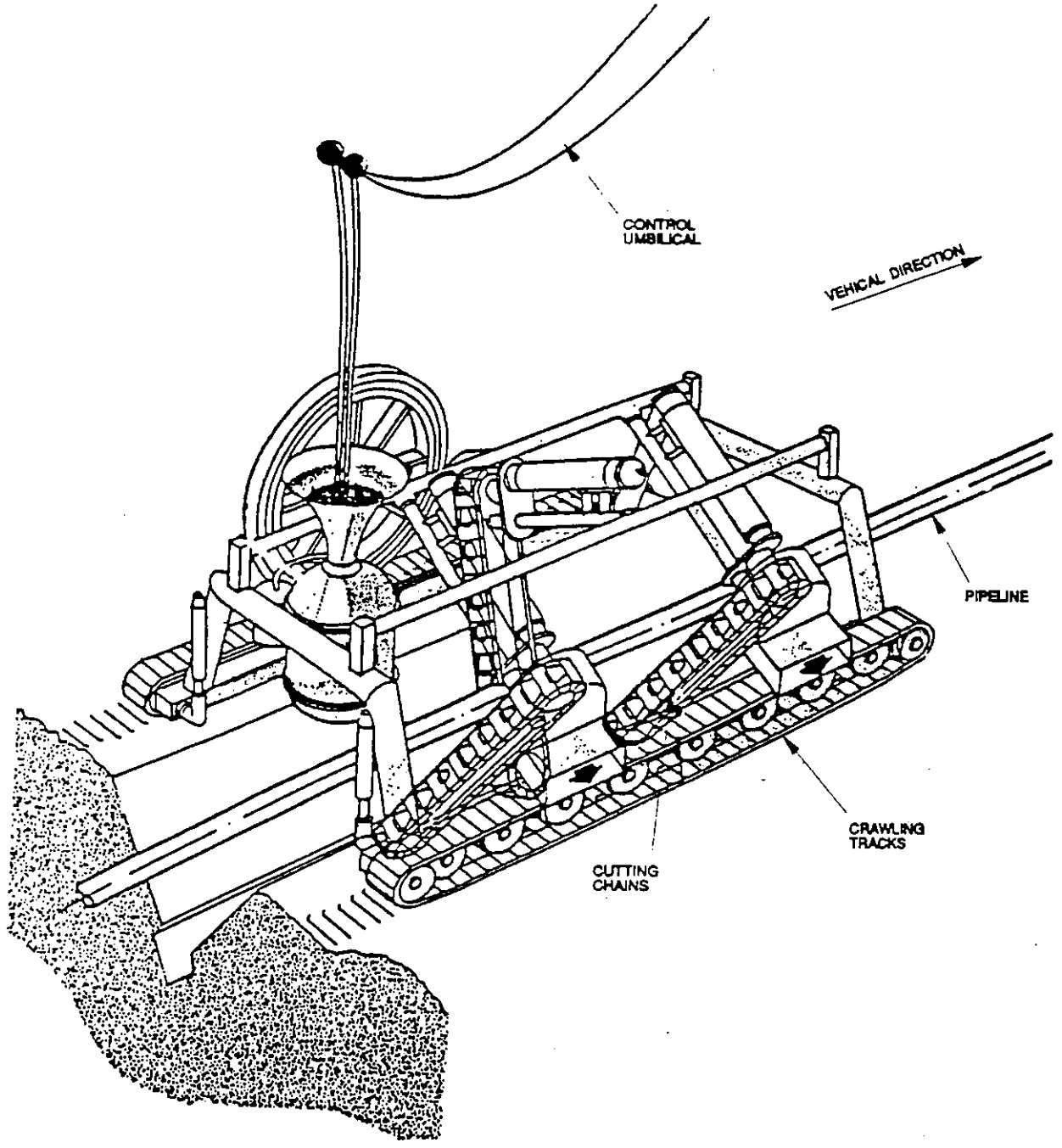
vehicle tracks to dig themselves into the seabed which increases the risk to the pipeline and requires the vehicle to be lifted off the pipeline and re-deployed. Any redeployment of the vehicle will result in a section of pipeline that will require remedial burial.

All machines are provided with a system for providing additional ballast or buoyancy and so adjust the submerged weight to suit varying soil conditions and to assist deployment and removal activities. To avoid damaging the pipelines, the machines are equipped with sensors which carefully monitor the vehicle position and the loadings transmitted to the pipe.

All machines are intended to be remote controlled although, with some concepts, diver intervention is an additional option which may prove useful in certain circumstances.

A typical arrangement for a vehicle-mounted mechanical cutting system is shown in Figure 3.3. The cutting system can comprise any number of cutting chains, although 3 or 4 would be typical. The vehicle straddles the pipeline and moves forward with the lifting arms positioned around and below the pipeline. The set of chain cutters cut out the soil below the pipeline allowing the pipe to span into the trench so that no pipeline/trencher contact occurs. A cutting sequence is depicted in Figure 3.4. In soil conditions containing boulders, damage can occur to the cutting teeth which necessitates regular vehicle recovery to the support vessel to allow replacement of the cutting teeth.

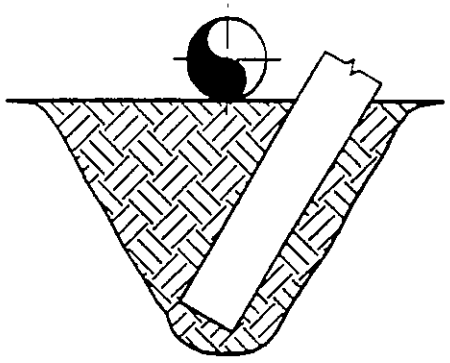
Pipeline tracking is achieved by sonar, magnetic sensors situated fore and aft, and video cameras positioned at critical locations on the vehicle. Forward movement of the trencher is either directly controlled from the surface control centre or else the vehicle can progress with automatic pipe tracking and a surface override. Any



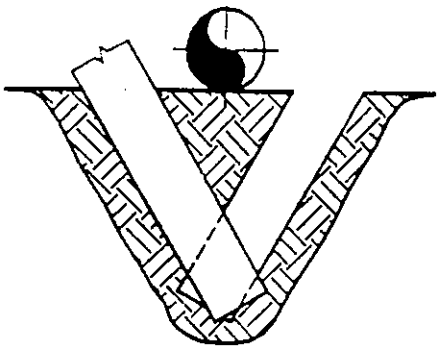

| | | |
|---|---|---|
| J P KENNY JPK | CLIENT: COMPANY STANDARD GUIDELINES | JOB No. 8150.41 |
| | TITLE: TRACKED MECHANICAL TRENCHER | FIG No. 3.3 |

1/10/92

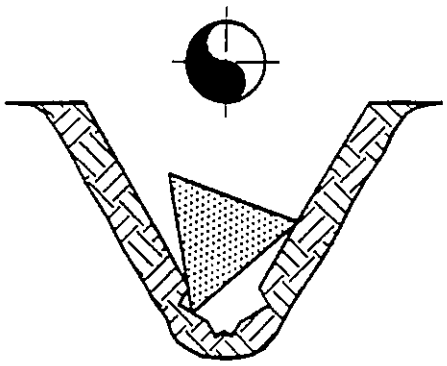
JPK-0122.CDR



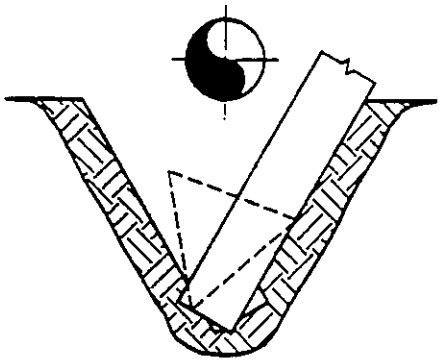
FIRST CUT BY CHAIN No. 1



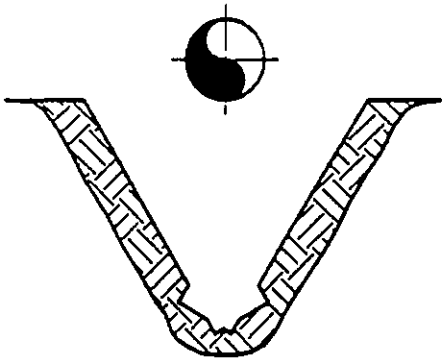
SECOND CUT BY CHAIN No. 2



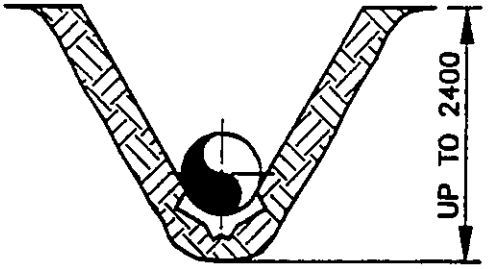
SOIL UNDER PIPE DROPS
TO BOTTOM OF TRENCH



TRENCH CLEARED BY
CHAIN No. 3



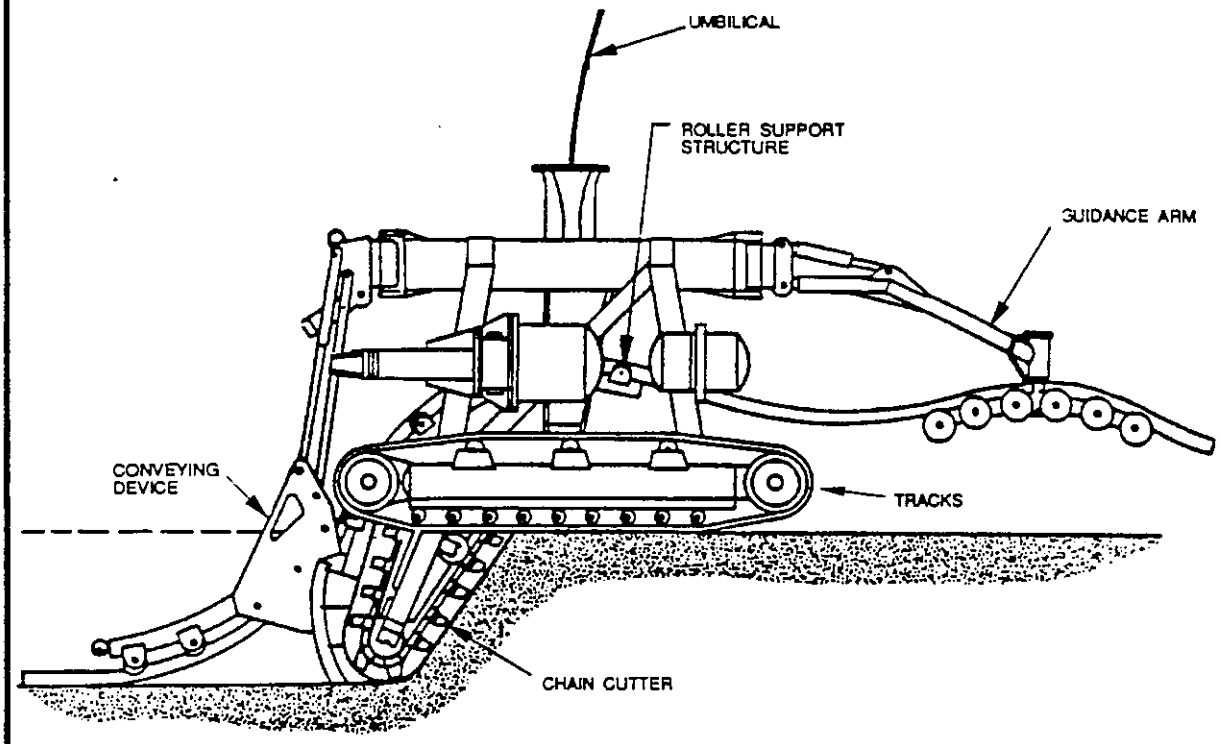
FINAL TRENCH PROFILE




FINAL POSITION OF
PIPE IN TRENCH

| | | |
|---|---|---|
| J P KENNY JPK | CLIENT: COMPANY STANDARD GUIDELINES | JOB NO. 8150.41 |
| | TITLE: MECHANICAL CUTTING PROCESS | FIG. NO. 3.4 |

A1-0030.DWG




1/10/92

JPK-0123.CDR

J P KENNY

| | | |
|---|---|---|
| CLIENT | COMPANY STANDARD GUIDELINES | JOB No. 8150.41 |
| TITLE | FLEXIBLE/CABLE/UMBILICAL TRENCHING VEHICLE | FIG No. 3.5 |

pipeline contact can be prevented, and the pipeline integrity ensured, by proximity switches mounted on the digging arms which, if activated, cause cutter shutdown. The trencher is orientated over the pipeline with rotational control provided by thrusters. Most commercial mechanical trenching systems are regularly deployed from a dedicated support vessel. However, they can be mobilised from any vessel which meets the support and positional requirements, and has a suitable handling system.

A small number of companies operate remote-controlled, self-propelled trenching vehicles designed to bury previously laid flexible pipe, cable and umbilical. A configuration of one such machine is shown in Figure 3.5. The digging of the trench is carried out by chain cutters, and the flexible pipe or cable is picked up from the seabed to pass through the machine on rollers and to be laid down behind the cutter in the newly-cut trench. These flexible cable and umbilical trenching machines are generally smaller than the pipeline trenchers. However, trencher control systems and operating procedures are very similar. These smaller machines tend not to be deployed from dedicated vessels but can be mounted on any vessel that has the required lift capacity and incorporates heave compensation.

## 3.4 JETTING

The lowering of subsea pipelines by the use of high pressure water jets mounted on a steel sled is a well established procedure. The technique and equipment configuration of a basic jet sled is, typically, like the vertical claw arrangement illustrated in Figure 3.6.

In operation the standard configuration jet sled straddles the pipeline and a claw containing the water jets projects below each side of the pipeline. Immediately behind each claw, an entraining or suction tube is provided to remove the material loosened by the jets and to expel it, via an

eductor, to form the required trench. As the sled is pulled along the pipeline to form the trench, the pipeline span behind it lowers and settles to the trench bottom under its self weight. This span is sometimes monitored by a monitoring and control system.

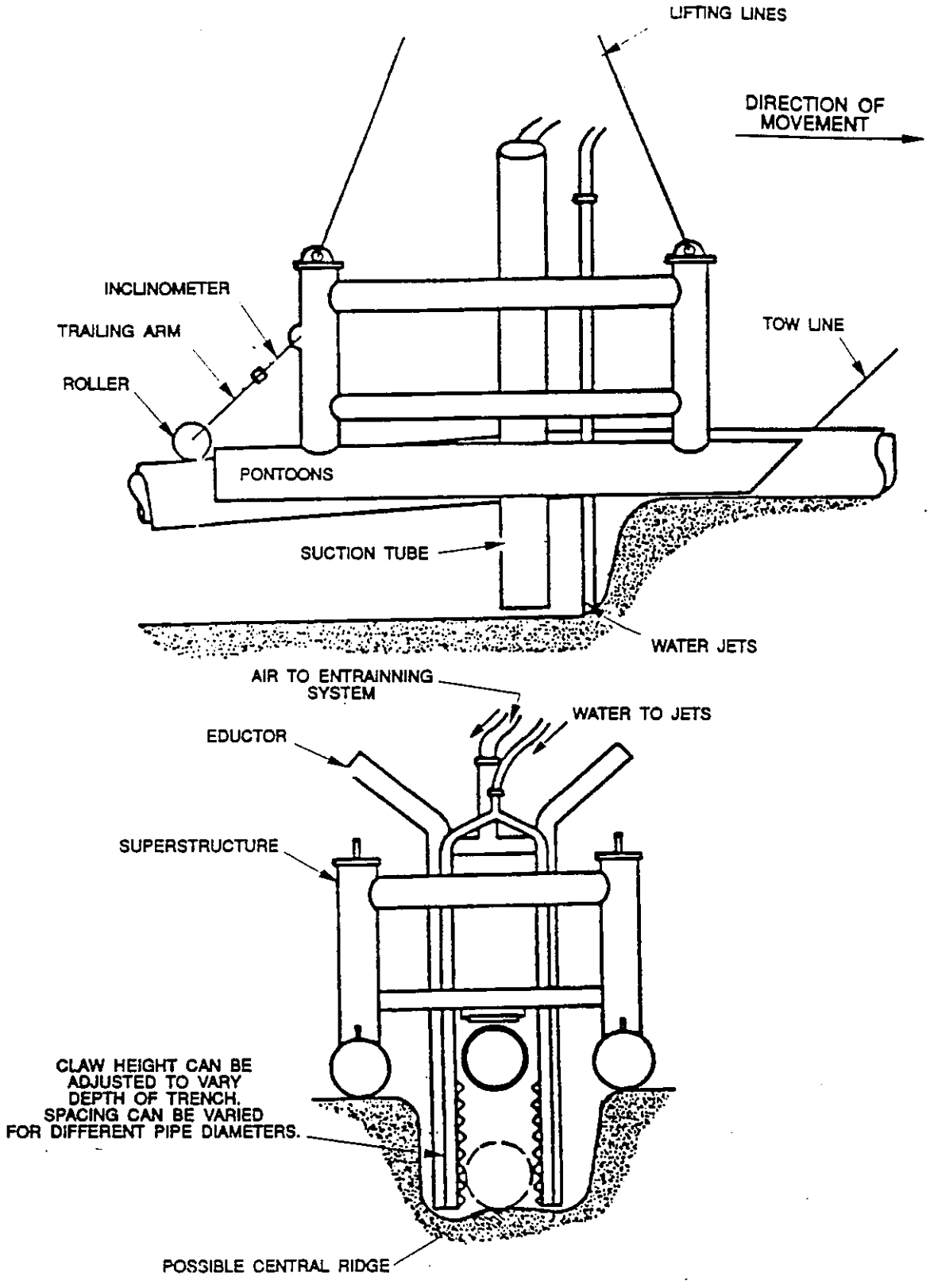
The configuration of the trench can be varied by adjusting the position of the claws and by altering the towing speed. A reduction in towing speed increases the overall size of the trench.

High pressure jetting machines have operated for several years, particularly in the North Sea and Gulf of Mexico. The technique has been demonstrated to lower pipelines of widely varying diameter in a range of soil types.

The jets and eductor system are mounted on the jet sled which is towed along the pipeline by cable or chain from a surface support vessel. This vessel also provides the pressurised water/air entraining streams, and any power and monitoring systems necessary to operate the sled, via umbilicals. The water pumping system to supply the jets is normally capable of supplying up to 5,500 $m^3$/hr at 17.2 $MN/m^2$ (2,500 psi). An air compressor of up to 13,500$m^3$/hr to supply the entrainment/eductor system is typically provided. Various monitoring systems may be mounted on the jet sled to assist control and reduce the risk of pipeline damage.

Typical trenching sleds weigh between 50 and 90 tonne in air, but submerged weight is easily adjusted to that required by means of ballast or buoyancy. The support vessel is equipped with a handling spread for the jet sled and may require multiple anchors for positional control and forward movement.

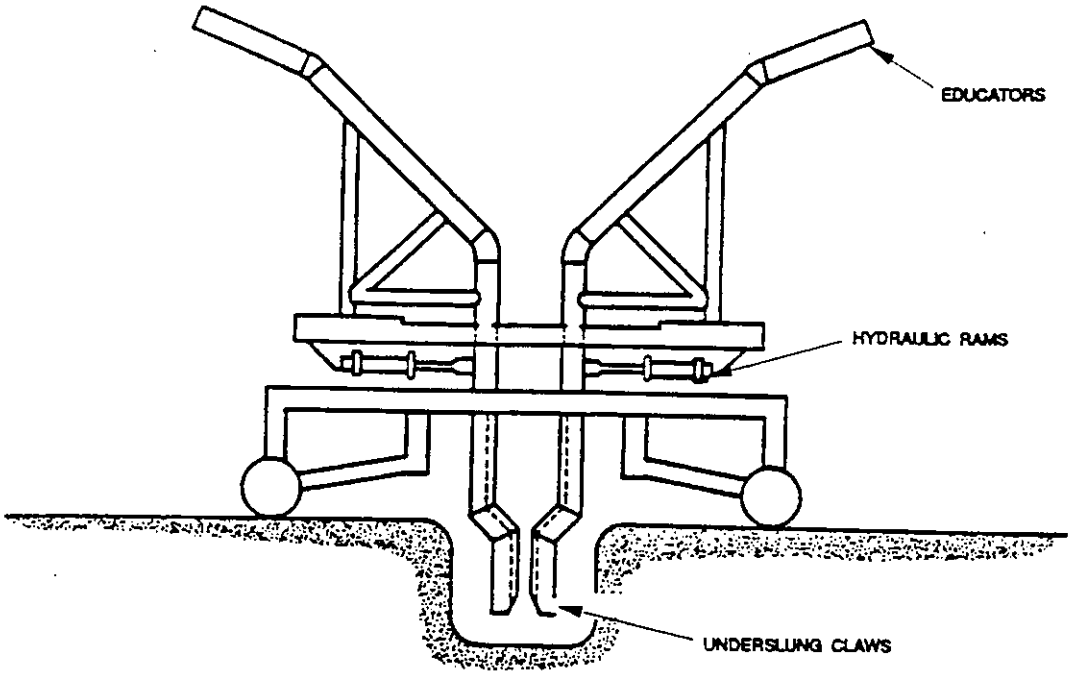
An adaption of the conventional high pressure jet sled to improve performance is the "underslung" claw (Figure 3.7).

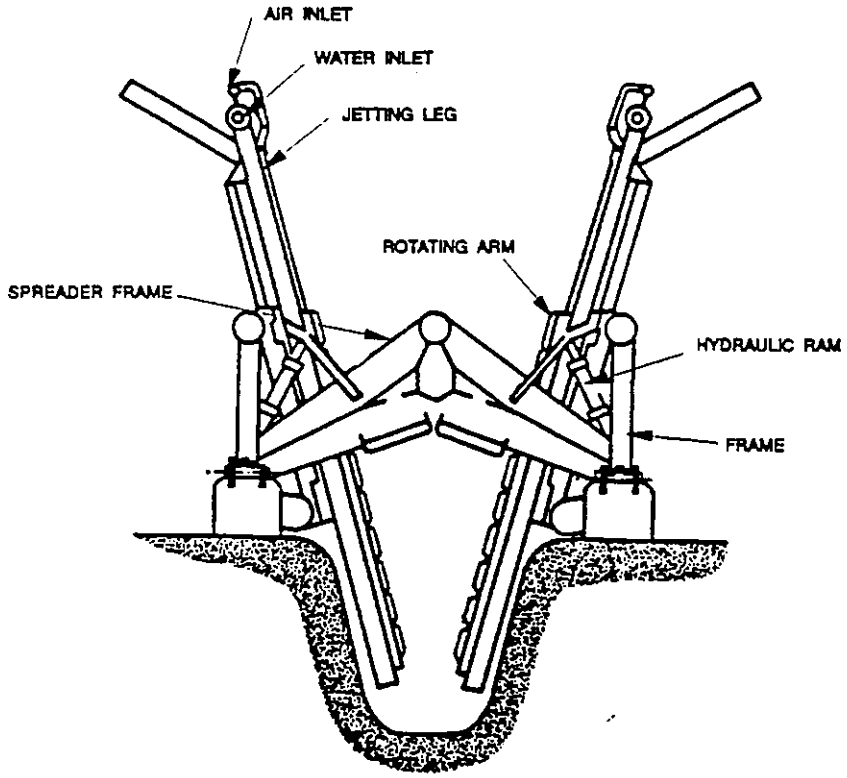



| | | |
|---|---|---|
| J P KENNY JPK | CLIENT: COMPANY STANDARD GUIDELINES | JOB No. 8150.41 |
| | TITLE: STANDARD CONFIGURATION OF HIGH PRESSURE JET SLED | FIG No. 3.6 |

1/10/92

JPK-0124.CDR




| | | |
|---|---|---|
| J P KENNY JPK | CLIENT: COMPANY STANDARD GUIDELINES | JOB No. 8150.41 |
| | TITLE: TYPICAL UNDERSLUNG CLAW CONFIGURATIONS | FIG No. 3.7 |

1/10/92

JPK 0125.CDR

Underslung claws close hydraulically under the pipeline reducing the trench width necessary for any given depth and eliminating the central ridge sometimes left by the vertical claw arrangement. Reducing the trench width can halve the quantity of material to be removed, and hence increase possible trenching rates, at the cost of some increased machine complexity. The risk of pipeline damage in the event of the jet sled attempting to jump, or to be dragged, off the pipe is correspondingly greater.

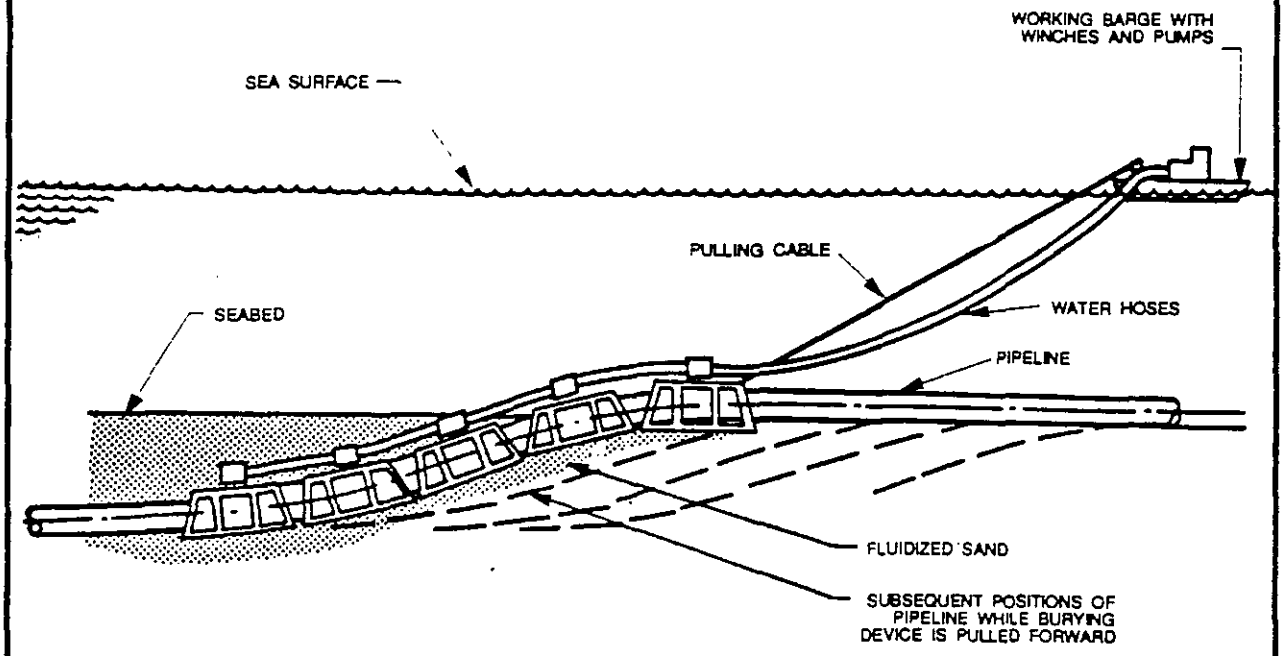
## 3.5 FLUIDIZATION

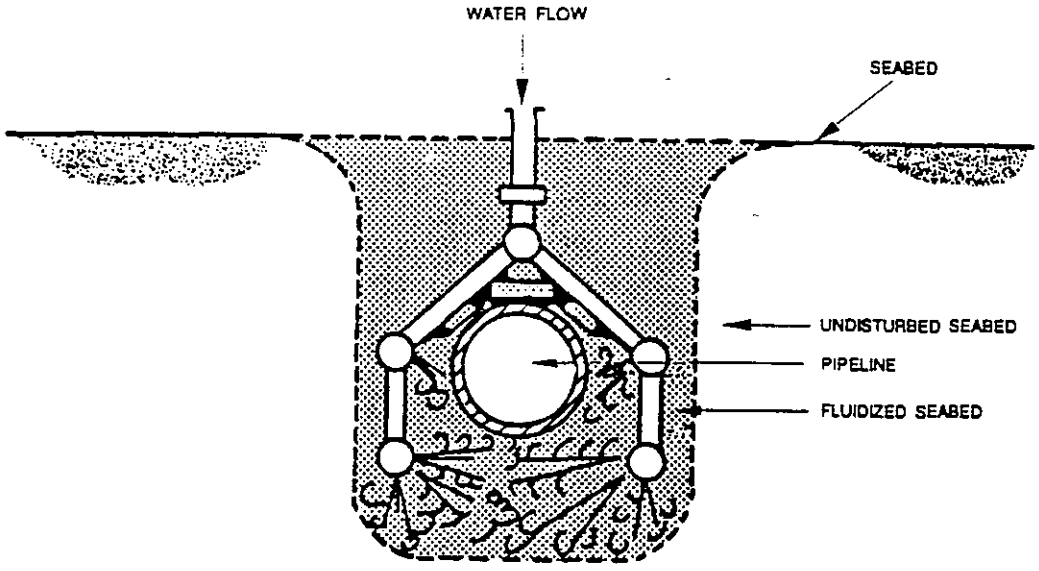
The fluidization technique has been developed as an alternative to lowering the pipeline by trenching. Burial is achieved by jetting water into the soil to liquefy it below the pipe. When sufficient length of the seabed is fluidized in this way the overlying pipeline sinks to the bottom of the fluidized layer under its own weight.

To liquefy a length of pipeline adequate to allow it to settle through the soil, a series of jets, installed in a long, articulated steel framework, are used. This arrangement, referred to as a "fluidization train", can be up to 100m long. To avoid overstressing the pipe whilst achieving efficient burial, the fluidization train length is critical and varies both with pipeline configuration and soil conditions.

The complete train straddles the pipeline and is towed along it by a surface vessel which also supplies the water and any necessary monitoring systems, via an umbilical. The main advantage of this method is the simultaneous lowering and covering of the pipeline. Figure 3.8 illustrates the above method.

To date, fluidization has been used to bury several subsea pipelines, totalling about 60km. These operations have taken place in shallow waters where depths have not exceeded




| | | |
|---|---|---|
| J P KENNY JPK | CLIENT: COMPANY STANDARD GUIDELINES | JOB No. 8150.41 |
| | TITLE: TYPICAL FLUIDISATION CONFIGURATION | FIG No. 3.8 |

1/10/92

JPK:0126.CDR

30m, and only in areas with sandy soils. Pipe sizes buried range from 4-inch to 36-inch and cover of between 0.9m and 4.5m has been achieved in a single pass. The method shows considerable promise as an effective way to bury pipelines in a single operation should soil conditions be suitable. The method was originally intended for burial of pipes in non-cohesive materials only, but it can work in soft silts and clays in addition to purely cohesionless materials. To date, the technique has not been used in deeper water, and therefore limited experience is available regarding fluidization train length requirements and the general handling of this equipment.

Annex IV

# Marine Department Requirements

*Annex IV – Marine Department's Requirements For Pipeline Installation*

2. Regulations

All vessels and craft provided or used for the construction of the Works shall comply with all the relevant regulations and requirements of the Marine Department, including the following:-

(a) The Shipping and Port Control Ordinance (Cap 313);

(b) The Shipping and Port Control Regulations 1978;

(c) The Merchant Shipping (Miscellaneous Craft) Regulations;

(d) The International Regulations for Preventing Collisions at Sea;

(e) The Dangerous Goods Ordinance (Cap 295);

(f) The Dangerous Goods (Shipping) Regulations (Cap. 295);

(g) The Merchant Shipping (Launches and Ferry Vessels) Regulations (Cap 281);

(h) The Pilotage Ordinance (Cap 84);

(i) The Merchant Shipping Ordinance and Regulations (Cap 281).

3. Communications

The Contractors shall maintain communication with the Vessel Traffic Centre (V.T.C.) network at all times and in a manner to be previously agreed.

4. Requirements Prior to Commencement of Pipeline Trenching, Laying and Backfilling Operations

(1) Prior to commencement of the marine works, including Site Investigation Works, the Contractor shall submit to the Marine Department for approval the following information:-

(a) details of proposed temporary marine facilities to be provided at landfall sites such as jetties, mooring dolphins, anchor blocks, caissons, bunds and the like;

(b) a plant of the marine works indicating the proposed overall limits of the working areas and the space requirements of each of the operations;

(c) full information, including schematic layouts, of buoyage and other aids to navigation to be provided by the Contractor to demarcate working areas;

(d) information of the type and operating frequency of all proposed electronic positioning systems;

/...

(e) proposed means of communication to be established between Marine Department V.T.C. and marine plant;

(f) name of the 24 hour contact procedure for the individual charged with relations with Marine Department.

(2) In addition the Contractor shall submit to the Marine Department for their information the following details of the proposed marine works areas for Site Investigation, Trenching, Pipelaying and Backfilling:-

(a) proposed schedule of all marine works including marine works to be carried out by sub-contractors indicating the different types of operations, their number, duration, space requirements and phasing;

(b) a complete list of vessels and craft to be used for site investigation and construction;

(c) details of weather conditions in which operations would cease and all working craft removed from the area;

(3) The Contractor shall be responsible for obtaining all necessary consents and licenses in relation to any dumping and borrowing operations.

/...

5. Requirements During Site Investigation Works, Pipeline Trenching, Laying and Backfilling Operations

(1) The Contractor shall at all times during the marine activities comply, and shall be responsible for ensuring that his sub-contractors comply, with any directions which may from time to time be issued by the Marine Department. In this respect marine activity means the use of any craft or carrying out of any operation which could cause an obstruction in the area or affect the navigation of craft through the area in the vicinity of the works.

(2) Prior to the commencement of each and every separate marine activity, the Contractor shall give one month's notice to the Marine Department and shall liaise with the Marine Department to give all information on working areas, types of craft and durations of activities necessary for the Marine Department to issue the appropriate Notices to Mariners and Marine Department Notices. The Contractor shall also advise the Marine Department on completion of each and every separate marine construction activity.

(3) The Contractor shall ensure that the pipeline is laid in a trench below existing bed level at a depth which will provide adequate protection for the pipeline installation. On completion of laying operations the pipeline trench shall be backfilled so as to reinstate the seabed and provide water depths of no less than those which existed prior to commencement of the works or as otherwise required by the Director of Marine.

/...

(4) The Contractor shall provide install and maintain approved temporary marker buoys, or such other marks as may be acceptable to the Marine Department, to delineate the approved works areas. No temporary marks whatsoever shall be laid without the prior approval of the Marine Department and the issue of an appropriate Notice to Mariners or Marine Department Notice in accordance with condition 4(2) above. On completion of works the Contractor shall be responsible for the removal of all temporary marks and any such other marks as may have been provided. The removal of such marks shall be to the requirements of the Marine Department.

(5) The Contractor shall if so required, attend regular liaison meetings with the Marine Department to coordinate the activities of all operators and other contractors using the areas in the vicinity of the works. The Contractor shall comply with any requirement or instruction regarding navigation which may be issued by the Marine Department as a result of such meetings.

(6) Guard boats shall be provided by the Contractor during all marine activities to safeguard both the Works and vessels transiting the area of the works. The deployment of these boats shall be to the agreement of the Marine Department.

(7) In respect of underwater blasting of rock, the Contractor shall provide to the Marine Department, prior to commencement, evidence of permission from the Commissioner of Mines for the blasting operation together with any condition thereof. Details on depth of holes, weight of explosive charges and any other relevant information shall also be provided. The Contractor shall obtain permission from Marine Department prior to performing any underwater blasting. The Contractor shall provide information on the anticipated effects of the blasting on adjacent structures and other craft in the vicinity.

/...

The Contractor may be required to carry out monitored tests at the direction of the Marine Department. The Contractor shall provide staff, labour and craft to cordon off blasting areas as directed by Marine Department.

(8) The Contractor shall comply with the Marine Department General Conditions for Dredging and Backfilling at Marine Borrow Areas and shall be responsible for obtaining all other necessary consents in relation to borrowing and dumping operations.

(9) The Contractor shall liaise with the Marine Department and Environmental Protection Department, in respect of all marine disposal of spoil. The routes for vessels and craft in transit between the Works Areas and dumping grounds shall be to the approval of the Marine Department.

(10) The Contractor shall carry out regular bathmetric surveys of the Works Areas and any spoil dumping grounds as relevant, in accordance with Marine Department and Civil Engineering Services Department requirements. Any areas which do not comply with the terms for the use of such dumping grounds shall be rectified, to the satisfaction of the above Department.

(11) Areas for temporary anchorage of Contractor's marine craft shall be agreed with the Marine Department.

(12) All vessels and craft to be used by the Contractor during the marine works and the use of such craft shall comply with the relevant requirements of the Marine Department, including the following:-

/...

(a) they shall be required to seek channel clearance and pilotage exemption as appropriate for navigating in the compulsory pilotage area;

(b) any vessel or craft in control of a construction activity shall be equipped with VHF radio operating on a specified channels for direct contact with the Marine Department's Vessel Traffic Centre (VTC);

(c) they shall display the appropriate day marks and lights and all anchor positions shall be marked in accordance with Marine Department's requirements;

(d) they shall have on board experienced and qualified local persons, approved in accordance with Marine Department's requirements, who will be responsible for the navigation.

6. Requirement on Completion of the Works

(1) The Contractor shall carry out monitoring surveys of the sea bed on completion of all marine works. The surveys shall be independently certified and a copy provided to the Marine Department.

(2) Any obstruction caused by the works shall be removed to the satisfaction of the Marine Department and in such a manner as agreed by the Marine Department.

Marine Department
Hong Kong
May 1992

Annex V

# Ecology

Va) Benthic Species

Vb) Demersal Fish Survey

Vc) Pelagic Fish Survey

*Annex Va – Benthic Species*

**Major animals in the benthic samples collected from the study area in February 1991, as based preliminary examination of the samples**

Gastropod

Turritella terebra

Crustaceans

Eucrate sp.
Some other crab species

Polychaetes

A number of polychaete species

Holothurian

Paracaudina sp.
Protankyra bidentata

Echinoids

Temnopleurus reevsii

Ophiuroids

Ophiura kinbergii

Pisces

Unidentifed species

**Species list and general abundance of fish and macro-invertebrates found in the study areas during the demersal fish survey in February 1991**

| Species | General Abundance* Yung Long to Lung Kwu Sheung Tan | Tap Shek Kok |
|---|---|---|
| Fish | | |
| Accentrogobius caninus | + | |
| Cynoglossus puncticeps | + | |
| Dasyatis zujei | + | |
| Gerreomorpha japonica | + | |
| Glossogobius giurus | + | |
| Inimicus japonicus | + | + |
| Johnius belengerii | + | ++++ |
| Leiognathus brevirostris | + | |
| Monacanthus sp. | + | |
| Mustelus sp. | + | |
| Paraplagusia blochi | + | |
| Platycephalus indicus | + | + |
| Polynemus sextarius | + | |
| Pseudorhombus sp. | + | |
| Siganus oramin | + | |
| Silago sihama | + | |
| Solea ovata | + | + |
| Thrissa kammalensis | + | |
| Trachurus japonicus | + | |
| Triacanthus brevirostris | + | |
| Unidentifed gobbies | + | + |
| Crabs | | |
| Charybdis truncata | + | + |
| Charybdis variegata | ++ | + |
| Dorippe facchio | + | |
| Portunus pelagicus | + | + |
| Hermit crabs | ++++ | |
| Shrimps | | |
| Lysmata vittata | + | + |
| Parapenaeopsis tenella | + | |
| Metapenaeopsis barbata | + | + |
| Metapenaeopsis palmensis | + | |
| Metapenaeus affinis | + | |

(cont'.....

| Species | General Abundance* Yung Long to Lung Kwu Sheung Tan | Tap Shek Kok |
|---|---|---|
| **Shrimps** | | |
| Parapenaeopsis hungerfordi | + | |
| Parapenaeopsis cornuta | + | |
| Parapenaeopsis hardwickii | + | |
| Penaeus indicus | + | |
| Penaeus penicillatus | + | |
| Tozeunia lanceolatum | + | |
| Trachypenaeus curvirostris | ++++ | |
| **Other Crustaceans** | | |
| Alpheus distinquendus | + | |
| Oratosquilla oratoria | + | + |
| **Cephalopods** | | |
| Octopus aegina | ++ | + |
| **Gastropods** | | |
| Hemifusus ternatana | + | |
| Turritella terebra | + | |
| **Urchins** | | |
| Temnopleurus reevsii | ++++ | ++++ |

* 

| | |
|---|---|
| Very High | ++++ |
| High | +++ |
| Moderate | ++ |
| Low | + |

**Species list and general abundance of fish and macro-invertebrates found in the study areas during the pelagic fish survey in February 1991.**

| Species | General Abundance* |
|---|---|
| Fish | |
| Clupanodon punctatus | + |
| Ilisha indicus | + |
| Johnius belengerii | ++++ |
| Leiognathus brevirostris | + |
| Paraplagusia blochi | + |
| Platycephalus indicus | + |
| Sciaena russelli | + |
| Solea ovata | + |
| Crabs | |
| Charybdis truncata | + |
| Hermit crab | + |
| Other Crustacean | |
| Oratosquilla oratoria | + |
| Urchins | |
| Temnopleurus reevsii | ++ |

*

| | |
|---|---|
| Very High | ++++ |
| High | +++ |
| Moderate | ++ |
| Low | + |

Annex VI

# ARCO's Operation Philosophy

# PRODUCTION OPERATIONS

## I. INTRODUCTION

This section covers the normal production and maintenance activities associated with operating the Yacheng 13-1 gas field over its producing life. This part of the Overall Development Plan covers only the field production operations activities, organization and cost estimate. The main office organization and cost is not included because the organizational structure is currently being considered as part of the Third Supplemental Agreement discussions which are ongoing at this time. An approximation of the main office cost is made in the economic calculations.

The following sections in this part of the ODP discuss ARCO's approach to production operations of the Yacheng 13-1 gas development. The discussion is specific to the field particulars to the degree that is possible at this time in the development schedule. Examples from other ARCO operated fields that are similar to Yacheng 13-1 field are used to describe the approach that will be followed. Specific programs, policies and procedures will be developed for the Yacheng 13-1 field before production startup as design and equipment details become better defined. This documentation will be prepared predominantly by the production operations staff as they are assigned to the Yacheng 13-1 development prior to startup.

## II. GENERAL

### A. PHILOSOPHY STATEMENT

The operation of the Hainan Island and Hong Kong facilities and the offshore production facilities will be carried out in such a manner to meet all legislative requirements and policies set by the operating company. The facilities will be designed and equipped to operate in an unmanned mode during severe storms or typhoons.

ARCO China will conduct all it's activities in accordance with the Atlantic Richfield Company Safety, Health and Environmental Protection Policy.

ARCO's policy is to manage all operations in a manner that protects the environment and the health and safety of employees, customers, contractors and the public. To accomplish this, we will:

- Advise each manager, supervisor and employee of safety, health and environmental requirements and hold them accountable for performance.
- Design and manage operations to minimize environmental and human health impacts and provide work places free of recognized safety hazards.
- Comply with all laws and regulations governing safety, health and environmental protection.
- Recognize the importance of safety, health and environmental factors where there is a competition with economic factors.
- Provide professional staff to support safety, health and environmental protection.

- Monitor, evaluate and report performance in safety, health and environmental protection.

- Provide training needed to protect human, environmental and physical resources.

- Participate in programs designed to enhance knowledge and improve technology, laws and regulations.

B. GOVERNING STANDARDS

A portion of the governing standards for the operations and maintenance of the Yacheng 13-1 Gas Development are referenced in the following documents:

- ARCO China Safety, Health, and Environmental Protection Design Basis (Section 1.2.0) - See Part 8.

- AIOGC Safety, Health, and Environmental Protection Policy Programs - See Part 8.

The remainder of the governing standards for the operations and maintenance of the Yacheng 13-1 Gas Development will be covered in the following future documents:

- ARCO China Yacheng Startup Procedures Manual

- ARCO China Yacheng Safe Operating Procedures Manual

- ARCO China Yacheng Maintenance Procedures Manual

- ARCO China Yacheng Emergency Procedures Manual

The above procedures manuals will be written after final design engineering is complete but prior to project startup. Equipment selection and specifications, vendor data, engineering input, as well as operator input, are all required to prepare these procedures.

As operating experience of the Yacheng 13-1 Field is gained, additional documents will be created as necessary to enhance consistency, efficiency and safety of field operating procedures. These documents are referenced as "Standing Orders" and apply as policy. An example of these orders from a Gulf of Mexico operation is presented in Attachment II.B.1. Shown is the Table of Contents from a typical Gulf Of Mexico field. Also, several examples of specific procedures are included. Other publications governing safe operating procedures are presented in Attachment II.B.2.

## III. OVERALL ORGANIZATION

A. OBJECTIVE

The operating organization is designed to maximize efficiency between departmental functions, responsibilities and logistics associated with a remote operation. The onshore and offshore groups function as a unit with a common goal to safely and efficiently furnish a product meeting market demands.

Annex VII

# Water Quality Monitoring Requirements

## *VII.1 Water Quality Monitoring*

The following section includes proposals for procedures designed to safeguard the environment on the water quality aspects during the installation of the ARCO pipeline.

### *VII1.1 General Requirements*

a) The construction works should be carried out in such a manner as to minimise adverse impacts on water quality, in accordance with the Deep Bay Guidelines on Dredging, Reclamation and Drainage works, and to ensure that the Water Quality Objectives (WQO) for Deep Bay as specified in the Statement of Water Quality Objectives (Deep Bay Water Control Zone) under the Water Pollution Control Ordinance (Cap. 358) are maintained.

b) The following standards on the Deep Bay Water Control Zone WQO shall be complied with:

   (i) Dissolved Oxygen – a minimum of 4mg/l in the surface layer and 2mg/l in the bottom layer at all stations.

   (ii) Suspended Solids – a maximum of 30% above ambient levels at Designated Monitoring Stations in Deep Bay.

### *VII1.2 Objectives*

The objective of the monitoring programme is to minimise adverse impacts on the water quality during the various stages of the pipeline installation. such as dredging, trenching, pipelaying, post trenching and backfilling. In order to achieve this the contractor shall design and implement methods of working that:

(i) minimise disturbance to the seabed whilst trenching, pipelaying, post trenching and backfilling

(ii) minimise leakage of dredged material during lifting

(iii) minimise loss of material during transport of fill or dredged material

(iv) prevent discharge of dredged material except at approved locations

(v) prevent the unacceptable reduction, due to the Works, of the dissolved oxygen content of the water adjacent to the Works.

*VII1.3* *Water Quality Monitoring Equipment*

The Contractor shall provide within one week of the date of the Purchaser's Instruction to Commence the Works, the following equipment:

(a) Dissolved oxygen and temperature measuring equipment.

The instrument shall be portable, weatherproof dissolved oxygen measuring instrument complete with cable, sensor, comprehensive operation manuals, and be operable from a DC power source. It shall be capable of measuring:

(i) dissolved oxygen level in the range of 0–20 mg/l and 0–200% saturation.

(ii) temperature in a range of 0–45 degree Celsius.

It shall have a membrane electrode with automatic temperature compensation complete with a cable of not less than 25m in length. Sufficient stocks of spare electrodes and cable shall be maintained for replacement where necessary. (SI model 58 metre, YSI 573 (probe, YSI 5795A submersible stirrer with reel and cable or similar approved).

(b) Turbidity Measurement Instrument

Turbidity within the water shall be measured in–situ by the nephelometric method. The instrument shall be a portable weatherproof turbidity–measuring instrument complete with cable sensor and comprehensive operation manuals. The equipment shall be operable from a DC power source, it shall have a photoelectric sensor capable of measuring turbidity between 0–200 NTU and be complete with cable not less than 25m in length. (Partech Turbidimeter Model 7000 3RP Mark 2 or similar approved).

(c) Suspended Solids

A 12 volt DC powered peristaltic pump equipped with a Tygon tubing of at least 25m in length shall be used for sampling water. Samples shall be collected in high density polythene bottles, packed in ice (cooled to 5°C without being frozen), and delivered to the laboratory as soon as possible after collection. Upon arrival to the laboratory, samples shall be well–mixed and then immediately filtered (with a vacuum of less than 381mm of Hg) through pre–weighed Millepore matched pair filters (for <5 mg.L) or preweighed Whatman GF/C filters (for >5mg.L). Particulate collected on the filter papers shall be stored at 5°C and be dried within 48 hours in a drying oven at 103°C until constant weight is reached on two consecutive weightings. Filter papers taken from the drying oven shall be cooled to room temperature in a desiccator prior to being weighed. An accurate electronic balance shall be used to give a precision level of 0.01mg.

(d) Thermometer

A laboratory standard certified mercury thermometer with an accuracy of at least 0.5 degree Celsius. Temperature sensors should be calibrated against a mercury thermometer of 0.1°C scale.

(e) Water Depth Detector

A portable, battery-operated Echo Sounder shall be used for the determination of water depth within the Site and at each Designated Monitoring Station. This unit can either be handheld or affixed to the bottom of the work boat if the same vessel is to be used throughout the monitoring programme (Seafarer 701 or similar approved).

All monitoring instruments shall be checked, calibrated and certified by an approved accredited laboratory before use on the Works and subsequently be returned to laboratory for re-calibration at 3-month intervals throughout all stages of the water quality monitoring. Responses of sensors and electrodes shall be checked with certified standard solutions before each use. The turbidity meter shall be calibrated to establish the relationship between turbidity readings (in NTU) and levels of suspended solids (in mg/l).

*VII1.4* *Water Quality Monitoring*

Monitoring should be carried out in accordance with the following:

a) Baseline conditions for the various water quality parameters should be established prior to the commencement of the marine works. The baseline conditions should be determined by measurement of turbidity, suspended solids (mg/L), dissolved oxygen concentration (DO in mg/L) and dissolved oxygen saturation at the locations specified in E1.1.5 below on 4 sampling days per week for 4 consecutive weeks at mid-flood and mid-ebb prior to Commencement of the Works. All measurements of temperature, dissolved oxygen concentration, dissolved oxygen saturation and turbidity shall be taken in situ at 3 water depths namely 1m below water surface, mid-water depth, and 1m above sea bed. Water samples for suspended solids analysis shall be taken at the same three depths. In the event of shallow waters less than 3m, samples shall be taken at mid depth but additional samples (3 samples) shall be taken.

b) During the course of the Works, monitoring shall be undertaken three days a week. Monitoring at each Designated Control and Monitoring Station shall be undertaken on a working day. The interval between each series (mid-ebb and mid-flood) of samplings shall not be less than 36 hours. The values of turbidity, DO, suspended solids shall be determined at the designated locations. Two measurements at each depth of each station shall be taken. The probes must be removed from the water after the first measurement and then redeployed for the second measurement. Where the difference in value between the first and

second ratings 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. For the purpose of evaluating the water quality, all values shall be depth averaged.

c) Should the monitoring programme record levels exceed the Trigger/Action/Target (TAT) levels stated in *Table VII1.4a*, immediate mitigation measures should be taken as required by the project manager in accordance with VII1.7.

d) At completion of all trenching, pipelaying and backfilling works, the Project Proponent/Engineer shall continue the monitoring of water quality for a period of six consecutive weeks. At the end of this period, the Project Proponent/Engineer shall submit a post-project audit report to EPD in printed and magnetic media form, and in an agreed format giving the dates and times of each series of measurements. The actual measurements of each recording, together with comments on any discarded measurements shall also be provided. For each location and series of measurements, the project proponent/Engineer shall compare these measurements with the established baseline water quality parameters and shall implement appropriate remedial measures if deterioration of water quality attributable to the works is discovered.

**Table VII1.4a Target/Action/Trigger Levels**

| | |
|---|---|
| Trigger Levels | · Station result greater than 30% above the baseline level for suspended solids; and/or less than 30% below the mean value of the baseline monitoring measurements for dissolved oxygen. |
| Action Levels | · Station result greater than 30% above the mean value of recorded reading in the same day at the controls station recording for suspended solids; and/or less than 4 mg/litre dissolved oxygen at the surface layer; and/or less than 2mg/litre dissolved oxygen at 2 meters above sea bottom |
| Target Levels | · Station result persistently (3 times) greater than 30% above maximum recorded reading in same day at the controls station recording for suspended solids; and/or persistently (3 times) less than 4 mg/litre dissolved oxygen at the surface layer; and/or less than 2mg/litre dissolved oxygen at 2 meters above sea bottom |

## *VII1.5 Positions of Designated Control and Monitoring Stations*

Water quality monitoring should be carried out at the Designated Control and Monitoring Stations to provide an indication of the water quality in the surrounding waters. Five monitoring stations are recommended along both sides of the pipeline corridor at about 100m away from the corridor making a total of 10 monitoring stations. In addition, four control monitoring stations will be located at around 2 km away from the corridor to allow true reflection of the ambient conditions. An additional control station (C5) is

located midway between the oyster bed and the pipeline corridor to detect any deterioration in water quality which may affect the oyster bed. The coordinates of the monitoring station are shown in *Table VII1.5a*. Figure VII1.5a shows the location of the proposed monitoring and control stations.

*Table VII1.5a* *Location of Monitoring Stations for Marine works for the ARCO Gas pipeline*

| | E | N |
|---|---|---|
| Control Station | | |
| C1 | 810600 | 832700 |
| C2 | 806450 | 833650 |
| C3 | 807300 | 828850 |
| C4 | 805100 | 828350 |
| C5 | 809550 | 832250 |
| Monitoring Station | | |
| M1 | 808500 | 831700 |
| M2 | 807450 | 831600 |
| M3 | 806400 | 831300 |
| M4 | 805400 | 830950 |
| M5 | 804600 | 830500 |
| M6 | 808350 | 830900 |
| M7 | 807500 | 830800 |
| M8 | 806550 | 830600 |
| M9 | 805500 | 830350 |
| M10 | 804650 | 830250 |

## *VII1.6 Recording of Monitoring Data*

The results of all Water Quality Monitoring shall be provided to the Project proponent/Engineer, in an agreed format, no later than 24 hours after the sampling, except for the results for the suspended solids which shall be reported no later than 48 hours after sampling.

Project Proponent/Engineer shall provide an EM&A progress report in an agreed format and frequency to the EPD. These will include the results of all water quality monitoring data obtained. In the event of any exceedance of WQOs recorded during the course of the works, a record of remedial actions adopted in order to restore water quality to a level compliant with the WQOs have to be recorded and included in the progress report.

*VII1.7* *Mitigation in the events of an exceedance of Trigger/Action/Target (TAT) Levels*

In the event of an exceedance of any one of the TAT levels as defined in *Table VII1.4a,* a review of dredging practice should be carried out by the Contractor. This may include a combination of the following:

a) a review of working methods and practices;

b) inspection and maintenance or replacement of any marine plant or equipment contributing to the deterioration;

c) checking the state of maintenance of all silt screens.

The Project Manager shall also review the overall due-diligence management practices by the dredging Contractor. A record of actions taken should be kept and made available for inspection by EPD.

An action plan which outlines details of appropriate responsibilities by relevant parties in the event of exceedance of the recommended level is given in *Table VII1.7a.*"

*Table VII1.7a Water Quality – Action Plan*

| Event | Action | |
|---|---|---|
| | Project Proponent/Engineer | Contractor |
| Exceedance of Trigger Level | Notify EPD<br>Evaluate the effectiveness of the contractor's proposed mitigation measures<br>Require contractor to implement the necessary mitigation measures to prevent breaching another level | Repeat measurements as soon as possible to check compliance of water quality parameters with reference to the compliance standards.<br>Notify Project Proponent/Engineer.<br>Review their own plants, equipment and working procedures.<br>Identify source and impose necessary mitigation measures.<br>Recommended mitigation measures include but are not limited to the following:<br>· Rescheduling of dredging activities.<br>· Improved operational and maintenance techniques. |
| Exceedance in Action Level | Notify EPD immediately.<br>Require Contractor to make additional proposals on mitigation measures | Repeat measurements as soon as possible to check compliance of water quality parameters with reference to the compliance standards.<br>Identify source.<br>Review plant and equipment and working procedures.<br>Submit proposals for mitigation measures to Project Proponent/Engineer.<br>Implement remedial action immediately.<br>Notify Project Proponent/Engineer of the action taken. |
| Exceedance of Target Level | Notify EPD immediately.<br>Require Contractor to make additional proposals and to take immediate steps to mitigate situation<br>Provide investigation report which should be sent to EPD as soon as possible. | Repeat measurements as soon as possible to check compliance of water quality parameters with reference to the compliance standards.<br>Daily monitoring is to be imposed.<br>Notify Project Proponent/Engineer.<br>Identify source.<br>Review plant and equipment and working procedures.<br>Submit proposals for mitigation measures to Project Proponent/Engineer.<br>Implement remedial action immediately.<br>Notify Project Proponent/Engineer of the action taken.<br>Provide investigation report which should include the findings and suggestions to prevent such exceedance happening again.<br>If target limits are breached for 3 consecutive measurements, dredging to be suspended until the Authority is convinced that the problem is well under control and that the continuation of dredging operations will be in compliance with DBWQO. |

Annex VIII

# Environmental Monitoring and Audit

# ENVIRONMENTAL MONITORING AND AUDIT MANUAL
# FORMAT GUIDELINES/CHECKLIST

Environmental Monitoring and Audit Manual

An Environmental Monitoring and Audit (EM&A) Manual is required to be submitted to the Director of Environmental Protection (DEP) at the commencement of the project.

The EM&A Manual should address but not necessarily be limited to the following requirements, which are not exhaustive:-

Purpose of the Manual:

| | |
|---|---|
| Background: | Site Detail and Project Description; Period and Structure of Project EIA study undertaken; Key issues studied in the EIA; Main study findings; Land Lease and Engineering Conditions; Environmental Protection Requirements in Contract Documents; etc. |
| Project Organisation: | Management Structure & Organisation Chart; Liaison & communications flowchart (Internal and External liaison pathways); etc. |
| Project programme: | Sequence of Project construction; Location of works areas (On- and off-site); Phasing of works; Temporary works; Summary of Project data; etc. |
| Environmental Monitoring and Audit Requirements: | EM&A Implementation Plan; Noise and Water Quality Parameters; Monitoring Locations; Baseline Monitoring & Audit; Impact Monitoring & Audit; Trigger/Action/Target Levels; Event/Action Plans (including Emergency Plans); Recommended Mitigation Measures; Guidance on the reviews of pollution sources/working procedures in the event of non-compliance with environmental quality levels; Compliance and Post-Project Audit follow-up procedures; Monitoring Equipment required; Equipment Maintenance and Calibration Requirements; etc. |
| Environmental complaints Procedures: | Liaison and consultation procedures (Internal & External liaison pathways etc.); Complaints database; reporting procedures (telephone/written complaints); complaints action plan; complaints audit follow-up procedures; etc. |
| Report Procedures: | Format; frequency; special report procedures; etc. |
| Appendices: | Appropriate drawings/tables of monitoring locations, sensitive receiver locations, EM&A requirements, correspondence and contact lists; definitions of terms used; etc. |

# ENVIRONMENTAL MONITORING AND AUDIT PROGRESS REPORTS FORMAT GUIDELINES/CHECKLIST

Environmental Monitoring and Audit (EM&A) Reports are required to be submitted to the Director of Environmental Protection (DEP) at agreed intervals, commencing one month after the commencement of the works.

The EM&A progress report to be submitted to DEP should address but not necessarily be limited to, the following requirements which are not exhaustive:-

Executive Summary

| | |
|---|---|
| Project Data: | A synopsis of the Project organisation; Project programme; management/liaison structure; etc. |
| Environmental Monitoring and Audit Requirements: | Summary of Monitoring Parameters; Trigger/Action/Target Levels; Event/Action Plans; Environmental Protection Requirements in Contract Documents; Land Lease and Engineering Conditions; etc |
| Monitoring Methodology: | Monitoring equipment used; Locations; Duration/Period; etc |
| Monitoring Results: | Example of an appropriate monitoring data report format is attached (not exhaustive). |
| Audit of Results: | Review of pollution sources/working procedures in the event of non-compliance with environmental quality levels; actions taken in the event of non-compliance; follow-up procedures related to earlier non-compliance actions; etc. |
| Complaints: | Liaison and consultation undertaken; actions taken; database of telephone/written complaints; location of complaints; complaints action plan and follow-up procedures; etc. |
| Appendices: | Appropriate drawings/tables of monitoring locations, sensitive receiver locations, EM&A requirements, etc. |

Annex IX

# Summary of Mitigation Measures – Gas Pipeline

## IX1 INTRODUCTION

This section presents a summary of recommended mitigation measures associated with the installation and commissioning of the ARCO gas pipeline (5 km) within the Hong Kong Territorial water. No specific mitigation measures are required during the operational phase.

## IX2 CONSTRUCTION PHASE

### IX2.1 WATER

*Dredging of Marine Mud*

- cutterheads of suction dredgers should be suitable for the material being excavated and should be designed to minimise overbreak and sedimentation around the cutter
- Automatic Lean Mixture Overboard (ALMOB) is prohibited in dredging operations.
- mechanical grabs if used should be designed and maintained to avoid spillage and should seal tightly while being lifted
- all vessels should be sized such that adequate clearance is maintained between vessels and the sea bed at all states of the tide to ensure that turbidity is not generated by turbulence from vessel movement or propeller wash
- all pipe leakages should be repaired promptly and plant should not be operated with leaking pipes
- the Works should cause no visible foam, oil, grease, scum, litter or other objectionable matter to be present on the water within the Site or dumping grounds
- loading of barges and hoppers should be controlled to prevent splashing of dredged material to the surrounding water and barges or hoppers should not be filled to a level which will cause overflowing of material or polluted water during loading or transportation.
- pipeline installation work shall comply with the requirements stipulated by the Marine Department as presented in Annex IV.
- special measures shall be taken during transportation and disposal of the dredged material. These are discussed in Section 3.3.4.

These are no specific mitigation measures for ploughing and jetting operations due to the simplicity of the operation. Good operation practice is

the principal mitigation measures. This include operation at the required speed and required depth below the sea bed.

*Landbased Construction Activities*

Special measures shall be undertaken for shorebased activities to minimise water quality impacts:

- Disposal of any solid materials, litter or wastes to marine waters should be avoided
- All chemical stores shall be contained such that spills are not allowed to gain access to water bodies.
- All fuel tanks should be provided with locks and be sited on sealed areas within bunds of a capacity of 110% of the tank size.
- Chemical toilets or septic tanks with appropriate desludging arrangements will be required to handle the sewage from the on-site construction workforce.

*Water Quality Monitoring*

It is recommended that during the pipeline installation, a water quality monitoring programme be conducted in order to detect any deterioration of water quality. The proposed water quality monitoring programme is discussed in Annex VII, with details on baseline and work phase monitoring, and the recommended locations of control and monitoring stations. An action plan which outlines details of appropriate responsibilities by relevant parties in the event of exceedance of the recommended level which is based on the Deep Bay WQO is also included.

## *IX2.2 WASTE MANAGEMENT*

The contractor(s) shall ensure that all dredging and disposal methods are in compliance with the guidelines specified in the Works Branch Technical Circular No. 22/92.

*Transportation Options*

- Bottom openings of barges to be fitted with tight fitting seals to prevent leakage of material. Excess material should be cleaned from the decks and exposed fittings of barges and hopper dredgers before the vessel is moved.
- Monitoring of the barge loading can ensure that loss of material does not take place during transportation. Transport barges or vessels shall be equipped with automatic self monitoring devices as specified by the DEP.

*Disposal Options*

Marine discharge can be through the bottom of a barge by various methods such as bottom opening doors, bottom valves, horizontal sliding doors and split hulls. Material is released downwards in each case. A grab or suction pump may also be used for marine discharge.

With a volume of less than 500,000 $m^3$ of dredged material, application for marine disposal will be required from the EPD.

The contractor must satisfy the appropriate authorities that the contamination levels of the muds have been analysed and recorded. The contractor shall ensure that dumping takes place only at approved locations and automatic marine positioning recorders are to be used to ensure accurate positioning of the barge prior to discharge.

## *IX2.3 ECOLOGY*

*Selection of Dredging Method and Equipment*

Proper selection of appropriate dredging and dewatering methods or treatment to reduce the amount of sediment resuspension.

*Scheduling of Dredging and Jetting*

Careful scheduling the dredging and jetting activities so as to avoid the peak reproductive periods (eg spawning, breeding) which generally occur in Spring or Autumn. Losses following the peak reproductive season would have less adverse effect than losses before the peak season.

*Research Studies Contribution*

Contractors should be advised of the possible presence of dolphins in the area, the need for their protection and should be encouraged to report sightings as a contribution to the research programme.

## *IX2.4 NOISE*

The construction activities will mostly be imperceptible at the nearest noise sensitive receivers, and it is considered that no specific noise constraint and monitoring is identified to be required for the works.

## *IX2.5 ENVIRONMENTAL MONITORING AND AUDIT MANUAL*

An Environmental Monitoring and Audit (EM&A) Manual will be required to provide information, guidance and instruction to environmental site staff undertaking the EM&A work. It is recommended that an on-site staff be appointed to monitor environmental performance of the contractor(s) and to ensure that the environmental requirements are met. The EM&A Manual should be submitted to DEP for consideration prior to commencement of baseline monitoring and construction work.

Monitoring data should be recorded and stored for ease of reference. An EM&A progress report should be submitted to EPD on a regular basis. The frequency of report submission should be agreed with EPD. The reports should include monitoring data, audit/review of the environmental monitoring data to identify compliance with regulatory requirements, policies and standards and any remedial works taken/required to mitigate the adverse impacts.

## *IX3 COMMISSIONING PHASE*

No effluent discharge into Hong Kong waters is permitted during the precommissioning and commissioning stage.

Annex X

# Summary of Mitigation Measures – Gas Receiving Station

## X1 INTRODUCTION

This section presents a summary of recommended mitigation measured associated with construction and operation of the Gas Receiving Station.

## X2 CONSTRUCTION PHASE

### X2.1 AIR

*Vehicle Dust*

- On-site unpaved roads that are frequently used should be regularly compacted and the road surface should be kept clear of loose material. Roadways longer than 100 m and with frequent vehicle movements can be paved with flexible surfacing. Water spraying can also be used to control dust.

- Vehicles should be restricted to designated routes and speed.

- Wheel-wash troughs and hoses should be provided at traffic exits from the site to minimise the quantity of material deposited on public roads.

- Vehicles that have the potential to create dust while transporting materials should have properly fitting side and tail boards. As required by law, materials transported by vehicles need to be covered, with the cover properly secured and extended over the edges of the side and tail boards. The materials should also be dampened if necessary before transportation.

*Concrete Batching*

- Under the Air Pollution Control Ordinance, the contractor should apply for a license for batching plants with a total silo capacity exceeding 50 tonnes.

- The fugitive emissions from the cement silos should be controlled by bag filters whilst emissions from conveying the product can be reduced by covering the conveyor belt. All conveyors carrying dry cement should be totally enclosed through all stages of the process. Spray systems at aggregate transfer points can further reduce emissions.

- The plant site and ancillary areas should be frequently cleaned and watered to minimise any fugitive dust emissions.

- All vents on cement silos should be fitted with fabric filters using either shaking or pulse-air cleaning mechanisms.

- The filter bags in the cement silo dust collector must be thoroughly shaken after cement is blown into the silo to ensure adequate dust collection capacity for subsequent loading.

- Weigh hoppers of a cement silo should be vented to a suitable fabric filter .

*Stockpiling Activities*

If there are extensive stockpiling activities, the following mitigation measures should be considered:

- Stockpiles of sand and aggregate greater than 20 $m^3$ should be enclosed on three sides, with walls extending above the pile and 2 m beyond the front of the pile.

- Water spray facilities should be provided and used both for damping during reception and storage of raw materials.

X2.2 *WASTE*

*Segregation of Wastes*

In order to ensure that all waste is disposed of in an appropriate manner, waste should be separated by category, on-site by the contractor. The criteria for sorting solid waste is described in the *New Disposal Arrangements for Construction Waste* issued in 1992 by the EPD and the CED. Waste containing in excess of 20% by volume of inerts should be segregated from waste with a larger proportion of putrescible material.

It is recommended that the Contractor segregate waste materials into inert, non-inert and chemical waste categories from the land based operations and should dispose of them as follows:-

- Inert construction waste material, when deemed suitable for reclamation or land formation, should be disposed of at reclamation sites or public dumping areas.

- Inert material deemed unsuitable for reclamation or land formation and non-inert construction waste and general refuse should be disposed of at a public landfill.

- Chemical waste as defined by *Schedule 1* of the *Waste Regulations (Chemical) 1992*, should be stored and transported using approved methods under the Regulation and the chemical waste disposed of at the CWTC located at Tsing Yi.

The different categories of wastes should be segregated, stored, transported and disposed of in the manner described previously in *Section 4.1.2.*

*Site Practice*

Good site practice will ensure that the on-site impacts discussed previously are minimised. These should include:

- daily collection of general refuse or as often as required;
- regular maintenance and cleaning of waste storage areas; and
- storage of waste in suitable containers/receptacles.

*Storage, Collection and Transportation of Waste*

It is the contractor's responsibility to ensure that only licensed waste collectors, authorised to collect the specific category of waste concerned, are employed and that appropriate measures to minimise windblown litter and dust during transportation are implemented.

The necessary waste disposal permits must be obtained from the appropriate authorities should they be required in accordance with the *Waste Disposal Ordinance (Cap 354)* and *Waste Disposal (Chemical Waste) (General) Regulation (Cap 354).*

## X2.3 *WATER QUALITY*

Proper site management is essential to minimise wash-off during rainy seasons and "good housekeeping" practices to ensure that debris and rubbish cannot gain access to nearby stormwater system should be implemented.

The following provides a guideline on the standard measures which should be enforced.

*Site runoff*

All site construction runoff should be controlled and treated to prevent runoff with high level of SS and the following measures may be considered:

- the boundaries of earthworks should be marked and surrounded by dykes or embankments for flood protection as necessary;
- temporary ditches should be provided to facilitate runoff discharge into the appropriate watercourses, via a silt retention pond;
- permanent drainage channels should also incorporate sediment basins or traps and baffles to enhance deposition;
- sediment traps must be regularly cleaned and maintained by the contractor. Daily inspections of such facilities should be required of the Contractor;
- collection of spent bentonite or other grouts in a separate slurry collection system either for reuse or disposal to landfill;
- all traps (temporary or permanent) should also incorporate oil and grease removal facilities;

- all drainage facilities must be adequate for the controlled release of storm flows; and

- minimising of exposed soil areas to reduce the potential for increased siltation and contamination of runoff.

*Debris and Litter*

In order to comply with the aesthetic criteria for the proposed Deep Bay WQO, contractors should ensure that site management is optimised and that any solid materials, litter or wastes should not enter to the surface and marine waters.

*Oils and Solvents*

All fuel tanks and store areas should be p ided with locks and be sited on sealed areas, within bunds of a capacity e to 110% of the storage capacity of the largest tank.

*Sewage*

All polluted water should be treated before discharge. Small integrated treatment units are available which combine grease traps and treatment chambers with aeration and settlement facilities. The treated effluent can subsequently be discharged to 'storm sewer', providing it complies with the TM. This level of treatment should be readily achieved by standard packaged sewage treatment units.

## *X2.4 NOISE*

Silenced equipment and quieter methods of construction should be considered. The use of quiet general construction plant can result in a significant reduction to the overall noise intrusion.

Regular site supervision and maintenance of construction equipment; this can eliminate the generation of unnecessary noise.

# *X3 OPERATIONAL PHASE*

## *X3.1 AIR QUALITY*

The installation of the heater stacks is required to comply with the Air Pollution Control (Furnaces, Ovens and Chimneys)(Installation and Alteration) Regulations.

*Good Engineering Practice* should be adopted in designing the stack height in order to avoid building downwash problems.

No building is located within 50m from the heaters within the GRS site in which case building downwash is unlikely to be a problem.

*X3.2* *WASTE MANAGEMENT*

Waste should be disposed of in accordance with the *Waste Disposal Ordinance (Cap 354)* and *Waste Disposal (Chemical Waste) (General) Regulation (Cap 354).*

Waste generation should be minimised and materials should be reused on-site as far as practicable to minimise the disposal requirement.

*X3.3* *WATER QUALITY*

Stormwater runoff should be well segregated from the runoff from process area. Drainage systems should include traps to collect SS in drainage or runoff (including metals) and interceptors to collect oil and grease.

The efficiency of silt traps and oil interceptors is highly dependent on regular cleaning and maintenance. These installations should be regularly cleaned and maintained in good working order.

Oily contents of the traps should be collected for reuse, or transferred to an appropriate disposal facility, such as the Government CWTC at Tsing Yi.

Sewage are required to meet the effluent standards stipulated in the TM. Sewage should be properly directed to the sewage treatment facility at the LTPS for treatment prior to discharge. Other site drainage with the exception of stormwater should be properly diverted to the treatment plants at the LTPS nearby for subsequent treatment.

*X3.4* *NOISE*

No specific noise mitigation measures and monitoring programmes are required.

# Natural Gas Supply to Black Point Power Station: Submarine Pipeline for Hong Kong Territorial Waters, Gas Receiving Station and Related Facilities: *Environmental Impact Assessment*

**Addendum to Final Report**

**Section A2.2 Last line**

" *Figure A2.2a* delineates the boundaries.....and the surrounding landuses." amended to read as " *Figure A2.2a* delineates the boundaries .....and the surrounding landuses. Mud dumping in the Urmston Road borrow pits is now substantially complete. Limited dumping may still take place from time to time."

**Section A3.2.6 Borrow Area second bullet point Page A20**

" Backfilling at the Outer Deep Bay and Urmston Road borrow area are ongoing. ..... Backfilling is anticipated to be complete by the end of the year." amended to read as " Backfilling at the Outer Deep Bay and Urmston Road borrow area are ongoing. ..... Backfilling is anticipated to be complete by the end of the year. Mud dumping in the Urmston Road borrow pits is now substantially complete. Limited dumping may still take place from time to time. "

**Section A3.3.4 Transportation and Disposal of Material page A25**

" In addition, the contractor must satisfy the appropriate authorities that the contamination levels of the muds have been analysed and recorded. Knowledge of the levels of contaminants ..... to ensure that the correct dredging, handling and disposal procedures are followed. Specific dredging procedures ...." amended to read as " Knowledge of the levels of contaminants .....to ensure that the correct dredging, handling and disposal procedures are followed. ARCO/CLP should notify DEP and FMC of mud disposal requirements, and the notification must include sampling and testing proposals. The contamination state of the material to be dredged has to be confirmed by EPD before disposal arrangements can be finalised. Specific dredging procedures ..... "

**Section A3.3.4 Disposal Options page A26**

" There are currently three existing gazetted marine disposal grounds: South of Cheung Chau (80Mm$^3$), East of Ninepins (3.7Mm$^3$) and Mirs Bay (9Mm$^3$). However, ..... Under the terms of the Works Branch Technical Circular No. 22/92, for disposal of mud less than 500,000 m$^3$, the Director of Environmental Protection is the authority for the licensing and statutory control of the marine disposal of dredged mud." amended to read as " There are currently three existing gazetted marine disposal grounds: South of Cheung Chau, East of Ninepins and Mirs Bay. However, ..... Under the terms of the Works Branch Technical Circular No. 22/92, for disposal of mud less than 500,000 m$^3$, the EPD will direct this to the marine disposal site without formal involvement of FMC.

However, as advised by the FMC, EPD are directing most uncontaminated spoil to East Ninepins"

**Section A6.2 Waste page A50**

" Results of sediment sampling in the Outer Deep Bay Borrow Area indicate that ..... It is likely that the dredged material will be allocated to the gazetted marine dump sites at South Cheung Chau and East of Ninepins. ...." amended to read as " Results of sediment sampling in the Outer Deep Bay Borrow Area indicate that ..... It is likely that the dredged material will be allocated to the gazetted marine dump sites at East of Ninepins. ...."

**Figure A5.1a Locations of Water Monitoring and Control Stations**

Figure A5.1a revised as attached to include control station C5

**Section B3.6**

Add the following Section B3.6 after B3.5

**B3.6 Design Changes**

The design of the vent stack has changed slightly since the EIA with the addition of a high pressure vent tip. The effective exit diameter is 0.59 metres as opposed to 0.46 metres as previously assessed in this EIA report. The proposed changes will increase the cross section area and decrease the efflux velocity from 0.03 to 0.02 m/s. The change in the stack diameter would not cause significant changes to the plume rise and the conclusion of the modelling results for this EIA report remains valid.

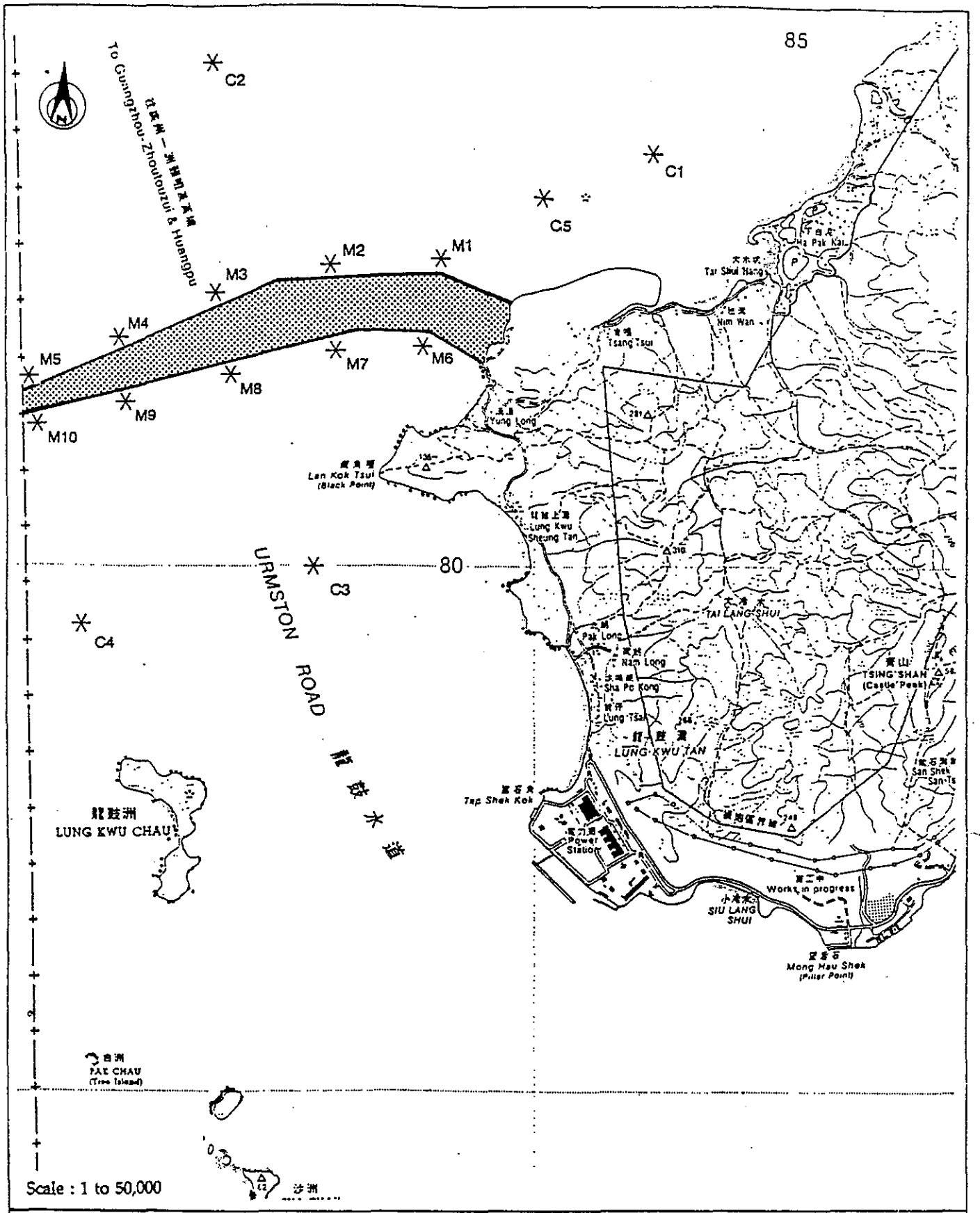



Figure A5.1a

Locations of Water Monitoring and Control Stations

ERM Hong Kong

11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG