FINAL REPORT

The Hongkong Electric Co., Ltd.

Environmental Impact Assessment of a 1,800MW Gas-Fired Power Station at Lamma Extension : *Executive Summary*

8 February 1999

Reference C1830

For and on behalf of
Environmental Resources Management

Approved by: Freeman Cheung

Signed: 

Position: Deputy Managing Director

Date: 8 February 1999

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1 INTRODUCTION

1.1 BACKGROUND

1.1.1 Status of the EIA Report

The Environmental Impact Assessment (EIA) Report for the Lamma Extension project was prepared in response to the *EIA Study Brief No. ESB-001/1998* issued to the Hongkong Electric Company Limited (HEC) on 20th May 1998 by the Hong Kong Government's Environmental Protection Department (EPD) in relation to HEC's proposed 1800 MW Gas-Fired Power Station at Lamma Extension.

The Study Brief was based on information provided in the Project Profile submitted by HEC on 8th April 1998 under the statutory provisions of the *Environmental Impact Assessment Ordinance (EIAO) (Cap.499).*

The approach adopted by the EIA Study Team follows the requirements of the *Environmental Impact Assessment Ordinance (EIAO) (Cap.499)* and is in compliance with the *Technical Memorandum on Environmental Impact Assessment Process (EIAO TM)* issued under the *EIAO.*

1.1.2 Context of the EIA Study

In view of the potential demand for electricity and the positive findings of earlier environmental studies, the Executive Council (ExCo) advised, and the Chief Executive ordered, *"that the HEC should be invited, without any commitment on the part of Government, to proceed with detailed site investigation and environmental impact assessment studies of an extension to Lamma Power Station for the possible construction of additional electricity generating facilities, with coal and natural gas as fuel options, the latter being the preferred option".*

Previous studies, including the *Site Search for a New Power Station: Detailed Site Selection* and *Stage I EIA for a New Power Station, Volumes 1 & 2,* had examined options for siting of the power station and evaluated a broad range of environmental issues and factors associated with these options. In addition, five non-site specific issues concerning the latest power generation technologies, fuel options, regional air quality impacts, greenhouse gas emissions, and prospective co-siting with a waste-to-energy incinerator, were also evaluated. A summary of the alternatives considered in defining the fuel, technology, location and transmission and pipeline routes for the new power station is provided in *Section 2.*

The *Site Search Study* concluded that an extension to Lamma Power Station was the preferred site for a new power station for both fuel options, and that it is feasible to build and operate a power station at that location without significant adverse impacts on the environment.

The outcome of the *Stage I EIA* is that the preferred fuel is natural gas and the preferred technology is combined cycle technology.

To confirm that the actual design, construction methods and operating regimes of the proposed plant will not cause adverse or unacceptable environmental impacts, a site-specific EIA Study is required. HEC has commissioned ERM to determine the environmental acceptability of the proposed new power station by undertaking this EIA Study.

1.2 DEVELOPMENT RATIONALE

1.2.1 *The Hongkong Electric Company Limited*

HEC is committed to providing a reliable and cost-effective electricity supply to meet the current and future power requirements of the SAR. The provision of adequate, reliable and low cost electricity is considered vital to the continuing economic success of Hong Kong.

In addition to guaranteeing electricity supply to Hong Kong, HEC is committed to policies and measures that aid the protection of Hong Kong's environment. The Company has sought to demonstrate this commitment through the application of a range of advanced environmental protection measures to meet the high standards expected by Government and the community. Measures have included the installation of flue gas desulphurisation plant and low NO_x combustion systems at some units of the existing Lamma Power Station to minimise air quality impacts, and the use of cable tunnels and extensive landscape planting to reduce landscape and amenity impacts and to improve the visual appearance of its facilities.

1.2.2 *Future Electricity Needs*

According to the supply record over the last three decades, the electricity demand in HEC's service area of Hong Kong Island and Lamma Island increases steadily each year, with a growth rate of 10% and 8% in the 1970s and 1980s respectively. HEC foresees that this trend will continue, keeping pace with the social and economic growth of Hong Kong over the forthcoming century.

In forecasting the future demand for electricity, HEC has made prudent assumptions and has taken into account the positive impacts arising from the promotion of Demand Side Management (DSM) by HEC and the Government.

Whilst HEC's load demand forecast will be under separate study, for the purpose of environmental impact assessment, it has been assumed that the proposed 1,800 MW new power station will need to be fully developed by 2012, with the first unit operational in 2003. All six 300 MW gas-fired units of the new power station will be operated as base-load units since these units will be more environmentally friendly, efficient and economical to operate than the existing Lamma units.

Assuming the forecast peak day loading in 2002 will be fully provided by the existing Lamma Power Station, 2002 is the final year without contribution from the new power station. This will represent the maximum output from the existing power station immediately before the commissioning of the first 300 MW unit of the new power station in 2003. 2002 has therefore been used as the base case scenario against which the environmental impacts of the new power station are compared.

1.3 SCOPE AND OBJECTIVES OF THE EIA

The purpose of the EIA Study was to evaluate the potential environmental impacts arising from the construction and operation of the proposed project and its related activities, develop and specify measures necessary to mitigate particular adverse impacts which are identified, and determine the environmental acceptability of the residual impacts of the overall project.

1.3.1 *Study Objectives*

The main objectives of the EIA Study were:

- to describe the proposed project and associated works, together with the requirements for undertaking the proposed project;
- to identify existing and future sensitive receivers, resources, activities and land uses which may be adversely affected by the project;
- to identify, predict and evaluate the potential impacts of the project on sensitive receivers, resources, activities and land uses, including consideration of air and water quality, noise, wastes, hazards, land contamination, landscape and visual issues, fishery resources and terrestrial and marine flora, fauna and habitats;
- to propose suitable mitigation measures to reduce or minimise any adverse impacts which have been identified, taking into account any associated constraints or consequential environmental implications of such measures;
- to identify, predict and evaluate the acceptability of the residual impacts of the project after mitigation, and estimate and evaluate any cumulative environmental impacts or effects to which the project may contribute;
- to identify, develop and specify methods, measures and standards to be included in the detailed design, construction and operation of the project to reduce environmental impacts to acceptable levels; and
- to identify and specify environmental monitoring and audit requirements for the implementation of the project.

The Study will address the environmental impacts associated with the following Designated Projects as defined under the *EIAO*:

- construction and operation of a 1,800 MW gas-fired combined cycle plant at the Lamma Extension Site; and
- laying of a submarine pipeline to supply gas from a regional liquefied natural gas (LNG) terminal in Shenzhen to the Lamma Extension site.

The EIA will also assess environmental impacts along the proposed route of the new transmission cables required to supply electricity to Hong Kong Island. For the purpose of this study the sections of the cable route from the Lamma Power Station up to landing points in Hong Kong Island will be assessed. Further transmission network development on Hong Kong Island will be dealt with separately, in a similar way to other HEC transmission cable projects.

1.3.2 *Technical Scope of the EIA Study*

The following technical assessments were undertaken, where appropriate and relevant to the various project components, for both the construction and operational phases of the power station development, transmission system and gas pipeline:

- Air Quality Impact Assessment;
- Water Quality Impact Assessment;
- Noise Impact Assessment;
- Landscape and Visual Impact Assessment;

- Waste Management Impact Assessment;
- Land Contamination Assessment;
- Ecological Impact Assessment (Aquatic and Terrestrial);
- Fisheries Impact Assessment; and
- Hazard to Life Assessment.

Detailed technical assessments in some of these areas were not required for all components of the project (eg there are no significant air quality impacts associated with the laying of the gas pipeline). Specific scope of assessment and the EIA findings for the power station, transmission system and the gas pipeline are presented in Sections 3, 4 and 5 respectively.

Appropriate Environmental Monitoring and Audit (EM&A) requirements were also identified for each component and phase of the project during the EIA Study.

2 CONSIDERATION OF ALTERNATIVES

2.1 INTRODUCTION

The assessment of the need for additional power generating capacity is the subject of separate consideration by the Hong Kong Government. As a consequence, the EIA Study Brief is focused on the provision of additional capacity through a new thermal power station at Lamma Extension.

The EIA Study has assessed the environmental implications of the new power station and the associated transmission and pipeline systems. However, prior to the commencement of the EIA Study each of these elements was the subject of detailed appraisal of alternatives to ensure that the potential impacts to the environment were minimised.

A summary of the consideration of the alternatives to the selected power station location, technology and fuel, the selected transmission routing and the selected pipeline routing is presented below.

2.2 THE POWER STATION

In early 1997, HEC commissioned two studies: *Site Search for a New Power Station: Detailed Site Selection* and *Stage I EIA for a New Power Station, Volumes 1 & 2* both of which were prepared by ERM-Hong Kong Ltd. These two studies examined a broad range of site selection and environmental factors, and included a review of available power generation technologies, a comparative assessment of coal versus gas-firing, the potential regional air quality impacts of the project, its implications for greenhouse gas emissions, and the feasibility of co-siting with a waste-to-energy incinerator.

The Stage 1 EIA was undertaken in accordance with the requirements of the Government's *Study Brief for the Stage 1 EIA (or EIA of Alternative Sites and Fuels) for a New Power Station Proposed by HEC* and is placed on the EIA Register under Section 15(1)(f) of the EIA Ordinance as *Stage 1 EIA for a New Power Station: Stage 1 EIA Report Volume I & II (EIA 130/BC).*

The Stage 1 EIA was undertaken as an integral part of the wider site search study and provided input on both site-specific environmental impacts and wider, non-site specific issues such as regional air quality and greenhouse gas emissions.

The EIA Study Brief identified the following key objectives:

- identification of environmentally preferred site, fuel, power generation technology and design options;
- identification of potential sites and evaluation of their environmental suitability for the development of a new power station; and
- determination of the environmental feasibility of building a new power station within Hong Kong.

The Stage 1 EIA determined the most environmentally preferred site for each of two fuelling scenarios:

- *Scenario One* assumed a 1,800 MW coal-fired power station at a coastal location that allows access by bulk coal carriers. The core landtake requirements for the coal-fired power station were approximately 80 hectares (including land required for ash lagoon); and

- *Scenario Two* assumed a 1,800 MW gas-fired power station supplied by a gas pipeline. This scenario also required a coastal location but navigational constraints were less important than those for Scenario One, since bulk carrier access was not required. The core landtake requirements for the pipeline gas-fired power station and associated gas receiving facilities were smaller (around 50 hectares) than for the coal-fired scenario.

The Site Search Study was undertaken in three phases, with a progressive "focusing in" from broad geographic areas to individual sites. Based on the whole territory of Hong Kong as the search envelop, the Site Search began with the consideration of all "non-constrained" areas within which a long list of sites was identified; these longlisted sites were examined and reduced to a shortlist which was subjected to much more detailed environmental appraisal. The Stage 1 EIA was undertaken in the same way, with the tasks identified in the Study Brief being carried out within the appropriate phase of the Site Search Study.

The overall conclusions of the Stage 1 EIA were as follows:

- Gas is environmentally preferred to coal as a fuel for the power station.

- The acceptability of the various options with respect to the greenhouse gas issue would depend on Government's policy for greenhouse gas control in Hong Kong.

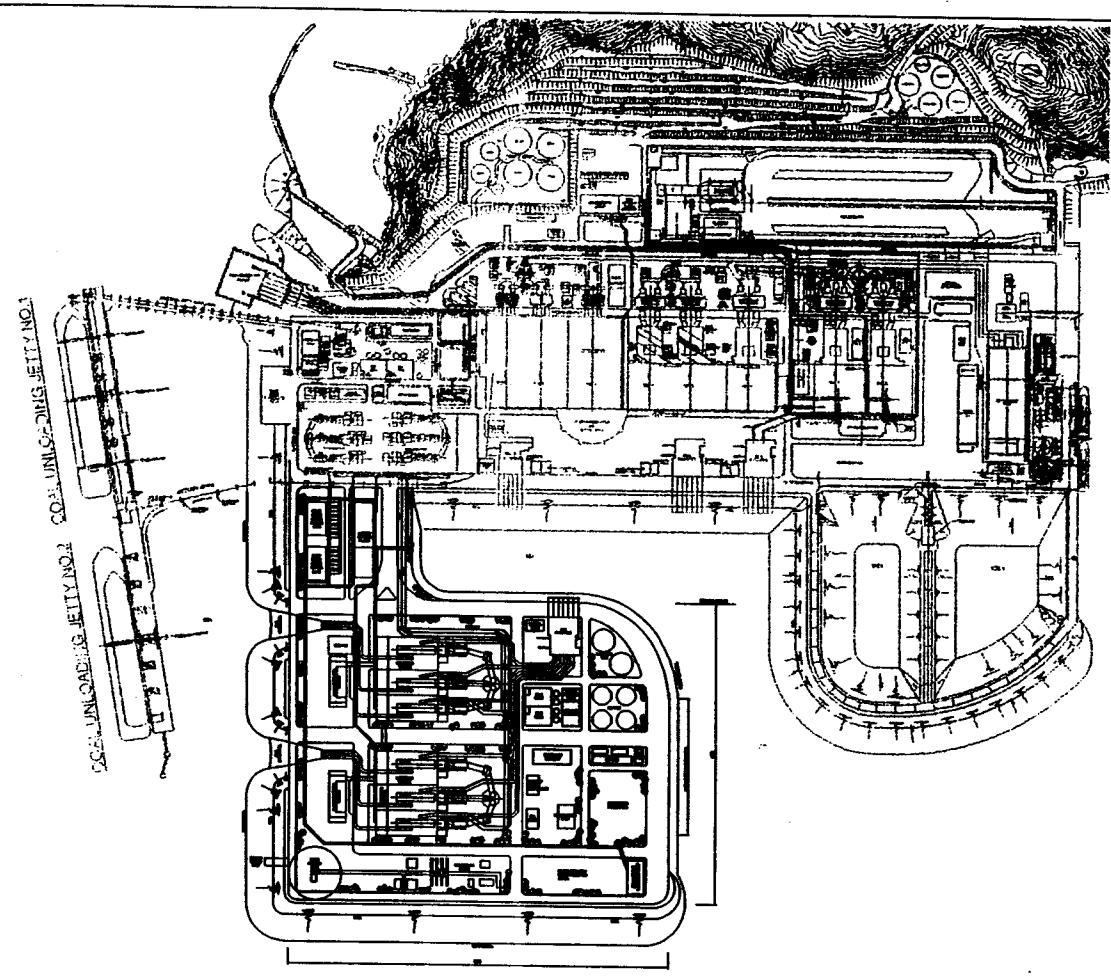
- For both the coal- and gas-firing scenarios, the environmentally preferred site was the Lamma Extension. Although the development of a new power station at the Lamma Extension site may cause noise, local air quality, water quality and marine ecology impacts, the Stage 1 EIA concluded that these impacts were amenable to mitigation.

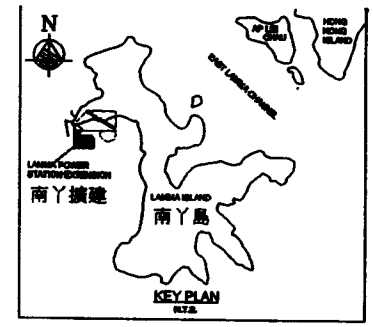
- The overall environmentally preferred combination of fuel, technology and site options was considered to be a gas-fired power station employing combined cycle gas turbine technology, forming an extension to the existing Lamma Power station.

- The Environmental Study Management Group is unable to endorse the coal-fired power station option due to the greenhouse gas issue.

After endorsement on the findings of the Stage 1 EIA and Site Search Study by the Government Study Management Group, HEC has consulted the Energy Advisory Committee, EIA subcommittee of the Advisory Council on the Environment (ACE), the Southern and Islands District Boards and the ACE full council. On 31 March 1998, the Executive Council decided that HEC should be invited, without any commitment on the part of Government, to proceed with detailed site investigation and environmental impact assessment studies of an extension to Lamma Power Station for the possible construction of additional electricity generating facilities, with coal and natural gas as fuel options, the latter being the preferred option.

Location and proposed layout of the Lamma Power Station Extension (termed "Lamma Extension") are shown in *Figures 2.2a & 2.2b*. The Lamma Extension site will be formed entirely by reclaiming a piece of land in the sea just off the





EXISTING
LAMMA
POWER
STATION
南丫發電廠

PROPOSED 1800MW COMBINED CYCLE UNITS
(LAMMA POWER STATION EXTENSION)
南丫擴建 1,800 兆瓦燃氣聯合循環機組

SCALE 1:10,000

FIGURE 2.2a
圖 2.2a

PROPOSED SITE LAYOUT PLAN OF LAMMA POWER STATION IN YEAR 2012
南丫擴建廠址位置及平面佈置圖(2012 年)

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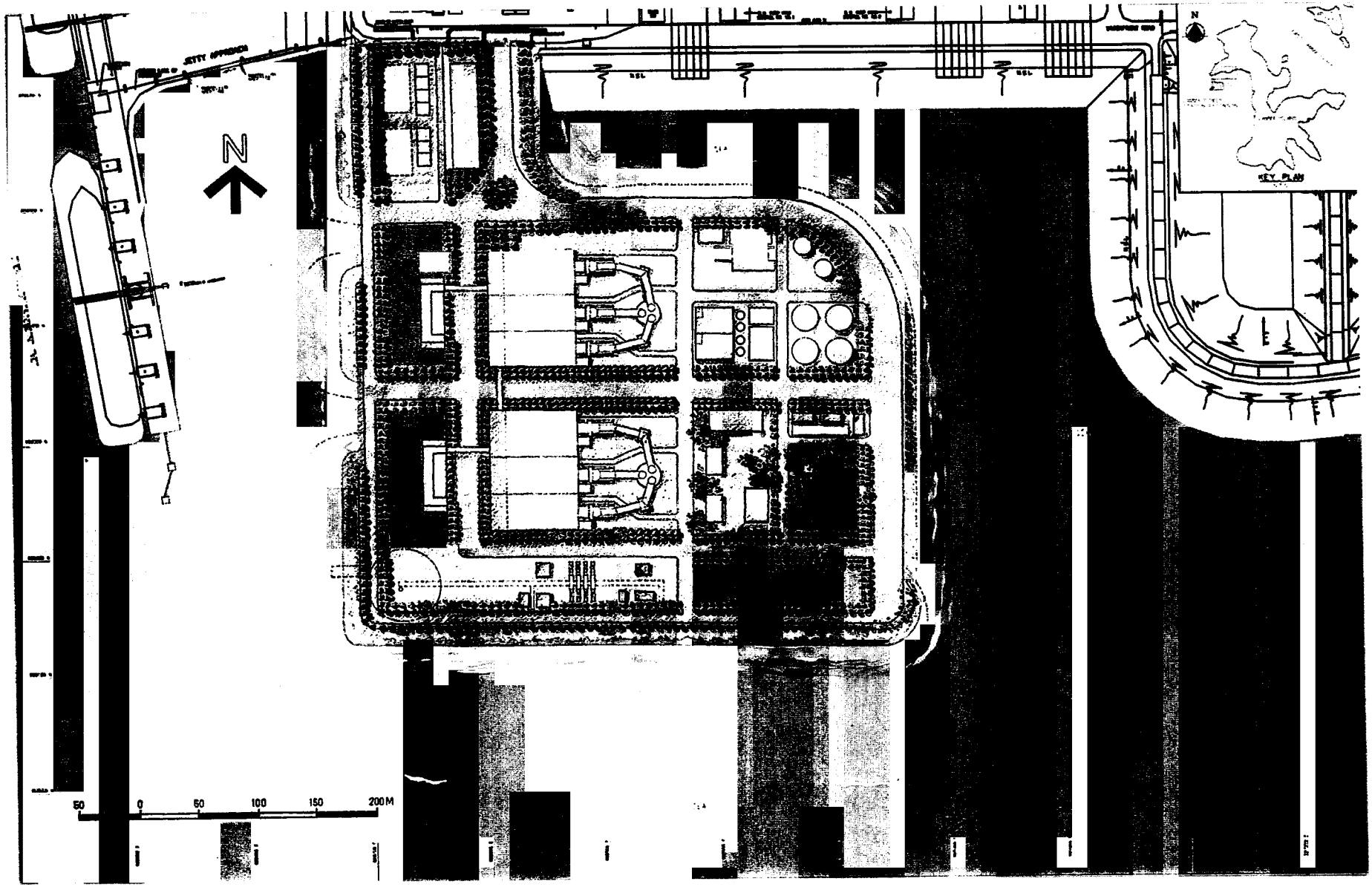

FIGURE 2.2b
圖 2.2b

1,800MW GAS-FIRED PLANT AT LAMMA EXTENSION SITE LAYOUT PLAN
南丫擴建 1,800 兆瓦燃氣電廠 -- 平面佈置圖

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southern seawall of existing Lamma Power Station. Due to sharing of facilities and services with the existing power station, a smaller area of about 22 hectares will be required. The site platform will be connected by a reclamation area to the south-west corner of the existing power station. Six 300MW combined cycle units will be constructed on the Lamma Extension. The proposed units will operate on natural gas which contains virtually no sulphur and results in almost zero discharges of particulates.

2.3 *THE TRANSMISSION ROUTING*

In parallel with the new power station Site Search exercise, HEC also conducted a study on a new power transmission system from Lamma Extension to the load centres on Hong Kong Island.

HEC has a policy of not constructing additional overhead lines because of system security, reliability and environmental reasons. Therefore, the transmission route study was confined to the identification and selection of a transmission system which employs 275 kV insulated submarine and land cables.

An initial step was to search for suitable sites for key locations, such as potential submarine cable landing points and new cable tunnel portals, using, wherever possible, existing HEC tunnel portals. Potential routes were then established by linking the key locations by the combination of submarine and underground cables, using existing linear features (roads, pavements, etc) wherever possible.

Following the identification of potential routes, these were evaluated by a two-stage screening process, i.e. coarse and fine screening until the preferred cable route was identified. Those routes which were considered unacceptable under one or more of the coarse screening phase criteria were excluded from the fine-screening evaluation.

Environmental issues addressed within this initial assessment focused on potential impacts on land and the marine environment. The key issues included the dredging of marine muds, fresh and marine water quality impacts, terrestrial and marine ecological impacts, noise and dust construction impacts, cultural heritage impacts and landscape and visual impacts.

Based on the assessment process described above, the preferred cable route from Lamma Extension to the Wanchai substation was identified. This route is shown in *Figure 2.3a* and offers minimum disruption and environmental effects combined with the best technical solution.

2.4 *THE GAS PIPELINE ROUTING*

It is intended that the new power station will be fuelled by gas provided by a dedicated new pipeline from the proposed regional liquefied natural gas (LNG) terminal in eastern Shenzhen (Cheng Tou Jiao). A route selection exercise comprised two phases was undertaken:

- a desk-top assessment of the physical and environmental constraints associated with the pipeline routing; and
- the subsequent formulation of alternative routing options which avoid these areas.

The constraints identified in the broad routing corridor for laying of this pipeline include:

- Physical Constraints - The primary physical constraints to the routing of the pipeline are the Eastern Waters Marine Borrow Areas and the East of Ninepins Open Water Dredged Material Disposal Site, and the anchorages south of Lamma Island.

- Marine Ecology Constraints - These include the coral communities, potential marine park/reserve at Ping Chau and south Lamma Islands, potential artificial reef deployment sites at Breaker Reef, Ninepins and Po Toi and mariculture zones on the western side of Po Toi Island.

The constraints were mapped to provide guidance to the pipeline engineers as the basis for the route optimisation to avoid areas of physical and environmental constraints. For those parts of the pipeline within Hong Kong SAR territorial waters, the engineers identified two open water route options and two options for the Lamma approach.

The two open water routing options share a common alignment from the point at which the pipeline enters Hong Kong territorial waters to a point south-southeast of Ping Chau. At this point the two options diverge, such that:

- Option 1 is closer to the land mass of Hong Kong and is routed to the west of the Ninepin Island marine borrow area. The pipeline route has a total length of 82 km.

- Option 2 is further from the land mass of Hong Kong and is routed to the eastern side of the Ninepin Island marine borrow area. The pipeline route has a total length of 90 km.

The two route options converge southeast of Waglan Island and share a common route to a point south of Lamma Island, where they diverge as the two Lamma approach options. As the two pipeline options comply with the environmental constraint criteria, the evaluation criteria applied in the selection of the preferred routing encompassed a range of indirect environmental, engineering, route curvature, cable crossing and financial issues. The comparative evaluation identified Option 2 as the preferred open water route for the following reasons:

- the Option 2 route is further offshore and in deeper water with a consequent reduction in the probability of anchor damage;

- the additional route length of Option 2 is within 10% of Option 1 and, as such, will not have significant impact on material or construction costs;

- whilst both options avoid areas of ecological constraint, Option 2 is further away from ecological resource areas, thereby ensuring a greater buffer distance during pipeline laying; and

- the cable crossings associated with Option 2 are less acute than those associated with Option 1, thereby reducing contact area and consequential potential risks.

The Lamma Approach options diverge south of Lamma Island, such that:

- Option A takes a northern course but is routed to the west of the potential boundary of the proposed Marine Park/Reserve with a landfall on the western side of new reclamation.

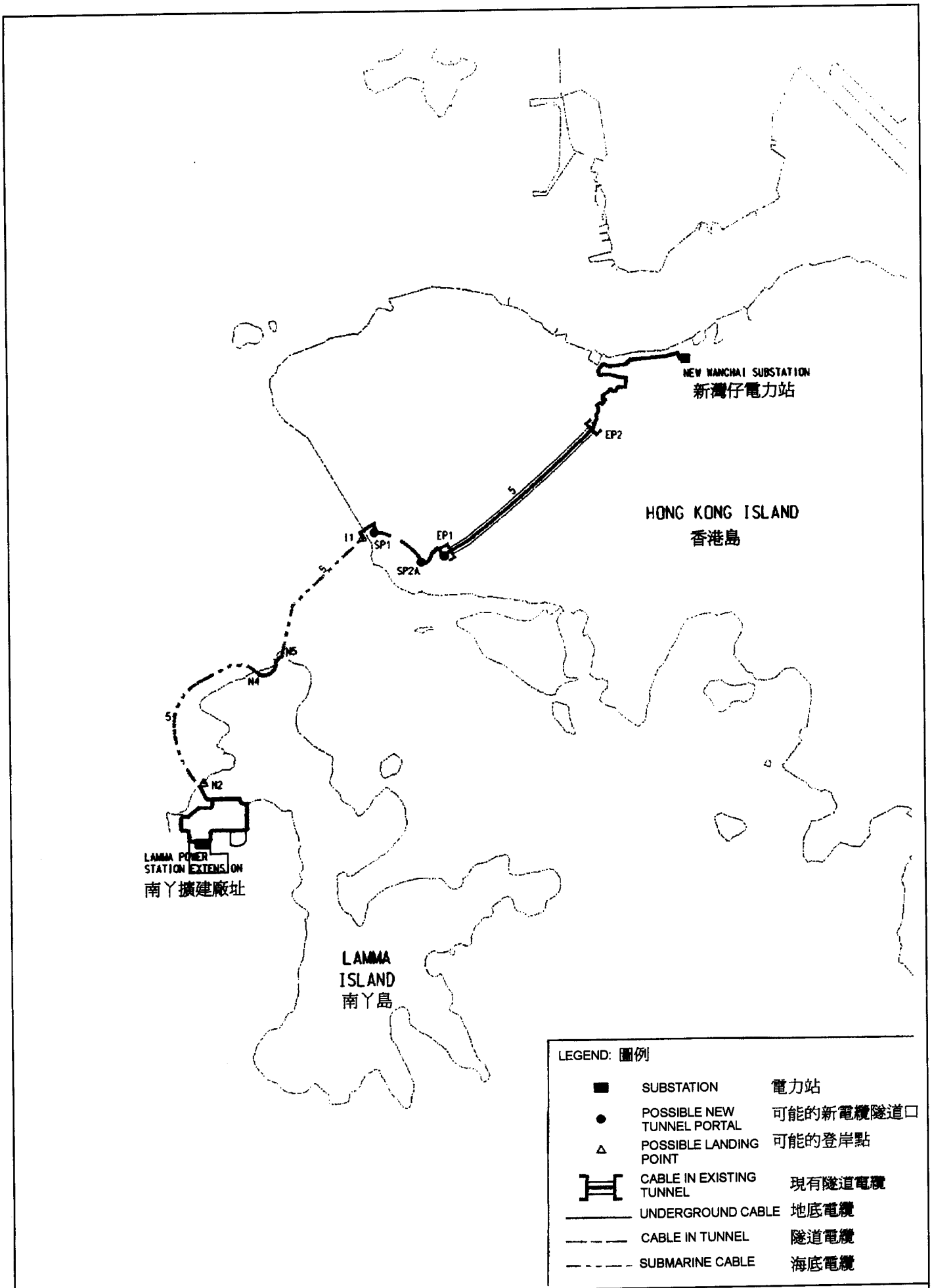

FIGURE 2.3a
圖 2.3a

PREFERRED TRANSMISSION CABLE ROUTE
最可取的輸電纜路線

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- Option B takes a much more direct, northerly course to a landfall on the south side of the Lamma Extension reclamation. This route option encroaches within the potential boundary of the proposed Marine Park/Reserve.

The evaluation criteria applied in the selection of the preferred routing encompassed a range of engineering, environmental, route curvature, cable crossing and financial issues. The comparative evaluation identified Option A as the preferred Lamma Approach route for the following reasons:

- the Option A route is outside the potential boundary of the proposed Marine Park/Reserve which the desk-top study had identified as a Tier 3 water quality and ecological resource region; and

- the route curvature of Option A is considerably less with benefits to the laying of the pipeline.

The route optimisation exercise identified the open water Option 2 and the Lamma Approach Option A as the preferred gas pipeline route. The preferred route of the submarine gas pipeline is shown in *Figure 2.4a* which has been optimised to avoid the marine sensitive receivers .

Actual field survey of the chosen route was then carried out including sounding of the seabed along the route path to ascertain no marine obstacles of any kind were along the pipeline route corridor.

2.5 CONCLUSIONS

The proposed new power station comprises the power generating facilities at the Lamma Extension, an associated transmission system from Lamma to Hong Kong Island and a gas pipeline from Shenzhen to the Lamma Extension. Each of these elements was the subject of a systematic environmental assessment of alternatives before the preferred option was selected, thereby ensuring the minimisation of potential environmental impacts.

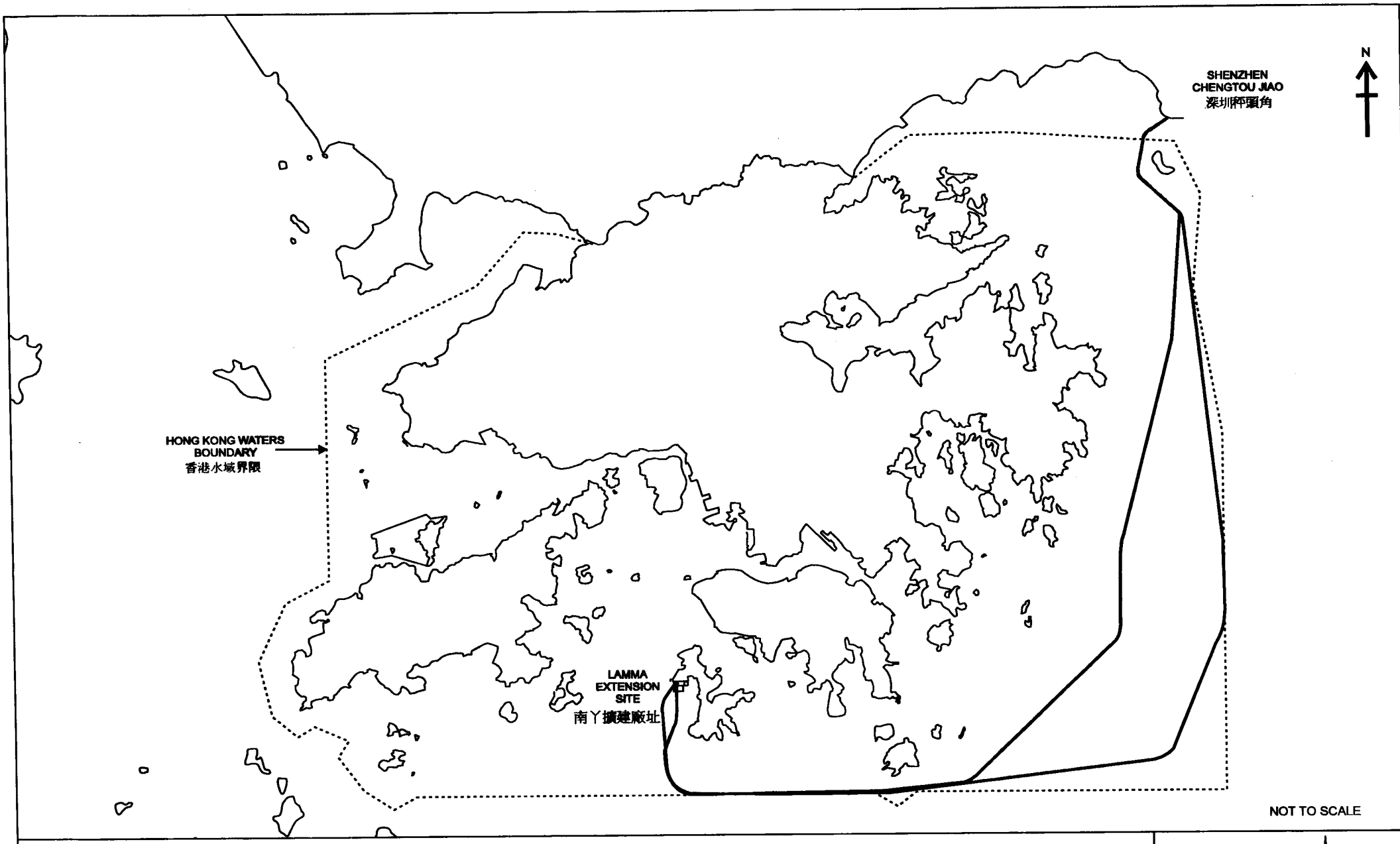

FIGURE 2.4a
圖 2.4a

ROUTE OF GAS PIPELINE
海底輸氣管道路線

PREPERRED GAS PIPELINE ROUTE
最可取的管道路線
ALTERNATIVE GAS PIPELINE ROUTE
可供選擇的管道路線

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3 FINDINGS OF THE TECHNICAL ASSESSMENTS FOR THE POWER STATION

3.1 INTRODUCTION

The full findings of the assessment of impacts to the environment arising from the new power station are presented in the main EIA Report. The key findings and recommendations of each of the technical studies which constituted the EIA Study are presented below.

3.2 AIR QUALITY ASSESSMENT

3.2.1 *The Scope of the Assessment*

The air quality assessment for the power station contained six components:

- a review of the baseline conditions;
- physical (ie wind tunnel) modelling of the combined impacts of emissions from the existing and proposed power stations, as well as the proposed waste-to-energy incineration facilities (WEIF)*;
- numerical modelling of the cumulative impacts of the existing and proposed power station, and the addition of a WEIF on air pollution levels throughout the SAR, especially photochemical pollution;
- a quantitative review of potential impacts of emissions from the new power station on air quality in the wider Pearl River Delta Region;
- an assessment of greenhouse gas emissions and proposed mitigation measures for HEC's overall operations; and
- an assessment of construction dust impacts.

Note: * *It should be noted that the WEIF is not part of the new power station development proposed by the HEC but a Government project currently undergoing a site search study.*

The key findings of each of these components are summarised below.

3.2.2 *Baseline Conditions*

Review of the monitoring results obtained from EPD and HEC monitoring network from 1992 to 1996 revealed that the measured SO_2 and NO_2 concentrations are well within the Air Quality Objectives (AQOs). The maximum hourly concentrations of an average day were chosen for the background levels for the assessment of the cumulative impacts. The background levels for hourly SO_2 and NO_2 are 33μg m^{-3} and 80μg m^{-3} respectively for the urban areas and 23μg m^{-3} and 49μg m^{-3} respectively for the rural/new development areas. For daily and annual averages, it is considered that average annual means for the 5 years period from 1992 to 1996 should be used. The background concentrations for daily and annual SO_2 and NO_2 are 20μg m^{-3} and 51μg m^{-3} respectively for the urban areas and 10μg m^{-3} and 28μg m^{-3} respectively for the rural/new development areas.

3.2.3 *Wind Tunnel Modelling*

Flow Visualisation Tests

The flow visualisation smoke tests generally indicated that larger impacts would be likely to occur with high wind speeds (around 12 to 15 m s^{-1}) than lower speeds (less than 9 m s^{-1}). The tests also suggested that impacts would be greater on or near Lamma Island than on Hong Kong Island or Cheung Chau. From the quantitative tracer gas measurements for five wind speeds under three stack height scenarios, the 110 metre high was recommended for the proposed gas-fired combined cycle units on the Lamma Extension.

Stack Height Determination

Based on the flow visualisation exercise, quantitative tracer gas measurements were made for five wind speeds and three stack height options at 26 receptors on Lamma Island, using the "worst case" emissions scenario of emergency oil firing. The results suggested that acceptable impacts can be expected with the 110 m PD option, which was recommended for the new power station.

Prediction of Combined Impacts in 2002 and 2012

Air quality impacts due to the combined operation of the existing and proposed power stations were then tested with further quantitative measurements. Predicted maximum hourly, daily and annual average concentrations were derived at each receptor for SO_2 and NO_2 respectively. The results indicated that there would be a general reduction in the predicted SO_2 and NO_2 pollution concentrations and the respective Air Quality Objectives (AQOs) would not be breached due to the peak load operations in 2012.

Table 3.2a summarise the hourly and daily average concentrations predicted at various sensitive receivers for SO_2 and NO_2 in 2002 and 2012. Significant improvements in ambient air quality were indicated for the commencement of operations of the new gas-fired power station due to the shifting of the load from the coal-fired units at the existing Lamma Power Station to the much cleaner gas-fired base-load units at Lamma Extension. Long term impacts as measured by the annual averages at each receptor were considered to be very low. Generally speaking, the predicted SO_2 and NO_2 concentrations were well within the AQOs for all modelled receptors.

Table 3.2a ***Predicted Cumulative SO_2 and NO_2 Concentrations ($\mu g\ m^{-3}$)***

Pollutant	Averaging Time	2002	2012 (with WEIF)	AQO
Sulphur Dioxide	Hourly	58 - 732	28 - 461 (31 - 461)	800
	Daily	16 - 169	11 - 90 (12 - 95)	350
Nitrogen Dioxide	Hourly	51 - 248	50 - 184 (51 - 184)	300
	Daily	28 - 75	28 - 64 (28 - 71)	150

Notes 1. Maximum system demand in 2002 is assumed to be 2,794MW which will be generated by the existing Lamma Power Station.

2. Maximum system demand in 2012 is assumed to be 3,916MW, of which 1,800MW will be generated by the new power plant and the remaining 2,116MW will be generated by the existing Lamma Power Station.

Evaluation of Predicted Impacts

The modelling results suggest that there should be no exceedances of the AQOs for any of the three modelled scenarios: the existing plant only in 2002; the new plant fully operational in 2012; and the addition of a waste-to-energy incineration facility (WEIF) at Lamma Island. This conclusion is applicable to conditions in the wind tunnel which resemble the neutral atmospheric stability conditions, commonly known as Stability Classes C and D according to the Pasquill-Gifford Classification Scheme. It is widely accepted that such atmospheric conditions are most representative for modelling worst case impacts during the full load operating conditions of the power station. However, at the request of the EPD, this premise was reviewed with data from the Hong Kong Observatory for 1993 to 1997.

Review of the meteorological data from the Hong Kong Observatory for 1993 to 1997 revealed that the stable atmospheric conditions (Stability Classes E and F) were unlikely to coincide with high load power plant conditions.

Conclusions

The wind tunnel modelling study concluded that:

- a stack height of 110 m PD is adequate for the combined cycle gas-turbine (CCGT) units at the new power station;
- the net and cumulative impact of the operation of the new 1,800MW power station with the existing Lamma Power Station in the year 2012 will not result in any predicted exceedances of the relevant AQOs for SO_2 and NO_2 at identified receptors in the near-field of the power station;
- the operation of a WEIF will not cause any constraints to the proposed development of the new power station and vice versa;
- improved air quality is observed in 2012 compared to 2002 due to the shifting of power station loads from the coal-fired units to the gas-fired units, despite an overall increase in electricity output from 2794 MW to 3916 MW; and
- in the unlikely situation of emergency oil firing, the expected air quality impacts are still within the relevant AQOs.

3.2.4 *PATH Modelling*

Modelling Approach

The PATH photochemical air quality modelling system was used to identify the *incremental* impact on air quality of the new power plant at Lamma Extension, by predicting air quality in 2012 *with* and *without* the emissions from the proposed new facility (Scenarios B and A respectively). The model covers the entire Hong Kong SAR and supplements the wind tunnel results for areas outside the spatial scope of the wind tunnel model.

A key concern was the possible impacts of the CCGT units when prevailing winds are southwesterly and any plume emitted from the proposed facility would be directed towards Hong Kong Island and Kowloon. A meteorology

simulation for the aforesaid conditions has already been developed for PATH and was used as the meterological scenario for predicting hourly and daily concentrations. Five additional days were simulated which represent typical meteorological conditions in Hong Kong. By combining the results of these simulations, annual average concentrations of pollutants may be estimated.

Predicted Hourly & Daily Average Concentrations: Southwesterly Day

For Scenario B all predicted one-hour average NO_2, SO_2 and O_3 concentrations are at least 50% below the AQOs. As a percentage of the hourly AQOs, the maximum contributions of the proposed CCGT units to levels of NO_2, SO_2 and O_3 anywhere within the SAR are 6.5%, 0.5% and 1.9% respectively. Predicted maximum 24-hour concentrations of SO_2 and NO_2 for Scenario B are also well within the AQOs, and the largest incremental contributions of the CCGT units are 0.4% and 3.7% of the AQOs for SO_2 and NO_2 respectively. Also, the contributions of the new power station to the maximum one-hour and 24-hour levels observed by modelling were negligible in the locations where those maxima are predicted to occur. The cumulative impacts involving the proposed CCGT units are well within the AQOs, and the impacts attributable to the proposed new plant are considered to be acceptable.

Predicted Hourly & Daily Average Concentrations: Other Days

The predictions for the other five days indicate that cumulative impacts will not cause pollution levels which exceed either the one-hour or 24-hour AQOs, with maximum predicted levels in the SAR falling between 35% and 64% of the AQOs. The maximum incremental impacts of emissions from the CCGT units on one-hour average and 24-hour concentrations are typically very low and tend to occur over the ocean rather than populated areas. The contributions from the proposed new plant to the maximum predicted levels are negligible.

Estimates of Annual Average Concentrations

Data from the six days simulated were combined to estimate the weighted annual average concentrations of NO_2 and SO_2. The assessment indicates that the highest annual average concentration of NO_2 is predicted to occur in the Western Harbour area and to be less than 80% of AQO (80 $\mu g\ m^{-3}$). The predicted concentration of SO_2 is well within the AQO (about 55%). The incremental contribution of the CCGT units to the maximum predicted NO_2 and SO_2 levels are negligible, especially at the locations where the highest cumulative impacts are predicted.

Conclusions

In summary, it was concluded from the PATH modelling studies that the additional impacts of the new power station on air quality in the Hong Kong region would be acceptable and, in terms of their contribution to maximum predicted levels of key pollutants, largely insignificant.

3.2.5 ***Regional Air Quality Review***

A quantitative assessment of the regional air quality impacts of a new power station was undertaken as part of the Stage 1 EIA. The findings of this earlier assessment were reviewed and updated for the purpose of this detailed EIA Study.

The earlier assessment provided a broad evaluation of the potential regional impacts of atmospheric emissions from the proposed new power station. It evaluated two alternative fuel options (coal and gas) and different emission control technologies for nitrogen oxides. Emissions and their effects at the regional level were addressed, including consideration of sulphur dioxide, nitrogen dioxide, particulates, acid deposition, visibility and photochemical reactions. A three-dimensional prognostic mesoscale meterological model, the *Lagrangian Atmospheric Dispersion Model* (LADM), was used to model the air quality impacts from the proposed new power station. Major existing and future pollution sources that are conductive to photochemical reactions were included in the simulations.

A comparison of scenarios with and without the new power station showed that the predicted maximum ozone (O_3) and NO_2 concentrations in 2012 differ very little, regardless of the technology or fuel used. Predictions for O_3 indicated little impact, suggesting that most of the O_3 originates from other sources. From the regional perspective, the contribution of the new power station to maximum NO_2 concentrations in the Pearl River Delta (PRD) was less than 1%. The new gas-fired power station emissions were also found to have little effect on fine particles and hence visibility. The study also found that the contributions of HEC power plant emissions to acid deposition in the region would be 3% and 1% for the years 2002 and 2012 respectively.

Summary of Review Findings

During the detailed EIA Study, estimates of NO_x and SO_2 emissions from all major sources in Hong Kong were updated and projected for the years 2002 and 2012, and emissions were re-estimated.

The new gas-fired power station would contribute negligibly to maximum regional concentrations of O_3, NO_2 and SO_2, since the emissions from an additional power station, compared to the emissions in the PRD region, are extremely small. There will be a reduction of less than 2% in the predicted O_3 concentration and less than 1% increase in the predicted NO_2 concentration from the new gas-fired power station.

With the introduction of the gas-fired station, HEC's contributions to the PRD regional NO_x and SO_2 concentrations amount to only 1.5% and 0.7% respectively in 2012. The proposed new power station will also help to reduce the overall acid deposition to the region by about 1%. The contributions from the new gas-fired station to regional NO_x and SO_2 are negligible in the context of emissions from the whole PRD region.

3.2.6 *Greenhouse Gas Emissions*

This component of the air quality assessment included the compilation of a greenhouse gas emissions inventory for all HEC operations, and an investigation of the impacts of proposed greenhouse gas mitigation measures.

The inventory was compiled and projected to 2002 and 2012, based on proposed operating parameters and mitigation measures for HEC operations over the estimation period. Total emissions were projected to increase from 1990 levels by 80% (5.11 Mt) and 62% (3.97 Mt) in 2002 and 2012 respectively, illustrating the beneficial impact of using gas-fired units for base-load operation after 2002 despite total electricity generation in the year 2012 being 2.57 times that of 1990. Estimated greenhouse gas emissions *per unit of energy produced* were predicted to fall from 1990 levels by 37% in 2012.

The impacts of mitigation measures in the areas of increased production and distribution efficiency, use of fuels with intrinsically low greenhouse gas emissions, improved consumption efficiency, reduced fugitive emissions, and carbon sequestration, were quantified in the assessment. A total of 6.5 million tonnes of emissions of CO_2 equivalent will be avoided in 2012 as a result of these measures (a 39% reduction in overall emissions), leaving an estimated total of 10.3 million tonnes for HEC operations in that year. The total mitigation achieved in 2012 will be more than HEC's total emissions in 1990.

HEC is committed to adopting all practical measures for reducing its greenhouse gas emissions, especially from the proposed 6 x 300 MW gas-fired power station. Measures such as base-load shifting to gas units, gas flaring and participation in afforestation programmes will be employed. With all these measures implemented, HEC is able to reduce the CO_2 emissions per unit electricity generated by 37% below the 1990 level in 2012. However, since both Hong Kong's population and economy will continue to grow substantially into the next decade, such reductions will still fall short of the Kyoto Protocol perceived objectives for developed countries. HEC will nevertheless continue to explore and implement all feasible and practical mitigation options to further reduce its greenhouse gas emissions in line with the Government policy.

3.2.7 *Construction Dust*

The potential impacts on sensitive receivers of dust emissions from construction work associated with the Lamma Extension reclamation and power station development were estimated and evaluated. Predicted dust concentration levels (without mitigation) at sensitive receivers were in the range of 104 to 178 $\mu g\ m^{-3}$ (hourly average) and 56 to 61$\mu g\ m^{-3}$ (daily average), both well within the recommended criteria of 500 and 260 $\mu g\ m^{-3}$ respectively. No special mitigation measures (beyond good site and housekeeping practices) were proposed.

3.2.8 *Conclusions of the Air Quality Assessment*

The potential air quality impacts of the proposed power station at Lamma Extension, and the cumulative impacts of emissions from both the proposed power station and other sources, have been quantitatively assessed with a combination of physical and mathematical modelling studies and desk top evaluations. The near-field, mid-field and far-field impacts of the new development are considered to be environmentally acceptable. Extensive gains in greenhouse gas emissions have been identified for the mitigation measures which have been proposed for the new project and HEC operations in general.

Table 3.2b shows the estimated electricity consumption and the annual emissions of SO_2, NO_x and CO_2 in years 2002 and 2012. 2002 represents the baseline scenario of the existing Lamma Power Station fully operating a year before the scheduled commissioning of the first 300MW gas-fired unit. 2012 stands for the fully developed scenario for the 1,800MW gas-fired power station in operation with the existing units.

Due to the shifting of base load from the existing coal-fired units to the new gas-fired combined cycle units, the emissions of SO_2 and NO_x will be significantly reduced from HEC sources, following the full commissioning of the Lamma Extension, despite the total electricity generation in 2012 is 43% higher than that in 2002. The reductions in SO_2 and NO_x will benefit the local air quality in Hong Kong, as well as regional air quality and acid rain depositions in the Pearl River

Delta. An overall reduction in greenhouse gas emission is also observed as indicated by the change in CO_2 emissions from 2002 to 2012.

Table 3.2b ***Estimated Emissions of SO_2, NO_x and CO_2 in Future Years***

Annual Total	2002	2012	% Change
Electricity Output (GWh)	13,351	19,142	+43%
SO_2 (Tonne)	47,687	18,426	-61%
NO_x (Tonne)	41,068	24,669	-40%
CO_2 (Tonne)	11,355,533	10,208,105	-10%

3.3 WATER QUALITY ASSESSMENT

3.3.1 *Construction Impacts*

Assessment of the water quality impacts of construction work for the Lamma extension project was focused on impacts on the hydrodynamic regime, and the dispersion of sediments during dredging and filling operations.

The *hydrodynamic assessment* included a baseline scenario (current conditions), and scenarios for both the Lamma Extension reclamation on its own, and the combination of Lamma Extension and WEIF reclamations. Discharges were calculated for each of the three scenarios. Modelled changes at the cross-section were found to be relatively small. The discharge rate across the southeast cross section was predicted for the Lamma Extension scenario in the dry season. The average discharge rate was found to change by 2%. This shows that impacts are small.

Four scenarios were constructed for *sediment dispersion modelling* to simulate different approaches to dredging operations and differing intensities of dredging activity. The most intensive of these (Scenario 1 - comprising 5 large grab dredgers & 1 small grab dredger) was simulated for four representative tide types (wet and dry season, spring and neap tides), and the results were used to determine the "worst case tide and season", which was then used for simulations with Scenario 2 (3 large grab dredgers & 1 small grab dredger) and Scenario 3 (1 trailer dredger & 2 large grab dredgers). A fourth scenario (involving simultaneous dredging and filling) is programmed for implementation in the wet season only, so only wet season spring and neap tides were simulated.

The simulations showed significant exceedances of water quality objectives (WQOs) for suspended solids (SS) for Scenario 1, and it was concluded that a lower rate of dredging would be required to meet the WQOs. The dry season neap tide was determined as the "worst case". Predicted SS levels for Scenario 2 was higher than Scenario 3 using these "worst case " conditions. It is anticipated that dredging by either scenario 2 or 3 would be able to meet the TM limits provided that silt curtains are deployed on the eastern, southern and north western sides of the reclamation during dredging, that for Scenario 2 the number of large dredgers is reduced on the flood tide and that proper EM&A monitoring is implemented. The simulation of combined dredging and backfilling operations (Scenario 4) produced results which were considered to be environmentally unacceptable. These results suggest that fill material will have to be retained during sand filling to prevent loss of excessive fines to the water column, so sea walls to above sea level should be in place before backfilling of the site platform commences.

Assessment of the cumulative impacts involving dredging for Container Terminal 9 and sand winning and backfilling at the South Tsing Yi Marine Borrow Area (STY MBA) revealed that majority of the impacts were not contributed by the Lamma Extension construction. Further mitigation measures on the Lamma Extension construction alone will not improve the situation. The EM&A programme would therefore be designed to ensure coordination between HEC and other project developers such that appropriate mitigation measures would be implemented by the relevant parties to prevent unacceptable impacts.

A range of mitigation measures was recommended as a result of the assessment, including constraints on dredging which correspond to environmentally acceptable scenarios, and recommended dredging methods, procedures, rates, the use of silt curtains and reducing dredging rates at certain stages of the tidal cycle.

3.3.2 *Operational Impacts*

The operational phase assessment examined the potential impacts of discharges of heated power station cooling water and residual chlorine, and potential changes in the local sedimentation regime.

The assessment of the *thermal discharge* considered the same three types of scenarios as the hydrodynamic impact assessment, and the assessment found that the WQO (no more than 2°C rise) was met at each of the SRs, even with the combined discharges of the existing and proposed power stations and the WEIF.

HEC is actively investigating the suitability of various types of anti-fouling agents for the cooling water system of the proposed new units. In this study, chlorine in the form of hypochlorite solution which is by far the most commonly adopted and reliable means of controlling marine growth was assumed for both the existing and proposed power stations, as well as the proposed WEIF assuming sea water would be used for plant cooling as the worst scenario. It was assumed that the discharge concentration for the residual chlorine for the Lamma Extension and the WEIF would be 0.3 mg/l, which is the same as the existing power station. The dispersion and decay of residual chlorine in the marine environment were analysed by modelling and laboratory testing to assess potential water quality impacts.

Based on a discharge concentration of residual chlorine of 0.3mg/l which is the same as the existing Lamma Power Station, the chlorine dispersion modelling predicted that within an area approximately 700 metres seaward of the existing outfall and extending southwards 1,500 metres to the south Lamma Extension outfall, the concentrations of residual chlorine would reduce to below 0.01 mg/l without impacting any sensitive receivers. Laboratory testing further proved that the chlorine concentration decay much faster in the marine water and suggested that the above modelling result was on the conservative side. The impacts to water quality would be localised to the outfalls vicinity and as such were considered to be environmentally acceptable. For the new plant, HEC will endeavour to further lower the discharge concentration of residual chlorine to 0.2 mg/l, and explore at the design stage the use of alternative biocides which are more environmentally acceptable.

Assessment of Sedimentation Changes

The assessment of impacts on the *sedimentation* regime was based on the hydrodynamic modelling for the construction phase, and concluded that there

would be no significant changes to either the tidal or sedimentation regimes as a result of reclamations constructed for the Lamma Extension and WEIF projects.

3.3.3 *Conclusions of the Water Quality Assessment*

The water quality assessment for the power station concluded that the impacts of the project would be acceptable (including the cumulative impacts), provided that the recommended mitigation measures were implemented. In particular, some regulation of dredging work at the site may be required to prevent cumulative impacts at some sensitive receivers from exceeding acceptable levels. In addition, all the storm drains at the Lamma Extension site will be designed to discharge away from the Hung Shing Ye Bay during construction and operational phases.

3.4 *NOISE ASSESSMENT*

3.4.1 *Construction Impacts*

The potential noise impacts of dredging, reclamation, piling, civil, structural, building and other construction work for the Lamma Extension project were assessed. Based on recognised data on sound power levels for the machinery and equipment to be used, and equipment inventories and work schedules for different phases of the project, noise levels at identified Noise Sensitive Receivers (NSRs) were estimated. The assessment found that predicted levels were environmentally acceptable, even for work during hours restricted by the NCO.

3.4.2 *Operational Impacts*

The operational noise assessment considered the potential impacts of all significant noise sources in the proposed power station complex. A computer model of the plant was developed to predict noise levels resulting from the large number of sources involved, taking into account atmospheric attenuation and the barrier effects of existing and proposed buildings and the local terrain.

The predicted noise levels at the nearest NSR at Hung Shing Ye were estimated for the combined impacts of both the existing and proposed power stations. Results show that the cumulative noise impacts will be below the NCO limits due to shifting of base load operation to Lamma Extension and hence less units will be operated in the existing Lamma Power Station during night time.

On the basis of this assessment, plant noise during normal operation is not expected to give rise to unacceptable environmental impacts, assuming the general utilisation of commercially available low noise plant and equipment.

3.4.3 *Conclusions of the Noise Assessment*

The assessment concluded that both the construction and operational noise impacts for the proposed power station are environmentally acceptable. It also provided guidance on approaches to mitigation for a variety of machinery and equipment to be used in the proposed power station. A further noise study during the detailed design of the plant was recommended to further refine the operational noise estimates. Noise compliance tests were recommended for major items of equipment, and a major noise survey after plant commissioning was proposed.

3.5 *LANDSCAPE AND VISUAL IMPACT ASSESSMENT*

The main potential impacts were considered to be the construction works, the new chimneys, power station and administration buildings, and raw water tanks on the Lamma Extension.

Views from many of the more populated areas on Lamma Island will be obstructed by the Po Lo Tsui headland, while those from many of the smaller villages and the recreation areas are largely impeded by the existing power station. Even the partial views that are available from some locations are not considered to have significant adverse impacts, as the existing station is larger and closer to viewers. However, the new station will be visible from Lo So Shing Beach as a separate entity.

For some of the more distant viewers, only the tops of the new chimneys will be visible, while for others the intervening distance and the existing visual character of the area (which is dominated by the existing power station) will reduce the expected impacts to negligible or acceptable levels.

The assessment has concluded that landscape and visual impacts will be acceptable with the implementation of the recommended mitigation measures. A number of mitigation measures as shown in *Figure 3.5a* were recommended to minimise impacts, including site layout, the form and arrangement of buildings and structures, the use of appropriate colours for buildings, and landscaping along the edges of the reclamation.

3.6 *WASTE ASSESSMENT*

The assessment examined the potential impacts from the generation, handling, storage, collection and disposal of wastes arising during the construction and operational phases of the project. Estimates were made of the types and quantities of waste that are expected. Options for waste minimisation, recycling, storage, collection and disposal of waste were examined, and measures for minimising the impacts were recommended.

The types of *construction waste* that were evaluated included dredged and excavated material, construction and demolition waste, chemical wastes and general refuse.

To reduce the quantity of dredged material a reclamation method has been recommended which limits dredging to areas under the seawall and the northern half of the reclamation, thus reducing material arisings by 15%. This material is uncontaminated, and about 5.2 Mm^3 will require disposal at designated dumping grounds at an average rate of about 44,000 m^3 per day.

Arisings of excavated material are not expected to be significant, but at least 7000 m^3 of construction and demolition waste is anticipated. It is expected that all the materials can be reused on site. Therefore no surplus excavated material will be generated. Chemical wastes are not expected to present a problem if recognised practices for minimising, handling and disposal of these wastes are followed. About 600 kg per day of general refuse is expected to arise during construction.

The *operational phase assessment* examined potential arisings of industrial and chemical wastes, sewage and general refuse. No significant impacts or concerns were identified for any of these waste types.

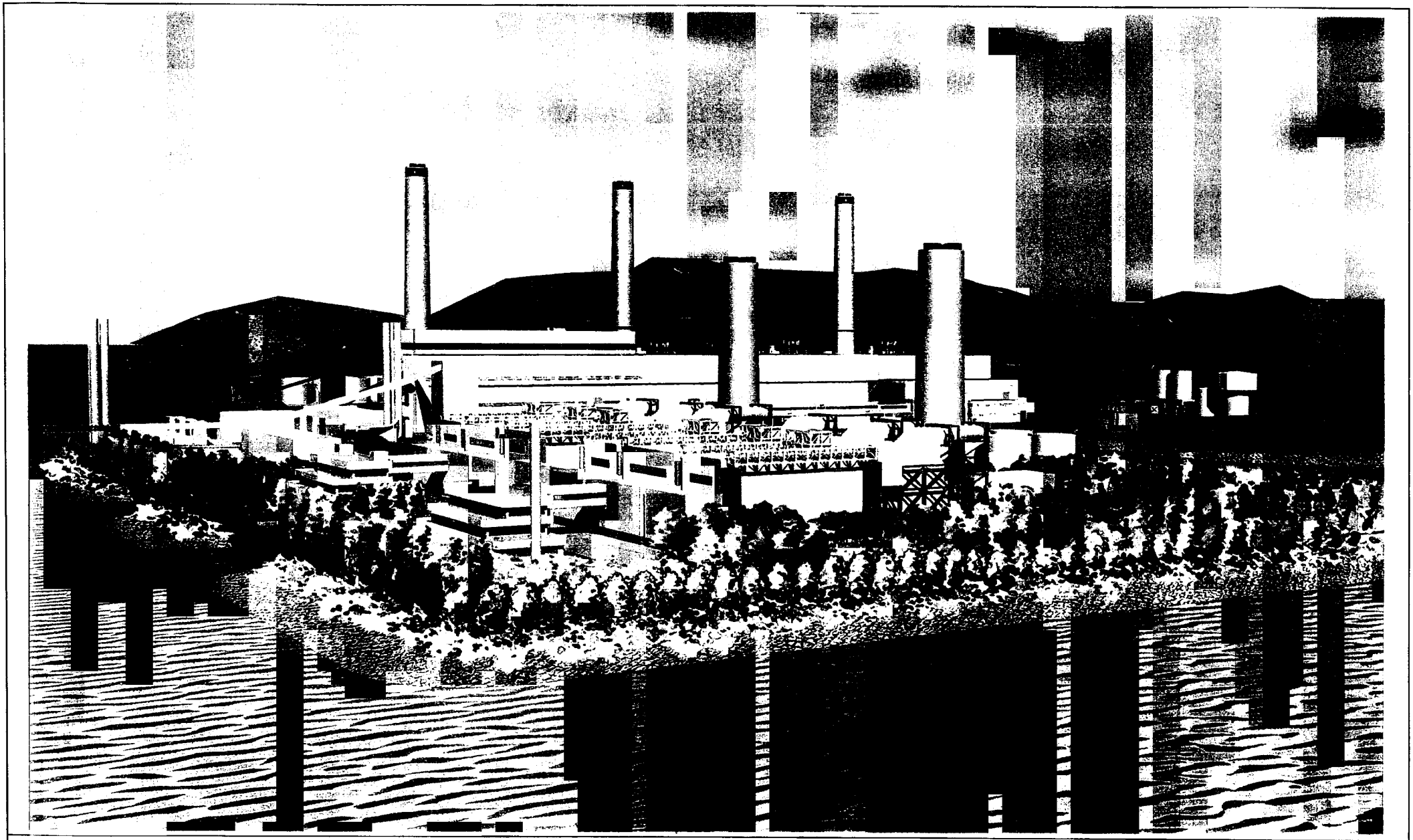

FIGURE 3.5a
圖 3.5a

PERSPECTIVE OF THE LAMMA EXTENSION SITE FROM SOUTHWEST WITH LANDSCAPING
從西南方觀看加以園林設計的南丫擴建發電廠

Environmental
Resources
Management

ERM

Proposed *mitigation measures* based on the accepted hierarchy of waste management were developed for managing waste arisings. These include:

- practices and procedures for minimising arisings of waste building products and materials, and industrial and chemical wastes;
- on-site reuse of excavated materials and other clean spoil;
- safe storage of chemicals and chemical wastes; and
- acceptable disposal options for different types of waste, such as dredged material, clean construction waste, chemical wastes and general refuse.

In conclusion, no unacceptable waste impacts are expected from the construction and operation of this project.

3.7 *LAND CONTAMINATION ASSESSMENT*

The assessment of the potential for land contamination focused primarily on the light gas oil system for the power station, and the storage and handling of chemicals and other dangerous goods.

In particular, the assessment evaluated the design and engineering measures, operating and emergency procedures (including inspection and monitoring arrangements, and reporting and recording of incidents), material and waste management practices, and drills and training activities, that are proposed by HEC to prevent, and in the last resort, manage the consequences of spills, leaks and other losses during the storage, transfer and handling of the light gas oil.

In addition, the assessment proposed a series of preventative measures to minimise the potential for spills and subsequent contamination from the storage and handling of chemicals and chemical wastes.

The assessment concluded that the potential for land contamination would be minimal if the proposed measures are implemented.

3.8 *MARINE ECOLOGY ASSESSMENT*

The assessment of potential impacts on marine ecological resources (habitats and species) considered both the direct and indirect potential impacts during the construction and operational phases of the project.

3.8.1 *Baseline Conditions*

The baseline conditions for the assessment were established through a review of the available literature and field surveys. Based on this work, the following marine ecological sensitive receivers were identified:

- high ecological value subtidal habitat at Ha Mei Tsui (SW Lamma);
- Finless Porpoise habitat in the coastal waters off southwest Lamma (as defined by the main area where finless porpoise populations have been observed); and
- the potential South Lamma Marine Park or Marine Reserve.

The ecological values of hard and soft bottom habitats in the potentially affected areas along the west coast of Lamma were then evaluated using the criteria in Annex 8 of the Environment Impact Assessment Ordinance Technical Memorandum (*EIAO TM)*, which yielded the following overall assessments:

- *Low* ecological value habitats with low diversity and abundance including: sandy shores, hard bottom subtidal habitats at West Lamma Coast from Yung Shue Wan to Lo So Shing (sites T1 - T4), soft bottom subtidal habitats of the reclamation site and marine waters close to the power station;

- *Medium* ecological value habitats with key features being lack of disturbance, size and moderate conservation interest including: rocky intertidal habitats along the west coast of Lamma and, hard bottom subtidal habitats at Ha Mei Tsui North (site T5); and

- *High* ecological value habitats with high conservation interest including: hard bottom subtidal habitats at Ha Mei Tsui South (site T6), and marine waters off the southwest coast of Lamma supporting finless porpoise population.

3.8.2 *Impact Assessment*

Direct impacts during *construction* will include direct loss of habitat due to the reclamation and indirect impacts due to water pollution. During the *operational* phase adverse impacts may be caused by the thermal discharge and residual chlorine in cooling water, and by entrainment or impingement of organisms in cooling water intakes.

Based on the results of the modelling work undertaken in the water quality assessment for the power station and an evaluation of the impacts in accordance with the *EIAO TM,* potential impacts to marine ecological resources during the construction phase of the project may arise from direct disturbances to habitats, or through changes to key water quality parameters, as a result of the reclamation for the Lamma Power Station Extension. No impacts are predicted to the medium value intertidal habitats identified from the field surveys. Subtidal assemblages of high ecological value (Ha Mei Tsui) are also not predicted to be impacted by either the construction or operation of the power station extension. Although the soft bottom habitat within the area to be reclaimed will be permanently lost, this habitat is of low ecological value.

Critical habitats utilised by the finless porpoise (eg coastal waters of southwest Lamma) are not predicted to be affected by either construction (dispersion of sediment plumes, vessel traffic, construction underwater noise) or operation (dispersion of cooling water and biocides, and vessel traffic) of the power station extension. The potential south Lamma marine park / marine reserve is not predicted to be impacted by either the construction or operation of the power station extension.

Mitigation measures specific to marine ecology include the provision of greater than 31,000 m^2 of rubble mound seawalls on the western and southwestern edges of the reclamation to facilitate recolonisation by soft corals and gorgonians. These low density assemblages cover an area of 30,000 m^2 located within the reclamation site and will be lost during construction of the power station extension. Other mitigation measures designed to mitigate impacts to water quality to acceptable levels (compliance with water quality objectives), including

constraints on dredging, the use of silt curtains and site platform filling operations, are also expected to mitigate impacts to marine ecological resources.

Mitigation measures designed to avoid impacts of vessel traffic to marine mammals, were complied in consultation with Dr Tom Jefferson of the Ocean Park Conservation Foundation, include the rerouting of all vessels involved in construction or operation of the power station extension so they approach the power station from the north or via the East Lamma Channel. During construction stage, all usage of percussive piling works will only be performed on reclaimed land to avoid noise impact to marine mammals. This is expected to mitigate impacts to the finless porpoise centred off the southwest coast of Lamma Island.

The residual impacts occurring as a result of construction and operation of the power station extension are the direct loss of the low ecological value subtidal assemblages present within the reclamation site and the indirect loss of the low ecological value assemblages outside of the reclamation site. The loss of the habitat within the reclamation site can be partially mitigated through the provision of rubble mound seawalls on which soft corals and gorgonians assemblages (lost during the reclamation) can colonise and grow. This mitigation measure coupled with the finding that the habitat is of low ecological value combine to reduce the magnitude of the residual impact to acceptable levels. The assemblages lost outside of the reclamation site are of low ecological value and are expected to recolonise once construction works have ceased. In the light of this the residual impact is considered to be acceptable.

An ecological monitoring programme involving the use of a remotely operated vehicle will be conducted to monitor predicted impacts to the soft corals and gorgonians adjacent to the reclamation site and to report on the progress of recolonisation of the rubble mound seawalls once construction works have ceased. As an additional habitat enhancement measure HEC have undertaken to deploy a minimum of 400 m^3 of Artificial Reefs in Hong Kong waters at a site (or sites) to be decided upon in consultation with the Director of Agriculture and Fisheries.

Further monitoring and audit activities specific to marine ecology are not deemed necessary as those conducted to detect and mitigate any unacceptable impacts to water quality will serve to protect against unacceptable impacts to marine ecological resources.

3.9 *FISHERIES IMPACT ASSESSMENT*

The fisheries impact assessment considered both direct and indirect impacts on fisheries resources, fishing operations and fish culture activities during construction and operation of the power station. A red tide assessment was also undertaken.

3.9.1 *Baseline Conditions*

A desk top study was undertaken to establish the baseline conditions for the assessment, and the importance of fishery resources in areas that may be adversely affected by the project. The size and value of the catches for the Fishing Zones within the Study Area characterise them as of medium to high importance to Hong Kong fisheries. Specific areas to the south of Hong Kong are

also recognised as spawning and nursery areas for important and high value commercial species, and these were established as sensitive receivers for the purposes of the assessment.

3.9.2 *Impact Assessment*

Direct impacts during *construction* will include loss of habitat due to the reclamation (including approximately 22 ha of seabed, about 5% of the Po Law Tsui Fishing Zone which equates to a 0.05% decrease in the value of Hong Kong fishery and is regarded as low), and indirect impacts due to water pollution. During the *operational phase* adverse impacts may be caused by the thermal discharge and residual chlorine in cooling water, and by entrainment or impingement of organisms in cooling water intakes. Based on the results of the water quality modelling exercises, it is expected that the largest impacts during construction will be localised to within and around the construction works, and that fisheries resources will not be significantly affected.

The results of the thermal plume modelling for the power station show that the cooling water effluent is not predicted to raise the temperature of the water column to levels higher than those with the existing power station. It should be noted that the cooling water requirement for a combined cycle plant is only about half of that of a coal fired plant with the same MW output. Although the MW demand in 2012 is higher than that in 2002 (3916MW vs 2794MW) by 40% during peak demand time, the total cooling water quantity for both existing and Lamma Extension is increased by less than 10% since the more efficient gas fired units will be on base load and that fewer coal fired units need to be run compared with that in 2002. In fact, for most of the time throughout the year, the quantity of the cooling water required for existing and Lamma Extension combined in 2012 is less than that for the existing units alone in 2002, hence the thermal plume and entrainment impacts are not expected to be worse than existing conditions.

An extensive literature review and analysis was also undertaken to examine the relationship between elevation in water temperature and the occurrence of red tides. This analysis indicated that discharges with elevated temperatures are not thought to be the primary cause of red tides or harmful algal blooms, and that conditions arising from cooling water discharges from the new power station are not conducive to the initiation of a red tide or harmful algal bloom.

The assessment identified habitat loss in the Po Law Tsui fishing zone as a residual impact. The combination of the small area affected and the low dependency on the area by local fishermen (about 0.05% of catch value) combine to reduce the magnitude of this residual impacts to acceptable levels. It should be noted, however, that permanent loss of fishing ground may be subject to claims for *ex gratia* allowances which are administered by the Planning Environment and Lands Bureau.

Residual chlorine levels are only likely to occur in close proximity to the outfall in the surface layers of the water column. Lethal or sublethal effects are not expected to occur to fisheries resources as research has indicated that adult fish will avoid areas where concentrations are elevated. Further away from the immediate vicinity of the discharge points the concentration of chlorine is low (less than 0.01 mg L^{-1} - below field detectable levels) and below the level at which toxic effects have been demonstrated to occur for fish eggs, fry and adult, the severity of this residual impact is considered to be low.

The loss of fishing area can be partially mitigated through the provision of rubble mound seawalls on which more diverse and abundant ecological assemblages than present in the existing flat muddy seabed can colonise and grow. This may enhance the value of the area to the fishery by providing habitat for juvenile and spawning resources that is not present on the existing flat muddy seabed of the reclamation site.

In summary, based on an evaluation of impacts in accordance with the *EIAO TM*, it was concluded that the expected impacts during both construction and operation would be acceptable.

3.10 *HAZARD ASSESSMENT*

Hazard assessments for both the fuel gas and non-fuel gas hazards associated with operation of the proposed power station were carried out. The assessment of fuel gas hazards was qualitative, and a more detailed assessment will be required by the Gas Standards Office (GSO) for the detailed design stage.

3.10.1 *Fuel Gas Hazards*

No fuel gas storage is provided on site, except that a gas receiving station will be required to receive natural gas delivered from a regional LNG terminal through a pipeline. The consequences of a major release of fuel gas (eg from the gas receiving station) could be severe with little scope for protection or escape. However, the siting of the gas receiving station is generally favourable from an off-site risk perspective as it lies over a kilometre from the nearest residential population.

Various standards and codes of practice exist for high pressure systems such as gas receiving stations and other gas facilities at the power station. These standards recognise all the hazards which have been identified and offer a variety of effective design solutions.

One issue which emerged from the Hazard Assessment for the gas receiving station was the importance of safety management, recognising that most industrial accidents have their root cause in human error. An effective safety management system will assist HEC in meeting the requirements which GSO may impose when HEC come to apply for registration as a gas supplier.

It was concluded from the high level qualitative review of the fuel gas hazards that the risks associated with the proposed new power station are acceptable.

3.10.2 *Non-Fuel Gas Hazards*

The risk associated with the light gas oil (LGO) system relates mainly to fire, although explosion is also possible in certain circumstances. An assessment of the thermal radiation levels which could arise in a major fire at the Lamma

Extension shows that the radiation levels will not exceed injury levels at the nearest residential population on Lamma, but may be exceeded beyond the site boundary in the immediately vicinity of the LGO storage area and the LGO unloading jetty. The effects of an explosion involving the light gas oil system would be confined to the Lamma Extension site itself and are not considered to present an off-site fatality risk.

The effects of an incident involving hydrogen would not lead to fatal off-site injury, as the hydrogen pipework to be provided for this project is small bore, and operating at relatively low pressure.

The various packaged DGs to be stored at the Lamma Extension present a hazard in terms of fire, explosion, toxic injury (due to the generation of toxic gases by fire, decomposition or chemical reaction) and projectiles (rocketing of drums and cylinders in a fire). The toxic products released in a fire may cause injurious effects at the site boundary but it is not considered that fatal effects could arise. Furthermore, the effects of fire, explosion or accidental mixing of chemicals (leading to toxic gas release) would also not extend off-site. The only hazard for which fatal off-site effects could conceivably arise is that of projectile generation due to a major fire at the DG store.

Various types of potential incident at the Lamma Extension were identified which could escalate to involve the fuel gas facilities. However, the fuel gas facilities at the Lamma Extension are well located with respect to incidents which could arise from other sources. They also include protective safety features typical of such installations, including an emergency shutdown valve on the main gas supply pipeline and an emergency depressurising and flare system.

A quantitative assessment of off-site risks due to accidents associated with the transport, storage and handling of the non-fuel gas DGs at the Lamma Extension shows that the risks are well below Government Risk Guidelines.

3.10.3 *Cumulative Risks*

In conclusion, no unacceptable risks associated with either the fuel gas-related or non-fuel gas hazards were identified during the assessment.

Although a more detailed assessment of the fuel gas hazards is still required by GSO, the results of the assessments reported above have indicated that the cumulative risks associated with the proposed project are acceptable.

3.11 *Conclusions of the Power Station Assessment*

A detailed and comprehensive assessment of the potential impacts of the proposed new power station and associated facilities at the Lamma Extension site has been completed. No unacceptable or insurmountable impacts (including cumulative impacts associated with other projects and activities) are expected from the proposed development, provided the recommended mitigation measures are adopted and implemented.

4 FINDINGS OF THE TECHNICAL ASSESSMENTS FOR THE TRANSMISSION SYSTEM

4.1 INTRODUCTION

The full findings of the assessment of impacts to the environment arising from the transmission system are presented in the main EIA Report. The key findings and recommendations of each of the technical studies which constituted the EIA Study are presented below.

The proposed network is planned to be installed in two stages, covering western and eastern areas of Hong Kong respectively. Assuming Stage 1 transmission network has to be commissioned by December 2002 to meet with the commissioning of the first generating unit at Lamma Extension, the Stage 2 transmission link for receiving substation at Quarry Bay/Mt. Parker will not be required until 2007. Till then the load growth pattern in Hong Kong Island East has to be further studied and the location of the receiving substation and the load injection arrangement into HEC network have yet to be identified. The Stage 2 cable routing cannot be determined now. It is therefore considered more appropriate to focus the current assessment on the Stage 1 transmission route, while leaving further study on Stage 2 routing upon the identification of the receiving substation and finalisation of the transmission route.

4.2 CONSTRUCTION DUST ASSESSMENT

The potential air quality impacts of airborne dust arising from construction of the tunnel, landing points and cable trough on Lamma Island, and the landing point on Hong Kong Island, were assessed.

The predicted dust levels at the nearest air sensitive receivers, at approximately 350m from the work sites are very low and similar to the existing background concentrations. Modelling results have confirmed the view that the potential dust impact is negligible.

4.3 WATER QUALITY ASSESSMENT

Impacts to water quality during cable laying will occur as a result of disturbance of seabed sediments during cable burying and excavation for the landfall approaches and hard seabed surfaces.

A conservative estimate was made of the likely rate of sediment release from jet ploughing of the cable trenches. Based on a comparison of this estimate with release rates from grab dredging, and the expectation of faster settling of sediments released only at the bottom of the water column, elevations in suspended solids (SS) concentrations were predicted to be very localised and of short term duration.

Similarly, the impacts of excavation near the landing points were also expected to be small and of short duration. The amount of material to be dredged is only about 8,000 m^3 for each cable landing point and the excavation would be carried out quite slowly.

Potential impacts on other water quality parameters such as dissolved oxygen and nutrient concentrations were also considered to be small because the sediment is unlikely to be contaminated or in suspension for a long enough time.

The only impacts that may occur during the operational phase would result from system maintenance and repair, for which the impacts are expected to be similar in nature and lesser in scale and period than during construction.

It was therefore concluded that construction and operation of the transmission system would not give rise to any unacceptable water quality impacts, and no mitigation is required.

4.4 *CONSTRUCTION NOISE ASSESSMENT*

This assessment considered the potential noise impacts during construction of the cable tunnel which consists of 18 micro horizontal bore-holes of 250mm diameter, landing points and cable trough on Lamma Island, and the landing point on Hong Kong Island.

The predictions showed that for a small number of residences located close to the Cable Landing points N4 and N5 (Pak Kok Tsui), the day time noise exposure is expected to be close or slightly exceed the 75 dB(A) criterion for general construction works contained in the EIAO-TM. Therefore, modest mitigation measures will need to be considered and a limited environmental noise monitoring programme carried out.

If pile driving should be required at Landing Site N5, and if it is decided to employ percussive piling techniques, then the selection of one of the "quiet" types of piling rigs would be necessary in order to avoid exceeding the applicable noise criterion - also 75dB(A) - since the use of diesel, hydraulic or steam-powered piling rigs would result in this limit being exceeded by 7 to 20dB(A).

In conclusion, the predicted impacts of the project would be acceptable, provided that the recommended mitigation measures were implemented. In particular, careful timing of construction activities may be required to prevent cumulative impacts from exceeding acceptable levels.

4.5 *MARINE ECOLOGY ASSESSMENT*

The assessment of potential impacts on marine ecological resources (habitats and species) considered both the direct and indirect potential impacts of laying the submarine transmission cables and constructing the associated landing points.

4.5.1 *Baseline Conditions*

The baseline conditions for the assessment were established by literature review and from the results of comprehensive two season field surveys has indicated that the area potentially affected by the transmission system does not contain any marine ecology sensitive receivers (defined as habitats of high ecological value) apart from isolated patches of soft and hard corals present at very low densities.

The ecological values of marine habitats in the potentially affected areas were then evaluated using the criteria in Annex 8 of the *EIAO TM*, with the following results:

- intertidal habitat at the proposed landing and launching points: *low* ecological value, supporting assemblages of a diversity which is typical to Hong Kong;

- subtidal habitat at the proposed landing points: *low* ecological value, with lower diversity and abundance than other areas; and

- soft bottom habitat along the cable route: *low* ecological value, supporting a low diversity and abundance of infaunal organisms that are typical to Hong Kong.

4.5.2 ***Impact Assessment***

Direct impacts during construction will include the loss of habitat at the sites of the three landing points on Lamma Island and along the routes of the cable trough and the submarine cables. As the landing point on Hong Kong Island will be located on an existing sea wall, no impact will occur.

Intertidal and subtidal rocky shores will effectively be lost at the landing points and replaced by artificial seawalls. These seawalls could, however, support a rich assemblage of intertidal fauna and flora through recolonisation, provided a suitable (heterogeneous) seawall design is adopted. Assuming successful recolonisation can be achieved, no adverse impacts are expected.

Short terms impacts are also predicted during trench formation associated with the cable laying, especially where jet ploughing is required. After these works have been completed, it is expected that the epibenthic and infaunal benthic assemblages will recolonise the affected areas.

Indirect impacts are expected to arise from increases in pollution associated with the laying of the submarine cables. Although full water quality modelling was not considered necessary and has not been conducted to assess the impacts of cable laying activities, it was assessed that the impacts on marine resources are considered to be minimal because sediment will be released at relatively low rates (especially near the coastal areas) and close to the bottom of the water column, which will restrict its dispersion prior to settling. Also, cable laying activities will be of short duration, lasting approximately four weeks (one week for one trip of simultaneously laying three cables) for each of the 12 transmission cables.

Indirect impacts from construction of the landing points are also expected to be low because only a single dredger will be operated at any of the sites at any one time, dredging rates will be low, and the volume of material to be removed is relatively small.

The residual impacts occurring as a result of the construction of the transmission system are that small areas of natural intertidal and subtidal hard surface assemblages will be lost permanently as a result of the reclamations for the landing and launching points. However, it is anticipated that given the use of rubble mound seawalls, assemblages typical of those lost will recolonise after construction thus reducing the magnitude of the residual impact to acceptable levels. Subtidal soft bottom assemblages along the cable route will be lost as a result of the dredging/jet ploughing operations. These assemblages are, however, of low ecological value and predicted to recolonise the area after laying of the transmission cables thus reducing the magnitude of the residual impact to acceptable levels. As indirect impacts arising from the proposed dredging works are predicted to be largely confined to the specific dredging areas, they are not expected to cause adverse impacts to any marine ecological resources of concern.

4.6 *FISHERIES IMPACT ASSESSMENT*

The fisheries impact assessment considered both the direct and indirect impacts on fisheries resources, fishing operations and fish culture activities associated with the laying of transmission cables and associated works.

4.6.1 *Baseline Conditions*

A desk top study was undertaken to establish the baseline conditions for the assessment. The study area includes four Fishing Zones and one Fish Culture Zone (FCZ), with another FCZ in relative close proximity. The only nursery and spawning ground identified in this impact assessment is to the south of both the areas affected by the construction of the landing points, and the area affected by the laying of transmission cables.

4.6.2 *Impact Assessment*

Direct impacts due to the deployment of the transmission cable will occur through the loss of habitat which supports fisheries resources. Short term impacts are also predicted to occur in the vicinity of dredging at the landing points and trench forming operations associated with the cable laying. After these works are completed it is expected that the benthic fauna will recolonise and support fisheries resources at current levels.

Indirect impacts may occur due to changes in water quality associated with cable laying and construction of the landing points. These changes may include elevations in SS, and consequent depletions of dissolved oxygen and increases in nutrients. Although water quality modelling has not been conducted to assess these impacts, they are considered to be minimal for the same reasons that are provided for the marine ecology assessment (see above). On this basis it is predicted that the indirect impacts to fisheries resources as a result of cable laying activities will be minimal.

The only residual impact identified that may affect commercial fishing operations is the disturbance to fishing activity during the 4 weeks of cable laying. The magnitude of this residual impact is low since the main area affected by the cable laying is a main fairway where fishing operations are restricted and the duration of the impact is very short (4 weeks).

Based on an evaluation of impacts in accordance with the *EIAO TM*, it was concluded that potential impacts to fisheries resources and fishing operations arising from the transmission system would not be unacceptable.

4.7 *TERRESTRIAL ECOLOGY ASSESSMENT*

This assessment examined the potential impacts on terrestrial ecological resources of establishing the transmission cable landing points on Lamma Island. Since the landing point on Hong Kong Island will be located on an existing seawall, no impacts will occur.

4.7.1 *Baseline Conditions*

A desktop study of the available literature found no records of ecological importance for the areas in the vicinity of the landing points. Field surveys were undertaken between July and December 1998 to establish a terrestrial ecological profile of these areas. On the basis of these field surveys, the resources around the three landing point sites were considered of low ecological importance, medium to low structural complexity, and moderate flora diversity.

The plant community of the predominant habitats (ie shrubland/tall shrubland and rocky shore) is typical to Hong Kong, and not considered to be of high conservation importance. However specimens of the locally uncommon or rare plant species, *Celtis biondii, Pteris dispar* and *Ardicia pusilla,* as well as locally restricted plants *Vitis balansaeana, Pterospermum heterophyllum* and *Rhapis excelsa* were found in the vicinity of the landing points.

Common bird species including resident species as well as summer and winter visitors were observed during the field surveys, with more species recorded in the shrubland habitats.

4.7.2 *Impact Assessment*

Only small areas of terrestrial habitat (approximately 0.07 ha) are expected to be directly lost due to landtake at the landing points and the cable trough. Indirect impacts may result from increased human activities (such as trampling of vegetation) during the construction phase. No impact on terrestrial ecology is expected during the operational phase.

Based on an evaluation of potential impacts in accordance with *Annex 8* of the *EIAO TM,* the predicted impacts on terrestrial ecology were considered to be low. With the sympathetic design of the landing points and cable trough to avoid the rare, uncommon and restricted plant species, as well as implementation of good construction practice such as preventing unnecessary encroachment on adjacent wooded areas by site personnel, disturbance to the surrounding environment will be minimised.

With the implementation of the recommended mitigation measures, no adverse residual terrestrial ecological impacts from construction of the landing points and cable trough are anticipated.

4.8 *Landscape and Visual Impact Assessment*

A qualitative assessment was undertaken of the potential landscape and visual impacts of the landing points for the transmission cable system.

The landing point on Hong Kong Island will be on an existing seawall and its appearance will not alter significantly after construction. For the landing points on Lamma Island, the landscape impact would be related to the loss of natural coastal features. These facilities are all located at relatively remote locations on Lamma Island and would be viewed either from the sea or other islands at considerable distances, or by the few local residents who may occasionally frequent the development areas.

Given the small scale, remote locations and horizontal nature of the landing points and cable trough, the potential landscape and visual impacts due to loss of the small coastal areas in the context of the surrounding coastline are not considered significant, given the application of the following mitigation measures to minimise potential impacts on the Countryside Conservation Area:

- the surface materials of the landing points should mimic the natural coastal features using irregularly arranged boulders instead of concrete;
- the cable trough that would be formed as a walkway should be shielded by boulders from potential viewers from or across the sea; and
- appropriate landscaping should be provided for any disruption to existing vegetation to blend in with the surrounding setting.

As a planning gain, parts of the landing points N4 and N5 (Pak Kok Tsui) and the cable trough between the landing points can be used for amenity and recreational purposes. Some low maintenance fixtures, matching with the natural environment, will be built or placed on the landing points for public use. A detailed Amenity Plan will be submitted to the Authority for approval before commencement of the site formation work at the landing points.

Since the exact landing points and cable route alignment are yet to be finalised, the management/maintenance responsibilities cannot be defined at this stage. HEC will resolve any management and maintenance requirements of the proposed mitigation measures during the processing stage of wayleave agreements. If required by Government, HEC commit to bear the management and maintenance responsibilities of these facilities.

4.9 *Conclusions of the Transmission System Assessment*

A detailed and comprehensive assessment of the potential impacts of the transmission cable system for the Lamma Extension project has been completed. No unacceptable or insurmountable impacts (including cumulative impacts associated with other projects and activities) are expected from the proposed development, provided the recommended mitigation measures are adopted and implemented.

5 FINDINGS OF THE TECHNICAL ASSESSMENTS FOR THE GAS PIPELINE

5.1 INTRODUCTION

The full findings of the assessment of impacts to the environment arising from the Gas Pipeline are presented in the main EIA Report. The key findings and recommendations of each of the technical studies which constituted the EIA Study are presented below.

5.2 PIPELAYING METHOD

A 90km pipeline of 24 inch outside diameter will be constructed from the Shenzhen LNG terminal to the Lamma Extension development to provide natural gas as fuel for the proposed 1800MW gas-fired power station. Except at the shore approaches to Shenzhen and Lamma Extension where a trench will be formed within which the pipeline will be laid, the entire pipelaying will be performed by a laybarge on which the pipes are welded and laid continuously on the seabed at a speed of 1 to 3km per day. The pipelaying operation will take about two months to complete and will not disturb the seabed. After laying the whole pipeline on to the sea bed, the pipeline will be lowered down to about 3m below sea bed by jetting method. In this method low pressure, high volume water jets are employed to fluidise the sea bed sediment which allows the pipe to sink by its own weight into the sea bed. Typical travelling speed of the jetting machine is about 1 metre per minute and it would take about 4 months to complete the jetting operation. At the Shenzhen and Lamma approaches where the pipeline is laid inside pre-dredged trenches, the pipe will be covered by sand and gravel.

5.3 WATER QUALITY ASSESSMENT

Impacts to water quality will occur as a result of jetting of the pipe route between Shenzhen and Lamma Island and dredging of the trench at the approaches to Shenzhen and Lamma Island. Trench dredging at the Lamma approach was assessed with reference to sediment dispersion modelling already carried out for the Lamma Extension reclamation, while additional modelling work was undertaken for assessment of the Shenzhen approach. Impacts from the jetting operations were assessed qualitatively.

Dredging

The potential impacts from jetting operations will arise from the suspension of seabed sediment in the water column. The sediment to be disturbed is unlikely to be contaminated due to its remoteness from human activities. Consequently, no analysis has been made of possible impacts on levels of dissolved oxygen or nutrients.

Water quality impacts from trench dredging at the Shenzhen approach were simulated using computer modelling of sediment dispersion. The results indicated that water quality objectives for suspended solids (SS) would be met at all four sensitive receivers in the vicinity of Ping Chau. The results also indicated that suspended solids (SS) concentrations would decrease rapidly with increasing distance from the works, so that sensitive areas should not be subject to unacceptable sediment deposition.

The sediment loss rate expected from trench dredging at the Lamma approach is more than an order of magnitude less than the loss rates already simulated for the Lamma Extension reclamation. Impacts to water quality would therefore be much less than those for the reclamation, which have already been found to be environmentally acceptable.

Jetting

The rate of release of sediment to the water column as a result of jetting operations was estimated from a consideration of trench design and jetting procedures. Based on a comparison of this estimate with release rates from grab dredging, and the expectation of faster flocculation and settling of sediments released only at the bottom of the water column (where currents are smaller), it was considered that the impacts from jetting would be much lower and more localised than grab dredging for the same rate of release. The closer the loss to the sea bed, the less chance there will be for the sediment to be transported away from the immediate vicinity.

Impacts from jetting should therefore be confined to a dense suspension in the immediate vicinity of the jetting machine, which would not be transported far from the work site and would settle rapidly onto the seabed. As there are no sensitive receivers in the immediate vicinity of the jetting machine, this operation is considered environmentally acceptable in terms of water quality impacts.

In summary, it was concluded that the water quality impacts of the gas pipeline installation were environmentally acceptable, and no mitigation measures were recommended.

5.4 MARINE ECOLOGY ASSESSMENT

The marine ecology impact assessment examined the potential impacts of the installation of the gas pipeline on marine habitats and species.

5.4.1 *Baseline Conditions*

Information presented in the review of literature and in the results of comprehensive field surveys has indicated that the area potentially affected by the gas pipeline contains the following marine ecology sensitive receivers:

- the soft coral and hard coral assemblages on the southwestern tip of Lamma Island, on Po Toi Island, on Waglan Island and on Ping Chau;
- the finless porpoise population in the waters surrounding Lamma and Po Toi Islands (mainly southwest Lamma);
- the potential South Lamma Marine Park/Marine Reserve; and
- the potential Ping Chau Marine Park/Marine Reserve.

The list of marine ecological sensitive receivers includes only habitats / populations of high ecological value. The ecological values of the marine habitats along the pipeline route were evaluated using the criteria in the *EIAO TM*, with the following results:

- soft bottom habitat along most of the route: *low* ecological value, with a low abundance of common species in an environment which is regularly disturbed by storms and trawling activity;

- hard bottom habitat at SW Lamma, Po Toi, Waglan, Ping Chau, Breakers Reef and Victor Rock (outside of the pipeline route): *high* ecological value, due to valuable soft and hard coral assemblages; and

- habitat of the Finless Porpoise in southern waters: *high* ecological value, as this protected species is known to seasonally inhabit waters around Po Toi and Lamma Islands.

5.4.2 *Impact Assessment*

No long-term direct impacts were expected to occur through the installation of the gas pipeline. Short term impacts will occur as a result of jetting operations but, once these operations have ceased, marine ecological resources in the affected area are expected to return due to recolonisation of the seabed by benthic fauna.

Indirect impacts are predicted to occur through elevations in SS concentrations, but impacts are expected to be localised and of short duration (see the above summary of the water quality assessment). Most of the disturbed material is expected to rapidly settle back onto the seabed in the immediate vicinity. A small portion may be lost to suspension but this should remain in the lower part of the water column and settle back onto the seabed over a short distance.

The pipeline along the remainder of the route (ie the one kilometre approaches to the LNG terminal in Shenzhen and the Lamma Extension) will be laid using grab dredging. Sediment loss rates will be at least 14 times less than for dredging of the Lamma Extension reclamation site, hence the water quality impacts were considered negligible. Similarly, impacts to the identified hard bottom habitat sensitive receivers at south Lamma, Po Toi Island, Waglan Island and Ping Chau are also negligible by the pipeline installation.

The Chinese White Dolphin (*Sousa chinensis*) and the Finless Porpoise (*Neophocaena phocaenoides*) are the only species of marine mammal regularly sighted in Hong Kong waters. Sightings of the Finless Porpoise have mainly been in the coastal waters of southwest Lamma Island, and there has been a seasonal pattern to these sightings. Installation works for the gas pipeline should take into account the occurrence of *Neophocaena phocaenoides* in the water around southwest Lamma.

Impacts to *Neophocaena phocaenoides* may arise through the following activities during construction of the gas pipeline:

- *Habitat Disturbance Due to Traffic and Noise*: The construction of the gas pipeline could potentially result in an increase in marine traffic and underwater noise affecting *Neophocaena phocaenoides*. Noise disturbance interferes with communication and echolocation pulses which are used for navigation and feeding, leading to behavioural changes. In addition, underwater noise and increases in marine traffic may disturb normal cetacean movement patterns through potential collision with vessels, increased turbidity generated by propellers, and submerged equipment.

- *Disruption to Food Supply*: The construction of the gas pipeline may cause perturbations to water quality which may potentially impact the fisheries resources of the southwest Lamma area. *Neophocaena phocaenoides* is thought to be an opportunistic feeder with known prey including shrimps, prawns, squids, octopus and small pelagic fish, and may be adversely affected by changes in key water quality parameters arising from construction work. A

deterioration in water quality is likely to cause these mobile fish to move out of the area, thus interfering with their normal feeding patterns.

Provided care is taken to schedule construction work so that it does not adversely affect the Finless Porpoise (ie there should be no jetting works in southwest Lamma during the spring peak in porpoise abundance), the residual marine ecological impacts associated with the construction of the gas pipeline are considered to be low.

Potential impacts to marine ecological resources and the above sensitive receivers may arise from direct disturbances to habitats, or through changes to key water quality parameters, as a result of the installation of the gas pipeline. However, the loss of subtidal assemblages during the dredging and laying of the gas pipeline, are predicted to be short term as assemblages are expected to recolonise post construction.

As impacts arising from the proposed dredging and jetting works are predicted to be largely confined to the specific dredging and jetting areas, they are not expected to cause adverse impacts to any marine ecological resources (habitats or species). Constraints on dredging and jetting operations recommended to control impacts to water quality to within acceptable levels (water quality objectives) also mitigate impacts to marine ecological resources. The marine ecological sensitive receivers listed above are all remote from the dredging / jetting operations and are not predicted to be impacted. In the interests of avoiding impacts to the breeding population of finless porpoise present around the south of Lamma Island during the spring peak in abundance, it is recommended that jetting operations in this area avoid this time of year. According to the existing timetable the jet ploughing will occur during the autumn in waters to the south of Lamma.

Based on the ecological value of the habitats discussed in the previous sections and the resultant mitigation requirements the residual impact can be determined. The only residual impact occurring as a result of laying of the gas pipeline is the loss of the subtidal assemblages present within the dredging/jetting areas. The residual impact is considered to be acceptable as the habitat is of low ecological value and because infaunal organisms and epibenthic fauna are expected to recolonise the sediments after the pipeline has been laid.

5.5 *FISHERIES IMPACT ASSESSMENT*

The fisheries impact assessment considered both the direct and indirect impacts on fisheries resources, fishing operations and fish culture activities associated with the laying of the gas pipeline.

5.5.1 *Baseline Conditions*

A desk top study was undertaken to establish the baseline conditions for the assessment. Five Fishing Zones examined in the power station component of this assessment are also included within areas that may be affected by the gas pipeline. A further seven Fishing Zones have been identified as areas which may be affected by the pipeline. The southern waters are of areas of high commercial value and of consequent high importance, while the eastern and northern waters along the pipeline route appear to have little value or importance. The southern waters of Hong Kong are also a spawning ground and nursery area for important and high value commercial species.

The following fisheries sensitive receivers were identified for the purposes of this assessment:

- the seasonal spawning ground in southern waters; and
- the seasonal nursery area in southern waters.

5.5.2 *Impact Assessment*

No long-term direct impacts are expected to occur as a result of pipeline installation. Fisheries resources dependent on areas affected by the works are expected to return after works are complete, due to recolonisation of the seabed by the supporting benthic fauna.

Indirect impacts are predicted to occur through elevations in suspended solids (SS), however only low levels of disturbance to the seabed are expected. Most of the mobilised sediment will form a fluidised suspension of sediment and water close to the seabed. This fluidised layer will very rapidly settle back onto the seabed in the immediate vicinity. A small portion of the sediment may be lost to suspension but should settle back onto the seabed over a relatively short distance and time period.

The approaches to the LNG terminal in Shenzhen and Lamma Extension will be formed using grab dredging. The sediment loss rates are predicted to be at least 14 times less than the values for dredging of the Lamma Extension reclamation site, hence the water quality impacts were considered negligible. Based on these assessments, the impacts to fisheries resources are negligible.

The only residual impact identified that may affect commercial fishing operations is the disturbance to fishing activity during the pipeline laying and jetting operations. The magnitude of this residual impact is low since the operations move at a rate of 1- 3 km per day and thus impacts to specific fishing grounds will be of very short duration.

Based on an evaluation of the impacts in accordance with the *EIAO TM*, it was concluded that no unacceptable impacts to fisheries would occur as a result of these gas pipeline installation, because of the localised and short-term nature of the predicted impacts.

5.6 *HAZARDS ASSESSMENT*

The risk assessment undertaken for the gas supply pipeline was essentially qualitative in nature, and focused on identifying any new or unusual features of this project, in relation to other similar facilities operating elsewhere. This approach recognised that the hazards associated with submarine gas pipelines are generally well understood and that reliable safeguards exist to ensure that risks are as low as reasonably practicable.

5.6.1 *Causes and Consequences of Pipeline Failure*

A review of the available literature was undertaken to analyse the most frequent causes of loss of containment and identify potential consequences and impacts. The review indicated that mechanical failure (eg due to corrosion or weld defects) and third party damage are the major causes of pipeline failure.

Loss of pipeline integrity presents significant potential hazards to anyone in the vicinity. Rupture could release a large volume of gas which would bubble to the surface and begin to disperse in the atmosphere. Where the cause of the damage

is a vessel, the vessel itself may provide a source of ignition, leading to a fireball or flash fire with potentially fatal effects. If immediate ignition does not occur, the cloud may be subsequently ignited downwind by another ignition source.

5.6.2 *Risk Assessment*

Considerable experience has been developed in the risks associated with gas pipelines and the means by which they can be reduced to as low a level as reasonably practicable. This is reflected in the various standards which exist for the design, construction, testing and commissioning of pipelines.

- Corrosion and Mechanical Failure

Corrosion is a recognised problem for pipelines in salt water environments, with well-established techniques for combatting external and internal corrosion, backed up by corrosion monitoring programmes. For the present pipeline it is proposed to protect against external corrosion by providing an asphalt enamel coating together with cathodic protection using a sacrificial anode. Internal corrosion will not be a significant hazard, as the gas from the LNG plant is free of sulphur and moisture.

Mechanical failures are becoming rarer due to better material specification, improved manufacturing controls and routine application of non-destructive application of field welds. BS 8010, for example, specifies quality assurance requirements covering the design, construction, testing and commissioning phases of the pipeline.

- Third Party Damage

The four main potential sources of damage are dropped objects, anchors, fishing/trawling gear, and vessel impact. The provision of trenching with armour rock backfill, pre-cast concrete slab or grout mattresses should provide substantial protection against these sources of impact. However, absolute protection is not guaranteed and the degree of residual risk needs to be considered further in a more detailed examination of the potential sources of third party damage, for which a more formal quantitative assessment is recommended when more detailed design information is available.

Where the pipeline route crosses telecommunications cables, it is likely that grout mattresses will be placed both above and below the pipeline to provide the necessary protection. Also, the water depth at these locations is in excess of 26 metres which is below the draught of even the largest vessels. At all crossing points the profile of any protrusion will be made as smooth as possible so that any objects being dragged along the seabed (such as trawl gear) will pass over the top of the pipeline with minimal damage or disturbance.

The crossing of the approach channel to the coal jetties at the Lamma Power Station is also significant because of the change in water depth from 10 to 15 metres (in the channel) and back to 10 metres. To protect against the possibility of damage due to grounding of a bulk carrier on the side of the channel, it is proposed to bury the pipe well below the seabed level and cover with pre-cast concrete slab for pipeline protection at the channel crossing area.

- Management and Monitoring Procedures

One of the key requirements for an operator of a potentially hazardous pipeline is to establish an effective *safety management* system. Detailed guidance on establishing and implementing such a system is available from a variety of

recognised sources, which document best practice in the industry and the standards which this project would be expected to meet.

The corrosion monitoring programme referred to above would be part of an overall integrity monitoring system which would also include inspection (internal and external) and leak detection. Pipeline inspection activities include techniques such as use of "intelligent" pigs (to detect buckles and dents, loss of wall thickness and pipe wall defects) and visual surveys (use of remote-operated vehicles to detect gross movements, scour and free spans, as well as damage to coating and anodes).

Pipelines are considered a comparatively safe mode of transport of hazardous substances. However, there are occasions when pipeline failure results an accidental release of the hazardous material to the environment. Emergency plans are required to cover this contingency so that suitable actions can be taken to mitigate the impacts. Detailed guidance is available on emergency planning from a variety of authoritative publications.

From the high-level review which has been undertaken, it is concluded that there are no insurmountable risks associated with the operation of the submarine gas pipeline for this project. Key areas of risk identified in the assessment include third party damage (for which more detailed assessment is recommended) and safety management.

5.7 *Conclusions of the Gas Pipeline Assessment*

A detailed and comprehensive assessment of the potential impacts of the gas pipeline for the Lamma Extension project has been completed. No unacceptable or insurmountable impacts are expected from the proposed development, provided the recommended mitigation measures are adopted and implemented.

6 FINDINGS OF THE CUMULATIVE IMPACT ASSESSMENTS

6.1 INTRODUCTION

The assessment of cumulative impacts was a key focus of the EIA Study for the Lamma Extension project. The assessment methodologies used were able to combine the projected impacts of existing and proposed projects and predict the likely "worst case" impacts that might arise from the combined influences of these projects.

One specific, as yet uncommitted, project which was formally assessed in terms of potential cumulative impacts arising from emissions to air and water is the Waste to Energy Incineration Facility (WEIF). In addition, a wide range of potential cumulative impacts was assessed in the EIA Study as an integral part of the individual technical assessments for the different components of the project. An overview of these assessments and their findings is provided below.

6.2 AIR QUALITY

The cumulative impacts on local air quality of HEC's existing and proposed power stations were tested with quantitative tracer gas measurements during the wind tunnel studies of the air quality assessment. The results indicated that there would be no breaches of the Air Quality Objectives (AQOs) due to the peak load operation in 2012. The wind tunnel studies also indicated that there would be no exceedances of the AQOs with the additional operation of a proposed waste-to-energy incineration facility (WEIF) at Lamma Island in 2012.

The PATH photochemical air quality modelling system was used to identify both the *cumulative* and *incremental* impacts on air quality of the new power station at Lamma Extension, by predicting air quality at hourly intervals throughout the SAR with and without the emissions from the proposed new facility. Under the simulated conditions, predicted one-hour, 24-hour and annual average concentrations were well below the AQOs, and the contributions of the new power station to the maximum levels observed by modelling were negligible in the locations where those maxima were predicted to occur. It should also be noted that the total emissions of SO_2, NO_x and particulates from HEC system in 2012 with Lamma Extension fully operational will be reduced compared with the 2002 emission before commissioning of the first new unit.

The quantitative assessment of the regional air quality impacts undertaken as part of the Stage 1 EIA was reviewed and updated during the detailed EIA Study. Estimates of oxides of nitrogen (NO_x) and SO_2 emissions from vehicle, domestic and industrial sources in Hong Kong were updated and projected for the years 2002 and 2012, and pollutant concentrations were re-estimated. The contributions of HEC emissions to regional NO_x and SO_2 levels in 2012 were estimated at 1.5% and 0.7% respectively.

This assessment included the compilation of a greenhouse gas emissions inventory for all HEC operations, and an investigation of the impacts of proposed greenhouse gas mitigation measures on both existing and proposed facilities at Lamma. Total emissions were projected to increase from 1990 levels by 80% and 62% in 2002 and 2012 respectively, illustrating the beneficial impact

of gas-fired operation after 2002 despite of the total electricity generation in year 2012 to be 2.57 times of 1990 level. Estimated greenhouse gas emissions per unit of energy produced were predicted to fall from 1990 levels by 37% in 2012. A cumulative reduction of 6.5 million tonnes of emissions of CO_2 equivalent is predicted in 2012 as a result of the mitigation measures (a 39% reduction in unmitigated emissions), leaving an estimated total of 10.3 million tonnes for HEC operations in that year.

6.3 *WATER QUALITY*

The hydrodynamic assessment for the Lamma Extension reclamation considered the combined impacts of the Lamma Extension and WEIF reclamations. Modelled changes at the cross-section were found to be relatively small, and it was concluded that the overall flushing characteristics of the area would not be adversely affected by the two reclamations. The assessment of impacts on the sedimentation regime was also based on the hydrodynamic modelling results, and concluded that there would be no significant changes to either the tidal or sedimentation regimes as a result of reclamations constructed for the Lamma Extension and WEIF projects.

Assessment of the cumulative impacts involving dredging for Container Terminal 9 and sand winning and backfilling at South Tsing Yi Marine Borrow Area (STY MBA) revealed that majority of the impacts were not contributed by the Lamma Extension construction. Further mitigation measures on the Lamma Extension construction alone will not improve the situation. The EM&A programme would therefore be designed to ensure coordination between HEC and other project developers such that appropriate mitigation measures would be implemented by the relevant parties to prevent unacceptable impacts.

Assessment of the thermal discharge in cooling water considered the cumulative impacts of the existing and proposed power stations and the WEIF, and found that the water quality objective (no more than 2°C rise) was met at each of the SRs.

6.4 *NOISE*

Operational noise levels were predicted for the combined impacts of both the existing and proposed power stations. The new plant will generally give rise to levels below those of the existing plant at the NSRs. Model results show that the cumulative noise impacts will be below the NCO limits due to shifting of base load operation to Lamma Extension and hence less units will be operated in the existing Lamma Power Station during night time.

6.5 *LANDSCAPE AND VISUAL IMPACTS*

This assessment considered the combined impacts of both the existing and proposed HEC power stations. The partial near field views available from locations on Lamma Island were not considered to have significant adverse impacts, as the existing station is larger and closer to viewers. For some of the more distant viewers, the intervening distance and the existing visual character of the area (which is dominated by the existing power station) would reduce the expected impacts to negligible or acceptable levels.

6.6 *MARINE ECOLOGY*

The assessment of indirect impacts on marine ecological resources during the construction phase for the project was based on the predicted cumulative water quality impacts. The assessment concluded that, provided water quality objectives are met, impacts on marine ecology would be acceptable.

6.7 *FISHERIES*

As with marine ecology, the assessment of indirect impacts was based on the predicted cumulative water quality impacts. This assessment also concluded that, provided water quality objectives are met, predicted impacts on fisheries would be acceptable.

6.8 *HAZARDS ASSESSMENT*

The assessment of hazards for the new power station considered possible hazardous interactions between the non-gas facilities at the Lamma Extension and the existing Lamma Power Station with the gas facilities for the new development. The assessment concluded that the possibility of incidents at the gas facilities being initiated by events at the power station was remote, because of the physical separation of the gas facilities from the existing power station. It was considered possible that missiles generated by failure of pressure vessels or catastrophic failure of rotating machinery might travel this distance, but the risks associated with such incidents were expected to be low. These interaction hazards would be considered further in the recommended detailed risk assessment for the gas facilities at the Lamma Extension.

6.9 *CONCLUSIONS OF THE CUMULATIVE ASSESSMENT*

The potential cumulative impacts associated with the construction and operation of the Lamma Extension development have been assessed as an integral part of the individual technical assessments undertaken in the EIA Report. No insurmountable or unacceptable cumulative impacts were identified in these assessments, provided that the recommended mitigation measures are implemented. In addition, in some cases (such as the operational noise and fuel gas-related risk assessments) further assessment was recommended during the detailed design to confirm that these cumulative impacts are acceptable.

The cumulative assessment of the potential co-siting of the new power station with a Waste to Energy Incineration Facility (WEIF) has indicated that neither the cumulative air quality impacts nor the thermal discharge impacts would preclude the selection of Lamma as the site for the planned WEIF. However, further cumulative assessments on the remaining environmental issues would be required, as part of the EIA of the WEIF, if the Lamma Site was selected as the preferred option for the facility.

7 ENVIRONMENTAL MONITORING AND AUDIT REQUIREMENTS

7.1 INTRODUCTION

The EIA Study has identified the need for environmental monitoring and audit (EM&A) programmes to be established for both the construction and operational phases of the new power station and its associated transmission system and gas pipeline.

The EM&A requirements include monitoring of media, including noise, air, water and ecological monitoring, as well as audit recommendations for the noise, air, water, ecological, waste, and land contamination issues. Associated with the EM&A requirements is the schedule for the implementation of specified mitigation measures; these two components form the basis of an environmental management system to be implemented by HEC to manage the environmental challenges posed during the construction and operational phases and to verify the performance pledges given in the EIA Report.

The main objectives of the EM&A programme include:

- To provide a database from which the environmental impacts of the project can be determined;
- To provide an early indication should any of the environmental control measures or practices fail to achieve the acceptable standards;
- To monitor the performance of the Project and the effectiveness of mitigation measures;
- To verify the environmental impacts predicted in the EIA;
- To determine project compliance with regulatory requirements, standards and Government policies;
- To take remedial action if unexpected problems or unacceptable impacts arise; and
- To provide data to enable an environmental audit.

The scope of the EM&A programme is to:

- Produce Construction and Operational Phase EM&A Manuals, the content and need for which shall be submitted to the EPD for approval prior to the commencement of construction works and the commissioning of the new power station;
- Establish baseline noise, air and water quality levels at specified locations and review these baseline levels at specified period acceptable to the Authority;
- Implement construction and operational noise, air, water and ecological monitoring programmes;

- Implement audit requirements for ecology, waste and land contamination issues;

- Liaise with and provide environmental advice (as requested or when otherwise necessary) to construction site and operational staff on the comprehension and consequences of the EM&A programme;

- Identify and resolve environmental issues and other functions as they may arise from works;

- Check and quantify the Contractor's overall environmental performance, implement Event & Action Plans , and recommend and implement remedial actions to mitigate adverse environmental effects as identified by the EM&A programme, the EIA and other relevant reports;

- Conduct regular reviews of monitored impact data as the basis for assessing compliance with defined criteria and to ensure that necessary mitigation measures are identified, designed and implemented, and to undertake additional *ad hoc* monitoring and auditing as required by special circumstances;

- Evaluate and interpret all environmental monitoring data to provide an early indication should any of the environmental control measures or practices fail to achieve the acceptable standards, and to verify the environmental impacts predicted in the EIA;

- Manage and liaise with other individuals or parties concerning any other environmental issues deemed to be relevant to the construction process;

- Conduct regular site audits of a formal or informal nature to assess:

  - the level of the Contractor's general environmental awareness,

  - the Contractor's implementation of the recommendations in the EIA,

  - the Contractor's performance as measured by the EM&A,

  - the need for specific mitigation measures to be implemented or the continued usage of those previously agreed,

  - to advise the site staff of any identified potential environmental issues; and

- Submit regular EM&A reports which summarise project monitoring and auditing data, with full interpretation illustrating the acceptability or otherwise of any environmental impacts and identification or assessment of the implementation status of agreed mitigation measures.

7.2 *ORGANISATION AND STRUCTURE OF THE EM&A PROGRAMME*

7.2.1 *Construction Phase*

During the construction phase, HEC will establish an Environmental Management Committee (EMC) to oversee the EM&A programme for the

Lamma Extension Project and will employ an EM&A Consultant to implement the environmental monitoring work defined in the Construction EM&A Manual.

The Chairman of the EMC (the "Environmental Manager") will be the official contact person between the EPD and HEC and shall authorise all submissions to the EPD in accordance with the requirements of the EM&A Manual.

Appropriate members of the project and resident site staff shall be assigned responsibility for the management of the Construction Contractor (the "Contractor"), the EM&A Consultant and its various specialist teams and other professional delegates.

An Independent Environmental Checker (IEC) will be appointed by HEC to audit and verify the overall environmental performance of the construction site and assess the effectiveness of the EM&A Consultant.

7.2.2 *Operational Phase*

In line with the EM&A Management Structure for the Construction Phase, an Environmental Management Committee (EMC) will be established to oversee the EM&A Programme for the operation of the Lamma Extension. The Environmental Manager shall continue to be the official contact person between the EPD and HEC and authorise all submissions to the EPD in accordance with the requirements of the Operational EM&A Manual.

An Independent Environmental Checker (IEC) will be appointed by HEC to audit and verify the overall environmental performance of the plant and assess the effectiveness of the Generation Team and Environmental Team during the operational phase.

7.3 *SCOPE OF THE EM&A PROGRAMME*

7.3.1 *Construction Phase*

A detailed Construction EM&A Manual programme will be prepared and submitted to the EPD for approval prior to the commencement of construction works and electronic environmental monitoring and auditing system will be implemented to speed up the reporting process. The Manual will define the scope, programme, methods and reporting requirements for the EM&A of the construction of the power station, transmission system and gas pipeline.

The recommendations of the EIA study have identified the following requirements for the construction phase EM&A programme:

- Construction Dust

  Periodic monitoring of construction dust will be undertaken at monitoring stations on Lamma Island and Event & Action Plans will be defined to ensure that mitigatory actions are implemented in light of monitored exceedances of the Action Levels.

- Water Quality Monitoring

  During the course of the dredging operations for the reclamation construction, monitoring shall be undertaken with sampling and measurement at the designated monitoring stations. Where exceedances are recorded changes to the monitoring and dredging operations will be

introduced in accordance with the Event & Action Plans presented in the EM&A Manual.

Upon completion of all dredging activities, a post project monitoring exercise on water quality shall be carried out for four weeks in the same manner as the impact monitoring.

Water quality monitoring will also be carried out during the construction of the pipeline, with sampling and monitoring undertaken at the designated stations. Where exceedances are recorded changes to the monitoring and dredging operations will be introduced in accordance with the Event & Action Plans presented in the EM&A Manual.

- Construction Noise

  Although predicted daytime construction noise levels are well within the limits indicated in the *EIAO TM*, limited daytime noise monitoring, at least within the initial 18 months of the construction schedule, will be undertaken. Due to the large margins between the projected levels and their limits, weekly noise monitoring is considered sufficient. Projected evening noise levels are also comfortably below the applicable limit. However, given the sensitivity of evening noise disturbance, monitoring will be conducted on a twice-weekly basis. Noise monitoring of construction work carried out on Sundays or public holidays will comprise 30 to 60 minutes of monitoring on every Sunday and holiday worked.

- Waste Management

  It is recommended that auditing of each waste stream should be carried out periodically by the Independent Environmental Checker to determine if wastes are being managed in accordance with approved procedures and the site waste management plan and to assess whether waste reduction could be enhanced.

- Marine Ecology Monitoring

  Before and during a two year period after the construction of the power station extension seawalls, monitoring of soft corals and gorgonians shall be undertaken with sampling and measurement along the extension and ash lagoon seawalls. Where recolonisation and colonisation is below existing levels HEC have committed to deploy more than 400 m^3 of additional habitat enhancement measures (Artificial Reefs). Where colonisation and recolonisation is at or above existing levels HEC have committed to deploy a minimum of 400 m^3 of additional habitat enhancement measures (Artificial Reefs).

In addition to the monitoring of air, water, ecology, noise and waste during the construction phase, the Independent Environmental Checker will undertake periodic site audits to assess the environmental performance of the Engineer, the Contractor and the EM&A Consultant. The site audits will include the effectiveness of the EM&A programme and the implementation of mitigation measures recommended by the EIA Study.

7.3.2 *Operational Phase*

A detailed Operational EM&A Manual programme will be prepared and submitted to the EPD for approval prior to the commissioning of the new power station and associated facilities. The Manual will define the scope, programme,

methods and reporting requirements for the EM&A of the operation of the power station, transmission system and gas pipeline.

The recommendations of the EIA study have identified the following requirements for the operational EM&A programme:

- Air Quality Monitoring

  Air emission from the new units in Lamma Extension is anticipated to be regulated under the terms of a licence issued by the EPD under the Air Pollution Control Ordinance. The licence will specify regulated limits on all identified emission points in terms of emission rates and concentrations; and the monitoring requirements at both source and the receivers. The results of the monitoring data and statistics will be submitted to the EPD at specified intervals or by on-line transmission.

  Stack emissions from the gas-fired units will be monitored by continuous monitoring equipment installed in flue gas path to collect the data of efflux NO_x, CO, O_2 and temperature , in line with the requirements for similar gas-fired generating units. This provides a continual check on the performance of pollution control devices incorporated in the new units. A requirement to provide continuous records of emission concentration for inspection by the EPD together with suitable alarm facilities to warn operations staff of equipment failure of pollution control plant will provide an adequate basis for monitoring emission at source.

  For ambient air quality monitoring, the existing monitoring network operated by HEC has already been set up as a condition of the specified process licence for the operation of the existing Lamma Power Station. It has proved to be extremely useful in assessing any changes in pollution level in the external environment that have arisen following the development of Lamma Power Station. The existing HEC ambient air quality monitoring stations collect the air quality data on SO_2 and NO_x at designated locations on Hong Kong Island, Ap Lei Chau and Lamma Island. Since the total emissions in 2012 from Lamma Extension and existing Lamma Power Station will be reduced compared with the total emissions from Lamma Power Station alone in 2002, it is considered that the existing HEC ambient air quality monitoring network will be sufficient for assessing any impact of the extension on the air environment at the identified ASRs, as well as for assessing cumulative impacts. Detailed requirement on ambient air quality monitoring will be further reviewed by the EPD as part of the conditions in the Specified Process Licence for the new gas-fired units in the future.

  The greenhouse gas inventory shall be updated annually. Records to demonstrate compliance with the operations plan for minimising Greenhouse Gas emissions shall be maintained and kept on-site. Records to demonstrate compliance with the comprehensive life cycle management program for HFC/PFC/SF_6 containing equipment and records of carbon sinks under a carbon accounting system for afforestation or reforestation schemes, shall also be maintained and kept on-site.

  The results of environmental monitoring enable a continuing appraisal of the environmental impact of the HEC air emissions to be made and also

provide the means of monitoring, ensuring that the station has no adverse environmental impacts to the ambient air quality.

- Water Quality Monitoring

  The objectives of the water quality monitoring programme are to confirm the actual size of the 2°C mixing zone and the areas predicted to be impacted by residual chlorine are within EIA predictions by monitoring at regular intervals as agreed by the Authority and to meet the residual chlorine concentration license requirement as set by the Authority.

  Baseline conditions shall be established prior to the commencement of the discharges from the Lamma Extension. The purposes of the baseline monitoring are to establish conditions prior to the commissioning of Lamma Extension. The baseline conditions shall be established by measuring the size of the 2°C temperature rise plume and the areas impacted by residual chlorine, or alternative biocide. The change in size of plume with operation of Lamma Extension will be monitored at intervals acceptable to the Authority to verify that it is within EIA prediction.

- Operational Noise

  The predicted operational noise levels are well within the limits indicated in the *EIAO TM*. However, monitoring of operational plant will be undertaken to ensure that the source terms derived for the operational noise predictions are achieved both in terms of the vendor's sound power specifications and the operational and maintenance assumptions.

- Waste Management

  It is recommended that auditing of each waste stream should be carried out periodically by the Independent Environmental Checker to determine if wastes are being managed in accordance with approved procedures and the site waste management plan and to assess whether waste reduction could be enhanced.

In addition to the monitoring of air, water, noise and waste during the operation of the new power station, the Independent Environmental Checker will undertake periodic site audits to assess the environmental performance of the new power station. The site audits will include the effectiveness of the EM&A programme and the implementation of mitigation measures recommended by the EIA Study.

A comprehensive EIA Study has been conducted for the construction and operational phases of the three main components of the proposed Lamma Extension project:

- the new power station and associated facilities on the Lamma Extension reclamation;
- the proposed transmission system linking the power station to the landing points on Hong Kong Island; and
- the proposed gas supply pipeline from Shenzhen.

The Study has taken into account the latest available information about the siting, routing, design, layout, construction and operation of individual components of the project. Most of the potential impacts identified and evaluated in the Study have been found acceptable without mitigation, although in several areas specific forms of mitigation have been recommended to reduce, minimise or manage impacts to acceptable levels. Specific examples include:

- the scheduling of pipeline installation works to periods which minimise impacts on marine mammals;
- carefully arrange the layout of the transmission cable landing point to avoid disturbance of a locally rare plant on Lamma Island;
- the sympathetic design of seawalls to reduce visual impact and encourage recolonisation of marine fauna; and
- the establishment of safety management and emergency response systems for the Lamma Extension operation to reduce the likelihood of undesirable events and provide for their effective management.

More general forms of guidance on methods, approaches and procedures which are considered to represent best practice or sound "housekeeping" are also provided as part of the recommended mitigation measures for different components of the project.

Environmental monitoring and audit requirements have also been specified for the implementation of those parts of the project which are considered to require special attention during construction or operation to ensure that unacceptable or avoidable impacts do not arise.

Provided that these measures are adopted and implemented, no unacceptable environmental impacts are expected to arise during project implementation.