

The Hongkong Electric Company, Limited
香港電燈有限公司



Stage 1 EIA for a New Power Station

新發電廠第一階段環境影響評估

20 January 1998
一九九八年一月二十日

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EIA 1303/BC

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FINAL EXECUTIVE SUMMARY

最終行政摘要

The Hongkong Electric Company, Limited
香港電燈有限公司

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Station**

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For and on behalf of ERM-Hong Kong, Ltd
香港環境資源管理顧問有限公司

Approved by 批核: *S. Chauhan*

Position 職位: *Executive Director*

Date 日期: *20th January 1998*

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1 INTRODUCTION

1.1 BACKGROUND

The Hongkong Electric Company, Limited (HEC) proposes to develop a new 1,800MW power station in Hong Kong to meet the forecast growth of electricity demand in the 21st century. In November 1996, it was agreed by the Executive Council of the Hong Kong Government that HEC should be invited, on a no commitment basis, to proceed with the site search and environmental impact assessment studies for additional generating facilities based on the assumption that there were two fuel options: coal and pipeline natural gas.

HEC's consultants undertook an Environmental Impact Assessment (EIA) to the requirements set out in the Hong Kong Government's *Study Brief for the Stage 1 EIA (or EIA of Alternative Sites and Fuels) for a New Power Station Proposed by HEC*. The Stage 1 EIA was overseen by the Environmental Protection Department (EPD), which chaired the Environmental Study Management Group (ESMG) for the study. The Stage 1 EIA was undertaken as an integral part of the Site Search Study which is overseen by the Planning, Environment and Lands Branch (PELB) under the *Study Brief for a Site Search Study for a New Power Station*.

The Stage 1 EIA Report was submitted to the ESGM in September 1997; this document presents an Executive Summary of the key findings of the Stage 1 EIA process and the conclusions and recommendations presented in the Stage 1 EIA Report.

1.2 THE STAGE 1 EIA PROCESS

1.2.1 The Function of the Stage 1 EIA

As an initial assessment, the Stage 1 EIA provides a preliminary evaluation of the range of potential impacts associated with the development of the new power station and ensures that opportunities are taken to minimise environmental impact through the development and application of site screening and selection criteria. The primary objective of the initial assessment is to determine whether the environmental impacts associated with a new power station are surmountable such that the development can be considered environmentally acceptable.

The EIA process is being undertaken as a two-stage process, corresponding with the phasing of the development planning for the new power station. The Stage 1 EIA focused on the environmental evaluation of possible sites, the two alternative fuels (coal or pipeline natural gas), and power generation technology to determine the environmentally preferred site(s), fuel, and technology.

The Stage 2 EIA will proceed at such time as the Government gives the go-ahead for the new power station. It will comprise a detailed site specific EIA Study, for which a separate Study Brief will be issued by the EPD.

Study Objectives

The Stage 1 EIA was undertaken as an integral part of a wider site search study and has provided environmental input to the Site Search Study team. The results of the Site Search Study were reported in a series of separate documents that were submitted to the Site Search Steering Group.

It should be noted that the Stage 1 EIA has provided input on both site specific environmental impacts to the Site Search Study, and the wider, non site specific issues of regional air quality and greenhouse gas emissions.

The primary objectives of the Stage 1 EIA, as laid down in the Study Brief, were as follows:

- the identification of the environmentally preferred site(s) 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;
- determination of the environmental feasibility of building a new power station within Hong Kong.

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

- *Scenario One* assumes an 1,800MW 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 will be approximately 80 hectares (including land required for ash lagoon);
- *Scenario Two* assumes an 1,800MW gas-fired power station supplied by a gas pipeline. This scenario also requires a coastal location but navigational constraints are less important than that for Scenario One, since bulk carrier access is not required. The core landtake requirement for the pipeline gas-fired power station and associated gas receiving facilities is smaller (around 50 ha) than for the coal-fired scenario.

The Stage 1 EIA methodology has been applied in parallel to both scenarios described above.

In addition, it was acknowledged during the early phases of the Study that if any of the site requirements for each of the two scenarios were provided by existing facilities, the landtake areas were likely to be reduced from those indicated above.

The Scope of the Stage 1 EIA

The scope of the Stage 1 EIA focused on the environmental evaluation of the potential sites and fuels for the new power station and associated on-site and off-site ancillary or supporting facilities. The Stage 1 EIA Study was to determine the environmental feasibility of building a new power station in Hong Kong, recommend the environmentally preferred site for the power station for each of the two firing scenarios (coal and pipeline gas), and identify the overall environmentally preferred combination of site, fuel and technology for the new

station.

In addition to the environmental input to the site search and selection exercise, several technical studies were undertaken as integral parts of the Stage 1 EIA. These technical studies focused on the environmental issues of alternative fuel and power generation technologies, the potential impact of the new power station on air quality in the Pearl River Delta region, greenhouse gas issues, and the feasibility of siting a waste-to-energy incinerator adjacent to the power station.

1.3 *PROJECT DESCRIPTION*

1.3.1 *General*

The Stage 1 EIA formed an integral part of HEC's Site Search Study which has been undertaken in three phases, representing a "focusing in" from broad geographic areas to individual sites. The Stage 1 EIA was undertaken in the same way, with the tasks identified in the EPD Stage 1 EIA Study Brief being carried out within the appropriate phase of the Site Search Study.

1.3.2 *Phase I - Technical Studies*

Several technical studies relating to broad, non-site specific, strategic issues were undertaken in the Stage 1 EIA Study. The technical studies were undertaken as integral parts of the site selection environmental work and were reported separately in individual Technical Papers. Summaries of the findings of each study are presented in *Section 2*.

1.3.3 *Phase II - Preliminary Site Search*

The second phase of the Stage 1 EIA involved applying broad environmental screening criteria (such as designated and potential country parks and special areas, sites of special scientific interest, designated and potential marine parks/reserves, and confined airsheds) to the "search envelop" (the territory of Hong Kong) defined by the Site Search Study, in order to screen out such areas from further consideration. The remaining areas resulting from the application of the broad environmental screening criteria were then fed to the Site Search Study Team for incorporation into the overall screening of the "search envelope". The areas resulting from application of both environmental and non-environmental screening criteria and the prototype site layouts were then used to form a "long list" of possible sites.

Sites on this "long list" were subjected to intermediate environmental assessment, in parallel with further scrutiny of engineering, planning and marine access issues, in order to define a "short list" of sites for the proposed power station for each fuel option. This work was reported as part of *Technical Report 2* of the Site Search Study, the findings of which are summarised below, in *Section 3*.

1.3.4 *Phase III - Detailed Site Selection*

Following agreement of the short list of sites by the Site Search Study Steering Group, an in-depth assessment of each site has been carried out under Phase III of the Stage 1 EIA. The detailed assessment criteria comprised :

- air pollution;
- water pollution;
- noise impact;
- terrestrial ecological impacts;
- marine ecological impacts / fishery resources implications;
- construction spoil disposal implications;
- landscape and visual impacts; and
- historic and cultural resources.

The sites were ranked in order of preference for each issue (ie a ranking of 1 meaning that the site was the most preferred for that issue) and indicators (+ or - signs) were allocated so as to convey the degree of difficulty in mitigating the impacts that had given rise to the rank which a site had received.

The findings and recommendations of the Stage 1 EIA assessments of the shortlisted sites are presented in *Section 4*.

2.1

INTRODUCTION

The following technical studies were undertaken as part of the Stage 1 EIA Study:

- *Power Generation Technology Review*: The identification of the most environmentally friendly power generation technology for the two fuel options, coal and pipeline gas;
- *Pearl River Delta (PRD) Air Quality Assessment*: An evaluation of the regional air quality implications of the development of the new power station for the Pearl River Delta;
- *Greenhouse Gas Study*: An assessment of the implications of the emissions from the proposed new power station for Hong Kong's greenhouse gas emissions;
- *Waste-to Energy Incineration Facility (WEIF) Study*: An examination of the feasibility of co-siting a waste-to-energy incineration facility as part of the development of the site identified for the new power station; and
- *Environmental Comparative Fuel Study*: An assessment of the environmental implications of the burning of coal versus pipeline natural gas.

A summary of each of the Technical Papers is presented below.

2.2

FINDINGS OF THE TECHNICAL STUDIES

2.2.1

Power Generation Technology Review

The *Power Generation Technology Review* identified the environmentally preferred technology for both gas-fired and coal-fired scenarios. The review concluded that:

- for gas-firing, whilst both combined cycle and conventional gas-fired steam cycle plant are proven and reliable power generation technologies, combined cycle plant is considered the environmentally preferred gas-firing technology.
- for coal-firing, Integrated Gasification Combined Cycle (IGCC) and Advanced Pulverised Coal (APC) firing with De-NO_x are both considered the environmentally preferred technologies. However, IGCC is a developing technology currently unproven at a commercial scale, while APC is extensively tried and tested. APC with De-NO_x can achieve reduction in NO_x emissions that are comparable to, or even lower than that of IGCC, although associated with the adoption of De-NO_x technology are potentially adverse issues concerning ammonia supply and storage. There are also issues associated with the contamination of fly ash with ammonia and increase of total nitrogen loading in the Flue Gas Desulphurisation wastewater which, whilst surmountable, would require additional technical scrutiny. It was therefore agreed by the Site Search Steering Group that for the purpose of detailed site selection both APC with and without De-NO_x be taken forward

as preferred technologies for the coal-firing scenario and that flexibility should be retained for the consideration of other, developing, technologies, in particular IGCC, for the second and third power generating units.

2.2.2

Pearl River Delta Air Quality Assessment

The *Pearl River Delta Air Quality Assessment* provided a broad evaluation of the potential regional impacts of atmospheric emissions from the proposed new power station and concluded that additional emissions of nitrogen oxides would not contribute significantly to regional surface ozone and nitrogen dioxide concentrations under the worst-case scenario. Maxima in the region would not be affected, irrespective of whether the new station is coal- or gas-fired. APC with De-NO_x technology does not seem to have any significant effect on regional ozone and nitrogen dioxide concentrations when compared with the coal-fired without De-NO_x simulation.

The results of the assessment of future acid deposition indicated that the proposed new power station will reduce the overall acid deposition to the region by about 1% and that the contribution of the new power station is negligible in the context of the marked increases in emissions from the whole PRD region.

2.2.3

Greenhouse Gas Study

The *Greenhouse Gas Study* concluded that there appears to be an ongoing correlation between the continued growth of Hong Kong and a consequent growth in emissions of Greenhouse Gases, particularly carbon dioxide (CO₂).

Historically, CO₂ emissions exhibited a decline from the period 1993 through 1996, but thereafter, the emissions of CO₂ have been projected to resume a rate of continuous growth. By the year 2012, total CO₂ emissions are projected to range from 46.3 to 62.2 million tonnes (Mt) under the lowest and highest scenario respectively. The lowest scenario is based on the low population growth estimate in the TDSR (TDSR Scenario A) with HEC burning gas at its new plant, China Light and Power Co. Ltd. (CLP) burning gas to meet post-Black point demands and no waste incineration. The highest scenario is based on the high population growth estimate (TDSR Scenario B) with HEC burning coal at its new plant, CLP burning coal to meet its post-Black Point demands and the presence of waste incineration. This represents an increase of 26% and 70% respectively over the 1990 level (36.6 Mt). Over the same period population growth estimates ranges from 7.52 to 8.10 million, increases of 32% and 42% respectively, over the 1990 population of 5.7 million.

In 1990, HEC contributed approximately 17% (6.26 Mt) of the total 36.61 Mt of Hong Kong's CO₂ emission. The Company's percentage contributions are forecasted to increase until the year 2003, at which point, whilst the absolute contribution will continue to rise (at approximately 0.4 Mt per year) under the highest scenario the percentage contribution will be maintained at approximately 27% of the total emissions through to 2012. Under the lowest scenario, between 2003 and 2012 HEC's contribution will decrease with commissioning of each new gas-fired unit from 27% of total contributions to a lower absolute which represents a percentage contribution of approximately 23-26% of total contributions.

Hong Kong's total 2012 CO₂ emissions will exceed 1990 emissions by 9.6 million tonnes in the low case assuming the new station is gas-fired, and by 25.6 million

tonnes in the high case assuming the new power station is coal-fired. In terms of contributions from the new plant, utilising gas instead of coal would result in a considerable reduction in CO₂ emissions of approximately 5.8 million tonnes. Given that even under the low scenario (which assumes the new station is gas-fired) Hong Kong's 2012 CO₂ emissions exceed 1990 emissions. By burning gas for new power stations alone, it will not be able to return Greenhouse Gas emissions to 1990 levels.

2.2.4 *Waste-To-Energy Incineration Facility Study*

The *Waste-to Energy Incineration Facility Study* considered the feasibility of siting a waste-to-energy incinerator next to the new power station. The study established the primary landtake and operational assumptions against which co-siting would be considered and concluded that, for the incinerator characteristics assumed, co-siting is feasible. Subsequent evaluation during the site selection process has concluded that the co-siting option is possible, in terms of marine access and land availability, at each of the shortlisted sites for both fuel options. An evaluation of the feasibility of co-siting a WEIF at the preferred site for the new power station concluded that co-siting does not entail unacceptable impacts, in terms of air and marine water quality impacts nor have definitive synergistic benefits, in engineering or operational terms, been identified.

2.2.5 *Environmental Comparison of Fuels Study*

The *Environmental Comparison of Fuels Study* considered a wide range of environmental factors, as well as the findings of the Greenhouse Gas and PRD Air Quality Studies, in determining the environmentally preferred fuel to be pipeline natural gas over coal.

3.1

SHORT LISTED SITES FOR GAS-FIRED POWER STATION DEVELOPMENT

In the course of this phase of the assessment, seventeen potential sites (see *Figure 3.1a*) were identified for a gas-fired power station within the established areas of least constraint (see *Figure 3.1b*). By considering the intermediate screening criteria (including environmental, engineering and marine access characteristics of each site as presented in *Table 3.1a*) in the site screening process, eleven sites were eliminated, leaving the following six sites to be included in the comparative assessment undertaken by the Stage 1 EIA Study team in the detailed site selection:

- Site 2 - Sunshine Island (Chau Kung To)
- Site 3 - South Soko Island (Tai a Chau)
- Site 4 - North Soko Island (Siu a Chau)
- Site 5 - Shek Kwu Chau
- Site 10 - Artificial Island, West Lamma Channel
- Site 17 - Lamma Extension

The locations of the shortlisted sites are illustrated in *Figure 3.1c*.

3.2

SHORT LISTED SITES FOR COAL-FIRED POWER STATION DEVELOPMENT

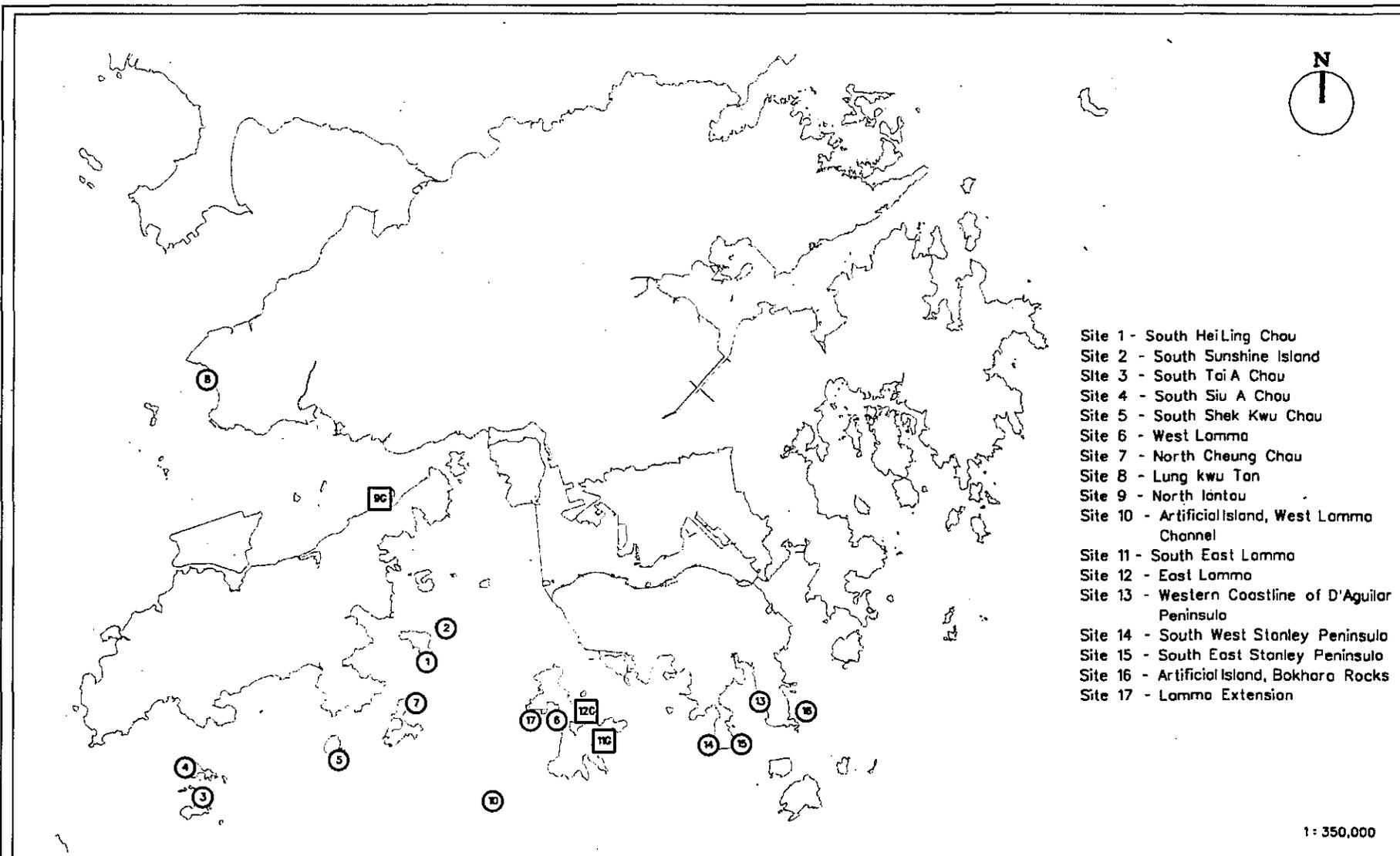
Fourteen potential sites (see *Figure 3.1a*) were identified for a coal-fired power station within the established areas of least constraint (see *Figure 3.1b*). By considering the intermediate screening criteria (including the environmental, engineering and marine access characteristics of each site as presented in *Table 3.1a*) in the site screening process, ten sites were eliminated, leaving the following four sites to be included in the comparative assessment undertaken by the Stage 1 EIA Study team in the detailed site selection:

- Site 3 - South Soko Island (Tai a Chau)
- Site 5 - Shek Kwu Chau
- Site 10 - Artificial Island, West Lamma Channel
- Site 17 - Lamma Extension

The locations of the shortlisted sites are illustrated in *Figure 3.1c*.

Table 3.1a Intermediate Site Screening Criteria

Marine Access	
Wind	<ul style="list-style-type: none"> Berthing and Unberthing would be difficult in winds over 30 knots.
Waves	<ul style="list-style-type: none"> Waves < 2m in the approach channels Waves < 1.5m at the berth Waves < 1m for berthing
Currents	<ul style="list-style-type: none"> Cross currents < 0.5 knots in the approach channels Cross currents < 0.75 knots at the berth Head-on currents < 2.5 knots at the berth
Approach Water Depth	<p><i>For Coal-fired Power Station</i></p> <ul style="list-style-type: none"> > 20m below C.D. <p><i>For Gas-fired Power Station</i></p> <ul style="list-style-type: none"> > 6-7m below C.D.
Jetty	<p><i>For Coal-fired Power Station</i></p> <ul style="list-style-type: none"> Minimum jetty length for one Cape size vessel Water depth > 20m below C.D. <p><i>For Gas-fired Power Station</i></p> <ul style="list-style-type: none"> >6-7m below C.D.
Engineering	
Site Area	<p><i>For Coal-fired Power Station</i></p> <ul style="list-style-type: none"> Total Power Station Area = 59ha Construction work and storage Area = 10 ha Ash Lagoon = 11 ha <p><i>For Gas-fired Power Station</i></p> <ul style="list-style-type: none"> Total Power Station Area = 42ha Construction work and storage Area = 8 ha
Geological Considerations	<ul style="list-style-type: none"> Availability of adequate rock for founding the power block Reasonable backslope heights Formation of seawalls being kept to within 20m depth of water
Ash Lagoon	<ul style="list-style-type: none"> Sufficient area and lagoon capacity of about 2 years ash production (for coal-fired power station only)
Cooling Water System	<ul style="list-style-type: none"> Water Depth at inlets = 7-10 m Water Depth at outlets > 5 m
Environment and Planning	
Strategic Plans	<ul style="list-style-type: none"> Potential conflicts with PADS proposals, land and marine conservation areas in TDSR
Marine Sediment Dredging and Disposal	<ul style="list-style-type: none"> Constraint to the two main spoil disposal grounds
Existing Landuses	<ul style="list-style-type: none"> Sensitive receivers in close proximity
Environmental Media	<ul style="list-style-type: none"> Air pollution dispersion capability Ecological Impacts
Cultural and Historic Sites	<ul style="list-style-type: none"> Cemeteries, monastery grounds and archaeological sites in close proximity
Amenity and Natural Resources	<ul style="list-style-type: none"> Country Parks and SSSI in close proximity Gazetted beaches in close proximity
Fish Culture Zones	<ul style="list-style-type: none"> Fish Culture Zones in close proximity



- Site 1 - South Hei Ling Chau
- Site 2 - South Sunshine Island
- Site 3 - South Tai A Chau
- Site 4 - South Siu A Chau
- Site 5 - South Shek Kwu Chau
- Site 6 - West Lamma
- Site 7 - North Cheung Chau
- Site 8 - Lung kwu Tan
- Site 9 - North Iantau
- Site 10 - Artificial Island, West Lamma Channel
- Site 11 - South East Lamma
- Site 12 - East Lamma
- Site 13 - Western Coastline of D'Aguiar Peninsula
- Site 14 - South West Stanley Peninsula
- Site 15 - South East Stanley Peninsula
- Site 16 - Artificial Island, Bokhara Rocks
- Site 17 - Lamma Extension

1: 350,000

FIGURE 3.1a Potential Sites Identified for the Power Station

Date : 30 May 1997	Drawing No. /Contract/C1432/C1432_1
Sources :	
<i>Prepared by ERM's GIS & MAPPING Group</i>	

KEY	
G	Gas Fired Station only
I	Gas or Coal Fired Power Station

ERM Hong Kong
 6th Floor
 Hecny Tower
 9 Chatham Road
 Tsimshatsui, Kowloon
 Hong Kong



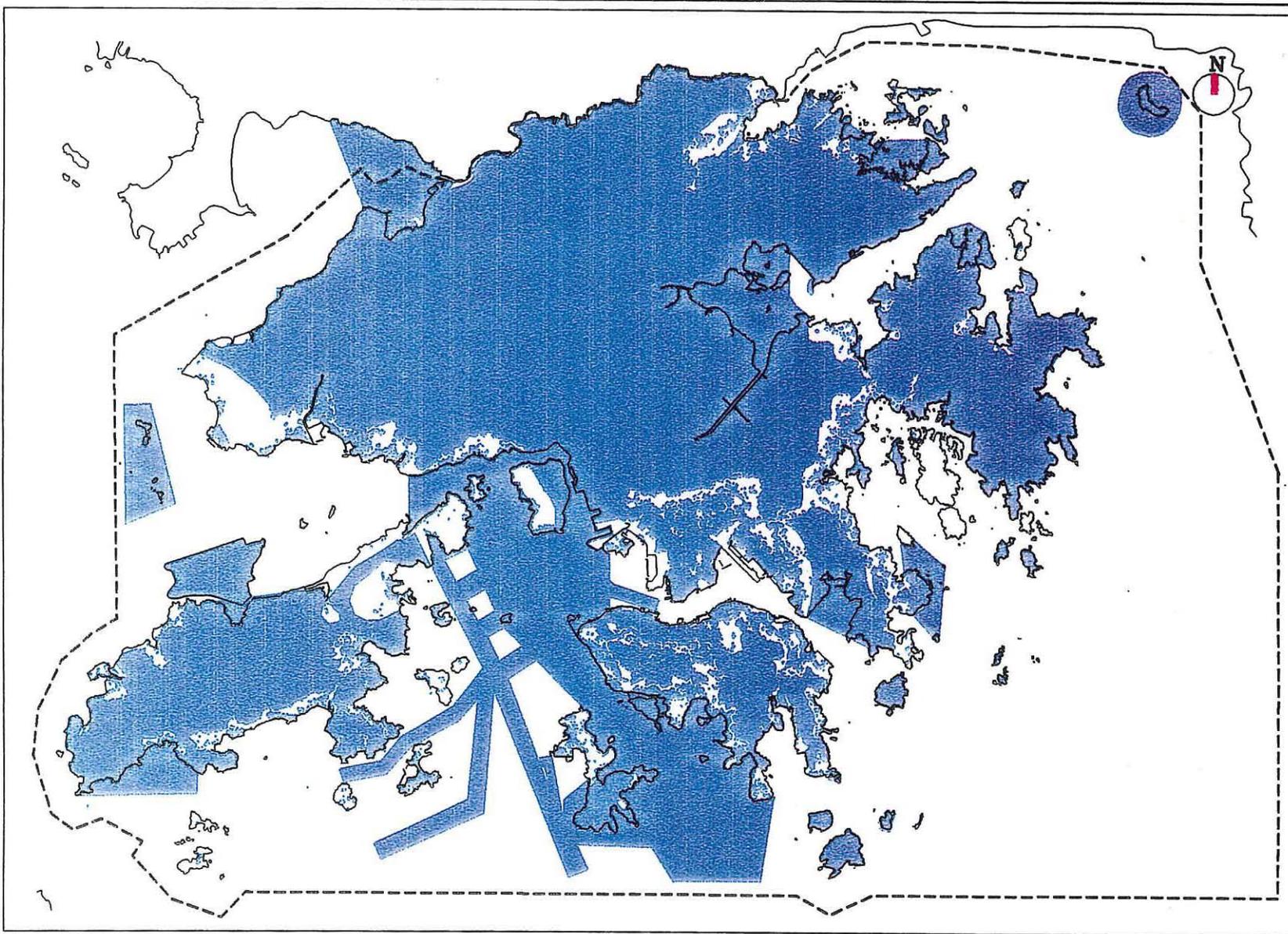


Figure 3.1b Composite Map of Constraint Areas

Date : Aug 1997 Drawing No.: ermhk/c1432/c1432-3.3a.dgn

Prepared by ERM's GIS & MAPPING group

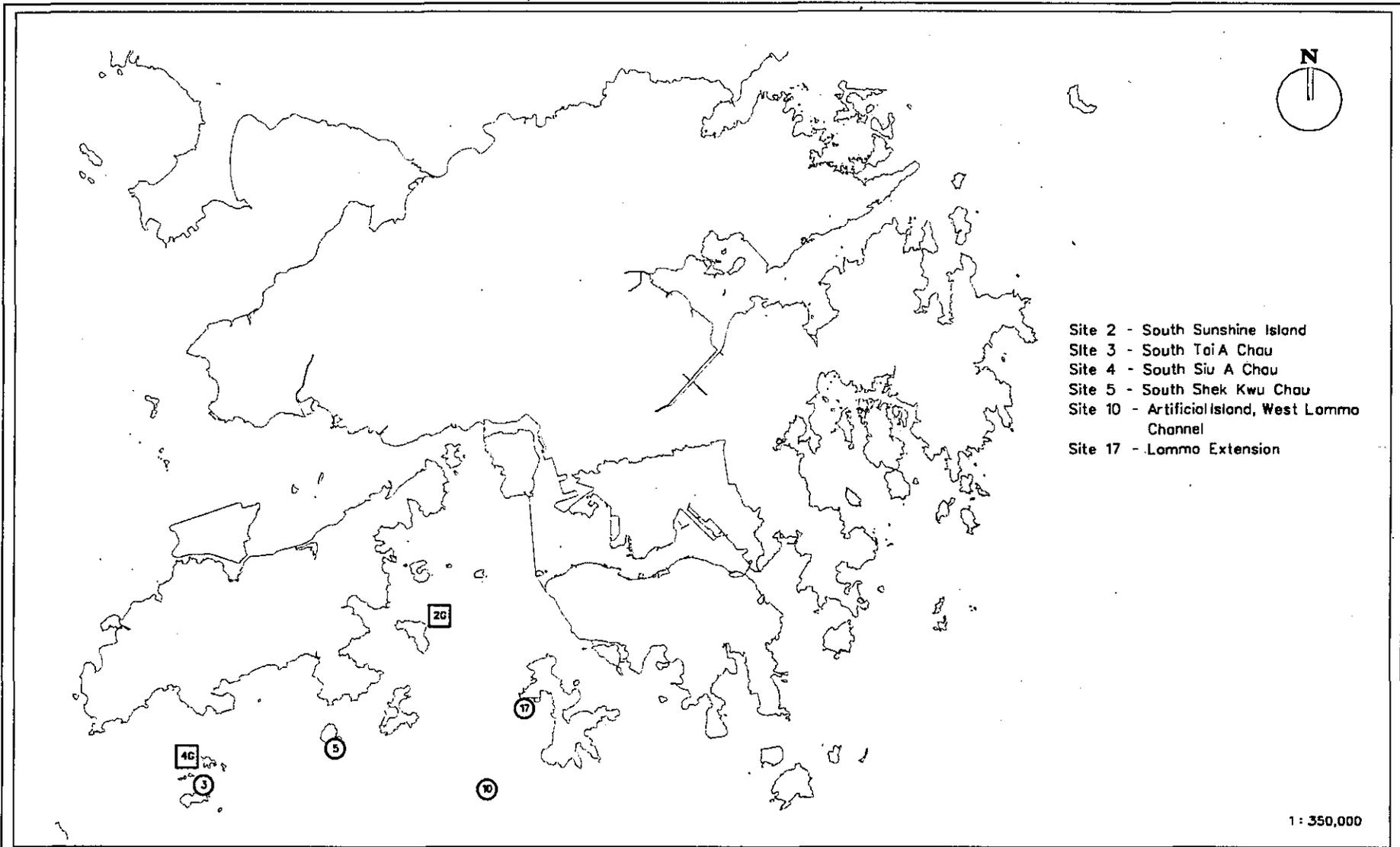
KEY

-  Search Envelope
-  Constrained Area

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- Site 2 - South Sunshine Island
- Site 3 - South Tai A Chau
- Site 4 - South Siu A Chau
- Site 5 - South Shek Kwu Chau
- Site 10 - Artificial Island, West Lamma Channel
- Site 17 - Lamma Extension

1 : 350,000

FIGURE 3.1c Short-Listed Sites for the Power Station

Date : 30 May 1997 Drawing No. /Contract/C1432/C1432_1a

Sources :

Prepared by ERM's GIS & MAPPING Group

KEY

- G Gas Fired Station only
- D Gas or Coal Fired Power Station

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 Hong Kong



4.1 INTRODUCTION

4.1.1 *Evaluation Objectives*

This section summarises the comparative assessment of the shortlisted sites for the gas-fired and coal-fired power station scenarios. Each of the shortlisted sites was evaluated in terms of the following technical issues:

- local air quality implications;
- water quality implications;
- noise implications;
- construction spoil disposal requirements;
- potential impacts on terrestrial ecological resources;
- effects on marine ecological resources;
- landscape and visual impacts; and
- potential impacts on historic and cultural resources.

4.1.2 *Approach to the Comparative Assessment of Shortlisted Sites*

In evaluating the shortlisted sites, the specialist teams employed objective, quantitative criteria where these are established. Professional judgement was employed to assign subjective, qualitative judgements where quantitative criteria were lacking or inappropriate. In addition to the standard ranking by preference (1st preferred, 2nd preferred, 3rd preferred and so on) a system of impact categorisation has been applied using either positive signs ("+") or negative signs ("-") depending upon whether the impacts are to a greater or lesser extent acceptable or unacceptable in terms of the relevant quantitative or qualitative criteria. The categories are :

- (+++)
 - (++)
 - (+)
 - (0)
 - (-)
 - (--)
 - (---)
- indicates no or negligible impacts
- indicates impacts detectable but acceptable without mitigation (over and above generally accepted good practice)
- indicates impacts acceptable without mitigation, (over and above generally accepted good practice) but may be of concern to particular groups or sectors
- indicates impacts unacceptable without mitigation but high levels of confidence are associated with the mitigation measures available.
- indicates impacts unacceptable without mitigation and a degree of uncertainty or possible secondary impacts are associated with the mitigation measures available.
- indicates impacts unacceptable without mitigation and a degree of uncertainty or possible secondary impacts are associated with the mitigation measures available, and even with mitigation the impacts are likely to be of major concern to particular groups or sectors.
- indicates impacts are unacceptable and cannot be mitigated with

currently available techniques.

Sites similarly categorised in terms of their acceptability may be widely different in terms of the level of likely impact and therefore the extent to which they are *environmentally preferred*. A second numerical evaluation has therefore been employed to indicate the preferential ranking assigned to each of the shortlisted sites for each specialist area. This ranking acknowledges the range of differential impacts that may arise, which although they may be considered equally acceptable according to the adopted criteria, are likely to give rise to different levels of impact. Thus, the ranking of the sites provides a clear indication of the specialist teams relative preference.

4.2 IDENTIFICATION OF THE PREFERRED GAS-FIRED POWER STATION SITE

4.2.1 Results of the Comparative Assessment

The comparative assessment has identified the following key issues associated with each of the sites:

- *Site 2 - Sunshine Island (Chau Kung To)*

The Sunshine Island site is considered to have environmental impacts associated with the relatively high terrestrial ecological value presented by this largely undisturbed uninhabited island, the mitigation measures for which have a degree of uncertainty. The site is also the least preferred site in terms of impacts to landscape and visual resources and the proximity of noise sensitive receivers. However, the waters around the island are not considered important in terms of marine ecological resources and the air emissions dispersal from the proposed site is considered favourable.

- *Site 3 - South Soko Island (Tai A Chau)*

The Tai A Chau site is constrained in terms of impacts associated with cooling water discharges and due to the high archaeological potential of the island. The air emissions dispersal from Tai A Chau is considered favourable and the remoteness of the site from noise sensitive receivers has considerable benefits.

- *Site 4 - North Soko Island (Siu A Chau)*

The Siu A Chau site is considered constrained in terms of the impacts associated with construction spoil disposal, the high archaeological potential of the island and relatively high impacts to landscape and visual resources. Air emissions dispersal from the potential site is considered favourable, the remoteness of the site from noise sensitive receivers has considerable benefits and the potential impacts to water quality are considered low.

- *Site 5 - Shek Kwu Chau*

The Shek Kwu Chau site is considered to have environmental impacts associated with the high terrestrial ecological value presented by the island, the mitigation measures for which have a degree of uncertainty, and which are likely to be of major concern to wildlife specialists and groups. The site is also considered constrained in terms of the marine ecological value of its surrounding waters and the proximity of noise sensitive receivers.

- *Site 10 - Artificial Island*

The area within which the reclamation is to be located has been identified as a candidate area for the protection of commercially valuable fish and crustacean spawning and nursery areas; the mitigation of such impacts is likely to require negotiations regarding levels of compensation to local fishermen. As such, the site is considered as least preferred with regard to impacts to marine ecological resources. The assessment of impacts to local air quality associated with a new gas-fired power station on the Artificial Island has concluded that the site is the least preferred in this regard, although the identified impacts are amenable to mitigation.

However, the Artificial Island, as a relatively remote location, is largely unconstrained with regard to several specialist evaluations. As such, the site is considered the preferred site in terms of potential impacts to historic and cultural resources, impacts to terrestrial ecological resources and noise impacts to sensitive receivers. The remoteness of the site has also favoured the Artificial Island in terms of impacts to landscape and visual resources and the thermal plume dispersal characteristics of a free-standing reclamation has resulted in the Artificial Island being the preferred site in terms of impacts to water quality.

- *Site 17 - Lamma Extension*

The assessment of impacts to local air quality and water quality, associated with a new gas-fired Lamma power station extension, has concluded that the site has a low preference ranking, although the identified impacts are amenable to mitigation.

However, the Lamma Extension, being a reclamation based extension to the existing station is largely unconstrained with regard to several specialist evaluations. As such, the site is considered the preferred site in terms of potential impacts to historic and cultural resources and impacts to terrestrial ecological resources. The landscape context provided by the existing power station has favoured the Lamma Extension such that it is the preferred site in terms of impacts to landscape and visual resources, whilst the relatively small scale of the required additional reclamation has resulted in the Lamma Extension being the preferred site in terms of the disposal of construction spoil. The site is also considered to have advantages with regard to impacts to marine ecological resources.

It is not envisaged that the Lamma Extension will constrain future residential developments on Lamma Island. Further investigations will be carried out in the Stage 2 EIA to assess the potential noise and air quality impacts, and hazard risk on future residential developments when more information is available.

4.2.2

Overall Ranking of the Shortlisted Sites

The results of the evaluation of the shortlisted sites and the overall ranking of sites are presented in *Table 4.2a*.

Table 4.2a

Overall Environmental Comparison of the Shortlisted Sites for Gas-fired Power Station

Environmental Parameters	Site 2 - Sunshine Island (Chau Kung To)	Site 3 - South Soko Island (Tai A Chau)	Site 4 - North Soko Island (Siu A Chau)	Site 5 - Shek Kwu Chau	Site 10 - Artificial Island	Site 17 - Lamma Extension
Air Quality	1 (++)	1 (++)	1 (++)	4 (++)	6 (++)	5 (++)
Water Quality	3 (0)	5 (0)	2 (+)	3 (0)	1 (+)	5 (0)
Noise	5 (0)	1 (+++)	1 (+++)	6 (0)	1 (+++)	4 (0)
Construction Spoil Disposal	2 (+)	3 (+)	6 (+)	4 (+)	5 (+)	1 (+)
Terrestrial Ecological Resources	5 (-)	3 (0)	4 (0)	6 (- -)	1 (+++)	1 (+++)
Marine Ecological Resources	1 (++)	3 (+)	4 (+)	5 (+)	6 (-)	2 (+)
Landscape & Visual Impact	6 (0)	3 (0)	5 (0)	3 (0)	2 (0)	1 (0)
Historic & Cultural Resources	4 (0)	5 (0)	5 (0)	3 (0)	1 (++)	1 (++)
Overall Ranking	5	4	3	6	2	1

In evaluating the shortlisted sites, the specialist teams have employed objective, quantitative criteria where these are established. However, professional judgement has been employed to assign subjective, qualitative judgements where quantitative criteria are lacking or inappropriate. Where this has been necessary, the basis for evaluation has been explained. In order that a consistent means of evaluating sites is employed, a system of impact categorisation has been applied using either positive signs ("+") or negative signs ("-") depending upon whether the site is to a greater or lesser extent acceptable or unacceptable in terms of the relevant quantitative or qualitative criteria. The categories are as follows:

- (+++)
 - (++)
 - (+)
 - (0)
 - (-)
 - (- -)
 - (- - -)
- indicates no or negligible impacts
- indicates impacts detectable but acceptable without mitigation (over and above generally accepted good practice)
- indicates impacts acceptable without mitigation, (over and above generally accepted good practice) but may be of concern to particular groups or sectors
- indicates impacts unacceptable without mitigation but high levels of confidence are associated with the mitigation measures available.
- indicates impacts unacceptable without mitigation and a degree of uncertainty or possible secondary impacts are associated with the mitigation measures available.
- indicates impacts unacceptable without mitigation and a degree of uncertainty or possible secondary impacts are associated with the mitigation measures available, and even with mitigation the impacts are likely to be of major concern to particular groups or sectors.
- indicates impacts are unacceptable and cannot be mitigated with currently available techniques.

Sites similarly categorised in terms of their acceptability may be widely different in terms of the level of likely impact and therefore the extent to which they are *environmentally preferred*. A second evaluation has therefore been employed to indicate the preferential ranking assigned to each of the shortlisted sites for each specialist area. This ranking acknowledges the range of differential impacts that may arise, which although they may be considered equally acceptable according to the adopted criteria, are likely to give rise to different levels of impact. Thus, the ranking of the sites provides a clear indication of the specialist teams relative preference.

From the issue rankings and acceptability indices, it can be seen that two of the existing island sites (Sunshine Island and Shek Kwu Chau) rate less well for terrestrial ecological issues, which are more difficult to mitigate than technical issues such as air and water quality, for which there are well established control methods. The mitigation of impacts to terrestrial ecological resources may require the creation of compensatory habitats and the possible relocation of plant and animal species. The level of success of such mitigation measures tends to be variable and has a degree of uncertainty associated with the re-creatability of complex ecosystems; certain ecologists believe that the recreation of habitats in different topographic and microclimatic conditions cannot be wholly successful. This low ranking for terrestrial ecology, and moderate rankings for the other parameters in comparison to the other sites leads to Sunshine Island and Shek Kwu Chau being ranked as the least preferred sites (5th and 6th) overall.

The other four sites are best distinguished between by reference to their collective rankings, rather than specific issues. It can be seen that the two Soko Island sites have been allocated middle to lower rankings (ie 3,4,5) for most issues, in contrast to a predominance of higher rankings (1,2) for the other two sites. These 'less preferred' rankings lead to overall rankings of 3rd for 4th for North Soko Island and South Soko Island respectively. These relative rankings reflect the preservation of environmental resources at these remote, undisturbed locations and the consequent relatively high level of environmental impact that would arise from the development of the new power station at these sites.

Since their general ranking allocations are similar, the principal contrasts between the two remaining sites, Artificial Island and Lamma Extension, are the potential noise impacts, the implications for water quality and the level of impact to marine ecological resources.

As indicated above, technical solutions to control noise levels and to mitigate potential impacts to water quality to within the Government's noise and water quality requirements are readily available, such that none of the six sites are considered to have unacceptable impacts in respect of these impacts. However, the Artificial Island site is the overall preferred site under each of these evaluation criteria; the Lamma Extension is ranked low for both noise and water impacts due to the relative proximity of residential and recreational areas and potentially sensitive water receivers respectively.

The differential ranking between the Artificial Island and the Lamma Extension is most marked in relation to the relative levels of impact to marine ecological resources. This is due to the Artificial Island's location in an area which is favoured by trawler fishermen due to the presence of commercially valuable fish and crustaceans. It also lies within a region which is known to be important as a spawning and nursery areas for commercially valuable species. Impacts associated with siting the new power station on the Artificial Island would be of concern to fishermen and would likely lead to claims for ex gratia, or similar compensation payments, involving extensive negotiations. This issue, for which the site receives a low ranking (6) coupled with the far greater amount of construction spoil involved with the site, for which it is ranked 5 out of the 6 sites, leads to the Artificial Island being ranked behind the Lamma Extension, ie 2nd in the overall ranking.

4.2.3

The Preferred Site

From the above discussion of the environmental comparison of the shortlisted

sites for a gas-fired power station, it is concluded that the Lamma Extension is the environmentally preferred site by virtue of its having minor or negligible impacts to existing resources (particularly terrestrial and marine ecology, historical and cultural resources), and where impacts may arise (air and water quality, and noise) they are of a nature and degree which are amenable to mitigation with a high degree of confidence using well established conventional techniques.

Whilst the comparative assessment has identified the Lamma Extension as the environmentally preferred site for a gas-fired power station, the impacts associated with the site will require detailed investigation in order that the environmental impacts are minimised.

4.3

IDENTIFICATION OF THE PREFERRED COAL-FIRED POWER STATION SITE

4.3.1

Results of the Comparative Assessment

The assessment has identified the following key issues associated with each of the sites:

- *Site 3 - South Soko Island (Tai A Chau)*

The Tai A Chau site is constrained in terms of impacts associated with cooling water discharges and the high archaeological potential of the island.

The air emissions dispersal from Tai A Chau is considered favourable and the remoteness of the site from noise sensitive receivers reduces the potential for impacts.

- *Site 5 - Shek Kwu Chau*

The Shek Kwu Chau site is considered to have environmental impacts associated with the high terrestrial ecological value presented by the island, the mitigation for which has a degree of uncertainty, and which are likely to be of major concern to particular groups. The site is also considered constrained in terms of the marine ecological value of its surrounding waters and the proximity of noise sensitive receivers. The air emission dispersal characteristics are considered favourable.

- *Site 10 - Artificial Island*

The Artificial Island, as a relatively remotely located reclamation, is largely unconstrained with regard to several specialist evaluations. As such, the site is considered the preferred site in terms of potential impacts to historic and cultural resources, impacts to terrestrial ecological resources and noise impacts to sensitive receivers. The remoteness of the site has favoured the Artificial Island in terms of impacts to landscape and visual resources and the thermal plume dispersal characteristics of a free-standing reclamation has resulted in the Artificial Island being the preferred site in terms of impacts to water quality.

However, the area within which the reclamation is to be located has been identified as a candidate area for the protection of commercially valuable fish and crustacean spawning and nursery areas; the mitigation of such impacts is

likely to require negotiations regarding levels of compensation to local fishermen. As such, the site is considered as least preferred with regard to impacts to marine ecological resources. The assessment of impacts to local air quality associated with a new coal-fired power station on the Artificial Island has concluded that the site is the least preferred in this regard, although the identified impacts are amenable to mitigation.

- *Site 17 - Lamma Extension*

The Lamma Extension, as a proposed extension to the existing reclamation, is largely unconstrained with regard to several specialist evaluations. As such, the site is considered the preferred site in terms of potential impacts to historic and cultural resources and impacts to terrestrial ecological resources. The landscape context provided by the existing power station has favoured the Lamma Extension such that it is the preferred site in terms of impacts to landscape and visual resources, whilst the relatively small scale of the required additional reclamation has resulted in the Lamma Extension being the preferred site in terms of the disposal of construction spoil. The site is also considered to have advantages with regard to impacts to marine ecological resources.

The assessment of impacts to local air quality and water quality, associated with a new coal-fired Lamma power station extension, has concluded that the site has a low preference ranking, although the identified impacts are amenable to mitigation.

It is not envisaged that the Lamma Extension will constrain future residential developments on Lamma Island. Further investigations will be carried out in the Stage 2 EIA to assess the potential noise and air quality impacts, and hazard risk on future residential developments when more information is available.

The general ranking allocations for the Artificial Island and Lamma Extension sites are similar (see *Table 4.3a*), with both sites being preferred locations under at least half of the comparison categories, with the Artificial Island benefitting by its remote seaward location under noise and water quality categories, whilst the Lamma Extension is preferred under construction spoil disposal and marine ecological resources by virtue of its limited size and location immediately adjacent to an existing industrialised section of coast. The principal contrast between the sites lies in the nature of the categories for which they are ranked poorly. For the Lamma Extension, these categories are the technical issues of water quality and noise, both of which are solvable using well established mitigation techniques. For the Artificial Island, however, the low ranking (4) relating to marine ecological resources is considered (relatively) more contentious, as the ranking arises from the Artificial Island's location in an area favoured by trawler fishermen because of the presence of commercially valuable fish and crustaceans. The area is also known to be important as spawning and nursery areas for commercially valuable species. Siting the power station in this location is likely to lead to compensation claims from fishermen, a process which could be expected to involve extensive negotiations. The Artificial Island also ranks poorly (4) for the disposal of construction spoil, as a result of the large volumes of marine mud requiring disposal during the site formation process, which would be a relatively greater concern for the Fill Management Committee than the volumes arising from the other sites (and from the Lamma Extension in particular).

Table 4.3a

Overall Environmental Comparison of the Shortlisted Sites for Coal-fired Power Station

Environmental Parameters	Site 3 - South Soko Island (Tai A Chau)	Site 5 - Shek Kwu Chau	Site 10 - Artificial Island	Site 17 - Lamma Extension
Air Quality	1 (+)	2 (+)	3 (0)	3 (0)
Water Quality	2 (0)	2 (0)	1 (+)	4 (0)
Noise	1 (+++)	4 (0)	1 (+++)	3 (0)
Construction Spoil Disposal	2 (+)	3 (+)	4 (+)	1 (+)
Terrestrial Ecological Resources	3 (0)	4 (-)	1 (+++)	1 (+++)
Marine Ecological Resources	2 (+)	3 (+)	4 (-)	1 (+)
Landscape & Visual Impact	3 (0)	3 (0)	2 (0)	1 (0)
Historic & Cultural Resources	4 (0)	3 (0)	1 (++)	1 (++)
Overall Ranking	3	4	2	1

In evaluating the shortlisted sites, the specialist teams have employed objective, quantitative criteria where these are established. However, professional judgement has been employed to assign subjective, qualitative judgements where quantitative criteria are lacking or inappropriate. Where this has been necessary, the basis for evaluation has been explained. In order that a consistent means of evaluating sites is employed, a system of impact categorisation has been applied using either positive signs ("+") or negative signs ("-") depending upon whether the site is to a greater or lesser extent acceptable or unacceptable in terms of the relevant quantitative or qualitative criteria. The categories are as follows:

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 - (-)
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- indicates impacts are unacceptable and cannot be mitigated with currently available techniques.

Sites similarly categorised in terms of their acceptability may be widely different in terms of the level of likely impact and therefore the extent to which they are *environmentally preferred*. A second evaluation has therefore been employed to indicate the preferential ranking assigned to each of the shortlisted sites for each specialist area. This ranking acknowledges the range of differential impacts that may arise, which although they may be considered equally acceptable according to the adopted criteria, are likely to give rise to different levels of impact. Thus, the ranking of the sites provides a clear indication of the specialist teams relative preference.

likely to require negotiations regarding levels of compensation to local fishermen. As such, the site is considered as least preferred with regard to impacts to marine ecological resources. The assessment of impacts to local air quality associated with a new coal-fired power station on the Artificial Island has concluded that the site is the least preferred in this regard, although the identified impacts are amenable to mitigation.

- *Site 17 - Lamma Extension*

The Lamma Extension, as a proposed extension to the existing reclamation, is largely unconstrained with regard to several specialist evaluations. As such, the site is considered the preferred site in terms of potential impacts to historic and cultural resources and impacts to terrestrial ecological resources. The landscape context provided by the existing power station has favoured the Lamma Extension such that it is the preferred site in terms of impacts to landscape and visual resources, whilst the relatively small scale of the required additional reclamation has resulted in the Lamma Extension being the preferred site in terms of the disposal of construction spoil. The site is also considered to have advantages with regard to impacts to marine ecological resources.

The assessment of impacts to local air quality and water quality, associated with a new coal-fired Lamma power station extension, has concluded that the site has a low preference ranking, although the identified impacts are amenable to mitigation.

It is not envisaged that the Lamma Extension will constrain future residential developments on Lamma Island. Further investigations will be carried out in the Stage 2 EIA to assess the potential noise and air quality impacts, and hazard risk on future residential developments when more information is available.

The general ranking allocations for the Artificial Island and Lamma Extension sites are similar (see *Table 4.3a*), with both sites being preferred locations under at least half of the comparison categories, with the Artificial Island benefitting by its remote seaward location under noise and water quality categories, whilst the Lamma Extension is preferred under construction spoil disposal and marine ecological resources by virtue of its limited size and location immediately adjacent to an existing industrialised section of coast. The principal contrast between the sites lies in the nature of the categories for which they are ranked poorly. For the Lamma Extension, these categories are the technical issues of water quality and noise, both of which are solvable using well established mitigation techniques. For the Artificial Island, however, the low ranking (4) relating to marine ecological resources is considered (relatively) more contentious, as the ranking arises from the Artificial Island's location in an area favoured by trawler fishermen because of the presence of commercially valuable fish and crustaceans. The area is also known to be important as spawning and nursery areas for commercially valuable species. Siting the power station in this location is likely to lead to compensation claims from fishermen, a process which could be expected to involve extensive negotiations. The Artificial Island also ranks poorly (4) for the disposal of construction spoil, as a result of the large volumes of marine mud requiring disposal during the site formation process, which would be a relatively greater concern for the Fill Management Committee than the volumes arising from the other sites (and from the Lamma Extension in particular).

Table 4.3a

Overall Environmental Comparison of the Shortlisted Sites for Coal-fired Power Station

Environmental Parameters	Site 3 - South Soko Island (Tai A Chau)	Site 5 - Shek Kwu Chau	Site 10 - Artificial Island	Site 17 - Lamma Extension
Air Quality	1 (+)	2 (+)	3 (0)	3 (0)
Water Quality	2 (0)	2 (0)	1 (+)	4 (0)
Noise	1 (+++)	4 (0)	1 (+++)	3 (0)
Construction Spoil Disposal	2 (+)	3 (+)	4 (+)	1 (+)
Terrestrial Ecological Resources	3 (0)	4 (--)	1 (+++)	1 (+++)
Marine Ecological Resources	2 (+)	3 (+)	4 (-)	1 (+)
Landscape & Visual Impact	3 (0)	3 (0)	2 (0)	1 (0)
Historic & Cultural Resources	4 (0)	3 (0)	1 (++)	1 (++)
Overall Ranking	3	4	2	1

In evaluating the shortlisted sites, the specialist teams have employed objective, quantitative criteria where these are established. However, professional judgement has been employed to assign subjective, qualitative judgements where quantitative criteria are lacking or inappropriate. Where this has been necessary, the basis for evaluation has been explained. In order that a consistent means of evaluating sites is employed, a system of impact categorisation has been applied using either positive signs ("+" or "-") depending upon whether the site is to a greater or lesser extent acceptable or unacceptable in terms of the relevant quantitative or qualitative criteria. The categories are as follows:

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- indicates impacts unacceptable without mitigation and a degree of uncertainty or possible secondary impacts are associated with the mitigation measures available.
- indicates impacts unacceptable without mitigation and a degree of uncertainty or possible secondary impacts are associated with the mitigation measures available, and even with mitigation the impacts are likely to be of major concern to particular groups or sectors.
- indicates impacts are unacceptable and cannot be mitigated with currently available techniques.

Sites similarly categorised in terms of their acceptability may be widely different in terms of the level of likely impact and therefore the extent to which they are *environmentally preferred*. A second evaluation has therefore been employed to indicate the preferential ranking assigned to each of the shortlisted sites for each specialist area. This ranking acknowledges the range of differential impacts that may arise, which although they may be considered equally acceptable according to the adopted criteria, are likely to give rise to different levels of impact. Thus, the ranking of the sites provides a clear indication of the specialist teams relative preference.

As a result of the above, the Lamma Island extension is preferable to the Artificial Island, and is thus the preferred site overall.

4.3.2

The Preferred Site

From the above discussion of the environmental comparison of the shortlisted sites for a coal-fired power station, it is concluded that the Lamma Extension is the environmentally preferred site by virtue of its having minor or negligible impacts to existing resources (particularly terrestrial and marine ecology, historical and cultural resources) and where potential impacts may arise (air and water quality, noise and landscape and visual impacts) they are of a nature and degree which are mitigatable with a high degree of confidence using well established conventional techniques.

Whilst the comparative assessment has identified the Lamma Extension as the environmentally preferred site for a coal-fired power station, the impacts associated with the site will require detailed investigation in order that the environmental impacts are minimised.

The Stage 1 EIA Study Report Volumes I & II provide the results of the evaluation undertaken as part of the wider Site Search Study for HEC's proposed new power station; Volume I of the Stage 1 EIA Report provides the findings of the formal EIA process whilst Volume II presents the findings of the technical studies undertaken as an integral part of the EIA Study.

5.1 SUMMARY OF THE FINDINGS OF THE STAGE 1 EIA

Through the input of the technical studies to the site selection process the key findings of the Stage 1 EIA are concluded as follows:

- Gas is more environmentally preferred fuel than coal.
- As there is no policy for greenhouse gas control in Hong Kong, no conclusion on the acceptability of the various options with respect to the greenhouse gas issue can be made.
- For both coal- and gas-firing scenarios, the environmentally preferred site is the Lamma Extension. Although the development of a new power station at the Lamma Extension site may cause noise, local air quality, water quality, marine ecology impacts and the disposal of construction spoil will need to be carefully managed, the Stage 1 EIA concluded that these impacts are amenable to mitigation.
- The overall environmentally preferred combination from the fuel, technology and site options is a gas-fired power station employing combined cycled gas turbine technology, forming an extension to the existing Lamma Power station.
- If coal is to be used, the environmentally preferred option is to use IGCC or APC with De-NO_x technology as an extension to the existing Lamma Power Station. However, IGCC is not commercially proven at this stage; it will, however, be retained for consideration for the 2nd and 3rd generating units.

5.2 FUTURE REQUIREMENTS

5.2.1 Stage 2 EIA

On the basis that the environmentally preferred combination of fuel, technology and site are endorsed by Government, the principal environmental issues to be addressed in a detailed EIA Study (the Stage 2 EIA) would be as follows :

- The identification and optimisation of routes, and the assessment of impacts from the installation, of transmission cables and gas pipeline from the territorial boundary of Hong Kong to the site. The route selection would seek to avoid pre-defined sensitive environmental receivers and would identify pipeline/cable laying methods, landfall location including ancillary structures and facilities and construction worksite locations and required mitigation measures.

- The impacts and mitigation of construction and operational noise for the Lamma Extension site, including the requirements for off-site facilities and works areas, etc.
- An assessment will be undertaken of potential water quality impacts associated with the construction of the new power station include impacts resulting from the construction at the site and from laying of power cables and, if required, a gas pipeline. Impacts will be predicted using three dimensional modelling to determine the transport and fate of any sediment that becomes suspended and changes to the hydrodynamic regime resulting from the reclamation.
- Potential water quality impacts associated with the operation of the power station are expected to be linked with those resulting from the treatment and disposal of wastewater and the discharge of cooling water. The behaviour of the thermal plume that results will be simulated for spring and neap tides during the wet and dry seasons. Sensitivity tests will be conducted to determine the effectiveness of potential mitigation measures including the position of the cooling water intakes and outfalls, and, the effect of varying the temperature of the discharge(s). Modelling results will be presented to show the spatial and temporal distribution of temperature elevations in receiving waters. Particular attention will be paid to the extent of the area and depth over which a 2°C elevation is predicted but temperature elevations above and below this value will also be shown. Any elevations that are predicted at sensitive receivers will be examined to determine if an impact is likely to occur, and, if so what the severity of the impact(s) is likely to be. Through the minimisation of temperature elevation to receiving water, the potential impacts of the discharge of cooling water will be reduced to meet WQO's.
- A pre-emptive twelve-month survey of marine mammals in southern Hong Kong waters was undertaken by ERM between November 1996 and November 1997. The survey included the area within which the preferred site at Lamma Extension is proposed. The survey was conducted following agreement of the methodology with the AFD. The information generated by this survey will be used as the basis of a detailed assessment of the impact of elevated water temperature on cetaceans (primarily Finless Porpoises).

In addition, subject to the findings of the modelling of the elevated temperature contours and profiles, surveys will be conducted of the potentially effected areas to establish the conservation value of impacted marine and littoral zone ecological resources. Following established practice, the surveys would be undertaken during the winter and summer months so as to provide a representative database upon which to base the assessment.

- Detailed air quality modelling will be carried out using wind tunnel simulations, appropriate mathematical models and photochemistry modelling, as necessary, to assess the potential local air quality impacts arising from the development of the new power station. Key sensitive receivers will include, but not be limited to, existing and planned developments in West Kowloon and Hong Kong Island and potential future residential areas on Lamma Island and Hong Kong Island South. The impact and mitigation of dust during construction will also be assessed.

- The assessment of marine mud required to be dredged during site formation including an evaluation of contamination and the identification of appropriate disposal arrangements.
- A quantitative risk assessment of the onsite storage and use of dangerous goods. If the quantity of dangerous goods is such that the new power station is classified as a Potentially Hazardous Installation (PHI), a formal Hazard Assessment, Planning Study and Action plan will be undertaken in accordance with Chapter 11 of the Hong Kong Planning Standards and Guidelines.
- As part of the package of mitigation measures to be recommended the issues of landuse and visual impacts will be addressed. The bulk and height of the structure will need to be minimised as far as possible, and positive design solutions to improve visual impact will be assessed.
- Environmental Monitoring & Audit (EM&A) requirements during construction and operation (see *Section 5.2.2* below).
- Subject to the SAR Government's policy position with regard to greenhouse gas emissions from the Hong Kong power sector, further study of the feasibility of, and opportunities for, mitigating CO₂ and other significant GHG's emissions as determined in the Kyoto Protocol will be undertaken.
- Where appropriate information is available, cumulative impacts due to other existing and planned developments will also be addressed in the Stage 2 EIA.

It is anticipated that the Environmental Impact Assessment Ordinance (the "EIA Ordinance") will be implemented during 1998. The Stage 2 EIA Study will comply with the legal requirements and the procedures of the implemented Ordinance.

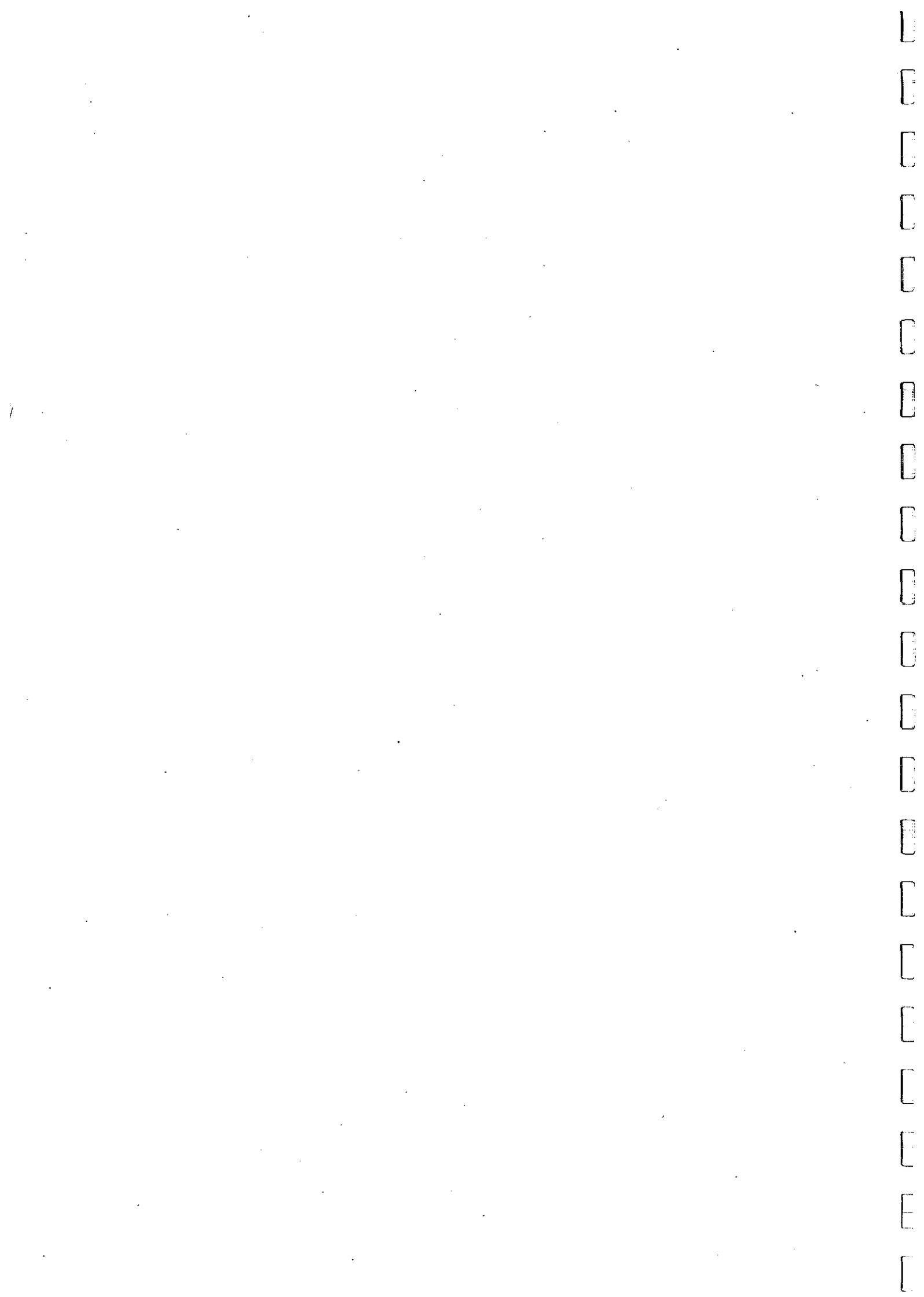
5.2.2

Environmental Monitoring and Audit Requirements

Baseline, impact and compliance monitoring will be required during both the construction and operational phases of the power station development as contributors to an EM&A programme designed to ensure compliance with the Stage 2 EIA study recommendations, ensure that mitigation measures work as expected to maintain environmental standards within the criteria laid down in the HKPSG and the relevant Government Ordinances, and identify the need for, and type of, additional measures if they do not.

The specific monitoring requirements, frequencies and locations will be identified in the Stage 2 EIA, and subsequently incorporated within the EM&A Manual for the power station. At present these are anticipated to cover air, noise and water quality during key periods of the construction process and during the operation of the station.

The EM&A Manual to be produced from the Stage 2 EIA report will need to identify the entities and individuals responsible for the execution and checking of the EM&A programme. It should also contain Event and Action Plans to establish who is to do what in response to changes in monitored levels, and the procedures to be followed if environmental complaints are received. Reporting arrangements should also be set out in the Manual.



1 引言

1.1 背景

香港電燈有限公司(港燈)建議在香港興建一座擁有一千八百兆瓦發電功率的發電廠,以應付二十一世紀電力需求的預期增長。一九九六年十一月,香港政府行政局同意以非承諾的形式,邀請港燈就煤及管道輸送天然氣兩個燃料方案,為新增的發電設施進行選址及環境影響評估(環評)研究。

港燈的顧問按照香港政府發出的《為港燈建議之新發電廠進行的第一階段環評研究(或新發電廠不同選址及燃料環評)概要》的要求,進行環評研究。第一階段環評在環境保護署(環保署)監督下進行,而該署亦擔任環評研究管理小組的主席。除第一階段環評外,另有一項選址研究由規劃環境地政科按照《新發電廠選址研究概要》的要求監督進行,而第一階段環評為選址研究不可分割的一部份。

第一階段環評報告已於一九九七年九月提交環評研究管理小組。本摘要闡述了第一階段環評的主要發現、結論和建議。

1.2 第一階段環評的過程

1.2.1 第一階段環評的功能

第一階段環評為一項初次評估,就着新發電廠發展可能引起的一系列環境影響提供初步的評估,並且確定有關環境影響透過制訂和採用廠址篩選標準而減至最低。是項初次評估的主要目的,是要釐定新發電廠引起的環境影響能否克服,以及斷定該項發展在環境方面是否可以接受。

環評按照新發電廠發展計劃的分期情況,分成兩階段進行。第一階段環評集中就環境方面的各種考慮,對各個廠址、兩種不同的燃料(煤或管道輸送天然氣)及各種發電技術作評價,從而釐定在環境方面最為可取的廠址、燃料及技術。

第二階段環評將在政府同意發展新發電廠之後進行。該項研究將會為一項就已選定的廠址而進行的詳細環評研究,而環保署將會就此研究發出另一研究概要。

1.2.2 研究目的

第一階段環評是研究範圍更廣的選址研究的一部份，並且為選址研究小組提供環境方面的資料。選址研究的結果已在另外一系列呈交予選址研究督導小組的文件中報告。

第一階段環評除了為選址研究就各廠址提供環境影響方面的資料外，更研究了地區性空氣質素和溫室氣體排放兩個範圍較廣而並非針對某一廠址的課題。

根據研究概要所訂，第一階段環評的主要目的如下：

- 認定在環境方面較可取的廠址、燃料、發電技術及設計方案；
- 認定可選用的廠址及就各選址在環境方面是否適合發展新發電廠作出評估；
- 針對環境因素，釐定在香港境內發展新發電廠的可行性。

第一階段環評就兩個不同的燃料方案，確定了每個方案中在環境方面最為可取的廠址：

- 方案一的假設，就是在一個大型運煤船可達的沿海地點，興建一所有一千八百兆瓦發電功率的燃煤發電廠。燃煤發電廠的核心土地需求(包括設置煤灰湖所需土地)約為八十公頃。
- 方案二的假設，就是興建一所使用管道輸送天然氣，擁有一千八百兆瓦發電功率的燃氣發電廠。本方案雖然亦要求發電廠設於一個沿海地點，但由於並不需要讓運送燃料的大型船舶進出，故此在航運方面的限制較方案一為少。燃氣發電廠及相關接收天然氣設施的核心土地需求較燃煤方案為低(約五十公頃)。

第一階段環評對上述兩個方案均採用同一方法評估。

此外，研究早已認定以上兩個方案中若有任何需求可由現有設施提供，則新取用土地的面積將可能較以上顯示的為少。

1.2.3 第一階段環評的研究範疇

第一階段環評的研究範疇，集中於新發電廠可選用的廠址和燃料，以及廠址以外的附屬或支援設施的環境評估。第一階段環評是要確定在香港境內興建一所新發電廠的環境可行性；就兩個不同的燃料方案(煤和管道天然氣)，建議在環境方面較可取的廠址；以及認定在環境方面較可取的廠址、燃料和發電技術組合。

第一階段環評除了為篩選廠址提供環境方面的資料外，亦同時進行了數項技術研究。這些技術研究集中探討各種燃料和發電技術對環境的影響、對珠江三角洲區域空氣質素的影響、溫室氣體問題、以及在新發電廠旁設置一所廢物轉化能源焚化爐的可行性。

1.3 項目簡介

1.3.1 緒言

港燈的新發電廠選址研究分三期進行，將研究範圍由較廣的地域逐步縮窄至個別廠址，而第一階段環評為選址研究的其中一部份。第一階段環評亦採用同一方法，將《第一階段環評研究概要》的各項工作，分配於選址研究的適當相應階段進行。

1.3.2 第一期 - 技術研究

《第一階段環評研究概要》認定需要進行數項涉及範圍較廣而並非針對某一廠址的策略問題技術研究。這些技術研究與選址的環境研究工作同時進行，其結果則在各自獨立的技術文件中作出報告。各項技術研究的結果在本報告第二節概述。

1.3.3 第二期 - 初步選址

第一階段環評的第二期將廣義的環境篩選準則(例如已公佈或可能公佈的郊野公園及特別地區、特具科學研究價值的地點、海岸公園及保護區、及密閉空氣流域等)，應用於選址研究界定的「選址規限範圍」(即香港全境)，以篩出不必再考慮的地區。採用廣義環境篩選準則後餘下的地區，隨後交予選址研究小組，在「選址規限範圍」的整體篩選中一併研究。採用環境及非環境性篩選準則和廠址設計原形後選出的地區，其後用於制訂一份可選用廠址的「初步候

選名單」。

研究就「初步候選名單」上的地點進行了中期環境評估，同時再就工程、規劃和海路交通方面作剖析，以求為新發電廠的每一個燃料方案訂出一份廠址「最終候選名單」。上述工作在選址研究的第二號技術報告中已作報導，其結果亦在本報告第三節中概述。

1.3.4 第三期 - 詳細選址

選址研究督導小組同意廠址最終候選名單後，第一階段環評的第三期對每個廠址作出了深入的評估。詳細評估的準則如下：

- 空氣污染
- 水質污染
- 噪音影響
- 陸地生態影響
- 海洋生態/漁業資源影響
- 施工廢土處置影響
- 景觀及視覺影響
- 歷史及文化資源

廠址就上述每個課題按其可取程度排序(排位一表示該廠址就該課題而言最為可取)，並且為每個廠址所得排位分配標記(+或-)，以顯示緩解環境影響的難度。最終候選名單上廠址的第一階段評估結果及建議在本報告第四節闡述。

2 第一期 - 技術研究摘要

2.1 引言

以下各項技術研究均為第一階段環評的一部份：

- 《發電技術檢討》：就兩個燃料方案，即煤及管道天然氣，認定最能配合環境要求的發電技術；
- 《珠江三角洲空氣質素評估》：評估發展新發電廠對珠江三角洲地區的空氣質素影響；
- 《溫室氣體研究》：評估建議中新發電廠的排放對香港的溫室氣體排放的影響；
- 《廢物轉化能源焚化設施研究》：評審在新發電廠廠址同時興建一座廢物轉化能源焚化設施的可行性；
- 《燃料對環境影響比較研究》：比較燃煤和燃氣發電兩者的環境影響。

以下為每份技術文件的摘要。

2.2 技術研究的結果

2.2.1 《發電技術檢討》

《發電技術檢討》分別為燃煤和燃氣方案認定了在環境方面較可取的發電技術。檢討的結論如下：

- 雖然聯合循環系統和傳統燃氣蒸氣渦輪均為已經驗證及可靠的發電技術，但該檢討認為聯合循環系統發電是在環境方面較可取的燃氣發電技術。
- 至於燃煤方案方面，檢討認為綜合煤氣化聯合循環系統(IGCC)和配有脫硝設施(De-NO_x)的先進粉煤燃燒系統都是在環境方面較可取的技術。不過，綜合煤氣化聯合循環系統仍屬發展中的技術，並未在商用規模的層面加以驗證；反觀先進粉煤燃燒系統則已經過廣泛的考驗和測試。配有脫硝設施的先進粉煤燃燒

系統可減低氮氧化物排放，其水平可媲美綜合煤氣化聯合循環系統的排放，甚至較之更低。不過，採用脫硝設施亦可能引起氮氣供應及儲存的負面問題。此外，亦有煤灰受氮污染及煙氣脫硫廢水中的總氮含量上升的問題；該等問題雖可克服，但仍需在技術上作進一步探討。鑑於上述原因，選址研究督導小組同意將配置及不配置脫硝設施的先進粉煤燃燒系統俱採納為燃煤方案中的較可取技術，而在興建第二及第三台發電機組時，應對其他發展中的技術(尤其是綜合煤氣化聯合循環系統)作彈性考慮。

2.2.2 《珠江三角洲空氣質素評估》

《珠江三角洲空氣質素評估》為建議中新發電廠的大氣排放可能帶來的地域性影響進行了廣泛的評估，並認為即使在最壞的情況下，額外的氮氧化物排放並不會顯著提高整個地區的地面臭氧和二氧化氮濃度。無論新發電廠燃煤或燃氣，區內大氣污染物的最高水平都不受影響。若與普通燃煤情況(即沒有脫硝設施)比較，配有脫硝設施的先進粉煤燃燒系統對區內的臭氧和二氧化氮濃度並無顯著影響。

有關酸性沉降物的評估結果顯示，建議中新發電廠將會令區內未來整體酸性沉降物水平減低約百分之一。在珠江三角洲整體排放量大增的情況下，來自新發電廠的排放可謂微不足道。

2.2.3 《溫室氣體研究》

《溫室氣體研究》得出的結論為香港的不斷發展與溫室氣體(尤其是二氧化碳)的排放之間似乎有著未曾間斷的關係。

紀錄顯示，在一九九三至一九九六年間，二氧化碳排放曾經一度下跌。不過，預料二氧化碳的排放其後會恢復持續增長。到二零一二年，在最低及最高排放量的情況下，預料二氧化碳總排放量分別為四千六百三十萬及六千二百二十萬噸。最低排放量的情況，就是基於《全港發展策略檢討》方案A的低人口增長預測；港燈以天然氣為新發電廠燃料；中華電力有限公司(中電)以燃燒天然氣供應龍鼓灘發電廠投產後的電力需求；兼且沒有興建廢物轉化能源焚化設施的情況。最高排放量的情況，就是基於《全港發展策略檢討》方案B的高人口增長預測；港燈以煤為新發電廠燃料；中電以燃煤供應

龍鼓灘發電廠投產後的電力需求；兼且興建廢物轉化能源焚化設施的情況。以上提及的排放量比一九九零年的排放量(三千六百六十萬噸)分別增加百分之二十六及百分之七十。同期的人口預料會增至七百五十二萬至八百一十萬，比一九九零年的五百七十萬人口增加百分之三十二至百分之四十二。

港燈在一九九零年的二氧化碳排放約佔全港總排放量三千六百六十一萬噸的百分之十七(即六百二十六萬噸)。預料港燈的排放所佔的百分比會逐年增長至二零零三年。屆時，雖然港燈的實際排放量會繼續上升(每年約四十萬噸)，但在最高排放量的情況下，該公司的排放所佔百分比會自二零零三年起停止增長，維持佔總排放量百分之二十七，直至二零一二年。在最低排放量的情況下，港燈的實際排放量會在二零零三年至二零一二年間，隨着每個新燃氣發電機組投產而下降，其所佔百分比亦會由總排放量的百分之二十七降至約為百分之二十三至二十六。

假設新發電廠燃燒天然氣而令排放量較低，香港在二零一二年的總二氧化碳排放會比一九九零年高出九百六十萬噸。假設新發電廠燃煤而令排放量較高，屆時的總二氧化碳排放量會比一九九零年的水平高出二千五百六十萬噸。至於新廠本身的排放，燃燒天然氣比燃煤可減少二氧化碳排放約五百八十萬噸。儘管在低排放的情況下(即假設新發電廠燃燒天然氣)，香港在二零一二年的二氧化碳排放量仍然會超出一九九零年的水平。若只倚賴新發電廠燃燒天然氣，仍不足以將溫室氣體的排放量回復至一九九零年的水平。

2.2.4 《廢物轉化能源焚化設施研究》

《廢物轉化能源焚化設施研究》考慮了在新發電廠旁設置一座廢物轉化能源焚化爐的可行性。研究訂下了兩個設施共存的基本用地需求和運作條件，並根據所假定的焚化爐特性，認為設施共存應屬可行。選址過程較後時所作的評估認為，就海路交通和可用土地而言，在每個最終候選名單上的廠址，無論發電廠採用何種燃料，均可與焚化設施共存。就可取廠址的發電廠與焚化設施共存而進行的可行性研究顯示，設施共存並不會引起空氣質素和海水水質方面不可接受的影響，但在工程或運作方面，亦無確實的協同利益。

2.2.5 《燃料對環境影響比較研究》

《燃料對環境影響比較研究》考慮了一系列的環境因素，再加上《溫室氣體研究》和《珠江三角洲空氣質素研究》的結果，從而釐定管道天然氣在環境方面較煤更為可取。

3 第二期 — 初步選址摘要

3.1 燃氣發電廠廠址的最終候選名單

在此評估階段，研究根據已確定為最少限制的地理範圍(見圖 3.1b)，認定了十七個可用以發展燃氣發電廠的地點(見圖 3.1a)。在廠址篩選過程中，經考慮中期篩選準則(包括表 3.1a 所示各地點的環境、工程和海路交通特性)後，剔除了十一個地點，餘下下列六個地點由第一階段環評小組再作詳細選址的比較評估：

- 廠址 2 — 周公島
- 廠址 3 — 大鴉洲
- 廠址 4 — 小鴉洲
- 廠址 5 — 石鼓洲
- 廠址 10 — 西博寮海峽人工島
- 廠址 17 — 南丫擴建廠址

最終候選名單上的廠址位置見圖 3.1c。

3.2 燃煤發電廠廠址的最終候選名單

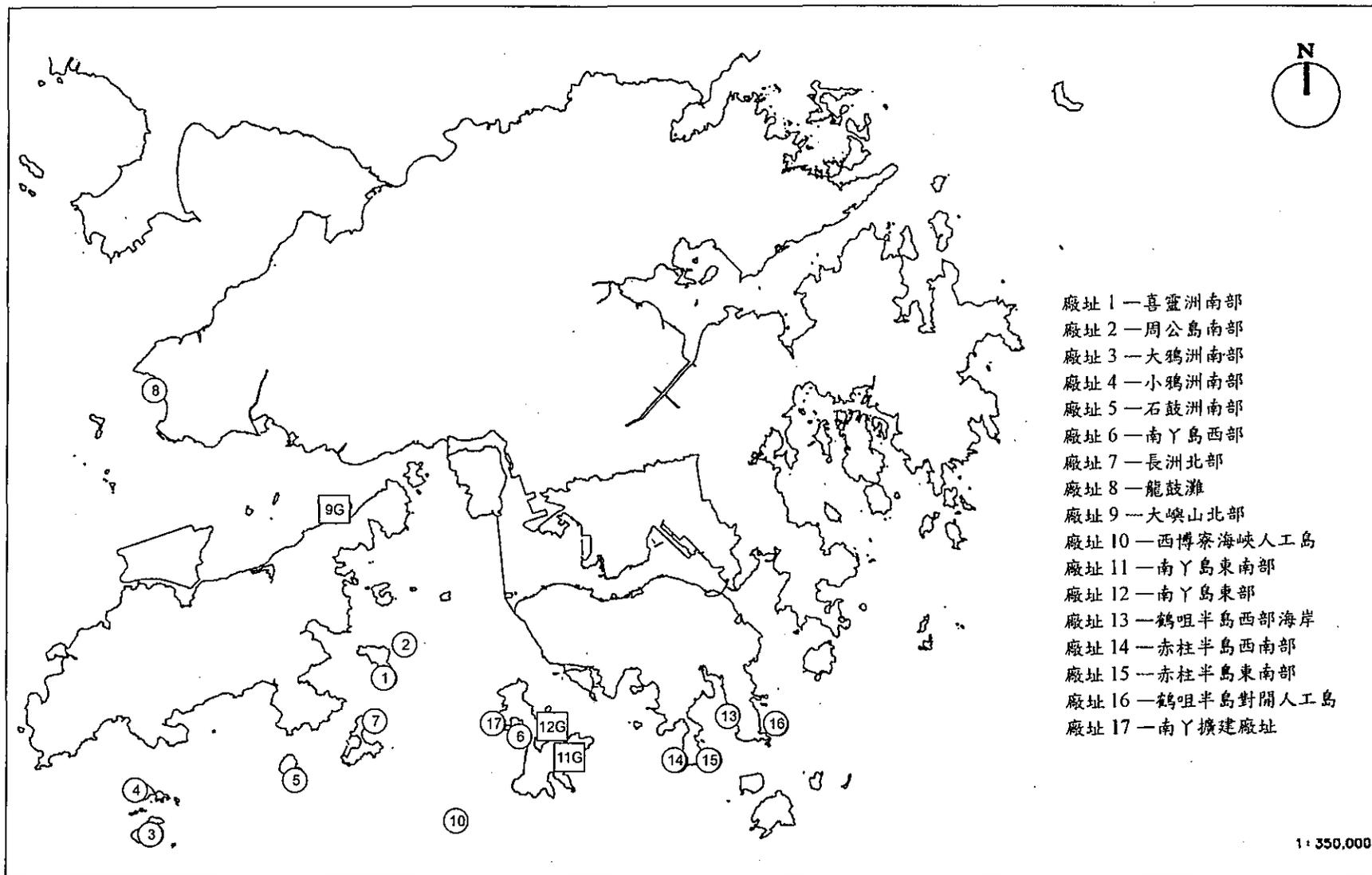
研究根據已確定為最少限制的地理範圍(見圖 3.1b)，認定了十四個可用以發展燃煤發電廠的地點(見圖 3.1a)。經考慮中期篩選準則(包括表 3.1a 所示各地點的環境、工程和海路交通特性)後，剔除了十個地點，餘下下列四個地點由第一階段環評小組再作詳細選址的比較評估：

- 廠址 3 — 大鴉洲
- 廠址 5 — 石鼓洲
- 廠址 10 — 西博寮海峽人工島
- 廠址 17 — 南丫擴建廠址

最終候選名單上的廠址位置見圖 3.1c。

表 3.1a 中期篩選廠址準則

<u>海路交通</u>	
風勢	<ul style="list-style-type: none"> 超過 30 海浬的風勢會令船舶較難靠岸及離岸
海浪	<ul style="list-style-type: none"> 入港航道海浪 < 2 米 碼頭海浪 < 1.5 米 靠岸時海浪 < 1 米
水流	<ul style="list-style-type: none"> 入港航道側流 < 0.5 海浬 碼頭側流 < 0.75 海浬 碼頭逆流 < 2.5 海浬
入港航道水深	燃煤發電廠 <ul style="list-style-type: none"> > 20 米 燃氣發電廠 <ul style="list-style-type: none"> > 6-7 米
碼頭	燃煤發電廠 <ul style="list-style-type: none"> 碼頭長度最低限度可容納一艘好望角級船舶 水深 > 20 米 燃氣發電廠 <ul style="list-style-type: none"> 水深 > 6-7 米
<u>工程</u>	
廠址面積	燃煤發電廠 <ul style="list-style-type: none"> 總發電廠面積 = 59 公頃 建築工程及物料儲存面積 = 10 公頃 煤灰湖 = 11 公頃 燃氣發電廠 <ul style="list-style-type: none"> 總發電廠面積 = 42 公頃 建築工程及物料儲存面積 = 8 公頃
地質條件	<ul style="list-style-type: none"> 有充足石層供建造發電廠地基 有足夠的內坡高度 海堤的建造在 20 米水深以內
煤灰湖	<ul style="list-style-type: none"> 足夠的面積及容量以容納兩年運作所產生的煤灰（只用於燃煤發電廠）
冷卻水系統	<ul style="list-style-type: none"> 入水口水深 = 7-10 米 出水口水深 > 5 米
<u>環境及規劃</u>	
策略性規劃	<ul style="list-style-type: none"> 可能與《港口及機場發展策略》中的建議及《全港發展策略檢討》中的陸上及海上自然保育區產生衝突
海上挖泥及棄置	<ul style="list-style-type: none"> 兩個主要海泥棄置場的限制
現有土地用途	<ul style="list-style-type: none"> 近距離的敏感地點
環境媒介	<ul style="list-style-type: none"> 空氣污染擴散能力 生態影響
文化及歷史遺產地點	<ul style="list-style-type: none"> 近距離的墳地、寺院及具考古學價值的地點
康樂及天然資源	<ul style="list-style-type: none"> 近距離的郊野公園及具有特別科學價值的地點 近距離已刊憲的公眾泳灘
魚類養殖區	<ul style="list-style-type: none"> 近距離的魚類養殖區



- 廠址 1 — 喜靈洲南部
- 廠址 2 — 周公島南部
- 廠址 3 — 大鴉洲南部
- 廠址 4 — 小鴉洲南部
- 廠址 5 — 石鼓洲南部
- 廠址 6 — 南丫島西部
- 廠址 7 — 長洲北部
- 廠址 8 — 龍鼓灘
- 廠址 9 — 大嶼山北部
- 廠址 10 — 西博寮海峽人工島
- 廠址 11 — 南丫島東南部
- 廠址 12 — 南丫島東部
- 廠址 13 — 鶴咀半島西部海岸
- 廠址 14 — 赤柱半島西南部
- 廠址 15 — 赤柱半島東南部
- 廠址 16 — 鶴咀半島對開人工島
- 廠址 17 — 南丫擴建廠址

1:350,000

圖 3.1a 新發電廠可能的廠址

Date 30 May 1997 Drawing No. 1 ermhk/c1432/c1432_1.dgn

Drawing Prepared by ERM's GIS & MAPPING group

圖例

只適用於燃氣發電廠 G

適用於燃氣或燃煤發電廠 1

ERM-Hong Kong, Ltd
 6th Floor
 Hecny Tower
 9 Chatham Road
 Tsimshatsui, Kowloon
 Hong Kong



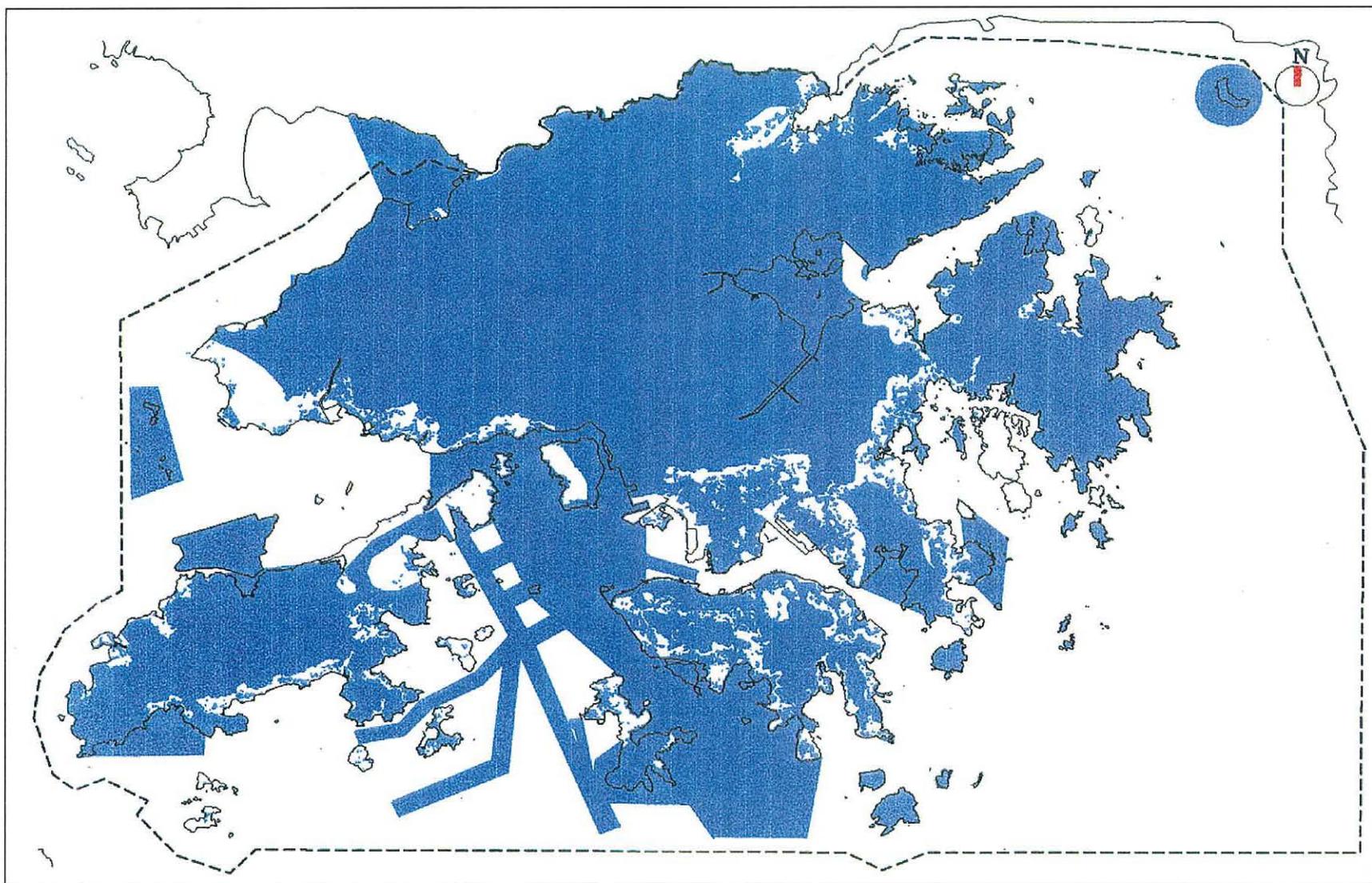


圖 3.1b 新發電廠選址受限制地區

Date	1 Aug 1997	Drawing No.	1 ermhk/c1432/c1432-3.3a.dgn
<i>Drawing Prepared by ERM's GIS & MAPPING group</i>			

圖例

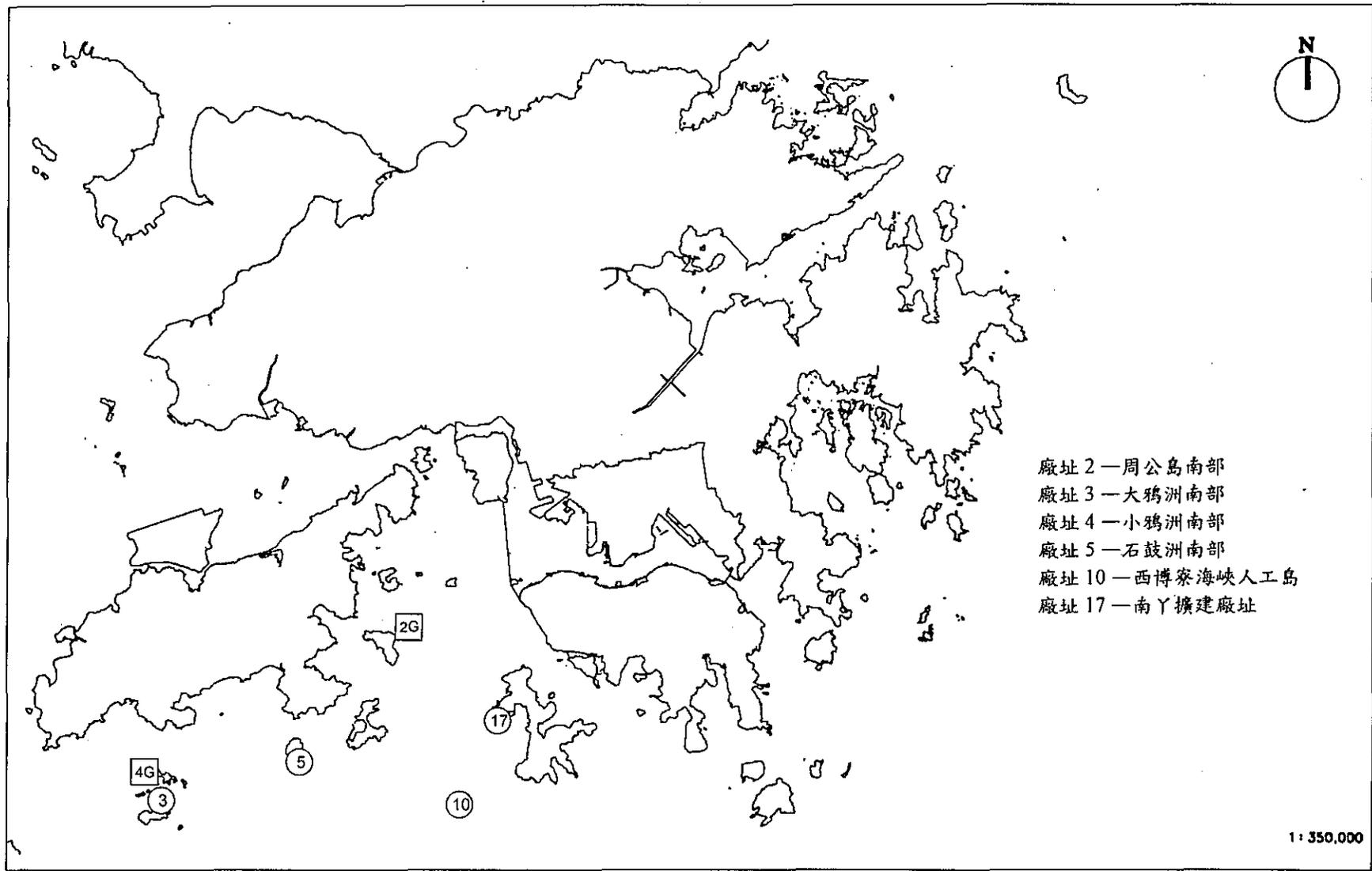
選址規限範圍 

受限制地區 

ERM-Hong Kong, Ltd

6th Floor
 Hecny Tower
 9 Chatham Road
 Tsimshatsui, Kowloon
 Hong Kong





- 廠址 2 — 周公島南部
- 廠址 3 — 大鴉洲南部
- 廠址 4 — 小鴉洲南部
- 廠址 5 — 石鼓洲南部
- 廠址 10 — 西博寮海峽人工島
- 廠址 17 — 南丫擴建廠址

1 : 350,000

圖 3.1c 新發電廠最終候選廠址	
Date 30 May 1997	Drawing No. 1 ermhk/c1432/c1432_1a.dgn
Drawing Prepared by ERM's GIS & MAPPING group	

圖例
只適用於燃氣發電廠 G
適用於燃氣或燃煤發電廠 1

ERM-Hong Kong, Ltd
 6th Floor
 Hecny Tower
 9 Chatham Road
 Tsimshatsui, Kowloon
 Hong Kong



4. 第三期 — 選址

4.1 引言

4.1.1 評估目的

本節概述燃氣及燃煤發電廠方案的最終候選名單上的廠址進行比較評估。研究為每一個在最終候選名單上的廠址都按下列課題作出了評估：

- 局部地區空氣質素影響；
- 水質影響；
- 噪音影響；
- 施工廢土處置的要求；
- 對陸地生態資源可能產生的影響；
- 對海洋生態資源的影響；
- 景觀及視覺影響；及
- 對歷史及文化資源可能產生的影響。

4.1.2 比較評估最終候選廠址的方法

對最終候選廠址作出評審時，若有既定的客觀及定量準則，專家小組已盡可能採用這些準則；在缺乏定量準則或此等準則不適用時，研究人員則根據專業知識作出了主觀定性的判斷。除了按可取程度所作的標準排位外(第一可取、第二可取、第三可取，如此類推)，研究亦採用了一套影響強度分類系統。在這套系統中，按有關的定量或定性準則，視乎影響是較可接受或較不可接受，給予正號「+」或負號「-」。評分系統中各個類別為：

- (+++) 表示全無影響或影響微不足道。
- (++) 表示有可測的影響，但在未經緩解的情況下仍可接受(比一般良好慣例為佳)。
- (+) 表示影響在未經緩解的情況下仍可接受(比一般良好慣例為佳)，但可能引起某些群體或界別關注。
- (0) 表示影響在未經緩解的情況下不可接受，但可採用的緩解措施極有把握成功。

大鴉洲的大氣排放擴散情況頗為有利，而該島位置距離噪音敏感地點極遠亦是有利條件。

- 廠址 4 — 小鴉洲

小鴉洲因施工廢土的棄置、甚高的考古學價值以及較高的景觀及視覺影響而受掣肘。

該處大氣排放擴散情況頗為有利，距離噪音敏感地點較遠是有利條件，而且可能對水質產生的影響亦低。

- 廠址 5 — 石鼓洲

石鼓洲的環境影響與其具有甚高的陸地生態價值有關，而緩解措施在某程度上未能肯定有效，並且會引起保護野生生物專家及團體的關注。該處亦受小島周圍水域的海洋生態價值和噪音敏感地點距離近兩個因素掣肘。

- 廠址 10 — 人工島

計劃用作填出人工島的地點已被認定為可用作保護具有商業價值的魚類和供甲殼類動物產卵及育幼的地點，若要緩解有關影響，可能涉及和當地漁民商討賠償問題。該處因此被認為是就海洋生態資源而言最不可取的廠址。有關人工島上新燃氣發電廠對局部地區空氣質素影響的評估顯示，雖然該等影響可以緩解，但就空氣質素影響而言，該處仍是最不可取的地點。

不過人工島的位置較偏遠，因而在多個專科的評估中都發現大致上沒有限制。正因上述緣故，此處就歷史及文化資源、陸地生態資源和對敏感地點的噪音影響而言，均為可取的地點。此處偏遠的位置亦令它在景觀及視覺影響方面較有利。人工島是一幅四周全無陸地的填海土地，其冷卻水熱捲流擴散特性亦令該處在水質方面最為可取。

- 廠址 17 — 南丫擴建廠址

有關南丫擴建廠址新燃氣發電廠的局部地區空氣質素和水質影響評估顯示，雖然有關影響可以緩解，但該處作為廠址的可取

程度排位仍較後。

不過，由於南丫擴建廠址是在原有廠址再填海而成，故此在多個專科評估中都發現大致沒有限制。正因上述緣故，此處就歷史及文化資源和陸地生態資源的影響而言是較為可取的廠址。現有南丫島發電廠的景觀特質，使南丫擴建廠址在景觀及視覺影響方面成為可取的廠址，而額外填海的規模較小亦使該處在施工廢土處置方面較為可取。就海洋生態資源影響而言，該處亦屬有利。

南丫擴建廠址預期不會對未來島上的住宅發展構成限制。當有更多資料可供參考時，第二階段環評會進一步研究發電廠可能對未來的住宅發展造成的噪音、空氣質素和風險影響。

4.2.2 最終候選名單上廠址的整體排位

最終候選名單上廠址的評估結果和各廠址的整體排位情況於表 4.2a 詳列。

從重要問題排位及可接受程度指數，可見其中兩個現有的小島(周公島和石鼓洲)在陸地生態影響方面得分較低，而且該類影響較其他如空氣質素和水質等早已有控制方法的技術問題更難於緩解。陸地生態資源影響的緩解或會涉及創造新生境作補償和動植物的遷移。此等緩解措施的成效參差，而且再造複雜生態系統的可能性在一定程度上仍存疑問。某些生態學家相信在地形和微氣候有別的地方再造生境定不能完全成功。由於周公島和石鼓洲在陸地生態方面排位較其他地點低，而且在其他方面的排位亦只是中等，故此兩處的整體排位均為最低(第五及第六)，成為最不可取的廠址。

其他四個地點可以用整體排位而非個別問題的排位清楚區別。大小鴉洲兩處在大部份問題的排位為中至低(即三、四、五位)，反觀其餘兩處的排位大致極高(即一、二位)。上述較低的個別問題排位令小鴉洲及大鴉洲的整體排位分別只為第三及第四位。以上排位反映這些未受滋擾的偏遠地點仍保留有環境資源，以及在這些地點發展新發電廠會引起嚴重的環境影響。

由於人工島和南丫擴建廠址的整體排位相似，所以這兩個地點的主要差異在於可能產生的噪音、水質和海洋生態資源的影響。

表 4.2a 燃氣發電廠最終候選廠址的整體環境比較

環境參數	廠址 2 - 周公島	廠址 3 - 大碼頭	廠址 4 - 小碼頭	廠址 5 - 石鼓洲	廠址 10 - 人工島	廠址 17 - 南丫擴建廠址
空氣質素	1(++)	1(++)	1(++)	4(++)	6(++)	5(++)
水質	3(0)	5(0)	2(+)	3(0)	1(+)	5(0)
噪音	5(0)	1(+++)	1(+++)	6(0)	1(+++)	4(0)
施工廢土棄置	2(+)	3(+)	6(+)	4(+)	5(+)	1(+)
陸地生態資源	5(-)	3(0)	4(0)	6(-)	1(+++)	1(+++)
海洋生態資源	1(++)	3(+)	4(+)	5(+)	6(-)	2(+)
景觀及視覺影響	6(0)	3(0)	5(0)	3(0)	2(0)	1(0)
歷史及文化資源	4(0)	5(0)	5(0)	3(0)	1(++)	1(++)
整體排位	5	4	3	6	2	1

對最終候選廠址作出評審時，若有既定的客觀及定量準則，專家小組已盡可能採用這些準則；在缺乏定量準則或此等準則不適用時，研究人員則根據專業知識作出了主觀定性的判斷。除了按可取程度所作的標準排位外(第一可取、第二可取、第三可取，如此類推)，研究亦採用了一套影響強度分類系統。在這套系統中，按有關的定量或定性準則，視乎影響是較可接受或較不可接受，給予正號「+」或負號「-」。評分系統中各個類別為：

- (+++)
- (++)
- (+)
- (0)
- (-)
- (--)
- (---)

表示全無影響或影響微不足道。
 表示有可測的影響，但在未經緩解的情況下仍可接受(比一般良好慣例為佳)。
 表示影響在未經緩解的情況下仍可接受(比一般良好慣例為佳)，但可能引起某些群體或界別關注。
 表示影響在未經緩解的情況下不可接受，但可採用的緩解措施極有把握成功。
 表示影響在未經緩解的情況下不可接受，而可採用的緩解措施在某程度上不肯定有效或可能有繼發的影響。
 表示影響在未經緩解的情況下不可接受，而可採用的緩解措施在某程度上不肯定有效或可能有繼發的影響，而儘管有緩解措施，仍可能對某些群體或界別可能事關重大。
 表示影響不可接受，而且不能以現有技術作出緩解。

按可接受程度而歸於同一類別的候選廠址可能在環境影響的水平方面迥相迥異，而在環境可取程度方面亦有分別。因此，研究採用了第二種數值評價方法，表示每個最終候選廠址在每個專業課題的可取程度排位。這種排位方法考慮了可能產生的不同種類影響，雖然這些不同種類影響，雖然這些不同種類影響的強度卻有所不同。故此，候選廠址的排位清楚顯示了各專家就各自的專業而評定的相對可取程度。

正如上面所述，由於已有現成的技術解決方案，可供控制噪音水平和緩解可能產生的水質影響，以達致政府噪音及水質的要求，故此六個候選廠址中無一因上述問題而產生不可接受影響。不過，就上述兩項評估準則而言，人工島為最可取的廠址；南丫擴建廠址因住宅區及康樂用地較接近和有水質敏感地點的關係，在噪音及水質影響方面的排位都較低。

人工島和南丫擴建廠址在排位方面的分別，在於海洋生態資源影響的水平。人工島所在水域由於有具有商業價值的魚類和甲殼類動物，故此頗受拖網漁民歡迎。該處亦為具有商業價值魚蝦品種的產卵及育幼地區。在該人工島興建新發電廠的影響將和漁民有關，並有可能導致漁民要求特惠或類似的賠償，引發多輪商討談判。在此問題上人工島的排位極低(第六位)，加上涉及的施工廢土遠比其他地點為多(就此而言，該處在六個候選廠址中排第五位)，令人工島的整體排位在南丫擴建廠址之後，即整體為第二位。

4.2.3 最可取的廠址

從以上有關燃氣發電廠最終候選廠址在環境因素方面的互相比較來看，南丫擴建廠址對現有環境資源(尤其是陸地及海洋生態、歷史和文化資源)的影響較少或微不足道，因而是最可取的廠址。儘管仍有某類影響(空氣質素、水質和噪音)，以該等影響的性質程度來看，亦可用傳統技術作出緩解，所作緩解並且極有把握取得成功。

雖然比較評估認定，南丫擴建廠址就環境而言為最可取的燃氣發電廠廠址，但是和設廠有關的環境影響仍需詳細研究，以求將環境影響減至最低。

4.3 燃煤發電廠較可取廠址的認定

4.3.1 比較評估的結果

比較評估認定了以下分別和各廠址有關主要事項：

- 廠址3 - 大鴉洲

大鴉洲因冷卻水排放的影響及其甚高的考古學價值而受掣肘。

大鴉洲的大氣排放擴散情況頗為有利，而該島位置離噪音敏感地點極遠亦是有利條件。

- 廠址 5 - 石鼓洲

石鼓洲的環境影響與其甚高的陸地生態價值有關，而緩解措施在某程度上未能肯定有效，並且會引起一些團體的關注。該處亦受小島周圍水域的海洋生態和較近噪音敏感地點兩個因素掣肘。石鼓洲的大氣排放擴散特質則頗為有利。

- 廠址 10 - 人工島

人工島的位置較偏遠，因而在多個專家評估中都發現大致上沒有限制。正因上述緣故，此處就歷史及文化資源、陸地生態資源和對敏感地點的噪音影響而言，均為可取地點。此處偏遠的位置亦令它在景觀及視覺方面較有利。人工島是一幅四周全無陸地的填海土地，其冷卻水熱流捲流散特性亦令該處在水質方面最為可取。

不過，計劃中用作填出人工島的地點已被認定為可作保護具有商業價值魚類和供甲殼類動物產卵及育幼的地點，要緩解有關影響，可能涉及和當地漁民商討賠償問題。該處因此被認為就海洋生態而言最不可取的廠址。有關人工島上新燃煤發電廠局部地區空質素影響的評估顯示，雖然該等影響可以緩解，但就空氣質素影響而言，該處仍是最不可取的廠址。

- 廠址 17 - 南丫擴建廠址

南丫擴建廠址由於是在原有廠址填海而成，故此在多個專家評估中發現大致上沒有限制。正因上述緣故，此處就歷史及文化資源和陸地生態影響而言是較為可取的廠址。現有南丫島發電廠的景觀特質使南丫擴建廠址在景觀及視覺影響方面成為可取廠址，而額外填海的規模較小亦使該處在施工廢土處置方面較為可取。就海洋生態資源影響而言，該處亦屬有利。

有關南丫擴建廠址新燃煤發電廠的局部地區空氣質素和水質評估影響顯示，雖然有關影響可以緩解，但該處作為廠址的可取

程度排位依然較後。

南丫擴建廠址預料不會限制未來在島上的住宅物業發展。在第二階段環評有更多資料時，研究將會就發電廠對未來的住宅發展噪音、空氣質素及風險影響作進一步的調查。

人工島和南丫擴建廠址的大致排位相似(見表 4.3a)。兩處在最少一半比較類別都是可取的地點。人工島因位處偏遠的海上而得益，在噪音和水質類別均排位較高；而南丫擴建廠址因面積較小和位處已工業化的一段海岸，在施工廢土處置和海洋生態資源方面均屬可取。兩處廠址的主要差別在於各自排位較差的項目的性質。對南丫擴建廠址來說，該等項目包括水質和噪音，而兩者都可用已有的技術解決。不過對人工島來說，排位低(第四位)的海洋生態資源問題則引起較多爭議。這是因為該地點有具有商業價值的魚類和甲殼類動物，所以受拖網漁民歡迎。此外，該區更因為是具有商業價值的魚類的產卵和育幼地點而變得重要。在此處興建發電廠將引發漁民要求賠償，過程中並會涉及大量的商討談判。人工島也在施工廢土處置方面排位甚差(第四位)。這是由於在填出所需工地過程中會有大量海泥需要處置，而填料管理委員會對於此處的情況，要比其他地點(尤其是南丫擴建廠址)更為關注。

基於上述種種因素，南丫擴建廠址較人工島可取，也是整體來說最可取廠址。

4.3.2 可取的廠址

由以上關於環境方面對燃煤發電廠最終候選廠址互相比較的討論看來，南丫擴建廠址對現有環境資源(尤其是陸地及海洋生態、歷史和文化資源)的影響較少或微不足道，因而是可取廠址。儘管仍有某類影響(空氣質素、水質、噪音和景觀及視覺影響)，以該等影響的性質和程度來看，亦可用已有的傳統技術作出緩解，所作緩解並且極有把握取得成功。

雖然比較評估認定，南丫擴建廠址就環境而言為最可取燃煤發電廠廠址，但是和設廠有關環境影響仍需詳細研究，以求將環境影響減至最低。

表 4.3a 燃煤發電廠最終候選廠址的整體環境比較

環境參數	廠址 3 - 大鴉洲	廠址 5 - 石鼓洲	廠址 10 - 人工島	廠址 17 - 南丫擴建廠址
空氣質素	1(+)	2(+)	3(0)	3(0)
水質	2(0)	2(0)	1(+)	4(0)
噪音	1(+++)	4(0)	1(+++)	3(0)
施工廢土棄置	2(+)	3(+)	4(+)	1(+)
陸地生態資源	3(0)	4(-)	1(+++)	1(+++)
海洋生態資源	2(+)	3(+)	4(-)	1(+)
景觀及視覺影響	3(0)	3(0)	2(0)	1(0)
歷史及文化資源	4(0)	3(0)	1(++)	1(++)
整體排位	3	4	2	1

對最終候選廠址作出評審時，若有既定的客觀及定量準則，專家小組已盡可能採用這些準則；在缺乏定量準則或此等準則不適用時，研究人員則根據專業知識作出了主觀定性的判斷。除了按可取程度所作的標準排位外(第一可取、第二可取、第三可取，如此類推)，研究亦採用了一套影響強度分類系統。在這套系統中，按有關的定量或定性準則，視乎影響是較可接受或較不可接受，給予正號「+」或負號「-」。評分系統中各個類別為：

- (+++)
 - (++)
 - (+)
 - (0)
 - (-)
 - (--)
 - (---)
- 表示全無影響或影響微不足道。
 表示有可測的影響，但在未經緩解的情況下仍可接受(比一般良好價例為佳)。
 表示影響在未經緩解的情況下仍可接受(比一般良好價例為佳)，但可能引起某些群體或界別關注。
 表示影響在未經緩解的情況下不可接受，但可採用的緩解措施極有把握成功。
 表示影響在未經緩解的情況下不可接受，而可採用的緩解措施在某程度上不肯定有效或可能有繼發的影響。
 表示影響在未經緩解的情況下不可接受，而可採用的緩解措施在某程度上不肯定有效或可能有繼發的影響，而儘管有緩解措施，仍可能對某些群體或界別可能事關重大。
 表示影響不可接受，而且不能以現有技術作出緩解。

按可接受程度而歸於同一類別的候選廠址可能在環境影響的水平方面迥相迥異，而在環境可取程度方面亦有分別。因此，研究採用了第二種數值評價方法，表示每個最終候選廠址在每個專業課題的可取程度排位。這種排位方法考慮了可能產生的不同種類影響，雖然這些不同影響根據研究採用的準則可能屬於可接受類別，但是有關影響的強度卻有所不同。故此，候選廠址的排位清楚顯示了各專家就各自的專業而評定的相對可取程度。

5 結論及建議

環境影響評估是港燈新發電廠選址研究其中一部份，第一階段環評研究報告卷一及卷二提供了有關評估的結果。第一階段環評報告卷一提供了正式環評過程的結果，而卷二則提供環評研究過程中所進行的各項技術研究的結果。

5.1 第一階段環評結果摘要

綜合各項技術研究在廠址篩選程序中提供的資料，第一階段環評得出了下列結論：

- 天然氣在環境方面是比煤更為可取的燃料。
- 由於香港並無控制溫室氣體的政策，因而研究未能就各種方案在溫室氣體排放方面的可接受程度作出結論。
- 無論是燃煤或燃氣方案，南丫擴建廠址都是就環境而言最為可取廠址。雖然在南丫擴建廠址發展新電廠可能引起噪音、局部地區空氣質素、水質和海洋生態各方面的影響，而施工廢土的處置亦要小心管理，但第一階段環評認為這些影響都可以緩解。
- 考慮各種燃料、發電技術和廠址方案後，就環境而言最為可取的組合就是採用聯合循環燃氣輪機技術的燃氣發電廠，作為現有南丫島發電廠的擴建部份。
- 燃煤發電廠方案方面，就環境而言最為可取的組合，就是以配備脫硝設施的先進粉煤燃燒系統或綜合煤氣化聯合循環系統的發電廠，作為現有南丫島發電廠的擴建部份。縱使綜合煤氣化聯合循環系統並未在商用規模的層面加以驗證，在發展第二及第三發電機組時仍會考慮該種技術。

5.2 進一步研究的要求

5.2.1 第二階段環評

假設在環境方面最可取的燃料、技術和廠址組合獲得政府同意，詳細環評研究（第二階段環評）探討的主要環境問題就應為下列各

點：

- 確定由香港水域邊界到發電廠廠址的輸電電纜和天然氣供應管道的最佳路線，並評估裝置這些設施的影響。路線篩選過程會盡量避免事先已界定對環境敏感地點的影響，亦會認定管道/電纜敷設方法、登陸地點(包括附設之建築物及設施)、施工地點及所需的緩解措施。
- 南丫擴建廠址施工及運作噪音的影響及其緩解，包括考慮廠址以外的設施和施工地點。
- 就興建新發電廠可能引起的水質影響作出評估，包括興建廠址及敷設電纜(及如有需要敷設天然氣管道)所引起的影響。研究將會以三維模擬斷定懸浮水中的沉積物傳輸及其最終結果，以及由填海產生的流體動力學方面的變化。
- 與發電廠運作有關的水質影響預料為污水處理及排放和冷卻水排放的影響。研究會模擬雨季及旱季大小潮時熱捲流的動向，並會以靈敏度測試斷定緩解措施(包括冷卻水進出口位置及改變排放的溫度)的實質效用。研究會提交模擬結果以顯示水體溫度上升的時空分佈。雖然研究會特別關注水溫增加攝氏兩度的範圍和深度，但亦會顯示溫度上升值在攝氏兩度以下及以下的地方。如預測敏感地點的溫度會上升，研究亦會斷定是否會有影響產生，和該等影響的嚴重程度。將接收水體的溫度上升減至最低後，冷卻水排放可能產生的影響將會減至符合水質指標的程度。
- 香港環境資源管理顧問有限公司在一九九六年十一月至一九九七年十一月間，在香港南面水域進行了一項為期十二個月的海洋哺乳類動物預先調查。調查範圍包括南丫擴建廠址所在一帶，並根據事先與漁農處協定的方法進行。調查所得的資料會用於詳細評估水溫上升對鯨目動物(主要是江豚)的影響。

再者，研究會視乎水溫上升的模擬結果，對水溫可能受影響水域的深海及淺海生態資源進行調查，以確定其自然保育價值。根據既定慣例，調查會在冬季及夏季進行以提供具有代表性的數據作評估之用。

- 研究會進行詳細空氣質素模擬(包括風洞模擬和適當的數學模擬；若有需要亦會進行光化反應模擬)，以評估發展新發電廠可能引起的空氣質素影響。主要考慮的敏感地點會包括但不限於西九龍及港島現有和已規劃的發展，以及南丫島和港島南區未來可能會有的住宅區。研究亦會評估施工期間產生的塵埃影響及有關緩解措施。
- 工地平整時挖出海泥的評估，包括污染的評估並認定適當的處置安排。
- 有關在廠內儲存及使用危險品的定量風險評估。假如危險品的儲存量達至令新發電廠被列為具有潛在危險的裝置的水平，就會根據《香港規劃標準及準則》第十一章的要求進行正式的風險評估、規劃研究和行動計劃研究。
- 景觀及視覺影響方面的考慮，亦會包括在研究建議的緩解措施中。發電廠廠房的外型大小和高度將會減至最低，並會考慮可以改善視覺質素的設計方案。
- 施工及運作期間的環境監測及審核要求(見 5.2.2 節)。
- 視乎香港特區政府對境內能源工業排放溫室氣體的政策取向，根據《京都公約》進一步研究緩解二氧化碳和其他主要溫室氣體排放的可行性及機會。
- 若有適當資料，第二階段環評亦會對新發電廠以外其他現有和已規劃發展所產生的累積環境影響作出評估。

預料《環境影響評估條例》將於一九九八年間實施，而第二階段環評將會根據所實施法例的法定要求及程序進行。

5.2.2. 環境監測及審核的要求

在發電廠發展施工及運作期間，需按一個環境監測及審核計劃、進行背景、影響及達標監測，以確定符合第二階段環評的各項建議；確保緩解措施有效，令環境質素維持在《香港規劃標準及準則》及有關政府法例所訂的準則範圍內；並認定在緩解措施失效時所需的額外措施。

監測的技術要求、頻率和地點將在第二階段環評中認定，其後並會列入發電廠的環境監測和審核手冊內。現時預期將包括在發電廠施工期和運作期中主要時段對空氣、噪音和水質的監測。

第二階段環評研究中撰寫的環境監測及審核手冊應指出負責執行及查核環境監測和審核計劃的組織或個別人士。手冊並應包括事件及行動計劃，指出當監測所得數據有變動時，應由何人採取何種行動，並應列出接獲環境方面的投訴時的處理程序。手冊並會列出有關提交報告的安排。