

PART B

THE NEW POWER STATION

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1 CONSIDERATION OF ALTERNATIVES

1.1 INTRODUCTION

1.1.1 Background

On 31st 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.

This followed reports from two preceding studies: *Site Search for a New Power Station: Detailed Site Selection and Stage I EIA for a New Power Station, Volumes 1 & 2* 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, 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 studies also undertook site-specific comparative environmental assessments of impacts on air quality, water quality, aquatic and terrestrial ecology, noise, wastes, landscape & visual impact, landuse planning, and historical & cultural resources.

The studies 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, using natural gas as the preferred fuel and combined cycle technology.

This Section presents a summary of the environmental content and inputs to the site search exercise undertaken for the new power station. A fuller presentation of the site search process and the integrated environmental assessment conducted in parallel may be found in the above two reports.

1.1.2 *The Stage 1 EIA of the Site Search Process*

The Management and Scope of the Study

In November 1996 ExCo invited HEC to proceed with the Site Search Study for this project and, in March 1997, a Steering Group was established by the Planning, Environment and Lands Branch (PELB) to monitor the Study and issue guidelines in the form of a *Study Brief for a Site Search Study for a New Power Station*.

A parallel Environmental Impact Assessment was undertaken by HEC's consultants 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*. The Stage 1 EIA was overseen by the Environmental Protection Department (EPD), which chaired the Environmental Study Management Group (ESMG) for the study.

As an initial assessment, the Stage 1 EIA provided a preliminary evaluation of the range of potential impacts associated with the development of the new

power station and ensured that opportunities were taken to minimise environmental impact through the development and application of site screening and selection criteria. The primary objective of this initial assessment was to determine whether the environmental impacts associated with a new power station were considered surmountable and therefore whether the proposed development could be considered environmentally acceptable.

Study Objectives

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 1800 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 1800 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 ha) than for the coal-fired scenario.

For both scenarios, it was acknowledged 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.

Scope of the Stage 1 EIA

The Stage 1 EIA focused on the environmental evaluation of potential sites and fuels for the new power station and associated on-site and off-site ancillary or supporting facilities. The 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 emission issues, and the feasibility of siting a waste-to-energy incinerator adjacent to the power station.

1.1.3 *The Site Search Methodology*

The Site Search Study was undertaken in three phases, with a progressive "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 Study Brief being carried out within the appropriate phase of the Site Search Study.

- *Phase I - Technical Studies*

Several technical studies relating to broad, non-site specific, strategic issues were undertaken as integral parts of the environmental work for the site selection exercise, and were reported separately in individual Technical Papers. Summaries of the findings of each study are presented in *Section 1.2* below.

- *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 envelope" (the territory of the Hong Kong SAR) 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 1.3*.

- *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 was carried out under Phase III of the Stage 1 EIA. The detailed assessment criteria comprised :

- air pollution;
- water pollution;
- noise impacts;
- terrestrial ecological impacts;
- marine ecological impacts and fishery resources implications;
- construction spoil disposal implications;
- landscape and visual impacts; and
- impacts on 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 1.4* below.

1.2 SUMMARY OF TECHNICAL STUDIES (PHASE I)

1.2.1 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.

1.2.2 Findings of the Technical Studies

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 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 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 developing technologies, in particular IGCC, for the second and third power generating units.

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 would 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 emissions from the whole PRD region.

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 reach between 46.3 to 62.2 million tonnes (Mt) under the lowest and highest scenarios 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

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 to 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 emissions to 1990 levels.

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. On the other hand, definitive synergistic benefits, in engineering or operational terms, were not identified.

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.

1.3 SUMMARY OF PRELIMINARY SITE SEARCH (PHASE II)

1.3.1 Short Listed Sites for Gas-fired Power Station Development

During the course of this phase of the assessment, seventeen potential sites were identified for a gas-fired power station within the established areas of least constraint. By considering the intermediate screening criteria (including environmental, engineering and marine access characteristics of each site as presented in *Table 1.3a*) 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; and
- Site 17 - Lamma Extension.

The locations of the shortlisted sites are illustrated in *Figure 1.3a*.

Short Listed Sites for Coal-Fired Power Station Development

Fourteen potential sites were identified for a coal-fired power station within the established areas of least constraint. By considering the intermediate screening criteria (including the environmental, engineering and marine access characteristics of each site as presented in *Table 1.3a*) 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; and
- Site 17 - Lamma Extension.

The locations of the shortlisted sites are illustrated in *Figure 1.3a*.

1.4

SUMMARY OF SITE SELECTION (PHASE III)

1.4.1

*Introduction**Evaluation Objectives*

The shortlisted sites for the gas-fired and coal-fired power stations were then evaluated and compared 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.

Approach to the Comparative Assessment of Shortlisted Sites

In evaluating the shortlisted sites, the specialist teams employed objective, quantitative criteria where these were established or available. 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 was applied using either positive signs ("+") or negative signs ("-") depending upon whether the impacts were considered to be acceptable or unacceptable to a greater or lesser extent in terms of the relevant quantitative or qualitative criteria. The categories were:

- (+++)
 - (++)
 - (+)
 - (0)
- indicated no or negligible impacts;
- indicated impacts which are detectable but acceptable without mitigation (over and above generally accepted good practice);
- indicated impacts which are acceptable without mitigation (over and above generally accepted good practice) but may be of concern to particular groups or sectors;
- indicated impacts which are unacceptable without mitigation but high levels of confidence were associated with the mitigation measures available;

- (-) indicated impacts which are unacceptable without mitigation and a degree of uncertainty or possible secondary impacts are associated with the mitigation measures available;
- (- -) indicated impacts which are unacceptable without mitigation and a degree of uncertainty or possible secondary impacts which 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;
- (- - -) indicated impacts which are unacceptable and cannot be mitigated with currently available techniques.

Table 1.3a 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 < 2 m in the approach channels • Waves < 1.5 m at the berth • Waves < 1 m 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"> • > 20 m below C.D. <p><i>For Gas-fired Power Station</i></p> <ul style="list-style-type: none"> • > 6-7 m 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 > 20 m below C.D. <p><i>For Gas-fired Power Station</i></p> <ul style="list-style-type: none"> • >6-7 m 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 = 59 ha • 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 = 42 ha • 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

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 was therefore employed to indicate the preferential ranking assigned to each of the shortlisted sites for each specialist area. This ranking acknowledged 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 provided a clearer indication of environmental preference.

1.4.2

Identification of the Preferred Gas-Fired Power Station Site

Results of the Comparative Assessment

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

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

The Sunshine Island site was 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 was 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 were not considered important in terms of marine ecological resources and the air emissions dispersion from the proposed site was considered favourable.

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

The Tai A Chau site was constrained in terms of impacts associated with cooling water discharges and due to the high archaeological potential of the island. Air emissions dispersion from Tai A Chau was 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 was 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 was considered favourable, the remoteness of the site from noise sensitive receivers has considerable benefits and the potential impacts to water quality were considered low.

- *Site 5 - Shek Kwu Chau*

The Shek Kwu Chau site was 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 were likely to be of major concern to wildlife specialists and groups. The site was 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 was to be located has been identified as a candidate area for the protection of commercially valuable fish and crustacean spawning and nursery areas. Mitigation of such impacts was likely to require negotiations regarding levels of compensation to local fishermen. As such, the site was 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 concluded that the site was the least preferred in this regard, although the identified impacts were considered amenable to mitigation.

However, the Artificial Island, as a relatively remote location, was considered largely unconstrained with regard to several specialist evaluations. As such, the site was 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 also favoured the Artificial Island in terms of impacts to landscape and visual resources and the thermal plume dispersion characteristics of a free-standing reclamation 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 concluded that the site has a low preference ranking, although the identified impacts are quite amenable to mitigation.

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

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 1.4a*.

From the issue rankings and acceptability indices, two of the existing island sites (Sunshine Island and Shek Kwu Chau) were rated 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. 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 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 or 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 desirability of preserving 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 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.

Table 1.4a

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

- (+++)
- (++) indicates no or negligible impacts
- (+) indicates impacts which are detectable but acceptable without mitigation (over and above generally accepted good practice)
- (0) indicates impacts which are acceptable without mitigation (over and above generally accepted good practice) but may be of concern to particular groups or sectors
- (-) indicates impacts which are unacceptable without mitigation but high levels of confidence are associated with the mitigation measures available.
- (--) indicates impacts which are 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 which 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 was employed therefore to indicate the preferential ranking assigned to each of the shortlisted sites for each specialist area. This ranking acknowledged 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 provided a clear indication of the specialist teams relative preference.

The Preferred Site

The Stage 1 EIA Study concluded that the Lamma Extension was considered 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 are expected (eg air and water quality, and noise), they are of a nature and degree which are likely to be amenable to mitigation with a high degree of confidence using well established conventional techniques.

1.4.3

Identification of the Preferred Coal-Fired Power Station Site

Results of the Comparative Assessment

The Stage 1 EIA Study identified the following key issues associated with each of the sites:

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

The Tai A Chau site was 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 was 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 was 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 was also considered constrained in terms of the marine ecological value of its surrounding waters and the proximity of noise sensitive receivers. The air emission dispersion characteristics were considered favourable.

- *Site 10 - Artificial Island*

The Artificial Island, as a relatively remotely located reclamation, was considered largely unconstrained with regard to several specialist evaluations. As such, the site was 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 also favoured the Artificial Island in terms of impacts to landscape and visual resources and the thermal plume dispersion characteristics of a free-standing reclamation resulted in the Artificial Island being the preferred site in terms of impacts to water quality.

However, the area within which the reclamation was to be located has been identified as a candidate area for the protection of commercially valuable fish and crustacean spawning and nursery areas. Mitigation of such impacts was likely to require negotiations regarding levels of compensation to local fishermen. As such, the site was considered 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 concluded that the site was the least preferred in this regard, although the identified impacts were considered amenable to mitigation.

- *Site 17 - Lamma Extension*

The Lamma Extension, as a proposed extension to the existing reclamation, was largely unconstrained with regard to several specialist evaluations. As such, the site was 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 also favoured the Lamma Extension such that it was the preferred site in terms of impacts to landscape and visual resources, whilst the relatively small scale of the required additional reclamation resulted in the Lamma Extension being the preferred site in terms of the disposal of construction spoil. The site was 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, concluded that the site had a low preference ranking, although the identified impacts were considered amenable to mitigation.

Overall Ranking of the Shortlisted Sites

The general ranking allocations for the Artificial Island and Lamma Extension sites were considered similar (see *Table 1.4b*), 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 was 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 lay in the nature of the categories for which they were ranked poorly. For the Lamma Extension, these categories were the technical issues of water quality and noise, both of which were considered solvable using well-established mitigation techniques. For the Artificial Island, however, the low ranking (4) relating to marine ecological resources was considered (relatively) more contentious, as the ranking arose 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 was likely to lead to compensation claims from fishermen, a process which could be expected to involve extensive negotiations. The Artificial Island also ranked 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 have been a relatively greater concern for the Fill Management Committee than the volumes arising from the other sites (and from the Lamma Extension in particular).

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

Table 1.4b

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:

- (+++)
- (++) indicates no or negligible impacts
- (+) indicates impacts detectable but acceptable without mitigation (over and above generally accepted good practice)
- (0) 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 and 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.

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 are expected (eg air and water quality, noise, and landscape and visual impacts), they are of a nature and degree which can be mitigated with a high degree of confidence using well established conventional techniques.

1.5

STAGE I EIA: CONCLUSIONS AND RECOMMENDATIONS

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, and the disposal of construction spoil will need to be carefully managed, the Stage 1 EIA concluded that these impacts were amenable to mitigation.
- The overall environmentally preferred combination from the fuel, technology and site options was considered to be a gas-fired power station employing combined cycled gas turbine technology, forming an extension to the existing Lamma Power station.
- The Environmental Study Management Group is unable to endorse the coal-field power station option due to the greenhouse gas issue.