PART H

OVERALL SUMMARY & CONCLUSIONS

CONTENTS:

1 INTRODUCTION

This Part of the EIA Report provides a summary of the findings, conclusions, recommendations and outputs of the EIA Study for the Lamma Extension project.

Sections 2, 3 and 4 present summaries of the results and conclusions of the technical assessments for the power station, transmission system and gas pipeline components of the overall project.

Section 5 summarises the findings and conclusions of cumulative impact assessments undertaken in the individual technical assessments, while *Section 6* presents a summary of the environmental monitoring and audit programmes which are recommended for the implementation of this project.

Section 7 presents the overall conclusions of the EIA Study.

2 SUMMARY AND CONCLUSIONS FOR THE TECHNICAL ASSESSMENTS OF THE POWER STATION

2.1 AIR QUALITY ASSESSMENT

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

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

2.1.1 *Baseline Air Quality*

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

2.1.2 *Wind Tunnel Modelling*

Flow Visualisation Tests

The flow visualisation smoke tests in the wind tunnel suggested that the direct impacts of the power station would be greater on or near Lamma Island than on Hong Kong Island or Cheung Chau.. While plumes from the taller stacks tended to overshoot the local terrain, those from the shorter stacks for the new power station were observed to directly impinge on the hilly terrain of Lamma Island. It was also observed that wake effects caused by the hilly terrain on Lamma Island had the potential to influence plumes emitted from the shorter stacks, and hence cause the most significant impacts in the vicinity of the facility.

Stack Height Determination

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

Prediction of Combined Impacts in 2002 and 2012

Air quality impacts due to the combined operation of the existing and proposed power stations were then tested with further quantitative measurements. Predicted maximum hourly, daily and annual average concentrations were derived at each receptor for SO_2 and NO_2 respectively. The results indicated that there would be no breaches of the Air Quality Objectives (AQOs) with peak load operations in 2002 and 2012.

Significant improvements in ambient air quality were indicated for the commencement of operations of the new gas-fired power station. Long term impacts as measured by the annual averages at each receptor were considered to be very low. Generally speaking, the predicted SO_2 and NO_2 concentrations were well within the AQOs for all modelled receptors.

Evaluation of Predicted Impacts

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

Only 24 morning or evening stable cases with southwest winds were identified over the five-year period, and only a fraction of those occasions would be expected to coincide with high load power plant conditions. It is estimated that the total number of hours with high load coinciding with southwest winds and stable conditions may be as low as three hours over five years.

Notwithstanding the fact that occurrences of stable conditions are rare during conditions of high power station loads, a supplementary 5 year episodes analysis was undertaken to address air quality impact during periods of stable and unstable atmospheric conditions and to examine episodes when levels of pollutant are high.

Conclusions

The wind tunnel modelling study concluded that:

- a stack height of 110 m PD is adequate for the combined cycle gas-turbine (CCGT) units at the new power station;
- the net and cumulative impacts of the operation of the new 1,800MW power station with the existing power station in 2012 will not result in any predicted

exceedance of the relevant AQOs for SO_2 and NO_2 at identified receptors in the near-field of the power station;

- the operation of a WEIF will not cause any constraints to the proposed development of the new power station and vice versa;
- improved air quality and reduction in the annual emissions of SO_2 and NO_2 are expected in 2012 compared to 2002 due to the shifting of power station loads from the coal-fired units to the gas-fired units, despite an overall increase in electricity output from 2794 MW to 3916 MW; and
- in the unlikely situation of emergency oil firing, the expected air quality impacts are still within the relevant AQOs.

2.1.3 *PATH Modelling*

Modelling Approach

The PATH regional air quality modelling system was used to identify the *incremental* impact on air quality of the new power station at Lamma Extension, by predicting air quality in 2012 at hourly intervals throughout the SAR *with* and *without* the emissions from the proposed new facility (Scenarios B and A respectively). The outputs of the model are a true cumulative assessment of emissions from existing and proposed units at Lamma, the proposed WEIF, motor vehicles, industrial facilities and other sources in Hong Kong.

A key concern was the possible impacts of the CCGT units when prevailing winds are southwesterly and any plume emitted from the proposed facility would be directed towards Hong Kong Island and Kowloon. A meteorology simulation for such conditions has already been developed for PATH. Five additional days were simulated which together encompass the range of meteorological conditions that prevail in Hong Kong over the course of a year. By combining the results of these simulations annual average concentrations of pollutants may be estimated.

Analysis of Results: Southwesterly Day

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

The cumulative impacts involving the proposed CCGT units under the "worst case" wind direction are well within the AQOs, and the impacts attributable to the proposed new plant are considered to be acceptable.

Analysis of Results: Other Days

The predictions for the other five days indicate that cumulative impacts will not cause pollution levels which exceed either the one-hour or 24-hour AQOs, with maximum predicted levels in the SAR falling between 35% and 64% of the

Objectives. The maximum incremental impacts of emissions from the CCGT units on one-hour average and 24-hour concentrations are typically very low and tend to occur over the ocean rather than populated areas. As with the "worst case" day, contributions to maximum predicted levels are negligible.

Estimates of Annual Average Concentrations

Data from the six days simulated were combined to produce a weighted average concentration that approximates to the annual average. The assessment indicates that both the nitrogen dioxide and sulphur dioxide annual average concentrations are predicted within the relevant AQOs. The incremental contribution of the CCGT units to the maximum predicted levels of both pollutants is negligible at the locations where those maxima are expected to occur.

Conclusions

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

2.1.4 *Regional Air Quality Review*

Pearl River Delta Air Quality Assessment

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

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

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

Summary of Review Findings

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

It was concluded that the new gas-fired station would contribute negligibly to maximum regional concentrations of O_3, NO_2, and SO_2, since the emissions from an additional power station, compared to the existing emissions in the PRD region, are extremely small. With the introduction of the gas-fired station, HEC's total contributions to the PRD regional NO_x and SO_2 concentrations amount to only 1.5% and 0.7% respectively in 2012. There will be a reduction of less than 2% in the predicted O_3 concentration and less than 1% increase in the predicted NO_2 concentration from the new gas-fired power station. In addition, the proposed new power station will also help to reduce the overall acid deposition to the region by about 1%.

Hence, it could be concluded that the contributions of the new gas-fired station to regional NO_2 and SO_2 are negligible in the context of the emissions from the whole PRD region.

2.1.5 *Greenhouse Gas Emissions*

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

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

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

HEC is committed to adopting all practical measures for reducing its GHG emissions, especially from the proposed 6 x 300 MW gas-fired power station. Measures such as base-load shifting to gas units, gas flaring and participation in afforestation programmes will be employed. However, since both Hong Kong's population and economy continue to grow substantially in the next decade, electricity consumption and GHG emissions will inevitably increase.

2.1.6 *Construction Dust*

The potential impacts on sensitive receivers of dust emissions from construction work associated with the Lamma Extension reclamation and power station development were estimated and evaluated. Predicted dust concentration levels (without mitigation) at sensitive receivers were in the range of 104 to 178 $\mu g\ m^{-3}$

(hourly average) and 56 to 61 μg m^{-3} (daily average), both well within the recommended criteria of 500 and 260 μg m^{-3} respectively. No special mitigation measures (beyond good site and housekeeping practices as well as compliance with Air Pollution Control (Construction Dust) Regulation were proposed.

2.1.7 *Conclusions*

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

2.2 *WATER QUALITY ASSESSMENT*

2.2.1 *Construction Impacts*

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

The *hydrodynamic assessment* included a baseline scenario (current conditions), and scenarios for both the Lamma Extension reclamation on its own, and the combination of Lamma Extension and WEIF reclamations. Discharges were calculated for each of the three scenarios. Modelled changes at the cross-section were found to be relatively small. Large changes (15.8%) in the maximum discharge rate across the southeast cross-section are predicted for the Lamma Extension scenario in the dry season, although reductions of this size only occur at the maximum rate (the average discharge rates change by only 2.0%). This shows that impacts only occur at the instantaneous maximum, and for the rest of the tide the changes are small. Therefore the overall flushing characteristics of the area are not adversely affected by the inclusion of the two reclamations.

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

The simulations showed significant exceedances of water quality objectives (WQOs) for suspended solids (SS) for Scenario 1, and it was concluded that a lower rate of dredging would be required to meet the WQOs. The dry season neap tide was determined as the "worst case". Predicted SS levels for Scenarios 2 and 3 using these "worst case " conditions were considered to be environmentally acceptable, as were the resulting dissolved oxygen and ammonia concentrations which did not cause breaches of the WQOs, provided that silt curtains are deployed on the eastern, southern and north western sides of the reclamation to mitigate predicted impacts at the nearby sensitive receivers

and that for Scenario 2 the number of large dredgers working is reduced by one on the flood phase of the tidal cycle. The simulation of combined dredging and backfilling operations (Scenario 4) produced results which were considered to be environmentally unacceptable. This results suggests that combined bulk dredging and filling would not be allowed and that fill material will have to be retained during sand filling to prevent loss of excessive fines to the water column, so sea walls should be in place before backfilling commences.

Cumulative impacts involving other projects, such as dredging for Container Terminal 9 and sand winning and backfilling at the South Tsing Yi Marine Borrow Area (STY MBA), were also considered in the assessment. Predicted impacts on levels of SS, dissolved oxygen and ammonia were found to be environmentally acceptable although, in relation to SS levels, this conclusion relies on backfilling rates at South Tsing Yi not increasing significantly over current levels. It was therefore recommended that backfilling rates at the STY MBA and associated SS levels at selected SRs be monitored as part of the environmental monitoring and audit programme for the construction phase, and that dredging activity be regulated as required to prevent unacceptable impacts.

A range of mitigation measures were recommended as a result of the assessment, including constraints on dredging which correspond to environmentally acceptable scenarios, and recommended dredging methods and procedures.

2.2.2 *Operational Impacts*

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

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

Both the existing and proposed power stations will discharge *chlorine* (which is used as an anti-fouling agent), and it was assumed that the proposed WEIF would do likewise. The dispersion and decay of residual chlorine in the marine environment was therefore modelled to assess potential water quality impacts. It was found that the cumulative scenario of discharge from the Lamma Extension and the WEIF would only lead to localised impacts above acceptable concentrations of chlorine and so was found to be environmentally acceptable.

Assessment of Sedimentation Changes

The assessment of impacts on the *sedimentation* regime was based on the hydrodynamic modelling for the construction phase, and concluded that there would be no significant changes to either the tidal or sedimentation regimes as a result of reclamations constructed for the Lamma extension and WEIF projects.

2.2.3 *Conclusions*

The water quality assessment for the power station concluded that the impacts of the project would be acceptable (including the cumulative impacts), provided that the recommended mitigation measures were implemented. In particular,

some regulation of dredging work at the site may be required to prevent cumulative impacts at some sensitive receivers from exceeding acceptable levels.

2.3 NOISE ASSESSMENT

2.3.1 *Construction Impacts*

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

2.3.2 *Operational Impacts*

The operational noise assessment considered the potential impacts of all significant noise sources in the proposed power station complex. A computer model of the plant was developed to predict noise levels resulting from the large number of sources involved, taking into account atmospheric attenuation and the barrier effects of existing and proposed buildings and the local terrain. The predicted noise levels at the nearest NSR at Hung Shing Ye were estimated for the combined impacts of both the existing and proposed power stations.

These predictions showed that the new plant will generally give rise to levels below those of the existing plant at this location. Under the quietest operational states of the existing plant, cumulative plant noise levels may be increased slightly due to new plant operation, but at the higher operational loads, the new plant will not create any significant increases in overall plant noise exposures at the NSRs.

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

2.3.3 *Conclusions*

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

2.4 LANDSCAPE AND VISUAL IMPACT ASSESSMENT

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

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

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

The assessment has concluded that landscape and visual impacts will be acceptable with the implementation of the proposed mitigation measures. A number of mitigation measures were recommended to minimise impacts, including site layout, the form and arrangement of buildings and structures, the use of appropriate colours on particular features such as buildings and chimneys, and landscaping along the edges of the reclamation.

2.5 *WASTE ASSESSMENT*

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

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

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

Arisings of excavated material are not expected to be significant, but at least 7000 m^3 of construction and demolition waste are anticipated. Chemical wastes are not expected to present a problem if recognised practices for minimising, handling and disposal of these wastes are followed. About 600 kg per day of general refuse is expected to arise during construction.

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

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

- practices and procedures for minimising arisings of waste building products and materials, and industrial and chemical wastes;

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

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

2.6 *LAND CONTAMINATION ASSESSMENT*

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

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

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

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

2.7 *MARINE ECOLOGY ASSESSMENT*

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

2.7.1 *Baseline Conditions*

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

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

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

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

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

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

2.7.2 *Impact Assessment*

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

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

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

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

Mitigation measures designed to avoid impacts of vessel traffic to marine mammals, were complied in consultation with Dr Tom Jefferson of the Ocean Park Conservation Foundation, include the rerouting of all vessels involved in construction or operation of the power station extension so they approach the power station from the north or via the East Lamma Channel. During

construction stage, all usage of percussive piling works will only be performed on reclaimed land to avoid noise impact to marine mammals. This is expected to mitigate impacts to the finless porpoise centred off the southwest coast of Lamma Island.

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

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

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

2.8 *FISHERIES IMPACT ASSESSMENT*

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

2.8.1 *Baseline Conditions*

A desk top study was undertaken to establish the baseline conditions for the assessment, and the importance of fishery resources in areas that may be adversely affected by the project. The size and value of the catches for the Fishing Zones within the Study Area characterise them as of medium to high importance to Hong Kong fisheries. Specific areas to the south of Hong Kong are also recognised as spawning and nursery areas for important and high value commercial species, and these were established as sensitive receivers for the purposes of the assessment.

2.8.2 *Impact Assessment*

Direct impacts during *construction* will include loss of habitat due to the reclamation (including approximately 22 ha of seabed, about 5% of the Po Law

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

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

Significant residual chlorine levels are only likely to occur in close proximity to the outfall in the surface layers of the water column. Lethal or sublethal effects are not expected to occur to fisheries resources as research has indicated that adult fish will avoid areas where concentrations are elevated.

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

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

The additional discharge of residual free chlorine in close proximity to the power station was also identified as a residual impact. However, as the concentration of chlorine is low in this area (0.01 mg L^{-1} - below field detectable levels) and below the level at which toxic effects have been demonstrated to occur for fish eggs, fry and adult, the severity of this residual impact is considered to be low.

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

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

2.9 *HAZARDS ASSESSMENT*

Risk assessments for both the fuel gas-related and non fuel gas-related hazards associated with operation of the proposed power station were carried out. The assessment of fuel gas-related hazards was qualitative, and a more detailed assessment was recommended for the detailed design stage.

Fuel Gas-Related Hazards

The consequences of a major release of fuel gas (eg from the gas receiving station) could be severe with little scope for protection or escape. However, the siting of the gas receiving station is generally favourable from an off-site risk perspective as it lies over a kilometre from the nearest residential population. Therefore, in the event of an accident, the effects would be largely confined to the transient marine population.

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

One issue worthy of close attention, however, is the design of the acoustic enclosure for the gas turbines. The UK Health and Safety Executive cite evidence that, despite provision of dilution ventilation, air distribution in enclosures is often inadequate, giving rise to the hazard of a gas explosion. This issue should be carefully considered in the design and commissioning of the power station.

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

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

Assessment of Non-Fuel Gas-Related Hazards

Hazards associated with the light gas oil system relate mainly to fire, although explosion is also possible in certain circumstances. An assessment of the thermal radiation levels which could arise in a major fire at the Lamma Extension shows that they will not exceed injury levels at the nearest residential population, but may be exceeded beyond the site boundary. This is unlikely to lead to fatal injury, however, as these areas are not routinely accessed by the public.

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

Packaged DGs to be stored at the site present a hazard in terms of fire, explosion, toxic injury (due to the generation of toxic gases by fire, decomposition or chemical reaction) and projectiles (rocketing of drums and cylinders in a fire). The toxic products released in a fire are unlikely to lead to fatal effects, and the relatively small quantities stored means that there are unlikely to be any significant off-site effects.

Various types of potential incidents at the Lamma Extension site could escalate to involve the gas facilities, including a major fire or explosion at the DGs store, a fire involving the alternate fuel system (in the vicinity of the gas turbines), and catastrophic failure of pressure vessels or rotating machinery. However, the gas facilities at the Lamma Extension are well located with respect to incidents which could arise from other sources. They also include protective safety features typical of such installations, including an emergency shutdown valve on the main gas supply pipeline and an emergency depressurising and flaring system.

It was concluded from the risk assessment for non fuel gas-related hazards that it is highly unlikely that there could be fatal injuries to persons off-site. For illustration purposes, a simple "order of magnitude" quantitative risk assessment was undertaken for two scenarios in which fatal effects at the site boundary could conceivably arise. The assessed risks were at least two orders of magnitude below the accepted Risk Guidelines.

In conclusion, no unacceptable risks associated with either the fuel gas-related or non fuel gas-related hazards were identified during the assessment. A more detailed risk assessment of the gas-related hazards will be required when more detailed project information is available.

2.10 CONCLUSIONS

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

3 SUMMARY AND CONCLUSIONS FOR THE TECHNICAL ASSESSMENTS OF THE TRANSMISSION SYSTEM

3.1 CONSTRUCTION DUST ASSESSMENT

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

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

3.2 WATER QUALITY ASSESSMENT

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

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

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

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

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

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

3.3 CONSTRUCTION NOISE ASSESSMENT

This assessment considered the potential noise impacts during construction of the tunnel, landing points and cable trough on Lamma Island, and the landing point on Hong Kong Island.

The predictions showed that for a small number of residences located close to the Cable Landing points N4 and N5 (Pak Kok Tsui), the day time noise exposure is

expected to be close or slightly exceed the 75 dB(A) criterion for general construction works contained in the EIAO-TM. Therefore, modest mitigation measures will need to be considered and a limited environmental noise monitoring programme carried out.

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

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

3.4 *MARINE ECOLOGY ASSESSMENT*

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

3.4.1 *Baseline Conditions*

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

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

- intertidal habitat at the proposed landing and launching points: *low* ecological value, supporting assemblages of a diversity which is typical to Hong Kong;
- subtidal habitat at the proposed landing points: *low* ecological value, with lower diversity and abundance than other areas; and
- soft bottom habitat along the cable route: *low* ecological value, supporting a low diversity and abundance of infaunal organisms that are typical to Hong Kong.

3.4.2 *Impact Assessment*

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

Intertidal and subtidal rocky shores will effectively be lost at the landing points and replaced by artificial seawalls. These seawalls could, however, support a

rich assemblage of intertidal fauna and flora through recolonisation, provided a suitable (heterogeneous) seawall design is adopted. Assuming successful recolonisation can be achieved, no adverse impacts are expected.

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

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

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

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

3.5 *FISHERIES IMPACT ASSESSMENT*

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

3.5.1 *Baseline Conditions*

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

3.5.2 *Impact Assessment*

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

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

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

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

3.6 *TERRESTRIAL ECOLOGY ASSESSMENT*

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

Baseline Conditions

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

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

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

Impact Assessment

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

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

3.7 LANDSCAPE AND VISUAL IMPACT ASSESSMENT

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

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

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

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

As a planning gain, parts of the landing points N4 and N5 and the cable trough between the landing points can be used for amenity and recreational purposes. Some low maintenance fixtures, matching the natural environment, will be built or placed on the landing points for public use. A detailed Amenity Plan will be submitted to the Authority for approval before commencement of the construction works. HEC will resolve any management and maintenance requirements of the proposed mitigation measures during the processing stage of wayleave agreements. If required by Government, HEC commit to bear the management and maintenance responsibilities of these facilities.

3.8 CONCLUSIONS

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

4 SUMMARY AND CONCLUSIONS FOR THE TECHNICAL ASSESSMENTS OF THE GAS PIPELINE

4.1 WATER QUALITY ASSESSMENT

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

Dredging

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

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

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

Jetting

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

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

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

4.2 *MARINE ECOLOGY ASSESSMENT*

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

4.2.1 *Baseline Conditions*

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

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

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

- soft bottom habitat along most of the route: *low* ecological value, with a low abundance of common species in an environment which is regularly disturbed by storms and trawling activity;
- hard bottom habitat at SW Lamma, Po Toi, Waglan, Ping Chau, Breakers Reef and Victor Rock (outside of the pipeline route): *high* ecological value, due to valuable soft and hard coral assemblages; and
- habitat of the Finless Porpoise in southern waters: *high* ecological value, as this protected species is known to seasonally inhabit waters around Po Toi and Lamma Islands.

4.2.2 *Impact Assessment*

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

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

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

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

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

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

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

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

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

As impacts arising from the proposed dredging and jetting works are predicted to be largely confined to the specific dredging and jetting areas, they are not expected to cause adverse impacts to any marine ecological resources (habitats or species). Constraints on dredging and jetting operations recommended to control impacts to water quality to within acceptable levels (water quality objectives) also mitigate impacts to marine ecological resources. The marine ecological sensitive receivers listed above are all remote from the dredging /

jetting operations and are not predicted to be impacted. In the interests of avoiding impacts to the breeding population of finless porpoise present around the south of Lamma Island during the spring peak in abundance, it is recommended that jetting operations in this area avoid this time of year. According to the existing timetable the jet ploughing will occur during the autumn in waters to the south of Lamma.

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

4.3 *FISHERIES IMPACT ASSESSMENT*

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

4.3.1 *Baseline Conditions*

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

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

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

4.3.2 *Impact Assessment*

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

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

The approaches to the LNG terminal in Shenzhen and Lamma Extension will be formed using grab dredging. The sediment loss rates are predicted to be at least

14 times less than the values for dredging of the Lamma Extension reclamation site, hence the water quality impacts were considered negligible. Based on these assessments, the impacts to fisheries resources are negligible.

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

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

4.4 *HAZARDS ASSESSMENT*

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

Causes and Consequences of Pipeline Failure

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

Loss of pipeline integrity presents significant potential hazards to anyone in the vicinity. Rupture could release a large volume of gas which would bubble to the surface and begin to disperse in the atmosphere. Where the cause of the damage is a vessel, the vessel itself may provide a source of ignition, leading to a fireball or flash fire with potentially fatal effects. If immediate ignition does not occur, the cloud may be subsequently ignited downwind by another ignition source.

Risk Assessment

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

- Corrosion and Mechanical Failure

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

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

- Third Party Damage

The four main potential sources of damage are dropped objects, anchors, fishing/trawling gear, and vessel impact. The provision of trenching with backfill (up to 50% rock armour) or grout mattresses should provide substantial protection against these sources of impact. However, absolute protection is not guaranteed and the degree of residual risk needs to be considered further in a more detailed examination of the potential sources of third party damage, for which a more formal quantitative assessment is recommended when more detailed design information is available.

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

The crossing of the approach channel to the coal jetties at the Lamma Power Station is also significant because of the change in water depth from 10 to 15 metres (in the channel) and back to 10 metres. To protect against the possibility of damage due to grounding of a bulk carrier on the side of the channel, it is proposed to take the pipeline burial depth down to 15 metres (below sea level) well before the channel crossing.

- Management and Monitoring Procedures

One of the key requirements for an operator of a potentially hazardous pipeline is to establish an effective *safety management* system. Detailed guidance on establishing and implementing such a system is available from a variety of recognised sources, which document best practice in the industry and the standards which this project would be expected to meet.

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

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

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

4.5 *CONCLUSIONS*

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

5 SUMMARY AND CONCLUSIONS FOR THE CUMULATIVE IMPACT ASSESSMENTS

5.1 INTRODUCTION

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

A wide range of potential cumulative impacts were assessed in the EIA Study as an integral part of the individual technical assessments for the different components of the project. Details of these assessments are contained within the individual sections of Parts B, C and D and summarised in Part E. An overview of these assessments and their findings is provided below.

5.2 AIR QUALITY

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

The PATH photochemical air quality modelling system was used to identify both the *cumulative* and *incremental* impacts on air quality of the new power station at Lamma Extension, by predicting air quality at hourly intervals throughout the SAR with and without the emissions from the proposed new facility. Under the simulated conditions, predicted one-hour, 24-hour and annual average concentrations were well below the AQOs, and the contributions of the new power station to the maximum levels observed with model were negligible in the locations where those maxima were predicted to occur.

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

This assessment included the compilation of a greenhouse gas emissions inventory for all HEC operations, and an investigation of the impacts of proposed greenhouse gas mitigation measures on both existing and proposed facilities at Lamma. Total emissions were projected to increase from 1990 levels by 80% (5.11 Mt) and 62% (3.97 Mt) in 2002 and 2012 respectively, illustrating the beneficial impact of gas-fired operation after 2002 despite total electricity generation in year 2012 being 2.57 times that of 1990. Estimated greenhouse gas emissions per unit of energy produced were predicted to fall from 1990 levels by

37% in 2012. A cumulative gain of 6.4 million tonnes of emissions of CO_2 equivalent is predicted in 2012 as a result of the mitigation measures (a 39% reduction in unmitigated emissions), leaving an estimated total of 10.3 million tonnes for HEC operations in that year.

5.3 *WATER QUALITY*

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

The cumulative impacts of dredging for the Lamma Extension and other projects, such as dredging for Container Terminal 9 and sand winning and backfilling at the South Tsing Yi Marine Borrow Area (STY MBA), were considered in the water quality assessment. Predicted impacts on levels of SS, dissolved oxygen and ammonia were found to be environmentally acceptable although, in relation to SS levels, this conclusion relied on backfilling rates at South Tsing Yi not increasing significantly over current levels. It was therefore recommended that backfilling rates at the STY MBA and associated SS levels at selected SRs be monitored as part of the environmental monitoring and audit programme for the construction phase, and that dredging activity be regulated as required to prevent unacceptable impacts.

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

5.4 *NOISE*

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

5.5 *LANDSCAPE AND VISUAL IMPACTS*

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

5.6 *MARINE ECOLOGY*

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

5.7 *FISHERIES*

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

5.8 *HAZARDS TO LIFE*

The assessment of hazards for the new power station considered possible hazardous interactions between the non fuel gas facilities at the Lamma Extension and the existing Lamma Power Station with the fuel gas facilities for the new development. The assessment concluded that the possibility of incidents at the gas facilities being initiated by events at the power station was remote, because of the physical separation of the gas facilities (600 m). It was considered possible that missiles generated by failure of pressure vessels or catastrophic failure of rotating machinery might travel this distance, but the risks associated with such incidents were expected to be low. These interaction hazards would be considered further in the recommended detailed risk assessment for the gas facilities at the Lamma Extension.

6 SUMMARY OF THE RECOMMENDED ENVIRONMENTAL MONITORING AND AUDIT REQUIREMENTS

6.1 INTRODUCTION

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

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

The main objectives of the EM&A programme include:

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

The scope of the EM&A programme is to:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

6.2 ORGANISATION AND STRUCTURE OF THE EM&A PROGRAMME

6.2.1 *Construction Phase*

During the construction phase, HEC will establish an Environmental Management Committee (EMC) to oversee the EM&A programme for the Lamma Extension Project and will employ an EM&A Consultant to implement the environmental monitoring work defined in the Construction EM&A Manual.

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

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

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

6.2.2 *Operational Phase*

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

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

6.3 *SCOPE OF THE EM&A PROGRAMME*

6.3.1 *Construction Phase*

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

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

- Construction Dust

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

- Water Quality Monitoring

  During the course of the dredging operations, monitoring shall be undertaken with sampling and measurement at the designated monitoring stations. Where exceedances are recorded changes to the monitoring and dredging operations will be introduced in accordance with the Event & Action Plan presented in the EM&A Manual.

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

- Construction Noise

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

- Waste Management

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

- Marine Ecology Monitoring

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

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

6.3.2 *Operational Phase*

A detailed Operational EM&A Manual programme will be prepared and submitted to the EPD for approval prior to the commissioning of the new power station and associated facilities. The Manual will define the scope, programme, methods and reporting requirements for the EM&A of the operation of the power station, transmission system and gas pipeline.

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

- Air Quality Monitoring

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

the monitoring data and statistics will be submitted to the EPD at specified intervals or by on-line transmission.

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

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

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

The results of environmental monitoring enable a continuing appraisal of the environmental impact of the HEC air emissions to be made and also provide the means of monitoring, ensuring that the station has no adverse environmental impacts to the ambient air quality.

- Water Quality Monitoring

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

Baseline conditions shall be established prior to the commencement of the discharges from the Lamma Extension. The purposes of the baseline monitoring are to establish conditions prior to the commissioning of Lamma Extension. The baseline conditions shall be established by measuring the size of the 2°C temperature rise plume and by measuring residual chlorine concentration in the waters around the existing power station. The change in size of the temperature and chlorine plumes with operation of Lamma

Extension will be monitored at intervals acceptable to the Authority to verify that it is within EIA predictions.

- Operational Noise

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

- Waste Management

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

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

7 OVERALL STUDY CONCLUSIONS

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

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

The Study has taken into account the latest available information on the siting, routing, design, layout, construction and operation of individual components of the project. In several areas, however, further detailed assessments have been recommended to confirm the findings of this Study. These areas include the assessment of operational noise impacts from the power station, and the assessment of risks associated with the supply, handling and use of natural gas.

Most of the potential impacts identified and evaluated in the Study have been found acceptable without mitigation, although in several areas specific forms of mitigation have been recommended to reduce, minimise or manage impacts to acceptable levels. Specific examples include:

- the scheduling of pipeline installation works to periods which minimise impacts on marine mammals;
- careful design of two transmission cable landing points to avoid the loss of locally rare plants on Lamma Island;
- the sympathetic design of seawalls to reduce visual impact and encourage recolonisation of marine fauna; and
- the establishment of safety management and emergency response systems for the Lamma Extension operation to reduce the likelihood of undesirable events and provide for the effective management.

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

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

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