Contents

LANTAU PORT AND WESTERN HARBOUR DEVELOPMENT STUDIES

FINAL REPORT VOLUME III - ENVIRONMENTAL IMPACT ASSESSMENT

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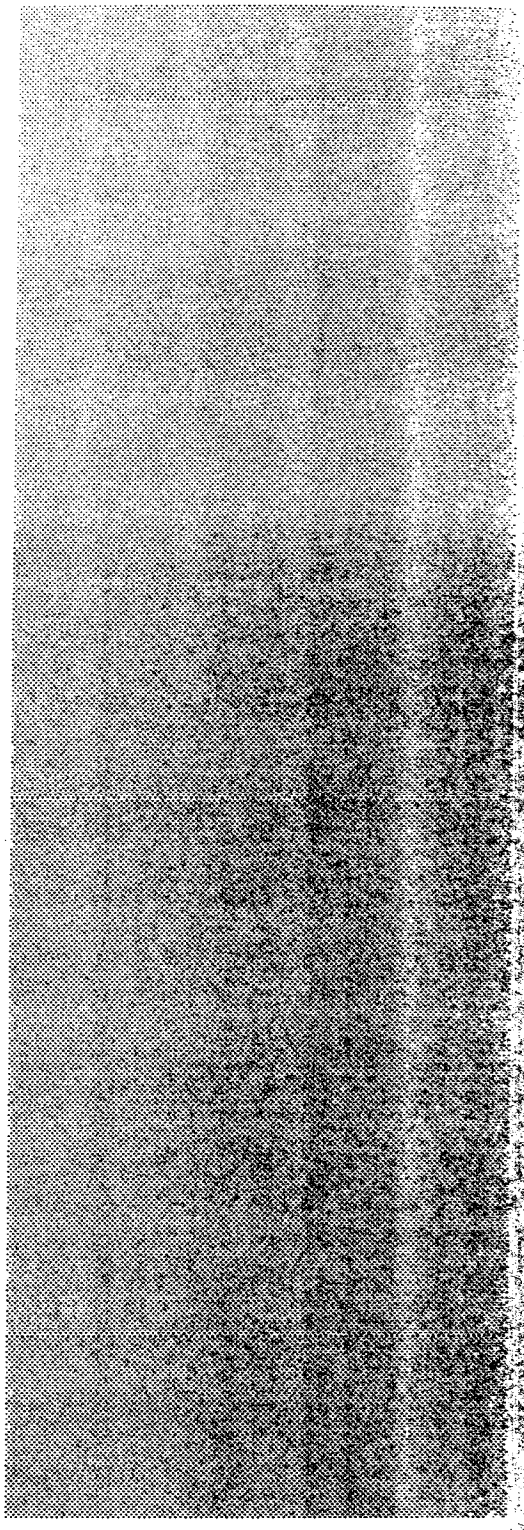
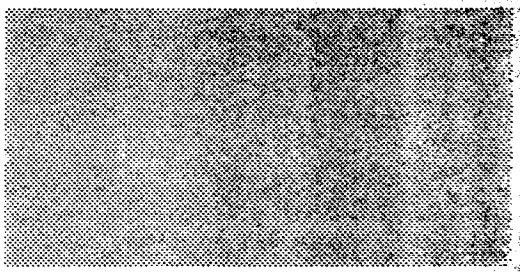
LIST OF ABBREVIATIONS

ACZ	Air Control Zone
AFD	Agriculture and Fisheries Department
ANL	Acceptable Noise Level
AQO	Air Quality Objective
ASR	Area Sensitivity Rating
BOD	Biochemical Oxygen Demand
BS	British Standards
CBA	Container Back-up Area
CCPHI	Co-ordinating Committee on the Land-use Planning and Control Relating to Potentially Hazardous Installations
CFS	Container Freight Station
CIF	Central Incineration Facility
CITES	Convention on the International Trading in Endangered Species of Wild Fauna and Flora
CLP	China Light and Power Company Ltd
cm	Centimetre
CO	Carbon Monoxide
CSD	Correctional Services Department
CWTC	Chemical Waste Treatment Centre
dB(A)	Decibels,('A' Weighted)
DG	Dangerous Goods
dWt	Dead Weight Tonnage
DO	Dissolved Oxygen
DTp	Department of Transport
E.coli	*Eschericia coli*
EIA	Environmental Impact Assessment
EPD	Environmental Protection Department
ESDR	Environmental Survey Data Report
FCZ	Fish Culture Zone
FSD	Fire Services Department
GIL	Green Island Link
Ha	Hectares
HEC	Hongkong Electric Company
HKAS	Hong Kong Archaeological Society
HKCGC	Hong Kong and China Gas Company Limited
HKPSG	Hong Kong Planning Standards and Guidelines
Hrs	Hours
Hz	Hertz
ISCST	Industrial Source Complex Short Term
IMDG	International Maritime Dangerous Goods
IMO	International Maritime Organization
ISCST	Industrial Source Complex Short Term Model
LAPH	Lantau Port and Western Harbour
L_{10}	Noise Level Exceeded for 10 % of the time
L_{90}	Noise Level Exceeded for 90% of the Time
Leq	Equivalent Continuous Noise LeveL
LFC	Lantau Fixed Crossing
m	Metre
MARPOL	Marine Pollution
Mm^3	Million Cubic Metres
MSSA	Marine Services Support Area
MTR	Mass Transit Railway
NCO	Noise Control Ordinance
NEF	Noise Exposure Forecast
NLD	North Lantau Development

NLE	North Lantau Expressway
NH_3-N	Ammoniacal Nitrogen
NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
NSR	Noise Sensitive Receiver
NTU	Nephelometric Turbidity Unit
O_3	Ozone
PADS	Port and Airport Development Strategy
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PCP	Preferred Concept Plan
PFA	Pulverised Fuel Ash
PHI	Potentially Hazardous Installation
ppm	Parts Per Million
ppb	Parts Per Billion
PRC	Peoples Republic of China
RMG	Rail Mounted Gantry
RODP	Recommended Outline Development Plan
RSD	Regional Services Department
RSP	Respirable Suspended Particulates
RTG	Rubber Tyred Gantry
RTS	Refuse Transfer Station
RTTW	River Trade Transhipment Wharves
SHRUG	The Study on Harbour Reclamations and Urban Growth
SPICE	The Study of Port-related Industrial and Commercial Enterprises
SPL	Sound Pressure Level
SR	Sensitive Receiver
SSDS	Strategic Sewage Disposal Scheme
SSSI	Site of Special Scientific Interest
STL	Sham Tseng Link
STW	Sewage Treatment Works
SWL	Sound Power Level
TBT	Tributyl Tin
TCT	Tsing Chau Tsai
TEU	Twenty Foot Equivalent Unit
TSP	Total Suspended Particulates
μm	Microns
USEPA	United States Environmental Protection Agency
WAHMO	Water Quality and Hydraulic Models
WCZ	Water Control Zone
WHDS	Western Harbour Development Studies
WQO	Water Quality Objective



Summary



SUMMARY

1 BACKGROUND

1.1 INTRODUCTION

This Section provides a summary of the key findings of the environmental studies and assessments that have been performed to assist in the preparation of the RODP. This Summary also gives an account of potential impacts and mitigation measures.

1.2 STUDY AREA

The Study Area is essentially rural in character and is dominated by the Western Harbour water area. Consideration of impacts has extended beyond the primary Study Area for certain specialist subjects, due to the nature of some of the potential environmental impacts.

The area includes many scenic and important amenity locations and is widely used for recreational pursuits including hill walking, water sports and beach activities. The marine areas are important for shipping and marine facilities/activities, such as anchorages, shipping lanes, ferry routes and commercial fishing. The land areas are mainly rural with a restricted transport network and limited industry in the form of shipbuilding, ship repair and power generation. There are a limited number of residential areas, notably Discovery Bay, Ma Wan, Silver Mine Bay, communities on Peng Chau, Cheung Chau, Hei Ling Chau and Lamma Island. Other areas, which are potentially significant residential expansion areas are all near Discovery Bay and include Yi Pak, Sz Pak, Sam Pak, and an undetermined area south of Discovery Bay.

Overall the area is quite distinct from the heavily populated and often congested areas typical of Hong Kong Island, Kowloon and the New Territories near Tsing Yi.

1.3 ASSESSMENT APPROACH

Lantau Port will have ongoing construction impacts throughout the period up to the completion of the development (15-20 years). The assessment has therefore considered the four notional phases of the development, identifying impacts arising from each phase of the construction and subsequent operation of the port developments. Assessment of Phase I considers much of the significant construction works and initial operation, while assessment of Phase IV represents the full development which is the worst environmental case as far as full operations are concerned.

2 ENVIRONMENTAL BASELINE

2.1 EXISTING CONDITIONS

In order to determine the existing environmental conditions within the Study Area a comprehensive environmental review was carried out, covering a wide range of aspects including :

- air quality;
- noise levels;
- water quality;
- terrestrial and marine ecology;
- landscape characteristics and visual aspects;
- archaeology and sites of historic interest; and
- waste management.

Where it was considered that the existing or available baseline data was insufficient for certain aspects, sampling and/or monitoring surveys were carried out to provide supplementary information. Surveys were carried out for the following :

- air quality (particulates and gaseous pollutants);
- noise levels;
- marine ecology (seabed grab sampling for biological and sediment analysis); and
- terrestrial ecology (using survey maps, aerial photographs and site visits).

The air quality and marine ecology surveys were carried out in two separate stages, approximately 6 months apart to identify any differences between the wet (summer) and dry (winter) seasons.

A description of the surveys and the results obtained is given in the *Environmental Data Surveys Report*, October 1992.

2.2 KEY EXISTING AND COMMITTED SENSITIVE RECEIVERS

Section 2 details the location of the key existing or committed sensitive receivers (SRs) within the area of influence of the proposed development.

General impact SRs comprise those areas susceptible to noise, visual and air quality impacts. In relation to the LAPH development, SRs have been identified as residential areas on Lantau, the Outlying Islands and Western Hong Kong Island.

3 ENVIRONMENTAL IMPACTS

3.1 GENERAL

As a consequence of the nature of the proposed development which involves ongoing construction at a relatively constant level over an extended period and operations which increase in an incremental manner, there will be both short and long term impacts. Environmental issues and measures have been considered throughout the Study to prevent impacts or reduce them to an acceptable level. An important goal has been to ensure that environmental controls and mitigation measures are "designed in" during this planning and outline design stage.

There are two general factors which are particularly significant in a consideration of the potential impacts. These are :

- the nature and character of the Study Area i.e. a quiet, scenic and predominantly rural area well used for recreational purposes and including large water areas; and,
- the sheer scale of the developments (and dimensions of the Container Port peninsula and Lamma Breakwater in particular) and the wide area covered or influenced by them.

Overall the most significant environmental issues arising from the LAPH development are considered to be air quality, noise, water quality, marine ecology and visual impacts during both the construction and operational stages. It is anticipated that there will also be significant disruption to the local fishing industry.

3.2 AIR QUALITY

Air quality impacts at SRs may be expected to occur during the construction and operation of the LAPH development. Emissions will occur from both stationary sources (construction sites and industrial processes) and mobile sources (traffic). Impacts have been assessed using accepted computer modelling techniques and assumptions.

The pollutant of greatest concern during construction is particulates. Impacts from construction activities were evaluated in terms of the distance within which air quality impacts could occur in excess of the Air Quality Objectives (AQO), or the 1 hr Total Suspended Particulate guideline. Where SRs exist within 500m of dusty construction activities, mitigation measures should be employed.

The TCT borrow area may represent the major source of land based fill for the LAPH development and as such has the potential to cause significant air quality impacts. The impacts will include exhaust fumes from vehicles and equipment as well as potentially considerable amounts of particulates from borrow operations. Control and mitigation measures such as spraying, wheel washing, ensuring vehicles carrying fill are covered and restricting speed limits on unpaved road will be necessary to reduce potential impacts.

Impacts during construction of Phase I would be of concern at Fa Peng, and to a lesser extent in the area of Penny's Bay power station. Mitigation measures should focus on these areas. Phase II will take the development northward and areas of concern will expand to include those Phase I developments adjacent to Phase II construction. Most Phase III construction will occur offshore and as such air quality impacts will be of lesser concern because the work areas are further remote from SRs. Mitigation of impacts should still be considered for adjacent areas with sensitive land uses. As with Phase III, mitigation measures should be employed to protect adjacent previously developed areas during the construction of Phase IV. Other SRs are sufficiently remote that no specific mitigation is required.

During construction of the LAPH development, dust control measures are likely to result in the most effective mitigation of particulate impacts. Construction contracts should include requirements for compliance with mitigation action plans if warning levels or the AQO is exceeded. The air

quality should be monitored using both stationary and portable meters so that the need for mitigation measures can be readily assessed and implemented in a timely fashion.

Operational air quality impacts may arise from numerous emission sources, of which, impacts from road transportation is of primary concern, from this source the pollutant of greatest concern is Nitrogen Dioxide (NO_2). Emission rates from vehicles were estimated and used to enable concentrations at SRs due to vehicle emissions to be calculated and compared to the AQO. Few SRs currently exist in the Study Area but the port related developments will create new, potential SRs. Where SRs do not yet exist, setback distances have been derived, for planning purposes, to meet the AQO.

During operation, estimated impacts at the existing SRs are within the AQO. Phase IV 1 hr NO_2 levels in the Fa Peng area become relatively high, though less than the AQO. These results suggest the conditions that may occur at receivers similarly situated in proximity to emission sources. Analysis of potential impacts from road traffic indicated that the critical impact is the 1 hr NO_2 concentration. 1 hr NO_2 impacts were evaluated in terms of required setback distances from roads, in order to maintain concentrations less than the AQO at future SRs.

For the Lamma Breakwater, the Industrial Source Complex Short Term (ISCST) model was used to determine the maximum area wide emission rates that would still allow concentrations at the nearest SRs to remain within the AQO. A range of meteorological conditions were modelled and the highest predicted concentrations were selected.

3.3 NOISE ASPECTS

Noise from container port construction has the potential to cause significant noise impacts on noise sensitive receivers (NSRs) in Peng Chau and Discovery Bay, particularly at night during Phase I. Mitigation measures as recommended in Section 5 to reduce the noise levels including the use of quietened equipment and/or barriers to block noise transmission will have to be implemented.

Construction noise impacts will be of concern during berth 1 construction following which berth 1 will become operational adding to the general noise environment of the area.

At present the timing for the LAPH development means that the need for night-time construction work is not envisaged, however, if the development timing were to be significantly brought forward the need for night working will (with potentially significant impacts) become inevitable.

The breakwater construction, and associated reclamation, is not expected to have significant noise impacts on nearby SRs providing the finishing of the filling is restricted to daytime hours.

The quarrying activities being carried out at the TCT borrow area will involve explosive blasting. Impacts of concern associated with quarrying are vibration and the "startle effect". The possible mitigation of these is limited, but as a minimum should include a public awareness scheme to pre-notify residents and ensure that the minimum practical charge size is used.

For the purpose of the noise assessment, all of the Phase I and Phase II berths were assumed to be operational for the 30-minute evaluation period. However, this 100% utilisation is considered unrealistic as discussions with existing operators in Hong Kong has clearly indicated that a 65% berth occupancy is the norm. For Phases III (maximum 12 berths) and IV (maximum 17 berths) two possible scenarios, utilising 11 and 14 occupied berths have been selected to give a worst-case scenario for the receiver area under consideration and is considered to be well beyond realistic operational occupancies. In summary the maximum berth occupancies which have been assessed are :

Phase I	-	100%
Phase II	-	100%
Phase III	-	92%
Phase IV	-	80%

This allows for any possible increases in berth occupancy during future years.

Each item of main port operational equipment has been assessed in terms of its average operational cycle and the period within the cycle when the equipment is under load and producing its ascribed noise levels. These factors have been employed in the calculation of the overall noise generation.

Port operational noise similarly has the potential to cause significant noise impacts. Adoption of quietened equipment currently available on the market can reduce noise levels significantly,

particularly in combination with end-of-berth barriers. With quietened equipment and barriers, noise levels are not expected to exceed NCO standards except at scattered, highly exposed dwellings. "Ultra-quietened" port equipment and end-of-berth barriers would be expected to result in even lower noise levels that lie within HKPSG standards at all but very exposed receivers.

In summary, with the use of appropriate and reasonable mitigation measures, NCO standards at all evaluated NSRs (except those on peng Chau headland and the tiny settlement at Fa Peng) are expected to be achieved in all phases of the Port.

3.4 WATER QUALITY

It is anticipated that the most significant activity which would impact on the marine environment is the dredging carried out during the construction of the developments. The main impacts associated with dredging relate to increased suspended solids and associated reduced dissolved oxygen levels.

The mitigation measures that will need to be adopted include careful selection of the method (particularly a mud retained approach) and type of equipment employed, timing and procedures used and the possible use of silt curtains. Reducing the rate of dredging, or even cessation, is a further possible measure in extreme circumstances.

Operational water quality impacts from the LAPH development can be divided into those related to (i) the presence of the port peninsula reclamations and (ii) pollution impacts arising during the day-to-day operations. The first of these is dealt with in Section 3.5 WAHMO Water Quality Modelling and the latter is discussed below;

Operational pollution impacts from the port can be divided into two groups: chronic and acute;

- chronic impacts would arise primarily from the increased hydrocarbon loading to the receiving waters due to fuel and oil run-off from the port and support activities. Although this additional loading can affect water quality, no threat to public health is anticipated to arise from the consumption of seafood caught in the area; and

- acute impacts which relate to the accidental spillage of dangerous goods/chemicals which may have toxic effects on the marine ecology or a large scale oil spill. It is not anticipated that dangerous goods in large quantities will be transported through the Lantau Port. A sufficient response capability already exists within Hong Kong to deal with oil spillage and no further precautions should be necessary.

The current layout for the RTTW on the North Shore creates an embayed area at Yam O Wan. It is anticipated that adjacent construction activities and operational impacts will lead to a deterioration in water quality. Possible mitigation measures are design changes or to rapidly fill in the embayed area commencing from the western shoreline, thus creating land suitable for alternative uses such as habitat creation. It is possible that a wetland habitat could be appropriate for Yam O Wan given that the bay is currently inhabited by waders and shorebirds.

3.5 WAHMO WATER QUALITY MODELLING

The WAHMO computer modelling of the Preferred Concept included the following five development scenarios:

- the Base Case;

- the completed Phase II development;

- the completed Phase IV development with a bridge connection between Phase II and III;

- the Ultimate development, with a bridge connection between Phase II and III; and

- the Ultimate development, with a causeway connection between Phase II and III.

Each of the scenarios has been modelled with the four combinations of dry and wet seasons, and spring and neap tide conditions. Pollutant loadings from the committed and proposed developments in the Study Area were estimated and included in the modelling. Also a further round of modelling was carried out which considered various sewage disposal scenarios for Discovery Bay, a future residential area nominally located at Yi Pak and Peng Chau and the possible removal of some of these loadings.

The most important changes to water quality predicted by the above initial modelling are summarised as follows :

- The construction of the major port facilities off north-eastern Lantau creates an embayment in the Discovery Bay area, and the assumption of increased pollutant loads in this area reveals that the assimilative capacity of the waters of this embayment is limited. While levels of dissolved oxygen and BOD_5 were predicted to improve in the embayment due to the entrainment of cleaner waters from the south of the Western Harbour, discharged sewage-derived pollutants were predicted to accumulate in the embayed waters. The resulting higher levels of nutrients were predicted to cause considerable increases in primary productivity, with high concentrations of chlorophyll-a eventuating. In addition, *E.coli* levels increased by up to 10-fold in certain scenarios and this may threaten the water quality at Discovery Bay.

- Smaller changes in water quality were predicted in the south of the Western Harbour to the north of the Lamma Breakwater, during the wet season where dissolved oxygen levels dropped slightly and levels of BOD_5 and chlorophyll-a increased slightly. These changes when compared to Base Case predictions are indicative of delayed mixing of the coastal waters with offshore oceanic water masses, and are more pronounced when a breakwater is present. No significant changes in chlorophyll-a and dissolved oxygen concentrations were predicted in the dry season conditions. The changes are not considered likely to threaten either the overall water quality south of the Western Harbour, or the attainment and maintenance of Water Quality Objectives in this area.

- The extended estuarine mixing also affected *E.coli* levels in the area of the East Lamma Channel under certain circumstances, *E.coli* levels were predicted to increase by up to 5-fold in comparison to the Base Case in instances where the larger port-related reclamations were modelled. These impacts did not, however, extend to the popular gazetted bathing beaches in the south of Hong Kong Island and are not considered to be significant in terms of the attainment or maintenance of Water Quality Objectives.

- Changes to water quality in the north of the Western Harbour were insignificant in both the wet and dry season modelling.

- No significant affects on water quality were predicted from the presence of the port-related reclamations in Victoria Harbour.

Discovery Bay Water Quality

Of the changes to water quality predicted by the initial modelling, those occurring in the Discovery Bay area were the most extreme, and these should be viewed with great concern. The alterations in the south of the Western Harbour and in the East Lamma Channel, both of which reflect aspects of extended estuarine mixing due to the presence of the port peninsula were minor in magnitude and are not found to materially affect the attainment or maintenance of Water Quality Objectives in this part of the Study Area.

It should be emphasised that the predicted deterioration in water quality in the Discovery Bay area is a function of two elements: (i) the embayment of these waters caused by the presence of the port reclamation; and (ii) the increased pollutant loading from the developments around the embayment assumed in the modelling.

The modelling indicated that the provision of a bridge (rather than a causeway) in the port reclamation joining Phase II to Phase III, would moderately alleviate the deterioration in water quality predicted in the embayed area.

It is considered that the predictions for water quality of the Discovery Bay area are of sufficient concern (particularly with respect to the chlorophyll-a levels) that mitigation should be sought. Two main options exist, these involve the increased flushing of the embayment and/or the reduction of the pollutant loading to this area:

- investigations should be undertaken to maximise the beneficial effect of the bridged opening to optimise flushing of the embayed waters; and

- the assumed pollutant loading into the embayed waters could be reduced, through either the high level treatment of these

discharges or their diversion to a location outside of the embayed area .

Given the potential sensitivity of the embayed area to changes in water quality the treatment of the pollutant discharges to the embayed waters, or their diversion, is required. Other than the Port itself three pollutant sources of note exist, these being sewage flows from Discovery Bay, Peng Chau, and the anticipated residential development at Yi Pak or elsewhere.

On the basis of the modelling undertaken to date, it is considered that the diversion of the Discovery Bay and Yi Pak discharges to Siu Ho Wan, coupled with further treatment and/or diversion of the Peng Chau discharge, would provide an adequate solution to the deterioration in water quality noted in the Discovery Bay area.

Finally, it may be noted that the modelling has emphasised the low assimilative capacity of the embayed waters of Discovery Bay subsequent to the construction of the port peninsula. This implies that all possible measures should be considered to minimise pollutant loading (from whatever source) to these waters, and that the flushing of these waters should be encouraged wherever possible. The discharge of stormwater derived from the port reclamation to the embayed water mass to the west is inevitable, and this will certainly constitute a pollutant load of some magnitude. There will also be day to day spillage of substances such as oil and grease which could not be allowed for in the modelling. As a result, it is considered essential that a conservative approach should be taken to the discharge of pollutants which can be controlled (i.e. those from sewage), in order to safeguard the water quality of the embayed areas and diversion to the Siu Ho Wan treatment plant is recommended. In line with this conservative approach, it is also recommended that the bridge between the lines of container berths should be retained in the final design of these facilities.

3.6 MARINE ECOLOGY

The Study Area is characterised by an intertidal zone comprising a range of habitats. In coastal areas the species most noteworthy is the Green-Sea turtle *(Chelonia mydas)* which has been reported to lay it's eggs on the southern beaches of Lamma Island. Annelid and mollusc species dominate the soft sub-tidal sediments which are commonly found in all parts of Hong Kong. However the diversity and abundance parameters suggest an impoverished community in the Study Area. The Chinese White Dolphin is occasionally sited in the northern parts of the Study Area and local fishermen also report the presence of whales during March and April.

The Study Area supports an extensive fishing industry (up to 600 vessels), utilizing a variety of fishing methods, the fishing industry represents a significant employment source for the people living on the outlying islands of the Study Area. During 1989/90 the value of fish caught by capture fisheries was estimated to be some HK$70 million (excluding fish caught from larger vessels, recreational and shore fishing, and fish culture activities). It is anticipated that fishing activities will be significantly and progressively disrupted from both construction and operation particularly during the latter phases of the development.

The main construction impact will be from dredging. The release of significant amounts of suspended solids into the water column may lead to the clogging of fish gills which could lead to fatalities and strict enforcement mitigation measures will be required to minimise impacts in general and prevent impacts on the fish culture zone at Ma Wan. Due to the relatively impoverished nature of the benthic fauna the impact of dredging on these communities while undesirable is not considered to be of major Territorial significance.

Removal of two sub-marine navigational obstructions in the shipping fairways of the LAPH development, namely Adamasta Rock and Lamma Patch has been considered but is no longer proposed. Sub-tidal visual surveys of the rock areas and their surrounds would be required in order to ascertain the potential for impact. The effects of blasting can be reduced by adapting appropriate techniques and use of known mitigation measures and these are outlined in Section 6.

Potential acute and chronic impacts relate to accidental spills through the operation of the Port. In extreme cases these spills may have short-term toxic effects on the marine ecology of the area.

3.7 TERRESTRIAL ECOLOGY

In general terms, the impacts of the LAPH developments on the terrestrial ecology of the Study Area are limited and (given the large timescales which allow for further study and mitigation to be resolved) should not be of major significance.

Key issues which have been identified are:

- the possible impacts of the TCT borrow area and the opportunity to reduce potential impacts on the habitats of ecological importance;

- the possible effect of habitat reduction and habitat severance on the Chinese Pangolin, (a small (50-80 cm), nocturnal mammal). Mitigation measures and further survey work have been recommended; and

- the probable loss of the breeding sites of the Reef Egret and the White-Bellied Sea-Eagle on Kau Yi Chau. Potential mitigation measures and further survey work have been recommended.

Of these key issues, the potential loss of breeding sites for the Reef Egret and White-bellied Sea-eagle on Kau Yi Chau is the only issue considered to be of significance in a Territory-wide context. This is only affected by post-2011 developments and possibly, construction of the GIL. It will be necessary to investigate the possibility of relocation to other potential breeding sites, possibly on the remoter outlying islands.

3.8 VISUAL ASPECTS

The most significant visual impact of the LAPH development will be upon Discovery Bay and Peng Chau. The impact is a result of the sheer scale of the port the most noticeable feature is likely to be the terminal cranes. The impact upon Discovery Bay will be proportionally more detrimental than on Peng Chau because of the greater numbers of people affected in Discovery Bay. The visual impact of the development upon other areas is reduced by distance from the development and by the low numbers of people affected. However, the LAPH development will change what is currently a predominantly rural area into a commercial port and industrial zone.

The 24 hr operation of the Port will additionally bring the visual impact of floodlighting glare to Discovery Bay and Peng Chau. However the achievement of a Glare Rating of 30 or less at Discovery Bay/Peng Chau and to Highways Department's requirements for Port and related roads is considered viable and can be achieved through the use of appropriate design methods. Implementation of the landscaping proposals including installation of earth bunds associated with noise barriers (see Figure 9.1) on the western extremities of the western most berths will also help in this respect.

The Lamma Breakwater, some 4.5km long and 6m high, represents a significant detrimental visual impact on views currently enjoyed by people utilising the Western Harbour and surrounding islands.

The overall visual impact of the LAPH development can be partially mitigated through the use of landscaping measures to screen the development and by the careful design of floodlighting to minimise the amount of glare produced. However the effectiveness of these measures will be limited and consequently the overall visual impact will remain high.

3.9 ARCHAEOLOGICAL AND HISTORIC SITES

Of the fifteen sites of archaeological and historic interest within the Study Area, two sites, Pa Tau Kwu and Luk Keng, are likely to be affected by the LAPH development. However, the potential impacts on these sites has been significantly reduced by consideration of road alignments and layout of container back-up areas. These considerations should be carried through to the detailed design of the container port, transport network and North Shore Developments.

3.10 WASTE MANAGEMENT

The main waste arising will be marine mud, which will be disposed of by marine dumping.

From various studies including the Green Island Link Preliminary Feasibility Study, the Contaminated Spoil Management Study, EPD's biannual sediment analyses and the data obtained from the LAPH Marine Ecology Survey, the amount of contaminated sediments to be dredged and requiring disposal has been estimated to be some $0.6Mm^3$ up to Phase IV of the LAPH development.

In addition contaminated material may arise from the Cheoy Lee Shipyard in Penny's Bay and require treatment or disposal, this needs to be evaluated by means of a contaminated land survey.

Wastes may also arise from damaged cargoes. Although these are not expected to constitute large amounts it will be necessary to provide a separate

bunded area where these can be safely stored/and assessed prior to disposal.

Some 200 tonnes of general waste will arise daily in 2011 from the LAPH development. This could be directly delivered to the North Lantau refuse transfer station, or to a purpose built transfer facility on the Container Port. The marine transport of the waste to the WENT landfill could be integrated with that of waste from the other proposed Lantau and Outlying Islands transfer stations.

Difficult wastes will generally arise in small quantities on an ad-hoc basis and collection and disposal will have to be organised appropriately. All of these wastes are likely to be suitable for disposal at Tsing Yi Chemical Waste Treatment Centre (CWTC).

With regard to oily wastes a decision will need to be taken on whether it is practical to rely solely on the CWTC MARPOL barge collection service, or to provide storage facilities within the LAPH area with subsequent transfer to the CTWC.

As the development will proceed on a phased basis the CWTC service could be used initially (subject to capacity and logistical/operational problems), enabling a more accurate assessment of future storage/treatment and disposal requirements to be made before a decision is taken on the provision and scale of facilities at LAPH. A land reserve for a MARPOL waste storage facility will be included in the RODP.

3.11 RISK ASPECTS

Lantau Port will handle dangerous goods, (DGs). A review of a sample of DG manifests of vessels using the Kwai Chung container terminals indicated that practically all vessels load or unload one or more consignment of DGs (in containers).

Experience from Hong Kong and elsewhere indicates that there will be incidents at the Port facilities involving DGs. Most incidents appear to be associated with poor packaging which results in a leakage of liquid or fumes.

The consequences of such incidents are generally highly localised. Typically in the more severe events, the immediate work area is cleared, the emergency services are called and the incident dealt with. To date, no major incidents (such as a large scale fire or one requiring off-site evacuation) have been experienced at the three large terminals contacted during the course of this Study (Kwai Chung, Rotterdam and Felixstowe).

Greater risks are likely to be associated with the storage and handling of non-containerised DGs as envisaged at the RTTW. It is likely that these facilities will be required to be licensed under the (Hong Kong) DG Regulations.

Finally, although there would appear to be minimal risks associated with the Penny's Bay power station, the barge-to-shore fuel transfer operations could present a risk of marine pollution in the event of a spillage.

There are no proposals to site PHIs on the Lantau Port, however, in general the Lamma Breakwater reclamation provides an ideal opportunity for the siting of such establishments, mainly because of its remote location and ease of access from the open sea. From a risk point of view there are a number of installations which would be favoured. These include installations which generally require large land areas but have low worker populations e.g. oil refineries and power stations.

4 MONITORING AND AUDIT SCHEDULES

Given the scale and nature of the LAPH development, environmental monitoring and audit schedules have been proposed to:

- ensure that impacts are kept within acceptable levels;
- establish procedures to ensure mitigation measures are applied; and
- provide a means of checking compliance with standards/objectives.

Baseline and compliance monitoring in accordance with environmental standards (Target levels), is recommended for air quality, noise and water quality. Trigger and Action levels have been devised to indicate potential problem areas. The Trigger level is a reference value to be used as an early warning of a deterioration in environmental quality. Action levels indicate that deterioration is significant and that corrective action is required. A possible mechanism has been identified to enable the required baseline monitoring to be carried out.

The audits would generally be undertaken on a monthly basis and Monthly Audit Reports would detail monitoring activities undertaken, any exceedence of standards, controls and mitigation action taken and record any complaints. The audits will ensure that unanticipated impacts are addressed and that any improvements required for further monitoring programmes are identified.

5 RECOMMENDATIONS AND CONCLUSIONS

A comprehensive assessment has been made of the potential environmental impacts of the LAPH developments. Environmental issues have been considered throughout the Study and many impacts have been avoided or addressed in the planning and design process. It is essential that this pro-active approach is continued into the detailed design stage.

Practical mitigation measures have been proposed to minimise the identified environmental impacts wherever possible. However for certain aspects effective mitigation will be difficult to achieve and are an inevitable consequence of installing a large industrial and commercial development into a predominantly rural area. Thus a deterioration of the overall environmental quality of the area is unavoidable.

5.1 KEY ENVIRONMENTAL IMPACTS AND RECOMMENDATIONS

Key environmental impacts are briefly presented below and a series of recommendations have been made, some of which identify further environmental studies which will need to be undertaken prior to implementation. As far as possible responsibilities have been identified for carrying forward the implementation issues.

Much of this can only be accurately specified and meaningfully incorporated at the detailed design stage. This would require provision of environmental controls in the form of environmental clauses in the various construction and operation contracts. It is therefore essential that a strong environmental input is carried forward into the detailed design stage.

Air:

Key impacts include elevated levels of suspended particulates from construction activities, and elevated concentrations of NO_2 from road traffic. Mitigation measures include utilising dust abatement equipment where appropriate, observing good site practice at all times and the implementation of roadway setback distances through land use planning and plot lease conditions, which could cover height restrictions and use of electric vehicles.

Recommendations :

- the existing recommendation that a height restriction of 50m for development in south west Penny's Bay should be complied with; and
- in order to provide important data on baseline air quality and trends, it is recommended that a permanent air quality monitoring station is established within the Study Area.

Noise:

Unmitigated noise levels will exceed the HKPSG at sensitive facades in Discovery Bay and Peng Chau. Mitigation measures will be necessary to reduce the noise at SRs to acceptable levels.

Recommendation :

It is recommended that noise control requirements should be incorporated in the construction tender/contract documents and operational leases. This should include :

- introduction of specially silenced equipment;
- orientation of container stacks so that they are perpendicular to the quay faces; and
- introduction of noise barriers in selected locations.

The use of "ultra quietened" equipment would be both feasible and cost effective and should be considered.

Water Quality:

Key water quality impacts include a potential long term reduction in water quality in Discovery Bay resulting from the creation of an embayment, increased pollution loads and limited assimilative capacity of the water body in the embayed area. Mitigation includes the future planning for sewerage at Discovery Bay, Peng Chau and a

future residential development, to be diverted or treated to a high standard; and a bridge connection between Phase II and Phase III of the Container Port to provide a waterway which permits flushing of the Discovery Bay water area.

Recommendations :

- a bridge structure between Phases II and III is recommended as opposed to a causeway, and investigations should be undertaken in order to optimise the hydraulic characteristics of the bridged opening;

- it is recommended that the wastewater at Discovery Bay and at Yi Pak is diverted to the Sewage Treatment Works at Siu Ho Wan;

- additional WAHMO modelling should be undertaken of the finalised Port layouts and incorporating the diverted pollutant loadings at the Siu Ho Wan Sewage Treatment Works; and

- it is recommended that wastewater from Peng Chau is treated to a high standard as detailed in Section 6.

Marine Ecology:

The LAPH development will inevitably cause impacts on the marine ecology of the Study Area, mitigation measures both during the construction and operational phases will have to be incorporated into the works contracts and lease conditions of the LAPH development.

Recommendation :

AFD should carry out comprehensive fisheries surveys in the Study Area to provide detailed data on important fishing grounds, fish spawning areas and fish catches.

Terrestrial Ecology:

The most significant impacts on Terrestrial Ecology are the probable loss of breeding sites for the Reef Egret and White-Bellied Sea-Eagle on Kau Yi Chau; and the possible habitat reduction and severance of the Chinese Pangolins situated on the TCT peninsula.

Recommendation :

- it is recommended that the potential for habitat creation should be studied at Yam O Wan; and

- ecological survey's are recommended to determine the distribution and other details of the Chinese Pangolin on the TCT peninsula, and to identify appropriate habitat and breeding areas for the Reef Egret and the White- Bellied Sea Eagle;

Visual:

Significant visual impacts will affect Discovery Bay and Peng Chau due to the sheer scale of the container port and the consequent transition from a currently predominantly rural area into a commercial and industrial zone. The single most visually intrusive feature is likely to be the Container Terminal cranes. Mitigation measures include incorporating lighting system design requirements to limit the Glare Rating to 30 at Discovery Bay/Peng Chau, and to Highways Department's requirement for port roads; and implementation of the landscaping proposals.

Recommendation:

- the completed LAPH developments will be very significant in visual terms and it is considered essential that the landscaping and visual mitigation measures are implemented to reduce impacts as far as practicable.

Waste Management:

The LAPH development will produce wastes in all the main categories. It will be necessary to implement mitigation measures to ensure no adverse impacts arise. By Phase IV some 0.6 Mm^3 of contaminated sediment will have to be dredged and disposed of. It will be necessary to ensure special precautions are used when handling these sediments.

Recommendations :

- a contaminated land investigation is recommended at the site of the Cheoy Lee Shipyard to determine the nature and extent of any required remedial measures prior to redevelopment;

- further studies are recommended to confirm MARPOL waste storage, treatment and disposal options and requirements.

Risk:

A policy decision will be required on the use of the Lantau Fixed Crossing in the transport of DGs within standard shipping containers.

Recommendations :

- it is recommended that further consideration is given to the nature of DGs traffic at the North Shore and also through the Kap Shui Mun Channel; and

- detailed procedures should be developed to cope with emergency situations;