

16. LAMMA NORTH ISLAND LANDFILL

16.1 Basic Information

Project Title

16.1.1 Lamma North Island Landfill (LNIL) – marine site M.11.

Nature of Project

16.1.2 The Project would form a new marine based waste disposal site in waters located off the northwest of Lamma Island (*Figure 16.1*).

16.1.3 The project would require the construction of an artificial island of approximately 435ha. The site would be designated as a public filling area for the receipt of inert C&D material; once the reclamation is completed, the site would be developed as a landfill for subsequent operation for the disposal of waste. Construction works would be as described in Part A; Section 3.2.

Location and Scale of Project

16.1.4 The LNIL is located approximately 0.6km to the north of Lamma Island and 1.1km from the HEC Lamma Power Station at the nearest point within the West Lamma Channel waters. Approximately 125Mcum of fill material will be required to construct the artificial island, with a final site formation level to +6mPD. The capacity of the landfill site would be approximately 85Mcum.

16.1.5 Seabed levels in this area are in the range 7 to 8m below Chart Datum. There would be no apparent need for dredging works to develop the site.

History of Site

16.1.6 The LNIL is located off the northwest coast of Lamma Island and would be entirely formed as part of this project. The site falls within the Hong Kong Island South & Lamma Island Planning and Development Study, and is on the boundary of the South West New Territories Development Strategy Review area. The site area currently includes designated shipping anchorages at “North Lamma” and “North West Lamma”.

16.1.7 There has been no previous development activity within the site. Coastal reclamation works have been undertaken for the existing Lamma Power Station that is located south of Yung Shue Wan, Lamma. There are also ongoing works to extend this Power Station, including reclamation activities slightly south into Ha Mei Wan. A Feasibility Study for siting a Waste-to-Energy Incineration Facility (WEIF) adjoining the south of the Lamma Power Station extension site has been completed. It is understood that a more detailed site selection study is presently being conducted on behalf of EPD.

Number and Types of Designated Projects covered

16.1.8 The LNIL would qualify as a Designated Project under the five categories listed in Part A; Section 2.1.

16.2 Outline Of Planning and Implementation Programme

16.2.1 An outline for the planning and implementation of this site is summarised in Part A; Section 3.3 and an outline programme is shown in *Figure 16.2*. Assuming landfill operations start in 2018, LNIL would be full during the period 2030 to 2035, depending upon the rate of waste arisings and the number of other landfills operating concurrently.

16.2.2 The site is currently not covered by any statutory town plans. As described in Section 3.3, Town Planning Ordinance procedures to cover the site would be required and the reclamation would need to be gazetted under the Foreshore & Sea-bed (Reclamations) Ordinance.

16.2.3 This site falls within the boundary of the South West New Territories Development Strategy Review. No recommendations for this area were made under this strategy.

- 16.2.4 The Recommended Development Strategy formulated under the South West New Territories Development Strategy Review identified the potential of Cheung Chau and Lamma as tourist and recreation developments; this recognised their mountain scenery, appealing coastal areas and the large number of archaeological and historical sites.
- 16.2.5 Lamma Island lies to the south of this site and is covered by the Lamma Island OZP Plan no. S/I – LI/3 issued in October 2001. The general, planning intentions of the Lamma Island OZP are to conserve the natural landscape, the cultural heritage, the rural character and the car-free environment of Lamma Island; and to enhance the role of Lamma Island as a leisure destination. The Island has been subject to further investigation under the Planning and Development Study on Hong Kong Island South and Lamma Island.

16.3 Possible Impacts on the Environment

- 16.3.1 Possible impacts on the environment during the construction, operation and aftercare phases of the LNIL are outlined below. *Figure 16.1* provides details of identified sensitive receivers. The individual assessments are summarised in *Tables 16.1 and 16.2*.

Air Quality

- 16.3.2 The LNIL development has the potential to cause the following air quality impacts:
- Dust (TSP / RSP) and exhaust emissions from on-site plant during construction and operation;
 - Gaseous emissions during landfill operation and aftercare arising from non-point source emissions and gas flaring / utilisation (including emissions of methane, carbon dioxide, carbon monoxide, sulphur dioxide, nitrous oxides, etc.); and
 - Odours arising during the operation of the landfill from waste decomposition and leachate treatment.
- 16.3.3 There are Air Sensitive Receivers (ASRs) found within a 500m radius from the boundary of this site, with the closest being a number of village houses in Pak Kok San Tsuen that is some 400m southeast of the site boundary. There are other ASRs located along the shoreline of Yung Shue Wan approximately 0.6km from the site boundary.
- 16.3.4 The existing HEC Lamma Power Station is located approximately 1.1km from the site boundary. The HEC's air quality monitoring programme at Pak Kok San Tsuen shows that levels of sulphur dioxide and nitrogen dioxide did not exceed the relevant AQOs in year 2000.¹
- 16.3.5 For the operational landfill, as the site lies in an open marine area (i.e., no airshed) there would not be any accumulation of air pollutants.
- 16.3.6 Marine vessel will be the mode of transportation for waste delivery to the site. The amount of air pollutants emitted from the territory-wide waste delivery to the site will be less compared to a land based site that relies on road transport. The estimated cumulative distance to be travelled from the existing and planned marine RTSs to the site is approximately 200km. Given the likely distance to be travelled and the benefit of the using marine transport, the regional impacts from waste transportation are considered to be insignificant.

Noise

- 16.3.7 The reclamation and landfill development has the potential to cause the following noise impacts:
- Construction – from dredging, tipping, piling works and general construction activities;

¹ EPD (2001). Air Quality in Hong Kong 2000. Air Services Group, Environmental Protection Department, HKSAR Govt.

- Operation – from the use of fixed plant, marine vessels, waste reception area, pumping plant, possible helicopter noise etc.
- 16.3.8 There are no NSRs within 300m of the LNIL site; the nearest NSRs are located at Pak Kok San Tsuen, approximately 400m to the southeast. Whilst the distance separation should significantly attenuate noise propagation, the effectiveness (compared to attenuation over a similar distance on land) would be diminished due to the lack of topographical features, vegetation etc. The extent of any noise impacts arising from reclamation, operation and construction of the landfill would be dependent upon the plant, programme and general scale of works. The acceptability of impacts would need to be confirmed during an EIA.
- 16.3.9 Although not anticipated at this stage, it is possible that activities could continue beyond normal working hours during the construction and operation phases. This would depend upon working arrangements for fill delivery, day-to-day landfill operations and the overall construction programme. The Area Sensitivity Rating for the village area is “A” and so the permissible night time noise limit is 45dBA. As such there is some potential for adverse noise impact should night time works take place.
- 16.3.10 Potential operational phase noise impacts would need to be considered in subsequent studies in the event that the island reclamation is used for other land uses (in addition to landfill) or a separate afteruse is developed on top of the landfill following completion of the landfilling operations.
- 16.3.11 The site can only be accessed by marine traffic during both operation and construction phase. Noise from land based waste delivery vehicles is not a concern for this site.

Water Quality

Baseline Conditions at the Site

- 16.3.12 The site would fall wholly within the Southern Water Control Zone (WCZ) although impacts upon water quality may potentially also extend to waters within the Western Buffer WCZ due west of the site. EPD conducts routine marine water quality monitoring at two locations in proximity to the artificial island site: SM7 in the Southern WCZ to the south and WS1 in the Western Buffer WCZ to the west, with sediment quality monitoring stations at the same locations – SS4 to the south and WS2 to the west.
- 16.3.13 Marine waters in the area are influenced by nitrogen and phosphorus discharges from the Pearl River, with nutrient levels generally declining along a north-south gradient in the West Lamma Channel.² Due to this influence there was non-compliance with the WQO for total inorganic nitrogen (TIN) at station SM7 in the year 2000, although there was full compliance with the WQOs for dissolved oxygen and un-ionised ammonia. There is a long-term trend of increased TIN in Ha Mei Wan that may also be due, at least in part, to the relatively low water current in this bay area and the influence of the Pearl River discharge. Water quality around station WS1 is similar to that at SM7 although there was full compliance with the WQO for TIN in the year 2000 due to a higher objective (0.4mg/L compared with 0.1mg/L as at SM7).
- 16.3.14 EPD data also shows marine sediment quality to be good in the area, with only levels of silver exceeding the Lower Chemical Exceedance Level at WS2 and no LCEL exceedance at SS4.

Key Issues and Sensitive Receivers

- 16.3.15 The project has the potential to cause the following water quality impacts:
- Sediment loss to the water column during dredging / reclamation;
 - Runoff with elevated levels of suspended solids from the site during landfill construction (post-reclamation); and

² EPD (2001). Marine Water Quality in Hong Kong in 2000. EPD, Government of the HKSAR – 2001.

- Change in the hydrodynamic regime (i.e., change in flushing capacity and sediment deposition / erosion patterns).
- 16.3.16 A number of Water Sensitive Receivers (WSRs) are present in the vicinity of the site. These include:
- Cooling water intake for HEC Lamma Power Station; including New Extension intake;
 - Seawater intakes (flushing) at Western District and Ap Lei Chau;
 - Seawater intake (cooling) at Pok Fu Lam;
 - Gazetted beach near the Power Station at Hung Shing Ye;
 - Gazetted beach at Lo So Shing; and
 - Secondary contact recreation sub-zone along north and west Lamma coastline.
- 16.3.17 In addition, there are a range of aquatic and inter-tidal ecological receivers within the vicinity of the site that may be sensitive to any decline or change in the water quality or sediment deposition / erosion patterns. Impacts upon these are discussed under the “Ecology” and “Fisheries” subsections. The sensitive receivers include:
- Coral community at Shek Kok Tsui, northwest Lamma;
 - Coral and Green Turtle habitat near Boulder Point (Pak Kok), northeast Lamma;
 - Coral community at Green Island;
 - The western / southwestern waters of the proposed South Lamma Marine Park; and
 - Lo Tik Wan Fish Culture Zone.
- 16.3.18 The area around the site coincides with the approximate northern habitat boundary of the Black Finless Porpoise, *Neophocaena phocaenoides*. From sightings data, it is known that the Finless Porpoise move into the waters of West Lamma in December and reach their peak abundance around southwest Lamma between March and May.³
- 16.3.19 The locations and uses of these sensitive receivers are shown in *Figure 16.1*.

Reclamation and Site Formation

- 16.3.20 During reclamation and site formation activities, sediment handling may lead to adverse water quality impacts from increased suspended solids and reduced dissolved oxygen levels. There is also potential for sediment plumes to form and be dispersed by the prevailing current, although from a review of generalised current pattern data for the area it would seem that the currents in the area are not strong.
- 16.3.21 The placement of fill for island construction is likely to lead to localised increases in suspended solid levels. The hydrodynamic and water quality modelling indicated that WQO exceedence would occur at SC1 (33.59%) in the dry season and at SC20 in both the dry (80.00%) and wet (38.66%) seasons during Phase 1 construction. Increased levels of SS were also predicted in the Phase 1 construction dry season at WI3 (16.94%), FC3 (24.51%), WI2 (15.11%), NS9 (18.51%) and NS8 (16.55%). In the Phase 2 construction WQO exceedence was predicted at SC1 (32.68%) and SC20 (70.35%) in the dry season. Increased levels of SS were also predicted in the Phase 2 construction dry season at W13 (15.16%), FC3 (21.74%) and NS9 (16.83%) and in the wet season at SC20 (28.01%). In the Phase 3 construction, WQO exceedence were predicted in the dry season at SC1 (42.41%) and FC3 (32.65%) and in both the dry and wet season at SC20 (161.18% and 85.91% respectively). Increased levels of SS were also predicted at WI3 (17.38%), WI2 (16.22%), NS9 (21.63%) and NS8 (17.99%).

³ AFCD (2001). Finless Porpoise: Distribution & Abundance
[http://www.afcd.gov.hk/con_new/fin_distri4.htm].

Hydrodynamic and Water Quality Impacts Following Island Formation

- 16.3.22 Hydrodynamic modelling showed that locating an island at North Lamma could reduce the cumulative flow significantly at East Lamma (approximately 17% in both seasons), West Lamma (29.84% in the wet season) and Tathong Channels (14.87% in the wet season). Although the site would be located approximately 400m off the northwest Lamma coastline with water depths between the island site and the coast of between 6 and 10m, the impact on water sensitive receivers to the north/northwest of Lamma Island would not be significant. The flow velocity is predicted to increase significantly in the area to the north of the island during the wet season spring ebb tide. The overall current magnitude is predicted to increase by 29.18% and 4.44% to the west and east of the island respectively.
- 16.3.23 In the hydrodynamic and water quality modelling, 13 sensitive receivers that are close to the site were selected for presentation. Of the 13 chosen indicator points, 7 are located in the Southern WCZ (FP8, NS9, NS8, SC20, CW4, FC4, FC3), 3 in the Victoria Harbour WCZ (CW6, CW5, WI3) and 3 in the Western Buffer WCZ (CW3, WI2, SC1).
- 16.3.24 According to the dry season water quality modelling results, the predicted 90%ile DO for depth average and bottom layer ranged from 5.13 to 7.32mg/L which complied with the WQOs of ≥ 4 mg/L for depth-averaged DO and ≥ 2 mg/L for bottom layer DO. Compared to the baseline water quality results, the percentage differences in DO caused by the presence of the island were minimal (less than 2.1%).
- 16.3.25 The predicted average dry season salinity ranged from 33.75 to 33.99ppt. Compared to the baseline water quality results, the island would reduce the salinity at a number of indicator points. The differences in salinity levels were minimal (less than 1%) at all of the selected indicator points as compared to the WQO requirements that change due to any waste discharge should not exceed 10% of natural ambient level.
- 16.3.26 The predicted dry season SS levels indicated points were in the range of 3.60 to 5.73mg/L. The predicted differences caused by the presence of the island ranged from 0.2 to 3.26%. Comparing to the WQO requirements that any waste discharge should not raise the natural ambient level by 30%, these differences are considered very small.
- 16.3.27 The predicted *E.coli* levels in the dry season ranged from 1 to 4,060count/100mL. Only CW6 with the *E.coli* levels of 4,060count/100mL exceeded the WQO of 610 cfu/100ml but the baseline value predicted at this station (4,097count/100mL) also exceeded the WQO. The predicted *E.coli* levels at all other stations are significantly lower (ranged from 1 to 287count/100ml).
- 16.3.28 The predicted average dry season UIA (0.00258 – 0.01418mg/L) at all indicator points were very small as compared to the WQO of 0.021mg/L for annual mean.
- 16.3.29 The dry season TIN levels ranged from 0.0724 to 0.563mg/L. Since the WQO of TIN is an annual mean value, the predicted mean TIN levels for both the dry and wet seasons were averaged to represent the annual mean values. It was found that all indicator points in the Southern WCZ (SC1, CW4, FC4, NS8, NS9 and SC20) breached the annual mean WQO of 0.1mg/L but the averaged baseline values at these stations also exceeded the WQO. The percentage increases in the annual mean TIN values caused by the island were less than 5.1% at these stations.
- 16.3.30 According to the water quality modelling results for the wet season, the predicted 90%ile DO for depth averaged and bottom layers ranged from 4.89 to 6.37mg/L which comply with the WQO of ≥ 4 mg/L for depth-averaged DO and ≥ 2 mg/L for bottom layer DO. Compared to the baseline water quality results, the percentage differences for 90%ile depth-averaged DO and bottom DO were small (less than 2%).
- 16.3.31 The predicted average wet season salinity ranged from 20.07 to 24.93ppt. Compared to the baseline water quality results, the largest difference was found at WI2 of 5.79%. The difference is considered small as compared to the WQO of 10%.

- 16.3.32 The predicted wet season SS levels at the indicator points were in the range of 4.84 to 6.84mg/L. It is predicted that the island would increase the SS level at most of the indicator points. The largest increase in SS levels was predicted at SC20 with percentage difference of 1.89% which is considered small as compared to the WQO requirement that any waste discharge should not raise the natural ambient level by 30%.
- 16.3.33 The predicted *E.coli* levels in the wet season ranged from 1 to 3,729count/100 mL. Only CW6 with *E Coli* levels of 3,729count/100mL exceeded the WQO of 610 cfu/100ml but the baseline value predicted at this station (3,743count/100mL) also exceeded the WQO. The predicted *E.coli* levels at all other stations were significantly lower (ranging from 1 to 307count/100ml).
- 16.3.34 The predicted wet season UIA (0.00406 – 0.00689mg/L) at all indicator points were low and well below the WQOs of 0.021mg/L. The predicted UIA levels would increase at most of the indicator points with the percentage increase of 0.16% to 1.98%.
- 16.3.35 For predicted wet season TIN levels, the values were high and ranged from 0.230 to 0.3031mg/L. It is predicted that the presence of the island would increase the TIN levels at most of the indicator points. Non-compliance of the annual mean WQO was found at all the indicator points in Southern WCZ (SC1, CW4, FC4, NS9, NS8 and SC20) as discussed in Section 16.3.29.
- 16.3.36 The modelling results also indicated that the water quality impacts due to the site on Sea Water Intakes were minimal. The pollutant levels at WI2 (WSD Sea Water Intake at Ap Lei Chau) and WI3 (WSD Sea Water Intake at Kennedy Town) complied with the WQO of Sea Water for Flushing Supply.

Cumulative Impacts

- 16.3.37 The capacity of the existing HEC Power Station on Lamma is presently being increased. The EIA Study for the Lamma Power Station Extension that was completed in 1999 assumed that the first of the six 300MW gas-fired units of the extension will be operational by 2003, with the fifth and sixth commissioned during 2012.⁴ This project would involve a southward extension of the existing site into the northern end of Ha Mei Wan. The reclamation would be complete before 2010 – the earliest commencement date for development activities for the LNIL.
- 16.3.38 The Feasibility Study completed for the siting of a potential Waste-to-Energy Incineration Facility (WEIF) at Lamma indicated that commissioning of the facility would be five years after the start of initial reclamation works. The reclamation area would cover a maximum area of 17ha and reclamation and dredging works for a seawall and breakwater would last for approximately one year.⁵ The EIA Study for the Lamma Power station extension concluded that there would be insignificant impacts on water quality / circulation patterns from the extension alone and from the combined Power Station extension and potential Waste to Energy Incineration Facility (WEIF) at Lamma.
- 16.3.39 Ultimately siting of a WEIF at Lamma was not recommended on environmental grounds (*ibid.*). Although there are ongoing studies for the development of a “waste to energy facility” for the HKSAR, for the purpose of this assessment it is assumed that any future facility would not be located at Lamma Island. As such, there is no potential for cumulative hydrodynamic / water quality impacts.

⁴ ERM (1999). EIA Study for 1,800 MW Gas-fired Power Station at Lamma Extension. Hongkong Electric Co. Ltd.

⁵ CDM (1998). Feasibility Study of Waste-to-Energy Incineration Facilities: Site Assessment Report – Lamma Island. Submitted to EPD, July 1998.

Waste Management

- 16.3.40 For construction of the “island” on which the landfill would be located, inert C&D material would be brought in exclusively by marine vessel, from a network of barging points in the SAR. The location of barging points would vary during the filling process, according to the source of materials at any given time.
- 16.3.41 Various options for construction have been explored for this site and it is anticipated that muds would not need to be excavated to facilitate construction of the outer seawall, prior to public filling. Upon completion of construction, the “island” would act as a major recipient of municipal solid waste and other landfilled waste streams.
- 16.3.42 Anticipated volume of materials are as follows:
- Volume of public fill that could be accepted for island construction: 125Mcum
- 16.3.43 Various potentially polluting materials may be stored, handled and transported to / from the site. Examples may include chemicals for waste water/leachate treatment, waste oils, fuel for plant working on the site, etc. These would be managed as described in Section 5.5.
- 16.3.44 Waste will be delivered to the LNIL by marine vessel only. This will have the benefit of lowering the GHG emission per kg waste handled compared to delivery by road vehicle. Besides, the cumulative distance to be travelled (between marine RTSs and the site) is around 200km (referred to Preliminary Marine Review (March 2002)), the impacts associated with the GHG emissions are considered to be neutral.

Ecology

Baseline Conditions

- 16.3.45 Data and information on aquatic resources in the area is available from the EIA Study Report on the HEC Power Station Extension. The EIA summarised the findings of past survey work on the benthic infauna for the general environs around the Lamma Power Station. Amongst the most relevant studies summarised were data from grab-sampling work undertaken in 1991 / 92 for the EIA for the Lantau Port and Harbour Development Study. This data showed the infauna community to be dominated by polychaete worms, whilst overall infauna community diversity and biomass was greater during the dry season survey than the wet season survey.⁶
- 16.3.46 A similar pattern of dominance was discovered from grab sampling conducted for the Lamma Power Station Navigation Channel and Jetty Modification Works Study in 1994, with molluscs and crustaceans also abundant in the benthic community. From a review of data from various locations across the HKSAR, it appears that benthic community biomass in the vicinity of the Power Station and the LNIL is relatively low (ERM, 1999).
- 16.3.47 Inter-tidal resources on the northwest Lamma Coastline were also investigated under the HEC Power Station Extension study and are reportedly characterised by molluscs and crustaceans. The most abundant fauna species included the Chiton *Acanthopleura japonica*, the Snail *Nodilittorina trochoides*, the Barnacle *Balanus amphitrite* and particularly the Limpet *Patelloida saccharina*.

⁶ APH Consultants (1992). Lantau Port and Harbour Development Study: Marine Baseline Studies. Submitted to CED, HKSAR Government. October 1992.

- 16.3.48 The encrusting hard coral *Psammocora superficialis* and small colonies of the family Faviidae were also observed along the northwest Lamma coast around Shek Kok Tsui. The coral density at this site was reported as 1.67% and is not of conservation importance. In contrast the density of the community of soft corals and gorgonians in the shallow sub-tidal waters around Pak Kok, northeast Lamma, is in the order of 13%. The Pak Kok community is of conservation significance.⁷ There are also hard corals of some conservation significance around the coast of Green Island, some 6km north of Lamma Island
- 16.3.49 The Green Turtle *Chelonia mydas* – one of 3 species of sea turtles found in Hong Kong – has also been observed in waters around Pak Kok. So far the Green Turtle is the only turtle species known to breed locally, with nesting only reported thus far at the sandy beach at Sham Wan, south Lamma.⁸ The Green Turtle is protected under the Wild Animals Protection Ordinance, Cap.170.
- 16.3.50 Observations of the Black Finless Porpoise in the area of the site are limited to occasional sightings made during the period September to May. Data on seasonal abundance and distribution for this species gives peak abundance during March to May. By the summer (June through August) the species has moved from West Lamma waters to the south and southwest waters – apparently coinciding with intrusion by the Chinese White Dolphins – and by autumn (September to November) species abundance in Hong Kong waters is at a low point. The species moves back into the waters of Lamma and South Lantau from December.⁹ From observations data collated by the AFCD, the core area for this species is in the coastal waters off southwest Lamma.
- 16.3.51 Fisheries resources of ecological significance in the area are present south of Cheung Chau and south of Lamma Island. These areas are important spawning and nursery grounds for a range of fish and crustacean species.¹⁰ These waters also support the squid *Loligo* sp., the lion-head fish *Collichthys lucida* and the tiger-tooth croaker *Otolithes argenteus* that comprise the most common and numerically important prey species of the Finless Porpoise.¹¹

Direct Habitat Loss

- 16.3.52 The site footprint covers a surface area of 435ha. The site area is entirely sub-tidal and its benthic community is dominated by common polychaetes, with molluscs and crustaceans also abundant. Whilst the exact island location has not been investigated, it is not expected that there are benthic species of ecological significance in the area.
- 16.3.53 Distribution data for the Black Finless Porpoise shows that this species is seasonally observed off northwest Lamma, and that these waters appear not to be a key habitat area. However, this species is relatively shy and elusive compared to the Chinese White Dolphin and tends not to socialize in surface waters as much (Jefferson, 2001). As such, there is some potential that it may be more abundant in the immediate environs of the site than field observations alone would suggest.

⁷ Binnie Consultants Ltd. (1995). Fill Management Study – Phase IV. Marine Ecology of Hong Kong: Report on Underwater Dive Surveys. Volume I, January 1995.

⁸ AFCD (2001). AFCD Website. Conservation: Protection of Green Turtles. [www.afcd.gov.hk/con_new/turtle.htm].

⁹ AFCD (2001). AFCD Website. Conservation: Finless Porpoise. [www.afcd.gov.hk/con_new/finpor.htm].

¹⁰ ERM (1998). Fisheries Resources and Fishing Operations in Hong Kong Waters. Report to AFCD, HKSAR Govt.

¹¹ Jefferson, T.A. (2001). Conservation Biology of the Finless Porpoise in Hong Kong Waters. Submitted to AFCD, HKSAR Government.

Water Quality / Hydrodynamics

- 16.3.54 Any deterioration in water quality would drive fish from the area due to their sensitivity to increased suspended sediment levels, resulting in reduced feeding opportunities for the Finless Porpoise in these waters. However, as the site is not a key area for the Finless Porpoise, the significance of a decline in water quality would not be expected to be greatly significant.
- 16.3.55 The model predicts that suspended solids levels around the small sub-tidal coral community at Shek Kok Tsui, northwest Lamma would increase by 1.8mg/L over the baseline to around 6mg/L under the Phase 3 construction dry season. Sediment levels at the ecologically valuable coral community at Pak Kok are predicted by the model to increase significantly by 7mg/L to around 11mg/L under the same scenario. It is noted that the Green Turtle has been observed in these waters. The model does not predict an adverse effect on the hard coral communities around Green Island. Whilst the exact effects of increased suspended sediment upon sedentary species such as the corals at Pak Kok cannot be predicted, they may potentially be increased stress brought about by decreased sunlight penetration that would affect photosynthesis or a change in localised sedimentation affecting filter feeding. Effects on motile species would most likely be insignificant due to their ability to actively avoid certain areas at certain times.
- 16.3.56 The northern boundary of the proposed South Lamma Marine Reserve / Park is some 5km south of the artificial island site. Whilst there is potential for sediment transport towards this area on the ebb tide, the current strengths are not considered great enough to carry suspended sediment this far (assuming standard control measures are in place during reclamation works). Likewise, due to the distances involved and the strengths of the water current it is not considered that any deterioration in water quality would be localised around the North Lamma area and would not affect the Finless Porpoise habitat or the important fisheries areas at South Cheung Chau and South Lamma.

Marine Vessel Disturbance

- 16.3.57 From a study conducted on behalf of the AFCD, it is known from data on strandings of Black Finless Porpoise specimens that vessel collision is a significant cause of death (Jefferson, 2001). The increase in marine traffic required for site formation / reclamation activities and operational marine traffic could potentially lead to an increase in incidences of vessel collision.

Fisheries

- 16.3.58 The LNIL is located around the delineation of three fishing zones: Pak Kok (zone 0096), Po Lo Tsui (0097) and West Lamma Channel (0109). The Ha Mei fishing zone is located to the southeast. Available data indicates that Ha Mei is the most popular area in terms of the number of fishing vessels utilizing the zone, although on a unit area basis Po Lo Tsui is the most productive zone for both adult and fry fish, ranking 43rd of 210 zones and 39th of 89 zones respectively. In terms of value ranking, Po Lo Tsui is 27th of 210 zones, with Pak Kok, West Lamma Channel and Ha Mei ranking 128th, 113th and 70th respectively (ERM, 1998).
- 16.3.59 Commercially important species (adult fish) caught in the area are the Yellow Croaker *Pseudosciaena crocea* at Pak Kok and Po Lo Tsui, and the Mantis shrimp *Oratosquilla* spp. around Ha Mei (*ibid.*). The catch of low value pelagic species such as scad *Caranx* spp. and sardine *Sardinella jussieui* is also high in these areas. Overall, the development of the artificial island may have an adverse impact on fisheries resources in the Po Lo Tsui due to the small area and relatively high productivity of this zone. Impacts on the other nearby zones would not be expected to be significant given their relatively low productivity / commercial value, and general distance from the works area.
- 16.3.60 It is predicted by the numerical model that there may be a small increase in suspended solids levels at Lo Tik Wan fish culture zone (FC3) by less than 1.5mg/L above baseline to around 5.5mg/L during the dry season, Phase 3 construction.

Cultural Heritage

- 16.3.61 There is no immediate evidence of archaeological remains in this area. However there are a significant number of archaeological sites on both Lamma and Cheung Chau. The presence of sites on land strongly suggests that seafarers would have used the natural harbours of the islands and the waters around the site for several thousand years.
- 16.3.62 Recognising the likelihood of archaeological remains in this area and the lack of archaeological data currently available for this site, a detailed marine archaeological investigation should be carried out in any future studies.

Landscape and Visual

- 16.3.63 *Landscape Planning Designations* - This area of landscape is not covered by any planning designations reflecting landscape/landscape values and so there will be no impact on these values.
- 16.3.64 *Landscape Resources* - The site lies in a marine area, so that the only landscape resource affected will be an area of offshore water. Given the low sensitivity of this resource, there will be no significant impacts on landscape resources.
- 16.3.65 *Landscape Character* - The site is located in the West Lamma Channel LCA, approximately 1km off the northwest coast of Lamma Island. The character of the area is open with some sense of containment provided by the outlying islands of Cheung Chau, Peng Chau and further on to Lantau Island which frames the area (*Figures 16.3 and 16.4*). There is a strong relationship between these outlying islands. The area is relatively undisturbed by major shipping although ferries to outlying islands, PRC and Macau regularly pass through the area providing some variation in visual character.
- 16.3.66 Construction/operation works will introduce new artificial elements which are incompatible with the existing natural characteristics of the landscape, resulting in substantial impacts on landscape character. During the afteruse phase of the island landfill, these impacts are likely to be reduced somewhat, as the completed island is restored. By virtue of its proximity to Lamma, the island will however contrast unfavourably with the natural landforms of Lamma Island. As a consequence of this, the long-term impact on landscape character will be moderate to substantial.
- 16.3.67 *VSRs* - VSRs affected by the proposals are identified in *Table 16.3 and 16.4*. The extent of the project visual envelope is shown in *Figure 16.5* and the key views to the site are shown in *Figure 16.6*.
- 16.3.68 The close proximity of the island to Lamma and Hong Kong Islands results in a number of residential VSRs being very significantly impacted upon by the site. Of note, is the large number of residential VSRs in Yung Shue Wan on Lamma Island and on Hong Kong Island who will experience high levels of visual impact. The occupational VSRs at the Lamma Power Station will also be affected as well as a number of recreational VSRs on Hong Kong Island, Cheung Chau and Lamma. A significant number of travelling VSRs will also be affected, including those in vessels and ferries using the shipping lanes.
- 16.3.69 These VSRs will experience works on the landfill (shipping, marine vessels and partially constructed island) as relatively close artificial elements contrasting with the open and natural qualities of the existing landscape. Resulting visual impacts will be substantial to moderate. After the restoration of the landfill island, its visual impact will be reduced somewhat during the afteruse phase, with the exception of VSRs located close to the site, such as Yung Shue Wan who will lose their views of the West Lamma Channel and Lantau. Generally, residual visual impacts for VSRs will be as moderate to substantial.

Landfill Gas

- 16.3.70 There are no sensitive receivers (targets) or pathways within 500m of the site and therefore no potential off-site landfill gas hazard. Landfill gas would have safety implications for those working on the site. In the event that the reclamation on which the landfill would be constructed is also developed for other afteruses, the potential operational phase landfill gas hazards would need to be considered for those developments.
- 16.3.71 There may be some potential for use of LFG as an energy source for surrounding communities at Lamma North, or possibly the Lamma Power Station. In any event LFG could be used as an on-site energy source.

16.4 Environmental Protection Measures to be Incorporated into Design and Further Environmental Implications

- 16.4.1 Environmental design measures have been identified in Part A (Section 3.8) and generic approaches to mitigating impacts on different environmental parameters are outlined in Part A (Section 5). Whilst the specific requirement for environmental mitigation would be dependent upon the findings of an EIA, the following environmental protection measures are site-specific to the site.

Air Quality

- 16.4.2 No specific air quality mitigation measures are recommended at this stage, other than good site practice as described in Part A (Section 5).

Noise

- 16.4.3 No specific noise mitigation measures are recommended at this stage, other than good site practice as described in Part A (Section 5).

Water Quality

- 16.4.4 Mitigation is likely to be required to prevent impacts during dredging and filling for the artificial island reclamation. Construction procedures, defining the rates and method of dredging and filling taking in to account the hydrodynamics of the surrounding waters and tidal effects (ebb and flood) should be defined in the EIA. If significant impacts are predicted, a silt curtain may be installed around the immediate works area to prevent dispersion of sediments.

Waste Management

- 16.4.5 No specific waste management mitigation measures are recommended at this stage, other than good site practice as described in Part A (Section 5).

Ecology

- 16.4.6 As a precaution, given the anticipated elevated limits of SS, water quality mitigation measures should be implemented to protect sensitive ecological SRs such as the coral reef community around Pak Kok, northeast Lamma.

Fisheries

- 16.4.7 No special measures are proposed to protect fisheries resources.

Cultural Heritage

- 16.4.8 No special measures are proposed to protect cultural heritage resources.

Landscape & Visual

- 16.4.9 *Mitigation Measures* - Landscape and visual mitigation measures are outlined in Section A and are illustrated in *Figure 16.8*.

16.5 Summary

16.5.1 A summary of the SEA for the LNIL is provided in *Tables 16.1 and 16.2*:

Table 16.1: Lamma North Island Landfill SEA

	Impacts	Score	Commentary
Air Quality Assessment			
1	Distance to areas of air sensitive land use	-	A small number of village houses in Pak Kok San Tsuen are within 500m of the site.
2	Presence of topographic features which could decrease or exacerbate impacts	O	The site does not lie within any airshed and generally experiences wind. It is unlikely that dust or odours would accumulate around the site.
3	Occurrence of meteorological conditions which could exacerbate impacts	O	Wind blows both towards and away from ASRs. No prevailing wind direction has been identified.
4	Cumulative Impacts of relevant emissions (TSP (construction), NO _x , CO, SO ₂ – LFG Flare) taking into account ambient conditions	-	The site is located in an open marine area. HEC Lamma Power Station is located approximately 1.1km from the site. Emissions from the Power Station may already contribute a considerable portion of the ambient condition.
5	Total Emissions of Air Pollutants from the territory-wide waste transportation between the RTSS and the site	O	Waste will be delivered to the site by marine vessel and the cumulative distance to be travelled is estimated to be 200km.
6	Overall Impact	-	'Negative – Low' . Given the fact that ASRs are located within 500m from the site and there are potential for cumulative impacts from the HEC Lamma Power Station.
Noise Assessment			
1	Distance to areas of noise sensitive land use	-	There are no noise sensitive receivers (NSRs) within 300m of the site. However, at night time the BNL for the village area is reduced to 30dBA and so potential for adverse impacts exists.
2	Topographic Features (Only applicable if there are NSRs within 300m)	O	The site is located within open marine waters with no NSRs located within 300m from the site boundary. Therefore, this criterion is not applicable.
3	Cumulative Impacts of developments within 300m	O	There are no known developments (existing or planned) within 300m of the site.
4	Overall Impact	O / -	'Neutral / Negative – Low' .

	Impacts	Score	Commentary
Water Quality Assessment			
1	Water Course Diversion	0	Artificial island. Not relevant.
2	Potential for sediment contaminant release	0	The sediment in the vicinity of the North Lamma artificial island is not contaminated, and so there is no potential for contaminant release.
3	Potential impacts on WSRs (including increase or exceedance of WQO)	--	Generalised current pattern data indicates that there is little potential for impacts upon WSRs in north Ha Mei Wan. However, there is greater potential for impacts upon the beach and secondary contact sub-zone in mid and southern Ha Mei Wan, including a potential decrease in flushing within the Bay area. WQO non-compliance was predicted at various nearby areas included the surveyed coral and Green Turtle sites at north Lamma.
4	Potential Impacts on Groundwater	0	Artificial island. Not relevant.
5	Potential Cumulative Impacts	0	There are no anticipated cumulative impacts as the Lamma Power Station reclamation works will be complete, whilst the proposed WEIF site has not been recommended on environmental grounds.
6	Overall Impact	-	There is potential for adverse water quality impact on a number of WSRs in the Ha Mei Wan area including the secondary contact recreation sub-zone and popular bathing beaches. However, as impacts are not anticipated for the other evaluation criteria the overall likelihood is ' Negative – Low '.
Waste Management Assessment			
1	Balance of Materials (surplus/deficit of public fill needed for landfill development)	+	The site could accommodate a significant amount of public fill (125Mcum), thus negating the need to import filling material for site formation. This site will not require the dredging of any muds.
2	GHG emissions from mode of transport for delivery of waste to the site from RTSS	0	Waste will be delivered to the site via marine vessel. The distance travelled from marine RTSS to the site has been estimated to be 200km.
3	Overall Impact	+	' Positive '.

	Impacts	Score	Commentary
Ecological Assessment			
1	Potential for secondary environmental impacts on "Areas of Absolute Exclusion"	0	There are no "Areas of Absolute Exclusion" in the vicinity that may be affected by the works.
2	Affects an important habitat	--	The model predicts a potentially significant increase in suspended solids levels in the vicinity of the coral communities at Shek Kok Tsui, northwest Lamma and at Pak Kok, northeast Lamma. Although not part of the core habitat area, the waters around the site are of marginal importance to the Finless Porpoise. The area is also of limited ecological importance as a fisheries area.
3	Affects a species of conservation importance	--	The coral community at Pak Kok supports species of conservation importance that the model predicts may be adversely affected during the construction of the island landfill. There is some potential for disturbance of the Finless Porpoise, either directly through loss of habitat and through marine vessel disturbance, or through the food chain by loss of feeding opportunities in the area during / after site development activities.
4	Potential for Cumulative Ecological Impacts on species / habitat of recognised value	0	There are no anticipated cumulative impacts as the Lamma Power Station reclamation works will be complete, whilst the proposed WEIF site has not been recommended on environmental grounds.
5	Overall Ecological Impact	- / --	The waters near the site are of ecological value due to the presence of the coral community at Pak Kok that the model predicts would be exposed to a significant increase in suspended solids. The waters to the south are also of limited use by the Finless Porpoise, although marine access to the site may lead to increased potential for vessel collision. As such, the overall the impact potential and significance is considered to be ' Negative – Low / High '.
Fisheries Assessment			
1	Potential for secondary environmental impacts on "Areas of Absolute Exclusion"	-	The Lo Tik Wan fish culture zone located on the east Lamma coast is the nearest "Area of Absolute Exclusion" to the site. The model predicts that sediment levels at this zone would become elevated during the works, and thus the potential for adverse fisheries impacts exists.
2	Affects an important mariculture / fisheries resources (including spawning / nursery ground)	-	The Po Lo Tsui fisheries zone is the closest to the site and the most likely to be affected by a decline in water quality from the works. This zone is also the smallest and most productive (commercially valuable). The other zones are larger and less productive per unit area. Despite this, any impact on the water column from the works would drive the fish from these coastal waters into other protected waters. Thus the potential impact would be marginal. There is also potential for impact upon the Lo Tik Wan fish culture zone as mentioned above.
3	Potential for Cumulative Fisheries Impacts on sites of recognised value	0	There are no anticipated cumulative impacts as the Lamma Power Station reclamation works will be complete, whilst the proposed WEIF site has not been recommended on environmental grounds.
4	Overall Impact	-	The model predicts the potential for adverse water quality impact upon the Lok Tik Wan Fish Culture Zone. There would also be direct loss of part of the relatively productive Po Lo Tsui fisheries zone. The overall impact on fisheries is considered to be ' Negative – Low '.

	Impacts	Score	Commentary
Cultural Heritage Assessment			
1	Important cultural (Declared, Deemed or Graded sites) / archaeological sites	0	There are no known sites of cultural heritage significance.
2	Potential for archaeological value	-	No marine based deposits of archaeological interest have been found in the vicinity of the site, although there is evidence of land based archaeological finds nearby on Lamma Island. This suggests that seafaring people have used the coastal area of Lamma Island for several thousands of years. Recognising the lack of archaeological data currently available, it is considered that the likelihood of archaeological remains in this area is reasonable. A detailed marine archaeological investigation should be carried out in any future studies.
3	Potential for Cumulative Heritage Impacts on sites of recognised value	0	The nearest sites of cultural heritage value are land based (on Lamma Island). Therefore they would not be affected by this development.
4	Overall Impact	-	The potential impacts on cultural heritage are considered to be ' Negative – Low '. Whilst there is not direct evidence of cultural heritage remains in the site area, the occurrence of remains on nearby Lamma Island increases the potential for marine archaeological finds.

	Impacts	Score	Commentary
Landscape and Visual Impact Assessment			
1	Implications for Landscape Planning and Designations	O	This area of seascape is not covered by any planning designations reflecting landscape/seascape values and so there will be no impact on these values. Overall impacts will therefore be Neutral.
2	Impacts on Landscape Resources	O	As the site lies in a marine area, there will be no significant impacts on landscape resources. Overall impacts on landscape resources will therefore be Neutral.
3	Impacts on Landscape Character	--	The open, natural character of the West Lamma Character Area will be lost with the introduction of the landfill island and the proximity of the island landfill adjacent to the Lamma coast will serve to emphasize its artificial qualities. Impacts on landscape will reduce through the afteruse phase but overall will be Negative – High.
4	Visual Impacts	--	Substantial numbers of VSRs in Yung Shue Wan, Hong Kong Island and ferry routes will be substantially impacted upon by the island landfill during both the operation / construction phase and the afteruse phase. Their open and expansive views across to the other outlying islands will be lost. Visual impacts on VSRs in Yung Shue Wan will be especially significant. Overall visual impacts will be Negative – High.
5	Overall Impact	--	Overall, landscape and visual impacts will be 'Negative – High' for the following reasons: <ul style="list-style-type: none"> • There are no landscape designations covering the disposal site. • As the site is a marine one, no significant landscape resources are affected. • The open, natural landscape character of the outlying islands will be significantly affected by the introduction of the artificial island. • There are large numbers of VSRs surrounding the site (many in very close proximity) that will experience significant visual impacts as a result of the construction/operation and afteruse of the island landfill.
Landfill Gas Assessment			
1	Distance between the new / extended landfill and SRs	O	The nearest sensitive receivers are >250m from the site.
2	Number of Receivers within 250m (i.e. Consultation Zone)	O	There are no sensitive receivers within 250m of the site.
3	Man Made/Natural Pathways for LFG Migration	O	None.
4	Additional Utilisation of LFG to Reduce GHG Emissions	+	There are potential users of LFG at North Lamma (village houses and Power Station).
5	Overall Impact	O / +	'Neutral / Positive – Low'

Table 16.2: Summary of Lamma North Island Landfill SEA

Overall Impacts	Score	Commentary
Overall Air Quality Impact	-	Negative – Low
Overall Noise Impact	O / -	Neutral / Negative – Low
Overall Water Quality Impact	-	Negative – Low
Overall Waste Management Impact	+	Positive
Overall Ecological Impact	- / - -	Negative – Low / High
Overall Fisheries Impact	-	Negative – Low
Overall Cultural Heritage Impact	-	Negative – Low
Overall Landscape & Visual Impact	- -	Negative – High
Overall Landfill Gas Impact	O / +	Neutral / Positive – Low

Table 16.3 Assessment of Significance of Visual Impacts for Lamma North Island Landfill During Construction / Operation (Note: All impacts adverse unless otherwise noted)

Identity No. of VSR	Key Visually Sensitive Receiver (VSR)	Approx Minimum Distance Between VSR and Source(s)	Nos. of VSRs (order of magnitude only)	Magnitude of Impact During Construction / Operation (Negligible, Small, Intermediate, Large)	VSR Sensitivity (Low, Medium, High)	Impact Significance before Mitigation Measures (Insubstantial, Slight, Moderate, Substantial)	Significance of Residual Impacts (Insubstantial, Slight, Moderate, Substantial)
<i>Residential VSRs</i>							
VR 61	Wah Fu, Hong Kong Island	3km	Many	Intermediate	High	Moderate to Substantial	Moderate to Substantial
VR 61a	Cyber Port, Hong Kong Island	3km	Many	Intermediate	Medium	Moderate	Moderate
VR 52	Yung Shue Wan, Lamma Island	1.5km	Many	Large	High	Substantial	Substantial
<i>Occupational VSRs</i>							
VR 54	Lamma Island Power Station	0.8km	Few	Large	Low	Moderate	Moderate
<i>Recreational VSRs</i>							
VR58	Victoria Peak, Hong Kong Island	5.5km	Few	Intermediate	Medium	Moderate	Moderate
VR55	Cheung Chau	7km	Many	Intermediate	Medium	Moderate	Slight
VR62	Chi Ma Wan, Lantau	10km	Few	Intermediate	Medium	Moderate	Slight
VR63	Penny's Bay (Future Disneyland)	10km	Many	Intermediate	Medium	Moderate	Slight
VR64	Coastal Headland trail between Yung Shue Wan and Tsang Tsai Au, Lamma Island	0.4km	Few	High	Medium	Substantial to Moderate	Substantial to Moderate
VR11	Area for Boating, Fishing, Diving and other water sports activities	0.5 – 10km	Many	Large	High	Substantial	Substantial
<i>Travelling VSRs</i>							
VR49	Maritime Vessels	0.5 – 10km	Many	Large	Medium	Substantial to Moderate	Moderate to Substantial

Table 16.4 Assessment of Significance of Visual Impacts for Lamma North Island Landfill During Afteruse Phase (Note: All impacts adverse unless otherwise noted)

Identity No. of VSR	Key Visually Sensitive Receiver (VSR)	Approx Minimum Distance Between VSR and Source(s)	No.s of VSRs (order of magnitude only)	Magnitude of Impact During Afteruse (Negligible, Small, Intermediate, Large)	VSR Sensitivity (Low, Medium, High)	Impact Significance before Mitigation Measures (Insubstantial, Slight, Moderate, Substantial)	Significance of Residual Impacts (Insubstantial, Slight, Moderate, Substantial)
<i>Residential VSRs</i>							
VR61	Wah Fu, Hong Kong Island	3km	Many	Intermediate	High	Moderate to Substantial	Moderate
VR 61a	Cyber Port, Hong Kong Island	3km	Many	Intermediate	Medium	Moderate	Slight
VR 52	Yung Shue Wan, Lamma Island	1.5km	Many	Large	High	Substantial	Substantial
<i>Occupational VSRs</i>							
VR 54	Lamma Island Power Station	0.8km	Few	Large	Low	Moderate	Moderate to Slight
<i>Recreational VSRs</i>							
VR58	Victoria Peak, Hong Kong Island	5.5km	Few	Intermediate	Medium	Moderate	Slight
VR55	Cheung Chau	7km	Many	Intermediate	Medium	Moderate	Insubstantial
VR62	Chi Ma Wan, Lantau	10km	Few	Intermediate	Medium	Moderate	Insubstantial
VR63	Penny's Bay (Future Disneyland)	10km	Many	Intermediate	Medium	Moderate	Insubstantial
VR64	Coastal Headland Trail between Yung Shue Wan and Tsang Tsai Au, Lamma Island	0.4km	Few	High	Medium	Substantial to Moderate	Moderate to Slight
VR11	Area for Boating, Fishing, Diving and other water sports activities	0.5 – 10km	Many	Large	High	Substantial	Substantial
<i>Travelling VSRs</i>							
VR49	Maritime Vessels	0.5 – 10km	Many	Large	Medium	Substantial	Moderate