5 WATER QUALITY

5.1 INTRODUCTION

This section assess the potential water quality impacts arising from both the construction and operational phases of PBRL. Appropriate mitigation measures are recommended where required.

5.2 ENVIRONMENTAL LEGISLATION AND GUIDELINES

The following legislation is applicable to the evaluation of water quality impacts associated with the construction and operation of the PBRL:

- *Environmental Impact Assessment Ordinance (Cap. 499. S.16)*, and the *Technical Memorandum on EIA Process (EIAO TM)*, especially *Annexes 6* and *14;*
- *Water Pollution Control Ordinance (WPCO)*; and
- *Technical Memorandum for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (TM).*

5.2.1 *Water Pollution Control Ordinance*

The WPCO is the primary legislation for the control of water pollution and water quality in Hong Kong. Under the WPCO Hong Kong waters are divided into 10 Water Control Zones (WCZs). Each WCZ has a designated set of statutory Water Quality Objectives (WQOs). The impacts from discharges during the construction and operation phases of the PBRL will primarily fall within two WCZs, the North Western and Southern.

WQOs for the North Western and Southern WCZs are presented in *Table 5.2a*, and are applicable as evaluation criteria for assessing the extent of marine water quality impacts associated with the discharges during the construction and operation of the PBRL.

Table 5.2a ***Water Quality Objectives for North Western and Southern WCZs***

Water Quality Objectives	Part or Parts of Zones
A. Aesthetic Appearance	
• There should be no objectionable odours or discolouration of the water.	Whole zone
• Tarry residues, floating wood, articles made of glass, plastic, rubber or of any other substances should be absent.	Whole zone
• Mineral oil should not be visible on the surface.	Whole zone

Water Quality Objectives	Part or Parts of Zones
Surfactants should not give rise to a lasting foam.	
• There should be no recognisable sewage-derived debris.	Whole zone
• Floating, submerged and semi-submerged objects of a size likely to interfere with the free movement of vessels, or cause damage to vessels, should be absent.	Whole zone
• The water should not contain substances which settle to form objectionable deposits.	Whole zone
B. Bacteria	
• The level of *Escherichia coli* should not exceed 1000 per 100 mL, calculated as the running median of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.	Inland waters of North Western WCZ
• The level of *Escherichia coli* should not exceed 610 per 100 mL, calculated as the geometric mean of all samples collected in one calendar year.	Secondary Contact Recreation Subzone of Southern Water
C. Colour	
• Human activity should not cause the colour of water to exceed 50 Hazen units.	Inland waters of North Western WCZ
D. Dissolved Oxygen	
• The level of dissolved oxygen should not fall below 4 mg per litre for 90% of the sampling occasions during the whole year; values should be calculated as the annual water column average (see Note). In addition, the concentration of dissolved oxygen should not be less than 2 mg per litre within 2 m of the seabed for 90% of the sampling occasions during the whole year.	Marine waters
• The dissolved oxygen level should not be less than 5 mg L^{-1} for 90% of the sampling occasions during the year; values should be calculated as water column average (see Note). In addition, the concentration of dissolved oxygen should not be less than 2 mg L^{-1} within 2 m of the seabed for 90% of the sampling occasions during the whole year.	Fish Culture Subzones of Southern WCZ
• The level of dissolved oxygen should not be less than 4 mg per litre.	Inland Waters
E. pH	
• The pH of the water should be within the range of 6.5 - 8.5 units. In addition, human activity should not cause the natural pH range to be extended by more than 0.2 units.	Marine waters except Bathing Beach Subzones
• Human activity should not cause the pH of the water to exceed the range of 6.0 - 9.0 units.	Inland waters
F. Temperature	
• Waste discharges shall not cause the natural daily temperature range to change by more than 2.0 °C.	Whole zone
G. Salinity	
• Waste discharges shall not cause the natural ambient	Whole zone

Water Quality Objectives	Part or Parts of Zones
salinity level to change by more than 10%.	
H. Suspended Solids	
• Human activity should neither cause the natural ambient level to be raised by more than 30% nor give rise to accumulation of suspended solids which may adversely affect aquatic communities.	Marine waters
• Waste discharges shall not cause the annual median of suspended solids to exceed 25 mg per litre.	Marine waters
I. Ammonia	
• The un-ionised ammoniacal nitrogen level should not be more than 0.021 mg per litre, calculated as the annual average (arithmetic mean).	Whole zone
J. Nutrients	
• Nutrients should not be present in quantities sufficient to cause excessive or nuisance growth of algae or other aquatic plants.	Marine water
• Without limiting the generality of objective (a) above, the level of inorganic nitrogen should not exceed 0.5 mg per litre, expressed as annual water column average (see Note).	Marine waters of the North Western WCZ
• Without limiting the generality of objective (a) above, the level of inorganic nitrogen should not exceed 0.1 mg per litre, expressed as annual water column average (see Note).	Marine waters of the Southern WCZ
K. 5-Day Biochemical Oxygen Demand	
• The 5-day biochemical oxygen demand should not exceed 5 mg per litre.	Inland waters
L. Chemical Oxygen Demand	
• The chemical oxygen demand should not exceed 30 mg per litre.	Inland waters
M. Toxin	
• Waste discharges shall not cause the toxins in water to attain such levels as to produce significant toxic, carcinogenic, mutagenic or teratogenic effects in humans, fish or any other aquatic organisms, with due regard to biologically cumulative effects in food chains and to interactions of toxic substances with each other.	Whole zone of the North Western WCZ
• Waste discharges shall not cause a risk to any beneficial use of the aquatic environment.	Whole zone of the North Western WCZ
N. Dangerous Substances	
• Waste discharges shall not cause the concentrations of dangerous substances in marine waters to attain such	Whole zone of Southern WCZ

Water Quality Objectives	Part or Parts of Zones
levels as to produce significant toxic effects in humans, fish or other aquatic organisms with due regard to biologically cumulative effects in food chains and to toxicant interactions with each other.	
• Waste discharges of dangerous substances shall not put a risk to any beneficial uses of the aquatic environment.	Whole zone of the Southern WCZ

Note: Expressed normally as the arithmetic mean of at least 3 measurements at 1 m below surface, mid-depth and 1 m above the seabed. However in water of a depth of 5 m or less the mean shall be that of 2 measurements (1 m below surface and 1 m above seabed), and in water of less than 3 m the 1 m below surface sample only shall apply.

5.2.2 *Technical Memorandum for Effluents*

All discharges during both the construction and operational phases of the project are required to comply with the TM issued under Section 21 of the WPCO, which defines acceptable discharge limits to different types of receiving waters. Under the TM effluents discharged into the drainage and sewerage systems, inshore and coastal waters of the WCZs are subject to pollutant concentration standards for particular volumes of discharge. These are defined by the EPD and specified in licence conditions for any new discharge within a WCZ. The PBRL study will be required to comply with *Table 10a* of the TM.

5.3 *BASELINE CONDITIONS*

5.3.1 *Hydrodynamics*

The Study Area covers the northeastern part of Lantau Island. Opposite the northern tip of Lantau Island is Ma Wan Island, around which flows pass into and out of the Western Harbour and Victoria Harbour. Kap Shui Mun, which is the channel between the northern tip of Lantau Island and Ma Wan Island, forms one of the main flow channels between the waters of the North West New Territories and the Western Harbour. The other flow channel is on the northern side of Ma Wan Island, the Ma Wan Channel. Tidal current speeds through Kap Shui Mun are generally high, greater than 1 ms^{-1} for the ebb phase of the tidal cycle for spring tides. In the vicinity of Yam O tidal currents are still reasonably strong, up to 0.6 ms^{-1}, with the main flows from the Pearl Estuary converging in this area before bifurcating around Ma Wan Island. On the Penny's Bay side currents are much lower, less than 0.3 ms^{-1}. This is because the main flows to and from Kap Shui Mun are along the East and West Lamma Channels and Victoria Harbour. The northeastern area of Lantau will exhibit seasonal differences in terms of salinity and temperature stratification. To the west of Ma Wan in the wet season strong salinity and temperature stratification is to be found due to the outflow from the Pearl Estuary. To the east of Ma Wan the stratification will be less strong due to the turbulence in the Ma Wan Channel and Kap Shui Mun causing a partial degradation in the stratification. In the sheltered bays along the coastline on southern side of northeast Lantau, stratification may be present due to localised run-off and heating of the relatively stagnant surface waters.

5.3.2 *Water Quality*

Any impacts from the construction and operation of the PBRL will occur within two WCZs , the North Western and Southern. There are two routine EPD water quality monitoring stations, one for each WCZ, in the vicinity of the Study Area. The monitoring data were extracted from the most up to data published information [1] and are summarised in *Table 5.3a.*

Table 5.3a ***EPD Routine Water Quality Monitoring Data in the Study Area***

WQ Parameter	SM10	NM1
Temperature (°C)	23.4	23.6
	(16.3 - 27.2)	(18.2 - 26.8)
Salinity (ppt)	30.2	29.3
	(26.9 - 33.4)	(21.9 - 32.5)
Dissolved Oxygen (mg L^{-1})	4.0	3.5
	(3.2 - 7.2)	(3.2 - 8.4)
Dissolved Oxygen Bottom (mg L^{-1})	4.3	2.9
	(3.9 - 7.2)	(2.7 - 8.3)
5-Day Biochemical Oxygen Demand (mg L^{-1})	0.9	0.9
	(0.1 - 1.8)	(0.2 - 2.0)
Suspended Solids (mg L^{-1})	6.9	4.0
	(4.1 - 9.9)	(1.1 - 6.7)
Total Inorganic Nitrogen (mg L^{-1})	0.27	0.43
	(0.14 - 0.43)	(0.24 - 0.66)
Unionised Ammonia (mg L^{-1})	0.003	0.005
	(0.001 - 0.009)	(0.002 - 0.007)
E coli (cfu per 100 mL)	9	110
	(2 - 300)	(6 - 570)

Notes:
1. Data presented are depth averaged, unless specified.
2. Data presented are annual arithmetric mean except for *E. coli* which are geometric means and dissolved oxygen which are 10th percentile.
3. Data enclosed in brackets indicate the ranges.
4. Shaded values indicate non-compliance with the Water Quality Objectives.

The EPD monitoring report [2] states that there are non-compliances with the WQOs for depth averaged dissolved oxygen at all three stations, although compliance is achieved with the bottom dissolved oxygen WQO at the stations. This is a deterioration from data collected in 1997, which showed compliance with both the depth averaged and bottom dissolved oxygen WQO [3]. A review of unpublished data for 1999 [4] determined that compliance with the depth averaged dissolved oxygen WQO was achieved. It may therefore be concluded that the dissolved oxygen levels in 1998 were not representative of long term water quality in the study area.

The total inorganic nitrogen WQO is also exceeded at Station SM10. The exceedence of the total inorganic nitrogen WQO at Station SM10 has been recorded for the last ten years.

(1) EPD (1999). Marine Water Quality in Hong Kong in 1998.
(2) EPD (1999). Op cit.
(3) EPD (1998). Marine Water Quality in Hong Kong in 1997.
(4) Data provided by EPD.

The WQO for *E. coli* at Station SM10, which is in a Secondary Contact Recreation Subzone, is achieved and the levels are low enough to satisfy the WQO for bathing beaches. Station NM1 is somewhat influenced by sewage effluent discharges, as shown by the higher *E. coli* concentrations. This is possibly because this station is in one of the main flow paths between the waters of the North West New Territories and Victoria Harbour and will therefore receive dilute discharges of sewage from these areas.

The data for temperature, salinity and dissolved oxygen show a wide variation, which indicates seasonal changes. These are most pronounced at Station NM1, which is the stations most influenced by the discharges from the Pearl River estuary.

In future, it is likley that the influence of sewage effluent discharges in the waters to the north of Lantau Island is likely to become greater. This will be due to future developments leading to increased flows from the Siu Ho Wan, Pillar Point and North West New Territories outfalls, coupled with increasing developments along the Pearl River estuary in mainland China.

5.4 *ASSESSMENT METHODOLOGY*

The construction and operational impacts associated with the PBRL are essentially land-based, but nevertheless may give rise to direct and indirect water quality impacts. Thus, the water quality assessment study area encompasses both local and directly affected waters, and water sensitive receivers (WSRs) located downstream and remote from the proposed works.

5.4.1 *Construction Phase*

Present construction designs were reviewed to assess the proximity of the PBRL construction activities to existing and committed WSRs. All WSRs were identified in accordance with the guidance provided in the *Hong Kong Planning Standards and Guidelines* and the EIAO TM.

The activities likely to have an impact upon the identified WSRs, water courses and streams were then identified.

Following the identification of WSRs and potential sources of water quality impacts, the scale, extent and severity of potential net (that is, unmitigated) construction impacts were evaluated with reference to the WPCO criteria.

Where water quality impacts are predicted to exceed the appropriate WPCO criteria, practical water pollution control measures and mitigation proposals are required to ensure compliance with reference to the WPCO. If appropriate, water quality monitoring and audit requirements will be also developed to ensure the efficacy of the construction stage water pollution control measures and mitigation measures.

5.4.2 *Operational Phase*

Operational PBRL designs were reviewed to assess the proximity of the rail alignment or any associated operational facilities to existing and future committed WSRs, in accordance with the *Hong Kong Planning Standards and Guidelines* and the EIAO TM.

Following the review of available information on the operation of the PBRL, the potential adverse effects, scale, extent and severity of potential impacts were assessed and evaluated, with reference to the WPCO criteria. Mitigation measures were recommended as appropriate.

5.5 *SENSITIVE RECEIVERS*

Considering the nature of the proposed construction works and operational phases of the railway, it is anticipated that those sensitive receivers more than 2 km from Penny's Bay are too distant to be directly impacted. Impacts will be localised and will be confined to small streams and coastal waters.

Water quality sensitive receivers (WSRs) which have been identified near the proposed project include:

- the marina near Nim Shue Wan which is located about 2 km south-west from Penny's Bay;
- Chinese White Dolphin (*Sousa chinensis*) habitat along Urmston Road and north Lantau; and
- local streams along the railway alignment.

5.6 *CONSTRUCTION PHASE*

5.6.1 *Potential Sources of Impact*

Potential sources of impacts on water quality from the construction of the PBRL include the following:

- construction runoff and drainage, including dewatering operations;
- runoff from the cut-and-cover and drill and blast tunnelling;
- runoff from station construction works;
- runoff from general construction activities; and
- sewage effluents generated from the construction work force.

It is noted that construction materials will probably be transported by barges to the works area near Penny's Bay as shown by *Figure 5.6a* and increased marine traffic is anticipated. When compared to nearby heavy marine traffic (as some of the busiest shipping lanes are located in the Study Area), water quality impacts associated with this increased marine traffic are likely to be minimal, and therefore they would not be further addressed in this section.

5.6.2 *Prediction of Impacts*

Construction Runoff

Runoff from construction sites may contain increased loads of suspended solids (SS) and other contaminants. Potential sources of water pollution from site runoff include:

- runoff and erosion from site surfaces, drainage channels, earth working areas and stockpiles;
- wastewater from dewatering activities;
- wash water from dust suppression sprays and wheel washing facilities; and
- fuel, oil and lubricants from maintenance of construction vehicles and equipment.

Construction runoff and drainage may cause both physical, chemical and biological effects. The physical effects could arise from any increase in SS from the site which could cause blockage of drainage channels and associated local flooding when heavy rainfall occurs, as well as local impacts on downstream water quality in Yam O Wan and Penny's Bay.

Possible chemical and biological effects could also arise as a result of construction runoff, depending upon the chemical and nutrient content of the runoff. Primary chemical effects may result from liquids containing significant quantities of concrete and cement-derived materials. These may include localised increases in turbidity and discolouration and localised elevations in pH.

Drainage

Diversion and relocation of storm water drains, including the existing sewer at Yam O near the Expressway, may be required. Any drainage modifications or relocation shall ensure that the flow of existing drainage channels is maintained and no reduction in the hydraulic capacity eventuates if construction work within a nullah or channel is required.

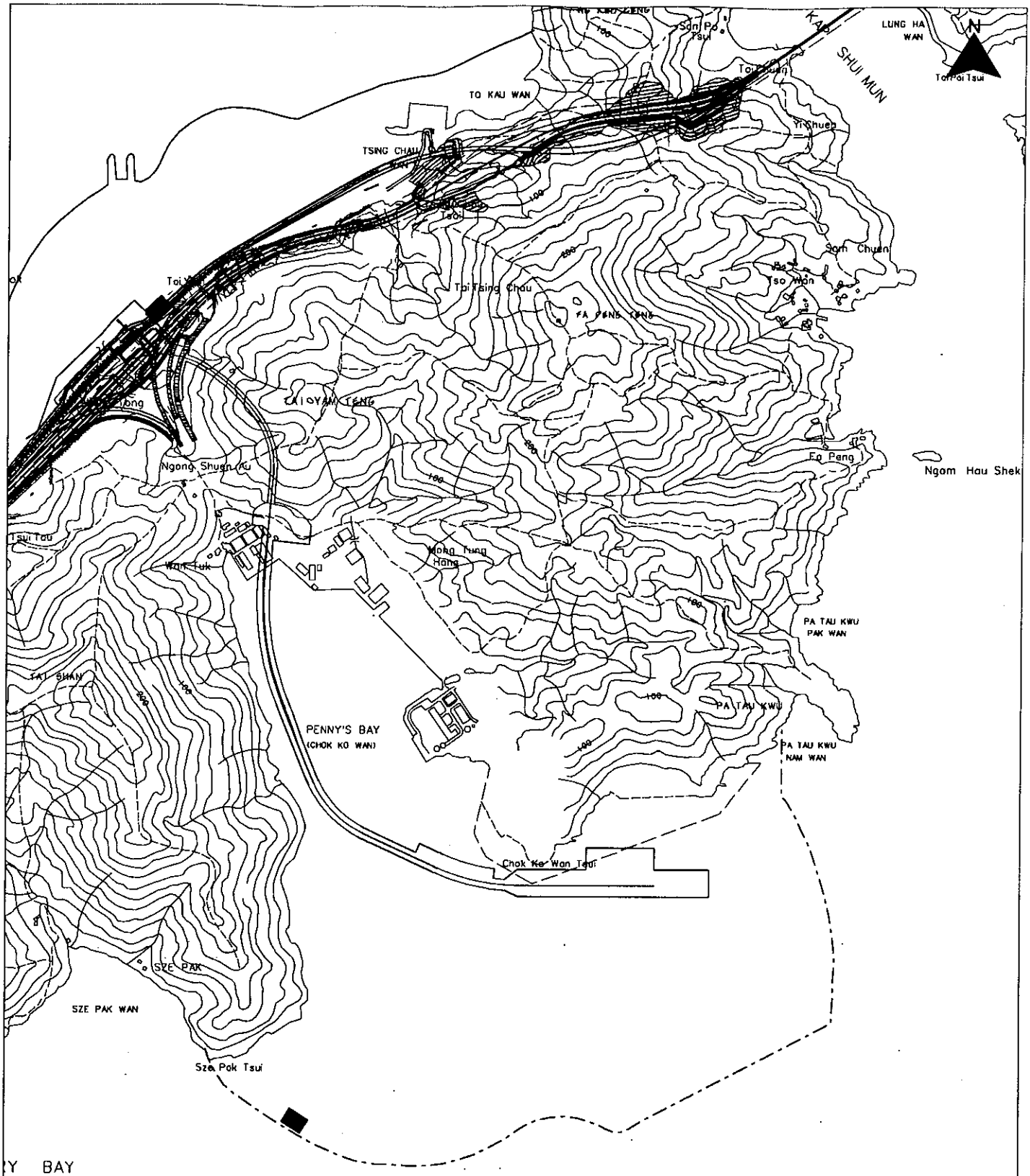

FIGURE 5.6a

LOCATIONS OF BARGE LOADING AND UNLOADING AREA

USTN FILE: C1937_8
DATE: 12/01/2000

Environmental Resources Management

ERM

Runoff from Cut-and-Cover Tunnelling

An excavation of approximately 100 m in length will be required north of the northern portal.

During wet periods, rainfall and surface runoff entering exposed excavations, and ground water seepage, could lead to construction runoff with high SS content. Thus, mitigation should be designed to reduce the influx of rainwater into the exposed cut-and-cover areas as well as arrangements to ensure proper silt removal prior to discharge.

Ground water may be extracted from excavations by pumps located north of the northern tunnel portal. The amount of ground water depends on the level of the water table, and the weather. However, provided the extracted water is passed through silt-traps to remove silt loadings prior to discharge, no significant water quality impact upon nearby marine waters is predicted.

Excavated material being used as backfill for the cut-and-cover works may require temporary storage on site. Runoff from the temporary storage area may result in siltation or blockage of receiving drainage channels and localised deterioration in water quality unless mitigation is provided.

Runoff from Drill-and-Blast Tunnelling

The 750 m drill-and-blast rock tunnel would have potential to cause water quality impacts, both from runoff from portal works and from the discharge of groundwater during tunnelling. At these locations silt traps will be required to prevent discharge of silty runoff from the construction areas.

The potential contamination of runoff and ground water during tunnelling activities, probing ahead and grouting will be similar to the cut-and cover tunnelling and would require appropriate collection and disposal methods to ensure that no unacceptable water quality impacts arise.

Runoff from Station Construction

Yam O Station will be constructed along the existing track at Yam O. Concourses will be constructed above the two platforms and connected by overhead link bridges. The station will be constructed primarily of reinforced concrete construction with simple beam and slab foundations.

Disneyland Station will be constructed on reclaimed land and will be mostly of steel frame construction on concrete raft footings.

Station construction works will require small quantities of excavation and will require temporary storage of materials on site. The potential water quality impact of runoff from the temporary storage areas may result in localised deterioration in water quality that may affect downstream receiving waters, if they are not controlled properly to meet the TM requirements.

Runoff from General Construction Activities

General construction activities, which will occur at both stations, both tunnels and the temporary depot area, have the potential to cause water pollution from debris and rubbish, such as packaging and used construction materials, entering the water column and resulting in floating refuse in the vicinity of the site that reduces the aesthetic quality of the receiving water body. Spillage of liquids stored on site, such as oil, diesel and solvents, could also result in water quality impacts if they enter surrounding water bodies and soils. These oily and greasy residues can be dripped, washed or spilled onto the ground surface within a working area. In areas such as the maintenance facilities where runoff could be contaminated by oil and grease, oil interceptors are recommended for separating oil from water prior to discharge.

Effluent produced from maintenance works has the potential to be heavily contaminated with oils, greases and other hydrocarbon-based produces. In addition, the washing of batteries during the maintenance process can produce an effluent contaminated with heavy metals, such as lead and nickel. All these effluents should be regarded as chemical wastes. Special handling, storage and treatment methods are specified in *Section 6.5.2.*

The effects on water quality from these construction activities are likely to be minimal, provided that site hoardings are well maintained and good construction practice is observed to ensure that litter, fuels and solvents are managed, stored and handled properly.

Sewage Effluents

Sewage effluents will arise from sanitary facilities provided for the on-site construction work force and these have the potential to cause water pollution. Sewage is characterised by high levels of biochemical oxygen demand (BOD), ammonia and *E. coli* counts. Owing to the lack of established guidelines for the sewage generation rates for construction sites, the recommended design rate for offices, specified in the *Guidelines for the Design of Small Sewage Treatment Plants, EPD Solids Waste Control Group, March 1990* has been used for this assessment. A sewage effluent volume of approximately 11.6 m^3 day^{-1} could be generated by the 210 workers that are expected to be working along the alignment. Discharge from on-site canteens serving the construction workers could also produce substantial amounts of sewage. Significant water quality impact will occur only if the sewage is discharged directly to the receiving water body without any prior treatment.

Currently, the only available sewerage system is at Yam O. It possible all the sewage effluent from the construction workers at Yam O shall be diverted to the foul sewer for treatment at Siu Ho Wan Sewage Treatment Works, otherwise portable toilets should be provided. Trunk sewer or sewage treatment facilities may not be available during the construction of the

proposed rail alignment at Penny's Bay. As the construction workers are likely to be dispersed along the alignment, the installation of portable toilets and the proper disposal of construction work force sewage are necessary to ensure that discharge standards are met.

5.6.3 *Evaluation of Impacts*

Unmitigated water quality impacts on WSRs may include runoff from construction activities associated with tunnelling and station construction, which may contain elevated concentrations of SS and associated contaminants, as well as the construction work force sewage discharges and general construction activities. These may directly affect the water quality of the WSRs and downstream water quality at Yam O Wan and Penny's Bay unless mitigated. Provided that recommended mitigation measures are implemented properly, elevated concentrations of SS and other contaminants should be reduced to minimal levels and thus no unacceptable water quality impacts are anticipated.

5.6.4 *Recommended Mitigation Measures*

It is important that measures are implemented to control runoff and drainage derived from the PBRL construction activities, and thereby prevent high loading of SS from entering the Yam O Wan, Penny's Bay, and adjacent waters. Proper site management is essential to minimise surface runoff, soil erosion and sewage effluents.

Construction site runoff and drainage shall be prevented or minimised in accordance with the guidelines stipulated in the EPD's *Practice Note for Professional Persons, Construction Site Drainage (ProPECC PN 1/94)*. Good housekeeping and stormwater best management practices, as detailed below, shall be implemented to ensure that runoff from construction areas and any stored excavated material complies with the WPCO and no unacceptable impact on the WSRs arises due to the construction of PBRL. All discharges from the construction site shall be controlled to comply with the relevant standards for effluents discharged into the Yam O Wan and Penny's Bay under the TM.

Construction Runoff and Drainage

The extent of exposed soil areas shall be minimised to reduce the potential for increased siltation, contamination of runoff, and erosion. Construction runoff related impacts associated with tunnelling and above ground construction activities and drainage to facilitate construction runoff can be readily controlled through the use of mitigation measures, which include:

- sediment traps, of sufficient capacity, shall be used for settling surface runoff prior to discharge to storm drains/culverts or discharge to marine waters. The system capacity should be flexible and able to handle multiple inputs from a variety of sources; and

- adequate maintenance of drainage systems to prevent flooding and overflow.

The boundaries of large areas of exposed earthworks shall be provided with flood protection measures, which could include temporary ditches to facilitate runoff discharge into the drainage system, via a sediment trap.

Traps shall also be installed to provide continuous extraction of sediment within the modified section of the culvert. Permanent drainage channels shall incorporate mitigation facilities based on the guidelines in Appendix A1 of ProPECC PN 1/94.

All exposed earth areas shall be completed as soon as possible after earthworks have been completed, or alternatively, within four weeks of the cessation of earthworks where practicable.

Open stockpiles of construction materials (e.g. aggregates, sand and fill material) of more than 50 m^3 shall be covered with tarpaulin or similar fabric during rainstorms. Measures shall be taken to prevent the washing away of construction materials, soil, silt or debris into any drainage system.

Material excavated in the vicinity of the Cheoy Lee Shipyard should appropriate testing of the soils determine contamination then this material should be ran off from prevented and it should be removed from site to minimise the risk of material being carried into the stormdrains and subsequently discharged to marine waters. Further discussion of this issue is given in *Section 6*.

Manholes (including newly constructed ones) shall always be adequately covered and temporarily sealed so as to prevent silt, construction materials or debris being washed into the drainage system and storm runoff being directed into foul sewers.

General Construction Activities

The MTRC shall comply with the requirements of the WPCO, and any licenses issued under the Ordinance, to ensure the mitigation of potential water quality impacts during construction.

In addition, MTRC shall employ standard good housekeeping to ensure the control of activities that may have implications for water quality as follows.

Debris and rubbish on site shall be collected, handled and disposed of properly to avoid entering the water column to cause water quality impacts. All fuel tanks and storage areas shall be provided with locks and be located on sealed areas, within bunds of a capacity equal to 110% of the storage capacity of the largest tank, to prevent spilled fuel oils from reaching coastal waters at Yam O Wan or Penny's Bay.

Sewage Effluent

If possible all the sewage effluent from the construction workers at Yam O should be diverted to the foul sewer for treatment at Siu Ho Wan Sewage Treatment Works. If no connection can be made to the foul sewer at Yam O then the work force shall use portable chemical toilets. Prior to the commissioning of the sewage system at Penny's Bay, the construction work force shall use portable chemical toilets along the rail alignment at Penny's Bay. Guidelines as stipulated in the WPCO shall be used for reference.

Runoff from Temporary Depot

The following measures shall be adopted, where appropriate, for the operation of the temporary depot:

- hard standing surfaces shall be provided for areas which may potentially give rise to contamination of storm water by oil and grease. Runoff and spillage prevention measures shall conform with relevant engineering and design standards;

- on-site drainage must focus on the areas where contaminated effluent may be generated and provide a clear segregation of clean and contaminated effluents;

- all plant maintenance areas shall be bunded and constructed on a hard standing, and provided with sediment traps and petrol interceptors. Traps and interceptors shall be regularly cleaned and maintained, especially after any accidental spillages. Each petrol interceptor shall have a bypass to prevent flushing during periods of heavy rains. Layers of sawdust, sand or equivalent material shall be available to be laid underneath and around any plant and equipment that may possibly leak oil to prevent transport o oil to storm drains and marine waters during rain storms;

- measures shall be developed for the temporary depot to ensure that any accidental spillage event is treated immediately and does not impact on any water bodies;

- the disposal of waste oil and other chemicals is controlled by the *Waste Disposal (Chemical Waste) (General) Regulation (Cap 354)*. Waste oil and other chemicals must be disposed of at the Government Chemical Waste Treatment Centre at Tsing Yi; and

- drainage and effluent collection and treatment systems shall be specified to meet the discharge limits as stipulated in the *Technical Memorandum of Standards for Effluents into Drainage and Coastal Waters* at the detailed design stage.

5.6.5 *Residual Impacts*

General construction activities associated with tunnelling and station construction could lead to site runoff containing elevated concentrations of SS and associated contaminants that may enter the marine water. However, it is anticipated that the above water quality impacts will generally be temporary and localised during construction. All other potential discharges to marine waters will be controlled through the implementation of suitable mitigation measures. Therefore, no unacceptable residual water quality impacts are anticipated during the PBRL construction phase, provided all the construction site/works area discharges comply with the TM standards.

5.7 *OPERATIONAL PHASE*

5.7.1 *Potential Sources of Impact*

Potential sources of impact on water quality from the operation of the PBRL include:

- trackwash and seepage from the railway;
- station runoff; and
- sewage generation at the Yam O Station and Disneyland Station.
- discharge from train washing facilities

5.7.2 *Prediction of Impacts*

Runoff from Trackwash and Seepage

Surface track runoff during rainfall may be contaminated with oil, grease and SS arising from track grindings, corrosion of rolling stock, and passing trains, which may cause downstream impacts on the public stormwater drains and the WSRs. The drainage system will be designed with provision for collection and treatment prior to disposal to storm water drains.

The tunnel drainage will comprise potentially contaminated trackwash from inside the tunnel, which will be subject to prior treatment as outlined above, and groundwater seepage to the outer tunnel lining, which will be uncontaminated and will be discharged directed to the stormwater drainage system.

Runoff from Stations

Rainwater runoff from the station structure, such as the station roofs, is expected to be "clean" and should therefore have no adverse impact on the WSRs.

Sewage Generation

Sewage effluent will be generated at Yam O and Disneyland Stations where staff toilet facilities will be provided. Uncontrolled discharge of sewage will cause unacceptable water quality impacts to WSRs.

Discharges from Train Washing Facilities

A train washing plant will be situated between the refuge siding and the Disneyland Station. The plant will employ mechanic scrubbers and detergent to clean the trains. Uncontrolled discharge of detergent contaminated water would have the potential to cause adverse impacts.

5.7.3 *Evaluation of Impacts*

Unmitigated water quality impacts on the WSRs may arise from discharges from the station and rail track / tunnel. Impacts on water quality from operation of the PBRL are evaluated below. Appropriate measures will be recommended, where necessary, to mitigate potential water quality impacts.

Runoff from Rail Tracks and Operational Drainage

Discharge from rail tracks and tunnel drainage is expected to contain limited amounts of oil and grease as the railway rolling stock will incorporate closed gearboxes. Where oils and lubricating fluids could be spilt, runoff should be diverted to silt and oil traps and would then be suitable for discharged to the public stormwater system. The treated runoff is unlikely to cause any unacceptable water quality impacts to the receiving marine waters.

Sewage

Sewage effluents from Yam O Station will be discharged directly to the foul sewer for treatment at Siu Ho Wan Sewage Treatment Works; at the Disneyland Station sewage effluents will be discharged to the foul sewer to be provided for the reclamation area. Therefore, provided the qualities of sewage effluents comply with the TM standards before discharge into foul sewers, it is predicted that the water quality impact upon local streams, water courses, and coastal waters at Yam O Wan and Penny's Bay will be minimal.

Discharges from Train Washing Facilities

Discharge from the train washing facilities will contain detergents. Following removal of the detergents, the waters may be discharged to the foul sewer. This is required because under the TM the discharge to foul sewers of substances liable to form scum is prohibited.

5.7.4 *Recommended Mitigation Measures*

The following measures shall be incorporated into the operation of the PBRL:

- a surface water drainage system shall be provided to collect operational tunnel seepage. Where oils and lubricating fluids could be spilt, facilities shall be provided to remove the oil / grease before being pumped to the public stormwater drainage system. It is envisaged that the operational tunnel discharge and track runoff will pass through the oil and grit / silt interceptors / chambers to remove oil, grease and sediment, however, other suitable alternative methods may be used;

- sewage effluents generated at the station are required to meet the TM standards prior to discharge. Sewage shall be directed to the public foul sewerage system and/or on-site sewage treatment facility for treatment prior to discharge to the public foul sewerage system;

- the efficiency of silt traps and oil interceptors is dependent on regular cleaning and maintenance. These installations shall be regularly cleaned and maintained in good working condition; and this shall be incorporated into operational procedures;

- oily contents of the oil interceptors shall be collected for reuse, or transferred to a disposal facility; and

- the design of the sanitary fitments and drainage works shall take into account the guidelines published in *Drainage Plans subject to Comment by the EPD, Practice Note for Professional Persons, Environmental Protection Department* (ProPECC PN 5/93).

- a small waste water treatment plant (or other suitable alternative method) should be provided to remove detergents from the waste waters arising from the train washing facilities prior to discharging to the foul sewers.

5.7.5 *Evaluation of Residual Impacts*

With the adoption and incorporation of drainage and effluent collection systems, minimal residual construction and operational water quality impacts are expected.

5.8 *ENVIRONMENTAL MONITORING AND AUDIT*

It is considered that only site inspections are required to ensure proper implementation, functioning and maintenance of the recommended water pollution mitigation measures at the work site during construction.

Discharge permits from the EPD will be required for any discharges from site during the operation stage, which will also specify requirements for sampling and testing. Provided that the recommended mitigation measures are regularly maintained by the Corporation, separate water quality monitoring and audit during operational phase is not considered necessary.

5.9 CONCLUSION

5.9.1 *Construction Phase*

Water quality impacts during the construction of PBRL may be associated with discharges of surface waters and collected groundwater from the various construction sites, and sewage from construction workers. Impacts can be controlled to comply with standards by implementing the recommended mitigation measures. No unacceptable residual impacts on water quality are anticipated.

5.9.2 *Operational Phase*

Drainage collection facilities, with the installation of silt traps and oil interceptors, shall be incorporated into the detailed PBRL design as the tunnel seepage and surface track runoff may contain contaminants such as oil and grease, which could impact upon water quality in receiving water bodies.

Local foul sewer system and sewage treatment facility shall be provided to collect and treat sewage from stations prior to discharge into the Government foul sewerage system. No residual water quality impact is therefore anticipated.

It is considered that, with the adoption of the proposed mitigation measures, no insurmountable water quality impacts will result from the operational phase of the PBRL.

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6 WASTE

6.1 INTRODUCTION

This section identifies the waste arising from the construction and operation of the PBRL and assesses the potential environmental impacts associated with the handling and disposal of the waste. Where potential environmental impacts are identified, mitigation measures are recommended.

6.2 ENVIRONMENTAL LEGISLATION AND GUIDELINES

6.2.1 *Introduction*

The criteria and guidelines for evaluating potential waste management implications are laid out in *Annexes 7* and *15* of the *Technical Memorandum on Environmental Impact Assessment Process* (*EIAO TM*) under the *EIA Ordinance* (Cap 499).

The following legislation covers, or has some bearing upon, the handling, treatment and disposal of wastes in the Hong Kong Special Administrative Region (HKSAR), and will also be considered in the assessment.

- *Waste Disposal Ordinance* (Cap 354);
- *Waste Disposal (Chemical Waste) (General) Regulation* (Cap 354);
- *Land (Miscellaneous Provisions) Ordinance* (Cap 28); *and*
- *Public Health and Municipal Services Ordinance* (Cap 132) - *Public Cleansing and Prevention of Nuisances (Urban Council) and (Regional Council) By-laws.*

6.2.2 *Waste Disposal Ordinance*

The *Waste Disposal Ordinance* (WDO) prohibits the unauthorised disposal of wastes, with waste defined as any substance or article which is abandoned. Construction and demolition (C&D) waste is not directly defined in the *WDO* but is considered to fall within the category of "trade waste". Trade waste is defined as waste from any trade, manufacturer or business, or any waste building, or civil engineering materials, but does not include animal waste.

Under the *WDO*, wastes can only be disposed of at a licensed site. A breach of these regulations can lead to the imposition of a fine and/or a prison sentence. The *WDO* also provides for the issuing of licences for the collection and transport of wastes. Licences are not, however, currently issued for the collection and transport of C&D waste or trade waste.

6.2.3 *Waste Disposal (Chemical Waste) (General) Regulation (Cap 354)*

Chemical waste as defined under the *Waste Disposal (Chemical Waste) (General) Regulation* includes any substance being scrap material, or unwanted substances specified under *Schedule 1* of the *Regulation,* if such a substance or chemical occurs in such a form, quantity or concentration so as to cause pollution or constitute a danger to health or risk of pollution to the environment.

A person shall not produce, or cause to be produced, chemical wastes unless he is registered with the EPD. Any person who contravenes this requirement commits an offence and is liable to fine and imprisonment.

Producers of chemical wastes must treat their wastes, utilising on-site plant licensed by the EPD or have a licensed collector take the wastes to a licensed facility. For each consignment of wastes, the waste producer, collector and disposer of the wastes must sign all relevant parts of a computerised trip ticket. The system is designed to allow the transfer of wastes to be traced from cradle-to-grave.

The *Regulation* prescribes the storage facilities to be provided on site, including labelling and warning signs. To minimise the risks of pollution and danger to human health or life, the waste producer is required to prepare, and make available, written procedures to be observed in the case of emergencies due to spillage, leakage or accidents arising from the storage of chemical wastes. The waste producer must also provide employees with sufficient training in such procedures.

6.2.4 *Land (Miscellaneous Provisions) Ordinance (Cap 28)*

Construction and demolition materials[1] which are wholly inert may be taken to public filling areas. Public filling areas usually form part of land reclamation schemes and are operated by the Civil Engineering Department (CED). The *Land (Miscellaneous Provisions) Ordinance* requires that public filling licences are obtained by individuals or companies who deliver inert C&D material (or public fill) to the public filling areas. The licences are issued by the CED under delegated authority from the Director of Lands.

Individual licences and windscreen stickers are issued for each vehicle involved. Under the licence conditions public filling areas will accept only inert building debris, soil, rock and broken concrete. There is no size limitation on the rock and broken concrete, and a small amount of timber mixed with inert material is permissible. The material should, however, be

(1) C&D material" refers to surplus materials arising from any land excavation or formation, civil/building construction, roadwork, building renovation or demolition activities. It includes various types of reusable materials, building debris, rubble, earth, concrete, timber and mixed site clearance materials. When sorted properly, materials suitable for land reclamation and site formation (know as public fill) should be reused at public filling areas whereas the remaining C&D waste are to be disposed of at landfills.

free from marine mud, household refuse, plastic, metal, industrial and chemical wastes, animal and vegetable matters and any other materials considered unsuitable by the public filling supervisor.

6.2.5 *Public Cleansing and Prevention of Nuisances by-Laws*

These by-laws provide a further control on the illegal tipping of wastes on unauthorised (unlicensed) sites. The illegal dumping of wastes can lead to fines and imprisonment.

6.2.6 *Additional Guidelines*

Other 'guideline' documents which detail how the contractor should comply with the regulations are as follows:

- *Waste Disposal Plan for Hong Kong* (December 1989), Planning, Environment and Lands Branch Government Secretariat;
- *Environmental Guidelines for Planning In Hong Kong* (1990), Hong Kong Planning and Standards Guidelines, Hong Kong Government;
- *New Disposal Arrangements for Construction Waste* (1992), Environmental Protection Department & Civil Engineering Department;
- *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes* (1992), Environmental Protection Department.
- *Works Branch Technical Circular No. 6/92, Fill Management*; Works Branch, Hong Kong Government;
- *Works Branch Technical Circular No. 2/93, Public Dumps*, Works Branch, Hong Kong Government;
- *Works Branch Technical Circular No. 16/96, Wet Soil in Public Dumps*; Works Branch, Hong Kong Government;
- *Works Bureau Technical Circular No. 4/98, Use of Public Fill in Reclamation and Earth Filling Projects*; Works Bureau, Hong Kong SAR Government; and
- *Works Bureau Technical Circular No 5/99, Trip-ticket System for Disposal of Construction and Demolition Material*; Works Bureau, Hong Kong SAR Government.
- *Works Bureau Technical Circular No 25/99, Incorporation of Information on Construction and Demolition Material Management in Public Works Subcommittee Papers*, Works Bureau, Hong Kong SAR Government.

6.3 CONSTRUCTION PHASE

6.3.1 *Construction Activities*

The majority of the PBRL is to be constructed at grade with portions of the track depressed in the vicinity of Yam O station to gain sufficient headroom underneath the existing viaducts of the North Lantau Highway and near the Disneyland Station to avoid the visual impact to visitors to the amusement park. The construction of the PBRL will involve the following construction works:

- site preparation;
- foundation works for the Yam O and Disneyland Stations;
- construction of a short section (about 100 m) of cut and cover tunnel near the existing North Shore Link Road at Yam O area;
- excavation of approximately 750 m of tunnel near Yam O using drill and blast method;
- construction of approximately 3.6 km of railway track; and
- installation and erection of electrical and mechanical equipment.

There will be two main Work Areas, one at Yam O on the proposed station site and the other at Penny's Bay near the Disneyland Station. There will also be a concrete batching plant north of Yam O Station.

6.3.2 *Potential Sources of Impact*

Construction activities will result in the generation of a variety of wastes which can be divided into distinct categories based on their composition, as follows:

- excavated material;
- construction and demolition waste;
- chemical waste; and
- general refuse.

The nature and quantity of each of these waste types arising from the construction of the PBRL are identified below.

Excavated Material

Excavated material is defined as inert virgin or reclamation fill material removed from the ground and sub-surface. As the majority of the PBRL will be constructed at grade, the excavation work will be limited to construction of cut and cover and drill and blast tunnels, and minor earthworks for the construction of tunnel portals. It is estimated that approximately 16,500 m^3

and 27,000 m^3 of excavated materials will be generated from the construction of cut and cover tunnel, and drill and blast tunnel, respectively. About 25,000 m^3 of excavated materials will be generated from other minor excavation work. These excavated materials (a total of 68,500 m^3) will be generated between third quarter 2002 and second quarter 2004 (approximately 21 months) and will comprise mainly clean rock and soil.

The Yam O station will be constructed on pad foundation, and hence no piling will be required. The Disneyland Station will be seated on raft foundation. No or minimal excavation will be required for the construction of the foundation. The quantity of excavated material arising from all the foundation works will be minimal.

Construction and Demolition Waste

The principal superstructures to be constructed will include:

- Yam O and Disneyland Stations; and
- concrete cut and cover box tunnel;
- single cell horse-shoe tunnel.

C&D material will be generated from the construction of these superstructures. These materials comprise unwanted materials generated during construction, including:

- rejected structures and materials;
- materials which have been over ordered or are surplus to requirements; and
- materials used and discarded.

A small amount of C&D material will also be generated from the construction of tunnel portals and reprovisioning of a short section of the existing road.

The C&D material will arise from a number of the construction activities and typically may include:

- wood from formwork and falsework;
- materials and equipment wrappings;
- unusable/surplus concrete/grout; and
- damaged/contaminated construction materials.

The quantity of C&D material generated from the construction of cut and cover tunnel will be minimal (in the order of 350 m^3). The amount of concrete which may be wasted from shotcreting of the tunnel wall and construction of tunnel lining will be negligible (in the order of 80 m^3) and will not be a concern.

The Yam O station will consist of two separate platforms which will be constructed along the existing track at Yam O. Concourses will be constructed above each of the platforms and connected by link bridges. The Disneyland Station will consist of two levels, the concourse and the platform levels. Both stations will be constructed by *in situ* concrete technique. The side walls and roofs of the stations will largely be structural steel with cladding. The gross floor areas (GFA) for the Yam O and Disneyland stations are about 16,000 m^2 and 30,000 m^2, respectively. Based on a generation rate of 0.1 m^3 per 1 m^2 of GFA constructed[1], the quantity of C&D material to be produced from the construction of Yam O and Disneyland stations will be approximately 4,600 m^3

As the majority of the PBRL section will be constructed on the newly formed Penny Bay Reclamation, no or negligible amount of C&D material will be generated from site clearance work.

Chemical Waste

Chemical Waste, as defined under the *Waste Disposal (Chemical Waste) (General) Regulation,* includes any substance being scrap material, or unwanted substances specified under *Schedule 1* of the *Regulation.* A complete list of substances is provided under the *Regulation,* however substances likely to be included in the above category generated as a result of construction activities will primarily arise from the maintenance of plant and equipment. These may typically include the following:

- scrap batteries or spent acid/alkali from their maintenance;
- used engine oil;
- hydraulic fluids;
- used air, oil and fuel filters from machinery;
- spent mineral oils/cleaning fluids from machinery; and
- spent solvents/solutions, which may be halogenated, from equipment cleaning activities.

Chemical waste will arise primarily from vehicle and plant maintenance at the two Work Areas. Chemical wastes may pose serious environmental, and health and safety hazards if not stored and disposed of in an appropriate manner as outlined in the *Waste Disposal (Chemical Waste) (General) Regulation* and the *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes.* These hazards may include:

[1] Reduction of Construction Waste Final Report (March 1993). Hong Kong Polytechnics.

- toxic effects to workers;
- adverse effect on air, water and land from spills;
- fire hazards; and
- disruption to sewage treatment works due to damage to the sewage biological treatment systems if waste is allowed to enter the sewerage system.

It is difficult to quantify the amount of chemical waste which will arise from the construction activities as it will be highly dependent on the contractor's on-site maintenance practices and the numbers of plant and vehicles utilised. However, it is anticipated that the quantity of chemical waste, such as lubricating oil and solvent produced from plant maintenance, will be small and in the order of a few hundred litres per month.

General Refuse

General refuse will be generated from construction personnel at the site offices and canteens. General refuse will mainly consist of food wastes, aluminum cans and waste paper.

The storage of general refuse has the potential to give rise to adverse environmental impacts. These include odour if the waste is not collected frequently, windblown litter, water quality impacts if waste enters water bodies, and visual impact. The sites may also attract pests, vermin, and other disease vectors if the waste storage areas are not well maintained and cleaned regularly. In addition, disposal of wastes at sites other than the approved landfills can also lead to adverse impacts at those sites.

Construction of the PBRL is expected to require a maximum of approximately 100 full time workers during the peak construction period. Based on a waste generation rate of 0.65 kg per worker per day, the amount of general refuse requiring disposal would be approximately 65 kg d^{-1}. Using an assumed density of 100 to 200 kg m^{-3}, the expected daily volume of general refuse will be about 0.33 to 0.65 m^3 d^{-1}.

Table 6.3a Breakdown of Construction Waste Arisings

Waste Type	Duration	Quantity	Estimated Arisings	Remarks
Excavated Material	Third quarter of 2002 - Second quarter of 2004	Cut & Cover Tunnel = 16,500m^3 Tunnel Drill and Blast = 27,000m^3 Minor Excavation Work = 25,000m^3	110 m^3d^{-1}	To be reused on-site or at nearby reclamation
C&D Material	First quarter of 2003 - Third quarter of 2004	Cut & Cover Tunnel = 350m^3 Shotcreting of Tunnel = 80m^3 Yam O Station = 1,600m^3 Disneyland Station = 3,000m^3	13 m^3d^{-1}	
- C&D Waste(1)			2.6 m^3d^{-1}	To be disposed at landfill
- Public Fill(1)			10.4 m^3d^{-1}	To be reused in nearby reclamation
Chemical Waste	Throughout Construction Period	Cannot be Quantified	Few Hundred Litres per Month	
General Refuse	Throughout Construction Period	100 Full-time Workers with a Generation Rate of 0.65 kg $person^{-1}d^{-1}$	65 kgd^{-1} or 0.33 - 0.65 m^3d^{-1}	To be disposed at landfill

6.3.3 *Evaluation of Impacts*

With reference to the criteria and guideline for evaluating potential waste management implications presented in *Annexes 7* and *15* of the *EIA O TM*, the assessment of potential environmental impacts associated with management of waste from the construction of the PBRL is based on the following factors:

- the types of waste generated;
- the quantities of the principal waste types generated; and
- the proposed storage, transport, treatment and disposal methods, and the impacts of these methods.

Excavated Material

Excavated material will be reused, wherever possible, on site for construction of noise protection bunds and other miscellaneous works such as landscaping while the excess material should be taken to other reclamation sites or public filling areas. Given the inert nature of this material, reuse of the material on-

(1) Forecasted ratio for C&D Waste: Public fill is 2:8 (Source Monitoring of Solid Waste in Hong Kong 1997)

site or in other reclamation works is unlikely to cause any adverse environmental impacts. As the amount of excavated material requiring off-site disposal will be small (about 68,500 m^3 or an average of 110 m^3 per day[1]), it is not expected that it will have significant impacts on the demand of public filling areas. Depending on the development programme of the Yam O and Penny's Bay reclamations, the surplus excavated material could be delivered to these sites for reuse. The excavated material will be generated from the two worksites and the daily quantity of material generated at each worksite will be small. The traffic associated with off-site disposal of excavated material will therefore be minimal (about 17 truck trips per day[2]) and it is not anticipated to cause any adverse traffic impacts.

The potential noise, dust and water quality impacts associated with the handling and disposal of excavated material are discussed in *Sections 3, 4* and *5*, respectively. It is not anticipated that there will be any potential hazards associated with the handling and disposal of excavated material, if general construction safety procedures are properly implemented.

Excavated sediment will also be generated in the vicinity of the Cheoy Lee Shipyard, although volume of excavated sediment is likely to be minimal, the sediment may be seriously contaminated. At the moment there is no information on the contamination level of the excavated material. However, this will be investigated in the Schedule 2 EIA on the demolition of Cheoy Lee Shipyard to be conducted by CED.

Construction and Demolition Waste

If not properly managed, the storage, handling, transport and disposal of C&D material have the potential to create visual, water, dust, noise and traffic impacts.

With respect to the nature of the construction activities, the C&D material will consist of a mixture of inert (i.e. concrete, tiles, bricks, etc. which are classified as public fill) and putrescible (paper, plastic, wood, etc. which are classified as C&D waste) materials. The public fill should be reused on site, as far as practicable. If on-site use is not practicable, the public fill should be delivered to other reclamation sites (such as the Penny's Bay or Yam O reclamations) or to public filling areas available at that time. The disposal of inert C&D material at public filling areas or other reclamation sites is unlikely to raise any long term concerns because of its inert nature.

Disposal of C&D waste to licenced landfill will not cause unacceptable environmental impacts. However, given the very limited landfill space which is available, it is important to minimise, wherever possible, the wastes being

(1) Majority of the excavation works will be undertaken between January 2003 and June 2004 (about 18 months).

(2) Assuming each truck has a carrying capacity of 6.7 m^3.

delivered to landfill. Government policy is not to accept C&D waste with more than 20% (by weight) inert material at landfill sites. Wherever, practical, the production of C&D waste should be minimised.

On-site sorting of C&D material into C&D waste and public fill should be carried to reduce the volume of C&D waste to be disposed off-site. With regard to the large fill requirement of Penny's Bay Reclamation, public fill generated by PBRL can be used as filling material. With respect to the small quantity (about 13 $m^3 d^{-1}$) (1) of C&D material (including both public fill, 10.4 m^3d^{-1} and C&D waste, 2.6 m^3d^{-1}) to be produced from the construction works, it is not anticipated that the off-site disposal of the C&D waste (which only required one truck loads per day) will cause any adverse noise and traffic impacts. With the implementation of good construction site practices such as those stated in the *Air Pollution Control (Construction Dust) Regulation*, the handling and disposal of C&D waste will not cause adverse dust impacts. With regard to small arisings of C&D material, the environmental impacts associated with the on-site sorting is minimal.

Similar to the management of excavated material, it is not anticipated that there will be any potential hazard associated with handling and disposal of C&D waste if general construction safety procedures are properly implemented.

Chemical Waste

The chemical waste to be generated from the construction activities will be readily accepted at the Chemical Waste Treatment Centre (CWTC) at Tsing Yi.

Storage, handling, transport and disposal of chemical waste should be arranged in accordance with the *Code of Practice on the Packaging, Labelling and Storage of Chemical Waste* published by the EPD. Provided that this occurs, the potential environmental impacts arising from the handling, storage and disposal of a small amount of chemical waste generated from the construction activities will be negligible.

General Refuse

The amount of general refuse to be generated from the worksites is small (in the order of 65 kg d^{-1}). Provided that the mitigation measures recommended in *Section 6.5* are adopted, the potential environmental impacts caused by storage, handling and disposal of general refuse are expected to be minimal.

(1) Assuming majority of the building works will be carried out between mid 2003 and mid 2004 (i.e. a 12 months period).

6.4 OPERATIONAL PHASE

6.4.1 *Identification of Waste Generation Activities*

The operation of the PBRL will involve the following waste generating activities:

- operations of the railway;
- maintenance works;
- commercial retailers within the stations; and
- office activities.

6.4.2 *Potential Sources of Impact*

The above activities will result in the generation of a variety of wastes which can be divided into distinct categories based on their composition, as follows:

- industrial waste;
- chemical waste; and
- general refuse.

The nature and quantity of each of these waste types are discussed below.

Industrial Waste

Industrial waste will be generated from the maintenance and upkeep of the building services of the two stations. The industrial waste will consist mainly of scrap metals, electronic equipment and used florescent tubes. With respect to the low maintenance design of the station (ie natural ventilation and daylighting, concrete slab and steel structural frame, etc), it is anticipated that minimal industrial waste will be produced during operation. Scrap metal and electronic equipment has good recycling value and is likely be scavenged for recycling.

Industrial wastes have the potential to create similar environmental impacts to general refuse as described above.

Chemical Waste

Chemical wastes will be generated from the maintenance of the depot, buildings and railway track. These may include, but need not be limited to the following types of waste:

- waste lubricants, oils, paints;
- pesticides;
- spent solvents/solutions, which may be halogenated, from equipment cleaning activities; and

- waste batteries.

As discussed for the construction phase, these chemical wastes may pose significant environmental, health and safety hazards if they are not properly managed.

The quantities of chemical waste cannot be determined at this stage. However, it is expected to be small and they can be readily disposed of at the CWTC.

General Refuse

General refuse will be generated by the public and commercial retailers and by the station offices and canteens within each of the stations. Based on similar operations, general refuse is likely to be composed of food waste, wood, plastic containers/bottles, office wastes, paper, aluminium cans, old tins/containers, cleaning materials and other miscellaneous wastes produced during daily activities. It has been estimated from experience that each of the stations may generate up to 5 m^3 d^{-1} of such waste although it is difficult to estimate at this stage the precise contribution from the commercial element until more details of their operations can be confirmed.

Approximately 50 staff comprising train operators, operator supervisors and general workers will be based at the stations. It is therefore expected that the station will generate less than 55 kg d^{-1}[6] or 0.6 m^3 of general refuse per day, primarily consisting of waste paper, rags, empty containers and packaging materials.

The storage of general refuse has the potential to give rise to adverse environmental impacts. These include odour (if the waste is not collected frequently), windblown litter, water quality impacts (if waste enters water bodies), and visual impacts. The sites may also attract pests, vermin, and other disease vectors if the waste storage areas are not well maintained and cleaned regularly. In addition, disposal of wastes at sites other than approved landfills can also lead to adverse impacts at those sites.

Table 6.4a ***Breakdown of Operation Waste Arisings***

Waste Type	Generation Rate
Industrial Waste	Minimal
Chemical Waste	Small
General Refuse	Yam O Station = 5 m^3d^{-1}
	Disneyland Station = 5 m^3d^{-1}
	Staff = 55 kg d^{-1} or 0.6 m^3d^{-1}

6.4.3 *Evaluation of Impacts*

Industrial Waste

Metals and discarded electronic equipment have high scrap value and may be sold for recycling. Provided that the scrap materials are collected regularly, it is not expected that the storage, handling, transport and disposal of these materials will cause adverse environmental impacts. Other general industrial waste such as plastic, cloth and paper can be collected together with general refuse and disposed of at a licensed waste transfer station (i.e. North Lantau Transfer Station) or landfill (i.e. WENT landfill).

Chemical Waste

Chemical waste should be stored, handled, transported and disposed of in accordance with the *Waste Disposal (Chemical Waste) (General) Regulation* and the *Code of Practice on Packaging, Labelling and Storage of Chemical Wastes.* They should be collected and transported to the CWTC or other licensed facility by a licensed waste haulier. Provided that appropriate handling, storage and disposal procedures are followed, no unacceptable impacts associated with the management of chemical waste during the operational phase of the PBRL are anticipated.

General Refuse

General refuse should be collected at each station on a daily basis and delivered to local refuse collection points or directly to the North Lantau Transfer Station. Provided that the mitigation measures recommended in *Section 6.5* are adopted, the environmental impacts caused by storage, handling, transport and disposal of general refuse are expected to be minimal.

6.5 *MITIGATION MEASURES*

6.5.1 *Introduction*

This section sets out storage, transportation and disposal measures which are recommended to avoid or minimise potential adverse impacts associated with the handling and disposal of waste arising from the construction and operation of the PBRL. Upon appointment of a contractor(s) for the PBRL, the contractor(s) shall prepare procedures and plans for the on-site management of waste in compliance with MTRC's Environmental Management Plan (EMP) taking into account the recommended mitigation measures in this report.

For the operational phase, MTRC shall incorporate the same procedures as currently in use for existing MTR Railways.

6.5.2 *Excavated Material*

Wherever practicable, excavated materials should be segregated from other wastes to avoid contamination thereby ensuring acceptability at public filling areas or reclamation sites and avoiding the need for disposal at landfill. The priority for off-site disposal of surplus excavated material should be as follows:

- transport to other reclamation sites at North Lantau and Penny's Bay areas; and
- transport to public filling areas.

Excavated Material

Potential impacts associated with the exposure to and disposal of contaminated excavated material could be mitigated by adopting the following measures:

- Minimising exposure to any contaminated material by the wearing of protective gear such as gloves, providing adequate hygiene and washing facilities, and preventing eating during excavation;

- contaminated material (if any) excavated should not be allowed to stockpile on the site and should be immediately removed from site once excavated; and

- all container for disposal excavated material should be fitted with tight fitting seals to prevent leakage of materials during transportation.

6.5.3 *Construction and Demolition Wastes*

Careful planning and good site management can minimise over ordering and waste of materials such as ready mixed concrete and cement grouts. The design of formwork should maximise the use of standard wooden panels so that high reuse levels can be achieved. More durable alternatives such as steel formwork or plastic facing should be considered in order to increase the potential for reuse. On site sorting of C&D material into C&D waste (to minimise volume to be disposed off-site) and public fill (to be reused in reclamation) is recommended.

Proper segregation of wastes and materials into different transit skips/containers on-site will increase the flexibility for disposal of certain components of the waste stream by contractors.

Waste containing putrescible materials should be disposed of at landfills. At present, Government is developing a charging policy for the disposal of waste to landfill. When it is implemented, this will provide additional incentive to reduce the volume of waste generated and to encourage proper segregation to allow free disposal of public fill to public filling areas.

6.5.4 *Chemical Waste*

Chemical waste that is produced, as defined by *Schedule 1* of the *Waste Disposal (Chemical Waste) (General) Regulation*, should be handled in accordance with the *Code of Practice on the Packaging, Handling and Storage of Chemical Wastes*. Containers used for the storage of chemical wastes should:

- be suitable for the substance they are holding, resistant to corrosion, maintained in a good condition, and securely closed;
- have a capacity of less than 450 l unless the specifications have been approved by the EPD; and
- display a label in English and Chinese in accordance with instructions prescribed in *Schedule 2* of the *Regulations*.

The storage area for chemical wastes should:

- be clearly labelled and used solely for the storage of chemical waste;
- be enclosed on at least three sides;
- have an impermeable floor and bunding, of capacity to accommodate 110% of the volume of the largest container or 20% by volume of the chemical waste stored in that area, whichever is the greatest;
- have adequate ventilation;
- be covered to prevent rainfall entering (water collected within the bund must be tested and disposed of as chemical waste if necessary); and
- be arranged so that incompatible materials are adequately separated.

Disposal of chemical waste should:

- be via a licensed waste collector; and
- be to a facility licensed to receive chemical waste, such as CWTC which also offers a chemical waste collection service and can supply the necessary storage containers; or
- be to a reuser of the waste, under approval from the EPD.

6.5.5 *General Refuse*

General refuse generated on-site shall be stored in enclosed bins or compaction units separate from public fill and chemical wastes. A reputable waste collector shall be employed to remove general refuse from the site,

separately from public fill and chemical wastes, on a daily basis so as to minimise odour, pest and litter impacts. The burning of refuse on-site is prohibited by law. The storage area should be washed as needed.

6.5.6 *Summary*

This section describes waste management requirements and provides practical recommendations which should be implemented to minimise the potential environmental impacts due to storage, handling, transport and disposal of wastes.

Waste reduction is best achieved at the planning and design stages, as well as by ensuring that processes are developed and operated efficiently. Good management and control can prevent the generation of significant amounts of waste. For unavoidable wastes, optimal disposal is recommended as follows:

- use of excavated material (inert) suitable for reclamation or fill;
- reuse of public fill for on-site reclamation or deliver any surplus public fill to public filling areas;
- disposal of C&D waste at landfills;
- consignment of chemical waste to the CWTC or other approved facilities for treatment and disposal;
- disposal of non-recyclable industrial waste and general refuse at landfills.

The criteria for sorting solid waste are described in *New Disposal Arrangements for Construction Waste*. Waste containing in excess of 20% by volume of inert material should be segregated from waste with a larger proportion of putrescible material.

Proper storage and site practices will minimise the damage or contamination of construction materials. On-site measures may be implemented which promote the proper disposal of wastes once it is moved off site. Since waste brought to public filling areas will not attract a charge, while that taken to landfill may attract some future charge, separating waste may also help to reduce waste disposal costs, should landfill charging be introduced as scheduled.

Specifically, it is recommended that:

- wastes should be handled and stored in a manner that ensures that they are held securely without loss or leakage thereby minimising the potential for pollution;
- only reputable waste collectors authorised to collect the specific category of waste concerned should be employed;

- surplus public fill and C&D waste should be removed immediately it is produced;

- appropriate measures should be employed to minimise windblown litter and dust during transportation of waste by either covering trucks with tarpaulin sheet or by transporting wastes in enclosed containers;

- the necessary waste disposal permits should be obtained from the appropriate authorities, if they are required, in accordance with the *Waste Disposal Ordinance* (Cap 354), *Waste Disposal (Chemical Waste) (General) Regulation* (Cap 354), *Land (Miscellaneous Provisions) Ordinance* (Cap 28).

- collection of general refuse should be carried out on a daily basis;

- waste should only be disposed of at licensed sites and site staff and the contractors should develop procedures to ensure that illegal disposal of wastes does not occur; and

- waste storage areas should be well maintained and cleaned regularly.

Training and instruction of construction staff should be given at the site to increase awareness and draw attention to waste management issues and the need to minimise waste generation.

6.6 *ENVIRONMENTAL MONITORING & AUDIT*

The contractor's waste management practices should submitted to Engineer for approval and shall be subject to contractual control and checking against the provisions of the contract and Environmental Management Plan will be undertaken by the MTRC on a weekly basis.

Further environmental monitoring and audit are not considered necessary.

6.7 *CONCLUSIONS*

The total quantity of excavated materials to be generated from the construction of the PBRL will be small, in the order of 68,500 m^3. It is important that the mitigation measures relating to good practice which have been recommended are followed to ensure that adverse impacts are prevented and that the opportunities for waste minimisation and reuse are taken.

The amount of general refuse arising from the operation of the PBRL is expected to be small, but all feasible measures should be taken to avoid, minimise and reuse wastes. Industrial and chemical wastes arising from

maintenance activities will be low and limited to plant and equipment maintenance.

Mitigation measures relating to good practice have been recommended to ensure that adverse environmental impacts are prevented and that opportunities for waste minimisation are followed.

If the recommendations of this report are implemented, the potential environmental impacts associated with the storage, handling, collection, transport, and disposal of wastes arising from the construction and operation of the PBRL will meet the criteria specified in the *EIAO TM* and no unacceptable environmental impacts are anticipated.

7 LANDSCAPE AND VISUAL IMPACTS

7.1 INTRODUCTION

This section of the report outlines the landscape and visual impacts associated with the Penny's Bay Rail Link in accordance with the EIAO. Both construction and operational impacts are assessed.

The assessment includes:

- A listing of the relevant environmental legislation and guidelines;
- a definition of the scope and contents of the study, including a description of the assessment methodology;
- a review of the relevant planning and development control framework;
- a baseline study providing a comprehensive and accurate description of the baseline landscape and visual character;
- recommendation of appropriate mitigation measures and associated implementation programmes; and,
- identification of the potential landscape and visual impacts and prediction of their magnitude and potential significance, before and after the mitigation measures.

7.2 ENVIRONMENTAL LEGISLATION AND GUIDELINES

The following legislation, standards and guidelines are applicable to the evaluation of landscape and visual impacts associated with the construction and operation of the PBRL:

- *Environmental Impact Assessment Ordinance (Cap.499) and the Technical Memorandum on EIA Process (EIAO TM), particularly Annexes 10 and 18;*
- *South West New Territories Development Strategy Review (August 1999);*
- *Draft North-East Lantau Outline Zoning Plan No. S/I-NEL/5 (13th August 1999);*
- *Hong Kong Planning Standards and Guidelines;*
- *WBTC No. 25/93 - Control of Visual Impact of Slopes;*
- *WBTC No. 18/94 - Management and Maintenance of both Natural Vegetation and Landscape Works;*
- *WBTC No. 24/94 [PELBTC No. 3/94] – Tree Preservation;*
- *GEO (1999) – Use of Vegetation as Surface Protection on Slopes*

In addition, reference has been made to the Recommended Outline Development Plan for North-East Lantau, currently being drafted under the auspices of the North Lantau Development Feasibility Study for Civil Engineering Department.

7.3 SCOPE AND CONTENT OF THE STUDY

7.3.1 *Penny's Bay Rail Link*

The nature and extent of the Penny's Bay Rail Link is described in detail in *Section 2* of this report.

7.3.2 *Limits of the Study Area*

The limit of the landscape impact study is 500m on either side of the limit of the railway works. The limits of the visual impact studies are the zones of visual influence (ZVIs) of the railway works during the construction and operation phases, which are illustrated later in the chapter in *Figures 7.5.8 and 7.5.9*. (It should be noted that the ZVIs does not extend to the 8km radius defined in the Study Brief for the reasons explained in section 7.5.5.)

7.3.3 *Assessment Methodology*

Landscape and visual impacts have been assessed separately for the construction and operational phases.

The assessment of landscape impacts has involved the following procedures.

- ***Identification of the baseline landscape resources (physical and cultural) and landscape character found within the study area.*** This has been achieved by site visit and desk-top study of topographical maps, information databases and photographs.

- ***Assessment of the degree of sensitivity to change of the landscape resources.*** This is influenced by a number of factors including whether the resource is common or rare, whether is considered to be of local, regional, national or global importance, and whether there are any statutory or regulatory limitations/ requirements relating to the resource.

- ***Identification of potential sources of landscape impacts.*** These are the various elements of the construction works and operational procedures that would generate landscape impacts.

- ***Identification of the magnitude of landscape impacts.*** The magnitude of the impact depends on a number of factors including the physical extent of the impact, the landscape and visual context of the impact, and the time-scale of the impact - i.e. whether it is temporary (short, medium or long term), permanent but potentially reversible, or permanent and irreversible.

- ***Identification of potential landscape mitigation measures.*** These may take the form of adopting alternative designs or revisions to the basic engineering and architectural design to prevent and/or minimise adverse impacts; remedial measures such as colour and textural treatment of building features; and compensatory measures such as the

implementation of landscape design measures (e.g. tree planting, creation of new open space etc) to compensate for unavoidable adverse impacts and to attempt to generate potentially beneficial long term impacts.

- ***Prediction of the significance of landscape impacts before and after the implementation of the mitigation measures.*** By synthesising the magnitude of the various impacts and the sensitivity of the various landscape resources it is possible to categorise impacts in a logical, well-reasoned and consistent fashion. *Table 7.3.1* shows the rationale for dividing the degree of significance into four thresholds, namely substantial, moderate, slight and negligible depending on the combination of a negligible-slight-moderate-substantial magnitude of impact and a low-medium-high degree of sensitivity of landscape resource.

- ***Prediction of the Acceptability of Impacts.*** An overall assessment of the acceptability, or otherwise, of the impacts according to the five criteria set out in Annex 10 of the EIAOTM. This assessment is presented in the chapter conclusion.

Table 7.31. ***Relationship Between Receptor Sensitivity and Impact Magnitude in Defining Impact Significance***

Magnitude of Impact	Receptor Sensitivity (Landscape Resource or VSR)		
	Low	Medium	High
Substantial	Slight/Moderate	Moderate/ Substantial	Substantial
Moderate	Slight/Moderate	Moderate	Moderate/ Substantial
Slight	Negligible/Slight	Slight/Moderate	Slight/Moderate
Negligible	Negligible	Negligible	Negligible

The assessment of visual impacts has involved the following procedures.

- ***Identification of the Zones of Visual Influence and Visibility Contours during the construction and operational phases of the PBRL.*** This is achieved by site visit and desk-top study of topographic maps and photographs, and preparation of cross-sections to determine visibility (location of visibility contours) of the PBRL from various locations.

- ***Identification of the Visually Sensitive Receivers (VSRs) within the ZVIs at construction and operational phases.*** These are the people who would reside within, work within, play within, or travel through, the ZVIs.

- *Assessment of the degree of sensitivity to change of the VSRs.* This relates to whether the person is at home, at work, at play, or travelling. Those who view the impact from their homes are considered to be highly sensitive as the attractiveness or otherwise of the outlook from their home will have a substantial effect on their perception of the quality and acceptability of their home environment and their general quality of life. Those who view the impact from their workplace are considered to be only moderately sensitive as the attractiveness or otherwise of the outlook will have a less important, although still material, effect on their perception of their quality of life. The degree to which this applies depends on whether the workplace is industrial, retail or commercial. Those who view the impact whilst taking part in an outdoor leisure activity may display varying sensitivity depending on the type of leisure activity. Those who view the impact whilst travelling on a public thoroughfare will also display varying sensitivity depending on the speed of travel and whether the view is continuous or occasionally glimpsed.

- *Identification of potential sources of visual impacts.* These are the various elements of the construction works and operational procedures that would generate visual impacts.

- *Assessment of potential magnitude of visual impacts.* This depends on a number of factors including the visual context of source of the impact, the duration of the impact, and the distance of the source of impact from the viewer.

- *Identification of potential visual mitigation measures.* These may take the form of revisions/refinements to the engineering and architectural design to minimise potential impacts, and/or the implementation of landscape design measures (e.g. screen tree planting, colour design of hard landscape features etc) to alleviate adverse visual impacts and generate potentially beneficial long term visual impacts.

- *Prediction of the significance of visual impacts before and after the implementation of the mitigation measures.* By synthesising the magnitude of the various visual impacts and the sensitivity of the various VSRs it is possible to categorise the degree of significance of the impacts in a logical, well-reasoned and consistent fashion. *Table 7.3.1* shows the rationale for dividing the degree of significance into four thresholds, namely substantial, moderate, slight and negligible depending on the combination of a negligible-slight-moderate-substantial magnitude of impact and a low-medium-high degree of sensitivity of VSRs. Consideration is also given to relative numbers of affected VSRs in predicting the final impact.

- *Prediction of the Acceptability of Impacts.* An overall assessment of the acceptability, or otherwise, of the impacts according to the five criteria set out in Annex 10 of the EIAOTM.

In addition, the following assumptions have been made in the assessment:

- It is assumed that the PBRL will be built only if Penny's Bay reclamation proceeds. Therefore, construction stage impacts are assessed on the basis that the existing Cheoy Lee Shipyards have been closed and Penny's Bay reclamation is in place prior to the construction of the PBRL.

- Based on the current development programme, it is assumed that none of the planned land uses described in the Draft RODP for North-East Lantau will be in operation during the construction of the PBRL. The currently envisioned timeframe is that the Theme Park and all other uses in Penny's Bay are intended to open in 2005. As stated in *Section 2.5*, the PBRL would also be commissioned in 2005. Therefore the assessment does not consider construction phase impacts on these planned developments, only on existing features.

- At the request of Planning Department, the assessment of operational phase impacts has been carried out for all potential future VSRs who would occupy the planned land use zonings.

- It is assumed that funding, implementation, management and maintenance of the mitigation proposals can be satisfactorily resolved. "In principle" commitments to the funding, implementation, management and maintenance of the mitigation proposals in this report have been given by Government (CED and the Commissioner for Tourism) and the MTRC. The agents for the implementation (and subsequent management and maintenance, if applicable) are indicated in *Table 7.7.1*. The MTRC will use its best endeavours to resolve any problems that may arise associated with issues of funding, implementation, management and maintenance to ensure that the landscape and visual mitigation proposals are implemented as set out in this Report, as far as the Corporation is able to do within its power.

7.4 *PLANNING AND DEVELOPMENT CONTROL FRAMEWORK*

A review has been undertaken of the current planning goals and objectives, statutory land-use and landscape planning designations for the Study Area.

The South West New Territories Development Strategy Review, August 1999, (SWNTDSR), sets out the recommended planning and development strategy for the South West New Territories, including North-East Lantau.

The SWNTDSR identifies North-East Lantau as presenting enormous potential for provision of tourism and recreational facilities. The proposed reclamation of Chok Ko Wan (Penny's Bay) is earmarked for Major Open Space/ Recreation/ Tourism and an International Theme Park. The hills north-east of Penny's Bay (Tai Yam Teng and Fa Peng Teng) are earmarked as a Landscape Protection Area. An extension to the Lantau North Country Park is proposed to extend eastwards as far as Tai Shan, which is located just

west of Penny's Bay. A future rail link, post 2011, from Yam O to Penny's Bay and thence to Hong Kong is 'under consideration'.

The statutory designations for North-East Lantau are shown on the Draft North-East Lantau Outline Zoning Plan (NELOZP) No. S/I-NEL/5 (13th August 1999) (see extract in *Figure 7.4.1*). In the Draft NELOZP, a railway reserve is indicated for the provision of a rail link from the proposed Yam O Station on the Tung Chung Line to a proposed station at the International Theme Park, with a possible extension to the east.

The Civil Engineering Department has commissioned the North Lantau Development Feasibility Study (NLDFS) to further study the development potential of North-East Lantau within the context of the SWNTDSR. The consultants for the NLDFS have produced a draft Recommended North-East Lantau Outline Development Plan (RNELODP). The draft RNELODP indicates a similar overall land-use layout as the Draft NELOZP, and provides more detail in some areas. A rail link from Yam O to the International Theme Park is also indicated in the draft RNELODP, also with a possible extension to the east. The land-use information portrayed in the draft RNELODP has been adopted as the baseline for the identification of future VSRs of the PBRL.

The proposed PBRL follows very closely the proposed railway alignments shown in the SWNTDSR, the Draft NELOZP and the draft NELRODP. It is therefore considered that the railway would be in harmony with the planning goals for the study area, as set out in the SWNTDSR, the draft NELOZP and the draft NELRODP.

However, given that tourism and recreation are the key elements of future development in North-East Lantau, any proposed rail development must be very carefully designed to minimise any potentially adverse impacts on the environment.

7.5 *BASELINE STUDY*

7.5.1 *Physical Landscape Resources*

The PBRL is proposed to run for much of its length on the land reclamation proposed for Penny's Bay. The baseline assumption of this assessment is therefore that the Penny's Bay reclamation will proceed and will be the "existing condition" prior to the construction of the PBRL.

The baseline landscape characteristics are mapped in *Figure 7.5.1*. Photo views illustrating the landscape and visual characteristics are illustrated in *Figures 7.5.2 to 7.5.7* inclusive, and *Figure 7.5.7.1*.

Landform

North-east Lantau is characterised by the two upland areas of Fa Peng Teng and Tai Shan, separated by Penny's Bay and the low-lying saddle at Ta Shui Wan.

In the north-west of study area lies the Yam O headland, which is severed from land to the south by the road and rail corridor. The headland is an attractive landscape resource comprising smooth rolling foothills and a small area of woodland along its northern shore. The low-lying island of Cheung Sok lies approximately 50m off the northern tip of the Yam O headland and stretches a further 350m into the sea. Between Cheung Sok and the edge of the reclamation lies the attractive inlet of Yam O Wan which is the mooring point for small fishing boats from Luk Keng Tsuen. The proposed reclamation along the northern Lantau coastline would have an open landscape character dominated by smooth undulating hillsides and views to Castle Peak, Tuen Mun and Tai Lam across the sea to the north.

A low saddle lies between Ta Shui Wan and Penny's Bay (Chok Ko Wan). Penny's Bay is contained on the west, north and east sides by hills and is thus very sheltered and calm. The smooth hillsides of Tai Shan to the west stretch south to the headland at Sz Pak Tsui. A proposed Country Park extension boundary lies approximately two thirds up the hillside (following the 160m contour).

The undulating hillsides of Tai Yam Teng and Fa Peng Teng form a grassy backdrop along the eastern edge of Penny's Bay. A series of ridgelines and spurs extend in different directions creating a varied topography which differs from the smooth east-west slopes of Tai Shan. There is evidence of the beginning of serious slope erosion in these eastern uplands, especially along the crest of spurs. Views from within Penny's Bay are channelled by the eastern and western hillsides to open sea in the south, where on a clear day one can view Peng Chau, Siu Kau Yi Chau and Kau Yi Chau, and in the far distance Lamma Island and the slopes of Mount Davis on Hong Kong Island. Extensive rock-cut slopes have been formed behind, and to the south of, Penny's Bay Power Station, and these create an unattractive visual impact on the surrounding areas.

Drainage

Surface water run-off within the study area drains naturally along stream courses into the sea. There are no major water-courses and all streams are seasonal. One stream course runs down the north-facing slopes of Tai Yam Teng into the Ta Shui Wan interchange area and passes through one of the few areas of woodland within the study area. The stream is culverted where it enters reclamation, beneath which it continues to the north Lantau sea wall. It is likely that this particular stream course will be affected by the Northern Tunnel Portal.

Vegetation

The smooth rolling hills within the study area are characterised by grassland and, in a few locations, scrub woodland around stream courses at their base. Three areas of notable woodland are located around the village of Luk Keng Tsuen, on the Yam O headland; on the lower north western slopes of Tai Yam Teng at Ta Shui Wan; and in the low-lying and sheltered gap between Tai Yam Teng and Tai Sham at Ngong Shuen Au. The woodlands comprise common varieties of indigenous and exotic species and are largely immature or semi-mature in nature.

7.5.2 *Human and Cultural Landscape Resources*

Buildings and Settlements

Two small settlements lie within the study area, at Luk Keng Tsuen on the Yam O headland and at Tso Wan on the east coast of Fa Peng Teng. Fishing boats can be seen moored off Luk Keng Tsuen in Yam O Wan. Timber logs are also stored in the water off Luk Keng Tsuen. Neither village is accessible by road, though footpaths do connect both areas with the north Lantau coast. A small derelict school is located on the lower east-facing hillside at Wan Tuk, above Ngong Shuen Au.

Cheoy Lee Shipyard, comprising semi-derelict steel and concrete sheds, and Penny's Bay Power Station are located on reclamation which runs along the eastern edge of Penny's Bay. The power station has three chimneys and is of a smaller scale than similar installations at Black Point and Lamma Island. A rough track has been cut into the hill slopes at approximately 30m above the reclamation and extends between the Power Station and the Shipyard. The Shipyard, Power Station and associated areas of reclamation and rock-cut slopes reduce the landscape and visual quality of Penny's Bay.

Infrastructure

The North Lantau Highway and the Tung Chung Line/ Airport Express railway run adjacent to each other along the north Lantau coast. The northern portion of the study area is visually dominated by elevated North Lantau highway and its associated elevated and at-grade link roads to Penny's Bay at Ta Shui Wan, which are presently closed. The road structures presently terminate at the low-lying saddle at Ngong Shuen Au.

A footpath runs from the sea wall at Tai Yam on the north Lantau coast beneath the road and railway and via Ta Shui Wan and Ngong Shuen Au to Penny's Bay in the south. The concrete footpath is illuminated at night. All other paths, such as the hill paths between the study area and Discovery Bay in the west, are unpaved and unserviced.

7.5.3 *Landscape and Visual Character Zones*

Six landscape and visual character zones have been identified within the study area. These are described below and indicated on *Figure 7.5.1.*

Existing and Proposed Penny's Bay Reclamation

The first phase of the planned Penny's Bay reclamation must be completed before the PBRL could be built. This character zone therefore comprises the existing reclaimed areas around the edge of Penny's Bay together with the proposed reclamation.

For the purposes of the construction phase assessment, it is assumed that Cheoy Lee Shipyards will be closed and the reclamation will still be a works area during construction of the PBRL. Thus during the construction phase the character zone will possess negligible landscape quality and negligible sensitivity to change.

For the operation phase assessment, it is assumed that all planned development will proceed, resulting in an attractive tourism and recreation development with a high landscape quality and high sensitivity to change.

Fa Peng Teng Upland Area

The Fa Peng Teng Upland Area character zone encompasses the natural hills between Penny's Bay in the west and Kap Shui Mun in the east. The area contains the peaks of Fa Peng Teng (273m) and Tai Yam Teng (186m) and associated ridges, spurs, valleys and streamcourses. Vegetation cover is primarily grassland, with shrubland in the lower slopes and valleys, and two small areas of woodland at Fa Peng and Ngong Shuen Au. There is evidence of serious soil erosion developing on some of the ridgelines. The area possesses high landscape quality and a high sensitivity to change.

North Lantau Transport Corridor

This comprises the transport corridor along the north Lantau shoreline, which contains the North Lantau Highway and Airport Railway/ Tung Chung Line. The area is linear in nature and possess low landscape quality and low sensitivity. Landscape character is defined by road and rail structures, the sea wall, and artificially stabilised cut slopes along the eastern boundary. The area benefits from the open sea views along its north-western boundary and the adjacent smooth rolling hills along the south-eastern boundary.

Proposed North Lantau Reclamation

This character area comprises the proposed reclamation along the north Lantau shoreline. For the purpose of the construction phase assessment it is assumed that the reclamation will still be a works area during construction of

the PBRL. Thus during the construction phase the character zone will possess negligible landscape quality and negligible sensitivity to change. For the operational phase assessment, it is assumed that all planned development will proceed, resulting in an attractive tourism and recreation development with a high landscape quality and medium sensitivity to change.

Yam O Headland

The Yam O Headland area is characterised by smooth, low rolling topography sloping down to a natural rocky coastline, with a small offshore island at Cheung Sok. Vegetation is primarily grassland, although there is a small area of attractive woodland near the coastal village of Luk Keng Tsuen. The village and associated boats moored in Yam O Wan add attractive visual character to the area. Yam O Headland retains a high landscape value and a high sensitivity to change, despite the proximity of the north Lantau transport corridor.

Tai Shan Upland Area

Tai Shan Upland Area comprises the hills to the west of Penny's Bay, including the peaks at Tai Shan (291m) and Lai Pik Shan (263m) and the associated ridges, spurs, valleys and stream courses. The area is characterised by smooth rolling slopes with grassland cover. As in the Fa Peng Teng Upland Area, there is evidence of soil erosion, although it is less extensive. Landscape value and sensitivity to change are high and would be increased further by the planned extension of the North Lantau Country Park to cover most of this character area.

7.5.4 *Landscape Sensitivity to Change*

The landscape resources and landscape character zones that will be affected during the construction phase and operational phase, together with their sensitivity to change, are listed in *Tables 7.5.1 and 7.5.2* respectively, and illustrated in *Figures 7.6.2 and 7.6.11* respectively. For ease of reference and co-ordination between text, *Tables* and *Figures* each landscape resource is given an identity number.

Table 7.5.1 List of Landscape Resources Affected During Construction Phase

Identity No. of Landscape Resource	Landscape Resource / Landscape Character Area	Sensitivity to Change (Low, Medium, High)
L1A	Slope profile at Northern Tunnel Portal at Ta Shui Wan	Medium
L1B	Woodland and seedling planting at Northern Tunnel Portal and Cut and Cover Tunnel at Ta Shui Wan	Medium
L1C	Topsoil at Northern Tunnel Portal at Ta Shui Wan	Medium

Identity No. of Landscape Resource	Landscape Resource / Landscape Character Area	Sensitivity to Change (Low, Medium, High)
L1D	Landscape character of lower north-west facing slopes of Fa Peng Teng Character Area	High
L2A	Slope profile at Southern Tunnel Portal at Mong Tung Hang	Medium
L2B	Scrub and grass cover at Southern Tunnel Portal at Mong Tung Hang	Low
L2C	Topsoil at Southern Tunnel Portal at Mong Tung Hang	Low
L2D	Landscape character of lower south-west facing slopes of Fa Peng Teng Character Area	High
L3A	Landscape character of Penny's Bay reclamation	Negligible

Table 7.5.2 ***List of Landscape Resources Affected During Operational Phase***

Identity No. of Landscape Resource	Landscape Resource / Landscape Character Area	Sensitivity to Change (Low, Medium, High)
L1A	Slope profile at Northern Tunnel Portal at Ta Shui Wan	Medium
L1B	Woodland and seedling planting at Northern Tunnel Portal and Cut and Cover Tunnel at Ta Shui Wan	Medium
L1C	Topsoil at Northern Tunnel Portal at Ta Shui Wan	Medium
L1D	Landscape character of lower north-west facing slopes of Fa Peng Teng Character Area	High
L2A	Slope profile at Southern Tunnel Portal at Mong Tung Hang	Medium
L2B	Scrub and grass cover at Southern Tunnel Portal at Mong Tung Hang	Low
L2C	Topsoil at Southern Tunnel Portal at Mong Tung Hang	Low
L2D	Landscape character of lower south-west facing slopes of Fa Peng Teng Character Area	High
L3A	Landscape character of Penny's Bay reclamation	High

7.5.5 *Zone of Visual Influence (delimited by Visibility Contours)*

The Zone of Visual Influence (ZVI) will vary between the construction phase and operational phase. The extents of the ZVIs have been determined by a combination of site visits and desk-top study. Sections (illustrated in *Figure 7.5.10*) have been drawn through the Study Area to determine the visibility of the PBRL from various locations. From these sections it is possible to determine "visibility contours" which delimit the extent of the ZVIs. The ZVIs are illustrated in *Figures 7.5.8* (construction phase) and *7.5.9* (operation phase). It should be noted that the areas shown in *Figures 7.5.8 and 7.5.9* do not extend to the 8km radius "visual envelope" specified in the Study Brief

for the Theme Park EIA, for two reasons. Firstly physical elements (primarily topography) contain the visual envelope to a smaller area than the 8km radius. Secondly, the scale of the PBRL development is very much smaller than the Theme Park and associated developments. Therefore, it is assessed that the magnitude of any visual impact caused by the PBRL that might occur over the open sea outside the limits of the areas shown on *Figures 7.5.8 and 7.5.9* would be negligible and can be discounted in the assessment.

Construction Phase

The ZVI for the construction phase is illustrated in *Figure 7.5.8*. It will extend along the ridgeline of Tai Shan to the Yam O headland in the west; over the north Lantau coastline and open sea to the north; along the ridgelines and spurs of Tai Yam Teng and Fa Peng Teng in the east; and, over the reclamation and open sea to the south.

Operational Phase

The ZVI for the operational phase is illustrated in *Figure 7.5.9*. It will extend along the ridgeline of Tai Shan to the Yam O headland in the west; over the north Lantau coastline and open sea to the north (including the proposed Tourist and Convention Village); along the north-west facing ridgelines and spurs of Tai Yam Teng and south-west facing ridgelines and spurs of Fa Peng Teng in the east; and over the proposed G/IC and transport-related development in Penny's Bay. It will not extend over the proposed International Theme Park and associated Resort Hotels.

7.5.6 *Visually Sensitive Receivers*

Tables 7.5.3 and 7.5.4 list the key Visually Sensitive Receivers (VSRs) found within the ZVI's for the construction phase and operational phase, respectively. For ease of reference, each VSR is given an identity number, which is used in the appropriate *Table* and also in *Figures 7.5.8 and 7.5.9*.

Table 7.5.3 List of the Key Visually Sensitive Receivers During Construction Phase

Identity No. of VSR*	Key Visually Sensitive Receivers	Sensitivity (Low, Medium, High)
R1	Residents at Luk Keng Tsuen	High
T1	Travellers on Airport Express and Tung Chung Line	Medium
T2	Travellers on North Lantau Highway	Medium
T3	Pedestrians on footpath between Ta Shui Wan and Penny's Bay	High
T4	Passengers in aeroplanes approaching/ leaving Chek Lap Kok	Low
O1	Walkers on north facing slopes of Tai Yam Teng	High
O2	Walkers on west facing slopes of Fa Peng Teng	High