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1 INTRODUCTION

1.1 Background

1.1.1 In August 1997 Scott Wilson (Hong Kong) Ltd, in association with specialist sub-consultants, were commissioned by the Civil Engineering Department (CED) to undertake a Planning and Engineering Feasibility Study for Development near Choi Wan Road and Jordan Valley (Agreement No. CE 19/97).

1.1.2 It has been estimated in the *Long Term Housing Strategy Review (LTHSR* - completed in 1997) that there will be a demand for 390,000 new flats (on average, 78,000 flats per year) for the period between April 2001 and March 2006. Taking into account the planned/committed developments on reserved sites on current Government Plans and expected redevelopment projects to be undertaken by the public and private sectors, there will still be a net requirement for approximately 210,000 new flats, i.e. 42,000 flats per year. For this to meet the expected housing requirement, the LTHSR recommended a number of measures to increase the land supply for housing development.

1.1.3 The Choi Wan Road / Jordan Valley area has been identified as a potential new development site on the periphery of a developed urban area to which new roads and infrastructure could be extended without undue difficulty.

1.1.4 This Study has examined the development potential and analysed the feasibility of various land-use options for the area. The Study outputs include the formulation of a preferred land-use plan, a preliminary engineering design, and impact assessments to address the environmental, drainage, sewerage, traffic and geotechnical aspects of the proposed development. Reservation of the site for public or private housing development will be made based on the findings of this Study and taking in to account the flat production targets under the LTHSR.

1.2 Objectives of the EIA

1.2.1 The purpose of this EIA is to provide information on the nature and extent of potential environmental impacts that could arise from the construction and operation of the proposed development to determine the feasibility of the project from an environmental perspective.

1.2.2 According to Schedule 3 of the Environmental Impact Assessment Ordinance, (EIAO) an engineering feasibility study for an urban development project with a study area greater than 20 ha, requires an EIA Report. There will not be any designated project under schedule 2 of the EIAO within the Study Boundary.

1.2.3 The objectives of the EIA are set out in Section 3.4.5 of the Study Brief and comprise the following:

- To describe the proposed project and associated works together with the requirements for carrying out the proposed project;

- To identify and describe the elements of the community and environment likely to be affected by the proposed project, and/or likely to cause adverse impacts upon the proposed project, including both the natural and man-made environment;

- To identify and quantify emission sources and determine the significance of impacts on sensitive receivers and potential affected uses;

- To identify existing landscape and visual quality in the Study Area so as to evaluate the landscape and visual impacts of the project;
- To identify and qualify the potential losses or damage to flora, fauna and natural habitats;

- To propose optimum provision of infrastructure and mitigation measures so as to minimise pollution, environmental disturbance and nuisance during construction and operation of the project;

- To identify, predict and evaluate the residual (i.e. after practicable mitigation) environmental impacts and cumulative effects expected to arise during the construction and operational phases of the project in relation to the sensitive receivers and potential affected uses to a level sufficient to determine the feasibility of the projects:

- To identify and establish land use arrangements, development control measures and/or other arrangements to minimise adverse environmental impacts for the proposed project;

- To design and specify the environmental monitoring and audit requirements necessary to ensure the implementation and the effectiveness of the environmental protection and pollution control measures adopted;

- To investigate the extent of side-effects of proposed mitigation measures that may lead to other forms of impacts;

- To identify constraints associated with the mitigation measures recommended in the study, and

- To identify any issues requiring further environmental impact assessment studies.

1.3 The Study Area

1.3.1 The Choi Wan Road / Jordan Valley area is situated in east Kowloon. The location and extent of the Study Area is shown in Figure 1.1. Further details of the Study Area are given in Chapter 2.

1.4 Structure of the EIA Report

1.4.1 The EIA Report is divided in to two Volumes, this Volume 1 which includes text and tables, and Volume 2 containing figures. This Volume 1 is organised as follows:

- *Chapter 1* Introduction
- *Chatper 2* Project Description
- *Chapter 3* Noise
- *Chapter 4* Air Quality
- *Chapter 5* Water Quality
- *Chapter 6* Waste Management
- *Chapter 7* Land Contamination
- *Chapter 8* Landscape and Visual Impact Assessment
- *Chapter 9* Ecology
- *Chapter 10* Landfill Gas Hazard Assessment
- *Chapter 11* Conclusions

1.4.2 In addition to those issues set out in the Study Brief, Section 9 of the Technical Memorandum on EIA identifies additional issues which do not fall under the responsibility of EPD. These include:

- Marine matters (authority: D of M);
- Hazards associated with fuel gas dangerous goods, electromagnetic field (authority: DEMS);
- Human health matters (authority: D of Health);
- Transport, handling and storage of dangerous goods (authority: D of FS);
- Antiquities and monuments (authority: SBCS); and
- Civil aviation matters (authority: D of CA).

1.4.3 The Antiquities and Monuments Office (AMO) were consulted. There is no monument in the site, and there is no need to conduct cultural heritage impact assessment in this study. The contractor will be required to apply for and hold an appropriate license for blasting and use of explosives as these are considered to be dangerous goods. Issues relating to human health are being addressed under the Landfill gas hazard assessment in Chapter 10 of this Report.

1.4.4 Other issues are not considered significant and therefore are not considered further in this EIA.

Other Reports Produced under this Study

1.4.5 The following reports have been produced as part of this study and to which this Report may refer include:

- Inception Report
- EIA Inception Report
- PPFS Report
- Final Planning Brief, and Master Layout Plan
- Design Memorandum
- TRI : Review of the Proposed Development Parameters
- TR2 : Proposed Infrastructural and Other Improvement/Upgrading Works
- TR3 : Formulation and Evaluation of Alternative and Preferred Development Proposals
- Report on Water Supplies
- TIA - Final Report
- DIA - Final Report
- SIA - Final Report
- EIA - final Initial Assessment Report
- Environmental Monitoring & Audit Manual
- EIA - Executive Summary
- Final Report
- Executive Summary

2 PROJECT DESCRIPTION

2.1 The Study Area

2.1.1 The Choi Wan Road / Jordan Valley area is situated in east Kowloon. The location and extent of the Study Area is shown in Figure 1.1. The environment of the Study Area comprises a variety of distinct features. To the east is the Jordan Valley Landfill, which includes an access road that extends to the eastern boundary of the Study Area. The sides of the landfill are vegetated with natural scrub of a relatively young age, whilst the plateau area is dominated by developing grassland.

2.1.2 A steep peak dominates the south-eastern portion of the Study Area (with a service reservoir on the summit). The steep slopes of this hill are vegetated by well-developed scrub. Immediately north of this hill lies Jordan Valley Nullah, which emerges from the dam at the base of Jordan Valley Landfill. Jordan Valley Nullah, which is the main watercourse that crosses the site, originates from the northern side of New Clear Water Bay Road, at its junction with Anderson Road. It passes beneath Shun Lee Estate and Shun Lee Tsuen Road in culvert before re-emerging at Jordan Valley Dam.

2.1.3 On the western side of the landfill lies a steep north-south running ridge, which slopes down towards a disused quarry and the Choi Ha Estate. To the west of this ridge there is a small perched valley, heavily vegetated with scrub that has small, cultivated lots within it. The southern part of the valley is bordered to the west by Flathill Quarry whilst to the north lies another disused quarry which is accessible from New Clear Water Bay Road.

2.1.4 The Study Area is bordered by residential areas to the south (Choi Ha Estate - including Tak Bo and Amoy Gardens) to the south-east (Lok Nga Court, Lok Wah North Estate and Lok Wah South Estate), to the north (Choi Wan Estate) and to the east (Shun Lee Estate, Shun On Estate and Shun Tin Estate).

<u>Existing Land Uses</u>

2.1.5 The Study Area remains largely undeveloped because of the steep topography, dominated by ridges of 188 mPD and 150 mPD running north - south. Parts of the slopes and ridges are accessible from the surrounding areas via footpaths. The existing landuse is illustrated in Figure 2.1.

2.1.6 There is no formal residential development within the Study Area although several temporary structures are found along some of the footpaths leading to the hillslopes and ridges.

2.1.7 There are four abandoned quarry sites within the Study Area. The most prominent site (Flathill Quarry) is currently used by the Construction Industry Training Association (CITA) as a training ground. The quarry site adjacent to New Clear Water Bay Road has a shrine situated within it. The other quarry is abandoned and vacant. Some small scale cultivation activities are found on the two sites located north of Choi Ha Estate.

2.1.8 The north-eastern part of the Study Area is dominated by the Jordan Valley Landfill. The landfill is a deep valley infill, which extends to an average depth of 32 metres and covers a plan area of about 6.5 ha. The landfill received waste between April 1986 and July 1990. During its operational life, it received approximately 1.52 million tonnes of domestic, construction and commercial wastes at proportions of 67.5 %, 31 % and 1.5 % respectively.

2.1.9 Jordan Valley Landfill is one of five landfills currently being restored under the Urban Landfills Restoration Contract (ULRC) administered by EPD. Restoration works include capping of the landfill platforms, a leachate pre-treatment system, passive gas venting, and an active extraction and flaring system. Capital works for the restoration of the landfill have been completed and a one year defects correction period (which includes commissioning tests) commenced in May 1998. Thereafter, the restoration contractor will maintain the landfill for a further 30 year aftercare period. Further details of the landfill restoration contract are included in Chapter 10 - *Landfill Gas Hazard Assessment*.

2.1.10 Upon completion of the restoration works, Jordan Valley Landfill is designated for recreational afteruse, e.g. Urban Fringe/Ecology Park. A proposal of developing an Ecology Park is being investigated under a separate Assignment.

2.1.11 There are two service reservoirs within the Study Area, namely, the Jordan Valley Salt Water Service Reservoir and covered Kwun Tong Service Reservoir.

2.1.12 A playground is provided above the covered Kwun Tong Service Reservoir. In addition, two football pitches are provided in the Shun Lee Tsuen Recreation Ground site on Shun Lee Tsuen Road.

Surrounding Areas

2.1.13 The surrounding areas comprise predominantly high-density residential development and associated commercial, community and recreational facilities. Industrial sites are located in Kowloon Bay, south-west of the proposed development area.

2.1.14 The existing residential sites surrounding the proposed development area are mainly Public Rental Housing (PRH) and Home Ownership Scheme (HOS) developments. Existing private residential developments include Amoy Gardens, Telford Gardens and Tak Bo Garden to the west and south-west of the Sites.

2.1.15 Other than the MTRC Headquarters and Hang Seng Tower above Kowloon Bay MTR Station and the commercial developments in the Kowloon Bay Industrial Area, there are no purpose-built commercial buildings in the vicinity of the proposed development area. The major shopping centre in the area is Telford Plaza, which is situated above Kowloon Bay MTR Station and comprises some 255,000 square feet of retail property. With the exception of Telford Plaza, which provides a comprehensive range of retail facilities, existing commercial facilities in the area primarily comprise retail and restaurant outlets provided at street level or within the shopping centre/podia associated with public and private residential developments.

2.2 Planning Context

Strategic Planning

2.2.1 The scope of the proposed development is consistent with strategic development proposals set out in the Territorial Development Strategy Review (TDSR) 1998, the 1997 'Policy Address of the Chief Executive' and the Government 'White Paper on Long Term Housing Strategy in Hong Kong'. At the sub-regional planning level, the context of the proposals are supported by *Metroplan* and the Central and East Kowloon Development Statement published in July 1997.

District Planning

2.2.2 The Study Area is covered by the Draft Ngau Tau Kok and Kowloon Bay Outline Zoning Plan (OZP) Number S/K13/10. The land use zonings for the Planning Area as specified on the OZP basically reflect the planning intentions of Metroplan, as identified above. The majority of the area is zoned Green Belt (GB), Open Space, (OS) or for Government and Institutional Uses, (G/IC). Part of the existing Flathill Quarry site is zoned 'Undetermined'.

2.2.3 There are no residential zones currently designated within the Planning Area. It is understood that amendments to the OZP would be made to enable the implementation of the residential development proposals in this Study.

2.2.4 The Study Area is also covered by the non-statutory Ngau Tau Kok Outline Development Plan (ODP) Number D/K13/1C. The ODP generally reflects the land use designations on the OZP, however, in a more elaborated form. For instance,

- The Jordan Valley Landfill, which is designated '*Urban Fringe Park*' under the Metroplan and zoned 'O' and 'GB' on OZP, is designated '*District Open Space - Proposed Site for Education Centre cum Natural Habitat with Forest Walks, Water Feature, Radio-controlled Model Car Circuit, Gateball Pitches and Playground*';

- The G/IC zones on the OZP are designated *"Government Reservation"* (for the *"Shun Lee Tsuen Recreation Ground"*, *"Custodial Wards Staff Quarters"*, *"Jordan Valley S.W. S/R"*, *"Kwun Tong Service Reservoir (Covered) - Playground Above"*), *"Institution and Community"* (for *"Fire Station"*, *"Public Toilet"* and *"Electricity Sub-Station") or "Educational"* for *"Secondary School"*.

- The underground MTR route running along the western fringe of the Study Area is indicated on the ODP as an *'MTR Protection Boundary'*. Acceptance and approval by MTRC is necessary for any development encroaching within this boundary.

2.3 Future Land Uses

2.3.1 Major future developments in the vicinity of the proposed development area include:

- Sandwich Class Housing development at the existing Police Detective Training School at Choi Shek Lane, providing a total of about 1,300 units;
- Government Staff Quarters development at the former Shun Lee Temporary Housing Area, which is to provide a total of about 2,200 units;
- Senior Citizen residential development at Choi Ha Road next to Maryknoll Practical Secondary School;
- the Commercial/Office development cum Park-and-Ride facilities at the existing Ping Shek Estate Bus Terminus;
- redevelopment of Lower Ngau Tau Kok Estate;
- development of the Ping Shek Playground and Jordan Valley Playground Phase II.

2.4 The Conceptual Choi Wan Road / Jordan Valley Development

2.4.1 The conceptual layout initially adopted for analysis was that given in the Study Brief. This layout is presented in Appendix A. Due to various elements of the existing environment, in particular Jordan Valley Landfill and the freshwater reservoir in the south-east of the Study Area, development was proposed to be concentrated on the western side of the site on two development sites R10 and R07, subdivided into separate areas. The conceptual layout also included access roads leading from Lee On road in the Shun Lee Temporary Housing Area to podium R10/A; from the east from the Jordan Valley Landfill to podium R10/C; and interconnecting podium R07/B and podium R10/C.

2.5 Consideration of Alternatives & the Development of the Preferred Layout Option

2.5.1 Environmental Impact Assessment (EIA) is an iterative process and environmental considerations have been incorporated in to the design process continuously throughout this project. This has allowed elimination of many potential major environmental impacts associated with the conceptual layout option described above.

2.5.2 Key environmental constraints and opportunities associated with the original conceptual layout were identified and reported in the *Planning and Engineering Feasibility Study for Development near Choi Wan Road and Jordan Valley Technical Report 1 (TR1)*, dated November 1997. TR1 provided the basis of the criteria for the evaluation of eight different development scenario options. These development options were subsequently assessed as part of a Value Management (VM) Workshop held with representatives from each of the relevant Government Departments in December 1997. The development scenarios were compared and the related impacts to the surrounding areas assessed to optimise development potential, whilst safeguarding environmental quality.

2.5.3 The findings of the VM Workshop resulted in a preferred development option which met the requirements of the Brief whilst minimising potential major environmental constraints. This preferred platform layout is described in the *Planning and Engineering Feasibility Study for Development near Choi Wan Road and Jordan Valley Technical Report 3*, (TR3), issued in December 1997). This layout was the focus of the Initial Environmental Impact Assessment (IEIA) undertaken in February 1998. Subsequent analysis has lead to the development of the preferred development scenario illustrated in Figures 2.2. This is an optimised version of the layout identified during the VM workshop, which has taken into account impacts identified during the IEIA and comments from Government.

2.5.4 The preferred layout includes 33 housing blocks (and related infrastructure), two primary schools, five secondary schools, a freshwater service reservoir and a saltwater service reservoir. The housing blocks are set on three platforms of 20, 40 and 60 mPD, (Sites 1, 2 and 3 respectively - note these are sub-divided into planning areas). The key environmental benefits that are afforded by the preferred platform layout, when compared to the original conceptual layout plan are:

- The retention of the existing central ridgeline, is a key visual landmark in the area. Retention of the ridgeline significantly reduces the landscape and visual impacts of the housing development and maximises the amount of natural vegetation retained. (See Chapter 8 - Landscape and Visual Assessment)

- A significant reduction in potential landfill gas hazard by retaining the central ridgeline and ensuring that the platforms are situated as far from the landfill as possible; all of the buildings are situated outside of the 250m landfill gas hazard Consultation Zone. (See Chapter 10 - Landfill Gas Hazard Assessment)

- A significant reduction in potential leachate migration has been achieved by maximising the distance between the landfill and the platforms. (See Chapter 5 - Water Quality)

- The distance between the landfill gas flare and development has been maximised minimising air pollution concerns from this source. (See Chapter 4 - Air Quality)

- The retention of the existing central ridgeline, minimises ecological impacts as it maximises the amount of natural vegetation retained. (See Chapter 9 - Ecology)

2.6 Description of the Works

Site Layout

2.6.1 The preferred development option for the sites near Choi Wan Road and Jordan Valley comprise three platform formations for residential development, namely sites 1, 2 and 3 founded at elevations 20, 40 and 60mPD respectively (see Figure 2.2).

2.6.2 To maximise the development potential of the sites, a domestic plot ratio of 7.5 has been used. This is the maximum domestic plot ratio which has been adopted for residential developments on sites greater than $400m^2$ in the Ngau Tau Kok and Kowloon Bay Planning Area.

2.6.3 By applying the domestic plot ratio of 7.5, a total residential GFA of about $667,200m^2$ will be provided. In addition, two platforms will be developed for infrastructure including Site 4, which will house two schools, a fresh-water reservoir and a salt-water reservoir, Site 5 will accommodate two schools a fire services substation and an electricity substation. This layout has maximised the development area for the site and has met the planning requirement by providing some 11,120 flats, in addition to providing sufficient space for G/IC facilities and local and district open space. The development will be reached by roads, which will link into the external transportation network. There is also a need for road junction improvements at locations that are external to the study area and for drainage and sewerage infrastructure improvements to be implemented so as to cater for increased flows from the development area. Landscaping measures are associated with the establishment of the platforms and surrounding slope works. The key features of each of the site formation platforms are described below:

2.6.4 The excavated spoil generated through the formation of the platforms would be available for reclamation work at South-East Kowloon Development (SEKD), subject to concurrent programmes for construction existing for the two developments. If SEKD is available to receive the surplus fill, the number of truck movements and the associated environmental impacts will be significantly reduced through the use of a conveyor system emanating from Site 2 to the SEKD. This option is discussed in Chapter 6 - Waste Management.

Site 1

2.6.5 Site 1 measuring some 5.87ha. will require the redevelopment of the Flathill Quarry. A level platform founded at 20mPD will be formed. This will be arranged through the development of steep cut slopes in rock along the northern and eastern border together with retaining structures located along the southern border. An internal looped road will provide access to Choi Wan Road, and provision for an external highway link to Kwun Tong Road. The proposed schedule of uses for Site 1 is shown in Table 2.1.

Table 2.1: Site 1 - Schedule of Uses and Areas

Use	Site Area (ha)	GFA (m²)	Flats	Populations
Subsidised housing	2.95	211,200	3,520	11,475
Commercial[1]	-	8,554	-	-
Education	1.21	-	-	-
District Open Space	0.91	-	-	-
Road	0.8	-	-	-
Total	5.87	219,754	3,520	11,475

Note: 1) The commercial centre is within the Subsidised Housing development.

2.6.6 The primary land use is public housing, which is mainly in the form of subsidised housing development. A total of 2.95 ha of land, representing 50% of the available land in Site 1, is reserved for subsidised housing development. The development comprises of nine NCB-type standard HOS blocks, providing a total of 3,520 units. It includes seven towers of 40 domestic floors and two 36-storey towers above a 4-storey carpark. The overall building height for the HOS blocks is 40-storeys. The domestic and non-domestic plot ratios are estimated to be 7.2 and 0.29, respectively.

Site 2

2.6.7 Site 2 measuring some 2.11ha. is located above the MTRC tunnel alignments that pass between Kowloon Bay Station and Choi Hung Station running below Choi Shek Lane. The site is situated to the west of Site 1. The platform will be created through a combination of blasting and non-blast excavation works and filling operations so as to develop a level platform at 40mPD. Except for the provision of the internal road, Site 2 is solely proposed for private development. It provides a total of 2,640 units with an average flat size of about 60m^2. A total of nine blocks with domestic floors ranging from 32 to 40 storeys are proposed for the estimated population of about 7,920.

2.6.8 The internal access road shall be branched from a perimeter access road that will form a connection between Choi Shek Lane and Site 3. Choi Shek Lane is to be upgraded to provide access to the external transportation network via Kwun Tong Road and New Clear Water Bay Road.

Site 3

2.6.9 Site 3, (divided into two portions a and b) measures some 8.0ha and is situated below the ridgeline feature of the Jordan Valley site. The layout has been arranged such that building height will be restricted to +125mPD so that it will not exceed the elevation of the natural ridgeline. The site will require considerable excavation in weathered and hard rock. The area located to the north of Site 1, is to be founded at +60mPD and lies immediately below a cut-slope extended up to 60m above platform level. An internal access road will be provided to connect the perimeter access route which also serves Site 2 to the west. A schedule of uses and areas is shown in Tables 2.2 and 2.3.

Table 2.2: Site 3A - Schedule of Uses and Areas

Use	Site Area (ha)	GFA (m^2)	Flats	Population
Private Housing	1.54	115,200	1,920	5,760
Road	0.42	-	-	-
Total	1.96	115,200	1,920	5,760

Table 2.3: Site 3B - Schedule of Uses and Areas

Use	Site Area (ha)	GFA (m^2)	Flats	Population
Subsidised Housing	2.43	182,400	3,040	9,911
Education	0.69	-	-	-
District Open Space	2.43	-	-	-
Road	0.64	-	-	-
Total	6.19	182,400	3,040	9,911

Site 4

2.6.10 Site 4 with a total land area of about 3 ha is mainly to accommodate government and educational facilities for the proposed development and the district. Table 2.4 outlines the schedule of uses and areas for Site 4.

Table 2.4: Site 4 - Schedule of Uses and Areas

Use	Site Area (ha)
Education	1.4
Government Reservation	0.9
Amenity Area	0.45
Road	0.19
Total	2.94

Site 5

2.6.11 Site 5 is located in the northern part of the Study Area and is to the south of the New Clear Water Bay Road. It has a total land area of about 2.18 ha. The schedule of uses and area for Site 5 is outlined in Table 2.5.

Table 2.5: Site 5 - Schedule of Uses and Areas

Use	Site Area (ha)
Education	1.6
Government Reservation	0.21
Institution and Community	0.31
Road	0.06
Total	2.18

Project Programme

2.6.12 The anticipated works programme for the project is shown in Figure 2.3. Upgrading works of existing infrastructure such as drainage, sewerage, water supply and road works are designated to be carried out by others with works commencing in the last quarter of 1999. For the main element of the works, design is due to commence late 1998 with contract award scheduled for the end of February 2001. Civil construction works, (i.e. site formation) and the building construction will follow immediately after design, with earliest occupation for Phase 1 (Sites 1 and 3A) scheduled for December 2006. Key dates from the project programme are summarised below in Table 2.6.

Table 2.6: Key Project Dates

Element of the Works	Start Date	Finish Date
Infrastructure Upgrading (by others)	1 October 1999	28 February 2001
Civil Construction Works (3 Phases)	1 March 2001	30 November 2005
Building Construction Works (3 Phases)	1 August 2003	30 November 2009
Building Occupancy (3 Phases)	23 September 2006	30 November 2009

Site Formation

2.6.13 Construction will start in phases commencing with site formation works on residential Site 1, then residential Sites 2 and 3. Whilst the formation of these three sites is in progress, formation of Sites 4 (reservoirs) and 5 (schools) will begin.

2.6.14 The proposed development plan requires considerable excavation into the hillside to form Sites 2 and 3 founded at 40 mPD and 60 mPD respectively. Since much of the excavation will be in strong to very strong bedrock, extensive use of blasting will be required.

2.6.15 Excavated material is expected to comprise predominantly concrete, granite, colluvium and soil. Approximately 3.45M m^3 of rock and 1.15M m^3 of soil is expected to be generated during earthworks activities. The majority of this site clearance material is expected to be clean and should, therefore, be acceptable for reuse either on site for landscaping purposes, filling and elevation and grading the site levels or for transportation to other sites with a materials deficit (e.g. SEKD).

2.6.16 The permanent rock faces will be cut back to an overall slope gradient ranging from 1.5V:1H (or 56°) to 2.2V:1H (or 66°) with benches at 12 m height intervals. Toppling failure could potentially occur on the slopes to the south-east of the proposed fresh water reservoir site, and is thus likely to require rock dowel installation. Otherwise, no other major rock slope instability problem is expected according to rock joint survey data and the proposed layout of the cut slopes. Nominal slope treatments such as doweling, removal of overhanging rocks and local shot-creting for the highly fractured rock mass will be required at various locations. The extent of rock slope stabilisation can only be finalised when the rock faces are exposed after blasting.

2.6.17 Sections of the soil slopes above the rock slopes are required to be further trimmed back to meet the current stability standards. This slope stabilisation may require extension of the cut slopes into the existing green belt.

2.6.18 Sections of the natural soil slopes above the proposed rock cuts will need to be stabilised. The stabilisation works will include flattening of the soil slopes, installing soil nails, trimming of the slope surfaces to ensure proper drainage, and installing surface drains. It would be practical to complete these stabilisation works that involve substantial earth works prior to downhill bulk excavation and blasting.

2.6.19 The existing near-vertical rock slopes adjoining the Flathill Quarry would be trimmed back as described above. Significant excavation is also required behind these slopes to provide the 40mPD and 60mPD platforms. Before building construction begins at the 20mPD platform, the rock slope between the 20mPD/60mPD platforms and that between the 20mPD/40mPD platforms must be properly formed and stabilised.

2.6.20 All blasting works must be properly designed to restrict the peak particle velocity to 25 mm/sec adjacent to nearby structures. This will be of particular relevance in the vicinity of the MTRC tunnels below Site 2 which is founded at 40mPD.

<u>Sewerage</u>

2.6.21 The most convenient discharge point from the Jordan Valley site to the trunk sewerage system is the Kwun Tong Road Trunk Sewer where it passes the end of Choi Wan Road. The connection from the site to the existing trunk sewer is some 145m in length. The length of sewer to be constructed outside of the development site comprises 145m of 525mm diameter sewer with four backdrop man-holes. The preliminary design of this sewer has been undertaken to prove the feasibility of this route with particular consideration given to crossings of the existing drain which follows a similar alignment. During construction of the proposed sewer it will be necessary to provide appropriate temporary traffic measures. The timing of this work within the overall site development programme will need careful consideration, as Choi Wan Road will be an important access route to the site for heavy plant. The sewer must therefore be completed in advance of the commencement of site formation works. No improvement works will be required on the sewerage infra-structure between the point of connection on Kwun Tong Road and the Kwun Tong Screening Plant.

2.6.22 The proposed gravity sewerage system for this development has been designed in accordance with the Sewerage Manual with reference to the Drainage Services Department Standard Details. The system comprises a network of pipes conveying sewage by gravity to the trunk sewer on Kwun Tong Road whereby it is conveyed to Kwun Tong Screening Plant. The pipes range in size from 225mm to 525mm. The pipes less than 450mm diameter are likely to be clay and pipes of 450mm diameter or greater will be concrete. One exception is a 156m length of 300mm diameter ductile iron pipe that will convey flows from Site 2 to Site 1 via a purpose built service/pedestrian tunnel. Over this length the gradient of the sewer must be the same as the gradient of the tunnel and as a result flow velocities will be higher than the acceptable limits for either clay or concrete.

2.6.23 The Kwun Tong Screening Plant (KTSP) will receive progressively higher inflows as developments within its catchment are completed. Under the SEKD Feasibility Study a site has been identified for the future expansion of the KTSP. The detailed design of such extension works would need to take the additional loading from this development into account. EPD is proposing to commission a Study entitled "Review of Central and East Kowloon Sewerage Master Plans" for commencement in early 1999 and completion in early 2000.

2.6.24 The outfall from Kwun Tong Screening Plant is to be connected into the SSDS Phase 1. It is understood that the design capacity of SSDS Phase 1 is currently under review and further consideration should be given to this matter once the design flow has been finalised.

2.6.25 At present the phasing of both the Jordan Valley development and the upgrading of Kwun Tong Screening Plant are not finalised. Also there are other significant unknowns such as the phasing of the many other proposed developments in the catchment. If, on completion of the review of the Kwun Tong Treatment Plant, it is confirmed that the plant will not have spare capacity and that improvement to the treatment plant will not be completed in time to meet the increased demand from Jordan Valley, a contingency measure/plan, such as the use of a temporary sewage holding tank on the housing development site itself will need to be investigated during the detailed design stage. However, until the review is undertaken there are too many unknowns to carry out such an assessment. The on-site and off-site sewerage systems are illustrated in Figure 2.4 and Figure 2.5 respectively.

Drainage

2.6.26 On site trunk drainage comprises a network of standard reinforced concrete pipes, generally following the alignment of access roads, as shown in Figure 2.6. A departure from this generalisation is a section of standard ductile iron pipeline designed to convey flows from Site 2 to Site 1, via the pedestrian and utilities link. Where possible drainage links share the same alignment as other utilities to minimise construction costs and reduce the sterilisation of developable land.

2.6.27 The majority of the stormwater runoff from the developments two main subcatchments is routed across Site 1 towards the existing Jordan Valley Nullah. Flow is to be carried via a new 2.1m diameter pipeline provided along Choi Ha Road, as indicated in Figure 2.7. The remaining runoff is routed to the existing pipeline and box culvert arrangement along Choi Wan Road.

2.6.28 The primary drainage route to the Jordan Valley Nullah involves construction of a new 2.1m diameter carrier main along Choi Ha Road and significant improvement works to the nullah itself. During construction, flow along existing drainage lines will be maintained and no diversion works will be necessary along Choi Ha Road. The new drainage carrier will only come on line once construction of the new pipeline is complete.

2.6.29 Improvement works to the Jordan Valley Nullah involve widening a section of the existing 7.5m wide nullah to 16.0m, extending the existing 16m wide section beneath the bus terminus further upstream. During construction of the widened section, the existing nullah function will be maintained. No diversion of flow will be necessary at any stage of construction. In the final stage of construction, the left nullah wall (looking upstream) is demolished to connect to the completed widened section.

Water Supply and Reservoirs

2.6.30 The preferred water supply scheme for the development is shown in Fig. 2.8 comprising a fresh water service reservoir, a salt water service reservoir and a salt water pumping station and the associated water mains. The sizes and alignment of the proposed water mains are provisional only subject to further detailed study by WSD. Although the site formation for the water supply facilities will be carried out as part of this project, the proposed water supply facilities will be implemented by WSD as a separate project. A preliminary environmental review on the impacts of the proposed service reservoirs is presented in Appendix F of this report.

2.6.31 Fresh water supply to Sites 1 and 2 will be provided through enlargement of the SEKD Second Service Reservoir (SSR) to be located within this development at Site 4 (situated to the north of Site 3).

2.6.32 Fresh water supply to Site 3 will be provided by the high level fresh water service reservoir as recommended in the Anderson Road Development project via the proposed water main linking the reservoir and the development site.

2.6.33 The proposed water mains are mainly ductile iron or mild steel pipes. The proposed fresh water distribution system within the development will be fed by gravity from the proposed fresh water service reservoirs.

2.6.34 A new salt water pumping station is proposed at Shum Wan Shan to provide flushing supply to Site 3 and the Anderson Road Development. Sites 1 and 2 will obtain the flushing supply by branching off from the existing salt mains along Jordan Valley North Road.

2.6.35 A salt water service reservoir supporting development Sites 1 and 2 and regional developments adjacent to Jordan Valley is proposed. This reservoir is to be sited adjacent to the SEKD fresh water service reservoir at a base elevation 69mPD and a top water level 75.5mPD within Site 4.

2.6.36 Salt Water Supply to Site 3 will be obtained by branching off from the salt water trunk mains delivering salt water from the new salt water pumping station at Shum Wan Shan to the proposed high level salt water service reservoir recommended in the Anderson Road project. For Sites 1 and 2, the flushing supply will be obtained by branching off from the proposed salt water mains linking the existing salt water trunk mains running along Jordan Valley North Road and the proposed salt water service reservoir adjacent to the SEKD fresh water service reservoir.

Roads

2.6.37 The internal road layout is shown on Figure 2.2. The internal road network will provide access to all platforms and links are provided between Sites 1 and 2, and between Sites 2 and 3. Access to Sites 4 and 5 will be via the up-graded and extended Choi Shek Lane. External access is provided on to Kwun Tong Road west bound via an elevated one-way single-lane slip road (5.2m wide) and south bound on to Kwun Tong Road via Choi Wan Road and Choi Shek Lane. In addition, there will be access from Choi Shek Lane on to New Clear Water Bay Road west bound. The inclusion of an emergency vehicular access (EVA) via the Jordan Valley Landfill access road on to Shun Lee Tsuen Road has been investigated but is deemed unnecessary at present.

2.6.38 Design speeds of internal roads will generally be 50kph and most roads will be two-way with single lanes in each direction. Widths of internal roads will generally be 7.3m with the following exceptions:

- the two-way access road (Road D1) between site 2 and the T-junction, which provides access on to Kwun Tong Road North bound, will be approximately 15m wide;
- the one-way access road (Road C1) on to Kwun Tong Road north bound will be approximately 5.2m wide.

2.6.39 The following Table 2.7 identifies where external road junctions will require improvements. The location of these junctions is shown in Figure 2.9. Based on the findings of the traffic impact assessment, the capacity of a number of junctions are likely to deficient as a result of the additional traffic load from the development (Figure 2.9 refers). A number of traffic improvement schemes are recommended as follows:

Table 2.7 External Junction Improvement Schemes

Scheme	Junction to be Improved	Nature of Works
1	New Clear Water Bay Road/K1	new junction
2	Choi Shek Lane/Kwun Tong Road	local road widening
3	Choi Ha Road/Choi Wan Road	junction modifications - roundabout
4	Choi Wan Road/Kwun Tong Road	minor junction modifications
5	Ngau Tau Kok Road/Jordan Valley North Road	local road widening
5	Choi Ha Road/Jordan Valley North Road	minor junction modifications
5	Chun Wah Road/Choi Ha Road	local road widening
5	Chun Wah Road/Ngau Tau Kok Road	local road widening
6	Shun On Road/Sau Mau Ping Road	2 sets of stairs to existing footbridge
7	Hong Ning Road/Hip Wo Street	local road widening
8	Chun Wah Road/Hong Ning Road	local road widening
9	Hong Ning Road/Kung Lok Road	changed to signalised junction
10	Tsui Ping Road/Hip Wo Street/Wan Hon Street	change in signal phasing
11	Yue Man Square/Hong Ning Road	local road widening
12	Tung Yan Street/Yue Man Square Street	local road widening

Note: Further details of the above External Junction Improvement Schemes are given in the Traffic Impact Assessment (1998).

Utilities and services

2.6.40 All utilities will be laid beneath footpaths with a minimum number of cross-road pipes or drains. The main criterion in determining the location of utility facilities such as sub-stations is to satisfy their functional requirements. Consideration is to be given to minimising visual intrusion and environmental impacts wherever practicable.

Gas

2.6.41 The Hong Kong and China Gas Company (HKCGC) have advised that no major difficulties are envisaged in providing a gas service to the development. The supply will be provided as a branch from the existing medium pressure underground piping located about the development.

2.6.42 The HKCGC have also advised that gas governor kiosks (inlet pressure not exceeding 240kpa) will be provided. The kiosks will be located at different locations throughout the development. Exact locations and the installation programme of the gas kiosks and associated supply network will be determined at the detailed design stage when the development layout and road networks are finalised. The environmental requirements set by EMSD and HKCGC for siting the governor kiosks will be taken into consideration during the detailed design.

2.6.43 In general, Towngas will be distributed via medium pressure underground pipework to the development whereupon the supply will be reduced to low pressure via the gas governor kiosks. The low pressure gas up-feed pipes will be housed inside the dedicated service risers to each building development or gas user. The gas distribution pipes will be connected to gas meters, valves and accessories for each gas user. Compliance with the installation and safety requirements of the HKCGC and the Gas Standards Office of the EMSD will be met. It should be noted that no gasmains will be sited in close proximity to Jordan Valley Landfill as this may severely affect gas detection works should a leak occur.

Electricity

2.6.44 Electricity supply serving this region is currently provided by the China Light and Power (CLP) Company. Given the high electrical demand requirement for this proposed development it is likely that the limit of the existing power supply network will be exceeded (this has been confirmed by CLP). A new primary 132KV/11KV power substation will be required and this would be constructed by CLP to match the growth in electricity demand of the development.

2.6.45 It is anticipated that a land reserve will be required to accommodate a new 132KV/11KV substation in the development. The proposed siting of the reserve is at Site 5 and is to be confirmed with CLP. Electricity will be distributed by means of underground 11KV cables from a new 132kV/11KV power substation through to local substations situated inside individual buildings. The new substation will serve the purpose of supplying power to the various developments. It is anticipated that provision of power supply to the future buildings will be discussed directly between the building owners and CLP.

Telephone

2.6.46 The following three telephone companies have been contacted regarding the provision of telephone services to the development:

- Hutchison,
- Hongkong Telecom, and
- New World Telephone.

2.6.47 Hongkong Telecom has advised that the existing plant located about the site can serve telecommunication requirements for the development. The existing plant located within the site that will be affected by the development would be removed upon request. Moreover the additional telecommunication plant required in order to optimise the service to the development would be determined once the detailed development layout is agreed.

2.6.48 Existing telephone ducts and cable routes located outside of the site serve the buildings and housing estates in the immediate vicinity in addition to connecting the east and west Kowloon Districts. Should potential conflicts occur, plant diversion could take up to 9 months to complete.

Cable TV

2.6.49 Initial contact has been made with Wharf Cable Limited regarding the provision of Cable TV services to the development. They have confirmed that a substation is not required for their cable TV services. A service would be provided through to the development by extending the existing plant facilities located at Ngau Tau Kok Estate and Choi Hung Estate. With regard to underground ducting, this will be located under the footways. Moreover provision of space inside individual buildings will be required for the installation of service equipment. It is anticipated that supply details of Cable TV services to future buildings will be discussed directly by the building owners and Wharf Cable Limited.

3 NOISE

3.1 Introduction

3.1.1 The construction and operation of the proposed development near Choi Wan Road and Jordan Valley may result in noise impacts that will need to be controlled and minimised. This Chapter addresses potential sources of impact during construction and operation, assesses their significance and where necessary, makes recommendations for suitable mitigation measures to reduce the identified impacts to acceptable levels.

Development of the Design

3.1.2 The assessments are based on the Master Development Plan (MDP), as shown in Figure 2.2. The MDP has been developed through an iterative process to optimise the development potential and minimise the requirement for mitigation measures in respect of environmental impacts, especially noise. The arrangement of the individual development sites and of the whole development have been determined having regard to a combination of preferred environmental, planning and engineering solutions to achieve optimum results in respect of noise and other environmental impacts.

3.1.3 The MDP has been developed in accordance with the comments of the Committee for Planning and Land Development (CPLD) meeting held on 13 August 1998. The major changes of the MDP are highlighted as follows:

- Amendments in response to comments received on the Draft Final Report made during the process of endorsement of the report by the Steering Group.
- Review in response to comments of the CPLD regarding vehicular access and pedestrian circulation, in particular in regard to schools especially those sited along Choi Shek Lane. Layout options in this area are constrained by space in this area, however a number of variations have been considered prior to arriving at the one shown which is considered by the consultants to be the optimum arrangement.
- Preference for siting of several Government and I/C facilities including Fire Sub-station, Refuse Collection Point as requested by Planning Department, Housing Department and Urban Services Department.
- Provision of footpaths and buffer zones in accordance with the Hong Kong Planning Standards and Guidelines (HKPSG) requirements on air quality.

3.1.4 The siting of schools has been determined based on the points below, in discussion with Education Department and Planning Department.

- Two primary schools are located centrally within the development at Area 1 to serve the overall population of the development.

- The secondary school in Area 3A/3B serves the development population's need from a central location. From the visual impact aspect, it satisfies a preference to extend the visual corridor to the ridgeline from the visual sensitive receivers on Kwun Tong Road and Choi Wan Road.

- Three (of the four) secondary schools located along Choi Shek Lane have been requested by Education Department and Planning Department to provide additional regional secondary schools in line with Government Policy. The two schools immediately adjacent to New Clear Water Bay Road are at sites already identified on the Outline Development Plan.

- Siting of the schools along Choi Shek Lane is preferred because access to 3 (of the 4) will be predominantly for "busing-in" students living outside the development.

3.1.5 The siting of the Fire Service Station (FSS) in Area 5 takes into account and optimises the points stated below.

- The priority of the proposed development site is to provide housing. The requirement to locate an FSS facility is a supplementary objective arising from regional planning considerations. The optimum location for the facility is along the boundary of the development site where it provides easiest access to main transport routes and creates least environmental impact and disruption during operation. At the present time no alternative location exists within the catchment area including outside the development site which meets an integrated development plan, however the future redevelopment of estates near Kwun Tong may provide such alternatives.

- Location of the proposed FSS is the preferred site as it provides appropriate access for use as a district facility in particular to lower Ngau Tau Kok Estate. It has good access to both New Clear Water Bay Road and Kwun Tong Road and creates least disruption to the housing development and best suits the alignment of the upgraded Choi Shek Lane.

3.1.6 The proposed location for the FSS has been selected with consideration for access, safety and land use requirements, and is considered to be the best available site within the development area. The access road to the east of the proposed FSS provides direct connection to New Clear Water Bay Road and fire engines would not be required to pass by the schools which would have safety implications.

3.1.7 The commercial centre located in Site 1 was identified at an early point in the Study as being the preferred centralised commercial node to serve the entire proposed development. A Public Transport Terminus (PTT) and adequate car-parking facilities are required to serve the expected population entering and leaving the commercial node. The deckover area provides sufficient Gross Floor Area for the commercial node and the associated area for transport facilities and ensures conformance with HKPSG percentage area requirements.

3.2 Government Legislation and Standards

3.2.1 In this study, reference has been made to the Hong Kong Environmental Planning Standards and Guidelines (HKPSG), the Environmental Impact Assessment Ordinance (EIAO) and the associated Technical Memorandum.

Construction Phase

3.2.2 The control of construction noise is carried out under the Noise Control Ordinance (NCO) and the two subsidiary Technical Memoranda on *Noise from Percussive Piling* (PP-TM) and *Noise from Construction Work Other Than Percussive Piling* (GW-TM). The TMs establish the permitted noise levels for construction work depending upon working hours and the existing noise climate.

3.2.3 An additional TM, *the Technical Memorandum on Noise from Construction Work in Designated Areas* (DA-TM), deals with the control of noise generated by Specified Powered Mechanical Equipment (SPME) and Prescribed Construction Works (PCWs) in identified designated areas. The SPME includes hand-held breaker, bulldozer, concrete lorry mixer, dump truck and hand-held poker vibrator and the PCWs include erection/dismantling of formwork/scaffolding, loading/unloading or handling of rubble, wooden boards, steel bars, wood or scaffolding material, and hammering. As the study area is within a designated area, the criteria in DA-TM will also be considered in this assessment.

3.2.4 The NCO criteria for the control of noise from Power Mechanical Equipment (PME) is dependent upon the Area Sensitivity Rating (ASR), which is a "letter" system describing the background noise conditions in which the Noise Sensitive Receivers (NSRs) are located, rather than the measured background noise levels. As the worst affected NSRs are located in an urban area, affected by Kwun Tong Road along the south-western boundary, the applicable ASR for these NSRs, as per GW-TM and DA-TM, is a 'C'. The NCO requires that construction related noise levels affecting the NSRs be less than the specified Acceptable Noise Level (ANL) which relates to the ASR. Table 3.1 below shows the ASR selection criteria as stated in GW-TM.

Table 3.1 Area Sensitivity Rating Criteria.

	Degree to which NSR is affected by IF		
Type of area containing the NSR	**Not Affected(1)**	**Indirectly Affected(2)**	**Directly Affected(3)**
(i) Rural area, including country parks or village type developments	A	B	B
(ii) Low density residential area consisting of low- rise or isolated high-rise developments	A	B	C
(iii) Urban area	B	C	C
(iv) Area other than those above	B	B	C

(1) Not Affected means that the NSR is at such a location that the noise generated by the influencing factors[4] (IFs) is not noticeable at the NSR.
(2) Indirectly Affected means that the NSR is at such a location that the noise generated by the IF, whilst noticeable at the NSR, is not a dominant feature of the noise climate of the NSR.
(3) Directly Affected means that the NSR is in such a location that the noise generated by the IF is readily noticeable at the NSR and is a dominant feature of the noise climate of the NSR.
(4) IFs are defined as industrial areas, major roads or the area within the boundary of Hong Kong International Airport.

3.2.5 It is intended that the construction activities of the proposed development will be planned and controlled in accordance with the NCO, GW-TM and DA-TM. Works requiring the use of PME during restricted hours and particularly at night will be carried out under the provision of a Construction Noise Permit (CNP) and planned to achieve the required Basic Noise Level (BNL). These are shown in Table 3.2 below.

Table 3.2 Basic Noise Levels (in Leq, 30 min dB(A)).

Time Period	Area Sensitivity Rating		
	A	B	C
All days during the evening (1900-2300) and general holidays (including Sundays) during the day and evening (0700-2300)	60(45)	65(50)	70(55)
All days during the night-time (2300-0700)	45(30)	50(35)	55(40)

N.B. BNL in brackets apply to SPME and PCW specified in DA-TM.

3.2.6 The BNL is corrected using the TM Methodology to produce the Acceptable Noise Level (ANL) which can be used in the CNP approval process.

3.2.7 A limit of $L_{eq,\ 30\ min}$ 75 dB(A) for daytime construction activities, as detailed in Annex 5, Table 1B of the *Technical Memorandum on Environmental Impact Assessment Process* (EIAO-TM), is adopted for this assessment. This standard applies to all domestic premises including temporary housing accommodation, hotels and hostels. For schools, a daytime noise level of L_{eq} 70 dB(A), lowered to 65 dB(A) during examination periods, is recommended.

3.2.8 Subsidiary regulations of the NCO include *the Noise Control (Hand Held Percussive Breakers)* and *Noise Control (Air Compressors) Regulations*, which require compliance with relevant noise emission standards and the fixing of noise emission labels to specified plant and equipment. While these requirements are not directly relevant to the construction noise impact assessment, Contractors must meet them during the construction phase of a project.

3.2.9 A Construction Noise Permit (CNP) is required by the regulations of the NCO for the use of all PME during restricted hours. The procedures set out in PP-TM, GW-TM and DA-TM are used by EPD to determine whether or not a CNP should be issued. CNPs will not automatically be granted and will be assessed on a case by case basis by the Authority.

3.2.10 Percussive piling is only permitted where a CNP has been approved by the EPD. PP-TM sets out the permitted hours of operation of percussive piling and Acceptable Noise Level (ANL) requirements, which are dependent on the architectural characteristics of the NSR. The ANL criteria for percussive piling are reproduced in Table 3.3. ANLs for hospitals, schools, clinics, courts of law and other particularly sensitive receivers are 10 dB below the figures quoted in Table 3.3.

Table 3.3 Acceptable Noise Levels for Percussive Piling

Architectural Characteristics of NSR	ANL, dB(A)
No windows or other openings	100
With central air conditioning system	95
With windows or other openings but without central air conditioning system	85

3.2.11 Referring to the proposed construction programme, no percussive piling has been included. The criteria set out in Table 3.3 are thus considered not relevant to this study.

3.2.12 The control of all blasting operations in Hong Kong is vested in the Mines and Quarries (M&Q) Division of the CED. Permits for the storage and use of explosives must be obtained from the M&Q Division which also stipulate particular restrictions on blasting procedures. In addition to the particulars of the blasting procedures required to be submitted in accordance with the General Specification for Civil Engineering Works, it is recommended that a requirement shall be implemented to restrict blasting within the hours of 1100 am and 1500 pm unless exceptional conditions pertain requiring otherwise, in which case blasting between 7 am and 7 pm may be considered.

Operational Phase

3.2.13 The Government noise policy objectives for new developments are based on prescribed noise standards which apply to buildings that rely on opened windows for ventilation. In HKPSG, it is recommended that the façade L10 (peak hour) for road traffic noise at the openable windows of residential and school developments be limited to 70 dB(A) and 65 dB(A) respectively.

3.2.14 In Hong Kong, noise emissions from fixed sources such as fire stations are governed by the NCO, HKPSG and the EIAO. In accordance with Table 1A in Annex 5 of the EIAO-TM, the noise levels from these sources should be i) 5 dB(A) lower than the Acceptable Noise Levels (ANLs) defined in the *Technical Memorandum for the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites* (FND-TM) or ii) below the prevailing background noise levels for quiet areas with ambient noise levels 5 dB(A) below the Acceptable Noise Levels (ANLs). The ANLs shown in Table 3 of FND-TM are presented in Table 3.4.

Table 3.4 Acceptable Noise Levels (in Leq, 30 min dB(A))

Time Period	Area Sensitivity Rating		
	A	B	C
Day (0700 to 1900 hours)	60	65	70
Evening (1900 to 2300 hours)	60	65	70
Night (2300 to 0700 hours)	50	55	60

3.3 Vibration Impacts

3.3.1 Over sustained periods, high vibration levels from blasting and other activities such as piling can cause severe damage to buildings, especially sub-standard structures. Lower vibration levels can cause nuisance to residents and, the degree of annoyance depends the vibration intensity and activities/conditions of the people being affected.

3.3.2 In Hong Kong, there is no legislation governing the construction related vibration impacts. UK guidance, BS 6472, suggests that nuisance is caused by vibration levels of 0.2 to 0.4mm/s during the day and 0.14mm/s at night (RMQ). Some UK local authorities quote VDV values of $0.2m/s^{1.75}$ for day and $0.13m/s^{1.75}$ for night. It is likely that local residents will complain about any perceived vibrations as soon as they become easily noticeable.

3.3.3 As a general guide, limits for vibration in Hong Kong are specified in Volume 1 of the General Specification for Civil Engineering Works, (Hong Kong Government 1992). This recommends that vibrations due to piling works or blasting should not exceed 25 mm/s, measured in terms of the peak particle velocity (ppv). This standard is adopted by Mass Transit Railway Corporation to minimise the risk of damage to their structures. In general, water-retaining structures tend to be less resilient to vibration, therefore Water Supplies Department recommend a limit of 13 mm/s to minimise impacts to their structures.

3.3.4 In accordance with GEO Circular No. 1/94 (Geotechnical Control of Blasting) an assessment of blasting vibration and its effects on nearby structures should be carried out by qualified blasting specialists, and submitted to the M&Q Division of CED for approval. This assessment will be carried out by a specialist contractor prior to commencement of the works. Therefore, detailed assessment of blasting vibration is not included in this study.

3.4 Baseline Conditions

3.4.1 The proximity of the proposed development is predominantly residential in nature with various public and private housing estates as well as schools and government institutional uses. There are no major industrial noise sources in the area. To Tai Industrial Building, located to the south of Tak Bo Garden, is considered to be the nearest industrial premises. As the industrial building is screened by the building structures of Tak Bo Garden, the associated industrial noise impacts to the proposed development are considered to be insignificant.

3.4.2 In view of the urban setting of the proposed development, the general noise climate of the proposed area is to be dominated by road traffic noise from both existing and new roads. Community noise will also contribute to the overall ambient noise levels.

3.5 Construction Noise Impacts

Methodology

3.5.1 The methodology for assessing noise from the construction activities associated with the proposed development was developed based on GW-TM and DA-TM. Percussive piling operations are not anticipated to be necessary, thus they are not considered. In general, the methodology for construction noise assessment is summarised as follows:

- Locate appropriate NSRs with respect to the work site;
- Determine distance attenuation and screening effects to NSRs from work site notional noise source point;
- Predict construction noise levels at NSRs in the absence of any mitigation measures; and
- Calculate the maximum total site Sound Power Level (SWL) for mitigated construction activities such that $L_{eq(30\ min)}$ noise levels at NSRs comply with appropriate noise criteria.

3.5.2 The practicality of achieving the above-mentioned maximum total site SWL is then considered in the light of viable options since this "performance specification" might offer a preferred form of mitigation. Other mitigation measures are then considered and recommended as appropriate.

3.5.3 It should be noted that in line with current Hong Kong practice, this methodology does not consider ground absorption effects which can be significant over the distances involved in this study. As a result, this study should be considered as a worse case assessment of the possible construction impacts at the nearest NSRs.

Impact Identification

3.5.4 The proposed development has been divided into a number of geographical work sites. Various construction activities and thus groups of PME have been assigned for each of these work sites during different construction phases. Details of the proposed construction program and the associated deployment schedule of PME are presented in Appendix B. Locations of the work sites are shown in Figure 16.3.

3.5.5 The likely construction activities include site formation (drilling, blasting, muckshift), foundation works, (building foundations utility installation and roadbases) and superstructure works and road surfacing, etc.

3.5.6 In view of the large amount of hard materials generated during site formation (estimated to be 3.45 Mm^3 - see Chapter 6), it is anticipated that blasting operations will be employed during the excavation process and crushing plant will be used for reducing the size of the hard material before transportation off-site.

3.5.7 The rock crushing and subsequent loading and removal via a conveyor belt system will have potential noise impacts. However, in practice these activities are located in fixed locations and contained in some form of enclosure for suppression of fugitive dust. The use of a belt conveyor system and the crushing plant is thus not expected to have significant noise impacts. According to the GW-TM, the SWL of a belt conveyor system is 90 dB(A), while that of the crushing plant is 121 dB(A).

3.5.8 Design measures for the control of dust such as enclosures with filters and curtains will also afford protection against noise emissions particularly when augmented with sound absorbent linings to the enclosures. Hoppers for the collection of crushed rock are generally designed with absorbent linings (such as used vehicle tyres) to prevent damage and minimise noise emissions. The conveyor system itself will be designed to be fully enclosed (for safety and noise reasons) and should run at a shallow incline to minimise noise associated with rock collision. Noise can also arise from fixed sources such as motors and belt movements and will require appropriate measures for attenuation.

3.5.9 The noise from blasting is audible to a varying degree depending on wind strength, direction and atmospheric conditions. However, this noise is not considered to have a significant adverse impact due to its infrequent and instantaneous nature.

Noise Sensitive Receivers

Construction Phase

3.5.10 Given the generally urban-residential nature of the Study Area, there are a number of NSRs, which may be affected by the construction works, including domestic premises, educational institutions and temporary housing areas. For this assessment, representative NSRs closest to the work sites have been selected to demonstrate the worst case scenario. The representative NSRs are shown in Figure 3.1 and tabulated in Table 3.5.

Table 3.5:Noise Sensitive Receivers for Construction Noise Assessment

NSR	Description	Land uses#	Area Sensitivity Rating*
1	Block C, Tak Bo Garden	R	C
2	Block D, Tak Bo Garden	R	C
3	Block E, Tak Bo Garden	R	C
4	Block F, Tak Bo Garden	R	C
5	Block G, Tak Bo Garden	R	C
6	Block H, Tak Bo Garden	R	C
7	Ka Lai Mansion	R	C
8	Ka Yin Mansion	R	C
9	Wang Kwong Building	R	C
10	Block C, Amoy Garden	R	C

NSR	Description	Land uses#	Area Sensitivity Rating*
11	Block D, Amoy Garden	R	C
12	Block E, Amoy Garden	R	C
13	Choi Yat House, Choi Ha Estate	R	C
14	Choi Yat House, Choi Ha Estate	R	C
15	Choi Yuet House, Choi Ha Estate	R	C
16	Choi Yuet House, Choi Ha Estate	R	C
17	Choi Yuet House, Choi Ha Estate	R	C
18	Choi Sing House, Choi Ha Estate	R	C
19	Choi Sing House, Choi Ha Estate	R	C
20	Ngan Ho House, Choi Wan Estate	R	C
21	Pak Hung House, Choi Wan Estate	R	C
22	Boon Yuet House, Choi Wan Estate	R	C
23	Welfare Centre, Choi Wan Estate	R	C
24	Kwai Fai House, Choi Wan Estate	R	C
25	Police Academy	S	C
26	St. Joseph's Anglo-Chinese School	S	C
27	St. Joseph's Anglo-Chinese School	S	C
28	Kai Yue House, Kai Tai Court	R	C
29	Lui Ming Choi Primary School	S	C
30	Chu Shek Lun Secondary School	S	C

R – Residential; S - School.
* Area Sensitive Rating as defined in GW-TM, DA-TM.

Evaluation of Potential Impacts

3.5.11 Construction noise levels at the identified NSRs during the peak construction period of each year have been predicted and are summarised in Table 3.6. Details are provided in Appendix B.

Table 3.6: Predicted Unmitigated Construction Noise Levels in dB(A)

NSR	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	68	**80**	**80**	**76**	75	**78**	**77**	**77**	n.a.
2	68	**79**	**80**	**78**	**77**	**80**	**78**	**78**	n.a.
3	n.a.	**78**	**80**	**80**	**78**	**78**	71	71	70
4	n.a.	**76**	**79**	**80**	**77**	**77**	71	71	70
5	n.a.	74	**79**	**80**	**77**	**77**	71	71	70
6	n.a.	73	**78**	**80**	**77**	**76**	71	71	70
7	n.a.	71	**77**	**79**	**76**	75	70	70	69
8	n.a.	72	**78**	**80**	**77**	**76**	71	71	70
9	n.a.	71	**78**	**80**	**77**	**76**	71	71	70
10	n.a.	68	73	74	71	70	64	64	62
11	n.a.	68	74	75	72	71	65	65	63
12	n.a.	68	74	75	71	71	65	65	63
13	65	73	**77**	**80**	**80**	**77**	**76**	**76**	75
14	64	72	**77**	**80**	**80**	**77**	**77**	**77**	**76**
15	n.a.	n.a.	69	**77**	**79**	74	75	75	75
16	63	71	75	**79**	**80**	**77**	**77**	**77**	**76**
17	n.a.	n.a.	67	**76**	**79**	74	75	75	75
18	63	70	74	**78**	**80**	**76**	**77**	**77**	**76**
19	n.a.	n.a.	69	**76**	**80**	75	**76**	**76**	**76**
20	71	**79**	73	74	72	71	70	70	63
21	70	**79**	74	74	72	71	70	70	64
22	69	**80**	75	74	72	71	70	70	65
23	68	**78**	**77**	74	73	70	70	70	65
24	66	74	**79**	74	73	69	68	68	65
25*	**74**	**75**	**72**	**74**	**73**	**74**	**75**	**75**	62
26*	**74**	**75**	**71**	**74**	**73**	**74**	**75**	**75**	61
27*	**74**	**75**	**73**	**75**	**74**	**75**	**75**	**75**	62
28	72	75	**76**	**77**	**76**	**77**	**76**	**76**	62
29*	**72**	**74**	**74**	**75**	**74**	**75**	**75**	**75**	63
30*	**68**	**73**	**75**	**74**	**73**	**74**	**72**	**72**	63

Note: Levels exceeding TM criteria are highlighted (Residential – 75 dB, School – 65 dB).

N.A. – NSRs are not to be affected during a particular year.

* School.

3.5.12 It is indicated in Table 3.6 that the noise impacts to the residents of Blocks C to H of Tak Bo Garden (NSRs 1 to 6) would exceed the 75 dB(A) daytime criterion in some years during the period of year 2002 to year 2008.

3.5.13 The prediction results indicate that the identified NSRs at Ka Lai Mansion (NSR 7), Ka Yin Mansion (NSR 8) and Wang Kwong Building (NSR 9) are likely to experience noise levels of up to 79 - 80 dB(A). NSRs 8 and 9 are likely to be affected from year 2003 and ends in year 2006. NSR8 is likely to be affected from year 2003 to year 2005.

3.5.14 The maximum predicted noise level at Blocks C, D and E of Amoy Gardens (NSRs 10 to 12) is 75 dB(A), which meets the EIAO-TM daytime criterion.

3.5.15 The maximum predicted noise level at Choi Ha Estate (NSRs 13 to 19) is 80 dB(A), which exceeds the 75 dB(A) daytime criterion by up to 5 dB (A). The period during which excessive noise levels are likely to be experienced is from year 2003 to 2009.

3.5.16 The maximum predicted noise level at NSRs 20-24 and 28 is 80 dB(A), which exceeds the 75 dB(A) daytime criterion.

3.5.17 The maximum predicted noise level at the identified schools NSRs 25, 26, 27, 29 and 30 is 75 dB(A), which exceeds the 65 dB(A) examination period criterion by 10 dB and the 70 dB(A) non-examination period criterion by 5 dB. Theses NSRs are likely to be affected by excessive noise levels from year 2001 to year 2008.

3.5.18 The prediction results indicate that noise levels at the identified NSRs exceed the EIAO-TM criteria, thus mitigation measures are required to reduce the construction related noise impacts.

Proposed Mitigation Measures

3.5.19 It has been predicted that there will likely be adverse impacts on the identified sensitive receivers during the construction phase. Possible mitigation measures that could be considered to reduce the construction related noise impacts are presented as follows:

- Selection and programming of construction processes;
- Use of "quiet" plant and working methods;
- Use of moveable noise barriers/noise enclosures;
- Reduction in the number of plant operating concurrently in critical areas close to NSRs; and
- Use of good site practice to limit noise emissions at sources.

Selection and Programming of Construction Processes

3.5.20 Scheduling of the timing and sequencing of the various construction activities could be undertaken to limit the amount of concurrent activities. In the case of schools, the potentially most disruptive construction activities should be programmed to coincide with school holiday and avoid school examination periods.

Use of "Quiet" Alternative Plant and Working Methods

3.5.21 The use of particular plant with equipment noise levels quieter than those specified in GW-TM can result in reduction of noise levels generated by plant. The level of noise reduction achieved is dependent on the Contractor's chosen methods of working. It is possible for the Contractor to achieve noise reductions from the adopted working methodologies by specifying maximum limits of sound power level for specific plant equipment.

3.5.22 "Quiet" plant is defined as a PME having actual SWLs lower than the values specified for PME in GW-TM. SWLs for selected "quiet" and alternative plant are presented in Table 3.7.

Table 3.7 Maximum SWLs for Selected "Quiet" and Alternative Plant

"Quiet" Alternative Plant	Maximum SWL, dB(A)
Breaker	114
Dump Truck	110
Excavator	105
Lorry	105
Concrete Pumps	105
Compressors	100
Generator	95
Rock Crusher	116
Rock Drill	118
Electric Crane	95

3.5.23 It should be noted that various types of silenced equipment can be found in Hong Kong and that the noise emission of a particular piece of equipment has to be validated by certificate or demonstration to EPD's requirements.

Mobile Noise Barriers

3.5.24 The use of 3 m high moveable barriers with skid footing and a small cantilevered upper portion can be located within a few metres from stationary plant and about 5 m from mobile plant such as excavators and bulldozers to reduce noise levels from construction equipment. Based on the heights of the NSRs and the site topography, moveable noise barriers of this type can result in noise attenuation from screening effects for stationary and mobile plants. Whilst these screening effects can be achieved at upper floors of NSRs, greater benefits would result at lower floors. A reduction of 5 dB(A) to 10 dB (A) can be achieved.

Noise Enclosures

3.5.25 Complete acoustic enclosures, which fully cover machinery, can give significant noise reductions of between 15 to 25 dB(A). The degree of reduction will vary depending upon nature of the material used for the enclosure, and whether there is any additional noise damping material, such as rockwool, incorporated into the design. Unless the enclosure is a proprietary model fitted directly to the plant, enclosures tend to be more effective for stationary plant, as any openings or gaps will significantly reduce the noise attenuation capacity.

Reduction in the Numbers of Plant

3.5.26 It is possible to restrict the number of plant or group of equipment to be used concurrently without severely affecting the progress of the work. This practice should be used where possible, particularly for noisy plant operating within certain parts of the construction site that are very close to NSRs. The combination of this mitigation measure with the selection of quiet plant will further reduce the total noise from the construction activities.

Good Site Practice

3.5.27 The use of good site practice/techniques on site can provide considerable reductions in noise emissions. Examples of these site practice include:

- Use of well-maintained and regularly-serviced plant during the works;
- Plant operating on intermittent basis should be turned off or throttled down when not in active use;
- Plant that is known to emit noise strongly in one direction should be orientated to face away from the NSRs;
- Silencers, mufflers and enclosures for plant should be used where possible and maintained adequately throughout the works;
- Where possible mobile plant should be sited away from NSRs; and
- Stockpiles of excavated materials and other structures such as site buildings should be used effectively to screen noise from the works.

3.5.28 Among the possible mitigation measures, use of "quiet" alternative plant and movable barriers are together considered to be a feasible and effective solution. Quieter equipment as presented in Table 3.7 are proposed to be the alternative plant. Movable barriers are proposed to be placed to screen the noise emitted from any operating PME. When schools are considered to be potential NSRs during a particular construction period, noise barriers are proposed to be located as such the PME will be totally screened and none will be visible when viewed from the schools.

Residual Impacts

3.5.29 The residual noise impacts during construction phase with the adoption of the proposed mitigation strategy have been assessed. The predicted noise levels are presented in Table 3.8 and sample calculations are provided in Appendix B

Table 3.8: Predicted Mitigated Construction Noise Levels in dB(A).

NSR	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	63	75	75	71	70	73	72	72	n.a.
2	63	74	75	73	72	75	73	73	n.a.
3	n.a.	73	75	75	73	73	66	66	65
4	n.a.	71	74	75	72	72	66	66	65
5	n.a.	69	74	75	72	72	66	66	65
6	n.a.	68	73	75	72	71	66	66	65
7	n.a.	66	72	74	71	70	65	65	64
8	n.a.	67	73	75	72	71	66	66	65
9	n.a.	66	73	75	72	71	66	66	65
10	n.a.	63	68	69	66	65	59	59	57
11	n.a.	63	69	70	67	66	60	60	58
12	n.a.	63	69	70	66	66	60	60	58
13	60	68	72	75	75	72	71	71	70

NSR	2001	2002	2003	2004	2005	2006	2007	2008	2009
14	59	67	72	75	75	72	72	72	71
15	n.a.	n.a.	64	72	74	69	70	70	70
16	58	66	70	74	75	72	72	72	71
17	n.a.	n.a.	62	71	74	69	70	70	70
18	58	65	69	73	75	71	72	72	71
19	n.a.	n.a.	64	71	75	70	71	71	71
20	66	74	68	69	67	66	65	65	58
21	65	74	69	69	67	66	65	65	59
22	64	75	70	69	67	66	65	65	60
23	63	73	72	69	68	65	65	65	60
24	61	69	74	69	68	64	63	63	60
25*	64	65	62	64	63	64	65	65	52
26*	64	65	61	64	63	64	65	65	51
27*	64	65	63	65	64	65	65	65	52
28	67	70	71	72	71	72	71	71	57
29*	62	64	64	65	64	65	65	65	53
30*	58	63	65	64	63	64	62	62	53

Note: N.A. - NSRs are not to be affected during a particular year.
* School.

3.5.30 With the use of the proposed mitigation strategy, the predicted noise levels at the identified NSRs would comply with the daytime criteria of 75 dB(A) for residential and 65 dB(A) for schools during examination period.

EM&A Requirements

3.5.31 The proposed mitigation measures including the use of "quiet" alternative plant as presented in Table 3.7 and movable barriers should be incorporated in the Action Plan in the EM&A Manual. The efficacy of the environmental control measures recommended will be checked to ensure that all measures are being carried out through the undertaking of Environmental Monitoring & Audit (EM&A). Noise monitoring and audit should be conducted regularly during the construction period of the proposed development at representative NSRs where exceedances of the noise criteria have been predicted, and practical noise mitigation measures should be implemented taking account of the suitability and circumstances of each NSR.

Summary of Construction Phase Impacts

3.5.32 The construction of the proposed development is anticipated to last for about 8 years from 2002 to 2009, with development activities being phased. Noise generation will occur, in periods, throughout the entire construction phase. The main receptor areas that could be affected by construction noise are the existing residential areas. These are generally urban areas that are affected by noise from existing roads, but also contain other noise sensitive receivers such as schools.

3.5.33 Where adverse impact is predicted, practicable mitigation measures such as "quiet"/alternative powered mechanical equipment and temporary noise barriers are proposed. The residual noise impacts with the incorporation of the proposed noise mitigation measures would meet the EIAO-TM daytime criteria. Alternative methods for noise reduction and control will be incorporated in the design and construction contract clauses.

3.6 Operational Traffic Noise Impacts

Impact Identification

3.6.1 Following the construction of the proposed development, the main sources of noise during the operational phase of the new development will be the road traffic in the vicinity of the development site. The principal contributor is likely to be the existing major trunk roads, as traffic will increase partly as a result of the proposed residential development. The predicted traffic flows along the internal local roads within the development areas are low and have limited potential for traffic noise impacts. Traffic flows projected for the design year 2024 on the existing and new roads are presented in Table 3.11.

Planned On-Site Noise Sensitive Receivers

3.6.2 A total of 38 representative noise sensitive buildings/facades have been identified in each of the planning areas within the development. The sensitive buildings primarily include residential blocks and schools, which are considered to be sensitive to road traffic noise of both new and existing roads. A number of assessment points have been identified for each of these buildings. The locations of the identified NSRs are shown in Figure 3.2. Noise levels have been predicted at these NSRs.

3.6.3 In addition, there are sensitive facades of the Fire Sub-station (FSS) in Area 5 which include bedrooms, dormitories, recreation rooms, conference and lecture rooms, etc. overlooking the nearby roads. There are potential noise impacts from traffic noise of Road K1 along the FSS boundary. It is understood that noise insulation and air conditioning are to be recommended for these sensitive rooms. Therefore, the associated noise impacts are not considered to be significant.

Table 3.9: On-site Noise Sensitive Receivers for Road Traffic Noise Assessment

NSR	Description	Area[&]	Landuses[#]
A1B1	Planned Development (Area 1, Block B-1)	1	R
A1B2	Planned Development (Area 1, Block B-2)	1	R
A1B3	Planned Development (Area 1, Block B-3)	1	R
A1B4	Planned Development (Area 1, Block B-4)	1	R
A1B5	Planned Development (Area 1, Block B-5)	1	R
A1B6	Planned Development (Area 1, Block B-6)	1	R
A1B7	Planned Development (Area 1, Block B-7)	1	R
A1B8	Planned Development (Area 1, Block B-8)	1	R
A1B9	Planned Development (Area 1, Block B-9)	1	R
A2T1	Planned Development (Area 2, Block T-1)	2	R
A2T2	Planned Development (Area 2, Block T-2)	2	R
A2T3	Planned Development (Area 2, Block T-3)	2	R

NSR	Description	Area&	Landuses#
A2T4	Planned Development (Area 2, Block T-4)	2	R
A2T5	Planned Development (Area 2, Block T-5)	2	R
A2T6	Planned Development (Area 2, Block T-6)	2	R
A2T7	Planned Development (Area 2, Block T-7)	2	R
A3T1	Planned Development (Area 3A, Block T-1)	3A	R
A3T2	Planned Development (Area 3A, Block T-2)	3A	R
A3T3	Planned Development (Area 3A, Block T-3)	3A	R
A3T4	Planned Development (Area 3A, Block T-4)	3A	R
A3T5	Planned Development (Area 3A, Block T-5)	3A	R
A3T6	Planned Development (Area 3A, Block T-6)	3A	R
A3T7	Planned Development (Area 3A, Block T-7)	3A	R
A3B1	Planned Development (Area 3B, Block B-1)	3B	R
A3B2	Planned Development (Area 3B, Block B-2)	3B	R
A3B3	Planned Development (Area 3B, Block B-3)	3B	R
A3B4	Planned Development (Area 3B, Block B-4)	3B	R
A3B5	Planned Development (Area 3B, Block B-5)	3B	R
A3B6	Planned Development (Area 3B, Block B-6)	3B	R
A3B7	Planned Development (Area 3, Block B-7)	3B	R
A3B8	Planned Development (Area 3, Block B-8)	3B	R
School 1	Planned Development (Area 1, School 1)	1	S
School 2	Planned Development (Area 1, School 2)	1	S
School 3	Planned Development (Area 3B, School 3)	3B	S
School 4	Planned Development (Area 4, School 4)	4	S
School 5	Planned Development (Area 4, School 5)	4	S
School 6	Planned Development (Area 5, School 6)	5	S
School 7	Planned Development (Area 5, School 7)	5	S

& Planning area in the proposed development.
# R – Residential; S – School.

Existing Off-Site Noise Sensitive Receivers

3.6.4 Existing NSRs surrounding the proposed development area will be exposed to increased traffic noise resulting from the introduction of new roads and traffic noise from existing roads. This assessment includes future changes in traffic volume induced on existing roads by the construction of new roads. A total of 15 existing representative NSRs including residential blocks, schools and a police training centre, have been selected for this assessment. The representative noise sensitive facades/buildings are presented in Table 3.10 and Figure 3.2.

Table 3.10: Existing Off-site Noise Sensitive Receivers for Road Traffic Noise Assessment

NSR	Description	Landuses#
Ex1	Choi Yat House, Choi Ha Estate	R
Ex2	Choi Yat House, Choi Ha Estate	R
Ex3	Ka Yin House	R
Ex4	Block E, Tak Bo Garden	R
Ex5	Block C, Tak Bo Garden	R
Ex6	Chu Shek Lun Secondary School	S
Ex7	Kai Wo Temporary Housing Area	R
Ex8	Kai Fan House, Kai Hong House	R
Ex9	Lui Ming Choi Primary School	S
Ex10	Kai Yue House, Kai Tai House	R
Ex11	St. Joseph's Anglo-Chinese School	S
Ex12	St. Joseph's Anglo-Chinese School	S
Ex13	Police Academy	S
Ex14	Pak Hung House, Choi Wan Estate	R
Ex15	Kwai Fai House, Choi Wan Estate	R

& Planning area in the proposed development.
# R – Residential; S – School.

Assessment Methodology

3.6.5 Traffic noise predictions have been carried out using the computer model which implements the methodology of "Calculation of Road Traffic Noise, 1988." published by the UK Department of Transport (CRTN).

3.6.6 Road segments of any expressway, trunk road, primary distributor road or district distributor have been identified and evaluated and classified as new and existing road sections for the purpose of the traffic noise impact assessment. When an existing road segment is proposed to undergo major modification which will directly result in 25% increase in lanes or substantial changes in alignment or character (e.g. the change of a low speed road into high speed road), it is regarded as a new road for the purpose of the assessment.

3.6.7 Future (year 2024) worst case L10 (peak hour) traffic noise levels have been predicted at representative NSRs based on the peak hourly traffic flows presented in Table 3.11.

3.6.8 The road surface of Kwun Tong Road was taken to be pervious and that of all the other roads was taken to be impervious.

3.6.9 As detailed in Table 3.18, the proposed site is likely to be affected by road traffic noise of Kwun Tong Road, New Clear Water Bay Road, Kai Cheung Road Flyover and Ngau Tau Kok Road. It is considered that these roads are likely to reach their maximum design flow by Year 2024. Design flow, as defined in Transport

Planning and Design Manual Volume 2 (TPDM) as *"the maximum volume of vehicles using the road without the traffic density becoming such as to cause unreasonable delay, hazard or restriction on the drivers' freedom to manoeuvre,"* has been used as the peak hour flow in this study. It is understood that Road C1 is the only planned distributor road in this study.

3.6.10 It is indicated in Table 3.11 that the projected peak hour traffic flow on Road C1 is only about 2% of that of the existing Kwun Tong Road. The noise contribution from Road C1 is therefore expected to be negligible, comprising an increase of less than 1 dB(A) above background levels at the existing and proposed NSRs.

Table 3.11: Projected Traffic Flows During P.M. Peak Hour in Year 2024.

Road Segments	Between	Speed (kph)	Status	Veh/hr	%Heavy Vehicles
New Clear Water Bay Road	Clear Water Bay Road and Fung Shing Street	70	Existing	7,000*	25
Kwun Tong Rd	Choi Shek Lane and Kai Cheung Road Flyover	70	Existing	16,800*	47
Kwun Tong Rd	Kai Cheung Road Flyover and Choi Wan Road	70	Existing	8,400*	47
Kwun Tong Rd	Ping Shek Estate Access Road and Choi Shek Lane	70	Existing	16,800*	47
Kai Cheung Rd Flyover	Kwun Tong Road and Kai Cheung Road	50	Existing	5,600*	30
Ngau Tau Kok Rd	Choi Wan Road and Amoy Garden	50	Existing	1,200*	47
Choi Shek Lane	Choi Shek Road and Kwun Tong Road	50	Existing	370	27
Choi Wan Road	Kwun Tong Road and Choi Ha Road	50	Existing	950	27
Choi Ha Road	Choi Wan Road and Jordan Valley North Road	50	Existing	1,250	12
Choi Ha Estate Rd	-	50	Existing	100	9
Road C1	Kwun Tong Road and Road D1	50	New	360	27

* 100% design capacity assumed.

3.6.11 The assessment points are identified according to their area, block no, and unit number, e.g. Site 1, Block B-1, Unit 1 is referred to as a1.b-1 (1). At each selected NSR, noise levels are calculation on every floor.

Evaluation of Road Traffic Noise Impacts

3.6.12 The road traffic noise impacts at the identified NSRs have been assessed based on the given scenario proposed by the planners. The noise levels at the most affected facades of each residential unit were predicted based on the given scenario of blanked end facades. No assessment point is located at the assumed blanked end facades, which are indicated in Figure 3.2. A tabulation of the prediction results and sample calculations are provided in Appendix C.

Area 1

3.6.13 The predicted noise levels at the identified NSRs in Area 1 are summarised in Table 3.12. The extent of compliance with the EIAO-TM requirement of L10 (peak hour) 70 dB(A) in this area is estimated to be 84%. The prediction results also indicate that Block B1 is the most affected residential block of the area with a maximum noise level of 76 dB(A).

Table 3.12 Summary of Predicted Noise Levels for Area 1 (Given Scenario)

Block	No. of floors	No. of Flats	Max Noise Levels, L10 (peak hour) dB(A)	No. of flats > 70 dB(A)
B-1	40	400	75	164
B-2	40	400	71	37
B-3	40	400	69	0
B-4	40	400	64	0
B-5	36	360	66	0
B-6	36	360	68	0
B-7	40	400	76	156
B-8	40	400	74	122
B-9	40	400	76	85
Total:	-	**3,520**	-	564

Area 2

3.6.14 The predicted noise levels at the identified NSRs in Area 2 are summarised in Table 3.13. The extent of compliance to the EIAO-TM requirement of L10 (peak hour) 70 dB(A) in this area is estimated to be 74%. The prediction results also indicate that Block T-1 is likely to be the most affected residential block of the area with a maximum noise level of 75 dB(A).

Table 3.13 Summary of Predicted Noise Levels for Area 2 (Given Scenario)

Block	No. of floors	No. of flats	Max Noise Levels, L10 (peak hour) dB(A)	No. of flats > 70 dB(A)
T-1	40	320	75	193
T-2	40	320	75	105
T-3	32	256	74	111
T-4	32	256	74	131
T-5	32	256	74	74
T-6	36	288	72	43
T-7	38	304	70	0
T-8	40	320	72	29
T-9	40	320	72	60
	Total:	**2,640**	-	**686**

Area 3

3.6.15 The predicted noise levels at the identified NSRs in Area 3 are summarised in Table 3.14. The extent of compliance with the EIAO-TM requirement of L10 (peak hour) 70 dB(A) in this area is estimated to be 98%. The prediction results also indicate that Block T-1 is likely to be the most affected residential block in the area with a maximum noise level of 73 dB(A).

Table 3.14 Summary of Predicted Noise Levels for Area 3 (Given Scenario)

Block	No. of floors	No. of flats	Max Noise Levels, L10 (peak hour) dB(A)	No. of flats > 70 dB(A)
T-1	40	320	73	105
T-2	40	320	70	0
T-3	36	288	69	0
T-4	34	272	68	0
T-5	32	256	68	0
T-6	30	240	69	0
T-7	28	224	67	0
B-1	36	360	66	0
B-2	36	360	64	0
B-3	36	360	63	0
B-4	36	360	63	0
B-5	40	400	62	0
B-6	40	400	62	0
B-7	40	400	63	0
B-8	40	400	65	0
	Total no.	**4960**	-	105

3.6.16 The overall compliance with the EIAO-TM requirement of L10 (peak hour) 70 dB(A) in all 3 areas is estimated to be 99%.

Schools

3.6.17 The predicted noise levels at the identified NSRs of the schools S1 and S2 in Area 1, S3 in Area 3, S4 and S5 in Area 4 and S6 and S7 in Area 5 are summarised in Table 3.15. The prediction results indicate that School 7 is likely to be the most affected school with a maximum noise level of 81 dB(A).

Table 3.15 Summary of Predicted Noise Levels for Schools (Given Scenario)

School	Location (Area)	Max Noise Levels, L10 (peak hour) dB(A)
1	1	74
2	1	58
3	3	63
4	4	71
5	4	75
6	5	79
7	5	81

Existing Off-site Receivers

3.6.18 Traffic noise impacts on existing NSRs have been assessed. The prediction results are summarised in Table 3.16. The prediction results indicate that noise levels at all off-site existing NSRs except Choi Yat House (NSR-Ex1 and NSR-Ex2) and the Police Academy will exceed the EIAO-TM criteria.

Table 3.16 Summary of Predicted Noise Levels for Off-site NSRs (Given Scenario)

NSR	Description	Predicted Noise Levels	Predicted Noise Levels of Road C1
		L10 (peak hour) dB(A)	
Ex1	Choi Yat House, Choi Ha Estate	63	17
Ex2	Choi Yat House, Choi Ha Estate	66	18
Ex3	Ka Yin House	71	30
Ex4	Block E, Tak Bo Garden	76	51
Ex5	Block C, Tak Bo Garden	76	53
Ex6	Chu Shek Lun Secondary School	74	49
Ex7	Kai Wo Temporary Housing Area	79	64
Ex8	Kai Fan House, Kai Hong House	79	64
Ex9	Lui Ming Choi Primary School	82	69
Ex10	Kai Yue House, Kai Tai House	82	68
Ex11	St. Joseph's Anglo-Chinese School	86	65
Ex12	St. Joseph's Anglo-Chinese School	82	53
Ex13	Police Academy	68	42
Ex14	Pak Hung House, Choi Wan Estate	82	27
Ex15	Kwai Fai House, Choi Wan Estate	84	16

3.6.19 The noise levels on the lower floors of Ka Yin House (NSR-Ex3) are predicted to exceed the L10 (peak hour) 70 dB(A) criterion by about 1 dB(A). As NSR-Ex3 is primarily affected by the existing Choi Ha Road, direct noise mitigation measures to address the traffic noise impacts from new roads are not considered to be effective.

3.6.20 The predicted noise levels at Blocks C and E of Tak Bo Garden (NSR-Ex4 and NSR-Ex5) exceed the EIAO-TM criterion by about 6 dB(A). As these NSRs are primarily affected by the existing Choi Wan Road and Kwun Tong Road (particularly on higher floors), direct noise mitigation measures to address the traffic noise impacts from new roads are not considered to be effective.

3.6.21 Noise levels at the off-site existing NSRs along the west bound of Kwun Tong Road (NSR-Ex6, Ex 7, Ex 8, Ex 9 and Ex 10) are predicted to exceed the EIAO-TM criteria with a maximum noise level of 82 dB(A). These NSRs are to be affected primarily by the existing Kwun Tong Road with contribution from Road C1 proposed in this Study being less than 1.0 dB(A). As these NSRs are primarily affected by the existing Choi Wan Road and Kwun Tong Road (particularly on higher floors), direct noise mitigation measures to address the traffic noise impacts from new roads are not considered to be effective.

3.6.22 The predicted noise levels at St Joseph's Anglo-Chinese School (NSR-Ex11 and Ex12) exceed the EIAO-TM with a maximum of 86 dB(A). The school is likely to be primarily affected by the existing Kwun Tong Road, direct noise mitigation measures on the proposed new roads are not considered to be effective.

3.6.23 It is understood that Choi Shek Lane from the Choi Shek Road junction through Road K1 Section 1 to Ping Shek Lane is to be upgraded. The existing off-site NSR that will be affected most by this road upgrading is identified to be the nearby Police Academy (NSR-Ex13). The predicted maximum noise level at NSR-Ex13 is 70 dB(A). It is found that the contribution from the planned road is less than 1.0 dB(A), direct mitigation measures are therefore not considered to be effective to reduce the noise impacts to acceptable levels.

3.6.24 The noise levels predicted at Pak Hung House (NSR-Ex14) and Kwai Fai House (NSR-Ex15) of Choi Wan Estate exceed the EIAO-TM by up to 12 dB(A). As these NSRs are primarily affected by the existing New Clear Water Bay Road, direct noise mitigation measures to address the traffic noise impacts from new roads are not considered to be effective.

3.6.25 The prediction results indicate that the proposed development is unlikely to cause significant noise impacts on the off-site existing NSRs.

3.6.26 Direct mitigation measures on new roads have been exhausted and the prediction results indicate that contribution from new roads to the overall noise levels at the existing NSRs is less than 1 dB(A), the existing NSRs would therefore not be eligible for indirect technical remedies.

Proposed Mitigation Measures

3.6.27 3 m high boundary walls/barriers are proposed to schools for mitigation of traffic noise from existing roads including New Clear Water Bay Road and Kwun Tong Road as shown on Figure 3.6. These are proposed to be examined exhaustively at the detailed design stage and provided in accordance with EIAO-TM.

3.6.28 Locations of the proposed mitigation measures are shown in Figure 3.6.

Residual Impacts

<u>Area 1, 2 and 3</u>

3.6.29 Due to site constraints, set back and orientation of buildings are not considered to be practicable in these areas. The proposed developments are mainly affected by existing roads. Given the buffer distance for proposed NSRs and the existing roads, low barriers are considered ineffective at the proposed development because of the high rise building structure. High barriers would impose architectural, building and engineering impracticalities. It is therefore considered all practicable effective mitigation measures have been exhausted. The residual impact is to be abated with indirect mitigation measures in the form of window insulation and air-conditioning.

Schools

3.6.30 The predicted noise levels at the identified NSRs of the schools S1 and S2 in Area 1, S3 in Area 3, S4 and S5 in Area 4 and S6 and S7 in Area 5 are summarised in Table 3.20. The prediction results indicate that School 6 is to be the most affected school with a maximum noise levels 77 dB(A). Due to site constraints, set back and orientation of the schools are not considered to be practicable. High barriers would impose architectural, building and engineering impracticalities. It is therefore considered all practicable effective mitigation measures have been exhausted. Indirect mitigation measures as the last resort in the form of window insulation and air-conditioning should be provided to abate the residual impact.

Table 3.20 Summary of Predicted Noise Levels for Schools (Mitigated)

School	Location (Area)	Max Noise Levels, L10 (peak hour) dB(A)
1	1	74
2	1	58
3	3	63
4	4	68
5	4	72
6	5	77
7	5	73

3.7 Operational Industrial Noise Impacts

Impact Identification

3.7.1 Operations of the proposed Electric Sub-station (ESS) and Fire Sub-station (FSS) in Area 5 may have potential noise impacts at the nearby sensitive receivers. In addition, generators and transformers proposed within the development area are potential noise sources.

3.7.2 The ESS is proposed on a platform of 58 mPD. The closest NSRs to the ESS have identified to be the schools in Areas 4 and 5. As the school in Area 4 is on a platform of 80 mPD, its line of sight to the ESS is likely screened by the topography. The school in Area 5, on a 55 mPD platform, will have a direct line of sight to the ESS with 97 m separation. These schools are to be provided with window insulation and air conditioners as indirect technical remedies to reduce road traffic noise impacts, and are not considered to be noise sensitive at night, during which a more stringent noise criterion is applicable. As the ESS is to be designed with necessary noise mitigation measures to meet the TM requirements and is located at a distance from the schools, the associated noise impacts due to ESS operation are considered to be insignificant.

3.7.3 The generators and transformers proposed within the development will be designed to be enclosed by building structures and equipped with necessary noise mitigation measures for TM compliance, the associated noise impacts are therefore not considered to be significant.

3.7.4 The noise sources during FSS operation include training activities, Public Address (PA) system, Wigwag system and sirens from rescue vehicles. The closest NSRs which are to be affected most by the FSS operation include sensitive facades of the FSS, Block T-1, the nearby schools and Choi Wan Estate. As Choi Wan Estate has a separation from the northern boundary of the FSS, the noise impacts at Choi Wan Estate is considered to be minimal.

3.7.5 The closest NSR to the proposed FSS has identified to be Block T-1 in Area 3A with a horizontal separation of about 28 m. In view of its proximity to the proposed FSS, there are potential noise impacts to Block T-1 during the operational phase. The schools located close to the FSS are to be window insulated and installed with air conditioners as indirect technical remedies to reduce road traffic noise impacts, and are not considered to be noise sensitive at night, during which a more stringent noise criterion is applicable. The schools may potentially be impacted by the FSS operation.

Baseline Conditions

3.7.6 The site is located in an urban area and the noise climate is dominated by road traffic noise and general community noise. It is considered that the ambient noise level is unlikely to be less than 65 dB(A) and 55 dB(A) during daytime and night-time, respectively.

Evaluation of Impacts

Training Routine

3.7.7 Daily routine activities taking place at a typical FSS during daytime include parades, appliance checking, dry drill and wet drill practices. The sound power levels presented in the Preliminary Environmental Review for 728XX-Braemar Hill Fire Station-cum-ambulance Depot are tabulated in Table 3.21. In order to conform with the TM Leq(30 min) 65 dB(A) requirement, a separation of at least 24 m is required if only appliance checking or wet drill is undertaken without screening. If only dry drill is in operation, a separation of at least 20 m is required. As the combined sound power level of the 3 activities is about 101.6 dB(A), a separation of 39 m is required with no screening.

Table 3.21 Sound Power Levels of Training Activities

Activity	SWL, dB(A)
Appliance checking	97.4
Dry drill	95.8
Wet drill	97.2

3.7.8 As the closest school is located 55 m from the proposed FSS site boundary, the noise level at the school is estimated to be about 62 dB(A). Training related noise impacts to the school are therefore considered to be insignificant. Block T-1 is located on a site platform of 60 mPD, the noise level at the most affected dwelling at Block T-1 is estimated to be 65 dB(A) which meets the TM criteria. It is therefore concluded that training related noise impacts to the nearby NSRs are considered to be insignificant.

Public Address System

3.7.9 As indicated in the PER, the SWL of a typical PA system loudspeaker is about 98 dB(A). PA systems should be designed to explicitly meet the requirements of the HKPSG and NCO noise criteria. It is also recommended that the loud speaker should have the same SWL or less, and be installed with a separation of at least 26 m from the most affected facades in order to meet the daytime noise criterion of Leq(30 min) 65 dB(A). On this basis, no noise impacts are expected. The designers of the PA system are also guided to ensure that highly directional loudspeakers are selected and located facing away from the surrounding NSRs to further reduce noise levels.

3.7.10 It is also required that the PA will not be used during training activities and therefore no cumulative impacts are to be expected.

Sirens

3.7.11 It is understood that in the proposed FSS, no sirens except those required for fire engines and ambulances will be installed. It is understood that the use of sirens while the emergency vehicles are travelling along the road from the depot to the destination, is an operational and safety requirement for FSD emergency vehicles and therefore, it would not be possible to totally switch them off. However, FSD drivers would only use the sirens when there is a need to do so according to the traffic condition at any time. The associated noise impact is thus considered to be minimal.

Wigwag System

3.7.12 Systems of audible warning to alert users of the footpath to traffic to and from the FSS in an emergency, if installed, will be potential noise sources. As locations for the signals have not been determined at this stage, it is not possible to quantify the associated impacts. However, it is understood that the Wigwag system, if required, will be designed, in the detailed design stage, to meet specifications formulated by determining the maximum acceptable SWLs for each signal. The Wigwag system related noise impact is not expected to be significant.

Proposed Mitigation Measures

3.7.13 Fixed plant noise will be emitted from the proposed ESS, generators and transformers within the site. Although noise impacts are not expected with the use of effective noise control equipment and proper design of the plant, it should be ensured during the detailed design of the works that noise emissions are limited at source to meet the ANL minus 5 dB(A) criteria at NSRs located both on- and off-site.

3.7.14 Low pitch, volume adjustable electronic sirens are recommended to be used to further reduce the siren associated noise impacts. Other administrative measures such as "hurry-call" system to control traffic lights in order to reduce the use of sirens at road junctions are also recommended.

3.7.15 The training activities are recommended to be carried out at a minimum distance of 5 m from the southern boundary of FSS site in order to comply with the TM Leq(30 min) 65 dB(A) requirement.

3.7.16 Possible measures to further reduce PA system related noise impacts are summarised as follows:

- the loud speaker for the PA system should be mounted on the wall in the drill yard with at least 26 m separation between the identified NSRs (based on SWL of 98 dB(A));
- avoid unnecessary use of the PA system including the loud speakers in the drill yard during daytime and night-time;
- switch off the loud speakers in the drill yard during night-time;
- close the appliance room to reduce noise impacts from PA system of the FSS during night-time;
- locate loud speakers in a manner in which they are directed away from the nearest NSRs, thereby taking advantage of the inherent directionality of the equipment; and
- adjust the volume of PA system to an appropriate level during night-time.

3.7.17 Possible mitigation measures to further reduce siren noise are summarised as follows:

- govern the use of sirens by strict internal orders;
- reduce the use of sirens to an absolute minimum;
- operate the sirens only if necessary; and
- provide volume adjustable sirens for fire engines and ambulance.

3.7.18 Possible mitigation measures to further reduce noise generated from the Wigwag system are summarised as follows:

- activate the Wigwag system only when fire engines and ambulances start to exit the FSS; and

- purchase a Wigwag system which meets the specifications formulated by determining the maximum acceptable SWLs for each signal.

Residual Impacts

3.7.19 The residual industrial noise impacts at the identified NSRs would meet the relevant criteria stipulated in EIAO-TM.

Summary of Operational Phase Noise Impacts

3.7.20 Results of the traffic noise impact assessment show that the existing Kwun Tong Road is the most significant noise source affecting the proposed development, with exceedance of noise levels predicted at residential blocks in Sites 1 and 2.

3.7.21 Due to site constraints, options for set back and orientation of buildings within the development sites are not considered to be practicable. In addition, low barriers are evaluated to be ineffective due to the high rise nature of residential building structures. High barriers and acoustic enclosures would impose architectural, visual, building and engineering impracticalities. It is therefore considered that all practicable effective mitigation measures have been exhausted. Indirect mitigation measures in the form of window insulation and air-conditioning should be provided to the affected dwellings.

3.7.22 The prediction results indicate that the proposed development is unlikely to cause any significant noise impacts upon the existing off-site NSRs.

3.7.23 The residual industrial noise impacts at the identified NSRs are considered to be insignificant.

3.8 Recommendations on Monitoring and Audit

3.8.1 Environmental monitoring and audit measures are recommended during the construction phase of the project. The schedule and extent of the monitoring programme is presented in the accompanying Environmental Monitoring and Audit (EM&A) Manual. A proactive EM&A programme will be necessary to ensure that exceedances are avoided. Although, the area has a history of blasting from the quarrying operations, public relations can be improved by increasing the awareness of local residents to the proposed development prior to and during the construction activities. An appropriate path for noise complaints and handling procedures will be a key element of the EM&A programme.

3.9 Conclusions and Development Constraints

Construction Phase

3.9.1 The construction of the proposed development is anticipated to last for about 8 years from 2002 to 2009, with development activities being phased. Noise generation will occur, in periods, throughout the entire construction phase. The main receptor areas that could be affected by construction noise are the existing residential and school developments.

3.9.2 Where adverse impacts are predicted, practicable mitigation measures such as "quiet"/alternative powered mechanical equipment and temporary noise barriers are proposed. The residual noise impacts with the incorporation of the proposed noise mitigation measures would meet the EIAO-TM daytime criteria. Alternative methods for noise reduction and control will be incorporated in the design and construction contract clauses.

Operational Phase

Road Traffic Noise

3.9.3 Traffic noise is a key environmental issue and constitutes the major environmental impact on the proposed development in Jordan Valley.

3.9.4 Exceedances of the HKPSG traffic noise limit L10 (peak hour) 70 dB(A) for residential receivers and L10 (peak hour) 65 dB(A) for schools are predicted in all of the planning areas. In particular, calculations indicate a high level of noise associated with existing roads at sensitive receivers which are located close to the roads.

3.9.5 The predicted results indicate that the exposed NSRs on the periphery of the proposed site are expected to be affected by traffic noise from the heavily trafficked existing roads such as Kwun Tong Road and New Clear Water Bay Road. Mitigation measures, using vertical barriers within the development have been considered to reduce the traffic noise levels at sensitive receivers within the proposed development but are evaluated to be ineffective. Building set-back, orientation, cantilevered barriers set atop building podiums and integrated decking design have also been considered to mitigate road traffic noise impacts. However, these direct technical remedies were found to be ineffective or impractical in many locations due to site constraints.

3.9.6 As all practicable effective noise mitigation measures have been exhausted, the residual impact is to be abated with indirect mitigation measures in the form of window insulation and air-conditioning.

3.9.7 The modelling results show that the proposed development, with its proposed new roads, is unlikely to cause significant noise impacts on the off-site existing NSRs. Existing roads provide the most significant noise contribution. In addition, direct mitigation measures on new roads has been exhausted and the predicted results indicate that contribution from new roads to the overall noise levels at the existing

NSRs is less than 1 dB(A), the existing NSRs would therefore not be eligible for indirect technical remedies.

Industrial Noise

3.9.8 Fixed plant noise will be emitted from the proposed electric sub-station, generators and transformers in Site 5. With the use of effective noise control equipment and proper design of the plant, the associated noise impacts at the identified noise sensitive receivers are expected to comply with the EIAO-TM requirements.

3.9.9 A fire sub-station has also been planned in Site 5. Noise assessment indicates that daytime and evening operations at the fire station would not result in exceedances of the EIAO-TM criteria.

4 AIR QUALITY

4.1 Introduction

4.1.1 This Chapter considers the air quality impacts associated with the construction and operation phases of the proposed development. The potential air quality impacts arising from the construction works will result mainly from dust emissions. The potential source of air pollution during the operational phase include vehicle exhaust emissions, industrial emissions, and potential emissions from the landfill gas flare soon to be operational adjacent to Jordan Valley Landfill.

4.2 Government Legislation and Standards

4.2.1 The main legislative instrument to control air quality within Hong Kong is the Air Pollution Control Ordinance (APCO, (*Cap. 311*)) and its subsidiary regulations. The titles of the Ordinance and its subsidiary regulations are given in Table 4.1.

Table 4.1 Air Pollution Control Ordinance Legislation

Air Pollution Control Ordinance
Air Pollution Control (Furnaces, Ovens and Chimneys) (Installation and Alteration) Regulations
Air Pollution Control (Dust and Grit Emission) Regulations
Air Pollution Control (Smoke) Regulations
Air Pollution Control (Appeal Board) Regulations
Air Pollution Control (Specified Processes) Regulations
Air Pollution Control (Fuel Restriction) Regulations
Air Pollution Control (Vehicle Design Standards) (Emission) Regulations
Air Pollution Control (Motor Vehicle Fuel) Regulation
Air Pollution Control (Open Burning) Regulation
Air Pollution Control (Construction Dust) Regulation

4.2.2. Ten air control zones, covering the entire SAR, have been declared under APCO. A set of Air Quality Objectives, (AQOs) applicable to all air control zones have also been established. These are shown in Table 4.2.

Table 4.2 Hong Kong Air Quality Objectives

Pollutant	Concentration in micrograms per cubic metre (i)				
	Averaging Time				
	1 Hour (ii)	8 Hours (iii)	24 Hours (iii)	3 Months (iv)	1 Year (iv)
Sulphur dioxide	800		350		80
Total Suspended Particulates			260		80
Respirable (v) Suspended Particulates			180		55
Nitrogen Dioxide	300		150		80
Carbon Monoxide	30,000	10,000			
Photochemical Oxidants (as Ozone) (vi)	240				
Lead				1.5	

Remarks:
(i) Measured at 298 K (25oC) and 101.325 kPa (one atmosphere).
(ii) Not to be exceeded more than three times per year.
(iii) Not to be exceeded more than once per year.
(iv) Arithmetic means.
(v) Respirable suspended particulates means suspended particles in air with a nominal aerodynamic diameter of 10 micrometres and smaller.
(vi) Photochemical oxidants are determined by measurement of ozone only.

4.2.3 According to the Technical Memorandum of the Environmental Impact Assessment Ordinance, it is required to meet hourly Total Suspended Particulate (TSP) concentration of 500 $\mu g/m^3$ measured at 298K and 101.325 Kpa for construction dust impact assessment.

4.2.4 The regulations most pertinent to the proposed development are Air Pollution Control (Specified Processes) Regulations and Air Pollution Control (Construction Dust) Regulation.

4.2.5 Air Pollution Control (Specified Processes) Regulations apply to certain designated operations identified in the Regulations. There are currently 31 Specified Processes, the most relevant one to this development being cement works. Under the requirements of the Ordinance, the operator must obtain a licence from EPD if the plant has a total silo capacity exceeding 50 tonnes. The license holder will be required to comply with a number of operational controls to minimize nuisance from air emissions. Since the site may require a concrete batching plant, an operating licence will be required should the silo capacity meet the above specifications.

4.2.6 The recently enacted Air Pollution Control (Construction Dust) Regulation identifies notifiable works and regulatory works for which specific controls are detailed to prevent air quality impacts. In addition to the control requirements specified in the Regulation, any contractor intending to undertake notifiable work (which includes site formation, building of foundations and superstructures of buildings) is required to notify the Authority in advance of works.

4.2.7 In addition to the legislative requirements for air pollution control, the proposed development should also follow the guidelines stipulated Chapter 9 of the Hong Kong Planning Standards and Guidelines (HKPSG). These guidelines recommend suitable buffer distances between polluting and sensitive uses. Examples of recommended buffers are given in Table 4.3.

Table 4.3 HKPSG Recommended Buffer Distances for Land Uses

Polluting Uses	Sensitive Uses	Buffer Distance
Multi-storey industrial buildings	Residential areas, schools	100m
Multi-storey industrial buildings	Commercial and G/IC uses	30m
Industrial areas	Hospital	500m
Industrial chimneys	Sensitive uses	Within 500m, consult EPD
Industrial chimneys	High-rise buildings	200m
Industrial chimneys	Active open spaces	10-100m
Odour sources	Sensitive uses	200m
Dusty uses	Sensitive uses	100m
Trunk roads	Active open spaces	20m

4.2.8 A Public Transport Interchange (PIT) will be provided for the proposed development. As the PTI is a semi-enclosed facility, adequate ventilation will be provided in the design stage to ensure that the air quality inside will not exceed the relevant air quality guideline limits, as set out in the Practice Note on Control of Air Pollution in Semi-Confined Public Transport Interchanges [ProPECC PN1/98] issued by EPD for the protection of public health.

4.3 Baseline Conditions

4.3.1 The baseline conditions of the air quality of the Study Area are best evaluated by long term environmental monitoring within the area. The nearest EPD ambient monitoring station is situated in Kwun Tong. A summary of the results from this station, for the last three years is shown in Table 4.4.

Table 4.4 Air Quality Monitoring Data for Kwun Tong EPD Monitoring Station

Pollutant	Averaging time	1994 (µg/m³)	1995 (µg/m³)	1996 (µg/m³)	AQO (µg/m³)
Sulphur dioxide SO_2	1 hour	260	121	234	800
	24 hour	109	42	99	350
	1 year	24	10	19	80
Nitrogen dioxide NO_2	1 hour	259	219	251	300
	24 hour	142	125	152	150
	1 year	59	57	65	80
Total suspended Particulate TSP	24 hour	<260	<260	202	260
	1 year	107	107	99	80
Respirable suspended Particulate RSP	24 hour	<180	<180	108	180
	1 year	57	62	59	55

4.3.2 The measurement results show that short term averages for all parameters at the Kwun Tong air quality monitoring station, i.e. one hour and twenty four hour averages, are all in compliance with the respective AQO. However, the long term averages for particulate pollutants are found to exceed the respective AQO.

4.3.3 It is likely that sulphur dioxide levels in Hong Kong are below the long term AQO because of the enforcement of the Air Pollution Control (Fuel Restriction) Regulations for stationary sources and the more recent Air Pollution Control (Vehicle Fuel) Regulation for mobile sources. The increased traffic volume of diesel vehicles in Hong Kong has probably contributed to the nitrogen dioxide level increases in the past few years. For TSP and RSP, the pollutant levels are constantly high; a key contribution factor is likely to be the intensive and widely spread construction activities.

4.3.4 For the purpose of this air quality assessment, the usual practice of adopting the latest annual average results of the nearest air quality monitoring station for the background air pollution levels will be used. In this case, the background pollutant levels for estimating cumulative air pollution impact are 19 µg/m³ for SO_2, 65 µg/m³ for NO_2, 99 µg/m³ for TSP, and 59 µg/m³ for RSP.

4.4 Air Sensitive Receivers

4.4.1 Air sensitive receivers (ASRs) of the development include any existing or planned residential areas, schools and parks etc. in the vicinity of the development near the Choi Wan Road/Jordan Valley area including residents of the development itself. These ASRs may be adversely affected, in terms of air quality, by the development if no effective mitigation measures are implemented. Potential ASRs outside of the development area have been identified from location plans and the information of tentative future development plans. Identified ASRs outside the proposed development (for use in the construction phase assessment) are listed in Table 4.5 and shown in Figure 4.1a while planned ASRs inside the proposed development (for use in the operation phase assessment) are depicted in Figure 4.1b.

Table 4.5 Potential Air Sensitive Receivers in the Vicinity of the Proposed Development - Construction

Air Sensitive Receiver	Location	Approx. Distance from Site [1]
1	Choi Wan Estate	50m
2	Schools at Re-development of Shun Lee Tsuen T.H.A.	350m
3	Shun Lee Estate	650m
4	Shun On Estate	570m
5	Shun Tin Estate	500m
6	Lok Wah Estate	700m
7	Lok Nga Court	350m
8	Jordan Valley Playground and Leisure Pool	100m
9	Choi Ha Estate	20m
10a	Tak Bo Garden	20m
10b	Amoy Gardens	30m
11	Telford Gardens	240m
12	Chu Shek Lun Secondary School/Kai Wo T.H.A	200m
13	Kai Yip Estate	120m
14	St. Joseph's Secondary School	70m
15	Kai Tak Mansions	170m
16	Ping Shek Estate	290m
17	Proposed Ping Shek Playground	150m
18	3 Schools adjacent to Ping Shek Estate	350m
19	Proposed housing development at detective training school site	100m

Notes: [1] Distance to ASRs is approximate, measured from the nearest site boundary.

4.4.2 Representative ASRs from Table 4.5 are selected for the detailed air impact assessment and the monitoring programme for the construction phase.

4.4.3 The planned ASRs from Figure 4.1b have been used in the operational phase assessment.

4.4.4 According to the schedule of works, all Phase I works (site formation) will be completed by 2005. High dust generating activities, such as drilling, blasting, and muckshift, will be conducted during phase I. The remaining works, are low dust generating activities. It has been assumed that the dust emissions during phases 2 and 3 are minimal and should not exert unacceptable impact on residents occupying the early phase of this development. Thus such residents have not been considered ASRs in this assessment.

4.5 Construction Phase

4.5.1 A comprehensive description of the project is included in Chapter 2. It is proposed that the construction of the development is carried out in two stages at five sites to be completed within about seven year period. The first stage is the civil construction, which includes site formation work, while the second stage is the building construction, which includes construction of buildings. During the construction stage, the major air quality impact will arise from fugitive dust emissions. The construction activities that may create significant dust impacts are:

- Site formation, (including excavation or earth moving, blasting, stockpiling of dusty materials and concrete production);
- Use of vehicles on site.

4.5.2 As well as dust emissions, gaseous pollution of sulphur dioxide, nitrogen dioxide, and carbon monoxide may increase due to construction related traffic, and diesel powered construction plant and machinery.

4.5.3 Unless proper dust control measures are implemented, excessive dust may be generated during the site formation, in particular from blasting and earth moving operations. It is anticipated that around 4.6M m^3 of material will be removed off-site over about 4.5 years during the site formation period. It is proposed that the material will be disposed of at the SEKD although the final destination will be subject to a review of the need for fill at that time. At this stage, two alternative approaches are being considered for delivery of the fill from the construction sites to the SEKD. One approach is to transport the fill by truck while the other is to deliver the fill by means of a covered conveyor belt, directly linking the two sites (See Chapter 6). If the first approach is employed, the sites are expected to receive around 50 trucks per hour (25 in/25 out) with a maximum of 84 trucks per hour (42 in / 42 out). Truck movement on unpaved roads within the construction site is a significant dust generating activity. In addition, the increased traffic volume also contributes vehicular exhaust emissions to the ASRs. If the second approach is adopted, the number of vehicles entering the site will be reduced hugely. As a result, fewer vehicle-generated air pollution problems will arise. However, dust may be emitted from the transfer points of the conveyor and the necessary associated crushing plant. Proper design and maintenance of the conveyor and crushing plant will reduce dust emissions from the transfer points.

4.5.4 Large volumes of concrete will be required during the second stage, the building construction period. The concrete will be supplied through trucks from an on-site concrete batching plant. The concrete batching plant will be required to implement stringent dust suppression measures in order to obtain relevant specified process licence under the APCO (if necessary). The dust emissions during the second stage are predicted to be minmal and should not exert unacceptable impact on the residents moving in before the completion of the whole development.

4.5.5 As part of the Final EIA, all these dust sources have been modelled using the Fugitive Dust Model (FDM) for assessment of the air quality impact due to construction activities on site. The detailed modelling methodology and results are discussed in the following sections.

Assessment Methodology

4.5.6 Potential air quality impact on the neighbouring environment caused during construction has been assessed using air dispersion modelling techniques. The predicted air pollutant concentration levels at the neighbouring air sensitive receivers have been compared with relevant AQOs to ensure the attainment and maintenance of AQOs, and the health of the general public in the surrounding of the development area will not be adversely affected by construction activities.

4.5.7 Fugitive Dust Model (FDM) which is approved by USEPA and the Hong Kong EPD has been used to assess the impact of the construction dust emission on the surrounding area. In general, FDM is specifically designed for the analysis of fugitive dust sources. The model is based on the widely used Gaussian Plume formulation for estimating pollutant concentrations, but has been adapted to incorporate a gradient-transfer deposition algorithm which accounts for the settling out of dust particles, and to include wind dependence factors on the dust emission rates.

4.5.8 The surface roughness and particulate density are assumed to be 10 cm and 1.5 g/m^3. Gravitational settling velocity and deposition velocity of particulate matters are considered in the modelling exercise. Moreover, Table 4.6 summarises the particle size distribution adopted in the modelling. These model options are in general conservative assumptions that have been frequently employed in similar air quality assessment exercises.

Table 4.6 Distribution of Particle size of the Particulate being Modelled

Diameter (μm)	Fraction in each size class
1.0	0.04
2.0	0.07
2.5	0.04
3.0	0.03
4.0	0.07
5.0	0.05
6.0	0.04
10.0	0.17
30.0	0.49

4.5.9 Both TSP and RSP impacts have been assessed. Daily and hourly TSP and daily RSP levels are compared with relevant AQOs. Moreover, contour maps showing the general distribution of the particulate concentrations in the surrounding areas are presented to graphically illustrate the results..

Source Information

4.5.10 As a conservative approach, it has been assumed that all the dust generating activities or processes described above will be occurring concurrently.

4.5.11 The equation used for the calculation of emission rates for construction activities within the site area have taken reference of relevant internationally recognized literature. Dust emission factors have been calculated using the equation in the 5th Edition of USEPA AP42 (1995).

4.5.12 According to section 13.2.3 (of the above document) Heavy Construction Operations, the emission factor for construction activities operations are:

	E	=	**1.2 tons/acre/month of activity**
	where		*1 acre = 4,047 m^2*
			Month = 30x24 hours
Therefore,	**E**	=	**1.2 x 1,000 / (4,047 x 30 x 24) kg/ m^2-hr**
		=	**4.12 x 10^{-4} kg/m^2-hr**

4.5.13 The construction site management will need to comply with and is under the control of the "Air Pollution Control (Construction Dust) Regulation". As such, mitigation measures are required to effectively suppress dust emission generated from the operation of the construction site. Assuming the control efficiency for such mitigation measures together with the site specific mitigation measures is 90%, then maximum controlled dust emission from the construction site is (4.12 x 10^{-4} x 0.1) = 4.12 x 10^{-4} kg/m^2-hr or 1.14 x 10^{-5} g/m^2-sec (TSP).

4.5.14 Similarly, it is assumed that RSP contribute about half of the mass fraction TSP. The emission factor of RSP is estimated to be half of that of TSP, i.e., 1/2 (TSP) = 0.5 x 1.14 x 10^{-5} = 5.7 x 10^{-6} g/m^2-sec (RSP).

Receptor Information

4.5.15 A Polar coordinate system has been adopted in the air dispersion modelling exercise. Uniform receiver points were placed within a region bounded by a radial distance of 1,000 m from the approximate center of the planned development area (840208E, 821088N). The uniform receptor points are placed at 10-degree intervals on concentric rings, making a total of 36 receivers on each ring. The maximum radial distance from the origin is set at 1,000 m and the concentric circles are placed at an interval of 100 m starting from an inner ring of 100 m. Thus, there are 360 (36 x 10) uniform grid points altogether. The three levels of receptor points representing lower floors, middle floors, and upper floors are defined respectively as 1.5 m, 30 m, and 60 m above ground.

4.5.16 In addition to the uniform grid points, discrete receiver points corresponding to the identified potential ASRs were evaluated. Elevated grid points (flag-pole receivers) were placed at every selection elevation interval (3 m or 30 m) from the ground level to top level of the buildings. A total of 434 discrete receiver points were placed. These discrete points, representing the potential ASRs, were identified based on information from the Lands Department.

Meteorological Information

4.5.17 One whole year of meteorological data (1995) was obtained from the Hong Kong Observatory (HKO). The majority of meteorological parameters were collected at the Junk Bay weather station, which is the nearest station to the Study Area. For parameters not available at Junk Bay station, data obtained at the HKO headquarters in Tsim Sha Tsui or at the King's Park weather station were used. The meteorological parameters used in the impact assessment are listed in Table 4.7.

Table 4.7 Meteorological Parameters Used in the Impact Assessment

Meteorological Parameters	Data Obtained at
Hourly wind direction Hourly wind speed Hourly temperature Hourly pressure	Junk Bay weather station
Cloud cover Ceiling height	Headquarters in Tsim Sha Tsui
Twice daily mixing heights	King's Park station

4.5.18 The wind rose summarising the wind speeds and directions at Junk Bay weather station is shown in Figure 4.2. It should be noted that the prevailing winds at the site are blowing from the north-northeast direction.

Background Levels

4.5.19 As stipulated in paragraph 4.3.4 of baseline conditions, the background levels of TSP and RSP are respectively assumed to be 99 $\mu g/m^3$ and 59 $\mu g/m^3$.

Results of the Prediction

4.5.20 The predicted maximum (unmitigated and mitigated) 1-hour and 24-hour average dust levels at individual sensitive receivers obtained for TSP and RSP are discussed below. It should be noted that all the tabulated results and contour maps have included baseline dust levels.

4.5.21 Table 4.8 shows the maximum hourly and daily TSP and daily RSP concentrations at ASRs with and without the adoption of dust suppression measures. With no mitigation, there may be exceedances of the hourly and daily TSP and daily RSP levels at some of the ASRs.

Table 4.8 Predicted Maximum Hourly and Daily Particulate Concentrations[(1)]

ASR	Without Mitigation			With Mitigation (90% Reduction)		
	RSP	TSP		RSP	TSP	
	Daily	Hourly	Daily	Daily	Hourly	Daily
1	673	2,022	1,326	120	291	222
2	327	2,059	635	86	295	153
3	225	1,523	431	76	241	132
4	166	1,626	312	70	252	120
5	178	1,971	336	71	286	123
6	213	1,495	408	74	239	130
7	277	1,727	535	81	262	143
8	407	2,220	786	94	311	169
9	604	2,456	1,188	113	335	208
10a	607	1,981	1,196	114	287	209
10b	677	3,042	1,335	121	393	223
11	413	2,001	807	94	289	170
12	460	2,342	902	99	323	179
13	449	2,670	879	98	356	177
14	451	2,674	883	98	356	177
15	423	2,899	829	95	379	172
16	356	2,656	692	89	355	158
17	514	2,597	1,010	105	348	190
18	327	2,086	634	86	297	153
19	411	2,115	803	94	300	169

Remarks:
All the values are in the unit of $\mu g/m^3$.
All of the above values are included the background dust level (TSP=99$\mu g/m^3$ and RSP=59$\mu g/m^3$).
All the predicted maximum concentrations occurred at 1.5m above ground.

4.5.22 Figures 4.3 to 4.11 show the contours of the maximum hourly and daily TSP and maximum daily RSP concentrations at the surrounding area without the adoption of dust suppression measures. Figures 4.12 to 4.20 show the contours of the maximum hourly and daily TSP and daily RSP concentrations at the surrounding area with the adoption of dust suppression measures. With the implementation of stringent mitigation measures, no exceedance is found at the surrounding area.

4.5.23 It should be noted that the predicted results would not normally occur simultaneously over the modelled area, and they are shown as the worst case scenarios that could occur at a particular location throughout the year. Furthermore, the site would not normally operate under the following assumed worst case conditions as assumed in the modelling exercise:

- The modelling exercise assumed that all emissions were emitted simultaneously.

- The emission factor as stated in the AP42 is a conservation estimate, especially for the case of RSP.

Dust Control Measures and EM&A Requirements during Construction

4.5.24 The construction of the development near the Choi Wan Road/Jordan Valley area is not expected to cause any significant dust impacts with respect to the AQOs, provided that the stringent site practices are fully implemented to suppress dust emissions. The recommendations are represented in the form of contractual clauses. Besides, as mentioned in 4.2.6, the Contractor is required to comply the requirements stipulated in the Air Pollution Control (Construction Dust) Regulation when conducting the construction works.

4.5.25 The Contractor shall implement dust suppression measures, which shall include but not be limited to the following:

I. The Contractor shall undertake at all times to prevent dust nuisance as a result of his activities. Effective dust suppression measures as are necessary should be installed to ensure that the air quality at the boundary of the site and at any sensitive receivers complies with the Hong Kong Air Quality Objectives.

II. The Contractor shall notify any specific construction work as stated in the Air Pollution Control (Construction Dust) Regulation to the Authority before the commencement of such work.

III. The Contractor shall apply for a licence or permit under the requirements of the relevant legislations (e.g., Air Pollution Control Ordinance and its subsidiary regulations) wherever applicable.

IV. Watering of unpaved areas, access roads, construction areas and dusty stockpiles shall be undertaken at least eight times daily during dry and windy weather. Watering of the haul road shall be undertaken four to eight times daily during dry or windy weather. Water sprays may be either fixed or mobile to follow individual areas to be wetted as and when required. If necessary, application of suitable wetting agents, such as dust suppression chemicals, shall be used in addition to water, especially during the dry season (October to December).

V. Effective water sprays shall be used during the delivery and handling of all raw sand and aggregate, and other similar materials, wet dust is likely to be created and to dampen all stored materials during dry and windy weather.

VI. Stockpiles of sand, aggregate or any other dusty materials greater than 20 m^3 shall be enclosed on three sides, with walls extending above the pile and 1 metres beyond the front of the pile.

VII. Suitable chemical wetting agent shall be used, where appropriate, on completed cuts and fills to reduce wind erosion.

VIII. Areas within the Site where there is a regular movement of vehicles shall have a paved surface and be kept clear of loose surface material.

IX. No blasting shall be carried out when the strong wind signal or tropical cyclone warning signal No. 3 or higher is hoisted (unless prior permission of the Commissioner of Mines is obtained).

X. Ensure the areas within 30m of the blasting areas are properly wetted before blasting begins.

XI. Should a conveyor system be used, the Contractor shall implement the following precautionary measures. Conveyor belts shall be fitted within windboards. Conveyor transfer points and hopper discharge areas shall be enclosed to minimize dust emission. All conveyors under control of the Contractor, and carrying materials which have the potential to create dust, shall be totally enclosed and fitted with belt cleaners.

XII. Where dusty materials are being discharged to vehicles from a conveying system at a fixed transfer point, a three-sided roofed enclosure with a flexible curtain across the entry shall be provided. Exhaust fans shall be provided for this enclosure and vented to a suitable fabric filter system.

XIII. The Contractor shall restrict all motorized vehicles within the site, excluding those on public roads, to maximum speed of 20 km per hour and confine haulage and delivery vehicles to designated roadways inside the Site.

XIV. Construction working areas will be restricted to a minimum practicable size.

XV. The Contractor shall ensure that no earth, rock or debris is deposited on public or private rights of way as result of his activities, including any deposits arising from the movement of plant or vehicles.

XVI. The Contractor shall provide a wheel washing facility at the exits from work areas to the satisfaction of the Engineer and to the requirements of the Commissioner of Police. Water in wheel washing facilities shall be changed at frequent intervals and sediments shall be removed regularly.

XVII. The Contractor shall submit details of the facility; such wheel washing facilities shall be usable prior to any earthworks excavation activity on the site. The Contractor shall also provide a hard-surfaced road between any washing facility and the public road.

XVIII. In the event of any spoil or debris from construction works being deposited on adjacent land, or streamed, or any slit being washed down to any area, then all such spoil, debris or material and silt shall be immediately removed and the affected land and areas restored to their natural state by the

Contractor to the satisfaction of the Engineer.

XIX. If spoil cannot be immediately transported out of the Site, stockpiles should be stored in sheltered areas.

XX. Plant and vehicles shall be regularly inspected to ensure that they are operating efficiently and that exhaust emissions are not causing a nuisance. All Site vehicle exhausts should be directed vertically upwards or directed away from ground.

XXI. At the end of the works, all stockpiles should be hydroseeded.

XXII. Dust monitoring will be included in the EM&A Manual at the most critical ASRs. In general, 24-hour total suspended particulates and 1-hour total suspended particulates are required to be measured at selected ASRs.

4.5.26 In addition to the general dust mitigation measures identified above, some site specific measures are also proposed to adopt in order to effectively suppress dust emission.

4.5.27 A fully-covered conveyor belt system is proposed transport fill material off site (to SEKD) instead of using trucks travelling in and out of the site. In order to minimize the dust emission from the transfer points of the conveyor belt system, an effective fabric filter system shall be used to further suppress dust emission in the material transfer process (See Chapter 6).

4.5.28 In addition to the conveyor belt system, it is proposed to use a "glory hole" for the transport of material from the highest point that requires excavation down to the 20m platform. This will entail the excavation of a hole (2.5 to 3m diameter) from the 120m (the existing ground level above the proposed 60m platform) down to the 20 platform which is the existing level Flathill Quarry. Excavated material will be passed down the hole to a cavern at the 20m platform where it will be transported to SEKD. The entrance to the loading area will be covered with a structure to minimise dust emissions. The use of the glory hole will minimise on-site movement of trucks carrying spoil and thus will minimise dust generation.

Conclusion

4.5.29 Based on the results of the air quality impact assessment, no significant dust impact on the ASRs and surrounding environment is anticipated to threaten the relevant AQO or acceptable criteria of TSP and RSP provided that implementation of effective dust mitigation measures are followed. The mitigation measures include, but are not limited to, frequent watering of stockpiles and surface road, proper covering or enclosure of materials and adequate wheeling washing facilities for vehicle travelling within the site. Moreover, some site specific mitigation measures are also proposed such as a conveyor belt to transport fill material to SEKD to reduce vehicles travelling within the site such that significant reduction of dust generated from vehicles travelling can be achieved.

4.5.30 Particulate (TSP and RSP) monitoring and audit programme should also be included to provide information regarding the effectiveness of dust suppression measures; the actual dust exposure of the ASRs; and the requirements of further dust suppression measures if necessary.

4.6 Operational Phase

4.6.1 Once the development is complete, the new residents and users of the proposed development will become air sensitive receivers (planned ASRs), to potential impacts from surrounding landuses.

4.6.2 The major sources of air pollution during the operational phase of the development area include those arising from traffic flows on new and existing roads, fixed emissions from industrial activities in the development area and potential emissions from the landfill gas flare at the adjacent Jordan Valley landfill site.

Traffic Generated Air Pollutant Emissions

4.6.3 Traffic generated air pollutant emissions are assessed based on the results of the traffic impact assessment for the year of 2011 and the corresponding vehicular air pollutant emission factors established by EPD. The traffic predictions provide traffic flow patterns of the proposed and existing major road networks within the development and its neighbouring areas.

Assessment Methodology

4.6.4 Nitrogen dioxide (NO_2) and respirable particulates (RSP) are the air pollutants of concern in traffic related emissions. Caline4, a widely accepted Gaussian dispersion model for traffic pollution, has been used for the prediction of maximum hourly concentrations of the two pollutants at planned ASRs of different elevations. Below are the model parameters used in this assessment:

- Nitrogen dioxide (NO_2) is an inert gas.
- 20% of nitrogen oxides (NO_X) is being nitrogen dioxide (NO_2).
- All particulates emitted from vehicles are RSP.
- Aerodynamic roughness coefficient is assumed to be 10 cm.
- No bluff or canyon option is used.

Source Information

4.6.5 Main trunk roads, including the existing and the newly built, inside or within 200 m from the boundary of the development area have been considered as the traffic emission sources. The assessed roads include Kwun Tong Road, Kai Cheung Road, Wai Yip Street, Ngau Tau Kok Road, Choi Ha Road, New Clear Water Bay Road and Clear Water Bay Road, as well as the newly built roads within the development area.

4.6.6 The Traffic Impact Assessment has predicted the peak traffic flow volumes and the traffic mix of the road links for the year of 2011. The year 2011 is considered to be the worst case scenario. The traffic flow and traffic mix data include the prediction of peak scenarios in the morning and in the afternoon. Vehicles are broadly categorized into two types, namely light vehicles and heavy vehicles. Light vehicles include private cars, taxies, light goods vehicles (up to 1.5 tonnes unladen), and motor cycles. Heavy vehicles include buses, medium or heavy goods vehicles (over 1.5 tonnes unladen). The emission factors for NO_x and RSP in 2011 were obtained by the Motor Vehicle Emissions Group of EPD. These factors were determined from the USEPA MOBILE IV program. HGV was used to represent heavy vehicles and P/C-p to represent light vehicles. The emission factors used in the modelling exercise are:

- NO_2: 0.18 g/km for light vehicles and 1.4 g/km for heavy vehicles
- RSP: 0.026 g/km for light vehicles and 0.678 g/km for heavy vehicles

Summary traffic data is given in Appendix D.

Receptor Information

4.6.7 The traffic emission model has been used to predict the concentrations of the said pollutants at different levels of the planned ASRs. Three receptor points at different levels have been located in the middle of each of the newly built buildings, including residential blocks and schools, in the developed area. The three levels of receptor points representing lower floors, middle floors, and upper floors are defined respectively as 1.5 m, 30 m, and 60 m above ground.

Meteorological Information

4.6.8 The meteorological conditions adopted in this impact assessment are:

- Wind speed is 1 m/s
- Stability class is D
- Wind direction is the worst case scenario
- *Wind direction standard deviation is assumed to be 25°
- Mixing height is 1,000 m

*According to USEPA, the taller the surrounding structures, the greater the wind direction standard deviation (sigma-theta). Therefore, if the site is located in a rural area or near shore, sigma-theta should be small, such as 10°. However, for this case the study area is situated in an urban area with high rise buildings and it is justified to adopt a greater sigma-theta, (25°), in the traffic air model.

Background Levels

4.6.9 As stipulated in paragraph 4.3.4 of the baseline conditions section, the background levels of nitrogen dioxide and respirable suspended particulates (RSP) are respectively assumed to be 65 $\mu g/m^3$ and 59 $\mu g/m^3$.

Results of the Prediction

4.6.10 The predicted maximum hourly averages of nitrogen dioxide and respirable suspended particulates at individual planned ASRs are presented in Table 4.9 while the corresponding concentration contours for lower floors are depicted in Figures 4.21 - 4.22. It should be noted that all the tabulated results and the contour maps have included the background concentrations.

Table 4.9a Predicted Maximum Hourly Nitrogen Dioxide

Planned ASRs	With Noise Barrier			Without Noise Barrier		
	Lower Floor	Middle Floor	Upper Floor	Lower Floor	Middle Floor	Upper Floor
1	210	161	110	210	161	110
2	212	161	108	212	161	108
3	214	159	105	214	159	105
4	202	150	101	202	150	101
5	191	142	101	191	142	101
6	248	165	99	248	165	99
7	221	153	97	221	153	97
8	199	144	95	201	144	95
9	189	138	95	191	138	95
10	167	142	105	167	142	105
11	159	138	105	159	138	105
12	148	133	103	148	133	103
13	144	129	103	144	129	103
14	152	133	103	152	133	103
15	157	135	101	157	135	101
16	159	135	99	159	135	99
17	159	133	99	159	133	99
18	244	150	91	261	150	91
19	191	140	91	193	140	91
20	155	131	97	155	131	97
21	283	159	93	293	159	93
22	264	161	97	266	161	97
23	278	174	103	280	174	103
24	248	165	101	248	165	101
25	232	138	88	236	138	88
26	217	142	90	217	142	90
27	208	148	93	208	148	93
28	199	150	97	199	150	97
29	184	144	95	184	144	95
30	191	131	88	191	131	88
31	172	129	88	172	129	88
32	165	129	88	165	129	88
33	159	131	91	159	131	91
34	157	131	93	157	131	93
35	185	131	90	185	131	90
36	170	133	93	170	133	93
37	153	123	95	159	123	95
38	144	118	95	144	118	95
39	137	120	95	137	120	95
40	127	116	95	127	116	95

Table 4.9b Predicted Maximum Hourly Respirable Suspended Particulates

Planned ASRs	With Noise Barrier			Without Noise Barrier		
	Lower Floor	Middle Floor	Upper Floor	Lower Floor	Middle Floor	Upper Floor
1	119	100	78	119	100	78
2	121	100	77	121	100	77
3	122	99	76	122	99	76
4	117	95	74	117	95	74
5	112	92	74	112	92	74
6	137	102	73	137	102	73
7	125	97	72	125	97	72
8	115	93	72	116	93	72
9	111	90	72	112	90	72
10	102	92	76	102	92	76
11	99	90	75	99	90	75
12	94	87	75	94	87	75
13	92	86	75	92	86	75
14	96	88	75	96	88	75
15	97	88	74	97	88	74
16	99	88	74	99	88	74
17	98	87	73	98	87	73
18	133	95	71	140	95	71
19	111	91	70	112	91	70
20	97	86	73	97	86	73
21	151	99	71	154	99	71
22	144	100	72	144	100	72
23	149	105	75	150	105	75
24	136	101	74	137	101	74
25	129	90	69	131	90	69
26	123	92	70	124	92	70
27	119	94	71	120	94	71
28	116	95	72	116	95	72
29	109	92	72	109	92	72
30	111	87	69	111	87	69
31	104	87	68	104	86	68
32	101	86	69	101	86	69
33	99	87	70	99	87	70
34	98	87	71	98	87	71
35	109	87	70	109	87	70
36	103	88	71	103	88	71
37	96	83	72	98	83	72
38	91	81	72	91	81	72
39	89	82	71	89	82	71
40	85	80	72	85	80	72

4.6.11 In order to assess whether the predicted concentrations are acceptable, 1 hour AQO for NO_2 is adopted. However, 24 hour AQO for RSP is adopted as a conservative estimate to assess the predicted hourly average RSP concentrations as there is no 1 hour AQO for RSP. As shown in Tables 4.9a and 4.9b, all predicted maximum hourly concentrations of NO_2 are found to be below the corresponding AQO. In addition, since all predicted maximum hourly concentrations of RSP are found to be below the 24 hour AQO for RSP, there are no predicted exceedances of the 24 hour AQO for RSP.

4.6.12 The traffic volumes of the new internal roads related to the new development are much lower that that of the existing main trunk roads. In addition, existing ASRs are situated much further away from the new roads than existing roads and thus the ASRs would not be adversely affected by traffic emissions from the internal roads.

Barrier Effect

4.6.13 The arrangements of the proposed noise barriers are detailed in Chaper 3. The air quality in relation to the presence of the noise barriers is assessed by assuming that the road segments with noise barriers are elevated roads and their elevations equal the height of the noise barriers in question. The results reflecting the barrier effect are given in Tables 4.9a - 4.9b and contour maps are shown in Figures 4.23 - 4.24.

4.6.14 The results show that the air impact due to the presence of noise barriers are not significant. Similar to the modelling results without barrier effect, no exceedances are identified at all.

Fixed Emissions From Industrial Activities and the Landfill Gas Flare

4.6.15 The existing landuse in the Study Area is predominantly high-density residential development with associated commercial, community and recreational facilities. The nearest industrial use is in Kowloon Bay Industrial Area, which is about 600 metres south-west of the Study Area.

4.6.16 Furthermore, the proposed development in the Study Area will not include heavy industries which are sources of air pollution.

4.6.17 However, there would still be air pollutant emissions from industrial activities where fuel is combusted in boilers or other industrial processes. Also, a landfill gas flare is proposed to flare off the LFG generated from Jordan Valley Landfill which lies within the Study Area.

Assessment Methodology

4.6.18 ISCST3 has been used for the prediction of air quality impacts from industrial activities and the landfill gas flare.

4.6.19 Sulphur dioxide (SO_2)and nitrogen dioxide (NO_2)are identified as the pollutants of concern in air pollution induced by industrial operations. ISCST3, a widely accepted Gaussian dispersion model for industrial sources, is used for the prediction of the maximum hourly and daily concentration of the two pollutants at the planned ASRs of different elevations. Below are the model parameters used in this assessment:

- URBAN dispersion mode
- gradual plume rise
- zero decay of air pollutants
- no deposition
- stack-tip downwash
- buoyancy-induced dispersion
- use calms processing routine
- receptors on elevated terrain

Source Information

4.6.20 Emission data of chimneys located within 500 m from the boundary of the development area have been obtained from EPD. According to EPD's record, there are only three chimneys, excluding emergency generators, identified within 500 m from the boundaries. One is located about 500 m from the boundary with Telford Garden and the other two are located about 300 m from the boundary with Amoy Garden. In other words, the identified chimneys are all located within a non-industrial area. From the locations, and the emission data of these chimneys, it appears they are connected to small scale fuel consumption appliances for non-industrial uses. Therefore, the air quality impact from the fixed industrial sources is expected to be insignificant. Sulphur dioxide and nitrogen dioxide emissions from the chimneys was considered in this modelling calculation and the following assumptions in calculating the emission rates have been used:

- sulphur content for fuel oil is 0.5 % by weight;
- the emission of sulphur dioxide (SO_2) will be calculated by considering that all sulphur in the fuel oil converts to sulphur dioxide (SO_2) in burning;
- nitrogen dioxide (NO_2) is assumed to be 30% of generated nitrogen oxides (NO_x), which is obtained from AP-42;
- the efflux velocity of the chimneys will all be assumed to be 7 m/s;
- the exit temperature is 450K when data are not available.

4.6.21 For the landfill gas flare, the emission data of nitrogen dioxide and sulphur dioxide were adopted from the landfill gas flare assessment as listed below:

- NO_2: 0.06 g/s
- SO_2: 0.16 g/s

Receptor Information

4.6.22 ISCST3 has been used to predict the concentrations of the said pollutants at different levels of the planned ASRs. Four receptor points of different levels have been located at the middle of each of the newly built buildings, including residential blocks and schools, in the development area. The four levels of receptor points are put at 1.5 m, 30 m, 60 m, and 90 m above ground.

Meteorological Information

4.6.23 The meteorological data used in ISCST3 are identical to that used in FDM, i.e. one year actual meteorological data of 1995 from Junk Bay, Tsim Sha Tsui, and King's Park Stations.

Background Levels

4.6.24 As stipulated in paragraph 4.3.4 of baseline conditions section, the background levels of sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) are respectively assumed to be 19 $\mu g/m^3$ and 65 $\mu g/m^3$.

Results of the Prediction

4.6.25 The predicted maximum hourly and daily averages of sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) at individual planned ASRs are presented in Table 4.10. It should be noted that all the tabulated results have included the background concentrations.

Table 4.10 Predicted Maximum Concentrations of SO_2 and NO_2

Height of receptor above ground (m)	Sulphur dioxide ($\mu g/m^3$)		Nitrogen dioxide ($\mu g/m^3$)	
	1 hour average	24 hour average	1 hour average	24 hour average
1.5	32	22	72	66
30	35	24	71	66
60	44	26	69	66
90	47	23	70	66

4.6.26 To assess whether the predicted concentrations are acceptable, they have been compared against 1 hour and daily AQOs for SO_2 and NO_2. As shown in Table 4.10, all predicted maximum hourly concentrations of SO_2 and NO_2 are found to be well below the corresponding AQO.

Cummulative Impact of the Emissions from Traffic, Chimney, and LFG Flare

4.6.27 To assess the cummulative impact of different sources of emissions during the operational phase, as a conservative approach, the maximum predicted levels of the common parameter of the models and the background level were added altogether. The common parameter of the models is the one hour nitrogen dioxide. The maximum one hour NO_2 levels are 228 $\mu g/m^3$ and 7 $\mu g/m^3$ respectively for the traffic sources and the fixed sources. With the addition of the background level of NO_2 of 65 $\mu g/m^3$, the result does not exceed the respective AQO. Therefore, it is concluded that the cummulative impact of the combined sources is acceptable.

Conclusion

4.6.28 From the modelling exercise using Caline4 for the traffic air assessment, there are no predicted exceedances of 1 hour AQO for NO_2 and 24 hour AQO for RSP at planned ASRs.

4.6.29 According to the modelling results of ISCST3, it is concluded that industrial sources and the landfill gas flare will not pose unacceptable air quality impact on the planned ASRs.

4.6.30 By considering the prediction from different models, it is concluded that the combined sources during the operational phases are unlikely to pose unacceptable air quality impact on the planned ASRs.

5. WATER QUALITY

5.1 Introduction

5.1.1 The construction and operation of the proposed development near Choi Wan Road and Jordan Valley has the potential to impact upon the aquatic environment. In order to assess the environmental risks posed by construction and operation activities, and thus the requirements for mitigation/treatment, the following strategy has been adopted herein:

- identify the applicable water quality legislation/environmental criteria to be complied with during the development construction/operation;
- identification of existing hydrological conditions and water quality sensitive receivers (SRs) in the vicinity of the Choi Wan Road/Jordan Valley development site which may be impacted during development construction and operation;
- identify potential sources of water contamination during the construction phase of the development;
- identify potential sources of water contamination during development operation;
- assess risks to identified SRs taking into account wastewater arising volumes and chemical characteristics;
- recommendation of appropriate mitigation measures for amelioration of adverse impacts such that the proposed scheme can proceed without significant impacts upon the aquatic environment. Assessment of residual impacts; and
- identification of water quality monitoring requirements.

5.1.2 The sections below detail how the steps outlined above have been carried out. Water supply, drainage and sewage impacts are considered in other Study deliverables (e.g. the sewage impact assessment (SIA), drainage impact assessment (DIA) etc.). However, relevant information from both the SIA and DIA has been included herein where applicable.

5.2 Government Legislation and Standards

5.2.1 This water quality assessment has been prepared taking into account the relevant Hong Kong legislation as follows:

- the Water Pollution Control Ordinance (Cap. 358);
- the Water Pollution Control (General) Regulations;
- the Water Pollution Control (Sewerage) Regulations;

- the Statement of Water Quality Objectives (WQO) (Victoria Harbour (Phase 2) Water Control Zone);
- Annex 6 and Annex 14 of the Technical Memorandum (TM) on the Environmental Impact Assessment (EIA) Process.

5.2.2 Hong Kong's water quality legislative framework is built around the Water Pollution Control Ordinance (WPCO 1981(Cap. 358)), from which over 20 other Regulations and Orders stem. 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 Victoria Harbour WCZ was declared in three separate phases, Phase 1 was declared in November 1994 (covering Kwai Chung, East Kowloon and their adjacent waters); Phase 2 was declared in September 1995 (covering North, South and West Kowloon and their adjacent waters); Phase 3 was declared on 1 April 1996 and covers the north shore of Hong Kong Island from Kennedy Town to Sai Wan Ho and its adjacent waters. Run-off from the Choi Wan Road/Jordan Valley Study Area catchment will discharge into Kai Tak Nullah Channel Approach which is within the Phase 2 Victoria Harbour WCZ. It is noted, however, that the Choi Wan Road/Jordan Valley Study Area itself lies within Phase 1 of the Victoria Harbour WCZ.

5.2.3 Table 5.1 presents the WQOs for Victoria Harbour (Phase 2) WCZ, into which construction and operational wastewaters arising from development of the Choi Wan Road/Jordan Valley site will ultimately discharge.

Table 5.1: Water Quality Objectives for Victoria Harbour (Phase 2) Water Control Zone

	Water Quality Objective	Part of Parts of Zone
A.	AESTHETIC APPEARANCE	
	(a) There should be no objectionable odours or discoloration of the water.	Whole zone
	(b) Tarry residues, floating wood, articles made of glass, plastic, rubber or of any other substances should be absent.	Whole zone
	(c) Mineral oil should not be visible on the surface. Surfactants should not give rise to a lasting foam.	Whole zone
	(d) There should be no recognisable sewage-derived debris.	Whole zone
	(e) 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
	(f) The water should not contain substances which settle to form objectionable deposits.	Whole zone
B.	BACTERIA	
	The level of *Escherichia coli* should not exceed 1,000 per 100 mL, calculated as the geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.	Inland waters
C.	COLOUR	
	Human activity should not cause the colour of water to exceed 50 Hazen units.	Inland waters
D.	DISSOLVED OXYGEN	
	(a) 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 sample occasions during the whole year.	Marine waters
	(b) The level of dissolved oxygen should not be less than 4 mg per litre.	Inland waters
E.	pH	
	(a) The pH of the water should be with 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 unit.	Marine waters
	(b) Human activity should not cause the pH of the water to exceed the range of 6.0 - 9.0 units	Inland waters
F.	TEMPERATURE	
	Human activity should not cause the daily temperature range to change by more than 2.0°C.	Whole zone
G.	SALINITY	
	Human activity should not cause the salinity level to change by more than 10%.	Whole zone
H.	SUSPENDED SOLIDS	
	(a) Human activity should neither cause the suspended solids concentration to be raised more than 30% nor give rise to accumulation of suspended solids which may adversely affect aquatic communities.	Marine waters
	(b) Human activity should not cause the annual median of suspended solids to exceed 25 mg per litre	Inland waters

Table 5.1 Continued

	Water Quality Objective	Part of Parts of Zone
I.	AMMONIA	
	The unionised ammoniacal nitrogen level should not be more than 0.021 mg per litre, calculation as the annual average (arithmetic mean).	Whole zone
J.	NUTRIENTS	
	(a) Nutrients should not be present in quantities sufficient to cause excessive or nuisance growth of algae or other aquatic plants.	Marine waters
	(b) Without limiting the generality of objective (a) above, the level of inorganic nitrogen should not exceed 0.4 mg per litre, expressed as annual water column average (see Note).	Marine waters
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.	TOXIC SUBSTANCES	
	(a) Toxic substances in the water should not 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
	(b) Human activity should not cause a risk to any beneficial use of the aquatic environment.	Whole zone

Note: Expressed normally as the arithmetic means 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.

5.2.4 Any discharge into the inland waters of the Victoria Harbour WCZ is required to comply with the standards as specified in the Technical Memorandum (TM) on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (1991) as issued under the provisions of the WPCO. These guidelines (see Table 5.2) are applicable during both construction and operation for discharges that are categorised as effluents. Rain water runoff from any part of a building, including any area appurtenant to a building, or runoff water which does not contain any poisonous, noxious or polluting matter is not subject to compliance with the WPCO and TM. However, any surface runoff other than those detailed above are subject to WPCO and TM control.

5.2.5 Inland waters are divided into four different zones based on their beneficial use as follows.

- Group A = abstraction for potable water supply
- Group B = irrigation
- Group C = pond fish culture
- Group D = general amenity and secondary contact recreation

5.2.6 It is noted that the recipient Victoria Harbour inland waters are not categorised under Groupings A, B, C or D and as such the discharge standards specified in the TM for Group A/B/C/D waters are not applicable.

Table 5.2: Water Quality Standards for Effluent Discharges into the Inshore Waters of Victoria Harbour Water Control Zone

Flow rate (m^3/day) Determinant	≤10	>10 and ≤200	>200 and ≤400	>400 and ≤600	>600 and ≤800	>800 and ≤100	>100 and ≤150	>150 and ≤200	>200 and ≤300	>300 and ≤400	>400 and ≤500	>500 and ≤600
pH (pH units)	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9
Temperature (°C)	40	40	40	40	40	40	40	40	40	40	40	40
Colour (lovibond units) (25mm cell length)	1	1	1	1	1	1	1	1	1	1	1	1
Suspended solids	50	30	30	30	30	30	30	30	30	30	30	30
BOD	50	20	20	20	20	20	20	20	20	20	20	20
COD	100	80	80	80	80	80	80	80	80	80	80	80
Oil & Grease	30	20	20	20	20	20	20	20	20	20	20	20
Iron	15	10	10	7	5	4	2.7	2	1.3	1	0.8	0.6
Boron	5	4	3	2.7	2.7	1.6	1.1	0.8	0.5	0.4	0.3	0.2
Barium	5	4	3	2.7	2.7	1.6	1.1	0.8	0.5	0.4	0.3	0.2
Mercury	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Other toxic metals individually	1	1	0.8	0.7	0.7	0.4	0.25	0.2	0.15	0.1	0.1	0.1
Total toxic metals	2	2	1.6	1.4	1.4	0.8	0.5	0.4	0.3	0.2	0.14	0.1
Cyanide	0.2	0.1	0.1	0.1	0.1	0.1	0.05	0.05	0.03	0.02	0.02	0.01
Phenols	0.5	0.5	0.5	0.3	0.3	0.2	0.13	0.1	0.1	0.1	0.1	0.1
Sulphide	5	5	5	5	5	5	2.5	2.5	1.5	1	1	0.5
Total residual chlorine	1	1	1	1	1	1	1	1	1	1	1	1
Total nitrogen	100	100	100	100	100	100	80	80	50	50	50	50
Total phosphorus	10	10	10	10	10	10	8	8	5	5	5	5
Surfactants (total)	20	15	15	15	15	15	10	10	10	10	10	10
E. coli (count/100 mL)	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000

(All units in mg/L unless otherwise stated; all figures are upper limits unless otherwise indicated)

5.3 Baseline Conditions

Sensitive Receivers

5.3.1 Sensitive receivers are defined as those users/occupants of the aquatic/marine environment whose use of the environment could be impaired as a result of the proposed development. According to the EIA TM, existing or potential beneficial uses that are sensitive to water pollution include, but are not limited to the following:

- areas of ecological or conservation value, including marine conservation areas, existing or gazetted proposed marine parks and marine reserves, Sites of Special Scientific Interest (SSSIs), existing or gazetted proposed Country Parks and Special Areas, wetlands, mangroves and important freshwater habitats;
- areas for abstraction of water for potable water supply;
- water abstraction for irrigation and aquaculture;
- fish spawning grounds, fish culture zones, shellfish harvesting/culture site and brackish/freshwater fish ponds;
- beaches and other recreational areas;
- water abstraction for cooling, flushing and other industrial purposes;
- areas for navigation/shipping including typhoon shelters, marinas and boat parks.

5.3.2 Water quality sensitive receivers that are important with respect to the Choi Wan Road/Jordan Valley development are shown on Figure 5.1.

5.3.3 The Study Area is currently largely undeveloped, although the area has been severely disrupted in the northern half of the site by quarrying and the subsequent completion of the Jordan Valley Landfill. The northern part of the site consists of a steep grassy hill, which hosts an existing water supply service reservoir at the summit at approximately 170 mPD.

5.3.4 Jordan Valley runs north-east to south-west through the Study Area with the proposed development occurring north/west of the valley. In the upper reach of the valley adjacent to the landfill site is a disused dam which has been reclaimed. The spillway is still in operation and controls flow into the lower watercourse, comprising a rocky stream, before flowing into the Jordan Valley Nullah which is the main watercourse within the Study Area. Paragraph 5.3.19 illustrates that water quality in the nullah is variable, with poor conditions being experienced in the dry season. In addition, sediment/debris which has accumulated in the nullah has been reported to cause an occasional odour nuisance in the vicinity of the bus depot. Downstream of the site are the well-established and densely populated areas of Kowloon Bay and Ngau Tau Kok.

5.3.5 Stormwater generated during construction and operation of the Choi Wan Road/Jordan Valley development will discharge into two drainage systems that ultimately flow into inner Victoria Harbour via the Kai Tak Nullah Approach Channel (refer to Paragraphs 5.3.9 - 5.3.14). Thus, pollutants discharged from the proposed development during construction and operation ultimately have the potential to affect water quality within Victoria Harbour. As is detailed in Paragraphs 5.3.21 - 5.3.23, water quality in the Kwun Tong Typhoon Shelter (which is within the Kai Tak Nullah Approach Channel) is already very poor. Nevertheless, it will be important to ensure that the construction and operation of the proposed development does not lead to further deteriorations in water quality. It is noted that, as part of the SEKD programme, Kai Tak Nullah will be reclaimed with the Jordan Valley Nullah discharge point being reprovisioned to discharge directly into Victoria Harbour.

5.3.6 A salt water intake and pumping station operated by Water Supplies Department (WSD) are located at Tai Wan which supplies flushing water to buildings in existing areas (refer to Figure 5.1). There is also a saltwater intake at Cha Kwo Ling. These intakes are defined as sensitive receivers and the proposed development should aim to prevent adverse impacts such as elevated suspended solids levels. WSD flushing target limits are shown in Table 5.3.

Table 5.3: WSD Quality Objectives for Flushing Purposes

Parameter	WSD Flushing Target Limit
Colour (HU)	< 20
Turbidity (NTU)	< 10
Threshold Odour Number	< 100
Ammoniacal Nitrogen (mgN/L)	< 1
Suspended Solids (mg/L)	< 10
Dissolved Oxygen (mg/L)	> 2
Biochemical Oxygen Demand (mg/L)	< 10
Synthetic Detergents (mg/L)	< 5
E.coli (no./100 mL)	< 20,000

5.3.7 The Hong Kong International Airport at Kai Tak operates a seawater cooling system. This involves seawater abstraction from the open harbour rather than from the Kai Tak Nullah Approach Channel. Whilst a seawater intake is classified as a sensitive receiver, by the time the Choi Wan Road/Jordan Valley development is being constructed, it is anticipated that the airport cooling system will no longer be utilised given that the airport will have been closed.

5.3.8 There are no areas of mariculture in the near vicinity of the Study Area which could be adversely affected by inputs to the storm water drainage system from the proposed development site.

Drainage Basin Characteristics

5.3.9 The drainage basin in which the Choi Wan Road/Jordan Valley development site is located has been referred to as Basin Catchment P in the recent SEKD Feasibility Study and has an overall catchment area of around 560 hectares.

5.3.10 All stormwater drainage from the proposed development area will flow into the existing urban stormwater drainage systems. Details of the existing stormwater drainage are illustrated on the Key Drainage Plan (refer to Figure 5.2). At present the main drainage of the disused quarry site and adjacent catchment comprises a series of 1.200m and 1.500m diameter pipes along Choi Wan Road leading to a 4 Cell 1.525m x 0.910m box culvert at the junction of Choi Wan Road and Ngau Tau Kok Road. This culvert (referred to as the Choi Wan Road Box Culvert) carries flow across the low lying MTR yards into a single cell (2.740m x 2.740m) box culvert adjacent the southbound Kai Cheung Road flyover. Flow then passes into a single cell (3.300m x 3.300m) box culvert.

5.3.11 The second major existing drainage route for the Study Area comprises the 7.5m wide Jordan Valley Nullah, which widens at the downstream end into a 15m wide section of decked nullah beneath the bus terminus. Flow is conveyed downstream of the decked section of nullah by a 4-cell (3.960m x 3.350m) box culvert, which carries flow along Shuen Yuet Road. Flow from Jordan Valley confluence with flows from Choi Wan Road at a junction on Shuen Yuet Road and ultimately discharges into Kai Tak Approach Nullah and hence Victoria Harbour via a 7-cell (4.120m x 3.800m) box culvert.

5.3.12 The drainage basin in which the site is located has been divided into representative subcatchments for analysis in the DIA. Figure 5.3 shows the Study Area and a subcatchment representation of the entire drainage basin. A smaller scale and more detailed view of the subcatchments comprising the Study Area are shown in Figure 5.4. The subcatchments that stand to be significantly altered as a result of the development are subcatchment 1b and the upper portion of subcatchment 5c, namely, 5c(a) (refer to Figure 5.4). Subcatchment 5c(a) ultimately drains to the Jordan Valley Nullah, via Choi Ha Estate Cascade and the drainage beneath Choi Ha Road. Subcatchment 1b drains to Choi Wan Road via the disused quarry.

5.3.13 For the purpose of monitoring the existing site drainage characteristics and evaluating hydrological changes caused by the proposed development, changes to catchment parameters have been compared at specific locations. The discharge locations are identified as follows:

- subcatchment 5c(a) drains initially to the top of Choi Ha Estate Cascade. This location is referred to as discharge location B, (refer to Figure 5.4);
- subcatchment 1b drains initially to the existing drainage along Choi Wan Road. This location is referred to as discharge location C, (refer to Figure 5.4);
- the entirety of the catchment 5c (including subcatchments 5c(a) and 5c(b)), drains to the Jordan Valley Nullah. For the purpose evaluating impacts of the development on the Jordan Valley Nullah, this is referred to as discharge location A, (refer to Figure 5.4).

5.3.14 The details of the drainage facilities immediately downstream of the discharge locations are summarised in Table 5.4.

Table 5.4: Summary of Existing Drainage Discharge Locations

Discharge Location	Type	Size	Location
A	Nullah	Base Width : 7.5m Depth : 2.7m	Adjacent Jordan Valley North Rd
B	Cascade	Width : 2.5m	Adjacent Choi Ha Rd
C	Reinforced Concrete Pipe	Diameter: 1.2m	Beneath Choi Wan Rd

Water Quality of Drainage System and Receiving Waters

5.3.15 EPD does not routinely monitor water quality in either the Jordan Valley Nullah or the Choi Wan Road drainage system. However, Maunsell (1997) investigated water quality in the Jordan Valley Nullah during the nullah decking feasibility study. As part of that study, it was observed that the water in the nullah appeared to be quite clean implying low levels of suspended solids, turbidity and oil and grease levels. In order to confirm this visual inspection a two day monitoring programme was carried out in March 1997, results of which are shown in Table 5.5. The monitoring locations are shown in Figure 5.5.

Table 5.5: Water Quality Monitoring Results - Jordan Valley Nullah (Maunsell 1997) (mg/L unless otherwise indicated)

	Sampling Date					
	Station 2A 13/03/97	**Station 2A 14/03/97**	**Station 2B 13/03/97**	**Station 2B 14/03/97**	**Station 2C 13/03/97**	**Station 2C 14/03/97**
pH Value	7.5	7.6	7.5	7.6	7.3	7.4
Temperature (°C)	23.7	22.8	23.5	22.7	23.1	22.3
Salinity (ppt)	10.1	10.1	9.5	9.1	8.7	7.9
Dissolved Oxygen	7.1	6.8	6.4	6.4	6.1	5.6
Dissolved Oxygen Saturation (%)	72%	73%	77%	71%	65%	63%
Turbidity (Ftu)	32.2	32.4	29.6	28.4	30.0	47.8
Suspended Solids	56	52	52	38	40	98
E. coli (cfu/100 mL)	25000	12000	110000	200000	42000	80000
Arsenic - Total (µg/L)	<5	<5	<5	<5	<5	<5
Boron - Total (µg/L)	2400	1230	1230	1170	1110	995
Ammoniacal Nitrogen	10.3	11	9.5	10.2	7.6	6.9
Total Organic Carbon	9	14	9	9	10	10
Total Inorganic Carbon	32	36	32	30	30	28
Total Carbon	42	50	41	39	40	39
Chemical Oxygen Demand	53	39	25	54	42	31
5-day Biochemical Oxygen Demand (mg/L)	12	12	8	9	12	15
Water Quality Index (WQI)	**11 (Bad)**	**11 (Bad)**	**10 (Fair)**	**10 (Fair)**	**12 (Bad)**	**12 (Bad)**

5.3.16 Table 5.5 illustrates that water in the Jordan Valley Nullah had suspended solids levels in the range 38 - 98 mg/L, *E. coli* levels in the range 12,000 - 200,000 per 100 mL, whilst chemical (COD) and biochemical (BOD_5) oxygen demand levels ranged from 25 – 54 and 8 - 15 mg/L respectively. *In situ* water testing illustrated that the nullah water had a dissolved oxygen (DO) saturation between 63 - 77%, and a pH between 7.3 - 7.6. On the basis of the DO, BOD_5 and ammoniacal nitrogen monitoring results, the Water Quality Index (WQI) for the watercourse was defined as ranging from fair to bad.

5.3.17 Table 5.5 also illustrates that water the Jordan Valley Nullah exceeds the Victoria Harbour (Phase 2) WQO for suspended solids (25 mg/L), as well as the WQOs for

E. coli (1000 per 100 mL), ammonia (0.021 mg/L), BOD (5 mg/L) and COD (30 mg/L). Levels of DO and pH were, however, compliant with the relevant WQOs.

5.3.18 These monitoring results suggest that the Jordan Valley Nullah was experiencing organic pollution, possibly due to domestic discharges, or discharges from squatter camps. It is noted that the sampling programme was undertaken in the dry season when nullah flows are low - thus offering a low dilution potential for any contaminative discharges.

5.3.19 In addition to the above, monitoring of water quality in the Jordan Valley Nullah has been undertaken as part of the Urban Landfills Restoration Contract (ULRC). The data for July - September 1997 are summarised in Table 5.6.

Table 5.6: Water Quality Data from Jordan Valley Nullah
(Data Collected during the Urban Landfills Restoration Contract Monitoring Programme) (units in mg/L unless indicated)

Parameter	Jordan Valley Nullah		
Date of sampling	3 Jul 97	8 Aug 97	29 Sep 97
Sampling time	12:18	10:38	10:10
Alkalinity	32	36.0	58.0
Ammoniacal-nitrogen	<0.1	<0.1	3.0
Total organic nitrogen	0.4	0.07	0.6
Total organic carbon	2.1	4.0	8.0
Biological oxygen demand	<2	<2	<2
Chemical oxygen demand	<5	<5	24.0
Potassium	2.6	3.1	12.0
Sodium	11	22.0	173.0
Magnesium	1.4	2.1	23.0
Sulphate	12	16.0	70.0
Suspended solids	2	<1	<0.1
Chloride	14	11.0	336.0
Iron	0.1	0.15	<0.6
Manganese	0.02	<0.01	<0.04
Zinc	<0.04	<0.04	<0.04
Copper	<0.02	<0.02	<0.02
Nickel	<0.05	<0.05	<0.05
Calcium	12	11.0	24.0
Lead	<0.07	<0.07	<0.07
Cadmium	<0.02	<0.02	<0.02

5.3.20 Table 5.6 illustrates that during the ULRC monitoring programme, water quality in the Jordan Valley Nullah was significantly better than observed during the monitoring undertaken by Maunsells in March 1997. Water samples collected from July to September 1997 contained low levels of suspended solids, ammonia, BOD, COD and heavy metals. No water sample contained a chemical constituent in excess of the relevant WQO. It is considered that the improved water quality in the Jordan Valley Nullah, as observed during the ULRC monitoring programme as compared to monitoring undertaken by Maunsells, is due in part to the higher nullah dilution potential during the wet season. These results illustrate the potentially great variability in nullah annual water quality, with worst conditions occurring in the dry season.

5.3.21 Discharges from the Jordan Valley Nullah and Choi Wan Road drainage system enter Kai Tak Nullah Inner Channel. EPD routinely monitors water quality in the Kwun Tong Typhoon Shelter is indicated to be heavy polluted by organic wastes - refer to Table 5.7.

Table 5.7: EPD Routine Water Quality Data for Kwun Tong Typhoon Shelter (mg/L unless otherwise indicated) (EPD, 1996)

Parameter	Location	Concentration
Temperature (^{o}C)	Surface	22.7 (16.9 – 28.0)
	Bottom	21.9 (16.1 – 27.8)
Salinity (ppt)	Surface	29.8 (25.5 – 33.3)
	Bottom	32.0 (31.2 – 33.1)
Dissolved oxygen (% saturation)	Surface	6.8 (3.4 – 9.1)
	Bottom	12.3 (0.2 – 53.5)
Dissolved oxygen	Surface	1.1 (0.2 – 4.0)
	Bottom	1.0 (<0.1 – 4.4)
pH	Depth average	7.7 (7.5 – 7.9)
Turbidity (NTU)	Depth average	6.8 (6.0 – 8.8)
Suspended solids	Depth average	8.2 (3.0 – 17.3)
BOD	Depth average	5.3 (3.1 – 10.9)
Nitrite nitrogen	Depth average	0.02 (<0.01 – 0.06)
Nitrate nitrogen	Depth average	0.02 (0.01 – 0.04)
Ammoniacal nitrogen	Depth average	1.63 (1.14 – 3.43)
Total inorganic nitrogen	Depth average	1.67 (1.21 – 3.44)
Total nitrogen	Depth average	2.20 (1.60 – 4.14)
Ortho-phosphate	Depth average	0.21 (0.12 – 0.33)
Total phosphate	Depth average	0.35 (0.24 – 0.50)
Chlorophyll-*a* (μg/L)	Depth average	4.51 (0.60 – 13.75)
E.coli (cfu/100mL)	Depth average	208,122 (81,000 – 472,000)
Faecal Coliform (cfu/100mL)	Depth average	268,445 (85,333 – 586,667)

Note: Data presented are annual arithmetic means except for *E.coli* and Faecal Coliform data which are geometric means
Data enclosed in brackets indicates ranges

5.3.22 On the basis of the available water quality data, EPD has classified the typhoon shelter as being of Category 3, which means that DO levels are generally below 4 mg/L, total nitrogen levels greater than 0.8 mg/L and *E.coli* levels in excess of 5000 cfu/100 mL. Water quality is poor in the Kwun Tong Typhoon Shelter due to the surface water and sewage effluents being received from the surrounding heavily urbanised areas combined with the minimal degree of tidal flushing.

5.3.23 Tables 5.5 and 5.6 illustrate that the Jordan Valley Nullah has the potential to contribute to the high pollutant load of the Kwun Tong Typhoon Shelter, whilst under low flow conditions there may be local adverse impacts on water quality. It is noted that under the proposed SEKD Programme, the Kwun Tong Typhoon Shelter will be reclaimed and discharges from Jordan Valley Nullah will be directly into Victoria Harbour. Following reprovisioning of the nullah, the associated contaminants will contribute to the pollutant load received by Victoria Harbour.

Jordan Valley Landfill

5.3.24 The management of leachate from Jordan Valley Landfill is the responsibility of the Restoration Contractor as specified in the Urban Landfill Restoration Contract (ULRC) and is thus will not be addressed in detail in this EIA. However, a qualitative assessment is given below.

5.3.25 Jordan Valley Landfill is a valley in-fill type landfill within an existing topographic valley. It is surrounded on three sides by high ridges forming a drainage divide. Ground water flows reflect the surface topography with water moving from the ridges down to the valley bottom, where small streams and springs were previously situated.

5.3.26 Leachate levels in the top platform of the landfill are known to be high. During the Restoration of Urban Landfills Study site investigation, (Binnie 1992) leachate levels at the top platform were encountered at depths of 3 to 5m below the surface illustrating the presence of approximately 45 m of saturated waste above a PVC liner of unknown hydraulic conductivity. Due to the nature of the surrounding topography groundwater flows into the landfill – inflow rates of 0.4 - 0.6 litres per second have been estimated (Binnie 1992). Groundwater generally flows from the surrounding ridges down hydraulic gradients towards the south-east toe of landfill, then once in the main valley, towards the existing dam. Therefore, whilst leachate migration off-site is known to occur, it is generally in a direction away from the proposed Choi Wan Road/Jordan Valley development site.

5.3.27 Currently, at Jordan Valley, leachate is collected by a series of leachate collection pipes installed above the base of the landfill. This collects in a concrete discharge pipe, which runs from the top of a rock bund down slope to a leachate weir where it discharges into the foul sewer system. Historical flows of leachate from Jordan Valley range from 0 - 1900 m^3/day. Recent flows have been in the region of 156 - 475 m^3/day as measured by the landfill Restoration Contractor.

5.3.28 Results of previous chemical analysis of leachate from Jordan Valley Landfill are given in Table 5.8 (Binnie 1992). This illustrates that leachate is highly polluted. Leachate has COD levels of around 6,000 mg/L, ammoniacal nitrogen levels of approximately 4,800 mg/L and chloride levels of 3,400 mg/L. Additional monitoring undertaken by the ULRC is provided in Table 5.9 and illustrates slightly lower levels of ammonia, BOD and COD than levels detected in 1992. Nevertheless, the monitoring data illustrate that any significant leachate breakout has the potential to cause serious environmental impacts.

Table 5.8: Leachate Chemistry Data - Jordan Valley Landfill Leachate Analyses January/February 1992 (Binnie 1992)

Parameter**	Monitoring Well	Weir Chamber
pH*	7.86	7.62
Temperature*	32	28
Colour	42	2.5
Conductivity*	45000	10000
Suspended solids	53	14
Settleable solids	950	0.5
BOD	1600	37
COD	6610	700
Dissolved Oxygen*	0.22	3.31
Oil and Grease	0.02	-
Radioactivity a	<0.2	0.4
b	32.9	7.3
c	<40	48
Sodium	2100	230
Potassium	620	120
Calcium	17	20
Magnesium	34	23
Alkalinity as $CaCO_3$	21000	3800
Cyanide	<0.1	<0.1
Phenols	0.99	0.1
Hydrogen Sulphide as S	<0.1	<0.1
Sulphide	<0.1	<0.1
Sulphate	39	16
Chloride	3400	870
Total Residual Chlorine	0.1	<0.1
NH_3 as N	4800	910
TKN as N	5300	980
NO_2 and NO_3 as N	<0.1	<0.1
Total P as P	54	2.4
MBAS	0.9	0.2
Surfactants (total)	0.9	-
*E Coli**	0	0
Antimony	<1	<1
Arsenic	0.055	0.071
Barium	0.3	0.4
Beryllium	0.3	<0.1
Boron	6	2
Cadmium	<0.01	<0.01
Total Chromium	0.35	<0.1
Copper	0.28	0.01
Iron	6.9	16
Lead	0.2	<0.1
Manganese	0.16	1.0

Parameter**	Monitoring Well	Weir Chamber
Mercury	<0.001	<0.001
Nickel	0.43	0.05
Selenium	<0.005	<0.005
Silver	<0.1	<0.01
Thallium	<0.5	<0.5
Vanadium	<5	<5
Zinc	1.10	0.04

* These parameters were re-ordered as filed/immediate laboratory tests results tabulated are from these later tests

** All results in mg/L except pH (pH units); temperature (^{o}C); colour (Lovibond units); conductivity (μ mhos/cm); *E Coli* (cfu/100 mL0); TOX, beryllium and thallium (mg/L); settleable solids (mL/L); radioactivity (Bq/kg)

Table 5.9: Leachate Chemistry Data - Jordan Valley Landfill Leachate Analyses July 1997

Parameter**	CMW1	CMW2	CMW3	GPL1	LP1
pH*	7.59 - 8.03	7.5 - 8.0	7.49 - 7.51	7.42 - 7.51	7.23 - 8.0
Temperature*	34.8 - 36.3	30.4 - 40.3	31.2 - 35.5	32.2 - 33.8	30.7 - 31.6
Conductivity*	23.77 - 32.61	25.69 - 33.69	22.72 - 32.83	23.81 - 31.15	20.67 - 29.83
Alkalinity as $CaCO_3$	14000	9600	9300	12000	8900
NH_3 as N	3600	2300	2300	2800	2100
TOC	<0.1	<0.1	<0.1	<0.1	<0.1
BOD	520	250	190	220	150
COD	2500	1500	1300	1800	1200
Calcium	27	71	19	60	57
Potassium	1200	820	1100	940	740
Sodium	1600	1400	1600	1400	1200
Magnesium	17	25	19	24	0.29
Sulphate	200	110	110	150	130
Chloride	2300	1600	1400	1900	1400
Iron	2.3	9.1	5.6	5.8	7.3
Manganese	0.06	0.28	0.19	0.25	0.29
Zinc	<0.04	0.09	0.15	<0.04	<0.04
Copper	<0.02	<0.02	<0.02	<0.02	<0.02
Nickel	0.14	0.11	0.14	0.11	0.1
Lead	<0.07	<0.07	<0.07	<0.07	<0.07
Cadmium	<0.02	<0.02	<0.02	<0.02	<0.02
Total Oxidised Nitrogen	<0.01	0.07	<0.01	0.03	0.17

* *in situ*

** All results in mg/L except pH (pH units); temperature (^{o}C); conductivity (ms)

5.4 Potential Water Quality Impacts During Development Construction

Potential Sources of Pollution

5.4.1 During the proposed Choi Wan Road/Jordan Valley development construction phase, the aquatic environment in the vicinity of the Study Area may be affected by the following pollution sources:

- spillages of oil/fuel/lubricants from construction vehicles and equipment, construction chemicals etc.;
- surface run-off from dust suppression activities, wheel washing facilities, soil/material storage areas, cement/grout;
- contaminated excavated materials;
- site surface run-off;
- sewage discharges; and
- water from draining and dewatering activities.

5.4.2 Construction site run-off is considered to be a polluting discharge by EPD and advice on handling and disposal of construction site discharges, including site run-off and contaminated wastewaters, is provided in the ProPECC Note (PN1/94) on Construction Site Drainage. Discharges from construction sites are controlled by the WPCO and governed by the Victoria Harbour (Phase 2) WCZ WQOs. Therefore, any construction site run-off must comply with the standards specified in the Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (1991).

5.4.3 Construction wastes if discharged into the aquatic environment can have a range of impacts. The major pollution problems associated with construction site run-off, as identified in the ProPECC Note, are as follows:

- siltation in storm drains caused by excessive sand and silt in storm run-off;
- visual nuisance and hazards to aquatic life caused by discharge of muddy water into streams or the marine environment;
- pollution caused by improper handling and disposal of other types of construction site wastewater such as sewage from site toilets.

Silt-laden Surface Run-off

5.4.4 The principal water quality concern during the construction phase relates to the discharge of surface run-off heavily laden with suspended solids from the work sites into the Jordan Valley Nullah and Choi Wan Road drainage system during periods of rain. Paragraphs 5.3.9 - 5.3.14 illustrate that discharges from the main construction site will discharge to the Choi Wan Road drainage system (Discharge Location C – refer to Figure 5.4).

5.4.5 Influx of silt-laden construction wastewater into the drainage system has the potential to increase sediment accumulation, turbidity, discoloration, BOD, nutrient enrichment and decrease DO levels. Accumulation of silt/sediment in the Jordan Valley Nullah and Choi Wan Road drainage system may exacerbate odour problems if the resultant accumulated sediment associates with organic wastes and becomes anaerobic. Such deposits can also be flushed out of the nullah and into Kai Tak Nullah Approach Channel. This could potentially locally elevate suspended solid load and lead to further non-compliances with the DO WQO. In addition, discharge of solids would stimulate the accumulation of sediments, which are known to be the cause of a serious odour nuisance in the Kai Tak area. Such discharges are not expected to have any biological impact given the prevailing restricted ecological conditions. Such discharges are also not expected to impact upon the WSD flushing seawater intake (refer to Figure 5.1).

5.4.6 Equally of concern is the entry of silt-laden run-off into the trunk sewerage system (refer to Figure 5.6). Any blockages to the sewer system from construction works could cause a serious pollution incident, whilst siltation reduces sewer carrying capacity and increases the potential of surcharges.

Other Run-off Contaminants

5.4.7 Whilst construction site run-off contamination is usually limited to suspended solids, it can occasionally be laden with cement (composed primarily of lime, clay, sand), grouting wastes, hydrocarbons, oil and grease (from construction vehicles and equipment). Such effluents can elevate receiving water pH, total dissolved solids, BOD, alkalinity, potassium and sulphate. It is generally expected that serious impacts upon water quality caused by such discharges are not expected unless there are accidental spillages.

Groundwater/Dewatering Effluents

5.4.8 During excavation, tunnelling and dewatering activities, wastewater will be generated which will require disposal. There is currently no groundwater quality data available for the study site. However, groundwater is not expected to be impacted by the Jordan Valley landfill given that the landfill and construction site are hydraulically separate. Such wastewaters are thus not expected to be of a quality poorer that the standards specified in the Technical Memorandum on Effluent Standards. However, such water may have a high suspended solid load and as such should be treated in the same manner as site run-off.

Human Generated Wastes

5.4.9 In addition to site run-off, pollutant problems may occur as the result of human waste from the on-site construction workers. Rubbish such as food packaging and debris including used construction materials may enter water courses, resulting in floating refuse in the vicinity of the site.

Sewage effluents arising from the on-site construction workforce have the potential to cause water pollution. Any effluents generated would require appropriate treatment to meet Technical Memorandum standards before being discharged from the construction site or discharge to the sewerage system.

Assessment of Impacts

5.4.10 The proposed site development is detailed in Section 2.5.

5.4.11 The development is planned for the west of the Study Area, for reasons outlined in Section 2.4. As illustrated on Figure 5.4, any surface water generated during site construction will be directed towards the Choi Wan Road drainage system during construction activities in northern part of development site (Catchment 1b), whilst run-off will be directed towards the Jordan Valley Nullah during development of the south of the site (Catchment 5c).

5.4.12 Site formation of the platform area such that it is made suitable for future housing will entail the movement and disposal of approximately 4.6M m^3 of spoil/rock off-site. Therefore, during construction there will be a considerable amount of site clearing, excavation works, site preparation, and material stockpiling. It follows that the potential for the generation of silt laden run-off during rain events and resultant impacts upon the drainage system and Kai Tak Nullah Channel Approach is high if appropriate mitigation measures and site management practices are not taken. This is also the case with respect to run-off impacts on the existing sewer system. As such Section 5.6 provides recommendations for applicable mitigation measures required during site construction phase.

5.4.13 Effluents generated during tunnelling, dewatering and groundwater seepages in excavations are expected to be of a quality compliant with the Technical Memorandum on Effluent Standards. These effluents should be suitable for discharge to the surface water system - however they may have an elevated suspended solids content which will need to be removed in a manner as used for surface run-off.

5.4.14 Given that cements, grouts, fuels, oils will be used and stored on site during the construction phase, there is the potential for such materials to become entrained in run-off and thus enter the aquatic environment. Whilst such impacts are only likely to occur due to spillages, it will be necessary to include specific mitigation measures to minimise the potential for impacts to occur as well as to minimise the potential for adverse impacts to result following accidental spillages.

5.4.15 Site development will require up to 600 construction workers. Sewage generation rates have been estimated from EPD's Guidelines for the Design of Small Sewage Treatment Plants, Solid Waste Control Group, March 1990. The daily volume of sewage generated is estimated to be in the region of 33 m^3 (recommended design flow rate set at 0.055 m^3 $head^{-1}$ day^{-1}). This sewage has a potential BOD load of approximately 18.84 kg day^{-1} (570 mg l^{-1} effluent BOD concentration) (refer to Tables 2 and 4 Sewerage Manual). Therefore there are potential impacts resulting from general disposal of waste materials as well as sewage generation. Specific plans and remedial measures will be required to ensure that any adverse effects on the aquatic environment are avoided.

Leachate Migration and Impacts

5.4.16 Under the ULRC, the Restoration Contractor has a remit to ensure the integrity of the Jordan Valley Landfill and to ensure that the leachate (as well as the landfill gas) is contained and managed in safe manner.

5.4.17 Landfill restoration will involve lining the platform of the landfill with a geomembrane capping system and will reduce leachate production to approximately 3600 m^3/year (10 m^3/day). In addition, the existing leachate collection system will be developed such that leachate is diverted to a pre-treatment works to be located near to the gas utilisation plant, on top of the Jordan Valley Dam to the south east of the Study Area. In addition, restoration will include the installation of a leachate collection well-field, with leachate being directed towards the treatment facility. Treated leachate will be discharged to the foul sewer system.

5.4.18 During the early stages of this EIA, discussions were held with the Restoration Contractor in order to ascertain their opinions of how best to minimise potential impacts of this proposed development on the restored landfill and conversely how best to minimise potential impacts of the landfill on the proposed development. These discussions and subsequent planning has lead to a maximisation of the distance between the landfill and the proposed development, within the available land and the planning boundary. This has minimised the possibility of leachates migrating from the landfill to areas of the development during construction and operation.

5.4.19 Overall, it is considered for the potential risks to the development with respect to leachate are minimal, the reasons for this are as follows:

- the development is over 200 m from the landfill boundary;
- there is a massive granite ridge separating the landfill from the proposed development which is unlikely to have fractures of a magnitude to allow leachate migration;
- groundwater flows into the landfill and from the surrounding ridges and moves towards the south-east. Thus groundwater and leachate migration is in a direction away from the Choi Wan Road/Jordan Valley development site;
- the Restoration Contractor will actively manage the leachate via leachate extraction wells which will pump the leachate to a pre-treatment works for proper treatment prior to disposal to the foul sewer; and
- leachate volumes will decrease significantly once the landfill has been fully capped, thus decreasing the potential for leachate migration.

5.4.20 From the above, it is considered that the Choi Wan Road/Jordan Valley development site is not at risk from leachate breakout or leakage. Despite this, it is recommended that extreme care is undertaken during site formation to identify any fissures or joints which may act as pathways for leachate migration, especially for formation works in the eastern parts of the construction site. If leachate is encountered, measures should be taken to collect, contain and treat leachate. The most appropriate method of treatment would be to send any collected leachate to the Jordan Valley leachate treatment facility which is to be constructed as part of the landfill restoration programme.

5.5 Potential Water Quality Impacts Due to Site Operation

Introduction

5.5.1 The currently undeveloped site will be formed to accommodate 11,120 flats. The development will thus lead to the transformation of site configuration and land use. The wastewaters generated during development's operation are thus very different from the existing conditions and as such it is necessary to undertake an operational water quality impact assessment. It is considered that the major effluents that have the potential to impact upon water quality during site operation will be changes to surface run-off characteristics and the generation of sewage effluents. Potential impacts on water quality during site operation are defined in the sections below, whilst Section 5.6 considers applicable mitigation techniques.

Surface Run-off Impacts

5.5.2 Construction of the proposed development area will result in the production of an intensively urbanised area with the majority of the built-up area being covered with concrete. Development will thus increase surface run-off due to the increase in impervious surfaces such as roads, pavements, car parks etc. This will result in high stormwater run-off coefficients causing the majority of the stormwater to run off the land in the first few hours after a storm and very little being lost due to soil infiltration as is currently the case. In general, the increased urbanisation of this area will result in increased wet-weather run-off with the stormwater drainage system conveying the water much more readily than the previous natural surfaces including grass and wooded areas, except in the area of Flathill Quarry, due to its impermeable nature. Changing rainfall/run-off infiltrating patterns can thus affect groundwater levels and flow characteristics.

5.5.3 The typical effects of urbanisation of this area, can be summarised as:

- total run-off will be greater after urbanisation due to a decrease in infiltration and depression storage;
- run-off will occur more rapidly due to greater flow velocities in the drainage system; and
- peak discharges will be greater due to the larger run-off volume occurring over a shorter time.

5.5.4 Tables 5.10 and 5.11 show the changes in peak flows and relative % increases in drainage flows in the recipient watercourses before and after site development as taken from the Final DIA Report.

Table 5.10: Changes to Subcatchment Peak Flows

Subcatchment Name	Discharge Location	Return Period (yr)	Peak Flow Before Development* (m^3/s)	Peak Flow After Development* (m^3/s)	% Increase
5c(a)	B	2	1.37	5.23	282
		10	2.88	8.52	196
		50	4.04	10.9	170
		200	5.29	13.4	153
1b	C	2	1.72	1.85	8
		10	3.03	2.78	-8
		50	3.97	4.86	22
		200	4.99	4.20	-16

* Peak flows at Jordan Valley Nullah were calculated using the "MIKE 11" hydrodynamic model. The results are given in Table 5.11 along with % increases in volume.

Table 5.11: Peak Flows at Jordan Valley Nullah

Return Period	Peak Discharge		Peak Discharge Increase	
	Before	After		
Years	m^3/s	m^3/s	m^3/s	%
2	20.1	23.5	3.4	17%
10	36.5	41.6	5.1	14%
50	51.1	57.9	6.8	13%
200	65.2	73.2	8	12%

5.5.5 Table 5.11 illustrates that following development, peak discharges in to Jordan Valley Nullah may increase by up to 17%.

5.5.6 The proposed topography and landform of the Choi Wan Road/Jordan Valley development is illustrated in Figure 2.2. Development will result in drainage leaving the proposed development at two points (B and C) as illustrated on the proposed Platform Drainage Layout in Figure 5.4.

<u>Sewage Generation</u>

5.5.7 The proposed housing development, comprising some 11,120 flats with a population of approximately 35,066 will generate a design peak sewage flow in the order of 0.504 m^3/s. It is proposed that this flow will be conveyed to Kwun Tong Screening Plant (refer to Figure 5.6). It should be noted that, as identified in paragraph 2.5.16, if the Kwun Tong Screening Plant has not been up-graded prior to this site becoming occupied, then a contingency measure/plan will be required. This decision will be made during detailed design.

5.5.8 This sewage generation estimate is as derived by the SIA using design criteria understood to be consistent with the criteria used by DSD. The method of figure derivation is given below.

Proposed Resident population

- a 300L/h/day unit flow has been adopted for the new inflow to the system in accordance with the Sewerage Manual
- a peaking factor of 4 has been applied to the unit flow in accordance with the Sewerage Manual
- an occupancy rate of 3.26 persons per flat Type HOS flat and 3.00 persons per Type R1 flat

Proposed School population

- a 25l/h/day unit flow has been adopted for the new inflow to the system
- a peaking factor of 4 has been applied to the unit flow in accordance with the Sewerage Manual
- an occupancy rate of 975 pupils per primary school, 1350 pupils per secondary school and 50 staff per school

Employed/Commercial population

- a 2901/h/day unit flow has been adopted for the new inflow to the system
- a peaking factor of 4 has been applied to the unit flow in accordance with the Sewerage Manual
- according to the planning brief, the commercial centre will employ some 428 persons

Design flow from Jordan Valley Development:

Residential = Population (35066) x unit flow (0.3/24x60x60) x peaking factor (4)
= $0.488^3/s$

Schools = [No. of primary schools (2) x student/P-school (975) + No. of secondary school (5) x students/S-school (1350) + Total No. of schools (6) x staff/school (50)] x unit flow (0.025/24x60x60) x peaking factor (4)
= $0.010m^3/s$

Commercial = [No. of employees (428) x unit flow (0.290/24x60x60) x peaking factor (4)
= $0.006m^3/s$

Total design flow = $0.488m^3/s + 0.010m^3/s + 0.006m^3/s = 0.504m^3/s$

5.5.9 It is estimated that the sewage generated by the development will have total BOD load of approximately 1,690 kg per day as calculated below:

- 0.042 kg BOD/d/resident (Table 4 - Sewerage Manual)
- 0.034 kg BOD/d/commercial employee (Table 4 - Sewerage Manual)
- 0.023 kg BOD/d/school attendee (Appendix 3 - Guidelines for the Design of Small Sewerage Treatment Plants)

- 1,473 kg per day BOD load from residents - (assuming 35066 residents)
- 14.5 kg per day BOD load from commercial workers - (assuming 428 commercial employees)
- 200 kg per day BOD load from schools - (assuming 8700 school occupants)

- total BOD load of 1,687 kg per day from Choi Wan Road/Jordan Valley development

Assessment of Water Quality Impacts

Urban Run-off Impact Assessment

5.5.10 Stormwater run-off from the proposed development may be expected to contain significant concentrations of pollutants which will vary depending upon the source of the run-off (e.g. residential, carparks etc.).

5.5.11 Many pollutants enter the urban environment from anthropogenic sources. Sources of pollutants include atmospheric fallout, vegetation and leaf litter, grass cuttings, land surface erosion, oil and chemical spills, pavement wear, car and truck emissions, airborne materials that have been washed out of the atmosphere by precipitation, rubber particles from vehicle tyres, asbestos fibres from brake linings, animal and bird droppings, pesticides and fertilisers, pavement degradation, building erosion and plastic. Typical sources of surface run-off pollutants are indicated in Table 5.12.

Table 5.12: Anthropogenic Pollutants Associated with Urban Environments (Sansalone and Buchberger 1997)

	Brakes	Tyres	Car Frame & Body	Fuels and Oils	Concrete Pavement	Asphalt Pavement	Litter
Cadmium (Cd)	✓	✓					
Chromium (Cr)							
Copper (Cu)	✓	✓					
Iron (Fe)		✓	✓				✓
Lead (Pb)	✓	✓		✓			
Nickel (Ni)		✓					
Vanadium (V)				✓			
Zinc (Zn)	✓	✓	✓				
Chlorides							
Organic Solids						✓	✓
Inorganic Solids			✓		✓	✓	✓
PAHs				✓		✓	
Phenols						✓	

5.5.12 Pollutants which have accumulated on urban surfaces will be removed during rain events. Approximately 80 - 95% of the rainfall landing on hard surfaces is generally expected to reach the surface water drainage system. Climatic conditions and intensity of precipitation have a particularly significant influence on the run-off characteristics. Rain events in excess of 0.5 - 0.7 mm per hour are expected to remove up to 80% of the contaminant mass accumulated on roads/pavements. Any further rainfall run-off is likely to be relatively less polluted. The initial run-off which contains most of the particulate matter and the associated contaminants is referred to as the "first flush" and can have a significant impact if discharged direct into a sensitive receiving watercourse. This is especially the case following high intensity storms which tend to scour road surfaces and can result in a relatively greater run-off pollutant load - this is considered further below.

5.5.13 The most common pollutants found in urban run-off include suspended sediment, heavy metals, organics including oil and grease, oxygen-demanding substances and bacteria including *E.coli* (USEPA, 1983). Indicative pollutant levels found in storm water run-off from residential and commercial areas are shown in Table 5.13 (data from the USA and from Tin Shui Wai).

Table 5.13: Typical Water Quality Characteristic of Run-off from Residential and Commercial Areas of the US as Compared to those Measured on the Tin Shui Wai (Binnie 1997) (mg/L unless indicated)

Parameter	Average[1] Concentration for Residential or Commercial Site	Weighted Mean[1] Concentration for Residential or Commercial Site	NURP[1] Recommendations for Load Estimate	Weighted[4] Average Measured at Tin Shui Wai
TSS	239	180	180 - 548	148 - 1200
BOD	12	12	12 - 19	7 - 103
COD	94	82	82 - 178	-
Total P	0.5	0.42	0.42 - 0.88	0.5
Sol. P	0.15	0.15	0.15 - 0.28	-
TKN	2.3	1.9	1.80 - 4.18	2.0
NO_3 + 3-N	1.4	0.86	0.86 - 2.2	-
Cu	53 μg/L	43 μg/L	43 - 118 μg/L	4 (20[2]) μg/L
Pb	238 μg/L	53 μg/L	182 - 443 μg/L	2 (14[2]) μg/l
Zn	353 μg/L	202 μg/L	202 - 633 μg/L	42 (46[2]) μg/L
E. coli	27,000/100 mL[3]	-	-	42,000

1 Results of nationwide urban run-off program, NURP, Vol, NTIS PB 84-185552, USEPA, 1983
2 Highest value from 4 points
3 Faecal coliforms
4 Only limited sampling and testing of urban stormwater was undertaken during this study during one rainfall incident (Binnie 1997)

5.5.14 Table 5.13 illustrates that contaminant levels can be highly variable dependent upon the occurrence and vicinity of pollutant sources. Generally highest pollutant levels occur where there is a high occurrence of traffic (Barrett *et al.*, 1998), although the configuration of the run-off drainage system also plays an important role in contaminant level control. Other important factors include rainfall intensity, time since the previous rain event, pavement residence time, etc. Urban run-off can contain contaminant levels in excess of environmental quality standards specified for the run-off's receiving system. The figures presented in Table 5.13 suggest that levels of pollutants, particularly those in "first flush" flows after prolonged dry periods may exceed WQO for Victoria Harbour (see Table 5.1) - levels of *E.Coli*, suspended solids, nutrients (inorganic Nitrogen), BOD and COD may exceed specified WQOs.

5.5.15 The contaminants of greatest concern with respect to water quality are particulates as well as heavy metals (such as iron, lead and zinc). Particulates may settle out rapidly in any receiving water system and can cause smothering of the bed, while some heavy metals are toxic to some sensitive life forms. The general effects of the major pollutants found in road run-off are indicated in Table 5.14.

Table 5.14: Effects of Pollutants Found in Highway/Urban Run-Off

Pollutant	Source	Potential effects
Suspended Solids	Wind blown particulates Vehicle corrosion Road surface wear	Smothering of the stream bed.
Oils/PAHs	Vehicle lubricants and coolants	Deoxygenation of water through increased biochemical oxygen demand (BOD). Creation of oil films that prevent re-aeration. Toxic to some life forms.
Heavy metals	Tyre wear Fuel Vehicle corrosion	Toxic to some life forms.
Nutrients (nitrates and phosphates)	Animal excreta Decaying vegetation Wind blown fertiliser	Eutrophication; increased algal growth may lead to deoxygenation.
Bacteria	Animal excreta Decaying vegetation	Public health problems, odour.

5.5.16 The environmental significance of run-off pollutants is dependent upon the contaminant speciation as well as absolute levels. Most pollutants can be present in run-off in a dissolved or particulate phase. Contaminants that are in the dissolved phase are generally expected to be more bioavailable and mobile and thus are anticipated to be more environmentally hazardous.

5.5.17 Whether a pollutant is present in the dissolved phase or particulate phase is a function of rainfall pH, pavement residence time (PRT) and solids concentration (Sansalone and Buchberger, 1997). Low rainfall pH levels and high PRTs tends to result in relatively higher dissolved contaminant levels. Recent research has shown that Zn, Cd, and Cu are main found in the dissolved phase, whilst Pb, Fe and Al are mainly particulate bound (Sansalone and Buchberger, 1997).

5.5.18 Whilst Table 5.13 provides levels of run-off pollutant concentration, it is apparent that levels can vary widely during the course of rain event. First flush effects are well documented where contaminant levels are elevated at the onset of a rain event, after which levels fall to a constant base concentration. Sansalone and Buchberger (1997) found a strong first flush effect for dissolved phase Zn, Cd and Cu, whilst particulate bound contaminants only gave a weak first flush effect. Generally the first flush effect is most pronounced during the first 5 mm of run-off after which levels tend to stabilise (Barrett *et al.*, 1998).

5.5.19 With regard to the Choi Wan Road/Jordan Valley development site, most site run-off will be directed towards the surface water drainage system which ultimately discharges into Victoria Harbour given that the Kai Tak Nullah will be reclaimed as part of the SEKD Programme. It is estimated that the flow of storm water drainage entering Jordan Valley Nullah from the proposed development will increase the overall flow in the Nullah by 12-17 % during storm events (refer to Section 5.6.2). In order to assess the indicative environmental significance of surface water run-off, worst case pollutant loads from the development site to Victoria Harbour have been calculated based upon the estimated run-off volume of 785,400 m^3 per year (assumes annual rainfall of 2,200 mm and site area of 357,000 m^2) and indicative run-off pollutant loads (NURP1 recommendations for load estimation - refer to Table 5.13) - results are shown in Table 5.15.

Table 5.15 Estimated Pollutant Load to Victoria Harbour Resulting from Development Site Storm Run-off

Parameter	Run-off Concentration* (mg/L except where indicated)		Load per year (kg)		Load per day (kg)	
	Low	High	Low	High	Low	High
TSS	180	548	141372	430399	387.3	1179.2
BOD	12	19	9425	14923	25.8	40.9
COD	82	178	64403	139801	176.4	383.0
Total P	0.42	0.88	330	691	0.90	1.89
Sol. P	0.15	0.28	118	220	0.32	0.60
TKN	1.8	4.18	1414	3283	3.87	8.99
NO_3 + $_3$-N	0.86	2.2	675	1728	1.85	4.73
Cu	43μg/L	118μg/L	34	93	0.09	0.25
Pb	182μg/L	443μg/L	143	348	0.39	0.95
Zn	202μg/L	633μg/L	159	497	0.43	1.36

* loads (NURP1 recommendations for load estimation - refer to Table 5.13

5.5.20 Table 5.15 illustrates that the proposed land development may result in an additional 41 kg of BOD being discharged to Victoria Harbour per day due to surface water discharges. It is stressed that this load is only an estimate and that the actual additional loading is dependent upon run-off pollutant concentrations, whilst the estimate assumes 100% of rainfall falling upon the whole development site enters the drainage system.

5.5.21 The SEKD Feasibility Study estimated that loads to Victoria Harbour in the south east Kowloon area for 2001 and 2006 – refer to Table 5.16. It is noted that reclamation of South East Kowloon will mean that the loads illustrated will be transferred directly into Victoria Harbour.

Table 5.16 Pollution Load from Major Drainage Channels to Existing Kai Tak Nullah Approach Channel (kg/day) in 2001 and 2006 (Maunsells, 1998)

Parameter	Kai Tak Nullah	Kwun Tong Nullah	KBB Culvert	Total Load
2001				
BOD	12285	2715	3477	**18477**
NH_3-N	1445	304	297	**2046**
TKN	2841	520	562	**3923**
2006				
BOD	8459	1306	1585	**11350**
NH_3-N	1069	146	133	**1348**
TKN	2141	250	250	**2641**

5.5.22 Table 5.16 illustrates that the BOD load from the major drainage channels entering Victoria Harbour in the south east Kowloon area are estimated to be in the region of 18.5 tonnes per day in 2001, falling to 11 tonnes per day in 2006. From this it can be illustrated that in 2006 the surface water run-off from the whole Choi Wan Road/Jordan Valley development will result in an additional pollution load of <0.36%. Therefore, run-off from the development site will not be a major contributor to the pollutant load of Victoria Harbour and thus impacts from this source alone will not be detectable. This aside, pollution from non-point sources should be minimised in an attempt to minimise the cumulative impacts of such pollution and as such mitigation measures as specified in Section 5.6 should be implemented.

Spillages

5.5.23 Accidental spillages of oil or toxic materials are potentially the most damaging form of pollution during development operation.

Materials may be spilled during transport, transfer and use. The materials spilled could include:

(i) petrol, fuel oils and diesel oils;
(iii) cement for construction sites; and
(iv) solvents used in cleaning or on construction sites.

Careful design of highway drainage should reduce the risk of water pollution from such accidental spillages.

5.6 Site Management and Mitigation Measures

Construction

5.6.1 Section 5.5 illustrated the requirement for specific mitigation measures to minimise adverse environmental impacts caused by the generation of site run-off, construction materials, construction worker general waste and sewage. The mitigation measures described below for the construction phases are in accordance with Practice Note for Professional Persons on Construction Site Drainage, Professional Persons Environmental Consultative Committee, 1994 (ProPECC PN

1/94). The effectiveness of the specified mitigation techniques can be evaluated and controlled through the environmental monitoring and audit (EM&A) programme as detailed in EM&A Manual. If environmental monitoring illustrates that the mitigation measures are not being effective, recommendations for alternative actions may need to be made.

Control and Mitigation of Silt-laden Run-off

5.6.2 In order to reduce suspended solids run-off into Victoria Harbour and the two main drainage channels, the following measures should be applied during the construction phase:

(i) at the start of site establishment, perimeter cut-off drains to direct off-site water around the site should be constructed and internal drainage works and erosion and sedimentation control facilities implemented. Channels, earth bunds or sandbag barriers should be provided on site to direct stormwater to such silt removal facilities. The design of efficient silt removal facilities should be based on the guidelines provided in ProPECC PN 1/94;

(ii) sediment basins of sufficient capacity, constructed from pre-formed individual cells of approximately 6-8 m^3 capacity are recommended as a general mitigation measure which can be used for settling wastewaters prior to disposal. The tanks are readily available and used primarily for recycling water for bored piling operations. The system capacity is flexible and able to handle multiple inputs from a variety of sources and particularly suited to applications where the influent is pumped. Various physical and chemical filters can be added should refinement of the sedimentation process be required;

(iii) ideally, construction works should be programmed to minimise surface excavations during the rainy season (April to September). If excavation of soil cannot be avoided during the rainy season, or at any time of year when rainstorms are likely, exposed slope surfaces should be covered by a tarpaulin or other means. Other measures that need to be implemented before, during and after rainstorms are summarised in ProPECC PN 1/94. Particular attention should be paid to the control of silty surface run-off during storms events, especially for sites located near steep slopes;

(iv) all exposed earth areas should be completed and revegetated as soon as possible after earthworks have been completed, or alternately, within 14 days of the cessation of earthworks where practicable;

(v) earthworks final surfaces should be well compacted and subsequent permanent work or surface protection should be carried out immediately after final surfaces are formed in order to prevent rainstorm erosion;

(vi) the overall slope of the site should be kept to a minimum to reduce the erosive potential of surface water flows and all trafficked areas and access roads protected by coarse stone ballast. An additional advantage accruing from the use of crushed stone is the positive traction gained during prolonged periods of inclement weather and the reduction of surface sheet flows;

(vii) silt contained in ground water and drilling water collected from boring operations, tunnelling, dewatering should be removed with properly designed silt removal facilities, such as the specified portable sedimentation tanks referred to above, such that TM standards are achieved prior to the discharge of waters into storm drains;

(viii) all drainage facilities and erosion and sediment control structures should be regularly inspected and maintained to ensure proper and efficient operation at all times and particularly following rainstorms. Deposited silt and grit should be removed regularly and disposed of by spreading evenly over stable, non-sensitive vegetated areas;

(ix) measures should be taken to minimise the ingress of site drainage into excavations. If the excavation of trenches in wet periods is necessary, they should be dug and backfilled in short sections wherever practicable. Water pumped out from trenches or foundation excavations should be discharged into storm drains via the silt removal facilities;

(x) any leachate encountered on site should be collected and transferred to the Jordan Valley Landfill leachate treatment facility. Collected leachate should not be mixed with cleaner effluents such as those generated during dewatering etc;

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

(xii) manholes (including newly constructed ones) should always be adequately covered and temporarily sealed so as to prevent silt, construction materials or debris being washed into the drainage system and storm run-off being directed into foul sewers. Discharge of surface run-off into foul sewers must always be prevented to avoid overloading the foul sewerage system;

(xiii) all vehicles and plant should be cleaned before leaving the construction site to ensure no earth, mud and debris is deposited on roads. An adequately designed and sited wheel washing bay should be provided at every site exit and wash-water should have sand and silt settled out and removed at least on a weekly basis to ensure the continued efficiency or the process. The section of access road leading to, and exiting from the wheel-wash bay to the public road should be paved with sufficient backfill toward the wheel-wash bay to prevent vehicle tracking of soil and silty water to public roads and drains;

(xiv) water used for construction purposes on site should, as far as practical, be recycled for use;

(xiv) information detailing storm run-off and wastewater discharge points, and the corresponding maximum (or range of) volumes of discharges expected from the construction sites on a dry day should be provided in the WPCO licence application. In general, assuming adequate information has been provided together with the licence application, EPD would need at least 20 days for the processing of a licence for a discharge. It is therefore recommended that the Contractor submit the licence application to EPD as early as possible before the commencement of any discharge.

5.6.3 If the good management practices as defined above are implemented, adverse impacts on the Choi Wan Road drainage system, Jordan Valley Nullah, the sewerage system and the receiving Kai Tak Mullah Channel Approach will be avoided.

Construction Materials

5.6.4 In order to prevent unacceptable impacts associated with construction material the following mitigation techniques are recommended (for further details refer to Chapter 6):

- stockpiles of cement and other construction material should be kept covered when not being used;

- entry points into the surface drainage system should be fitted with oil interceptors;
- waste oils and other chemicals Chemical wastes as defined in the Waste Disposal (Chemical Waste) (General) Regulation will require disposal by an appropriate means and could require pre-notification to EPD prior to disposal. An appropriate disposal facility could be the Chemical Waste Treatment Centre (CWTC) at Tsing Yi. If chemical wastes are to be generated, the contractor will need to register with EPD as a chemical waste producer and observe the requirements for chemical waste storage, labelling, transportation and disposal. The requirements for waste storage, transportation and disposal are considered in the waste management Chapter 6.

Construction Worker General Waste

5.6.5 Site workers will generate solid and liquid wastes during the construction phase. Estimated arisings and proposals for management are presented in Chapter 6. Assuming responsible site management procedures are followed no adverse impacts on the aquatic environment are expected.

Construction Worker Sewage

5.6.6 Sewage effluents arising from the on-site construction workforce have the potential to cause water pollution. Therefore plans for the collection, treatment and disposal of sewage wastewater during the construction phase must be specified.

5.6.7 The proposed development site contains little or no sewerage facilities (refer to Figure 5.6). The two parallel sewers on Kwun Tong Road convey flows south towards Kwun Tong Screening Plant are currently being upgrade according to the recommendations of the Development of a Master Plan for Sewage Disposal for East Kowloon (June 1989). It is proposed that the existing sewerage facilities within the CITA training compound be utilised by the construction workforce to minimise impacts and additional cost. If this is not possible it is considered feasible to use portable toilets.

5.6.8 In addition to the above, in order to accommodate the proposed Jordan Valley Housing Development a new sewer will be required to connect the development area to the existing system. The proposed arrangement is given on Figure 5.7. The proposed sewer follows Choi Wan Road down to Kwun Tong Road.

5.6.9 The sewerage system to each platform will necessarily be completed at an early point within the overall construction programme. It is possible that live sewers will serve the upper platforms while construction is ongoing in the lower platforms. Where construction is ongoing in the vicinity of live sewers control measures will be required to ensure that site operations do not adversely affect the performance of sewerage both on site and in the downstream trunk sewerage system. Conversely such sewers may be used for the disposal of sewage generated on-site by construction workers.

5.6.10 Overall it is considered that no water quality impact are expected to arise from on site generated sewage if the sewage facilities as described above are provided.

<u>Operation</u>

Sewerage

5.6.11 As part of this impact assessment a range of options for connecting the Choi Wan Road/Jordan Valley site to the trunk sewerage network were considered. Following an evaluation of the various options (refer to the SIA Report) it was recommended that in order to accommodate the proposed Jordan Valley Housing Development a new sewer is required to connect the development area to the existing system (refer to Figure 5.7). The proposed 145m length of sewer follows Choi Wan Road down to Kwun Tong Road. A series of drop manholes would be required to prevent excessive gradients and resulting unacceptably high flow velocities. The careful location of the drop manholes would also facilitate the crossing of the existing surface water drain that also follows Choi Wan Road. The connection to the Kwun Tong Road trunk sewer would be at an existing manhole.

5.6.12 The sewerage from the proposed development site will be thus directed towards to Kwun Tong Screening Plant for treatment. By the time the development is operational it is expected that Stage 1 of the Strategic Sewage Disposal Strategy (SSDS) will have been completed - thus effluent received by the Kwun Tong Screening Plant will be directed towards Stonecutters Island for treatment. Thus the generation of sewage at the Choi Wan Road/Jordan Valley development site is not anticipated to impact upon water quality. Impacts resulting from the discharge of treated effluent from the SSDS are being investigated under a separate consultancy study.

5.6.13 The proposed housing development comprises some 11,120 flats. The design peak sewage flow has been estimated to be in the order of 0.504 m^3/s with a total daily BOD load of 1,687kg. The sewage flow arising from the proposed development will be conveyed to the Kwun Tong Sewage Treatment Plant which needs to be upgraded to meet the demand from this site as well as those arising from other developments in East Kowloon. In this connection, the Environmental Protection Department will commission a study entitled "Review of Central and East Kowloon Sewerage Master Plans" (SMP Review) to address this sewerage issue. If the sewerage upgrading works to be recommended in the SMP Review cannot be completed in time to meet the population intake of the development, the Civil Engineering Department will provide interim measures such as the use of holding tanks to ameliorate the impact.

Stormwater Run-off

5.6.14 Section 5.5 illustrated that significant effects on water quality resulting from the generation and discharge of stormwater run-off are not anticipated. Nevertheless, there are actions which can be undertaken which will reduce any impacts further.

5.6.15 There are two main categories of stormwater control, source control and site control, often referred to as preventative measures and control measures respectively. Preventive measures, or source controls, are techniques designed to reduce exposure of materials to stormwater, hence limiting the amount of pollutants incorporated into run-off. Source reduction measures include elimination of expedient connections, prevention of illegal tipping of wastes, coverage of chemical storage areas, prevention and containment of spills, minimisation of chemical applications, catch basin cleaning, erosion control, and landuse control. Site controls generally attempt to reduce the run-off rate and volume from the affected site and include the use of infiltration devices, the use of porous surfaces, silt traps, catch pits and oil and grease traps.

5.6.16 If the measures highlighted below are adopted, and if the drainage network is maintained appropriately with sedimentation traps being regularly cleared, the impacts on the water environment should be minimal and the standards required in the Technical Memorandum of Effluent Standards should be achieved.

Preventative Measures

5.6.17 Measures to prevent contaminant incorporation into stormwater run-off which may be incorporated into the design of the proposed development site include the following:

I) Road Cleaning

Road sweeping and cleaning involves the collection and proper disposal of fine particle size material to which pollutants are attached. This can significantly reduce the load of pollutants that are available for incorporation into run-off.

II) Buffer Zones

Buffer zones are strips of vegetation, either natural or planted, around drains which help to reduce the impact of surface run-off by trapping sediment and sediment-bound pollutants, encouraging infiltration, and by slowing and spreading stormwater flows over a wide area. Buffer zones incorporated into the design of the proposed development should be considered one of the most important aspects of pollution control in addition to providing landscape areas and natural habitat for local fauna. Disadvantages of vegetated buffer zones may include erosion, sedimentation and nutrient enrichment of the downstream water courses/bodies.

III) Minimisation of Pollutants

Reduction in the potential for contaminant spills can be achieved by keeping petrol filling stations and chemical storage areas out of the proposed development area. Use of chemicals such as fertilisers and pesticides on landscaped areas should also be minimised to limit their incorporation into run-off.

Control Measures

5.6.18 Measures to control stormwater run-off that may be used in the design of the proposed development site include the following:

I) Infiltration (Exfiltration) Devices

Infiltration devices are areas of porous material which allow soaking of water into the ground. They include trenches dug into the ground and filled with porous materials to facilitate drainage into the porous soil areas beneath at a slower rate. Dry wells are small areas near buildings which are pervious and capture run-off from roofs and other impervious surfaces. Infiltration devices can be very effective in the removal of pollutants through adsorption onto soil particles, and biological and chemical conversion in the soil. Disadvantages of these devices include the requirement for frequent maintenance through cleaning, to avoid nuisance problems especially with insect breeding and odour. The feasibility of using such devices at Choi Wan Road/Jordan Valley is compromised by the site geology.

II) Oil and Grease Traps

Oil and grease can be washed into the stormwater system from car parks, roads, bus depots etc. Underground catch basins should be installed to remove oils, grease, other floating substances and sediment from stormwater before the pollutants enter the storm water drainage system. These devices are relatively small and inexpensive, but can only detain stormwater for short periods. However, they are effectively used as a first stage of treatment to remove oil and sediment from stormwater.

Advantages of catch basins are their easy installation, and they create few aesthetic problems. However, apart from oil and grease and sediment, pollutant removal is low and odours can cause a problem. Oil and grease traps/catch basins require regular inspection and cleaning at least twice a year to remove sediment, accumulated oils and grease, floatables, and other pollutants.

III) Filter Strips and Grass Swales

Filter strips and grass swales are one of the oldest forms of stormwater treatment devices. Filter strips are strips of land planted with vegetation, usually tough grasses, planted between the source and the receiving waters whereas swales are in effect grassed waterways and are used primarily at the outlet of road culverts and as roadway medians.

Filter strips remove sediment, organic matter and many trace metals by the filtering action of the vegetation, infiltration and sediment deposition. The addition of trees can greatly increase the effectiveness by increasing uptake and long-term retention. Both devices have low pollutant removal efficiency but they can be effective when combined with other devices as part of the stormwater management system. At Jordan Valley, the landscape planting will require up to 1.8 m of soil and subsoil placed upon relevant areas. If carefully planned, areas could be designed such that water will infiltrate into the landscape areas reducing pollutant loads. Landscape areas could be designed with sub-surface drainage to allow ultimate drainage into the storm water drainage system.

IV) Emergency Spill Response

Spill action plans should be formulated specifying the actions required in the case of spillages and the measures for controlling and cleaning up spills. Such a system will minimise the potential impacts from spillages as far as practical. The aims of any spill action plan should include:

- sedimentation tanks/lagoons and drainage channels should be regularly inspected to ensure that they are not blocked and are functioning correctly;
- provide procedures for each category of spillage of light petroleum based compounds, cement etc.;
- provide guidelines for immediate handling of oil-based and hazardous materials;
- specify requirement for monitoring of the receiving water environment;
- provide details of appropriate pollution control equipment; and
- specify actions to restore the impacted receiving system.

5.7 Environmental Monitoring

5.7.1 During the construction phase of the Choi Wan Road/Jordan Valley development it will be necessary to monitor wastewater run-off to assess compliance with the Technical Memorandum of Effluent Standards and any applicable discharge licenses issued under the WPCO. This monitoring will be the responsibility of the Contractor and will be specified by EPD as a license condition. In addition, the following environmental monitoring and management measures should also be incorporated into the Environmental Protection and Pollution Control Requirements in the Contractor's specification, as a minimum:

- development of a spill action plan to include measures for dealing with spillages of hazardous chemicals and hydrocarbons;
- the impact of any spillages should be monitored; and
- effluents containing cement-generated material should be checked periodically with respect to pH.

5.8 Conclusions

5.8.1 The sections above illustrate that construction and operation of Choi Wan Road/Jordan Valley development has the potential to impact upon the water environment. The sensitive receivers at most risk are the existing surface water drainage system which includes the Jordan Valley Nullah and Choi Wan Road drainage system, the trunk sewerage system and the receiving marine environment (i.e. Kai Tak Nullah Approach Channel and Victoria Harbour). The main conclusions of the water quality impact assessment are as follows:

Construction

- site formation of the platform area such that it is made suitable for future housing will entail the movement and disposal of approximately 4.6M m^3 of spoil/rock off-site. Therefore, during construction there will be a considerable amount of site clearing, excavation works, site preparation, and material stockpiling;

- during the development construction phase the greatest potential for adverse impacts on the aquatic environment is from the discharge of silt-laden sediment into the surface drainage and trunk sewer system. If good site management practices (as detailed in ProPECC PN 1/94) prevail to remove suspended solids prior to discharge, adverse impacts on the drainage/sewer systems and the receiving marine environment are not anticipated;

- impacts related to the on-site generation of sewage can be mitigated through the supply of temporary facilities or the use of facilities currently available at the CITA site;

- the Choi Wan Road/Jordan Valley development site is not considered to be at risk from leachate breakout or leakage given that the site is hydraulically separated from the Jordan Valley Landfill with groundwater movement being away from the construction site.

Operation

- the major effluents that have the potential to impact upon water quality during site operation includes surface run-off and sewage effluents;

- the proposed housing development comprises some 11,120 flats with a population of 35,066. It has been calculated that the sewage generated by the development will have a BOD pollution load at approximately 1,690 kg per day. In order to prevent adverse environmental impacts an additional sewer connection is recommended with flow being directed towards the Kwun Tong Screening Plant. Upon implementation of the SSDS this sewage will be conveyed to Stonecutters Island for treatment;

- if the sewerage upgrading works to be recommended in the "Review of Central and East Kowloon Sewerage Master Plans" cannot be completed in time to meet the population intake of the development, the Civil Engineering Department will provide interim measures such as the use of holding tanks to ameliorate the impact;

- the proposed land development will increase the amount of surface run-off entering the drainage system. This surface run-off is estimated to result in the discharge of approximately 41 kg of BOD to Victoria Harbour a day. This additional BOD load is not considered to be significant with respect to the other identified pollution sources entering Victoria Harbour in the south east Kowloon area. Water quality impacts resulting from the additional surface water run-off is not expected to be apparent, nevertheless specific preventative measures and control measures are detailed herein.

6 WASTE MANAGEMENT

6.1 Introduction

6.1.1 This Chapter presents an assessment of the waste disposal and management issues associated with the proposed development. Construction of the Choi Wan Road/Jordan Valley development will generate waste material that will need to be handled, stored, transported and disposed of by appropriate methods such that any potential environmental impacts are controlled and minimised. This chapter assesses relevant waste disposal legislation, potential sources of waste during construction and operation, the potential for waste recycling/reuse, requirements for waste treatment/storage/collection/transport/disposal and mitigation measures required in order to prevent adverse environmental effects.

6.1.2 In order to assess the environmental risks posed by solid waste during the Choi Wan Road/Jordan Valley development construction and operation, and thus the requirements for mitigation/handling/treatment/disposal, the following strategy has been adopted:

- identify relevant waste management legislation applicable for the development construction and operation;
- identify Sensitive Receivers (SRs) which may be impacted by solid waste generation during both construction and operational phases;
- identify and quantify potential sources of solid waste during the construction and operational phases. Identify characteristics of waste generated in terms of location, when waste is generated, waste volumes, waste physical and chemical characteristics;
- assess risks to the environment taking into account solid waste arising volumes, physical and chemical characteristics;
- provide guidance on actions/remedial measures that need be implemented to reduce impacts to an acceptable level. This will identify which waste streams should be segregated, treated etc, guidance on applicable methods of waste segregation, treatment, disposal, and provisions for development layout and operation.

6.1.3 The management procedures and mitigation measures outlined in this Chapter should be developed during the detailed design as further information is made available, to form a Waste Management Plan (WMP). The WMP should identify more precisely, the anticipated type and quantity of waste arisings and give procedures for the safe and environmentally sound; reuse, recycling, handling, treatment, transport and disposal of waste arisings.

6.2 Government Legislation and Standards

6.2.1 The following legislation refers to the handling, treatment and disposal of wastes in Hong Kong which are of relevance to this Assignment:

- Waste Disposal Ordinance (Cap 354);
- Crown Land Ordinance (Cap 28);

- Public Cleansing and Prevention of Nuisances (Urban Council) and (Regional Council) By-laws (Cap 132); and
- Waste Disposal (Chemical Waste) (General) Regulation (Cap 354).

Waste Disposal Ordinance

6.2.2 The *Waste Disposal Ordinance* (WDO) prohibits the unauthorised disposal of wastes - waste being defined as any substance or article which has been abandoned. Construction waste is not directly defined in the Ordinance 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.

6.2.3 Under the Ordinance, 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 Ordinance 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 construction and/or trade wastes.

Crown Land Ordinance

6.2.4 Construction wastes that 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 *Crown Land Ordinance* requires that individuals or companies who deliver suitable construction wastes to public filling areas obtain public filling licences. The licences are issued by the CED under delegated powers from the Director of Lands.

6.2.5 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. In general, there is no size limitation on the rock and broken concrete, and a small amount of timber mixed with other suitable material is permissible. The material should, however, be free from marine mud, household refuse, plastic, metal, industrial and chemical waste, animal and vegetable matter and other material considered unsuitable by the dump supervisor of the public filling areas.

6.2.6 Rock and broken concrete up to 250mm in size will have little effect on subsequent piling operations and can therefore be placed anywhere in reclamations. However, hard material above this size could pose serious restrictions to piling; this must therefore be placed in areas zoned as non-building areas or must be broken down to a size smaller than 250mm. Reinforcement bars must either be cut to lengths that will not interfere with piling, or placed in non-building areas.

Public Cleansing and Prevention of Nuisances and By-laws

6.2.7 These Regulations provide a further control on the illegal tipping of wastes on unauthorised (unlicensed) sites. The illegal tipping of wastes can lead to fines or imprisonment.

Waste Disposal (Chemical Waste) Regulation

6.2.8 Chemical wastes as defined under the *Waste Disposal (Chemical Waste) (General) Regulation* includes any scrap material, effluent or unwanted substance or by-product which is, or contains, any substance specified under Schedule 1 of the Regulation, if it constitutes a danger to health or a risk of pollution.

6.2.9 Producers of chemical waste must comply with the *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes* covered under the *Waste Disposal Ordinance.* A person should not produce or cause to be produced chemical wastes unless he is registered with the Environmental Protection Department (EPD). Any person who contravenes this requirement commits an offence and is liable upon conviction to a fine or imprisonment.

6.2.10 Producers of chemical wastes must treat their wastes utilising an on-site plant licensed by 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 transfer of wastes from cradle to grave can therefore be traced.

6.2.11 The Regulations prescribe 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. They must also train employees to follow the designated procedures.

Additional Guidelines and New Legislation

6.2.12 Other guideline documents that detail how a 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;
- *Code of Practice on the Handling, Transportation and Disposal of Asbestos Waste (1993)* - Environmental Protection Department.

6.2.13 There are various current amendments proposed to the Waste Disposal Ordinance aimed at strengthening control on the management of all types of waste. The following changes are currently proposed:

- comprehensive changes to the Ordinance to provide for the control of the handling, collection, treatment and disposal of different categories of waste;
- amendments to the Ordinance to improve the enforcement provisions for waste disposal charging;
- changes to the *Water Disposal (Charges for disposal of Chemical Waste) Amendment Regulation 1997* to improve the charging scheme, increasing cost recovery.

6.3 Sensitive Receivers

6.3.1 Sensitive receivers which may be impacted by solid waste during construction and operational phases of the Choi Wan Road/Jordan Valley development include the following sectors:

- current residential populations in the vicinity of the site;
- the future residential population;
- non-residential locations (including historic buildings, graves, cultural sites and places of worship);
- surrounding ecological habitats and drainage channels;
- all nearby water bodies.

6.3.2 Such sensitive receivers have been identified in the relevant preceding chapters (i.e. refer to *Chapters 3, 4, 5, 9*).

6.4 Construction Waste Arisings and Impacts

6.4.1 It is not possible to fully quantify the extent and nature of all the wastes likely to arise during the construction of the Choi Wan Road/Jordan Valley development. However, it is possible to estimate the types of waste likely to be produced and specify appropriate methods for their handling, storage and disposal based on the knowledge of general construction practices in Hong Kong.

6.4.2 The types of waste likely to be generated during the construction phase can be divided into distinct categories based on their nature and the options for their disposal, these include:

- construction and demolition (C & D) wastes; such as wood, metal scraps and concrete;
- public fill including inert waste spoil from site clearance, site preparation, excavation and earthworks;
- chemical wastes generated by general site practices and vehicle and plant maintenance/servicing;
- municipal wastes generated by site workers; and,
- sewage wastes generated by site workers.

6.4.3 The definitions for each of these categories and the nature of their arisings and potential impacts are discussed in the following sections.

Construction & Demolition (C & D) Wastes

6.4.4 Demolition wastes will arise from the clearance of existing facilities at the CITA Training Ground in Flathill Quarry - this includes the demolition of 4 steel framed structures and 2 office buildings. Breaking up hard surfaces will also be required where roads are to be up-graded. Such demolition waste is expected to be generated from January to April 2001. The volume of demolition waste is currently unknown.

6.4.5 Construction waste will arise from a number of different activities carried out during the construction period which may include:

- wood from formwork;
- equipment and vehicle maintenance parts;
- materials and equipment wrappings;
- unusable cement/grouting mixes; and
- damaged or contaminated construction materials.

6.4.6 Construction and demolition wastes should be stored temporarily on site and segregated from other waste arisings. Wherever possible, these waste materials should be reused or recycled (i.e. steel/scrap metal) with the remaining inert materials then being disposed of at public filling areas. Waste containing putrescible materials should be disposed of to landfill. In order to minimise the impacts of the demolition works these wastes must be cleared from site as quickly as possible after works. Demolition and clearance works should, where possible, be undertaken simultaneously.

6.4.7 On site measures may be implemented which promote the proper disposal of C&D wastes once off site. For example separate skips for inert (rubble, sand, stone, etc) and non-inert (wood, organics, etc) wastes would help ensure that the former are taken to public filling areas, while the latter are properly disposed of at controlled landfills. Since waste brought to public filling areas will not be charged, while those brought of landfill may be charged, separating waste may also help to reduce waste management costs.

6.4.8 Generation of C & D wastes should be limited and will be determined by the Contractor's working practices and procedures and thus cannot be quantified at this stage. However, if construction wastes are generated in large quantities, they may hinder building operations and present a safety hazard if not removed. The storage and disposal of construction wastes has the potential to create similar visual, dust and associated traffic impacts as the storage and disposal of excavated materials.

6.4.9 A number of measures can be introduced during the construction period to ensure a high standard of management which will minimise the generation of C&D wastes. The design could maximise the use of standard wooden panels in formwork so that the maximum reuse of panels can be achieved. The need to cut panels could also be minimised. Alternatives such as the use of steel formwork or plastic facing could be considered to increase the potential for reuse. It is important that wood wastes are stored separately from other C&D wastes to minimise any contamination which would render the wastes unsuitable for disposal at public filling areas.

6.4.10 Careful planning and good site management should be employed to minimise the over ordering or mixing of excess concrete, mortars and cement grouts. In addition, proper storage and site practices will minimise the damage or contamination of construction materials.

6.4.11 It may be necessary to stockpile some construction wastes prior to material disposal. Whilst such material is inherently inert, if stockpiling is required, the mitigation measures detailed in the previous section on "waste spoil" will be required to prevent unacceptable dust, visual, water quality and general health and safety impacts.

6.4.12 Depending on the nature of the wastes generated, surplus C & D wastes not suitable for re-use on-site will be collected by a waste collector under arrangement with the Contractor and deposited at suitable public filling areas or designated landfill. It will be the Contractor's responsibility to ensure that waste is collected by approved licensed waste collectors and that appropriate measures are taken to minimise adverse impacts such as dust generation. the Contractor must also ensure that all necessary waste disposal permits are obtained.

6.4.13 In order to conserve void space at the landfill sites, C & D wastes must not be disposed of at a landfill site if it contains more than 20% inert material by volume. Such material may be suitable for disposal at public filling areas or at reclamations. Putrescible materials must be disposed of to landfill. The South East New Territories Landfill (SENT) is the nearest landfill available for the disposal of such C & D wastes.

Public Fill

6.4.14 Waste spoil is likely to be generated during the site clearance and preparation works expected to take place between 2001 and 2004. Excavated material will predominantly comprise concrete, cement, granite, colluvium and soil. Approximately 3.45M m^3 of rock and 1.15M m^3 of soil is expected to be generated during earthwork activities. The majority of this site clearance material to be excavated is expected to be clean and should, therefore, be acceptable for reuse either on site for landscaping purposes, filling and elevation and grading the site level or for transportation to other sites with a materials deficit.

6.4.15 The design consultants should devise a feasible method of excavated material disposal. It is currently hoped that this fill can be beneficially used in the SEKD. If the material cannot be utilised at the SEKD reclamation, the material may be used beneficially at other concurrently occurring earth-filling projects - the "FMC

Database of Fill Requirement and Surpluses" should be used as a reference for this purpose. The final destination of the excavated material is subject to on-going review.

6.4.16 Should the SEKD development be available for receipt of surplus fill during the earthworks activities, it is recommended that the spoil is exported from the Site directly to SEKD via a spoil conveyor system. The public fill can be used for site formation directly, or temporarily stockpiled. Alternatively, the material could be conveyed to SEKD for onward transport by barge to another suitable public filling area identified following consultation with FMC at the appropriate time.

6.4.17 Emanating from Site 2, the conveyor should run due west, for a length of approximately 1000m to a delivery area situated at Kai Tak. A suggested alignment for the conveyor is shown in Figure 6.1. Use of a conveyor will simplify site management and reduce secondary environmental impacts associated with the less desirable alternative disposal method, of transportation via trucks.

6.4.18 If the conveyor system approach is adopted for the development, the exit point and the alignment from the site should be reviewed during the detailed design in relation to the finalised construction programme, the methodology and the location of the designated public filling area.

6.4.19 Should trucks be used for transport of fill, it has been estimated that approximately 1.26 million movements will be required over a 4.5 year period. A rock crushing plant will be required to reduce the size of blasted rock prior to transportation by either method. Noise and dust impacts associated with both disposal options are discussed in Chapters 3 and 4 respectively.

6.4.20 The site formation activity (and hence construction traffic movements) will peak in early 2003. A separate Traffic Impact Assessment (TIA) has been carried out to address the effects of construction traffic on the route to the SEKD site.

6.4.21 As shown in Chapter 2,the TIA has identified that the existing junction of Jordan Valley North Road/Ngau Tau Kok Road would experience capacity deficiency with the addition of the construction traffic. The location of the junction is shown as 'Scheme 5' in Figure 2.9. A number of traffic improvement schemes have been examined and works including signal control, set back of the Jordan Valley North Road kerb-line and a staggered pedestrian crossing are recommended before 2003 should transport of fill by truck be required.

6.4.22 Given that the current site land use is predominantly vegetated, much of the top surface site clearance material should be suitable for reuse as topsoil for landscaping purposes. It is not considered possible to stockpile all of this valuable resource since the soil organic matter starts to degrade if stockpiles in excess of 1 m thick are maintained for long periods of time. With regard to the Choi Wan Road/Jordan Valley development site, the space available for stockpiling is relatively restricted and the top soil would need to be kept for several years before use. Whilst some small scale stockpiling of top soil may be possible on-site, the majority of the material may be sold for off-site use.

6.4.23 Other site clearance material may also need to be stockpiled prior to disposal. Stockpile material should be clearly segregated in terms of material type, as this will aid in the potential for re-use of material and final disposal if necessary. The potential adverse environmental impacts which can arise from stockpiled spoil include:

- adverse noise levels during loading/unloading and haulage;
- congestion of traffic routes during haulage;
- unsightly stockpiles on site;
- excessive dust levels during loading/unloading, storage and haulage;
- sediment laden run-off from over-watering; and
- exhaust emissions from haulage vehicles.

6.4.24 Stockpiles of excavated material will need to be managed in a manner that minimises the release of fugitive dust, especially during hot and dry weather. This will require the use of dust suppression measures such as dampening with fine water sprays and covering with a tarpaulin. However, the use of water sprays should be undertaken in a manner that does not generate silt laden run-off which may be able to enter nearby watercourses and cause subsequent adverse water quality impacts - refer to *Chapter 5*. Stockpiles can also be visually intrusive and use of plant can cause a noise nuisance. Such impacts can be mitigated through appropriate stockpile location, spraying and covering. Noise impacts can also be mitigated through the selection of quiet plant and working methods and restricted working hours (refer to *Chapter 3*).

6.4.25 The following measures should be incorporated into the Environmental Pollution and Control Requirements for the Contractor's specification for stockpile management and waste haulage:

- locate stockpiles to minimise visual impacts and nuisance related to noise and air quality (dust);
- minimise land-take by minimising the size of the stockpiles and associated working areas;
- provide fencing to separate sensitive habits and landscape areas to prevent stockpiling at inappropriate locations;
- designate appropriate haulage routes;
- appropriate measures should be employed to minimise windblown litter and dust during transportation by either covering trucks or transporting wastes in enclosed containers;
- use dust suppression techniques (dust suppression activities should use a minimum volume of liquid);
- consider reducing noise impacts through restrictive working hours for noisy practices;
- use of quiet plant;
- prevent surface water pollution by the use of appropriate bunding, interceptors and direction of run-off into settlement ponds; and
- following removal of stockpiles, the area should be restored to its original condition.

6.4.26 The impacts indicated above and the resultant mitigation measures are also applicable for stockpiles of material imported onto the site for use as fill.

Chemical Wastes

6.4.27 Chemical waste as defined under the *Waste Disposal (Chemical Waste) (General) Regulation* includes any scrap material, effluent or unwanted substance or by-product which is, or contains, any substance specified under Schedule 1 of the Regulation, if it constitutes a danger to health or a risk of pollution. A complete list of such substances is provided under the Regulations. Typical chemical waste materials expected to be generated include the following:

- solid wastes
  - used oil/air filters;
  - scrap batteries;
  - brake clutch linings; and
  - vehicle parts.

- liquid wastes
  - used lubricants;
  - spent acid/alkali from batteries maintenance;
  - waste oils/grease;
  - gearbox fluids;
  - spent mineral oils/cleaning fluids; and
  - spent solvents/solution produced from cleaning activities.

6.4.28 Presently, no asbestos has been identified within the Study Area. However, it is possible that some asbestos will be found within the CITA training ground during demolition works. Should asbestos be found, removal should be carried out in accordance with the *Air Pollution Control (Amendment) Ordinance No 13 of 1993 (APC(A)O), Part IX, Section 69 to 73*. Handing and disposal of asbestos wastes should be in accordance with the *Code of Practice on Handling and Disposal of Asbestos Waste.* The asbestos management section of EPD's Air Management Group has a list of consultants specialising in asbestos and HOKLAS accredited asbestos laboratories; a list of licensed Contractors for the disposal of asbestos is also kept by EPD.

6.4.29 If chemical wastes are to be generated, the Contractor will need to register with EPD as a chemical waste producer and observe the requirements for chemical waste storage, labelling, transportation and disposal. The Contractor will have to furnish EPD with the following information:

- particulars of the waste producer, a nominated contact person and type of business;
- particulars of the waste generation processes, locations of waste arisings; and
- waste types, quantities and generation rates.

6.4.30 The Contractor will also need to consider the guidance in *A Guide to Chemical Waste Control Scheme: A Guide to the Registration of Chemical Waste Producers* and the *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes*.

6.4.31 It is not possible to quantify the chemical wastes likely to be generated given that it will depend on the Contractor's on-site maintenance requirements and practices and the number of plant utilised. However, chemical wastes likely to be generated during the construction will for the most part arise from the maintenance of plant and equipment and consist of waste lubricants and oils. Such liquid wastes have particular potential to cause surface water, ground and groundwater pollution and should be collected, stored and disposed of by an appropriate method. Some of this material may also be recyclable. These materials are hazardous since they can cause:

- toxic effects on site workers and nearby sensitive receivers;
- toxic effects on vegetation;
- adverse environmental impacts on surface water and ground water quality following spillage;
- adverse impacts on nullah waters and downstream environments following spillages;
- soil and groundwater contamination following spillages;
- fire hazards; and
- disruption to sewage treatments works if discharged to sewer.

6.4.32 Due to these potential environmental impacts, all chemical wastes must be handled with care and in accordance with the *Waste Disposal (Chemical Waste) (General) Regulation (Cap. 354)* and relevant guidance documents such as the *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes*.

6.4.33 The volumes of chemical waste should be kept to a minimum by separation of waste streams and good management which reduce the potential for contamination. If chemical wastes do arise from the construction works then appropriate methods should be employed for their storage collection and disposal.

6.4.34 Containers used for the storage of chemical wastes should be suitable for the substance they are holding, resistant to corrosion and maintained in a good condition. The containers should be stored safely and securely closed. Chemical wastes should not be stored in any container with a capacity exceeding 450 litres unless the specifications have been approved by the EPD. Every container of chemical waste should display a label in English and Chinese in accordance with instructions prescribed in Schedule 2 of the Regulations.

6.4.35 The storage area for any containers should be designed in accordance with the *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes*. The storage area must not be used for any purpose except for the storage of chemical wastes and should be fully labelled in accordance with the Regulations. Chemicals which are incompatible and can cause fire or explosion if they are mixed should be segregated in separate areas. The storage area should be enclosed on at least three sides by a wall, partition or fence which is at least 2 m in height or the height of the tallest container, whichever is the greater. Adequate ventilation and space for the handling of containers should be provided, with the area being kept clean and dry.

6.4.36 Liquid chemical wastes should be stored in an appropriate manner with full concrete bunding and interceptors to prevent ground contamination. Any ground material contaminated by chemical spillage will need to be disposed of at an appropriate facility at the expense of the Contractor. Liquid chemical wastes should be stored in an area which has an impermeable floor and retention structure with the capacity to accommodate 10% of the volume of the largest container or 20% by volume of the chemical waste stored in that area, whichever is the greatest. When calculating the available retaining capacity, the volume occupied by the containers being stored should be taken into consideration. Bunded areas should be kept clean tested before being disposed. this requirement does not apply to large, approved below ground containers.

6.4.37 Risks associated with spillage of chemical wastes can be minimised by the following:

- appropriate storage of chemical wastes and isolation from working areas;
- secure storage areas;
- minimisation of waste production and careful handling of waste fuel and oil residues;
- spill absorbent material and emulsifiers should be available on site in case of spillage;
- storage of wastes remote from sensitive receivers such as residential properties and water bodies; and
- education of workers on the concepts of site cleanliness and appropriate waste management procedures.

6.4.38 The Contractor should contact Enviropace, the Chemical Waste Treatment Facility (CWTC) operator, who offer both a chemical waste collection service and supply the necessary storage containers for these wastes. Materials which are not acceptable to the CWTC, such as spent batteries, should be sent to a co-disposal landfill such as SENT Landfill.

<u>Land Contamination</u>

6.4.39 An assessment of the potential for land contamination at the current CITA site at Flathill Quarry is presented in Chapter 7. It has been concluded that the potential of encountering contaminated spoil is minimal and no further investigation is recommended.

6.4.40 Blasting operations will be carried out using nitrogen based inorganic chemicals such as trinitrotoluene (TNT). By the nature of blasting the high temperature combustion is unlikely to cause land contamination and no further investigation is recommended.

Municipal Wastes

6.4.41 The construction works will result in the generation of a variety of general refuse requiring disposal. These wastes will be composed predominantly of food wastes, packaging, waste paper, newspapers etc. from construction site workers and will generally be disposed of to landfill.

6.4.42 It has been estimated that the maximum number of workers on site at any one time is likely to be around 600. The maximum period of worker activity will occur during building construction peaking around 2006 when construction overlaps with site formation. EPD forecaster wasted arising, (Monitoring of Solid Waste in Hong Kong, EPD 1996), for year 2006, indicate that around 1.25 kg/person/day of domestic waste are likely to be produced. Using this figure as a general guide for site workers it can estimated that during peak activities, approximately 0.75 tonnes/day of municipal waste will be produced on site.

6.4.43 The storage of municipal wastes if not managed can give rise to several adverse environmental impacts, namely:

- odour nuisance if putrescible material is not collected on a frequent basis;
- wind-blow of material causing litter problems;
- vermin and pests in the waste storage area if it is not well maintained and cleaned regularly;
- water quality impacts; and
- adverse visual impact.

6.4.44 In addition, disposal of wastes, at sites other than approved landfills, can also lead to similar adverse impacts at those sites.

6.4.45 Good site practice can ensure that adverse environmental impacts do not occur and should include at least the following measures:

- municipal wastes generated on-site should be collected and stored separately from other wastes.;
- a temporary refuse collection facility should be set-up by the Contractor;
- municipal wastes should be collected frequently. The removal of waste from the site should be arranged on a daily or at least on every second day by the Contractor to minimise any potential odour impacts, minimise the presence of pests, vermin and other scavengers and prevent unsightly accumulation of waste;
- construction wastes should be sorted on site into public fill and C&D fraction for re-use and recycling as far as practical by the Contractor as described in the New Disposal Arrangements of Construction Waste (1992). Non-inert fraction containing greater than 20% by volume of inert content can be disposed of at landfills, whilst the inert fraction should be delivered to public dumps or other reclamation sites;
- regular maintenance and cleaning of the waste storage areas; and

- storage of material in suitable containers- Municipal wastes should be stored in enclosed bins or compaction units. Compaction units assist in reducing the volumes of waste to be transported for disposal. The relatively small volumes of wastes generated during the construction may be insufficient to justify the use of compaction units. Provided appropriate handling, storage, and disposal procedures and facilities are employed during the construction stage, no unacceptable impacts resulting from waste generation are anticipated to occur.

6.4.46 A reputable private waste collection firm may be commissioned by the site Contractor to remove the waste regularly, to the satisfaction of the Engineer.

6.4.47 Segregation of municipal wastes will maximise recycling possibilities. This should be achieved via the provision of waste receptacles identified according to waste type placed in areas of waste generation. Workers on site will require instruction in understanding the use and purpose of segregated waste receptacles. Alternatively, an area can be set aside within the facility or depot which can be used as a small transfer facility where wastes are segregated according to type after primary collection. Municipal wastes should be segregated in the following manner:

- food and other organic material (i.e. landscape maintenance waste);
- paper/packaging;
- plastics;
- inert materials (i.e. road sweepings); and
- glass.

6.4.48 Waste receptacles should be of an appropriate size and material. Receptacles of 12 m^3 capacity are considered to be suitable.

Sewage

6.4.49 The site workers will generate sewage. Estimates of sewage volume arisings, chemical characteristics, associated environmental hazards and requirements for treatment/mitigation are provided in *Chapter 5*.

Summary

6.4.50 Table 6.1 provides a summary of the construction wastes expected to be generated during the Choi Wan Road/Jordan Valley development, details of waste characteristics, when wastes are likely to be generated and the requirements for disposal.

Table 6.1 Waste Arisings as a Result of Development Construction

Major Activity	Works Description	Timing	Waste Composition	Disposal
Construction and Demolition Wastes	General construction activities Clearance of the CITA area including 4 steel framed structures, 2 office buildings, a small reservoir, hard-standing and other infrastructure.	Jan-April 2001	Steel Wood Concrete Block work Bamboo	Recycle Reuse/landfill Reuse/public fill area Reuse/public fill area Reuse/landfill
Site Formation (Excavation Wastes)	Generated during the formation of the site ready for construction activities	April 2001 - Sep 2004	Inert fill (partially decomposed rock (granite) & granite/ soil (75% Rock/25% Soil)	Preferred option - to transport by conveyor to SEKD for use or transferral by barge. Alternative option -transport by Truck to SEKD.
Chemical Wastes	Generated during construction activities - generally maintenance of site vehicles	As above	Oils Other chemical wastes	Co-disposal landfill Chemical Waste Treatment Facility (CWTF)
Municipal Wastes	Generated by site workers	As above	Municipal wastes	Landfill
Worker Sewage	Generated by site workers	As above	Sewage	Refer to Chapter 5

6.5 Recommended Mitigation Measures

6.5.1 The potential environmental impacts associated with waste arisings from the construction of the proposed development and the recommended handling, transportation and disposal options have been detailed. This section summarises appropriate mitigation measures to minimise any impact from these construction waste arisings.

Waste Minimisation

6.5.2 C & D wastes should be recycled or reused wherever possible. The waste management strategy to be employed should promote waste minimisation at source. Where waste generation is unavoidable then the potential for recycling or reuse should be explored and opportunities taken. If wastes cannot be recycled then the recommended disposal routes should be followed.

6.5.3 Waste reduction measures should be introduced at the design stage and carried through the construction activities, wherever possible, by careful purchasing control, reuse of formwork and good site management.

6.5.4 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. The training requirements should be included in the site waste management plan.

Segregation of Wastes

6.5.5 One of the key mechanisms to minimise construction waste impacts is the provision of suitable facilities for on-site sorting of wastes, to reduce the overall volumes to be delivered to landfill. In order to ensure that all construction waste is disposed of in an appropriate manner, waste should be separated by category on-site by the Contractor. It is recommended that wastes are segregated into the previously defined categories, namely:

(i) public fill (inert excavated material) for on-site reuse;
(ii) public fill (including inert C&D wastes) for public filling areas;
(iii) C & D waste (for landfill);
(iv) chemical waste; and
(v) municipal waste.

Disposal of Wastes

6.5.6 It is recommended that the segregated wastes should be disposed of as follows:

(i) public fill (inert excavated material) should, if possible, be re-used on site to minimise both the costs and secondary environmental impacts associated with transportation;
(ii) excess public fill (including inert C&D wastes) should be disposed of to a public filling area (i.e. the SEKD via a spoil conveyor system) or to another reclamation site;
(iii) C&D wastes (excluding and inert fraction that can be segregated) can be disposed of to landfill. As identified in (ii) above,where the inert fraction can be segregated this should be disposed of to a public filling area or other reclamation site;
(iv) Chemical Waste as defined by Schedule 1 of the Waste Regulations (Chemical) 1992, should be stored in accordance with approved methods defined in the Regulations and the chemical waste disposed of at the Chemical Waste Treatment Centre located at Tsing Yi.
(v) Municipal wastes arising from the construction workforce should be disposed of to landfill.

6.5.7 The Waste Disposal Authority should be consulted by the successful Contractor on the final disposal of these wastes.

Waste Treatment

6.5.8 It is not currently anticipated that any solid waste treatment will be required on site during the construction phase.

Storage, Collection and Transport of Waste

6.5.9 Reputable waste hauliers should be used to collect and transport the wastes to the appropriate disposal points. The necessary measures to minimise adverse impacts such as windblown litter and dust from the transportation of these wastes and impacts on water quality during the storage, handling and transportation of these wastes should be instigated. It is recommended that:

(i) wastes should be handled and stored in a manner which ensures that they are held securely without loss or leakage thereby minimising the potential for pollution. Release of these potential pollutants into marine waters during storage and handling should not be permitted as this is likely to have detrimental effects on water quality and water sensitive receivers;
(ii) only reputable waste hauliers authorised to collect the specific category of waste concerned should be employed;
(iii) removal of demolition wastes should coincide with the demolition work;
(iv) appropriate measures should be employed to minimise windblown litter and dust during transportation by either covering trucks or transporting wastes in enclosed containers;
(v) 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) and the Crown Land Ordinance;
(vi) collection of municipal wastes should be carried out frequently, preferably daily;
(vii) waste should only be disposed of at licensed sites and site staff and the civil engineering Contractor should develop procedures to ensure that illegal disposal of wastes does not occur;
(viii) waste storage areas should be well maintained and cleaned regularly; and
(ix) records should be maintained of the quantities of wastes generated, recycled and disposed, determined by weighing each load or other methods.

6.6 Operational Waste Arisings

6.6.1 During the operational phase of the Choi Wan Road/Jordan Valley development, the main wastes generated include the following:

- domestic/public cleansing waste;
- commercial waste;
- industrial waste;
- sewage arisings.

6.6.2 The requirement for collection, storage, treatment and disposal of these waste arisings is specified below.

<u>Waste Types</u>

Domestic/Public Cleaning Waste

6.6.3 Domestic/public cleansing waste refers to waste generated by residential premises in the course of normal daily activities – this includes bulky wastes such as domestic appliances and furniture. Publicly collected refuse includes litter and dust from street cleaning and litter bins maintained and emptied by the RSD and USD. The majority of this waste is disposed of to landfill site.

Commercial Waste

6.6.4 Commercial waste refers to waste generated by commercial premises such as markets, shops, restaurants, hotels and offices. Private Contractors generally collect such waste, although RSD and USD collect some. The majority of such waste goes to landfill.

Industrial Waste

6.6.5 Industrial waste refers to all waste generated by manufacturing premises. Any such waste is generally collected by private Contractors and disposed of to landfill, unless it is defined as a chemical waste in which case it will need to be stored, transported and disposed of in accordance with paragraphs 6.4.27 - 6.4.38.

Sewage

6.6.6 The eventual site occupants will generate sewage. The requirements for sewage treatment are provided in *Chapter 5* and detailed in the Sewage Impact Assessment.

Waste Volumes

6.6.7 Waste generation rates for Hong Kong are monitored by EPD. Table 6.2, shows the average rates of domestic and commercial / industrial wastes produced between 1993 and 1996.

Table 6.2 Waste Arisings Estimates (EPD 1996)

	Domestic Waste (kg/person/day)				**Commercial and Industrial Waste (kg/employee/day)**			
Year	1993	1994	1995	1996	1993	1994	1995	1996
S.A.R Average	1.02	1.04	1.01	1.00	1.44	1.38	0.88	1.07

6.6.8 Table 6.2 illustrates that in 1996 each person in Hong Kong per day produced approximately 1 kg of domestic waste.

6.6.9 EPD also forecasts waste generation rates in the future using predictive models. Waste generation predictions for 2001, 2006 and 2011 are illustrated in Table 6.3 which assumes that the generation of domestic waste will increase according to previously observed historical trends

Table 6.3 Forecasted Waste Arisings (EPD 1996)

	Domestic Waste (kg/person/day)			**Commercial and Industrial Waste (kg/employee/day)**		
Year	2001	2006	2011	2001	2006	2011
S.A.R Average	1.13	1.25	1.37	1.21	1.35	1.49

6.6.10 Given that the proposed development is expected to reach its design population limit of 35,066 people by the end of year 2009, it can be estimated that approximately 46 tonnes per day of domestic waste may be generated which will require collection, storage, transport and disposal. This waste generation figure rises to approximately 48 tonnes by 2011.

6.6.11 The main sources of employment in the development area will be the commercial centre located in Site 1. Applying an employment density per worker ratio of 1 per 20 m^2 for retail activities to the total retail area of 8554 m^2, a total of about 428 job places are expected to be generated by the retail activities. Using the waste generation rates given in Table 6.3 it can be estimated that approximately 0.6 tonnes of commercial/industrial waste may be generated by retail activities by 2009.

Refuse Collection Points

6.6.12 According to Chapter 9 of the HKPSG, a refuse collection point (RCP) is required to serve the needs of each population of 20,000 persons or areas within a distance of 500 metres. However, consultation with the Housing Department has indicated the need for 1 RCP per Home Ownership Scheme (HOS) court at the Choi Wan Road/Jordan Valley development, whilst the USD has requested an additional RCP. Thus, a total of 3 RCP (total area requirement of 400 - 600 m^2) have been proposed for the Choi Wan Road/Jordan Valley development.

Impacts Resulting from Refuse Collection Points

6.6.13 Provision of RCPs has the potential to generate environmental nuisance in terms of noise, odour and visual appearance. Noise impacts may result through the use of refuse collection vehicles (RCVs) which will regularly visit the RCPs. Odour and adverse visual impacts may result if waste is not collected – this could also result in problems with vermin.

Mitigation of Impacts Resulting from Refuse Collection Points

6.6.14 The adverse environmental impacts indicated above can largely be mitigated through appropriate design of the RCP, as well as operational and management controls.

6.6.15 Specific measures that can be used to minimise environmental impacts include the following:

- noise can be mitigated through enclosure of the RCP unit;
- enclosing the facility can also mitigate the odour nuisance whilst if necessary an odour control system and ventilation system can be installed;
- odour impacts can be reduced if wastes are stored in sealed containers and by promptly cleaning up any spilt wastes/leachates;
- RCPs should be fitted with water points and high pressure hoses for cleaning operations;
- the RCP drainage systems should be connected to the foul sewerage network to prevent leachate entry into the surface water drainage system;
- visual impacts can be mitigated though the design of the RCP and by maintaining a clean environment around and within the site. Appropriate landscaping can also reduce the visual obtrusiveness of the RCP and to act as a buffer from adjacent sensitive land uses.

6.6.16 The responsibility for the collection and disposal of municipal wastes will rest with the Urban Services Department. Whilst it is outside the scope of this EIA to directly influence the procedures for the management of wastes during the operational phase, it is considered that management of waste arisings is a general community responsibility. Residents, schools and those responsible for building management should actively promote waste reduction. Provisions for the segregation of waste in to glass, paper, plastics, metal tins etc. should be made available to residents of the development and suitable arrangements encouraged for their subsequent recycling.

6.7 Environmental Monitoring and Auditing

6.7.1 It is recommended that auditing of waste streams is carried out periodically by the Engineers' Representative during the construction phase. This will determine if wastes are being managed in accordance with the Contractor's procedures and the site waste management plan. The audits should look at all aspects of waste management including waste generation, storage, recycling, treatment, transport, and disposal. Additional measures for the monitoring and audit of wastes is presented in the Environmental Monitoring and Audit (EM&A) Manual.

6.8 Conclusions

6.8.1 Provided that waste arisings from the construction of the proposed development are handled, transported and disposed of using approved methods as described above, no unacceptable adverse environmental impacts are envisaged. In most cases the waste material can be easily re-used at public filling areas or disposed of to landfill.

6.8.2 The mitigation measures recommended in this Chapter should be incorporated into a Waste Management Plan and applied through the contract documents to ensure that environmental nuisance does not arise from the storage, transport and disposal of the various types of waste arisings from this proposed development.

6.8.3 During operation of the proposed development, domestic waste arising will need to be collected and delivered to a RCP from where wastes will be transported to waste transfer stations and an appropriate landfill site. Through the appropriate design of the RCP, no unacceptable adverse environmental impacts are envisaged.

7. LAND CONTAMINATION

7.1 Introduction

7.1.1 This Chapter presents an assessment of the potential for contamination at the Study Area. As described in the Brief, this assessment addresses the potential for contamination of the Site at Choi Wan Road site which was previously used as a quarry.

7.1.2 The assessment includes:

- A review of the past and present uses of the land.
- An assessment of the potential characterisation in terms of the quality/quantity and extent of potential contamination.
- An evaluation of impacts and recommendation for further action.

Jordan Valley Landfill

7.1.3 Jordan Valley Landfill is a deep valley infill, which extends to an average depth of 32 metres and covers a total plan area of about 6.5 ha. The landfill received waste between April 1986 and July 1990. During its operational life, it received approximately 1.52 million tonnes of domestic, construction and commercial wastes at proportions of 67.5 %, 31 % and 1.5 % respectively.

Restoration Works

7.1.4 Jordan Valley landfill is one of five landfills currently being restored under the Urban Landfills Restoration Contract (ULRC) administered by EPD. Restoration works have commenced, these include a landfill gas management system, capping of the landfill platforms, and measures to reduce volumes and treat leachate within the landfill. The restoration works were completed in May 1998 and commissioning tests are currently ongoing as part of a one year defects correction period.

7.1.5 Due to the difficulties of developing upon landfill sites, no residential development is proposed for Jordan Valley Landfill. Under the ULRC, the Restoration Contractor will be responsible for maintaining the capping of the landfill and no works will be under taken as part of this project to excavate or disturb the landfilled wastes.

7.1.6 Upon completion of the restoration works, it is proposed that the landfill is developed for a passive recreational afteruse, e.g. Urban Fringe Park for local residents. The status and details of this project are unclear at this time although separate studies will be carried out to address the potential impacts upon users of the restored landfill. Therefore and in accordance with the Brief, the landfill as potential source of contaminated land is not considered further in this assessment.

7.2 Government Legislation and Standards

7.2.1 Legislation and guidance relating to contaminated land and groundwater is included in the Environmental Impact Assessment Ordinance (EIAO) and the EPD Practice Note for Professional Persons 'Contaminated Land Assessment and Remediation' (ProPECC PN 3/94).

7.2.2 The EIA Ordinance came in to force in April 1998, a Technical Memorandum (TM) has been issued and Regulations are currently being drafted.
Provisions for consideration of contamination issues as part of the EIA are included in Annex 19 to the TM, "Guidelines for the assessment of impact on sites of Cultural heritage and other impacts" and Annex 7 to the TM, "Criteria for Evaluating Waste Management Implications".

7.2.3 The EPD ProPECC Note PN 3/94 sets out the requirements for proper assessment and management of potentially contaminated sites, provides guidelines on how site assessments should be conducted and suggests practical remedial measures that can be adopted for the clean-up of a contaminated site.

7.2.4 The ProPECC Note includes criteria for contamination of both soil and groundwater. The criteria are developed from the Dutch Indicative Index or "Dutch Guidelines". The Dutch Guidelines provide reference values for pollution contamination at three levels, A, B and C:

- 'A' value represents the normal background level
- 'B' value is that 'delimiting value for soil having potential for harmful effects on human health or the environment and requiring further investigation'
- 'C' value indicates 'heavy pollution and requirement for remedial action'

7.3 Site History and the Proposed Development

General Site Description

7.3.1 A project description and the preferred outline layout plans for the development are described in Chapter 2.

Site History

7.3.2 The previous land uses at Flathill Quarry and the site history of the area have been established through a desk-based study including reference to:

- Aerial photographs of the site taken between 1960 and 1996;
- Government landuse and geological mapping;
- Site visits;
- Review of existing information relating to past quarrying operations, (held by Mines and Quarries Division of CED); and
- Discussions with EPD;
- Discussions with the current occupiers.

7.3.3 Although the exact date of commencement is not clear, the FlatHill Quarry was mined by the FlatHill Quarry Company until 1974. Activities included standard mining operations such as blasting and rock crushing.

7.3.4 In 1983 the site was recorded as being used for coach and lorry parking for a short period. The site is currently occupied by the Construction Industry Training Association, (CITA) who have occupied the area under licence since 1984. The CITA are a quasi-autonomous non governmental organisation who train individuals in construction techniques, such as use and maintenance of heavy plant and machinery. A number of items of plant are kept at the quarry.

Proposed Development

7.3.5 The Flathill Quarry site is located to the west of the Study Area and is shown in Figure 2.1. Under the preferred layout for the proposed development, the existing quarry area will be developed as Site 1, (as shown in Figure 2.2) which will include housing blocks, two primary schools, a commercial centre a bus terminus and carparking on the 20mPD platform.

7.4 Environmental Setting

Geology

7.4.1 A review of the 'Hong Kong Geological Survey, (1986a) Sheet 11, Hong Kong and Kowloon' indicates that the underlying geology of the quarry site is of major intrusive igneous rocks, comprising fine to medium grained granite.

7.4.2 Scott Wilson carried out a joint survey at Flathill Quarry in November 1997. On the near-vertical rock faces, joints are described as closely to widely spaced. Their persistence is generally greater than 3m. Most of the joint apertures are extremely narrow (<6 mm wide); some of the occasionally wider joints are infilled with weathered parent rock. Some joints are rough, but the majority of them are smooth. Minor seepage was observed in the joints on the north and north-east slopes of the quarry.

7.4.3 The quarry floor is presently overlain with a veneer of silty sand fill. The fill was presumably placed to cover the uneven ground surfaces resulted from previous quarrying activities. To date, no investigative trial pits have been excavated from the quarry floor, but the fill thickness is expected to be fairly thin.

Hydrogeology

7.4.4 The available piezometric data indicates that groundwater flows in a southerly direction towards Choi Ha Estate. The bounding ridge, which separates the landfill and the development areas, appears to act as a groundwater divide between the landfill site and the development areas.

7.5 Sensitive Receivers

7.5.1 For developments carried out on contaminated land, the main sensitive receivers during construction are workers exposed to contaminated spoil and water receivers. Exposure principally occurs during demolition works, earth moving operations, construction of building foundations, and laying of services. The main exposure routes for site construction workers are inhalation of dusts and direct ingestion of contaminated spoil through eating or smoking on site.

7.5.2. Site termination could lead to the mobilisation of contained contamination. Once mobilised, such contamination could enter the aquatic environment eg. follow rainstorms and have adverse impacts on the aquatic environment.

7.5.3 Following completion of the development, the main sensitive receivers will be the future residents of the housing blocks, visitors, (such as school children) and workers involved in the maintenance of site services.

7.6 Potential for Land Contamination

7.6.1 A review of the previous land uses of the quarry indicates that principal source of contamination is from petroleum hydrocarbons arising from spills and leaks from the temporary lorry parking and construction site plant of CITA. Discussions held with CITA indicated that to their knowledge, there have been no major spills at the site. Given the relatively small scale occupancy of the site by potentially polluting uses in the past. The level of potential contamination is likely to be minimal.

7.6.2 As the Site has been quarried in the past there are very limited superficial deposits and no soils to which contaminates could bind. Any minor spillages would therefore either; remain on the rock surface (and volatile elements evaporate), seep in to surface cracks, or be washed off-site by surface water discharges.

Construction Phase Issues

7.6.3 As the existing level of the FlatHill quarry is around 22mPD and the final formed platform is to be at 20mPD. the volume of fill which will need to be excavated is minimal. Therefore, exposure of site workers to spoil will be limited.

7.6.4 It is likely that excess spoil from Flathill quarry will either be mixed with excess spoil from other areas and used as fill elsewhere on site, or form part of an estimated surplus of 4.6 million cubic metres of fill which will be exported off site to a suitable public filling area. In the unlikely event that there are isolated pockets of minor contaminants, this 'dilution' of spoil will further reduce the potential exposure to site workers following the initial excavation.

Operational Phase Issues

7.6.5 The potential impact to future site users is considered to be minimal. There are no subsurface buildings proposed for the development and the site will be covered with buildings and concrete hardstanding. This will minimise contact with any potential contaminants present in the soil.

7.7 Conclusions

7.7.1 The potential for contamination at Flathill quarry is considered minimal. There is no reason to suspect that any undocumented activities with the potential to contaminate the area have been carried out either at, or adjacent to the quarry. Therefore, no further investigations are recommended.

8. LANDSCAPE AND VISUAL IMPACT ASSESSMENT

8.1 Introduction

8.1.1 This Chapter presents an assessment of the landscape and visual impacts associated with the development shown on the Master Development Plan (see Figures 2.2). The methodology and baseline condition of the Study Area is described and then an assessment is carried out of the proposed development within the existing and planned context.

8.2 Objectives

8.2.1 The objective of the Landscape and Visual Impact Assessment (LVIA) is, primarily, to assess the impacts of development on the existing baseline condition, both during construction and on completion. Clearly, any development of this relatively undisturbed site will result in significant landscape and visual impacts.

8.2.2 LVIA has been used as an iterative tool to assist in establishing the optimal development of the Study Area. It has also been used to develop the landscape planning and urban design guidelines. The aim has been to "design out" landscape and visual impacts as far as possible. The recommendations of this EIA process have been incorporated into the Landscape Master Plan.

8.3 Government Legislation and Standards

8.3.1 The assessment of landscape and visual impacts will be based on the guidelines in Annex 18 of the Technical Memorandum of the EIA Ordinance.

8.4 Assessment Methodology

8.4.1 The basic requirements of the LVIA were outlined in the Brief and developed in the Inception Report. From this, a methodology has been developed and is summarised below:

<u>Baseline Review</u>

8.4.2 The baseline review describes the existing landscape and visual character of the Study Area and provides a benchmark against which the significance of change to landscape and visual resources can be assessed. This has been carried out by desktop study as well as site investigation.

8.4.3 The visual baseline review is defined by a visual envelope which in turn defines the scope of the visual impact assessment (VIA). As this includes a wide area, the visual impact assessment focuses on visually sensitive receivers (VSR) and agreed key viewpoints around the Study Area. The highest VSR's are usually considered to be existing and committed residential developments.

8.4.4 The landscape character of the Study Area is based on a review of the key landscape features such as topography, vegetation cover and land use. From this, the overall landscape character is established and its sensitivity to change assessed.

8.4.5 A review of the planning and development control framework has been undertaken in order to appreciate the role of the Study Area within a larger context. The location of planned public open space, amenity areas have been identified as these are the key landscape resources of the area and will form part of the LIA.

Landscape and Visual Impacts

8.4.6 The development has been described in landscape and visual terms. This examines the site formation, disposition and profile of the development blocks and schools, access arrangements to the Study Area as well as the associated infrastructure development.

8.4.7 An assessment of impacts during construction and on completion has been made including an indication of their significance and magnitude. The key visual issues will be visual compatibility and visual obstruction. Views from the VSR's are indicated and impacts from key viewpoints (previously agreed with Planning Department) are illustrated by photomontages. A key map identifies the location and direction of these viewpoints.

8.4.8 Landscape impact assessment (LIA) concentrates on the level of disturbance to the landscape resources within the Study Area balanced against their sensitivity to change. The magnitude and significance of impact has been predicted.

Recommendations on Mitigation Measures

8.4.9 Mitigation measures are proposed to reduce and attenuate the landscape and visual impacts. In addition, areas have been identified where landscape and visual quality within the Study Area could be enhanced. Where appropriate, these measures are included in the MLP.

8.5 Definition of Technical Terms

8.5.1 For the purpose of this LVIA Study, the following technical terms used throughout the report are defined as follows:

- **Landscape impact** is a direct physical change to existing landscape features such as vegetation, topography, open space and recreation facilities as well as buildings and structures. By mapping the extent and location of these features, any loss or change can be objectively assessed and, where possible, re-provisioned or compensated by mitigation measures incorporated into the project.

- **Visual impact** is a change to the appearance of the study area which affect visually sensitive receivers (VSR's) and key viewpoints. Visual impact can vary in significance from overall improvement to degradation. The assessment of visual impact relies on an appreciation of aesthetic principles, the design and function of urban form, and the characteristics of human perception. It should be noted that adverse levels of visual impact can lead to the blighting of urban and rural areas resulting in a long-term decline in the quality of an environment and a subsequent loss in socio-economic vitality. Visual impact may also have a direct impact on the value of property.

- **Sensitive viewpoints** are considered to have varying degrees of "sensitivity" to change based on the land-use at each viewpoint. The Environmental Guidelines for Planning in Hong Kong defines sensitive users as "land uses which, by virtue of the nature of the activities thereon --- are susceptible to the influence of residual or physical changes generated by polluting uses".

8.5.2 **Highly sensitive viewpoints** are residential viewpoints. Local residents with a permanent view over a site would be particularly aware of visual change. In addition, residents are likely to care about visual impact as it can affect the quality of residential amenity. In addition, residents may have a financial interest in the property (either ownership or rental) and a change in the appearance of the surroundings could have a financial implication on property values. Visual impacts could lead to community objections.

8.5.3 Pedestrians, tourists, hikers and users of open spaces are considered **moderately sensitive** as they are only temporarily viewing an area, often during recreation. Passing motorists are considered to be of **low sensitivity** because of their temporary "exposure" to the views. People affected by visual impact are generally referred to as **visually sensitive receivers (VSR's)** in this report.

- The **significance** of the visual impact is judged using the following criteria:

  - Whether the impact is during construction or operation;
  - The proximity of the sensitive viewpoint to the Study Area;
  - The activity of the viewer (for example, leisure time, working etc.);
  - The frequency and length of the view of the proposed development;
  - The scale or visual obstruction of the proposed works in relation to the overall view (the impact would be less if part of a wide or panoramic view);
  - The existing context and the level of change to the baseline condition.

- Other **key viewpoints** around the Study Area are also considered in the visual impact assessment. These include important areas of open space or amenity at varying elevations.

8.6 Landscape Baseline Review

Landform and Topography

8.6.1 The Study Area has a dramatic landform with ridges rising to 188mPD at the highest point. The ridelines form a continuation of the Kowloon Hills which terminate in Fei Ngo Shan (Kowloon Peak), which rises steeply north of the Study Area. This ridge forms an extension to the Kowloon Hills extending into the urban area and has great local significance as it separates three districts (Ngau Chi Wan, Ngau Tau Kok and Shun Lee), provides identity to these districts and is a recreational resource to urban residents.

8.6.2 The Study Area is divided into two distinct physical areas by Jordan Valley. The original water course is now damned, channelled and placed in a culvert. The natural form of the Study Area has also been heavily modified by quarrying, landfill operations, the construction of the service water reservoir and the formation of the temporary housing platform at Ping Shek. The perimeter of the Study Area has been altered by cutting into the slopes to form and widen New Clear Water Bay Road.

8.6.3 The dominant landforms within the Study Area are shown in Figure 8.1 (topography and landform) and are characterised by a horse shoe shaped ridge and a distinctive conical hill in the southern part of the site. As shown in the aerial photo (Figure 8.2 - aerial photo), the ridgelines are heavily eroded; mainly because of the thin soil and heavy recreational use (see Figure 8.5 - Degraded Landscape). The hillsides, however, create a valuable natural backdrop to development in East Kowloon.

8.6.4 The ridgelines within the Study Area provide excellent viewpoints across the urban area to Kai Tak airport (Figure 8.3 - photograph of ridgelines). To the north, Fei Ngo Shan (Kowloon Peak) rises dramatically behind the Study Area. Within the site, the ridgeline and hilltop vantage points also afford interesting views of the lower parts of the Study Area.

Vegetation Cover

8.6.5 At lower levels, the undisturbed slopes and valleys are heavily vegetated with predominantly native trees and shrubs (Figure 8.4 - Vegetation Cover). In the last 5 to 8 years the hilltops and ridges have been planted with fast-growing introduced tree species (predominantly *Acacia* and *Eucalyptus*) to assist in erosion control (Figure 8.5- Degraded Landscape). In many areas these have successfully formed plantations. The cut slopes adjacent to New Clear Water Bay Road have also been planted with mainly introduced species. Grass and shrubland dominate on the southern hill and around the quarries. There is also evidence of small scale vegetable cultivation and gardening on the ridgelines and in the valleys. Details of plant species are included in Chapter 9 - Ecology.

Land-Use

8.6.6 Most of the Study Area is currently undeveloped and zoned as Green Belt or Open Space. The major ridgeline is zoned for G/IC IC use and was the site set aside for the Eastern District Hospital. The north-east part of the Study Area has been used as a landfill in the past and is now being restored with an ecological park planned as the after-use. Substantial areas within the Study Area are heavily disturbed by quarrying with three former quarries within the site. The platform of the large "Flathill Quarry" is now being used by CITA as a training ground (zoned as community use). The western end of Jordan Valley is zoned as DO and is being developed as a recreational complex. Figure 8.7 - Open Space and Recreation Framework and Figure 8.8 illustrates these areas.

8.6.7 There are several informal uses, primarily recreational, taking place within the Study Area (see Figure 8.9 - Informal recreation). Gardens are cultivated along the ridgelines which are actively used for morning exercise and sitting out. There are actively cultivated vegetable plots in the main valley. On the northern slopes (off New Clear Water Bay Road) there is an outdoor shrine/temple complex. The HKHA and District Boards have provided pavilions, shelters and amenities throughout the Study Area in association with the District Board's Jordan Valley Morning Walking Trail.

Planning and Development Control Framework

8.6.8 This section describes the planned context of the Study Area and also the intended role of the site as part of a wider landscape framework.

8.6.9 The "Metroplan Landscape Strategy for the Urban Fringe and Coastal Areas" (1989) forms the basis of government policy on landscape matters in the urban area (Figure 8.7 - Open space and recreation framework). In this document, the eastern part of the Study Area is identified as a "Landscape Protection Area" which is intended to protect the highest ridgeline on the site. In LPA's there is a presumption against additional inappropriate development.

8.6.10 The western part of the Study Area was identified as a "Development Area with High Landscape Value" where development should also conserve and protect existing landscape features. This provides supplementary controls and guidelines to ensure future development takes proper account of existing landforms, vegetation cover and landscape character. Particular emphasis is given to platform size and configuration, slope treatment, landscape design and reinstatement.

8.6.11 Because of its proximity to a large and growing urban population, Metroplan identified Jordan Valley (predominantly the eastern part of the Study Area and the landfill) as an "Urban Fringe Park (UFP)". The intention of the UFP is to provide alternative recreational outlets for urban dwellers by taking advantage of local landscape features, particularly those overlooking the urban area. The UFP proposal was followed up by an "Outline Feasibility Study" (1990) which examined development opportunities for the landfill, valley and southern hills of the Study Area. It was proposed that the area would be developed as a "special" urban park and recreational facility with a mixture of active, passive and special facilities. Commercial / retail development was proposed in the southern part of the site to generate revenue. The Central and East Kowloon Development Statement (CEKDS) shows the UFP extending to include the hill in the south of the Study Area.

8.6.12 The intentions of the Metroplan Landscape Strategy are now reflected in the zoning (OZP) and planned outline development of the site (ODP). The Jordan Valley Leisure Pool Complex is now open and is part of a large, phased DO development of that area. Trees have been planted (reforestation) on the hillsides to control erosion and restoration of the landfill to a recreation facility is in progress.

8.6.13 CEKDS assumes that Upper Jordan Valley and the Flathill Quarry will be developed for residential use. This document gives no particular importance to the hills and ridgelines within the Study Area in the overall assessment, however the undeveloped parts of the site are identified as "Landscape Upgrade Area" (LUA).

8.6.14 On the OZP, most of the Study Area is zoned as Green Belt. This zoning is intended to conserve landscape features and to define the limits of urban development and there is generally a presumption against inappropriate development in these areas. Only low density development is usually permitted on sites zoned GB.

Planned Open Space and Recreation Facilities

8.6.15 The former Jordan Valley landfill is zoned as open space (District Open Space on the ODP). Restoration of the site is in progress and an Ecological Park is proposed for its after-use. The ODP describes the landfill as an "Education Centre cum Natural Habitat with forest walks, radio controlled model car circuit, gateball pitches and playground". The implementation and development programme for this facility are, however, still in question. The landfill will require ongoing monitoring and maintenance of the restoration systems and it is likely that public access will be controlled and activities may be restricted.

8.6.16 A large DO complex is planned to extend and enlarge the facilities in the area of the existing Jordan Valley Leisure Pool and Jordan Valley Playground. Phase 2, Stage I of the works in the area north of the nullah are due to commence in November 1998 and it is planned that Phase 2, Stage II will commence early 1999 (funding approval awaited).

8.6.17 The development of a sports hall and recreation area at Shun Lee Tsuen is at the design stage with construction now in progress.

8.6.18 The ODP shows two areas of Local Open Space (LO); one within the R07 site and the other above the MTRC tunnel adjacent to Choi Shek Lane. There are no plans or programme for the development of these sites.

8.6.19 The Urban Council have plans to develop a sitting out area on the north side of Choi Wan Road. Construction, due to commence in March 1998, has been postponed pending the outcome of this Study.

Landscape Quality

8.6.20 As identified in the planning documents reviewed and as observed on site, the dramatic, undeveloped hills within the Study Area are degraded due to erosion and dominated by non-native vegetation. This would typically reduce the landscape quality of an area however, in this case, the importance of the actual landform and in particular the ridgelines, are considered to outweigh these negative characteristics. The landform of the Study Area is recognised as an extremely important feature within the local landscape. This importance is reinforced by the obvious value of the ridgelines to local residents who heavily use this accessible, urban fringe area for passive recreation. For this reason, the Study Area is considered to have high landscape quality at the local level.

8.6.21 The regional importance of the hills within the Study Area is recognised in the planning documents reviewed. In addition, these documents recognise the recreational potential of this urban fringe area by its designation as an Urban Fringe Park. The hills also create an important backdrop to the urban area. In conclusion, the Study Area is considered to have high inherent landscape quality and recreation potential at the regional level.

8.7 Visual Baseline Review

8.7.1 As described, the Study Area has considerable value as a visual resource. It creates a dramatic green backdrop to the urban area which is a feature of development in Hong Kong. The broad visual envelope is indicated in the Figure 8.10 - visual envelope. The upper parts of the Study Area are visible from most of Kowloon and Hong Kong island. The site is a feature within the East Kowloon skyline; particularly from the adjacent urban area.

8.7.2 Planning Department have identified the following key viewpoints for examination. They are located around the site and illustrate the Study Area within its urban and broader context (see Figures 8.15 and 8.16 Photomontages):

- Kowloon Bay Recreation Area;
- Jordan Valley Leisure Pool Complex;
- Shun Lee Estate (Fei Ngo Shan Road);
- Ping Shek Recreation Ground; and
- Viewing tower in Quarry Bay Park

8.7.3 One of the most significant visual characteristics of the Study Area is the spectacular, long distance views afforded from the ridgelines and highest viewpoints within the Study Area (Figure 8.6 - Visual Characteristics). A panoramic view extends from Lion Rock along the Kowloon hills and around to Anderson Road Quarry. Across Victoria harbour, Quarry Bay and most of the north of Hong Kong island is visible, including the Peak. Peng Chau and other outlying islands can be seen in the distance as well as the Kwai Chung container terminals and Stonecutters Island. The views are likely to be one of the main reasons that the site is a popular recreation area for local residents.

8.7.4 The Study Area is surrounded by high-rise residential blocks; mainly public housing estates. It will be visible to residents of blocks with windows facing the site as illustrated in Figure 8.11 (Sensitive viewpoints). The actual view will be dependent on the floor of the building in relation to the site. The residential blocks around the Study Area will all be classified as sensitive viewpoints and existing views from representative viewpoints are shown in Figures 8.12 to 8.14.

8.8 Recommended Development Option

Measures to Minimise Landscape and Visual Impacts

8.8.1 The landscape and visual importance of the north and east ridgelines was recognised at the outset of the project and was an important consideration in the selection of the preferred development option. During the evaluation of the site formation and development options, retaining the ridgelines as far as possible was an important criteria and rated highly during the option evaluation process.

8.8.2 As a result of this process, the Master Development Plan has retained the most significant landscape, recreational and visual features of the site; the eastern ridgeline and most of the northern ridgeline. The MLP shows development concentrated on the north-western part of the Study Area; adjacent to the existing development in the Ngau Tau Kok area. The southern part of the Study Area remains undisturbed as does most of the area around the former landfill and Shun Lee Tsuen area. From a landscape and visual impact perspective, this represents a significantly lower impact from the initial development proposal shown in the Brief (see Appendix A) (which showed development on top of the ridges) as well as other development options considered.

8.8.3 As far as possible, site formation for the development has been concentrated within existing areas of disturbed landscape; primarily the existing quarries. This minimises disturbance of the higher quality landscape areas within the Study Area as well as providing an opportunity for landscape upgrading in association with the development.

8.8.4 Having retained the ridges, another important principle incorporated into the MLP is the creation of a major visual corridor through the site to the highest point at 188 mPD. This is achieved by zoning low rise uses along this corridor. This is an important principle incorporated into the development to minimise landscape and visual impacts.

8.8.5 As part of the Study process, several options for vehicular access to the development have been considered. One option involved constructing an elevated road over the nullah adjacent to the Jordan Valley Leisure Pool to give access to Choi Ha Road. This would have resulted in significant landscape and visual impacts to the existing and planned open space facilities in this area. This access option has not been pursued thereby minimising the visual impact on these recreational facilities.

8.8.6 The angle of the slope behind Site 3B has been reduced to 45° to allow soiling and revegetation with grass and shrubs. A "soft" slope in this area reduces noise impacts as well as improves the appearance of the rock slope thereby minimising visual impacts. By allowing limited revegetation, this will also assist in ecological mitigation.

8.8.7 The area of USD's planned Choi Wan Road Sitting-out Area has been included in a public open space to minimise the impact on this facility when it is constructed. It is, however, likely that the facility as currently designed will be affected by the widening of Choi Ha Road.

8.8.8 A landscape framework has been developed as an integral part of the development. The objective of this framework is to create a comprehensive system of public open space within the development to meet the needs of the residents and to facilitate and improve pedestrian connections between the existing urban area and the ridgelines. This will assist in minimising the landscape and visual impacts of the development.

Effects on the Baseline Condition

8.8.9 The elements of the recommended development option which affect the landscape and visual baseline condition are summarised as follows:

- Extensive earthworks to form the three residential development platforms and access roads:
    - Site 1 requiring cutting into the face of the existing Flathill Quarry;
    - Site 2 requiring earthworks over the MTRC tunnel (Figure 8.14); and
    - Site 3 requiring cutting into the bottom of the north and west ridgelines

These site formation activities will commence in March 2001 with completion in November 2005.

- Slope cutting into the eastern-end of the northern ridgeline to form the Fresh Water Reservoir and Salt Water Reservoir site (Site 4).
- Excavation of the hillside and quarry adjacent to New Clear Water Bay Road to form four school sites (Site 5).
- Construction of the elevated slip road to Kwun Tong Road (north bound) as well as site formation and construction of the at-grade access to Site 1 and elevated access road to Site 2.
- High-rise residential buildings: public housing blocks to 40 storeys (or 4 storey carpark podium and 36-storeys) and private residential blocks from 28 to 40 storeys.

- Low-rise school and commercial buildings.

- Site formation, grading, importation of soil and construction of District Open Space (DO) at-grade to provide active and passive recreation space to meet the needs of the new residential population in accordance with HKPSG.

- Local open space and additional private open space and club house facilities incorporated within the developments.

- Above-ground and underground utilities.

8.9 Assessment of Landscape and Visual Impacts

8.9.1 The landscape and visual impact of the proposed development can be divided into impacts during construction and impacts on completion. Tables 8.1 and 8.2 summarise these impacts assuming no further mitigation is incorporated into scheme. The impacts of the completed development from the key viewpoints are illustrated in Figures 8.15 and 8.16.

Table 8.1 Landscape and Visual Impacts during Construction

Source of Impact	Unmitigated Impact	Impact Receiver
Site Formation • Earthworks to form the development platforms • Haulage roads and vehicle movements; likely to involve the widening of Choi Wan Road	• Temporary (36 months) but significant landscape and visual impacts while earthworks are in progress • Creation of new and extensive rock cut slopes adjacent to all development platforms; maximum 40 metres high • Removal of existing soil cover and vegetation • Loss of amenity (Jordan Valley Morning Walking Trail) • Landscape impacts on the planned Sitting Out Area at Choi Wan Road • Permanent loss of part of the Northern Ridgeline • Permanent loss of wooded hillsides (see Chapter 9, Table 9.8 for details of areas of habitats lost) • There are no apparent impacts upon the protected species *Enkianthus quinqueflorus*.	• All VSR's to the east of the Study Area in particular Tak Bo Garden, Choi Ha Estate, Amoy Gardens, Kei Hing Estate • VSR's in the Choi Hung Estate will be affected by quarry excavation for the school • Areas of primarily degraded and eroded landscape • Area of high quality landscape and high visual amenity along the northern ridgeline • Residents of the area who use the site for informal recreation • Urban Council planned facilities • Urban Council zoned open spaces
Construction of the Slip Road to Kwun Tong Road and Elevated Access Road to Site 2 and at - Grade Access to Site 1	• Further excavation of the rock slope to the east of Kwun Tong Road (slope stabilisation work currently in progress) • Significant concrete structures constructed onto rock slope; an already degraded landscape	• Residents of Kai Tai Court to west of Kwun Tong Road • Motorists on Kwun Tong Road and passengers on the MTR
High-Rise Building Construction Activities • Piling and construction operations	• Permanent negative impact - loss of views of urban-fringe and replacement with a construction site • Temporary negative impact - exposure of topsoil to erosion	• All VSR's and key viewpoints identified • Landscape of high local value

Source of Impact	Unmitigated Impact	Impact Receiver
Site Formation of Site 4 • Excavation for FWR, SWR and access road and formation of 60° rock slopes around site • Site formation and construction for schools and associated access roads	• Permanent loss of up to 15 metres from the top of the northern ridgeline due to excavation into the hillside from the north - significant landscape and visual impact • Permanent loss of wooded hillside and part of northern ridgeline • Permanent loss of degraded roadside landscape and revegetated quarry	• Residents of the Choi Wan Estate • Motorists of New Clear Water Bay Road • Landscape (vegetation) of high local value • Landscape feature (ridgeline) of high regional importance

Table 8.2 Landscape and Visual Impacts on Completion

Source of Impact	Unmitigated Impact	Impact Receiver
High-rise Residential Blocks	• Permanent negative visual impact - appearance of new man-made elements in an otherwise undisturbed landscape • Permanent change to some areas of high quality landscape and loss of the recreational use of degraded landscape areas • Screening and obstruction of the ridgelines	• All VSR's and key viewpoints • High quality landscape within the Study Area • Users of Jordan Valley Morning Walking Trail
Reservoirs in Area 4 Surface of the reservoirs grassed and developed for active recreation	• Visual impact of steep rock slopes around the reservoirs and • Minor landscape impact due to limited revegetation of surface	• Residents of the Choi Wan Estate • Motorists of New Clear Water Bay Road • Overall landscape quality
Final Site Formation for all Sites	• Permanent visual impact of steep 60°, predominantly rock slopes • Permanent loss of soil and existing vegetation cover • Permanent loss of part of the Northern Ridgeline • Permanent loss of wooded hillsides (see Chapter 9, Table 9.8 for details of areas of habitats lost)	• VSR's within the new development as well as adjacent estates • Degraded landscape of high local value • High quality landscape areas

Source of Impact	Unmitigated Impact	Impact Receiver
Slip Road on to Kwun Tong Road (Road C1)	• Permanent negative visual impact of new, elevated roads through already disturbed landscape	• Residents of Kai Tai Court • New VSR's in Area 2 • Users of Kwun Tong Road and passengers on the MTR
District Open Space and Landscape Framework	• Permanent positive impact - improved landscape access to the walking trails and viewpoints on the ridgelines from the surrounding areas	• All residents in the Ngau Tau Kok area, particularly in the areas immediately adjacent to the site

8.10 Examination of the Development Height Profile

8.10.1 The urban design of the development has been constrained by the need to achieve the specified plot ratio, GFA and population specified in the Brief. These requirements have been balanced against the principle of minimising disturbance to the ridgelines and concentrating development in the most disturbed areas of landscape. From this, the following urban design principles have dictated the residential development profile:

- Optimise the views to and from the existing high point of the site at 188 mPD. For this reason, the maximum development height was specified as 185 mPD.
- Creation of view corridors through the development to preserve views to and from the existing peaks.
- Arrangement of blocks to maximise views and minimise overlooking.
- Maximise building heights to optimise the use of the site.

8.10.2 Building height for the public housing in Sites 1 and 3B are based on the HKHA standard block of 40 storeys and 125 metres high (or 36 storeys and 4 car park) and offer no opportunity for varying the height profile of the development. There will be more flexibility for the private development in Sites 2 and 3A, and building heights are shown on the MLP between 28 and 40 storeys.

8.10.3 While development constraints allow for relatively little variation in building height, a "tiered" height profile is achieved by the formation of three residential development platforms at 20 mPD, 40 mPD and 60 mPD.

8.10.4 A wide view corridor has been created through the development by zoning low-rise development and open space on an axis from the Kowloon Bay Fountain Garden parallel to Choi Ha Road to the highest point of the site.

8.10.5 The buildings on Sites 3A and 3B, as currently planned, will obscure some views of the ridgeline. In order to preserve views of the ridgelines, all buildings would need to be reduced to less than 30 storeys. In order to meet the population targets, more blocks would be required resulting in an increase in the platform size. This option would, therefore, require additional site formation resulting in a greater impact on the ridgelines and is considered to have a greater overall landscape and visual impact.

8.10.6 In conclusion, due to the required development intensity of the site combined with the landscape and visual constraints of preserving the ridgeline, variation in the building height profile is achieved primarily achieved through the variation in platform heights. A major view corridor through the development is safe-guarded by zoning. There are more opportunities to vary the height profile on the private development sites.

8.11 Mitigation Proposals

8.11.1 Inevitably in a development of this nature, landscape and visual impacts remain and the following mitigation measures are proposed:

Review of Development Layout in Sites 4 and 5

8.11.2 The development of Sites 4 and 5, north of the northern ridgeline, will result in an overall lowering of this ridgeline by up to 15 metres with earthworks falling within 50 metres of the highest point of the site. While there is little opportunity to change the level of the reservoirs, the overall disposition and formation level of the schools should be reviewed at the detailed design stage with the aim of minimising disturbance to the northern ridgeline. Preliminary studies indicate that some rationalisation in this area could reduce the impacts.

8.11.3 The school layout shown on the MLP is a standard footprint. This is relatively land extensive resulting in the area set aside for schools is more than half of that developed for residential use. Any opportunity to combine the schools and reduce the footprint would assist in minimising landscape impacts on this site.

Mitigation of Earthworks and Site Formation

8.11.4 Earthworks and hauling material from the site will have considerable visual impact for approximately 36 months. This will be cumulative with other environmental impacts such as noise and dust. Due to the relative elevation and scale of site formation, effective visual mitigation from the adjacent residential blocks (VSR's) will be difficult to achieve. Visual mitigation to pedestrians can be achieved using hoarding. It is proposed that permanent landscape works are carried out on the slopes as they are formed (this also has the advantage of easy access). This will minimise the duration of earthwork "scars" which will be highly visible from all adjacent viewpoints.

8.11.5 The site formation should be designed to blend into the natural landform as far as possible. This may involve rounding the edges of site formation to improve the overall appearance of the site. While this may involve minor additional excavation, it is likely to be into the softer material at the interface between soil and rock and will therefore be capable of revegetation.

Treatment of the Rock Slopes

8.11.6 The Study Area is currently rocky with a thin covering of soil. The site formation will result in the formation of large rock cut slopes at the "back" of all the developments. At the design stage, consideration must be given to the appearance of these slopes as well as ensuring their safety. An integrated geotechnical and landscape design solution is required.

8.11.7 All slopes (except that behind Site 3b) forming the platforms are currently proposed at 60°. This will allow a steep rock cut with berms (or benches) at 10 metre intervals up the slope. Every effort should be made to form planters on these benches so that small trees, shrubs and trailing plants can be established to minimise the visual impact of the rock slopes to the local residents and from more distant viewpoints. It is recommended that the planters are constructed concurrent with site formation for ease of access and to establish planting as soon as possible.

8.11.8 The angle of the slope behind Site 3b has been reduced to 45° to allow soiling and revegetation with grass and shrubs. A "soft" slope in this area reduces noise impacts and improves the appearance of the rock slope thereby minimising visual impacts. By allowing limited revegetation, this will also assist in ecological mitigation.

8.11.9 Should shotcrete be required to stabilise the existing HyD's slopes, coloured dyes should be applied to mitigate its appearance. This should be shaded and applied by an experienced contractor and agreed during detailed design. Shotcrete should only be used where absolutely required with reference to WBTC No 25/93.

8.11.10 Maintenance responsibilities for the slopes must be clearly established and agreement to the proposed treatment approved by the responsible group.

General Landscape Mitigation

8.11.11 Development of this site will involve destroying large areas of existing vegetation from low to high quality. The resulting site formation will be predominantly rock and the establishment of any new landscape or green open space areas within the development will require the filling with soil onto the rock platforms. At the commencement of the site formation, all existing top soil and required volumes of Completely Decomposed Granite (CDG) should be stripped from the site and conserved for future revegetaion.

8.11.12 Opportunities for revegetation of the site should be rigorously explored wherever possible; innovative techniques must be developed by landscape architects working closely with geotechnical engineers. Plant material for revegetation of the more natural areas of the site should be based on ecological mitigation principles employing at least 60% native plant species, where feasible. Recreational areas and other areas that fall under the jurisdiction of USD will initially be under the control of DLO/KE. Once they have been passed to USD to develop, USD will be responsible for the physical and horticultural management and maintenance. Management and maintenance responsibilities in other areas will be distributed as appropriate according to WBTCs No 18/94 and 24/94.

Reprovision of Jordan Valley Morning Walking Trail

8.11.13 Access to the hillsides from the surrounding area should be retained as far as possible during construction. Safety of users must, of course, be ensured. The existing Jordan Valley Morning Walking Trail should be diverted and the alternative route signed and, if necessary, a new trail constructed.

8.11.14 On completion, a walking trail should be incorporated into the public open spaces and landscape framework as shown on the Master Landscape Plan. On the hillsides, planting alongside the path and in adjacent eroded areas should be included to assist in upgrading the overall landscape of the site.

Introduction of Variation in the Height Profile

8.11.15 At the design stage, opportunities to vary the height profile of the development and retain wider views through to the natural backdrop should be explored. As stated, there will be little opportunity to vary the height of the public housing blocks however a varied height profile for the private residential blocks on Site 2 (40 mPD) and Site 3A (60 mPD) could be achieved through lease conditions. A profile should be developed that responds to the natural backdrop with lower towers located closer to the view corridor and gradually increasing to the north.

8.11.16 Where buildings are located on podia, it is possible to reduce their apparent height by incorporating planting at ground level and within the building so that the ground plain is less clearly defined.

Building Colour

8.11.17 As the buildings on the upper platforms will be set against a natural backdrop it is proposed that they should be clad in recessive colours. White tiles are not favoured as these reflect light and will stand out against the background. Blue/grey, brown or darker toned tiles would be favoured.

Full Development of the Landscape Framework

8.11.18 The landscape framework as shown on the Master Landscape Plan (Figure 8.17) should be developed in full. Development of the top of the Service Water Reservoirs should be pursued to make full use of the site and flat areas of open space.

8.11.19 Wherever appropriate, these mitigation measures have been included in the Master Landscape Plan.

Road C1

8.11.20 Due to the scale and elevation of Road C1 there will be landscape and visual impacts (as identified in Table 8.2). The design of the road should be sympathetic to the local environment and a modern, innovative design should be forwarded at the detailed design stage. The design will be vetted by the Advisory Committee on the Appearance of Bridges and Structures (ACABAS) in accordance with WBTC 11/89 which will ensure an acceptable design.

8.12 Conclusions

8.12.1 As outlined in Sections 8.8.1 and 8.8.8, landscape and visual impact issues have played an important role in dictating the form of the development. Several fundamental measures have been included in the MLP to minimise the impact of this large scale development.

8.12.2 The development of the Study Area will have a significant impact on the character of the existing landscape which, although disturbed, has considerable local and regional importance. As part of the development of the site, the main landscape features of the site have been retained and will form an integral part of the landscape framework. The landscape framework, as developed in the Master Landscape Plan, demonstrates an opportunity to improve the overall amenity of the area for the local residents by improving connections between the existing residential areas, through the site to the hillsides, the adjacent planned urban fringe park and open space areas.

8.12.3 The development of this Study Area combined with the density of the development will lead to significant and permanent visual impacts to the VSR's around the Study Area. These will be impossible to fully mitigate however measures are recommended to minimise the impacts through the design and disposition of the development.

9. ECOLOGY

9.1 Introduction

9.1.1 This Chapter describes the results of the ecological survey, provides an assessment and evaluation of the ecological impacts arising singly from the proposed project, or cumulatively with other projects, and proposes mitigation measures.

9.2 Government Legislation and Standards

Hong Kong Legislation and Guidelines

9.2.1 Hong Kong Government Ordinances and Regulations relevant to the present project include the following:

- The Forests and Countryside Ordinance (Cap. 96), which protects both natural and planted forests;
- The Forestry Regulations, which protect specified local wild plant species;
- The Wild Animals Protection Ordinance (Cap. 170), which provides for protection of listed species of wild animals by prohibiting the disturbance, taking or removal of animals and/or their nests or eggs; and
- The Town Planning Ordinance.

9.2.2 Statutory landuse zones of Green Belt (GB), Government/Institution/Community (G/IC), Open Space (O) and Undetermined (U) occur in the Study Area. These categories derive their legal status from the *Town Planning Ordinance Cap. 131* and are indicated on the Outline Zoning Plan S/K13/9 dated 7 April 1995.

9.2.3 The GB zone covers most of the Study Area. The objective of the Green Belt zoning is "to define the limits of urban development area by conserving landscape features" (Planning Dept. 1995). This is not an ecological designation. One of the proposed housing areas as well as the existing Service Reservoir are covered by the G/IC and U zones. The Jordan Valley Landfill is zoned as open space, which is intended to provide land for both active and passive recreational uses.

9.2.4 In addition, this study makes reference to the following Technical Memorandum, Technical Circular and Guidelines:

- Technical Memorandum on Environmental Impact Assessment Process (EIA Ordinance, Cap. 499, S. 16) (the "TM on EIA Process");

9.2.5 Annex 16, Appendix A, Note 1 of the TM sets forth a number of "Sites of Recognised Conservation Interest". No such sites, including country parks, special areas, Sites of Special Scientific Interest (SSSIs), Marine Parks or Reserves, Ramsar Sites, or other areas with special identified conservation importance occur within or in the vicinity of the site.

9.2.6 Annex 16, Appendix A, Note 2 of the Technical Memorandum sets forth a number of "important habitats which will need an ecological assessment". These include the following categories which occur in the Study Area:

1. woodland of over 1 ha in area (young plantation on the site cannot be classified as woodland but was still studied because of the size involved);

2. natural stream courses and rivers of over 100 m in length.

9.2.7 According to the Technical Memorandum, following assessment of the severity of impacts arising from a project, the policy for mitigating serious impacts on habitats and wildlife is to pursue impact avoidance, impact minimisation, and impact compensation in that order of priority. Impact *avoidance* typically consists of modifications to the existing project design, but may in extreme cases require abandonment of the project (the "no-go" alternative). Impact *minimisation* includes any means of reducing the scope or severity of a given impact, e.g. through timing of construction works, modification in design, or ecological restoration of disturbed areas following the completion of works. Impact *compensation* assumes that an irreversible impact will occur upon a given habitat or species and attempts to compensate for it elsewhere, e.g. by enhancement or creation of suitable habitat. Compensation may take place on-site or off-site; the latter is discussed as "off-site mitigation" for the purposes of this study.

9.2.8 According to the PELB/Works Branch Technical Circular on off-site mitigation of ecological impacts, off-site mitigation should be considered only if significant residual impacts remain after all on-site opportunities have been exhausted. Off-site mitigation proposals should be based on the "like for like" principle enshrined in the Technical Circular, and every attempt should be made to place mitigation sites as close as possible to the project site.

9.2.9 Finally, the TM on EIA Process and other Government documents recommend the assessment of cumulative impacts.

- "Guidelines for Implementing the Policy on Off-site Ecological Mitigation Measures" (PELB Technical Circular 1/97, Works Branch Technical Circular 4/97, dated 17 February 1997) (the "Technical Circular"); and

- Hong Kong Planning Standards and Guidelines: Chapter 10, "Conservation".

International Conventions

9.2.10 The study takes note of the United Nations Convention on Biological Diversity (Rio, 1992), which addresses the urgency of protecting biodiversity on local and international scales. The present study takes note primarily of Article 8 of the Convention, which states (Paragraph (c)) that each Contracting Party shall "regulate or manage biological resources important for the conservation of biological diversity whether within or outside protected areas, with a view to ensuring their conservation and sustainable use." Article 8 also sets forth requirements to "promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings" (Paragraph (d)) and to "rehabilitate and restore degraded ecosystems" (Paragraph (f)).

9.2.11 The PRC, a Contracting Party, has not yet indicated whether it will extend application of the Convention to Hong Kong. However, the Hong Kong Government has stated that it is "committed to meeting the environmental objectives" of the Convention (PELB 1996).

9.3 Assessment Methodology

9.3.1 The Study Area is defined as the area within the planning area boundary. Areas outside the boundary comprise a built urban environment and thus there are unlikely to be ecological impacts as a result of this project. As such they have not been included in this assessment.

9.3.2 Literature relevant to the study site was reviewed. No ecological assessment of the site has previously been performed. A project funded by the Territory Development Department (TDD), however, involved large scale planting on the site. The details of the project were not published, but the information presented in this report was obtained based on the landscape fact sheet (TDD 1995), discussion with TDD, and raw planting data accessed with the permission of TDD.

9.3.3 Field surveys were performed on 23 October, 5 and 19 November 1997, and 16 April 1998 to describe habitats, flora and fauna recorded on the site. Special attention was focused on habitats and species of conservation significance. A habitat map was prepared at 1:5000 scale based on field survey and a 1997 aerial photo (taken at 4000 ft altitude) from the Government Map Office. The major stream valleys in the Study Area were visited.

9.3.4 Vegetation was recorded according to relative abundance and habitats. Attention was focused on species protected by local regulation or known to be rare.

9.3.5 The bird community at the Choi Wan Road site was surveyed on 23 October, 5 November 1997 (autumn survey) and 16 April 1998 (spring survey). Birds heard and seen were identified and counted. Names follow Viney *et al.* (1994).

9.3.6 Breeding bird surveys were carried out in spring. The method used is a modified version of Sharrock (1976). Birds were graded according to the behaviour observed (Table 9.1). No intensive search for nests was done.

Table 9.1 The criterion of breeding bird survey

Grades	Behaviours
A. Present	Species present in the sites
B. Possible breeding	Species present in potential breeding habitats
C. Probable breeding	Pair observed in suitable nesting habitat in breeding season, or species observed showing territorial behaviour, such as intensive singing and calling for territories, or chasing intruders out of territories, or species displaying or observed carrying nesting materials
D. Confirmed breeding	Nests found, or adults observed carrying food for juveniles, or adults observed feeding juveniles, or nestling or recent fledged juveniles observed.

9.3.7 Butterflies and dragonflies sighted were identified to species. Names of butterflies used in this report follow Bascombe (1995). Names of dragonflies used in this report follow Wilson (1995).

9.3.8 Surveys of mammals, reptiles and amphibians were performed in the course of the avifauna survey. Individuals seen were recorded by species, number, and habitat. Searches were carried out for burrows, dens, trails, rooting sites, or other signs of mammalian activity. Species identification was made based on indirect evidence of mammal activity where possible.

9.3.9 Impacts were predicted based on the design drawings which indicated the total area and nature of surface disturbance, and on predicted construction methods, and design population of the site. Habitat loss estimates are subject to change if there are variations in the final design.

9.3.10 Impacts to species or groups which were assessed as 'minor' or 'minimal' were predicted to cause a slight and/or short-term reduction in the local population numbers or geographic distribution of a species or group, but from which the species or group was predicted to recover with no long-term adverse impacts. Habitat impacts were considered 'minor' or 'minimal' when no plant species of conservation or regulatory concern were found, and when the habitat in question was widely distributed locally.

9.3.11 Impacts to species or groups which were assessed as 'moderate' were predicted to cause a local reduction of species or group population numbers. The reductions would be long-term, and probably not recoverable, but the species or groups in question are considered widely distributed or common, and abundant on a local, regional, or global scale. Habitat impacts were judged 'moderate' when the habitat in question was of limited local or regional distribution or declining in extent, and when the potential for the habitat to support fauna was considered of conservation or regulatory importance.

9.3.12 Impacts to species or groups were assessed as 'severe' when they were judged to adversely affect species or groups which are of conservation or regulatory concern locally, regionally, or globally due to scarcity or declining population or distribution trends. Impacts to habitats were considered 'severe' when the habitats were found to be limited or declining in geographic distribution, contained plant species of regulatory or conservation concern, or are generally considered by the scientific community to be of local, regional or global importance to the support of wild fauna.

9.4 Baseline Conditions

Terrestrial Habitats and Flora

Literature Review I

9.4.1 Between 1991 and 1996, a total of some 140,000 plants were planted by TDD under the Jordan Valley Metroplan Urban Forestry Project (TDD, unpubl. data). About 20-30 ha of degraded land within the Study Area was planted with about 37 tree and shrub species (Table 9.2), half of which were exotic. The area, severely eroded before planting, improved in terms of soil erosion, plant cover and use by wildlife (TDD 1995).

Table 9.2 Species Planted under the Jordan Valley Metroplan Urban Forestry Project between 1991 and 1996 (TDD, unpubl. data)

Species	Growth Form	Exotic	Species	Growth Form	Exotic
Acacia auriculiformis	T	Yes	*Liquidambar formosana*	T	
Acacia confusa	T	Yes	*Lophostemon confertus*	T	Yes
Acacia mangium	T	Yes	*Machilus breviflora*	T	
Alangium chinense	T		*Machilus oreophila*	T	
Alnus japonica	T	Yes	*Machilus thunbergii*	T	
Aquilaria sinensis	T		*Melaleuca quinquenervia*	T	Yes
Bauhinia variegata	T		*Morus alba*	T	Yes
Bischofia javanica	T		*Myrica rubra*	T	
Cassia surattensis	T	Yes	*Pinus elliottii*	T	Yes
Castanopsis fissa	T		*Pterocarpus indicus*	T	Yes
Casuarina equisetifolia	T	Yes	*Quercus edithae*	T	
Cinnamomum camphora	T		*Quercus myrsinaefolia*	T	
Cleistocalyx operculata	T		*Rhaphiolepis indica*	S	
Endospermum chinense	T		*Sapium discolor*	T	
Eucalyptus torelliana	T	Yes	*Sapium sebiferum*	T	
Eucalyptus robusta	T	Yes	*Sterculia lanceolata*	T	
Ficus elastica	T	Yes	*Syzygium jambos*	T	Yes
Gordonia axillaris	T		*Thevetia peruviana*	T	Yes
Hibiscus rosa-sinensis	S	Yes	*Vetiveria zizanoides*	G	Yes

Note: T = trees, S = shrubs, G = grass

Results of Field Study I

9.4.2 The Study Area covers about 100 ha. Macro habitat types included plantation, tall shrubland, low shrub with grass, agricultural, marsh, streams, and disturbed/urbanised area (Table 9.3, Figure 9.1). It should be noted that Ashworth *et al.* 1993 classified the habitats in the Study Area as "high density urban", "low shrub with grass", "grassland", "woodland", "cultivation" and "bare soil" on a 1:50000 scale, while in this study the habitats are classified at 1:5000 scale. The difference in classification is mainly due to the scale used and the TDD plantation project (performed mostly after Ashworth et al. (1993)'s field study). However, since Ashworth *et al.* provide the only available estimates of surface areas in the HK SAR, their estimates were used for reference and comparison. The percentage total (Table 9.3) and percentage loss (Table 9.8) is an approximate estimate.

9.4.3 In total 158 plant species were recorded, of which 45 were exotics (Table 9.11). *Enkianthus quinqueflorus* (Chinese New Year Flower) was found on the Study Area, and it is protected under local regulation.

Table 9.3 Areas of Habitat Type in the Study Area as a Percentage of Total Areas in Hong Kong

Major habitats*	Approximate area of habitat on site (ha)	Area of habitat throughout the HKSAR (ha)**	% of HKSAR total for habitat
Plantation	43.8	4830	0.91
Tall Shrubland	7.2	7933	0.09
Low shrub with Grass	13.9	9203	0.15
Agriculture (abandoned)	0.9	3167	0.03

* marsh is not included due to its small size (less than 0.5 ha)
**Ashworth *et al.* 1993.

Plantation

9.4.4 Most of the vegetated areas on site were interplanted during the past 5 years under the Metroplan Forestry Project (see previous section), and therefore these planted areas are classified as plantation regardless of height and density of the planted vegetation.

9.4.5 Most of the plantation area was sparsely vegetated, e.g. southwest slope of Jordan Valley, on ridges, near the edge of the quarry, and along the access road to Jordan Valley Landfill. The planted trees or shrubs were young and less than 2 m in height.

9.4.6 On the northeast slope of Jordan Valley, the headland near the temporary housing area and along the major trails for morning walkers the height of the planted trees were generally taller and varied between 2-8 m. Dominant species found included *Acacia* spp., *Eucalyptus* spp. and *Lophostemon conferta*.

9.4.7 About half of the species planted for the Metroplan Project were recorded during field surveys. The others were probably not recorded due to small numbers planted or poor survival. These include some native trees of conservation significance such as *Endospermum chinense*. *Endospermum chinense* is a light demanding species but regenerates only in fairly good soils. It is included in a list of rare, threatened or extinct species in Hong Kong by Zhuang and Corlett (1996), who accord it "vulnerable" status.

9.4.8 The two *Quercus* spp. (Fagaceae family, or "oaks) (Table 9.2) planted by the forestry project were also not recorded on the Study Area. Both species are relatively common in Hong Kong, but many other species in the Oak family are restricted in distribution, probably due to lack of dispersal agents. Both *Endospermum chinense* and the Oak family are components of the original forest in Hong Kong.

9.4.9 Native tree and shrub species were also found in plantation, but mostly in ravines, near the temple (Figure 9.1), or under more mature stands of *Acacia* where species diversity was relatively higher. These included *Litsea rotundifolia, Ternstroemia gymnanthera, Itea chinensis, Liriope spicata,* and *Litsea glutinosa*. A few large, mature individuals of *Ficus microcarpa* were also noted near the temple.

Tall Shrubland

9.4.10 This habitat was mainly located on the north slope above Clearwater Bay Road. It was fairly diverse and well developed, indicating that it had not recently been disturbed by fire. It was dominated by *Rhodomyrtus tomentosa, Melastoma sanguineum, Ficus variolosa, Gordonia axillaris*, and *Litsea rotundifolia*. Other native species, such as *Rhus succedanea, Dianella ensifolia, Ormosia emarginata, Ternstroemia gymnanthera*, and *Millettia nitida* were also recorded. These species formed dense thickets of about 1 m to 3 m in height. In the ravines the canopy reached 5 to 7 m in height where there were more tree species, including *Schefflera octophylla* and *Sterculia lanceolata*.

9.4.11 *Enkianthus quinqueflorus* (Chinese New Year Flower) is protected under the Forestry Regulations and was recorded in the shrubland habitat within the Study Area. This species is protected because its abundance and distribution had been reduced by extensive cutting for Chinese New Year. No literature describes the distribution and rarity of this species. However, it appears that this species is restricted in local distribution but can be abundant wherever it occurs. Examples of preferred habitats are hillsides of Hong Kong Island South as well as the South Portal area of Route 3 at Tai Lam Country Park. 7 individuals of the Chinese New Year Flower were found during the spring survey. However, the actual population of this plant may be underestimated due to inaccessibility of the densely vegetated area.

9.4.12 Vegetation was also established in the old quarry to the north of the Study Area. It is also classified as tall shrubland, but was mainly dominated by an exotic tree, *Leucaena leucocephala,* which is naturalised in Hong Kong, and tends to form dense thickets locally. Other associated species are pioneer species including *Celtis sinensis* and *Macaranga tanarius*.

Agriculture

9.4.13 The agriculture fields were small and patchy and mainly located in between the main ridge line and the existing quarry. Most of the fields together with the village houses had been abandoned. Remnants of crops including Ginger, Longan, Papaya, and Wampi were managed by morning walkers.

Low shrub with Grass

9.4.14 This habitat on site occurred only on hydroseeded cut-slope along New Clear Water Bay Road and to the west of the Jordan Valley Landfill. These slopes were still largely barren, and species diversity was very low. A few native grasses ferns, and shrubs, including *Saccharum arundinaceum, Dicranopteris linearis, Blechnum orientale*, and *Rhodomyrtus tomentosa* had begun to establish themselves on the slopes.

Stream Valleys

9.4.15 Most of the stream valleys were located on the hillside below the service reservoir. These streams were either channelled or ephemeral and were dry during the time of survey. No aquatic survey was performed due to the lack of stream flow. A stream bed found near the abandoned settlement was seen to have sewage discharge pipes protruding from the sides of the earthen channels. Some remaining stagnant pools of water were also found near areas of dense vegetation along the dry stream bed. Overall these streams were ephemeral, had little ecological value and reflected the disturbed nature of the water catchment which resulted from high levels of human interference. Based on the poor ecological condition of the streams there is no need for further stream surveys to be performed.

Marsh

9.4.16 In the site of the Construction Industry Training Association (CITA), a small marshy area of about 0.3 ha in size was found around the base of the quarried rock face. Normally trespassing is forbidden in CITA, but with the assistance of their staff this marsh was found during spring by searching for frog callings. Runoff from the quarried rock surface was collected and diverted to a water retention pond, and a freshwater marsh was formed in the inundated areas. The water retention pond was surrounded by ruderal species such as *Pueraria* sp., *Sesbania cochinchinensis, Miscanthus* sp., *Mikania micrantha* and *Bidens pilosa*. The marsh was composed of a mixture of weedy species, wetland dependent species, and upland species. Apart from the ruderals mentioned above, wetland dependent plants such as *Cyclosorus interruptus* and *Equisetum debile* were found in or near standing water. Upland species such as *Schefflera octophylla, Rhus* spp., *Mallotus paniculatus*, and *Sterculia lanceolata* were established on the drier fringe of the marsh.

Urbanised/Disturbed Area

9.4.17 The Jordan Valley Landfill, the disused quarries, and the service reservoir were the main constituents of this habitat category. These areas were void of vegetation and had little ecological value.

Avifauna

9.4.18 A total of 38 bird species was recorded in autumn 1997 and spring 1998 (Table 9.4). Twenty-six recorded species are common and widespread. Twelve are less abundant or more restricted in distribution: Large Hawk-cuckoo, Siberian Rubythroat, Daurian Redstart, Hwamei, Blackbird, Grey-backed Thrush, Plain Prinia, Dusky Warbler, Crested Goshawk, Hobby, Ashy Drongo and White-backed Munia. Siberian Rubythroat, Daurian Redstart, and Hwamei were seen at the abandoned village. Siberian Rubythroat and Hwamei are common in shrubland while Daurian Redstart is widespread but not common. Both Blackbird (Cheng 1993) and Grey-backed Thrush (Corlett 1992) are mainly frugivorous when they overwinter in Hong Kong. These two species favour habitats of denser vegetation. Ashy Drongo was sighted in the shrubland. This is a rare species and only a few are recorded annually (Viney *et al.* 1994).

9.4.19 The Hobby recorded on 25 October was a juvenile. It was observed hunting small birds (probably bulbuls) above the slope near the Service Reservoir. This species favours foraging in open country and usually preys on migrating birds. This species is listed in Appendix I in CITES. It is rare in Hong Kong and also throughout China (Yan *et al.* 1996). A pair of Crested Goshawk were sighted near the abandoned village on 16 April 1998. A Black-eared Kite was sighted simultaneously. Black-eared Kite is listed on Appendix II in CITES and Crested Goshawk is also listed on CITES. All three species of birds of prey are listed in Class II of the State Protected Terrestrial Wildlife List of China (Hua and Yin 1993). The number of Black-eared Kite in Hong Kong is declining due to increasing urbanization (Viney *et al.* 1994).

Table 9.4 Bird Species Recorded at the Study Area

Common names	Latin names	Status	Abundance	Autumn	Spring
Black-eared Kite	*Milvus lineatus*	R	●		✓
Crested Goshawk	*Accipiter trivirgatus*	R	Ø		✓
Hobby	*Falco subbuteo*	PM	Ø	✓	
Spotted Dove	*Streptopelia chinensis*	R	●	✓	✓
Large-Hawk-cuckoo	*Cuculus sparverioides*	SV	○		✓
Koel	*Eudynamis scolopacea*	R	●		✓
Greater Coucal	*Centropus sinensis*	R	●	✓	✓
Barn Swallow	*Hirundo rustica*	SV PM	●		✓
White Wagtail	*Motacilla alba*	WV	●	✓	
Olive-backed Pipit	*Anthus hodgsoni*	WV	●	✓	
Crested Bulbul	*Pycnonotus jocosus*	R	●	✓	✓
Chinese Bulbul	*Pycnonotus sinensis*	R	●	✓	✓

Table 9.4 (cont.)

Red-vented Bulbul	*Pycnonotus aurigaster*	R	●	✓	✓
Siberian Rubythroat	*Luscinia calliope*	WV	O	✓	
Daurian Redstart	*Phoenicurus auroreus*	WV	O	✓	
Magpie Robin	*Copsychus saularis*	R	●	✓	✓
Violet Whistling Thrush	*Myiophoneus caeruleus*	R	●	✓	✓
Blackbird	*Turdus merula*	WV	O	✓	
Grey-backed Thrush	*Turdus hortulorum*	WV	O	✓	
Plain Prinia	*Prinia subflava*	R	O		✓
Yellow-bellied Prinia	*Prinia flaviventris*	R	●	✓	✓
Common Tailorbird	*Orthotomus sutorius*	R	●	✓	✓
Yellow-browed Warbler	*Phylloscopus inornatus*	WV	●	✓	✓
Dusky Warbler	*Phylloscopus fuscatus*	WV	O	✓	
Hwamei	*Garrulax canorus*	R	O	✓	✓
Black-faced Laughingthrush	*Garrulax perspicillatus*	R	●	✓	✓
Great Tit	*Parus major*	R	●	✓	✓
Fork-tailed Sunbird	*Aethopyga christinae*	R	●	✓	✓
Japanese White-eye	*Zosterops japonica*	R	●	✓	✓
Rufous-backed shrike	*Lanius schach*	R	●		✓
Ashy Drongo	*Dicrurus leucophaeus*	WV	Ø		✓
Black Drongo	*Dicrurus macrocercus*	SV	●	✓	
Magpie	*Pica pica*	R	●	✓	✓
Jungle Crow	*Corvus macrorhynchus*	R	●	✓	
Black-necked Starling	*Sturnus nigricollis*	R	●	✓	
Crested Myna	*Acridotheres cristatellus*	R	●		✓
Tree Sparrow	*Passer montanus*	R	●		✓
White-backed Munia	*Lonchura striatus*	R	O		✓

Status: R = resident, SV = summer visitor, PM = Passage Migrant and WV = winter visitor. Abundance: ● = common and widespread, O = local but not uncommon and Ø = very local or rare.

9.4.20 There are many fleshy-fruit bearing plants at the shrubland site which therefore can be an important overwintering habitat for these species (also for other thrushes and robins). In spring survey no confirmed breeder was recorded. Nine probable and eight possible breeders were recorded. (Table 9.5).

Table 9.5 Breeding bird species recorded at the Choi Wan Road site in April 1998

Species	Grades and behaviour
Large Hawk-cuckoo	C. Calling for territories
Koel	C. Calling for territories
Magpie Robin	C. Singing for territories
Violet Whistling Thrush	C. Calling for territories
Plain Prinia	C. Singing for territories
Yellow-bellied Prinia	C. Singing for territories
Rufous-backed Shrike	C. Calling for territories
Magpie	C. Carrying nesting materials
Tree Sparrow	C. Carrying nesting materials
Crested Goshawk	C. Displaying
Spotted Dove	B. Birds present in potential breeding habitats
Chinese Bulbul	B. Birds present in potential breeding habitats
Crested Bulbul	B. Birds present in potential breeding habitats
Red-vented Bulbul	B. Birds present in potential breeding habitats
Japanese White-eye	B. Birds present in potential breeding habitats
Crested Myna	B. Birds present in potential breeding habitats
Black Drongo	B. Birds present in potential breeding habitats
White-backed Munia	B. Birds present in potential breeding habitats

Invertebrate Fauna

9.4.21 Four species of dragonfly were recorded in the spring survey. These were the *Pantala flavescens*, *Trithemis aurora*, *Trithemis festiva* and *Orthetrum chrysis*. All are common and widespread in Hong Kong (Wilson 1995).

9.4.22 A total of 23 butterfly species were recorded. Most were common and widespread (Table 9.6). The Small Leopard is uncommon (Walthew 1997). Neither its larvae nor its larval foodplants, *Salix babylonica* and *Scolopia chinensis*, were recorded in the Study Area. The adult individual observed may therefore be a visitor rather than a breeder in the site.

Table 9.6 Butterfly Species Recorded at the Study Area

Latin name	Common name	Abundance
Papilionidae		
Graphium agamemnon	Tailed Green Jay	VC
Papilio helenus	Red Helen	VC
Papilio polytes	Common Mormon	VC
Papilio memnon	Great Mormon	VC
Papilio paris	Paris Peacock	VC
Pieridae		
Pierinae		
Delias pasithoe	Common Black Jezebel	C
Hebomoia glaucippe	Great Orange Tip Butterfly	C
Coliadinae		
Eurema hecabe	Common Grass Yellow	VC

Table 9.6 (cont.)

Lycaenidae		
Polyommatinae		
Chilades lajus	Lime Blue	VC
Riodininae		
Zemeros flegyas	Punchinello	C
Nymphalidae		
Satyrinae		
Mycalesis mineus	Dark Brand Bush Brown	VC
Amathusiinae		
Faunis eumeus	Common Faun	C
Nymphalinae		
Cupha erymanthis	Rustic	VC
Phalanta phalantha	Small Leopard	UC
Symbrenthia hippoclus	Common Jester	C
Neptis hylas	Common Sailor	VC
Pantopona hordonia	Common Lascar	C
Phaedyma columella	Short-banded Sailor	C
Hypolimnas bolina	Great Eggfly	C
Danainae		
Danaus genutia	Dark Veined Tiger	VC
Euploea midamus	Blue Spotted Crow	VC
Euploea core	Common Crow	VC
Tirumala limniace	Blue Tiger	C

Abundance: VC = very common, C = common, and UC = uncommon.

Other Fauna

9.4.23 Scats of size about 4cm x 1cm were sighted at the site on 23 October (Figure 9.1). The size of the scat suggested that it was that of a civet. A Masked Palm Civet *Paguma larvata* was sighted on 5 November (Figure 9.1) in a shrubby thicket next to a footpath (Figure 9.1). This species is protected by law in Hong Kong under the *Wild Animals Protection Ordinance* (Cap.170) and there have been no reported records in Kowloon between at least mid-1992 and December 1996 (Reels 1996). Most of the sightings of this species come from central New Territories (Kam Tin) and east Hong Kong Island. This species feeds mainly on small mammals (mainly rodents) in summer and fleshy fruits in winter. Therefore, it is an important seed-disperser as well as a predator on the local rodent population (Goodyer 1992). Like other civets, this species is mainly nocturnal and direct sighting is difficult. Hence it is possible that there is more than one individual inhabiting the site.

9.4.24 Survey during spring 1988 found no signs or sightings of mammals. No scats or burrows or prints were observed.

9.4.25 Asiatic Painted Toad *Kaloula pulchra* and Gunther's Frog *Rana guentheri* were recorded at the marsh in CITA on April 1998. Both species are common in Hong Kong. Tadpoles were also found in small ponds, wells, and streams all over the site. Therefore breeding of anurans at the site is confirmed.

9.5 Potential Impacts

Impact Identification and Prediction

9.5.1 The proposed master development plan, according to Figure 1.1, will include construction of housing and associated facilities, which mainly occupy the west section of the Study Area. The Jordan Valley Landfill and the hillside along the existing service reservoir to the southeast will remain intact.

9.5.2 The "Grid Count" method has been used to estimate habitat loss. The master layout plan (showing the housing development and associated infra-structure) was overlaid on the habitat map. Unit areas of each habitat that would be lost to the development were then calculated. The potential impacts of the project are summarised in Table 9.7. Permanent loss of 11.5 ha plantation, 4.5 ha tall shrubland, 5.1 ha low shrub with grass, 0.9 ha agriculture and 0.3 ha marsh will constitute the major direct impacts of the project (Table 9.8). Others are disturbance and pollution which may disturb plants and animals using the habitats.

Table 9.7 Potential Impacts on Ecological Resources from the Proposed Development

Period of Works	Potential Impacts	Ecological Resource Potentially Impacted	
		Direct Impact	Indirect Impact
Construction	Permanent Habitat Loss	Loss of plantation, shrubland, agriculture, and marsh Loss of protected plant species	Loss of foraging /nesting/roosting area • birds • mammals • invertebrates • herpetofauna
	Long Term (5-10 years) Noise and human disturbance and creation of dust	birds, mammals and other species groups using the habitat	

Period of Works	Potential Impacts	Ecological Resource Potentially Impacted	
		Direct Impact	Indirect Impact
Operation	Premanent Contamination of water courses through increased heavy metals in run-off from roads and covered areas from urban stormwater run-off	plants, birds, mammals, and other species group using the habitat	
	Premanent Noise, light and human disturbance from Residences	plants, birds, mammals, and other species group using the habitat	

Table 9.8 Estimate of Habitat Loss due to the Proposed Development.

Habitats	HK SAR Total (ha) *	potential loss (permanent) (ha)	% of total in HK SAR
Plantation	4830	11.5	0.24
Tall Shrubland	7933	4.5	0.06
Low shrub with grass	9203	5.1	0.06
Agriculture (abandoned)	3167	0.9	0.03
Marsh	-	0.3	-
Disturbed/Urbanised	17086	11.0	0.06

* Ashworth *et al.* 1993

Impact Evaluation

9.5.3 Ecological values of each habitat are quantified using the criteria in the TM on EIA Process, Annex 8, Table 2. Each criterion is given a score from 1 to 5, a relative ranking with 1 representing the lowest conservation value (e.g. small size, less diverse, highly fragmented, easily recreated) to 5 representing the highest conservation value (e.g. big size, more diverse, less fragmented, difficult to re-create) (Table 9.9). It should be noted that such quantification is rough and must be interpreted with due caution.

Table 9.9 Evaluation of the habitats in the Study Area (Total Maximum potential conservation value score = 55, minimum score = 11)

Criteria	Plantation	Shrubland	Stream	Agriculture	Grassland	Marsh
Naturalness	1	3	2	1	1	2
Rarity	1	2	1	1	1	2
Size	3	1	1	1	1	1
Diversity	3	3	1	2	1	2
Irreplaceability	1	3	4	1	1	3
Integrity	2	2	2	1	1	2
Ecological linkage	2	3	1	1	1	2
Potential value	2	3	1	1	1	2
Nusery/ breeding ground	2	3	1	1	1	2
Age	1	2	2	1	1	1
Abundance /Richness of wildlife	2	2	1	2	1	2
Total	20	27	17	13	11	21

*relative ranking with 1 representing the lowest conservation value (e.g. small size, less diverse, highly fragmented, easily recreated) to 5 representing the highest conservation value (e.g. big size, more diverse, less fragmented, difficult to re-create).

9.5.4 Table 9.9 above describes the ecological values of the habitats in the Study Area. Loss of grassland, agricultural field would have a minor impact on flora. Despite the relatively large area involved, loss of plantation would also have minor ecological significance due to its commonness, young age, and moderate diversity. As described in the previous section most of the plantation area is sparsely vegetated with low canopy and very young vegetation. This habitat is also easy to recreate, and the loss can be mitigated by compensatory planting on site (see section 9.6). Impacts to invertebrate fauna are not likely to be severe due to the commonness of the species recorded.

9.5.5 The major ecological concerns will be the potential impacts on species of conservation significance, which are the Chinese New Year Flower, the Hobby, the Ashy Drongo, the Crested Goshawk and the Masked Palm Civet.

9.5.6 The proposed cut slope to the north of the site will encroach upon the tall shrubland habitat. Shrubland habitat is relatively widespread locally. Shrubland of any size is not listed as one of the "important habitats which will need an ecological assessment" in Annex 16, Appendix A, Note 2 of the TM on EIA Process. However, the naturalness, the diversity, the presence of a protected plant and a protected mammal result in a higher score. Most of the shrubland species produce fleshy fruits, providing a food source for avifauna and civets. However, of the 4.5 ha shrubland to be encroached, 2.5 ha was actually the old quarry area, which is much disturbed. Additionally due to the small size of the area to be affected, impact to shrubland habitat is ranked as minor.

9.5.7 The feeding ground of the Hobby is not habitat specific and therefore impacts of the project to this passage migrant are likely to be minor. Ashy Drongo usually establish winter terriorites in tall shrubland and woodland habitats when they overwinter in Hong Kong (pers. obs.). Although no nest was observed, Crested Goshawk is a probable breeder in the ravines within the tall shrubland habitat. Loss of tall shrubland habitat would potentially affect the winter habitat of the Ashy Drongo and the Crested Goshawk. However, due to the small area of tall shrubland habitat likely to be affected, impacts on these bird species are likely to be minor. The Masked Palm Civet appears to be limited in distribution in Hong Kong although, it is still fairly common regionally. The potential operational impacts will include disturbance to wildlife from human residents. Such impacts are considered minor due to the limited usage of the site by wildlife.

9.6 Mitigation Measures

9.6.1 Loss of plantation can be mitigated by compensatory planting on site. Results of site inspection indicate that rock cut slopes on the site would be formed at an average of 60°, which would be a constraint for compensatory planting.

9.6.2 The angle of the slope behind Site 3B has been reduced from 60° to 45° to allow soiling and revegetation with grass and shrubs. A "soft" slope in this area reduces noise impacts, minimises visual impacts and assists ecological mitigation by providing 3.3 ha for compensatory planting (see Table 9.10 for recommended species).

9.6.3 In addition, a 10 m belt of soft slope suitable for compensatory planting can be formed at the upper 5 to 10 m of each rock cut slope (Figure 9.2). Approximately 1.9 ha would be available for compensatory planting. Tree and shrub species suitable for the compensatory planting are recommended in Table 9.10. It includes some of the native species planted in limited numbers in previous planting projects. Planting with native species will enhance the ecological value of the area as well as promoting the establishment of flora with conservation value (e.g. *Endospermum chinense*, *Quercus* spp.). Planting with berry producing native species can also mitigate the project impacts on civets, which consume fleshy fruits in winter. Native species listed in Table 9.10 or equivalent should be used as possible in Open Space, District Park, and other landscape planting. A total of 5.2 ha (3.3 ha + 1.9 ha) will thus be available for conpensatory planting. Whilst the loss of 11.5 ha of plantation and 4.5 ha of tall shrubland cannot be replaced with 15.9 ha of compensatory planting due to space limitation, the 5.2 ha of compensatory planting on site, plus an additional 4.5 ha (approximately) at Jordan Valley Ecology Park will replace most lost habitat. When side slopes of the Landfill are also taken into consideration, the ratio of lost habitat to compensatory planting in this area approaches 1:1. In addition, compensatory planting will be of primarily native species which will be of greater ecological value in the long term than the degraded habitats being lost.

9.6.4 Loss of shrubland and the protected species *Enkianthus quinqueflorus* should be minimised. Based on the results of spring surveys, it appeared that the individuals found will not be disturbed. Temporary works area, although not yet defined at this stage, should avoid the shrubland habitats to minimise the disturbance. Should the impact be unavoidable, mitigation measures suggested in the previous paragraph may mitigate this loss.

9.6.5 Landscape contractors should be consulted for transplanting of the protected species and provision of native plants, which are in relatively short supply and require a relatively long lead time to produce. The landscape contractor should also be responsible for the planting and maintenance of the plantation for at least 1 year to enhance the survival rate of immature trees. Detailed planting specification and the cost of compensatory planting should be estimated and included in the detailed design phase.

9.6.6 The use of the existing Jordan Valley Landfill, which is currently being restored under the Urban Landfills Restoration Contract, will provide a core area for ecological mitigation in this area as its current afteruse is planned as an urban ecology park of approximately 5 ha. EPD will implement the ecology park afteruse contract and the park is currently planned to open in Mid-2001, providing approximately 4.5 ha of additional compensatory planting.

9.6.7 Should the mitigation measures be implemented, there will not be significant residual impacts from the project.

Table 9.10 Plant Species recommended for shrubland and woodland planting for Choi Wan Road and Jordan Valley Development

Species	Growth Form
Acronychia pedunculata	tree
Aporusa dioica	tree
Ardisia crenata	shrub
Baeckea frutescens	shrub
Breynia fruticosa	shrub
Bridelia tomentosa	tree
Celtis sinensis	tree
Cinnamomum camphora	tree
Cleistocalyx operculata	tree
Cratoxylum cochinchinensis	tree
Daphniphyllum calycinum	tree
Endospermum chinense	tree
Enkianthus quinqueflorus	shrub
Evodia lepta	tree
Ficus hispida	tree
Ficus microcarpa	tree
Ficus superba	tree
Ficus variolosa	tree
Gordonia axillaris	shrub
Ilex pubescens	shrub
Itea chinensis	tree
Ligustrum sinensis	shrub
Litsea glutinosa	tree
Litsea rotundifolia	shrub
Macaranga tanarius	tree
Machilus breviflora	tree
Machilus oreophila	tree
Machilus spp.	tree
Machilus thunbergii	tree
Mallotus paniculatus	tree
Melastoma candidum	shrub
Melastoma sanguineum	shrub
Microcos paniculatus	tree
Ormosia emarginata	tree
Psychotria rubra	shrub
Quercus edithae	tree
Quercus myrsinaefolia	tree
Rhaphiolepis indica	shrub
Rhodomyrtus tomentosa	shrub
Rhus chinensis	tree
Rhus succedanea	tree

Table 9.10 (cont.)

Sapium discolor	tree
Sapium sebiferum	tree
Sarcandra glabra	shrub
Schefflera octophylla	tree
Schima superba	tree
Sterculia lanceolata	tree
Ternstroemia gymnanthera	tree

9.7 Environmental Monitoring and Audit

9.7.1 Ecological monitoring should include:

- Supervision for hand excavation of any burrows encountered during construction and release of captured animals unharmed in areas secure from disturbance;
- Supervision of transplanting and aftercare of protected plant species, if any;
- Supervision for initial planting. Planting and maintenance specifications should be reviewed to ensure native species are included as well as survival and establishment of the new plantings.

9.8 Conclusions

9.8.1 Macro-habitats found within the 100 ha Study Area included plantation, tall shrubland, low shrub with grass, agriculture, marsh, disturbed area and streams. Potential impacts of the project will include loss of 11.5 ha plantation, 4.5 ha tall shrubland, 5.1 ha low shrub with grass, 0.9 ha agriculture and 0.3 ha marsh will constitute the major direct impacts of the project. Loss of plantation and agricultural fields will have a minor impact on flora. Impacts to invertebrate fauna are not likely to be severe due to the commonness of the species recorded. Mitigation measures include compensatory planting including native species on the soft cut slope belt and establishment of an ecology park on the restored landfill.

Table 9.11 Plant species recorded in the Study Area, 1997-8.

Species	Growth Form	Exotic	Relative Abundance				
			Plantation	Tall Shrubland	Agricultural	Low Shrub with Grass	Marsh
Acacia auriculiformis	T	Yes	+++				
Acacia confusa	T	Yes	+++				
Acacia mangium	T	Yes	++				
Achyranthes aspera	H		+				
Acronychia pedunculata	T			+			
Adenosma glutinosum	H			+			
Albizia lebbeck	T	Yes			+		
Allamanda neriifolia	T	Yes	+				
Alocasia macrorrhiza	H		+		+		
Alternanthera sp.	H						+
Alyxia chinensis	C			+			
Aporusa dioica	T			+			
Archidendron lucidum	T		+				
Ardisia punctata	S			+			
Artemisia sp.	H		++				
Arundinella setosa	G		++				
Aster baccharoides	H		++	++			
Baeckea frutescens	S			+			
Bambusa tuldoides	B		+				
Bambusa ventricosa	B		+				
Bauhinia sp.	T		+				
Bidens pilosa	H		+				++
Blechnum orientalis	F			+		+	
Boehmeria nivea	S		+		+		
Breynia fruticosa	S		+				
Bridelia tomentosa	T		+				+
Brucea javanica	S				+		
Canna indica	H	Yes	+				
Canarium sp.	T	Yes	+				
Capillipedium parviflorum	G		+				
Carica papaya	T	Yes	+		+		
Cassia alata	T	Yes	+				
Cassia siamea	T	Yes	+				
Cassia surrattensis	T	Yes	+				
Casuarina equisetifolia	T	Yes	+++				
Casuarina stricta	T	Yes	+				
Catharanthus roseus	S	Yes	+				
Celtis sinensis	T		+		+		+
Chara sp.	H						+
Chrysalidocarpus lutescens	T	Yes	+				
Chrysanthemum sp.	H		+				
Cinnamomum camphora	T		+				
Citrus microcarpa	T	Yes			+		
Clausena lansium	T	Yes			++		
Cocculus trilobus	C			+			
Cratoxylum cochinchinensis	T						
Cyclosorus interruptus	F						+
Cymbopogon sp.	G		+++				

Table 9.11 (cont.)

Cynodon dactylon	G					++	
Cyperus haspans	SE						+
Cyperus polystachyos	SE						
Cyrtococcum patens	G		+		++		
Daphniphyllum calycinum	T		+				
Delonix regia	T	Yes	+				
Dendrotrope frutescens	C			+			
Desmodium heterocarpon	H		+				
Dianella ensifolia	H		+	++			
Dicranopteris linearis	F			++			++
Dimocarpus longan	T	Yes	+		++		
Diospyros vaccinoides	S		+	++			
Elephantopus scaber	S		+				
Embelia laeta	C		+	+			
Embelia ribes	C			+			
Enkianthus quinqueflorus	S			++			
Equisetum debile	F						++
Eragrostis sp.	G		++				
Eriachne pallescens	G		++				
Eriobotrya japonica	T	Yes	+				
Erythrina sp.	T	Yes	++				
Eucalyptus torelliana	T	Yes	+				
Eucalyptus robusta	T	Yes	+				
Eulalia speciosa	G		++				
Eurya chinensis	S	Yes	+	++			
Ficus elastica	T	Yes	+				
Ficus hirta	S		+				
Ficus hispida	T		+		+		
Ficus microcarpa	T		+				+
Ficus pyriformis	S		+				
Ficus superba	T		+				
Ficus variolosa	T		+	+++			
Fimbristylis spp.	SE		+				
Gahnia tristis	SE			+			
Gnetum montanum	C		+	++			
Gordonia axillaris	S		+	+++			
Hedyotis acutangula	H		+	++			
Hibiscus rosa-sinensis	S	Yes	+				
Hibiscus schizopetalus	S	Yes	+				
Ilex pubescens	S			+			
Imperata cylindrica	G						++
Inula cappa	S		+				
Ipomoea cairica	C						++
Ipomoea hederacea	C		+				+
Ischaemum indicum	G		+				
Itea chinensis	T		+	+++			
Ixora coccinea	S	Yes			+		
Lactuca indica	H		+				+
Lasianthus chinensis	T		+				
Lantana camara	S	Yes	+		++		++
Lepidosperma chinense	SE						++
Leucaena leucocephala	T	Yes	++	+++			+

Table 9.11 (cont.)

Ligustrum sinensis	S		+				
Liriope spicata	H		+				
Litsea glutinosa	T		++				+
Litsea rotundifolia	S		+	++			
Lophatherum gracile	G		+				
Lophostemon confertus	T	Yes	+++				
Lycopodium cernuum	F			+			
Macaranga tanarius	T		++		++		+
Machilus sp.	T		+	+			
Machilus breviflora	T			+			
Mallotus paniculatus	T		+	+	+		+
Malvaviscus arboreus	S	Yes	+				
Manihot esculenta	S		+				
Michelia alba	T	Yes	+				
Melaleuca quinquenervia	T	Yes	++				
Melastoma sanguineum	S		+	++			+
Merremia sp.	C						+
Microcos paniculatus	T		+		+		
Mikania micrantha	C	Yes	+		++		+++
Millettia nitida	C		++	++			
Mimosa indica	H		+				
Miscanthus sinensis	G		+++	++			++
Morinda umbellata	C		+	+			
Musa paradisiaca	T	Yes	++				
Mussaenda pubescens	S						+
Neyraudia reynaudiana	G		++				
Ormosia emarginata	T			+			
Pandanus urophylla	S		+	+			
Panicum maximum	G	Yes	++				
Pennisetum purpureum	G	Yes	+				
Pennisetum sp.	G		++			++	++
Phoenix hanceana	S		+				
Phyllanthus cochinchinensis	S		+	+			
Phyllanthus emblica	S			+			
Phyllanthus urinaria	S		+				
Pinus elliottii	T	Yes	++				
Pinus massoniana	T		+	++			
Plantago major	H				+		
Pluchea indica	H						+
Plumeria rubra	T	Yes			+		
Podocarpus macrophyllus	T	Yes	+				
Pogonatherum critinum	G				+		
Praxelis clematidea	H	Yes	++				
Psidium gujava	T	Yes	+				
Psychotria rubra	S		+				
Psychotria serpens	C		+	++			
Pteris biaurita	F		+				
Pteris ensiformis	F		+	++			
Pteris semipinnata	F		+				
Pueraria lobata	C						++
Rhaphiolepis indica	S		+				
Rhapis excelsa	H	Yes	+				

Table 9.11 (cont.)

Rhodomyrtus tomentosa	S		+	+++		+	
Rhus chinensis	T						
Rhus hypoleuca	T						+
Rhus succedanea	T		+	++			+
Rhynchelytrum repens	G						
Saccharum arundinaceum	G		+++	+++		++	
Salvia splendens	H	Yes	+				
Sansevieria cylindrica	H	Yes	+				
Sapium discolor	T			+			
Sapium sebiferum	T			++			
Schefflera octophylla	T		+	+			+
Sesbania cochinchinense	S						+
Sida sp.	H				++		
Smilax glabra	C		+	+			
Sterculia lanceolata	T		+	+			+
Strophantus divaricatus	S		+	++			
Suaeda australis	H				+		
Ternstroemia gymnanthera	T		+	++			
Tetracera asiatica	C		+				
Thevetia peruviana	T	Yes	+				
Urena lobata	S				+		
Wedelia triloba	C	Yes	++				
Youngia japonica	H		+	+			
Zingiber officinale	H	Yes			+		

Notes: Relative Abundance: +++ = common, ++ = occasional, + = rare
Boldface: Protected Species

Growth Form:

T = Tree
H = Herbs
G = Grass
S = Shrubs

F = Fern
SE = Sedges
C = Climber
B = Bamboo

10 LANDFILL GAS HAZARD ASSESSMENT

10.1 Introduction

10.1.1 This Chapter presents a qualitative assessment of the potential hazards caused by landfill gas (LFG) on the proposed development. Specifically, this Chapter examines the potential hazards associated with LFG migration from Jordan Valley landfill, which is situated within the Study Area.

The Potential Risk of Landfill Gas

10.1.2 Landfill gas is a flammable and asphyxiating mixture of methane and carbon dioxide, often with trace amounts of toxic volatile compounds. It is a product of the anaerobic decomposition of solid wastes. Explosion can occur when methane in concentrations between 5% and 15 % by volume (representing the lower and upper explosive limits, LEL and UEL respectively) is mixed with air in confined spaces and given a source of ignition such as an electrical spark.

10.1.3 The LFG mixture has a density similar to that of air, although this varies according to its exact composition. Upward movement of LFG is usually a result of excess pressure over ambient conditions rather than buoyancy. Changes in atmospheric pressure will influence venting of landfill gas to atmosphere as well as subsurface lateral migration. Bulk gas movements may be caused by the pumping effect of a rising water table, whereas sub-surface lateral diffusion through semi-porous strata and cracks and faults may also be due to a concentration gradient.

10.1.4 Landfill gas is capable of moving away from its sources along permeable media such as cracks and fissures in the surrounding rock and other preferential paths of least resistance such as utility routes (trenches and ducts) to the potential target, for a distance of 300m or more.

10.2 Government Legislation and Standards

10.2.1 There is no primary legislation covering hazards to development caused by LFG. A ProPECC Note, "Landfill Gas Hazard Assessment for Developments adjacent to Landfills" (PN3/96) has been issued by EPD. This Note sets out the conditions under which a LFG hazard assessment should be carried out. EPD have also produced a "Landfill Gas Hazard Assessment Guidance Note"(EPD TR8/97) which issues further guidance on undertaking LFG hazard assessments. The guidelines recommend that in general, assessment of risks from LFG are required for proposed developments that lie within a 250m "Consultation Zone" around the landfill site.

10.2.2 Chapter 9, of the Hong Kong Planning Standards and Guidelines also includes guidance on siting of developments in the vicinity of landfills. The guidance states that safe distances depend on factors such as the existence of gas control systems, barriers, landfill site configuration and geological conditions.

10.3 The Proposed Development

10.3.1 The development is based on five main Sites on platforms at 20, 40, 60 and 80 mPD, as shown in Figure 2.2. The proposed development will include private and public residential blocks, schools, playgrounds, commercial centres, and carparks as well as a freshwater service reservoir and a saltwater service reservoir.

10.3.2 The platform arrangement is such that the northern and eastern bounding ridges adjacent to the landfill are retained to serve as a visual and physical separation between the development Sites and the landfill. There are extensive cut slopes around the platforms.

10.3.3 The process by which the preferred development option was arrived at is described in Chapter 2. The preferred option has been planned to considerably reduce the potential LFG hazard by maximising the distance between the landfill and the development. All development is retained outside a 50m "no development zone" recommended by the Restoration Contractor and is outside of the boundary of the 250m Consultation Zone.

10.3.4 The elements of the development that are closest to the landfill are located around 250m from the waste boundary, these include: public housing blocks and a secondary school in Site 3b, and a secondary school in Site 4. In Site 3b, situated within the 250m Consultation Zone at around 100m from the waste boundary, there is also a proposed District Park (at the former quarry to the south west of the landfill).

10.3.5 The proposed development, the location of the 250m Consultation Zone and the 50m "no development zone" are shown in Figure 10.1.

10.4 Landfill Site History and Restoration Works

Landfill Site History

10.4.1 The landfill is a deep valley infill, which extends to an average depth of 32 metres and covers a total plan area of about 6.5 ha. The landfill received waste between April 1986 and July 1990. During its operational life, it received approximately 1.52 million tonnes of domestic, construction and commercial wastes at proportions of 67.5 %, 31 % and 1.5 % respectively.

Restoration Works

10.4.2 Jordan Valley Landfill is one of five landfills currently being restored under the Urban Landfills Restoration Contract (ULRC) administered by EPD. Capital works for the restoration of the landfill have been completed and a one year defects correction period (which includes commissioning tests) commenced in May 1998. Thereafter, the Restoration Contractor will maintain the landfill for a 30-year aftercare period. Under the ULRC, the minimum design life of the LFG management system is 35 years.

10.4.3 The Restoration Contractor is responsible for ensuring that LFG does not pose a hazard either on-site or off-site. Upon completion of the restoration works, it is proposed that the landfill is developed for passive recreational afteruse, e.g. Ecology Park for use by local residents. The status and details of the afteruse project have not been finalised. Potential hazards associated with the landfill afteruse have not been addressed in this Study.

Landfill Capping

10.4.4 The specification for the components of the landfill restoration capping system (from top to bottom) is as follows:

- An 850mm thick general cover layer;
- A subsoil drainage layer consisting of a continuous geotextile integrated with regular spaced geodrain strips;
- A low permeability layer comprising a continuous 1 mm thick low density textured polyethylene (LLDPE) geomembrane;
- A gas/leachate interceptor drainage layer consisting of a continuous geotextile with regular spaced geodrain strips; and
- A minimum 500 mm thick layer of intermediate cover soil.

The geotextile in the drainage layers functions as a reinforcement layer for the system and provides protection against puncture of the overlying geomembrane.

Landfill Gas Management System

10.4.5 The outline design for the gas management system prepared by the Restoration Contractor includes passive venting as well as active extraction, interception and flaring. There are also provisions for monitoring of LFG migration both on and off-site and integral monitoring of flare emissions at the LFG flare. The landfill gas extraction system is integrated with the leachate management system and the restoration capping system.

10.4.6 A passive venting trench is located along the northern boundary of the landfill site adjacent to the New Clear Water Bay Road. The restoration works will include seven additional passive gas vent risers for the existing vent trench. The trench will also be connected to the proposed gas abstraction system.

10.4.7 The gas flare and plant are situated to the southeast of the landfill. The active gas control system comprises 28 extraction wells installed on both the platform and slopes connected to a blower/ flare assembly. The flare will be an enclosed, ground-level flare designed to burn at 1000 to 1200°C with a residence time of 0.6 seconds to prevent the emission of unacceptable levels of methane, carbon dioxide, odourants and volatile organics to the atmosphere. Notwithstanding these specification requirements, the Restoration Contractor is obliged to ensure that no adverse environmental impacts arise from the landfill gas flare either off-site or on site.

10.4.8 A landfill gas flare assessment has been carried out by the Restoration Contractor as part of his design. The assessment includes prediction of various pollutant levels that will be emitted from the gas flare. At this stage, discussions with the Restoration Contractor indicate that the flare is operating satisfactorily. The potential air quality impacts associated with landfill gas flare are identified in Chapter 4.

10.4.9 The Restoration Contractor has designed a gas emission monitoring system to detect off-site LFG migration and assess the quality and quantity of any gas emissions through the landfill capping. Thirteen monitoring wells have been installed on-site and a total of ten additional gas-monitoring wells are proposed.

The Potential Release of Landfill Gas

10.4.10 The factors that affect the potential for gas production at the landfill site include climatic influences and the characteristics of the waste such as; organic content, moisture coefficient, density, volume and age.

10.4.11 Although gas utilisation has been considered by the Restoration Contractor, it is likely that the quantity and quality of LFG recovered may be insufficient to economically justify the initial capital costs and long term operational costs required to implement energy recovery. On-site utilisation of the LFG may be considered for small-scale electric power generation for the proposed Afteruse (Ecology Park). But this is only likely to be implemented if gas utilisation is considered a better alternative to flaring. The estimated LFG production rates between 1996 and 2006 are presented in Table 10.1 below.

Table 10.1 : Estimated Landfill Gas Production Rates Between 1996 and 2006

Year	LFG Generation Rate	LFG Production Rate	LFG Recovery Rate
1996	0.016m^3/tonne/day	660m^3/hr	460m^3/hr
2000	0.012m^3/tonne/day	512m^3/hr	358m^3/hr
2006	0.0088m^3/tonne/day	350m^3/hr	250m^3/hr

Source: Urban Landfills Restoration Contract Document Volume 4, HKLRG for EPD.

10.4.12 It is expected that by the year 2016, the above rates will have decreased to levels that require continued LFG interception and extraction but may not support unsupplemented gas flaring or energy recovery. By the end of the 30-year aftercare period, it is anticipated that LFG production levels will have dropped sufficiently to cease continuous extraction and flaring.

Management of Hazards by the Restoration Contractor

10.4.13 In addition to the engineering works, the Restoration Contractor will be responsible for drafting and implementing a number of plans to ensure the safe management of LFG. These include a Monitoring Plan, Emergency Procedures Plan and an Event Contingency Plan, as follows:

10.4.14 The Draft Monitoring Plan includes for:

- Surveys of surface gas emission;
- Examination of monitoring holes and piezometers;
- Surveys of buildings and confined spaces (on and offsite) for LFG emissions;
- Monitoring of controlled LFG emissions;
- Monitoring of condensate;
- Monitoring of extraction equipment;
- Monitoring of locations of gas wells and probes, and;
- Monitoring of flammable gas using portable equipment.

10.4.15 The draft Emergency Procedures Plan sets out the actions to be taken in the event of an emergency or alarm. Procedures that have relevance to the management of LFG include arrangements to deal with:

- Multiple plant failure;
- Typhoon events;
- Slope instability and settlement;
- Slope failure, and;
- Unexpected LFG quality and quantity.

10.4.16 The draft Event Contingency Plan is currently being developed by the Restoration Contractor and will address the issues of LFG migration, LFG emissions and LFG in buildings. This Plan will provide trigger, action and target limits for on and off site levels of LFG. The trigger limits will act as a flag to alert the Restoration Contractor to a possible exceedance, at which point he will implement corrective actions to reduce the exceedance to below trigger limits.

10.5 Geological Assessment

10.5.1 A desk study was carried out to review information relevant to the geology of the site. Information was obtained from:

- Ground investigation records from the Restoration of Urban Landfills Study (Binnie for EPD, 1992);
- Hong Kong Geological Survey 1:20,000 Scale Map Sheet 11, (GCO, 1986a);
- Geotechincal Analysis Report of Afteruse Development of Restored Urban Landfill at Jordan Valley (Scott Wilson, 1997).

10.5.2 A ground investigation, (GI) was carried out in April 1998 as part of this Consultancy Study. The GI included the drilling of four additional monitoring wells (BMW1 to BMW4), six geotechnical boreholes as well as trial pits at locations between the landfill and the proposed development. The GI confirmed the findings of the desk study presented below. Further details of the GI are presented in the "Planning and Engineering Feasibility Study for Development Near Choi Wan Road and Jordan Valley - Final Report", September 1998.

Geology and Hydrogeology at the Study Area

10.5.3 The geological map of the Study Area is shown in Figure 10.2. The bedrock within the Study Area is formed of fine to medium grained granite of Jurassic to Cretaceous age, occasionally with minor intrusions of quartzphyric ryholite. Completely, to highly decomposed granite (C/HDG) overlies the moderately to slightly weathered bedrock at thicknesses typically less than 15m. This material mainly comprises medium sized sand, with small amounts of silt and gravel. Occasional areas have superficial materials of silt, sand and gravel of colluvial origin. As shown in Figure 10.2, there are three geological faults in the Study Area. The locations of the two north-west/south east trending faults are shown to be uncertain on the map. The extent and exact position of the geological faults will require further investigation. Cross sections of the geology in the area where the north-west trending fault crosses the landfill site in the vicinity of the development sites are shown in Figures 10.1a and 10.1b.

10.5.4 An understanding of the hydrogeological characteristics of the Study Area is based upon the geology. Generally the groundwater contours at Jordan Valley occur as a subdued reflection of the surface topography, with an overall pattern of flow from the topographically higher ridges to lower elevations.

Geology and Hydrogeology at the Jordan Valley Landfill

10.5.5 Along the western valley slope, fresh, unweathered granite is overlain by a superficial layer of C/HDG approximately 5 to 15m thick. The superficial C/HDG layer is apparently not present along the eastern slope of the valley, which suggests that the landfill wastes lie on relatively fresh, unweathered granite on this portion of the site.

10.5.6 In the area above the former Jordan Valley Reservoir dam, the available information indicates that the superficial materials overlying unweathered granite comprise the following general sequence of soils: a 5 to 10m layer of C/HDG, a thin (approximately 1m in thickness) silty clay alluvium, and a layer of silty courses and fill of 3 to 5 m in thickness.

10.5.7 As described, three geological faults reportedly occur in the immediate vicinity of the landfill. One geological fault runs in a north-west/ south-east direction through the middle of the landfill site. This crosses another geological fault running NE-SW immediately to the south of the landfill. A third geological fault extends to the SE from this fault. The exact location of the NW-SE faults are not certain. The degree to which the faults are fractured is also not known.

10.5.8 The maximum thickness of waste is estimated to be approximately 50m based on the present surface elevation of the main waste platform (which is approximately at 120 mPD), and the minimum landfill base elevation of 70 mPD. The cover material was found to consist of a yellowish-brown silty sand with gravel and is presumably CDG with thickness varying from 1.5 to 3.5m.

10.5.9 During the Restoration of Urban Landfills Study site investigation, leachate levels at the top platform were encountered at depths of 3 to 5m below the surface, (Binnie 1992). Considering that the maximum thickness of the waste is in excess of 50m in places, more than 45m of the waste at the landfill is apparently saturated. Generally, across the landfill site groundwater and leachate were encountered at depths ranging from less than 1m to over 20m below ground level (bgl).

10.5.10 As part of a Pre-Tender leachate monitoring Programme, (Scott Wilson Kirkpatrick, March 1996), monthly monitoring of groundwater and leachate was carried out for five months between August and December 1995. Results concurred with those from the Restoration of Urban Landfills Study described above. Leachate levels fluctuated across the landfill with the greatest variation shown in the top waste platform with levels varying between 4.3m bgl in September to 9.15 m bgl in November, showing a variation of 4.85m.

10.5.11 Despite high leachate levels beneath the main waste platform, water levels were quite low beneath the downsloping face of the dam. Groundwater was very near the surface along the main valley bottom, just up-valley of the former Jordan Valley Reservoir dam. There were occasional ponding over some areas on the main waste platform.

10.5.12 Under the ULRC, the Restoration Contractor will be required to manage leachate levels within the main platform, reducing elevations by around 15 to 20m over a period of 5 years.

10.5.13 In the ridges surrounding the main waste platform, groundwater ranges from 6 to 8 m below the capping surface. The Restoration of Urban Landfills Study identified that flow was taking place from the higher bounding ridges into the landfill then down -valley to the south-east towards the toe of the landfill, (Binnie 1992). In the main valley, the predominant flow direction is towards the south-west, towards the existing masonry dam.

10.5.14 Groundwater flows from the bounding ridges into the landfill under a horizontal hydraulic gradient of approximately 0.1 m/m. Beneath the main waste platform, the gradient reduces to only approximately 0.06 m/m. Flow occurs down the landfill slope towards the toe at relatively steep gradient of about 0.25 m/m. Within the former reservoir valley, flow occurs to the south-west under a small gradient of 0.01 m/m.

Geology and Hydrogeology at the Proposed Development Sites

10.5.15 The geology at the proposed development site is generally of fine to medium grained granite overlain by a layer of completely to highly decomposed granite. There are debris flow deposits along the base of the valley. This material comprises silt, sand and gravel and is of colluvial origin.

10.5.16 Scott Wilson carried out a joint survey at Flathill Quarry in November 1997. On the near-vertical rock faces, joints are described as closely to widely spaced. Their persistence is generally greater than 3m. Most of the joint apertures are extremely narrow (<6 mm wide); some of the occasionally wider joints are infilled with weathered parent rock. Some joints are rough, but the majority of them are smooth. Minor seepage was observed in the joints on the north and north-east slopes of the quarry.

10.5.17 A preliminary rock joint survey was also carried out at the abandoned quarry between the landfill and Choi Ha Estate in the location of the proposed District Park. The spacing of the exposed joints on the 50-m high near-vertical rock faces varies widely at different locations. The joints are typically smooth and the apertures are very narrow (<6mm wide). The wider joint apertures are infilled with completely decomposed materials and highly fractured rock fragments. Minor seepage was observed in isolated areas near the slope toe.

10.5.18 The available piezometric data indicates that groundwater flows in a southerly direction towards Choi Ha Estate. The bounding ridge, which separates the landfill and the development areas, appears to act as a groundwater divide between the landfill site and the development areas.

10.6 Qualitative Risk Assessment

Methodology

10.6.1 The degree of risk, which LFG may impose on the proposed development near Jordan Valley, has been evaluated using a procedure based on the "source - pathway - target" model. These terms are defined as followed:

- *Source* - the location, nature and likely quantities/ concentration of LFG which has the potential to affect the proposed housing development.
- *Pathway* - the ground and groundwater conditions through which the LFG must pass if it is to reach the development areas. The pathways may be natural ground or man-made utility conduits.
- *Target* - the elements of the development, which are considered sensitive to the effects of LFG.

10.6.2 Depending on the characteristics of the site conditions, three categories of risk can be defined: high, medium and low. The allocation of these categories to the situation on site is based on simple rules, which allow consistent application of the process to all sites. The rules are set out in Table 10.2.

Table 10.2: Quantification of Risk Category

Pathway Type	Pathway Length	Status of Receptor	Risk Category
Direct	Short	Sensitive	High
		Insensitive	Medium
	Long	Sensitive	Medium
		Insensitive	Low
Indirect	Short	Sensitive	Medium
		Insensitive	Low
	Long	Sensitive	Low
		Insensitive	Low

Term	Definition
Direct pathway	A single media or route through which gas can travel from source to target, e.g. where fissured rock is continuous from the landfill boundary to the location of the target.
Indirect pathway	More than one medium or route through which gas must travel from source to target, e.g. via backfill in utilities trench, and then through permeable soil.
Short pathway	Less than or equal to 100 metres from edge of waste to target.
Long pathway	Greater than 100 metres from edge of waste to target.
Sensitive and exposed target	A target which will be vulnerable to gas entry by virtue of its proposed design and will be adversely affected by gas.
Insensitive and exposed target	A target which is not particularly sensitive to gas ingress, due to its open structure or absence of human entry or ignition source.

The Source, Pathways and Targets are discussed and assessed below. The hazard assessment is also summarised in Table 10.4 at the end of this section.

Source

10.6.3 Predicted LFG production rates shown in Table 10.1 indicate that for 1996 estimated rates of production are 660m^3/hr, with recovery by the LFG system at a rate of about 460m^3/hr. Due to high leachate levels in the landfill platform area, it is expected that LFG is contained near the surface. Existing LFG concentrations are monitored by 20 monitoring probes on site.

10.6.4 A pre-restoration monitoring programme was carried out on a monthly basis over 21 months between December 1994 and August 1996. Monitoring wells to the south and east of the landfill generally showed low levels of methane. The only wells situated between the landfill and the proposed development are wells GW3 and GW4, both these wells are situated within natural ground close to the waste boundary, their locations shown in Figure 10.1.

10.6.5 Methane levels in GW3 were very low and no methane was measured in 14 of the 21-month monitoring period. The maximum levels recorded were 3.2% (v/v). Recorded levels of methane in GW4 were much greater ranging between 0 and 80 % over the 21 months period with consistent results between 50% and 60% (v/v) methane.

10.6.6 At present, LFG monitoring surveys are carried out monthly under the ULRC, as part of the restoration works. The monitoring points are at wells on the perimeter of the landfill site, at piezometers within the waste boundary, two off-site buildings in Shun Lee Tsuen Road and Lee Hong House, and four risers from the passive venting trench that runs parallel to New Clearwater Bay Road. The locations of these monitoring points are shown in Figure 10.1.

10.6.7 According to the ULRC August 1997 landfill gas monitoring report, concentrations in the piezometers and passive vents on-site were expectedly high ranging between 11.7 - 59.6 % and 7.2 - 28.8 % (v/v) for methane and carbon dioxide respectively.

10.6.8 Measured results indicate high methane levels up to 59.6 % (CO_2 up to 28.8%) by volume at the north-eastern boundary of the landfill. The location of this methane reading is at a monitoring point (JVL5) in natural ground outside the landfill boundary. Methane levels recorded at four selected passive vents adjacent to this side of the landfill were measured up to 18.6% (CO_2 up to 12.4%) by volume. This shows that levels of methane may vary significantly even at a close distance.

10.6.9 In the same month, in the southeast part of the landfill site (presently covered by a trail of track road), the methane levels recorded at one of the three monitoring stations (LP1, LP2, LP3) was up to 55.9 % (CO_2 up to 23.1%) by volume.

10.6.10 A six-month landfill gas monitoring programme of the four new boreholes (BMW1 to BMW4) situated between the landfill and the proposed development was commissioned in August 1998. The borehole locations and representative cross sections are shown in Figure 10.1. To date, four rounds of monthly landfill gas data have been collected between September 1998 and December 1998 inclusively. The results of the landfill gas monitoring are shown in Table 10.3 below.

Table 10.3: Landfill Gas Monitoring Data at Boreholes BMW1 to BMW4

Date		BMW1	BMW2	BMW3	BMW4
September 1998	% by volume CH_4	0.02	0.00	0.00	0.00
	% by volume CO_2	6.35	0.06	0.06	0.06
	% by volume O_2	15.3	20.8	20.6	20.6
	Pressure (mmHg)	746	746	745	746
October 1998	% by volume CH_4	0.04	0.04	0.04	0.07
	% by volume CO_2	7.24	0.05	0.06	1.4
	% by volume O_2	15.5	20.7	20.8	19.5
	Pressure (mmHg)	747	748	748	752
November 1998	% by volume CH_4	0.00	0.00	0.00	0.00
	% by volume CO_2	0.66	3.87	2.21	0.11
	% by volume O_2	20.5	17.5	18.6	21
	Pressure (mmHg)	752	751	751	757
December 1998	% by volume CH_4	0.12	0.04	0.04	0.00
	% by volume CO_2	4.46	1.89	1.95	0.04
	% by volume O_2	18.3	19.7	18.2	20.9
	Pressure (mmHg)	755	758	756	762

10.6.11 Table 10.3 indicates that during the four month monitoring period, recorded levels of methane at all four locations were consistently below 0.1% by volume except borehole BMW1 which showed a level of 0.12% during December 1998.

10.6.12 Levels of carbon dioxide and oxygen showed some deviation from ambient conditions. Recorded levels of carbon dioxide in boreholes BMW2, BMW3 and BMW4 ranged from below 1 % to 3.87 % by volume, while oxygen showed some deviations from ambient in these boreholes, the largest being in borehole BMW2 where oxygen levels were recorded at 17.5 % during the month of November 1998.

10.6.13 The mot significant recorded levels of carbon dioxide and oxygen where from Borehole BMW1. Carbon dioxide levels in BMW1 were consistently above 0.5 %, ranging from 0.66 % to 7.24 % by volume. Oxygen levels were found to be reduced below 18 % on three of the four monitoring events, ranging from 20.5 % to a low of 15.3 % by volume.

10.6.14 The information presented in Table 10.3 has been collected over a limited, four-month period. As such an interpretation of the nature of landfill gas behaviour in this area should be viewed accordingly. However, it is indicated that methane migration is limited through the natural bedrock although deviations from ambient levels were recorded for carbon dioxide and oxygen indicating a need for careful consideration of potentially asphyxiating conditions for construction workers in confined, underground spaces. This issue is discussed further in Section 10.8.

10.6.15 Given the high levels of methane recorded in the waste and at borehole GW4 situated at the waste boundary (between the waste and the proposed development), the landfill is considered to be a major source of LFG. However, it is noted that these levels of methane have been recorded in monitoring wells before the commissioning of the landfill gas extraction system constructed under the ULRC. Following a review of the landfill gas management system proposed by the Restoration Contractor it is considered that when fully operational, this system effectively reduces the classification of the landfill to one of Medium Source.

10.6.16 This should be confirmed by continued monthly monitoring, of both the existing well GW4 and the four additional wells BMW1 to BMW4, prior to the detailed design.

Identification of Pathways

10.6.17 The potential pathways by which LFG may migrate, fall into three categories:

(i) Man-made pathways - Including service ducting, tunnels and culverts

(ii) Natural pathways - Including porous soil, planar openings such as joints, and geological faults

(iii) A combination of natural and man-made pathways.

The potential pathways are discussed in more detail below:

Man-made Pathways

10.6.18 As-built information for utilities in the vicinity of the landfill has been obtained from relevant Government Departments and private utility companies. The layout of existing and proposed utilities is described in Chapter 2 and shown in the Planning and Engineering Feasibility Study for Development Near Choi Wan Road and Jordan Valley -Technical Report 1. To identify potential manmade pathways for LFG migration, the following utilities have been examined:

(a) Stormwater Drains and Sewers

10.6.19 Jordan Valley Nullah is situated to the south-east of the landfill. It originates from New Clear Water Bay Road and passes through Shun Lee Estate in a culvert before emerging at Jordan Valley Dam. The nullah directs flow south-westward in culverts to an outfall. Other than this watercourse, there are no stormwater drains in the vicinity of the landfill. Currently there is no sewerage within the Study Area as the area is undeveloped.

10.6.20 The information showing the existing sewerage and stormwater drains indicates that the present layout of these utilities is unlikely to serve as pathways for LFG migration. Stormwater and sewerage drainage from the proposed development Sites is unlikely to present new pathways for LFG migration as flows from the sites will be directed away from the landfill to the existing sewerage system in Choi Wan Road.

(b) Telephone cables

10.6.21 Current plans from HongKong Telecom show that there is currently no telephone network in the vicinity of the landfill (except that in Shun Lee Tsuen THA to the north of Clearwater Bay Road). HKTC has confirmed that the proposed development could be served by the existing telephone plant in the vicinity but it is likely that two new telephone broadcasting and electrical (TBE) rooms will be required. The likely location of these rooms is not known at present.

(c) Gas pipelines

10.6.22 Supply and distribution gas mains for the Study Area are those of Hong Kong & China Gas Ltd. Plans show that the existing pipelines are located along the New Clearwater Bay Road and Kwun Tong Road. Except for the supply to Shun Lee Tsuen THA, these mains are outside the 250m Consultation Zone of the landfill. The most likely link for the gas supply to the proposed development is via Choi Wan Road to Site 1. Therefore, there is no potential pathway for gas migration to the development sites via the gas main routes.

(d) Power cables

10.6.23 Record plans of the existing power cables from China Light & Power Co. Ltd, indicate that 11 KV cables are aligned to the south of the landfill in the general vicinity of the NE-SW trending geological fault. This does not offer a direct pathway to the proposed development, although cable routes from the trunk to the site via Site 3b could provide a long / indirect pathway for LFG migration.

(e) Watermains

10.6.24 WSD plans show both fresh and saltwater mains are to the south of the landfill site in the vicinity of the NE-SW trending geological fault. As described for the power cables, connection routes for fresh and salt water from these mains to the development via Site 3b could provide a long / indirect pathway for LFG migration.

(f) Other Utilities

10.6.25 Wharf, Hutchinson and New World Telephone confirmed that there is no existing plant in the vicinity of the development site.

Natural Pathways

10.6.26 The high levels of methane and CO_2 in the south-east part of the landfill suggest that there is potential for LFG to migrate along the NW-SE geological fault which is intersected by another geological fault in the NE-SW direction. These faults are potential indirect and long pathways, particularly if new watermains and power cables are proposed in the vicinity, or the intersect of the NE-SW trending fault. In addition, the NW/SE trending fault appears to interest the north eastern boundary of the development site in the vicinity of site 4/5. This presents a long direct pathway. Cross sections of the geology in the area where the NW/SE trending fault crosses the landfill site in the vicinity of the development sites are shown in Figures 10.1a and 10.1b

10.6.27 The existing information on groundwater levels show that groundwater in the rock strata surrounding the main waste platform is generally at a depth 6 to 8m below the ground surface. The ground water will impede the migration of LFG thereby acting as a natural form of barrier to gas movement towards the development sites. Information on the actual degree of saturation in the ground is not available. As only slight water seepage was detected on the rock face at Flathill Quarry, this observation suggests that the groundwater levels may vary within the Study Area.

10.6.28 Leachate levels within the wastes are high and subject to fluctuations of around 5m. In general, for unlined but capped landfills, fluctuations in the levels of leachate can force landfill gas along paths of least resistance and has been known to exacerbate migration along highly fractured fault zones where these break the surface beyond the waste boundary. As the major faults in the Study Area do not directly cross the development site and the Restoration Contractor will manage the leachate levels, this is not considered likely.

10.6.29 The distance between the edge of the landfill to the nearest development Sites is about 250m and to the proposed District Park, around 100m. The rock stratum (fine to medium grained granite) is considered to be of low permeability for significant gas migration. Joints in the Study Area could be pathways for gas to migrate along; although the recent joints survey at Flathill Quarry showed that joints are predominantly closely spaced with weathered infills with only slight water seepage through the joints.

10.6.30 The minor intrusions are relatively fresh. The young rock is unlikely to be permeable enough to act as a significant LFG migration pathway. Cross sections of the geology in the area where the north-west/south-east trending fault crosses the landfill site in the vicinity of the development sites are shown in Figures 10.1, 10.1a and 10.1b. Figure 10.1a, shows a cross section concordant with the general alignment of the fault. As noted, the general alignment of the fault is found to be uncertain and there is no evidence on the ground, which allows a more precise delineation of the fault. The boreholes confirm that the rock is of low permeability granite and the measured groundwater in borehole BMW1 is at around 120mPD, a similar elevation to the landfilled waste.

10.6.31 The cross section shows that the landfill waste rises to an elevation of around 120mPD, the hillside separating the waste from the development site rises to around 180mPD, with a distance separation between the waste and the edge of the development site of around 250m. At the development site, the fault appears to follow an approximate line through Site 5, in the vicinity of the proposed electricity sub-station, a distance of around 300m.

10.6.32 Figure 10.1b, shows a cross section at right angles to the north-west/south-east trending. The indicative location of the fault is shown to be in the area to be excavated as part of the cut slope to Site 4. Comparison of Figures 10.1, 10.1a and 10.1b shows that the indicative alignment of the fault, will intercept the edge of the development area in the location of internal access road in Site 4/5.

Analysis of Pathways

10.6.33 Based on the available information it is considered that the potential for migration through the natural ground is limited. Migration of gas in solution is considered to be insignificant, as the groundwater velocities in the vicinity of the landfill are low[1] whilst the high level of leachate in the waste will act as a barrier to gas flow. However, it is noted that under the ULRC, leachate levels in the waste will fall due to the implementation of the leachate management system. The most significant natural pathway is via the geological faults that cross the landfill however the investigation of the exact location of these faults may clearly define where these intersect the proposed development.

10.6.34 The recorded groundwater elevations in the natural ground were recorded at up to 120 mPD similar to those of the landfill. In general, the ground water level will follow the topography of the landform suggesting that as the natural landform rises, the elevation of the groundwater will also rise above the elevation of the waste. In addition, Site 4 where the fault line is shown to cross the boundary of the development is at a lower elevation than both the waste and the groundwater. As methane is lighter than air (and the groundwater will act as a barrier to gas movement), there is likely to be a tendency for any methane to disperse upward away from the development site. Notwithstanding this given that the location of fault line is not certain, the boreholes may be offset from the fault alignment to some degree. As such the potential for migration along the fault cannot be fully determined until detailed SI is undertaken during the detailed design.

10.6.35 Although the potential for migration to development Site 5 is limited and at this stage unquantifiable, if the alignment of the fault is shown to be correct, this does form a potentially direct link to the development site in the vicinity of the electricity sub station. Therefore, this pathway can be classified as *Direct and Long*.

10.6.36 Natural pathways to the proposed District Park are indirect but as the distance from the waste is around 100m, the route is moderately short. Therefore this pathway can be classified as Moderately Short/Indirect.

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[1] Urban Landfills Restoration Study Working Paper No.8.

10.6.37 There are no utilities proposed which will directly link the development area and the landfill site. The freshwater and power supplies are likely to join the development at Site 3b via the existing trunk mains that run across the Study Area from the Jordan Valley North Road. This utility route passes in close proximity to the NE-SW trending geological fault, which in turn intersects with the NW-SE geological fault crossing the landfill site. As such there is the possibility for gas migration to take place via ***Indirect and Long pathways***.

Targets

10.6.38 The proposed development comprises public and private housing blocks, carparks, schools, playgrounds, commercial centres and other community facilities on the development platforms shown in Figure 10.1.

10.6.39 Target elements are usually separated into internal and external areas. The most vulnerable target areas include any freely accessible, poorly ventilated underground rooms, which have a source of ignition and with services directly entering the void space. Significantly, no basement rooms are proposed for the development.

10.6.40 For this development, internal elements sensitive to LFG hazard are those which are closest to the source and can be considered to be elements of the public housing blocks and schools along the boundary of the 250m Consultation Zone. These include ground level rooms, lift shafts as well as transformer, switch and pump rooms directly associated with the development. External areas include trenches and chambers for various utilities, and service manholes.

10.6.41 There are also likely to be additional utility structures as follows:

- Gas - Gas governor kiosks to mediate gas flows
- Electricity - A new 132KV/11KV power sub-station
- Telephone - Two new telephone broadcasting and electrical (TBE) rooms will be required by HongKong Telecom to service the development

10.6.42 The precise requirements and the location of these and other utility buildings will be developed at the detailed design stage.

10.6.43 The area designated for a District Park (at the former quarry to the south east of the landfill) is not expected to include any buildings, which could present a target element.

Analysis of Targets

10.6.44 The sensitivity of the internal building elements of the targets situated on those development Sites closest to the landfill (i.e. Sites 4, 5 and 3b) are considered to be ***Medium.*** This is based on the assumption that there are no underground confined spaces and buildings with rooms at ground level will be designed such that services do not enter directly from the ground.

10.6.45 Utility chambers and manholes often include confined, below-ground voids. They may also contain electrical equipment, which could act as an ignition source. It may be assumed that access to these premises will be restricted to authorised persons who have awareness of the hazards of LFG and have been suitably trained to deal with potentially hazardous situations. Therefore, this target can be considered to be of Medium sensitivity.

10.6.46 Similarly the Electrical Sub station will have a limited access, although confined spaces and below ground voids would not be present. Therefore, this target is considered to be of Medium Sensitivity.

10.6.47 The District Park situated in the former quarry will not include any structures which could confine landfill gas. Therefore, this target is considered to be Insensitive and Exposed.

10.6.48 In addition to the permanent elements of the proposed development, landfill gas may also accumulate in temporary excavations formed during construction. Particular consideration should be given to working practices to minimise and monitor the risk to construction workers.

10.6.49 The landfill gas hazard assessment is summarised in Table 10.4. This concludes that the development is of Medium sensitivity.

10.7 Mitigation Measures

Introduction

10.7.1 A variety of mitigation measures can be adopted to minimise the risk of LFG hazards. As the perceived risk at this stage is not significant, these recommendations are based on passive measures. However, these recommendations should be critically reviewed at the detailed design stage based upon additional monitoring data and any alterations to the design.

Restoration Measures

10.7.2 As discussed, mitigation measures are currently being implemented by the Restoration Contractor to effectively abstract and flare-off the LFG thereby preventing off-site migration.

10.7.3 The on going monitoring programme by the Restoration Contractor should demonstrate that the maximum emission limits are being complied with.

Building Protection Measures

10.7.4 For those buildings around the 250m Consultation Zone, it is recommended that service entry points be located aboveground and all ingress and egress points are sealed off using puddle flanges, sealant and/or membranes. At this stage, further building protection measures are not recommended.

10.7.5 However, in the event that the critical review of the landfill gas hazard assessment indicates that that there is a risk of LFG migration into the development area, building protection measures should be included in the design of the development. Typical passive measures include:

- Gas resistant membranes within floorslab and below ground walls;
- Use of dense, well-compacted reinforced concrete to enhance resistance to gas penetration;
- Avoiding confined spaces at or below ground level;
- Provision of a clear void beneath particularly at-risk elements allowing clear movement of natural air and dilution of any LFG (and/or forced ventilation if necessary); and

Protection of Utilities

10.7.6 Utility companies should be advised of the possible presence of flammable gas in the ground and should take this into account when designing, constructing and maintaining these structures.

10.7.7 Any external manholes or enclosed areas containing electrical equipment, pumps or switchgear should have vented covers to dissipate gas harmlessly to the atmosphere.

10.7.8 Any utilities conduits (such as the water mains or power connections) that are partially routed through areas within the 250m Consultation Zone may require mitigation measures to prevent gas migrating long distances along service ducts and trenches. Actual measures used should be determined at the detailed design stage in consultation with the relevant Utilities companies. At that time, the refinement of the design should allow further consideration of the potential to re-route the utilities such that they do not cross the 250m Consultation Zone. Where this is not a practical approach, a simple cut-off gas barrier should be fitted to the utilities trench in conjunction with suitable venting arrangements described above for manholes.

10.7.9 The cut-off barrier should be installed at the edge of the Consultation Zone. This can be achieved at low cost, through backfilling a length of the trench with an impermeable material such as well-compacted bentonite or clay. Alternatively an HDPE membrane can be fitted in the trench; this should include a collar attachment to seal the interface between the pipe and backfill. Typical details of these methods are shown in Figures 10.3 and 10.4.

10.8 Monitoring Requirements

10.8.1 Detailed recommendations for landfill gas monitoring and audit for this development are presented in the Environmental Monitoring and Audit Manual. Whilst the Restoration Contractor has a comprehensive monitoring programme in place to identify any off-site LFG migration, the effectiveness of the landfill gas management system has not been verified. Therefore, routine monitoring of the proposed development should also be carried out. Ideally this should be compatible with the monitoring carried out by the Restoration Contractor.

Monitoring carried out by the Restoration Contractor

10.8.2 In the event that Performance Requirements for LFG emissions under the Restoration Contract are exceeded during the Defects Correction Period, on-site LFG monitoring will take place weekly until the recorded levels return to less than the specified limits, for three consecutive monitoring events.

10.8.3 Following the Defects Correction Period i.e. the Aftercare Period, the concentration of gases detected in boreholes beyond the landfill site boundary is not to exceed 1% and 1.5% by volume, above the natural background level, for methane and carbon dioxide respectively. These measures will ensure that LFG is effectively controlled and migration beyond the landfill site prevented.

Borehole Monitoring

10.8.4 Routine, monthly monitoring of methane, carbon dioxide, and oxygen should be carried out prior to, during and after construction at the four monitoring wells (BMW1 to BMW4) constructed under this Study to verify that migration does not occur through natural pathways. The monitoring results should be used to confirm the findings of this hazard assessment and identify any additional design requirements that may be needed to prevent LFG ingress.

Monitoring of Construction Works

10.8.5 During construction, excavations of 1m depth or more, should be monitored before entry and periodically during the works. If drilling occurs, the procedures for safety management and working procedures described in the EPD Guidance Note 'Landfill Gas Hazard Assessment' 1997 should be adopted.

Monitoring of Services and Utilities

10.8.6 Following construction, it is recommended that routine monthly monitoring is carried at service voids and utility boxes. The locations of monitoring points should be established based on the detailed design.

10.9 Conclusions

10.9.1 Monitoring data indicates that the Jordan Valley landfill is still producing LFG with hazardous concentrations of methane and carbon dioxide. Under the Urban Landfills Restoration Contract, a comprehensive, landfill gas management system commenced operation in May 1998, and commissioning tests are being carried out as part of a one year Defects Correction Period. Therefore the effectiveness of the landfill gas management system has yet to be demonstrated.

10.9.2 The design of the proposed residential development has been developed to maximise the distance between the development and the landfill. It is situated outside the 50m 'no development zone' and the 250m Consultation Zone. Although the site has three major geological faults, the locations of the two NW/SE trending faults are uncertain, there appears to be no direct pathways to sensitive receivers in the proposed development.

10.9.3 There are a number of at-risk elements such as underground utility trenches to the proposed development, although no sub-surface structures are proposed for the development. The precise routing of services to the development will need to be carefully considered and defined at the detailed design stage, in consultation with the relevant utilities companies. The freshwater and power supplies are likely to join the development at Site 3b via the existing trunk mains that run across the Study Area from the Jordan Valley North Road. This utility route passes in close proximity to the NE-SW trending geological fault, which in turn intersects with the NW-SE geological fault crossing the landfill site. As such there is the possibility for gas migration to take place via a ***long and indirect*** pathway.

10.9.4 Additional boreholes have been constructed as part of a ground investigation for this Study; a six month monitoring programme was commissioned in August 1998. To date, four rounds of monthly landfill gas data have been collected from the boreholes between September 1998 and December 1998 inclusively. The results indicate low levels of carbon dioxide and reduced oxygen levels with very low (0 to 0.12%), trace levels of methane. One possible source of the trace level of methane may be from the natural background. However, continued monitoring of these boreholes will provide further information about the nature of the LFG and its migration potential in the area of the proposed development. The groundwater acts as a natural barrier between the landfill and the proposed development the flow of methane to the development is likely to be small.

10.9.5 On the basis of the recommendation for additional monitoring and the uncertainties regarding the routing of utilities and fault lines etc it is recommended that a Critical Review of the findings of this landfill gas hazard assessment is carried out at the detailed design stage. The purpose of the Critical Review will be to:

- Verify the assumptions made in this LFG Hazard Assessment basing on the interpretation of up-to-date monitoring data at boreholes installed;
- Identify the at-risk elements and review if protection measures are required;
- Identify the existence of new pathways introduced by new services routings

and the like;

- Verify the location of the fault in the vicinity of the Sites 4 and 5; and
- Review the need for any protection measures during construction, and develop protection measures for design and/or future operation/maintence, when required.

When undertaking the Critical Review, particular consideration should be given to the fact that:

(a) elevated concentrations (>1.5 & by volume) of carbon dioxide have been detected at 3 out of the 4 BMW wells which are located at some distance away from the landfill; and

(b) although the Jordan Valley Landfill has been installed with an active gas extraction system and a passive vent trench, it should be recognised that the active system shall be subject to down-time for routine maintenance and that the passive vent trench which is designed as a second line of defence is only installed along the New Clear Water Bay Road.

10.9.6 This qualitative landfill gas hazard assessment concludes that at present the landfill presents a ***Medium*** risk to the proposed development. It is likely that this would be high were it not for the limited pathway opportunities for migration. However, once the effectiveness of the landfill gas management system has been proven, it is likely that this classification will reduce to one of ***Medium/Minor***.

10.9.7 On the basis of the available information, it is considered that the Jordan Valley Landfill does not present an undue hazard to the proposed development. However, a critical review will be undertaken at the detailed design stage to confirm the level of risk assessed and to determine the suitable protective measures to ensure the development is safe.

Table 10.4 Landfill Gas Hazard Assessment Summary

Source	Pathway	Target	Assessment of Risk
Wastes 8 year old with > 65% domestic refuse. Pre-Restoration monitoring programme between December 1994 and August 1996 showed peak methane up to 80% by volume in GW4 situated between waste and development site.	**Natural Pathways** Via fine to medium grained Hong Kong granite with NW-SE trending fault across the landfill site and intersected by another NE-SW trending fault at southeast of the landfill. Joints occur in the granite bedrock (shown on the rock faces at Flathill Quarry) are narrow to tight, infilled with weathered parent materials.	**Residential blocks Electricity Sub Station & Schools** At minimum path length of 250m from the landfill. Ground level rooms, lift shafts as well as transformer, switch and pump rooms directly associated with the development. No underground structures, assumed utilities enter above ground. Target= ***Medium*** Sensitive	***Medium***
Restoration Works completed in May 1998. Includes active extraction/passive venting/HDPE capping / monitoring programme). Performance Requirement to prevent off site LFG migration. Performance limit of 1% v/v CH_4.	For schools which are 250m from the edge of the landfill respectively: Pathway= ***Long/Indirect***	**District Park** No buildings to confine gas ***Target = Insensitive and Exposed.***	***Low***
Reliability of the gas extraction system needs to be established by ongoing comprehensive monitoring programme to detect any migration of gas beyond the landfill boundary in the direction of the new development.	For District Park which is 100m from the edge of the landfill: Pathway= ***Moderately Short/Indirect***	**Utilities** External areas include trenches and chambers for various utilities, and service manholes. Detailed routing and requirements not known Target= ***Medium*** Sensitive	***Medium***
Any migration off-site will be ascertained based on monitoring of additional boreholes BMW1 to BMW4 at locations between the landfill and the development sites. ***Source = Medium***	**Man-Made & Natural Pathways** Via water mains and utilities trenches that route partially within the 250m consultation zone close to SE trending fault. For residential developments ***Pathway=Long/Indirect*** Not applicable for the District Park.		

11 CONCLUSIONS

11.1 Introduction

11.1.1 This Chapter presents the conclusions of the EIA, indicating the major environmental impacts of the proposed development. The conclusions are followed by Table 11.1 which summarises proposed environmental mitigation measures, indicating what measures are required, where they are referred to in the EIA Report, when and where they will be implemented and the responsible party.

11.2 Noise

Construction Phase

11.2.1 The construction of the proposed development is anticipated to last for about 8 years from 2002 to 2009, with development activities being phased. Noise generation will occur, in periods, throughout the entire construction phase. The main receptor areas that could be affected by construction noise are the existing residential and school developments.

11.2.2 Where adverse impacts are predicted, practicable mitigation measures such as "quiet"/alternative powered mechanical equipment and temporary noise barriers are proposed. The residual noise impacts with the incorporation of the proposed noise mitigation measures would meet the EIAO-TM daytime criteria. Alternative methods for noise reduction and control will be incorporated in the design and construction contract clauses.

Operational Phase - Road Traffic Noise

11.2.3 Traffic noise is a key environmental issue and constitutes the major environmental impact on the proposed development in Jordan Valley.

11.2.4 Exceedances of the HKPSG traffic noise limit L10 (peak hour) 70 dB(A) for residential receivers and L10 (peak hour) 65 dB(A) for schools are predicted in all of the planning areas. In particular, calculations indicate a high level of noise associated with existing roads at sensitive receivers which are located close to the roads.

11.2.5 The predicted results indicate that the exposed NSRs on the periphery of the proposed site are expected to be affected by traffic noise from the heavily trafficked existing roads such as Kwun Tong Road and New Clear Water Bay Road. Mitigation measures, using vertical barriers within the development have been considered to reduce the traffic noise levels at sensitive receivers within the proposed development but are evaluated to be ineffective. Building set-back, orientation, cantilevered barriers set atop building podiums and integrated decking design have also been considered to mitigate road traffic noise impacts. However, these direct technical remedies were found to be ineffective or impractical in many locations due to site constraints.

11.2.6 As all practicable effective noise mitigation measures have been exhausted, the residual impact is to be abated with indirect mitigation measures in the form of window insulation and air conditioning.

11.2.7 The modelling results show that the proposed development, with its proposed new roads, is unlikely to cause significant noise impacts on the off-site existing NSRs. Existing roads provide the most significant noise contribution. In addition, direct mitigation measures on new roads has been exhausted and the predicted results indicate that contribution from new roads to the overall noise levels at the existing NSRs is less than 1 dB(A), the existing NSRs would therefore not be eligible for indirect technical remedies.

Industrial Noise

11.2.8 Fixed plant noise will be emitted from the proposed electric sub-station, generators and transformers in Site 5. With the use of effective noise control equipment and proper design of the plant, the associated noise impacts at the identified noise sensitive receivers are expected to comply with the EIAO-TM requirements.

11.2.9 A fire sub-station has also been planned in Site 5. Noise assessment indicates that daytime and evening operations at the fire station would not result in exceedances of the EIAO-TM criteria.

11.3 Air Quality

Construction Phase

11.3.1 Based on the results of the air quality impact assessment, no significant dust impact on the ASRs and surrounding environment is anticipated to threaten the relevant AQO or acceptable criteria of TSP and RSP provided that implementation of effective dust mitigation measures are followed. Moreover, some site specific mitigation measures are also proposed such as a conveyor belt to transport fill material to SEKD to reduce vehicles travelling within the site such that significant reduction of dust generated from vehicles travelling can be achieved.

11.3.2 Particulate (TSP and RSP) monitoring and audit programme should also be included to provide information regarding the effectiveness of dust suppression measures; the actual dust exposure of the ASRs; and the requirements of further dust suppression measures if necessary.

Operational Phase

11.3.3 From the modelling exercise using Caline4 for the traffic air assessment, there are no predicted exceedances of 1 hour AQO for NO_2 and 24 hour AQO for RSP at planned ASRs.

11.3.4 According to the modelling results of ISCST3, it is concluded that industrial sources and the landfill gas flare will not pose unacceptable air quality impact on the planned ASRs.

11.3.5 By considering the prediction from different models, it is concluded that the combined sources during the operational phases are unlikely to pose unacceptable air quality impact on the planned ASRs.

11.4 Water Quality

Construction Phase

11.4.1 Chapter 5 illustrates that construction and operation of the development has the potential to impact upon the water environment. The sensitive receivers at most risk are the existing surface water drainage system which includes the Jordan Valley Nullah and Choi Wan Road drainage system, the trunk sewerage system and the receiving marine environment (i.e. Kai Tak Nullah Approach Channel and Victoria Harbour). The main conclusions of the water quality impact assessment are given below.

11.4.2 During construction the greatest potential for adverse impacts on the aquatic environment is from the discharge of silt-laden sediment into the surface drainage and trunk sewer system. If good site management practices (as detailed in ProPECC PN 1/94) prevail to remove suspended solids prior to discharge, adverse impacts on the drainage/sewer systems and the receiving marine environment are not anticipated.

11.4.3 Impacts related to the on-site generation of sewage can be mitigated through the supply of temporary facilities or the use of facilities currently available at the CITA site.

11.4.4 The development site is not considered to be at risk from leachate breakout or leakage given that the site is hydraulically separated from the Jordan Valley Landfill with groundwater movement being away from the development site.

11.4.5 The major effluents that have the potential to impact upon water quality when the development is occupied includes surface run-off and sewage effluents.

Operational Phase

11.4.6 The proposed housing development comprises some 11,120 flats with a population of 35,066. The sewage generated by the Choi Wan Road/Jordan Valley development is estimated to have a BOD load of approximated, 1,690 kg/day. In order to prevent adverse environmental impacts an additional sewer connection is recommended with flow being directed towards the Kwun Tong Screening Plant. Upon implementation of the SSDS this sewage will be conveyed to Stonecutters Island for treatment.

11.4.7 The proposed land development will increase the amount of surface run-off entering the drainage system. This surface run-off is estimated to result in the discharge of approximately 41 kg of BOD to Victoria Harbour a day. This additional BOD load is not considered to be significant with respect to the other identified pollution sources entering Victoria Harbour in the south-east Kowloon area. Water quality impacts resulting from the additional surface water run-off is not expected to be apparent, nevertheless specific preventative measures and control measures are detailed in Chapter 5. If the sewerage upgrading works to be recommended in the "Review of Central and East Kowloon Sewerage Master Plans" cannot be completed in time to meet the population intake of the development, the Civil Engineering Department will provide interim measures such as the use of holding tanks to ameliorate the impact.

11.5 Waste Management

11.5.1 Provided that waste arisings from the construction of the proposed development are handled, transported and disposed of using approved methods as described in Chapter 6 of this EIA, no unacceptable adverse environmental impacts are envisaged. In most cases the waste material can be easily re-used at public filling areas or disposed of to landfill.

11.5.2 The mitigation measures recommended should be incorporated into Contract Specifications and applied to ensure that environmental nuisance does not arise from the storage, transport and disposal of the various types of waste arisings from this proposed development. These recommendations will form the basis of the site waste management plan to be developed at the detailed design stage.

11.5.3 When the proposed development is occupied domestic waste arisings will be disposed of to landfill. However, measures to encourage reducing, reusing and re-cycling waste, are recommended. No unacceptable adverse environmental impacts are envisaged.

11.6 Land Contamination

11.6.1 A desk study in accorance with ProPECC Note 3/94 has been undertaken. The potential for contamination at Flathill quarry is considered minimal. There is no reason to suspect that any undocumented activities with the potential to contaminate the area have been carried out either at, or adjacent to the quarry. Therefore, no further investigations are recommended.

11.7 Landscape and Visual Impacts

11.7.1 As outlined in Chapter 8, landscape and visual impact issues have played an important role in dictating the form of the development. Several fundamental measures have been included in the MLP to minimise the impact of this large scale development.

11.7.2 The development of the Study Area will have a significant impact on the character of the existing landscape which, although disturbed, has considerable local and regional importance. As part of the development of the site, the main landscape features have been retained and will form an integral part of the landscape framework. The landscape framework, as developed in the Landscape Master Plan, demonstrates an opportunity to improve the overall amenity of the area for the local residents by improving connections between existing residential areas, through the site to the hillsides, the adjacent planned urban fringe park and open space areas.

11.7.3 The development of this Study Area combined with the density of the development will lead to significant and permanent visual impacts to the VSR's around the Study Area. It will not be possible to fully mitigate these impacts, however measures are recommended in Chapter 8 to minimise the impacts through the design and disposition of the development.

11.8 Ecology

11.8.1 Macro-habitats found within the 100 ha Study Area include plantation, tall shrubland, low shrub with grass, agriculture, marsh, disturbed area and streams. Potential impacts of the project will include loss of 11.5 ha plantation, 4.5 ha tall shrubland, 5.1 ha low shrub with grass, 0.9 ha agriculture and 0.3 ha marsh will constitute the major direct impacts of the project. Loss of plantation and agricultural fields will have a minor impact on flora. Impacts to invertebrate fauna are not likely to be severe due to the commonness of the species recorded. Mitigation measures include compensatory planting on the soft cut slope belt, inclusion of native species in replanting, and establishment of an ecology park on the restored landfill. Further details are given in Chapter 9.

11.9 Landfill Gas Hazard Assessment

11.9.1 Monitoring data indicates that the Jordan Valley landfill is still producing LFG with hazardous concentrations of methane and carbon dioxide. Under the Urban Landfills Restoration Contract, a comprehensive, landfill gas management system has been constructed and commenced operation in May 1998. Commissioning tests are being carried out as part of a 1-year, defects correction period. The effectiveness of the landfill gas management system has yet to be demonstrated.

11.9.2 The design of the proposed residential development has been developed to maximise the distance between the development and the landfill. It is situated outside the 50m 'no development zone' and the 250m Consultation Zone. Although the site has three major geological faults, the locations of the two NW/SE trending faults are shown to be uncertain.

11.9.3 There are a number of at-risk elements to the proposed development, although no sub-surface structures are proposed for the development. The precise routing of services to the development will need to be carefully considered and defined at the detailed design stage, in consultation with the relevant utilities companies. The freshwater and power supplies are likely to join the development at Site 3b via the existing trunk mains that run across the Study Area from the Jordan Valley North Road. This utility route passes in close proximity to the NE-SW trending geological fault, which in turn intersects with the NW-SE geological fault crossing the landfill site. As such there is the possibility for gas migration to take place via a ***long and indirect*** pathway.

In addition, the NW-SE appears to intersect the north eastern boundary of the development in the vicinity of site 4/5, which presents a long and direct pathway. However, the exact orientation of the fault should be established during the detailed design.

11.9.4 Additional boreholes have been constructed as part of a ground investigation for this Study; a six month monitoring programme was commissioned in August 1998. This will provide further information about the nature of the LFG and its migration potential in the area of the proposed development.

11.9.5 This qualitative landfill gas hazard assessment concludes that at present the landfill presents a ***Medium*** risk to the proposed development. It is likely that this would be high were it not for the limited pathway opportunities for migration. However, once the effectiveness of the landfill gas management system has been proven, it is likely that this classification will reduce to one of ***Medium/Minor***.

11.9.6 On the basis of the recommendation for further monitoring and the uncertainties regarding the routing of utilities and the orientation of faults etc, it is recommended that a critical review of the findings of landfill gas hazard assessment is carried out at the detailed design stage. Notwithstanding this, on the basis of the available information, it is considered that the Jordan Valley Landfill does not present an undue hazard to the proposed development.

TABLE: 11.1: SUMMARY OF ENVIRONMENTAL MITIGATION MEASURES FOR DEVELOPMENT AT CHOI WAN ROAD/JORDAN VALLEY

EIA Ref	Environmental Protection Measures *	Location/ Timing	Funding Agent	Implementation Agent	Maintenance Agent	Implementation Stages**			Relevant Legislation & Guidelines
						D	C	O	
NOISE MITIGATION (see Chapter 3)									
3.5.20 – 3.5.27	Construction Noise Mitigation Measures.	All Construction sites	CED	CED & Contractor	N/A	✓	✓		TM on EIA Process, NCO
3.6.27	3 m high sold boundary walls are proposed for the schools.	At school sites during operation	ED	Arch S.D.	Arch S.D.	✓	✓		TM on EIA Process
3.6.29 3.6.30	Indirect Mitigation Measures at identified receivers					✓	✓		
AIR QUALITY MITIGATION (see Chapter 4)									
4.2.8	A Public Transport Interchange (PTI) will be provided for the proposed development. As the PTI is a semi-enclosed facility, adequate ventilation will be provided in the design stage to ensure that the air quality inside will not exceed the relevant air quality guideline limits, as set out in the Practice Note on Control of Air Pollution in Semi-Confined Public Transport Interchanges [ProPECC PN1/98] issued by EPD for the protection of public health.	Future developer at design stage	Future Developer	Future Developer	Future Developer	✓	✓		ProPECC PN 1/98
4.5.25 (I)	Application of appropriate dust suppression measures.	CED & contractor/ All construction sites	CED	CED & contractor	N/A		✓		TM on EIA process, APCO
	Watering of the access roads regularly. Application of suitable wetting agent if necessary during the dry season.						✓		
4.5.25 (IV)	Watering of the stock piles during material handling process.						✓		
4.5.25 (V)									
4.5.25 (VI)	Enclosure on three sides for stock piles.						✓		
4.5.25 (VII)	Suitable chemical wetting agent shall be used, where appropriate, on completed cuts and fills to reduce wind erosion.						✓		

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						D	C	O	
4.5.25 (VIII)	Areas within the Site where there is a regular movement of vehicles shall have a paved surface and be kept clear of loose surface material.						✓		
4.5.25 (IX)	No blasting when Typhoon signal No. 3 or higher is hoisted.						✓		
4.5.25 (X)	Wetting of the blasting areas within 30 m before blasting.						✓		
4.5.25 (XI)	Measures in the conveyor system to reduce dust emission.					✓	✓		
4.5.25 (XI)	Installation of fabric filter system and enclosure to reduce dust emission in transfer points.						✓		
4.5.25 (XII)	Where dusty materials are being discharged to vehicles from a conveying system at a fixed transfer point, a three-sided roofed enclosure with a flexible curtain across the entry shall be provided. Exhaust fans shall be provided for this enclosure and vented to a suitable fabric filter system.	CED & Contractor/ All construction sites.	CED	CED & contractor	N/A		✓		TM on EIA process, APCO
4.5.25 (XIII)	Control of speed limit of the motorised vehicles within the site.						✓		
4.5.25 (XIV)	Construction working areas will be restricted to a minimum practicable size.						✓		
4.5.25 (XV)	The Contractor shall ensure that no earth, rock or debris is deposited on public or private rights of way as result of his activities, including any deposits arising from the movement of plant or vehicles.						✓		
4.5.25 (XVI)	Installation of wheel washing facilities.					✓	✓		

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						D	C	O	
4.5.25 (XVII)	The Contractor shall submit details of the facility; such wheel washing facilities shall be usable prior to any earthworks excavation activity on the site. The Contractor shall also provide a hard-surfaced road between any washing facility and the public road.						✓		
4.5.25 (XVIII)	Removal of spoil or debris as soon as possible to covered areas, stockpiles or the conveyor belt.						✓		
4.5.25 (XIX)	If spoil cannot be immediately transported out of the Site, stockpiles should be stored in sheltered areas.						✓		
4.5.25 (XX)	Regular inspection and maintenance of the plant machines and vehicles.						✓		
4.5.25 (XXI)	Hydro-seeding of the exposed earth after the end of the works (where applicable).					✓	✓		
4.5.25 (XXII)	24-hr and 1-hr TSP monitoring at selected sensitive receptors.					✓	✓		

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						D	C	O	
WATER QUALITY MITIGATION (see Chapter 5)									
2.6.21	The sewerage connection from this site to Kwun Tong Road Trunk Sewer must be completed in advance of the commencement of the site formation works.	before occupation	CED	CED & Contractor	DSD	✓	✓		TM on EIA process
5.6.2 (i)	Perimeter cut-off drains to direct off-site water around the site. Channels, earth bunds or sandbag barriers should be provided on site to direct storm-water to such silt removal facilities.	CED & contractor/ All construction sites	CED	CED & contractor	N/A		✓		TM on EIA process, WPCO Pro PECC PN 1/94
5.6.2 (ii)	Sediment basins of approximately 6-8 m^3 capacity for removing suspended solids from stormwater runoff prior to discharge to stormwater drains					✓	✓		
5.6.2 (iii)	Appropriate construction works programming to avoid surface excavations during the rainy season.						✓		
5.6.2 (iv)	All exposed earth areas should be completed and revegetated as soon as possible after earthworks have been completed, or alternately, within 14 days of the cessation of earthworks where practicable.						✓		
5.6.2 (v)	Earthworks final surfaces should be well compacted and subsequent permanent works or surface protection should be carried out immediately to prevent rainstorm erosion.						✓		
5.6.2 (vi)	The overall slope of the site should be kept to a minimum to reduce the erosive potential of surface water flows and all trafficked areas and access roads protected by coarse stone ballast.					✓	✓		
5.6.2 (vii)	Silt contained in ground water and drilling water collected from boring operations, tunneling, dewatering should be removed with properly designed silt removal facilities, such as the specified portable sedimentation tanks referred to above, such that TM standards are achieved prior to the discharge of waters into storm drains.						✓		

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						D	C	O	
5.6.2 (viii)	All drainage facilities and erosion and sediment control structures should be regularly inspected and maintained to ensure proper and efficient operation at all times, particularly following rainstorms. Deposited silt and grit should be removed regularly and disposed of by spreading evenly over stable, non-sensitive vegetated areas.						✓		
5.6.2 (ix)	Measures should be taken to minimise the ingress of site drainage into excavations. Water pumped out from trenches or foundation excavations should be discharged into storm drains via the silt removal facilities.	CED & contractor/ All construction sites	CED	CED & contractor	N/A		✓		TM on EIA process, WPCO, Pro PECC PN 1/94
5.6.2 (x)	Any leachate encountered on site should be collected and transferred to the Jordan Valley Landfill leachate treatment facility. Collected leachate should not be mixed with cleaner effluents such as those generated during dewatering etc.					✓	✓		
5.6.2 (xi)	Open stockpiles of construction materials (e.g. aggregates, sand and fill material) of more than $50m^3$ should be covered with a tarpaulin or similar fabric during rainstorms. Measures should be taken to prevent the washing away of construction materials, soil, silt or debris into any drainage system.						✓		
5.6.2 (xii)	Manholes (including newly constructed ones) should always be adequately covered and temporarily sealed so as to prevent silt, construction materials or debris being washed into the drainage system and storm run-off being directed into foul sewers. Discharge of surface run-off into foul sewers must always be prevented to avoid overloading the foul sewerage system.						✓	✓	
5.6.2 (xiii)	All vehicles and plant should be cleaned before leaving the construction site to ensure no earth, mud and debris is deposited on roads. An adequately designed and sited wheel washing bay should be provided at every site exit and wash-water should have sand and silt settled out and removed at least on a weekly basis to ensure the continued efficiency or the process.						✓		

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						D	C	O	
5.6.2 (xiv)	Water used for construction purposes on site should, as far as practical, be recycled for use.						✓		
5.6.2 (xv)	Information detailing storm run-off and wastewater discharge points, and the corresponding maximum (or range of) volumes of discharges expected from the construction sites on a dry day should be provided in the WPCO license application.						✓		
	On site sewerage facilities shall be provided for site workers.	CED & contractor/ All construction sites	CED	CED & contractor	N/A		✓		TM on EIA process, WPCO
5.6.5 - 5.6.9	New sewer is required to connect the development area to the existing system.								
5.6.17 (I)	Routine road cleaning of existing highways around the Site.							✓	
5.6.17 (II)	Inclusion of buffer zones around drains.						✓		
5.7.1	Monitor wastewater run-off to assess compliance with the Technical Memorandum of Effluent Standards and any applicable discharge licenses issued under the WPCO.						✓		
5.6.17 (III)	Reduce potential for contaminant spills by keeping petrol and filling stations out of development area.	Design stage of the PFS	PFS operator	PFS operator	PFS operator	✓			TM on EIA process, WPCO
5.6.18 (I)	Where feasible inclusion of infiltration devices in areas of porous ground.	Development site / design & operational stage	Future developer of the site	Future developer of the site	Future developer of the site	✓		✓	TM on EIA process, WPCO
5.6.18 (II)	Oil/grease/sediment traps included in design.					✓		✓	
5.6.18 (III)	Filter strip and grass swales in road medians.					✓		✓	
5.6.18 (IV)	Emergency Spill Response procedures developed for accidental spillages.					✓		✓	

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						D	C	O	
WASTE MITIGATION (see Chapter 6)									
6.4.17 – 6.4.19	The design and alignment of the conveyor system shall be subject to review at the detailed design stage.	CED & contractor/ All construction sites	CED	CED & contractor	N/A	✓	✓		TM on EIA process, WDO
6.5.2 - 6.5.4	C & D materials should be reduced, recycled or reused wherever possible. If wastes cannot be recycled then the recommended disposal routes should be followed.						✓		
6.5.5 (i - v)	Waste should be separated by category on-site.						✓		
6.5.6 (i)	Public fill material should, if possible be re-used on site.						✓		
6.5.6 (ii)	If excess public fill (including inert C & D waste) cannot be used on site it should be the aim to dispose the material at reclamation sites (i.e. the SEKD) or a public filling area.						✓		
6.5.6 (iii)	C & D waste should be disposed of at a public filling area or landfill.						✓		
6.5.6 (iv)	Chemical Waste as defined by *Schedule 1* of the *Waste Regulations (Chemical) 1992*, should be stored in accordance with approved methods defined in the Regulations and the chemical waste disposed of at the Chemical Waste Treatment Centre located at Tsing Yi.						✓		
6.5.6 (v)	Municipal waste refuse should be disposed of at a landfill.	Operation stage	Land owner	Land owner	Land owner			✓	TM on EIA process, HKPSG
6.5.9 (i)	Wastes should be handled and stored in a manner which ensures that they are held securely without loss or leakage thereby minimising the potential for pollution.							✓	

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						D	C	O	
6.5.9 (ii)	Only reputable waste hauliers authorised to collect the specific category of waste concerned should be employed.	CED & contractor/ All construction sites	CED	CED & contractor	N/A		✓		TM on EIA process, WDO
6.5.9 (iii)	Removal of demolition wastes should coincide with the demolition work.						✓		
6.5.9 (iv)	Appropriate measures should be employed to minimise windblown litter and dust during transportation by either covering trucks or transporting wastes in enclosed containers.	CED & contractor/ All construction sites	CED	CED & contractor	CED & contractor		✓		
6.5.9 (v)	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)* and the *Crown Land Ordinance.*						✓		
6.5.9 (vi)	Collection of municipal wastes should be carried out daily.						✓		
6.5.9 (vii)	Waste should only be disposed of at licensed sites and site staff and the civil engineering Contractor should develop procedures to ensure that illegal disposal of wastes does not occur.						✓		
6.5.9 (viii)	Waste storage areas should be well maintained and cleaned regularly.						✓		
6.5.9 (ix)	Records should be maintained of the quantities of wastes generated, recycled and disposed, determined by weighing each load or other methods.						✓		
6.6.14 - 6.6.15	RCP should be designed to minimise adverse environmental impacts.	Operation stage	USD	USD	USD	✓	✓		
6.6.16	In order to reduce the amount of waste being sent to landfill, waste recycling (such as newspapers and cans) should be encouraged at the RCP.							✓	TM on EIA process, HKPSG

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						D	C	O	
LANDSCAPE AND VISUAL IMPACT MITIGATION (see Chapter 8)									
8.11.2 – 8.11.3	Adopt alternative school layouts in sites 4 and 5 to reduce the slope works on the ridgeline	Plan D at design stage	ED	Arch S.D.	Arch S.D.	✓			TM on EIA process
8.11.4 - 8.11.5	Mitigation of earthworks and site formation: Visual impact of earthworks on pedestrians should be mitigated using hoarding. Permanent landscape works should be carried out on the slopes as they are formed.	CED & contractor/ All construction sites	CED	CED & contractor	CED	✓	✓		TM on EIA process
	The site formation should be designed to blend into the natural landform. This may involve rounding the edges of site formation to improve the overall appearance of the site.					✓	✓		
8.11.6 - 8.11.10	Treatment of the rock slopes: The site formation will result in the formation of large rock cut slopes at the "back" of all the developments. Consideration must be given to the appearance of these slopes as well as ensuring their safety. An integrated geotechnical and landscape design solution is required.					✓	✓		
	Should shotcrete be required to stabilise the slopes, coloured dyes should be applied to mitigate its appearance.					✓	✓		

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						D	C	O	
8.11.10	Planters should be established on benches on the cut slopes so that small trees, shrubs and trailing plants can be established to minimise the visual impact of the rock slopes to the local residents and from more distant viewpoints.	Operation of the site	CED	CED & Contractor	USD	✓	✓		TM on EIA process, WBTC, No. 24/94
8.11.11 – 8.11.12	General Landscape Mitigation: At the commencement of the site formation, all existing top soil and required volumes of Completely Decomposed Granite (CDG) should be stripped from the site and conserved for future revegetaion					✓	✓		
	Plant material for revegetation of the more natural areas of the site should be based on ecological mitigation principles employing at least 60% native species, where feasible					✓	✓		
8.11.13 – 8.11.14	Reprovision Jordan Valley Morning Walking Trail: Access to the hillsides from the surrounding area should be retained as far as possible during construction. Safety of users must be ensured. The existing Jordan Valley Morning Walking Trail should be diverted and the alternative route signed and, if necessary, a new trail constructed.					✓	✓		
	On completion, a walking trail should be incorporated into the public open spaces and landscape framework as shown on the Master Landscape Plan. On the hillsides, planting alongside the path and in adjacent eroded areas should be included to assist in upgrading the overall landscape of the site.					✓	✓		

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						D	C	O	
8.11.15 8.11.16	Introduction of variation in the height profile: A profile should be developed that responds to the natural backdrop with lower towers located closer to the view corridor and gradually increasing to the north.	Future Developer of the site at the design stage.	Future Developer of the site	Future Developer of the site	Future Developer of the site	✓			TM on EIA process, HKPSG Metroplan
	Where buildings are located on podia, it is possible to reduce their apparent height by incorporating planting at ground level and within the building so that the ground plan is less clearly defined.					✓	✓		
8.11.17	Building colour : As the buildings on the upper platforms will be set against a natural backdrop it is proposed that they should be clad in recessive colours. Blue/grey, brown or darker toned tiles would be favoured.					✓	✓		
8.11.18 - 8.11.19	Full development of the landscape framework: The landscape framework as shown on the Master Landscape Plan should be developed in full. Development of the top of the Service Water Reservoirs should be pursued to make full use of the site and flat areas of open space.					✓	✓		
8.11.20	Road C1 to be designed sympathetically and ACABAS to be consulted.	CED	CED	CED		✓	✓		TM on EIA process
9.6.6	Landscape contractors should be consulted for transplanting of the protected species and provision of native plants, which are in relatively short supply and require a relatively long lead time to produce. The landscape contractor should also be responsible for the planting and maintenance of the plantation for at least 1 year to enhance the survival rate of immature trees. Detailed planting specification and the cost of compensatory planting should be estimated and included in the detailed design phase.	All construction sites at construction and maintenance stages	CED	Landscape Contractor	*AFD, USD & Future Developer*	✓	✓	✓	*TM on EIA Process WBTC No. 24/94*

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						D	C	O	
ECOLOGICAL MITIGATION (see Chapter 9)									
9.7.1	Supervision for hand excavation of any burrows encountered during construction and release of captured animals unharmed in areas secure from disturbance.	All construction sites at construction stage	CED	Environmental Team and Resident Site Straff	N/A		✓		TM on EIA process, WBTC No. 24/94
9.6.4	Avoidance of tall shrubland as temporary works area. Disturbance to be minimised in the remaining habitat.					✓	✓		
9.6.1 - 9.6.3	Compensatory planting and monitoring / maintenance on the 10m belt of soft slope at the upper edge of the rock cut slope including native tree and shrub species.	All construction sites at construction and maintenance stages	CED	Landscape Contractor	*AFD, USD & Future Developer*	✓	✓	✓	*TM on EIA Process WBTC No. 24/94*

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						D	C	O	
LANDFILL GAS MIGRATION MITIGATION (see Chapter 10)									
10.7.4	Service entry points for buildings to be located above ground. Sealing off ingress and egress points using puddle flanges, sealant and/or membranes.	Construction areas as identified in the EIA Reports at construction stage.	Developers / Utility Undertakers	Developer / Utility Undertakers	N/A	✓	✓		TM on EIA process, Pro PECC PN 3/96
10.7.7	Gas venting to utilities structures.					✓	✓		
10.7.8 - 10.7.9	Implement cut-off gas barrier in utilities trenches passing through 250m CZ.					✓	✓		
10.8	Landfill gas Monitoring.	Construction areas as identified in the EIA Reports at construction stage.	CED	CED & contractor (developers and utility undertakers may also be involved when necessary).	N/A	✓	✓		
10.7.5 & 10.9.5	A critical review to conclude whether there is any risk of landfill gas migration into the development area, and determine whether it is necessary to provide suitable protective measures.					✓	✓		

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Appendices A to H are not available at this web site

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