Ministry of Home Affairs & Provincial Councils; and the Western Provincial Council
Government of Sri Lanka

Environmental Assessment of a Landfill Site at Galudupita Marsh, Welisara

April 1994
Ministry of Home Affairs & Provinical
Councils; and the Western Provinical Council
Government of Sri Lanka

Environmental Assessment of a
Landfill Site at Galudupita Marsh,
Walisara

April 1994
Reference 2283

For and on behalf of Environmental
Resources Management

Approved by: [Signature]
Position: [Position]
Date: 12 April 1994

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INTRODUCTION

BACKGROUND

This Environmental Assessment has been prepared by ERM as part of the SWM component of the Colombo Environmental Improvement Project (CEIP), proposed for funding by the World Bank. It has been prepared on behalf of the Ministry of Home Affairs and Provincial Councils (MHA&PC), and the Western Provincial Council (WPC) of the Government of Sri Lanka (GOSL), the project proponents. Coordination of the CEIP is the responsibility of the Metropolitan Environment Improvement Programme of the Ministry of Policy Planning and Implementation (MPPI). The SWM component covers the following activities:

- **Activity 1:** development of a management and organisation structure for municipal solid waste management, including model contracts for private sector participation, proposals for institutional strengthening and the identification of the requirements for solid waste management infrastructure (initially identified as a transfer station and a landfill site). Four district councils will be identified for the introduction of pilot schemes for private sector involvement in waste collection, transfer, recycling and disposal.

- **Activity 2:** geotechnical investigations of sites proposed for the solid waste management infrastructure.

- **Activity 3:** preparation of conceptual designs for the proposed solid waste management infrastructure.

- **Activity 4:** preparation of environmental analyses of sites proposed for solid waste transfer and final disposal facilities and the preparation of an Environmental Impact Assessment (EIA) incorporating the results of Activities 1-6.

- **Activity 5:** development of a strategy for the management of solid (industrial) wastes arising at Biyagama and Katunayake Export Processing Zones (EPZs), including consideration of appropriate disposal options, together with the preparation of conceptual designs and identification of sites for proposed transfer/disposal facilities.

- **Activity 6:** development of a hospital waste management system, including a Master Management Plan and consideration of appropriate transport/disposal options for hospital waste.

At the time of writing, four pilot projects, in three local authorities, for private sector involvement in waste collection have been identified.
together with the preparation of conceptual designs and identification of sites for proposed transfer/disposal facilities.

In addition, as an extension to the above activities, ERM has carried out research into the availability and technical/environmental attributes of six potential landfill sites for the disposal of solid waste arising from the Colombo Metropolitan Area, leading to the identification of the selected site at Galudupita Road, Welisara in the Gampaha district of the Western Province.

An Inception Report covering all the original prescribed activities (Activity 1-6) was submitted by ERM to the GOSL (MEIP/MPPI) and the World Bank in August 1993 (1). Two other reports have also been submitted to date, in October 1993 and March 1994, which provide evaluations of alternative landfill sites for solid waste disposal (2) (3).

The present report is prepared on behalf of the project proponent (MHA&PC and WPC of the GOSL) and provides the final EIA for the landfill site proposed to serve the disposal needs of the Colombo Metropolitan Area over the next 15 years. The EIA report forms the output of Activity 4.

1.2 SCOPE OF THE EIA

The disposal site for solid waste is proposed to be a single landfill site at Galudupita marsh, in the Welisara area, located approximately 10 km north-east of central Colombo. The landfill is planned to have sufficient capacity to dispose of the solid waste arisings from the Colombo Metropolitan Area for at least 15 years. This landfill site is the focus of this draft EIA, within the broader context of solid waste management for the Colombo Metropolitan Area.

The overall solid waste management system will also include one or more transfer stations, through which a proportion of the collected waste arisings will be processed for cost-effective bulk delivery to the landfill site. A transfer station site to serve the landfill has been selected at Baseline Road. Its availability has recently been confirmed by the Colombo Municipal Council (CMC). The potential environmental impact at the transfer station site is addressed in this draft EIA, in the context of road transport of waste to the landfill site, and an environmental review of the overall operation of the site is presented in Annex A.

Over the operational life of the landfill, a variety of factors, including changes to the pattern of waste generation, could indicate the need for further transfer station sites to optimise the overall cost of delivery of wastes...
to the landfill. Site selection criteria and draft Terms of Reference for the studies necessary to identify and investigate such future sites are included in Annex B of this draft EIA.

1.3 APPROACH TO THE EIA

1.3.1 Integration with the Conceptual Design

The initial concept for the design of the landfill site, including the approach proposed to engineer the site and address the key geotechnical, design and operational aspects (see ERM report, dated March 1994 (1)), has been used as the basis of the EIA.

1.3.2 Consideration of Environmental Impacts

The design and method of operation of the site are key factors in establishing the effects which the proposed landfill may have on the local and wider environment. The design and EIA of the landfill site are interlinked, where mitigation of the potential environmental impacts forms an integral part of the design process.

The environmental aspects considered in the draft EIA have been prepared in accordance with the World Bank Operational Directive (OD) 4.01 (October 1991) and the relevant GOSL legislation (2). The description and evaluation of the potential environmental impacts are addressed under the following headings:

- socio-cultural factors;
- hydrogeology and hydrology;
- biological factors (flora and fauna);
- air quality;
- traffic;
- aesthetics;
- noise;

A preliminary environmental review of the proposed site carried out by ERM (3) has identified the key environmental issues related to the development of the landfill site. These issues are given specific attention in this report.

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Public consultation is an essential part of the project planning process, and is a formal requirement in Environmental Assessment, both of the World Bank (1) and of the Sri Lankan Government (2).

- The World Bank requires that public forum meetings are held early on in the project planning cycle to ensure that the views of all affected parties are adequately taken into consideration in the decision-making process. The World Bank also requires that the EA report be placed in a public place so that any interested party may refer to the document.

- Part IVc of the National Environment Act requires that a 30 day consultation period is provided following submission of the draft final EA report for any prescribed development project, and that the report itself is placed in the office of the Central Environmental Authority (CEA), the Project Approving Agency (in this case, the Ministry of Housing, Construction and Urban Development), and the relevant local authority (in this case, the Divisional Secretariat Wattala) for ease of reference (this has now taken place). The disclosure of the EA report is advertised in The Gazette and the local newspapers, and the public are invited to submit written comments to the Project Approving Agency within 30 days. This is a new procedure in Sri Lanka and so far the main respondents are NGOs who take an active interest in new development proposals.

In response to these requirements, a programme of public consultation and disclosure has been developed and implemented by the Ministry of Home Affairs and Provincial Councils. During the course of the site selection exercise and the preliminary environmental review of the selected site, two public meetings have been held by the Divisional Secretariat at Wattala, to which local residents were invited. A record of these meetings is presented in Annex D as part of the ongoing consultation and public awareness campaign.

The meetings were held under the chairmanship of the Secretary to the Ministry of Home Affairs and Provincial Councils (MHA&PC) on the 12th and 22nd of December 1993. The first meeting was attended by approximately 25 people, predominantly residents and business representatives from the local area. After initial opposition to the landfill site, the public realised, from the explanations given, that the landfill will be based on sound scientific and engineering principles and not the usual open dump, commonly in evidence in Colombo. Also, the fact that the site would be available for agricultural and recreational use once the site was closed helped to make the audience more amenable to accept the landfill than before the meeting.


(2) The National Environment Act was passed in 1981. Part IVc (Gazette 772/22) came into force on 24 June 1993, and stipulates the requirement for (i) an EA for prescribed development projects, (ii) the appointment of a Project Approving Agency, and (iii) a 30 day consultation period following submission of the EA report.
At the second meeting, where approximately 30 people were present, the audience were predominantly from a wider area than just the immediate vicinity of the landfill site. After considerable discussion, they agreed on the safety of the engineering design, but voiced serious concerns that the site would not be managed properly. They also questioned why the landfill site could not be situated in part of the uninhabited land in the much larger Muthurajawela marsh area, even though this is an ecologically significant and designated conservation area. The meeting concluded with the public unanimously opposed to the development of the site. Several further meetings will be scheduled as and when the need arises.

There are four particularly important factors to bear in mind when considering public attitudes to the proposed development.

- This was the first time that direct public consultation of this type during the project planning process has been undertaken in Sri Lanka, and the public are not experienced in responding to this situation.

- There is a general lack of understanding about the distinction between a dump and a sanitary landfill, and this is at the root of the majority of objections to the development. Public consultation is also a part of the overall public awareness campaign (see Annex D) and, once this misconception is removed, objections are generally greatly reduced.

- The Galudupita Road Marsh had already been officially designated as land for development by the serving of a Section 2 Notice under the Land Acquisition Act in July 1993, prior to the proposal of a sanitary landfill on the site. Local residents have therefore been aware for sometime that the site would not remain as open marshland.

- The people directly affected by the development of the Welisara site have been designated as priority recipients of community development assistance, and US$ 1 million has been allocated from CEIP funds for the implementation of a Community Development Programme for the area. For this reason public opposition to the landfill development at Welisara has been minimal.

Since preparation of the EIA, a third meeting has been held (9 April, 1994) with the families that are liable to be resettled. This meeting was generally reported to have gone well, with a considerable degree of acceptance achieved amongst residents.

1.5 LAYOUT OF THE EIA

The remainder of this draft report is set out as follows:

- Section 2 discusses the POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK of the EIA process.
• Section 3 describes the ANALYSIS OF ALTERNATIVES to the proposed landfill site, including alternative technical options and the site selection procedure.

• Section 4 provides a DESCRIPTION OF THE LANDFILL DESIGN AND METHOD OF OPERATION, within the overall context of the Solid Waste Component of the CEI project.

• Section 5 provides a DESCRIPTION OF THE WELISARA SITE, including the key existing environmental aspects and conditions.

• Section 6 provides an ASSESSMENT OF ENVIRONMENTAL IMPACTS of the development of the site, and highlights the mitigation measures to be employed.

• Section 7 provides a summary of the ENVIRONMENTAL MITIGATION AND MONITORING PLAN in tabular format, including a description of the mitigation measures that were proposed for the site in Section 6, and recommendations for an ongoing environmental monitoring programme.

• Annex A provides an environmental review of the Baseline Road transfer station;

• Annex B provides generic Terms of Reference for selecting sites and carrying out Environmental Impact Assessment(s) of any future transfer stations that may be required as a result of changes in waste generation patterns or other factors.

• Annex C presents the resettlement plan for the residents of the three small islands of high ground within the Welisara site.

• Annex D presents the public consultation and awareness campaign.

• Annex E provides WASTE ANALYSIS data.

• Annex F provides BACKGROUND INFORMATION on solid waste management in Colombo, by reproducing relevant sections from the Inception Report prepared by ERM in August 1993 (1).

• Annex G provides the details of the SELECTION OF THE WELISARA LANDFILL SITE from a shortlist of 6 sites, by reproducing relevant sections from the site selection report prepared by ERM in March 1994 (2).

• Annex H TRAFFIC COUNT DATA


- *Annex I* OFF-SITE HYDROLOGICAL IMPACTS OF LANDFILL DEVELOPMENT.

- *Annex J* PROPOSAL FOR THE ESTABLISHMENT OF AN ENVIRONMENTAL UNIT WITHIN THE WESTERN PROVINCIAL COUNCIL

- *Annex K* LIST OF REFERENCES and other sources used in the preparation of this report.
POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

INTRODUCTION

This section presents a summary of the policy, legal and administrative framework governing environmental management in Sri Lanka, and the EA process in particular.

LAWS GOVERNING EA OF DEVELOPMENT PROJECTS IN SRI LANKA

The key legislation governing Environmental Assessment in Sri Lanka is contained largely within the Acts listed below:

- Urban Development Authority Law No. 41 of 1978;
- National Environment Act No. 47 of 1980 as amended by Act No. 56 of 1988;
- National Environment (Procedure for Approval of Projects) Regulations, No. 1 of 1993, Gazette Extraordinary No 772/22;
- Planning and Building Regulations of the Urban Development Authority (UDA) 1985; and
- Municipal Council By-laws.

The National Environment Act

The National Environment Act was passed in 1980. Part IVc (Gazette 772/22 came into force on 24 June 1993, and stipulates the requirement of (i) an EA for prescribed development projects, (ii) the appointment of a Project Approving Agency and (iii) a 30 day consultation period following submission of the EA report. The Project Approving Agency, are responsible for setting up a Technical Working Group to prepare Terms of Reference for the EIA of the development project, and to review the reports.

Industrial Pollution

All industries having pollution potential must presently be licensed by the CEA, under the Environmental Protection Licensing (EPL) Scheme. This license is issued to industries conforming to the required emission or discharge standards specified in the CEA Regulations (CEAR). Emission standards to control the discharge of air pollutants are being framed at present.

Vehicular Pollution

There are a number of laws in Sri Lanka which relate to vehicle traffic, most notably are the Motor Traffic (Special Provisions) Act No. 60 of 1979 and the Transport Board Law No.19 of 1978. Both contain provisions to control vehicular pollution. Also, the recently formulated 'Clean Air 2000 - Action Plan' has clearly demarcated institutional responsibilities for the management of air pollution from both stationary and mobile sources.
2.4 Solid Waste Management

Solid waste management is covered by National (CEA), Provincial (Western Provincial Council), and Local Authority Legal/Regulations as referred to the 13th Amendment to the Constitution (1987), decentralising power to the provinces and the Provincial Councils Act No 42 of 1987. The Conservancy and Scavenging powers set down for the municipal and urban councils in The Municipal Councils Ordnance (Volume 18 Cap 576-579) of the Legal Enactments of the Democratic Socialist Republic of Sri Lanka 1980 is concerned with solid waste management. In this, the municipal and urban councils have powers to collect and dispose of waste, that such waste is the property of the councils and that they have the power to sell or dispose of all such matter and retain any income therefrom, (XVII/38, paragraphs 129,130 and 131).

2.3 INSTITUTIONAL STRUCTURE RELATING TO ENVIRONMENTAL PROTECTION

The institutional framework for the protection and management of the environment has four levels, as shown in Table 2.3a. These are summarised in turn in the sections below.

2.3.1 National Government Level

Central Government Ministries are responsible for setting broad national and sectoral policies for execution by line agencies. Some of the main Ministries with a role in the inter-sectoral co-ordination of environmental issues include:

- Ministry of Policy Planning and Implementation (M/PP&l);
- Ministry of Environment and Parliamentary Affairs (M/E&PA);
- Ministry of Industries, Science and Technology (M/IS&T);
- Ministry of Housing, Construction and Urban Development (M/HC&UD);
- Ministry of Power and Energy (M/P&E)
- Ministry of Lands and Land Development
- Ministry of Forests, Irrigation and Mahaweli Development (M/LI&MD);

2.3.2 Government Agencies and Departments, Level two

At the second level there are a large number of Government Agencies entrusted with specific responsibilities with respect to a wide variety of sectors. Important agencies with a role in urban environmental planning, monitoring and implementation include the following:

- National Planning Department (NPD);
- Central Environment Authority (CEA);
- Urban Development Authority (UDA);
Table 2.3a

PRESENT OVERALL INSTITUTIONAL FRAMEWORK FOR THE MANAGEMENT OF THE ENVIRONMENT

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**Agencies/Depts., Planning, Implementation and/or Maintenance**

**Research and Monitoring**

**Provincial Level**

Western Provincial Council

**Local Government Level**

MCs, UCs, PSs

**Donors**

UNDP, World Bank, JICA, CIDA, USAID, NORAD, Dutch Assistance

**Private Sector and NGOs**

SLEC, EFL, WLNPS/SL, MIC, SLAAS

**Source:** Institutional Arrangements for Urban Environmental Management
The National Planning Department

The NPD is responsible for evaluation of Government development projects. It has wide powers within the Government decision making structure to seek clarification, call for accounting and guide the project cycle.

Urban Development Authority

The UDA, under the Colombo Master Plan (CMP), has identified the Colombo Urban Area (CUA) and the Colombo Metropolitan Area (CMA) as a primary focus of its activities and is the main agency involved in the execution of development projects. The Authority is responsible for providing standards on buildings, zoning, controlling pollution and maintaining environmental quality.

The Board of Investment

The Environmental Unit of the BOI is responsible for ensuring that environmental management functions are properly integrated within BOI planning activities. The BOI has the authority to license industries and monitor waste prior to disposal.

The National Building Research Organisation (NBRO)

NBRO is a semi-Government organisation, also operates under the M/HC&UD. The Environmental Division of the NBRO has facilities to carry out industrial pollution surveys, monitoring of surface and drinking water quality and air quality monitoring.

The Central Environmental Authority

The CEA which falls within the purview of the M/E&PA is the executing agency for the protection and management of the environment, and now acts in the role of an enforcement agency. The CEA has the following divisions concerned with this role:

- Environmental Protection Division is engaged in regulatory activities in relation to the control of pollutants discharged into the environment. This division which deals with promotion of environmental awareness and education and ensuring active public participation in environmental programmes.
- The Natural Resources Management Division is engaged in the formulation and implementation of strategies for the suitable utilisation,
conservation and management of the natural resource base of the country. EIA's come under the responsibility of this division.

The following departments and institutions are responsible for environmental management within the CUA:

- Forest Department
- Department of Wildlife Conservation
- Irrigation Department
- Water Resources Board

The Irrigation Department must be informed of any change in drainage patterns intended in its area of responsibility.

*Semi-Government Institutions*

Under the M/HC&UB is the National Water Supply and Drainage Board (NWS&DB). It is a semi-government institution responsible for the provision of drinking water, sewerage facilities, and the planning and construction of such facilities to residences, industries and commercial establishments within the CUA. The Sri Lanka Land Reclamation and Development Corporation (SLLR&DC), also a semi-Government institution under the M/HC&UB, is responsible for issues involving land reclamation and the maintenance of the canals and water bodies within its area of jurisdiction.

*The National Environmental Steering Committee (NESC)*

The NESC consists of principal policy-makers of key development and resource conservation ministries and agencies. The functions of the committee include: ensuring environmental implications are considered in development projects; providing policy guidance and direction to environmental initiatives, programmes and projects; co-ordinating of different environmental initiatives, programmes and projects.

**23.3 Provincial Council, Level 3**

The third level of government is the Provincial Council (PC) administration which shares the responsibility for the environment with the Central Government. The Colombo Urban Area (CUA) falls within the jurisdiction of the Western Provincial Council (WPC) which is presently in the process of establishing an Environmental Unit. The primary responsibility of this unit is to co-ordinate and manage issues relating to solid waste. PCs have wide legislative and executive power covering public lands, police powers, environment, irrigation, agriculture, etc. Of principal concern to the environment is the Provincial Housing and Construction department, the Agriculture and Agrarian Services and the Health departments.

**23.4 Local Government, Level 4**

The fourth level is the Local Government administration, which include Municipal Councils, Urban Councils and Pradeshiya Sabhas.
The Western Provincial Council (WPC) has been identified by GOSL as the implementing agency for solid waste management in the CMA. It was chosen because of its jurisdiction over the CMC and the other local authorities within the Western Province. However, at the time of identification WPC did not have the technical capabilities to exercise this responsibility and, therefore, a Unit (The Environmental Unit of the WPC) was created (for which details are included in Annex J). The primary responsibility of the Environmental Unit is solid waste management. In the future it is expected that the Unit would also have wider responsibilities for other environmental matters.

2.3.5 Non-Government Organisations

There are well established NGOs involved in diverse environmental issues. Prominent among them are the Sri Lanka Environmental Congress (SLEC), Environmental Foundation Ltd (EFL), March for Conservation (MfC), Sri Lanka Association for the Advancement of Science (SLAAS), Ruk Rekeganno (Save the Trees) and Sevanatha. Most of the NGOs actively participate in bringing about environmental awareness among the public, providing legal assistance to the public, helping in community development projects and in commenting on EIAs. Notably the EFL has been involved in advocating environmental law reforms in different fora. For example, they assisted the National Wetlands Steering Committee, to draft wetlands legislations and advocated reforms in the new EIA regulations drafted by the CEA.

2.4 Private Sector Involvement in Solid Waste Management

The GOSL is examining the potential for privatisation in the waste management sector, initially in solid waste collection, management of the transfer station and the Welisara landfill, and subsequently, a composting plant. Four areas in three local authorities have been identified for pilot projects on privatised refuse collection services and, if these prove successful, the approach will be extended to further local authorities.

The issues raised by involving the private sector in this currently public sector service are being addressed in Activity 1 of this ERM study. The following sections outline the considerations necessary regarding contractual arrangements and related issues.

2.4.1 General Contract Forms

The TOR requires ERM, under Activity 1 to prepare model contracts for various waste management services to be determined during the course of the study. As a precursor to this, we have carried out a preliminary assessment of contract types and procedures which are already in general use in Sri Lanka, on which we aim to base our own model forms.

The Government of Sri Lanka has well established contract procedures, and the Consultants and Contracts working in the country are already very familiar with these procedures and the more common international model
forms of contract are in everyday use. These include the forms issued by the Institution of Civil Engineers in the UK and the International Federation Internationale Des Ingenieurs Conseils (FIDIC). These typically relate to works of civil engineering construction on lump sum and measurement methods of payment.

In addition, the Government has issued guidelines for implementing Build, Own and Operate (BOO) and Build, Operate and Transfer (BOT) contracts for infrastructure development and investment.

2.4.2 Contractual and Institutional Issues

Options

Under Activity 1, ERM will address the various options that are available in the execution of the landfill and transfer station contracts. In the case of the landfill contract these will include design only, design and construct, design construct and operate and design construct operation and restoration variants.

It will also be necessary to address the question of the aftercare of the landfill site and how this is to be managed. Some of these options also apply to the transfer station. In this instance, it will be necessary to debate whether the bulk transfer to landfill should be integrated with or separated from the transfer station operation. The same would apply to other waste management processes such as clinical waste incineration.

A choice will have to be made as to the form of the specification in each case. This can be based on a detailed design or a performance specification laying down a set of guidelines, physical and environmental standards and criteria allowing the tenderer (under supervision) to exercise skill and judgement in complying with the conditions of the contract. Waste collection and cleansing contracts are perhaps the best documented with many hundreds of contracts already operating throughout the world, but ERM will need to consider how these can be sensibly applied, say within a ward or wards of Colombo Municipal Council on an experimental basis.

Institutional Issues Relating to Contracts

• The preferred grouping of the design, construct, operate and other elements of the contract.

• The identification of the Employer (the party to the contract) in each case.

• The necessity for an agreement between the 31 authorities to cooperate in and utilize the contract facilities.

• Any additional principles to be followed in the contractual relationship between the Employer and Contractor.
- Adherence to World Bank guidelines and regulations. The identification of the body to take overall responsibility for all financial and contractual relations with the World Bank.

- The detailed nature of World Bank financial support for the project and access to any Appraisal Reports that have been produced.

- The acquisition of land for the project. The identification of the body to initiate and manage the procedures set out in the Land Acquisition Act 1956 Revision (and later revisions).

- The phasing of capital investments in the landfill site need to be considered. Most landfills require investment for initial development, in set phases during the operation of the site, on completion and restoration of the site and possibly in the aftercare period. Is the World Bank supporting all or part of these investments and in what form?

- It is normal for landfill operating contractors to receive a monthly fee, usually tonnage related and with a fixed and variable element. If the contract is to be for the life of the site, price fluctuation clauses will need to be considered. If the Contract is to fund some capital investments, the costs of these will also need to be reflected in the fees charged. Are these preferred World Bank policies in these matters?

- What systems are to be used and through which parties will World Bank funds be paid to the Contractor? These will need to be defined in the General Conditions of Contract.

**Form of Contract**

There is a considerable amount of common ground in all the contract forms discussed in Section 3.2, relating to the basic laws of contract and the form of the principal clauses and terms. There is nothing to be gained from reinventing them for this particular project. The major effort needs therefore, to be concentrated on the special conditions attached to waste management operations, which makes them substantially different from the construction type contracts that are well known in Sri Lanka. These range from the materials movement, transport and labour dominated features of waste collection contracts to be particular needs of a landfill development and operation contract. Landfill contracts require an appreciation of the contractual implications of site design, development, operation, restoration and aftercare of the site and its potential for long term liabilities to be incurred. In every case, the general and special conditions of contract will require to be supported by carefully framed specifications describing how the works are to be executed. An appropriate method of payment for the contractors will need to be devised.

- The general form of the documents in each case will be:

  - Instructions to Tenderers.
  - General Conditions of Contract.
Special Conditions of Contract.
Specification of the Works and Services.
Schedules of Resources.
Bill of Quantities and/or
Summary of Prices.
Form of Tender.
Appendix to the Form of Tender.
Form of Agreement.
Form of Bonds.
Form of Guarantees.
Appendices and Drawings.

Liabilities

Although strictly not within the scope of this project, ERM considers it prudent to raise the question of liabilities, particularly in respect of landfill operations. Landfill sites can present some unique and long term risks to adjoining landowners, the public at large, as well as surface and groundwaters. These may arise principally through the migration from the site of leachate and landfill gas, but may be compounded by public health risks due to smell, vermin and other manifestations, if the sites are not well managed.

The question arises as to what is an equitable balance and sharing of liabilities between the Employer and the Contractor. These questions of liability caused considerable debate in the recently awarded (1992-1993) strategic landfill contracts in Hong Kong which was on a design, construct, operate, restore and aftercare basis. This will need to be considered on this project by the appropriate departments of Government.

Contractual and Institutional Issues

Under Activity 1, ERM will address the various options that are available in the execution of the landfill site and transfer station contracts. In the case of the landfill contract these will include design only, design and construct, design construct and operate and design construct operate and restoration variants. It will also be necessary to address the question of aftercare of the landfill site and how it is to be managed. A choice will have to be made as to the form of the specification in each case.

Identification of Interested Private Sector Companies

As required by the TOR, we have identified a number (approximately 15) of local private companies who are or may be interested in providing waste management services.
ANALYSIS OF ALTERNATIVES

INTRODUCTION

This section looks at the alternatives available for solid waste management in the Colombo Metropolitan Area. The section provides the following information.

- A description of the quantity and composition of solid waste arisings and the existing waste management system.

- A comparison of the feasibility of alternative options for future waste management, including their advantages and disadvantages, and provides a recommendation for the best practicable option. The options considered are:
  - materials recovery and recycling;
  - composting;
  - incineration (with and without energy recovery);
  - landfill.

- A summary of the selection of the site for the recommended option. Approximately 300 vacant sites within a 35 km radius from the centre of Colombo were identified as potential landfill sites. The National Building Research Organisation (NBRO) prepared a list of approximately 50 sites from this original 300. These were subsequently shortlisted to 6 sites which were further evaluated against a range of technical, logistical and environmental criteria. The sites considered were:
  - Pitumpa;
  - Kerawalapitiya;
  - Hanwella;
  - Hewagama;
  - Morakelle;
  - Welisara;

The key conclusions of the evaluation of options are:

- the development and extension of materials recovery is not feasible;

- composting is not feasible in the short term but, over the medium-long term, it is a potentially viable component of a future MSW management system (1);

- incineration is not feasible;

(1) The project plans to promote composting with private sector involvement. A pilot scale demonstration compost plant funded by USAID has been designed by MEIP and is currently under construction. A market survey which was conducted in 1993 to determine the potential market for compost, has indicated that the plantation sector represents a potential demand of approximately 180,000 MT/year.
• landfilling is feasible, and is the most appropriate technique to be applied in Sri Lanka.

Hence, the Consultants recommend that the disposal option for solid waste is landfill. Through progressive screening of the six potential sites, the site selected for the landfill is Galudupita marsh, in the Welisara area, which has been approved by the Government of Sri Lanka.

Composting is higher in the preferred waste management hierarchy than landfill, with benefits from the production of a useful product (compost/soil conditioner) and, by the use of certain technologies, the generation of a biogas fuel. Therefore, the Consultants recommend that the strategy of establishing economically viable composting in the longer term should continue to be pursued as a complement to landfill.

3.2 CURRENT WASTE MANAGEMENT SITUATION

3.2.1 Previous Studies

A number of previous waste management studies have been carried out in recent years, relevant to the Metropolitan Colombo Area, including two by ERM (formerly ERL) in 1985 and 1987. The most recent and relevant to the present study were carried out by the National Building Research Organisation of GOSL. Four reports have been produced as follows:

• Solid Waste Management in the Greater Colombo Metropolitan Area:
  - Feasibility Study of Rail Transfer to Padukka Site, September 1991.
• Metropolitan Colombo Solid Waste Management Study:

3.2.2 Waste Arisings And Composition

This section gives a detailed description of the main sources of waste which would eventually be handled at the Welisara landfill, namely:

• Municipal Solid Waste (MSW);
• Industrial Waste from Export Processing Zones (EPZs);
• Hospital Waste.

MSW and Similar Commercial Waste

The estimated quantity and typical composition of MSW and similar commercial waste collected in the Colombo Metropolitan Area is summarised in Table 3.2a below. A more detailed analysis is provided in Annex E.
### Table 3.2a

<table>
<thead>
<tr>
<th></th>
<th>Household Waste</th>
<th>Commercial Waste</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Waste Arising</strong>:</td>
<td>1,000 tonnes per day</td>
<td></td>
</tr>
<tr>
<td>MSW and similar commercial waste</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Composition (% by weight)</strong>:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paper</td>
<td>7.0</td>
<td>6.7</td>
</tr>
<tr>
<td>Plastic</td>
<td>5.6</td>
<td>5.2</td>
</tr>
<tr>
<td>Metals</td>
<td>2.0</td>
<td>0.6</td>
</tr>
<tr>
<td>Glass</td>
<td>0.7</td>
<td>0.0</td>
</tr>
<tr>
<td>Organic waste</td>
<td>83.6</td>
<td>86.4</td>
</tr>
<tr>
<td>Other</td>
<td>1.1</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**Sources:**


The NBRO reports estimate that the per capita waste generation rate was 0.98 kg/day in 1990 for the Colombo Municipal Council (CMC) area. Conversations with CMC staff indicated that a figure of around 0.4 kg/day was nearer the current figure (in 1993). The NBRO figure does include the contribution from daily commuters to Colombo, which would inflate the residents' figure. Even so, the figure of 0.98 seems high to the consultants. However, in the absence of more accurate figures, we are basing our estimates of landfill life on this starting figure, together with the NBRO estimated growth rate of 1% per capita per until 2010. Outside the city, we have used a growth rate of 2% per capita per year. A number of waste density figures are quoted in the NBRO reports, ranging from 250 kg/cu m for wastes as collected to 800 kg/cu m for the final density after deposit in the landfill. These figures are reasonable. However, the NBRO figure of 250 kg/cu m for waste during bulk transport from the transfer station is considered too low and a figure of 450 kg/cu m has been adopted in this study for bulk haulage calculations.

**Solid Waste from Export Processing Zones (EPZs)**

In order to promote exports, the GOSL, through the Board of Investment (BOI), established two Export Processing Zones (EPZs) at Katunayake (KEPZ), which is 22.4 km north of Colombo adjacent to the Katunayake International Airport, and at Biyagama (BEPZ), which is 11.2 km east of Colombo in the Malwana area of the Kelani River. Companies within each EPZ enjoy favourable conditions with regard to Inland Revenue, Exchange Control Acts and the Customs Ordinance.
KEPZ and BEPZ give rise to solid industrial wastes and summaries of the waste arisings in the two EPZs are given in Tables 3.2b and 3.2c. Further details of the waste arising from these sources are provided in Annex F. It will be noted that KEPZ is dominated by wastes from garment manufacturers, whilst BEPZ has a wider range of industries and, therefore, of waste products some of which are hazardous and will require special attention.

**Table 3.2b**

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight per day (tonnes)</th>
<th>%age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fabric off-cuts</td>
<td>12.0</td>
<td>60</td>
</tr>
<tr>
<td>Rubber and rubber-based items (synthetics)</td>
<td>3.0</td>
<td>15</td>
</tr>
<tr>
<td>Paper and cardboard</td>
<td>1.6</td>
<td>8</td>
</tr>
<tr>
<td>Putrescible waste (canteen wastes, etc)</td>
<td>1.4</td>
<td>7</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>18</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: Board of Investment of the Government of Sri Lanka.

**Table 3.2c**

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight per day (tonnes)</th>
<th>%age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste rubber</td>
<td>1.5</td>
<td>13.8</td>
</tr>
<tr>
<td>Polythene bags</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Paper/Cardboard</td>
<td>&lt;0.1</td>
<td>2.8</td>
</tr>
<tr>
<td>Wood</td>
<td>&lt;0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Food wastes</td>
<td>1.5</td>
<td>13.5</td>
</tr>
<tr>
<td>Pile clothing</td>
<td>5.5</td>
<td>52.3</td>
</tr>
<tr>
<td>Sponge/Nylon/Plastic</td>
<td>1.1</td>
<td>10.0</td>
</tr>
<tr>
<td>Leather off-cuts</td>
<td>&lt;0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Cotton/Polyester</td>
<td>0.2</td>
<td>2.0</td>
</tr>
<tr>
<td>Cotton wastes</td>
<td>0.1</td>
<td>0.7</td>
</tr>
<tr>
<td>Cashew husk</td>
<td>&lt;0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Tobacco stump</td>
<td>0.5</td>
<td>4.3</td>
</tr>
<tr>
<td>Ink</td>
<td>&lt;0.1</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>10.5</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: Derived from data supplied by the Board of Investment of the Government of Sri Lanka.
**Hospital Waste**

A survey of the arisings of hospital waste in the CMA was carried out by ERM in August 1993 and the results are shown on Table 3.2d. The Colombo General Hospital is by far the largest hospital in the CMA covering an area of 24 ha, with 2,300 beds, and generates almost 1 tonne of hospital waste per day. Waste management practices at the hospital currently fall far below acceptable Western and World Health Organisation standards for the storage, handling, transportation and disposal of clinical wastes. At ward level the segregation of sharps has recently been introduced, although storage is generally unacceptable. Storage is in unlidded standard cardboard containers in which other materials have been delivered, and which can be filled to overcapacity. It is now generally accepted that sharps should be stored in containers made purposely for hospital use which allow used items to be placed into them, but not subsequently withdrawn, and then securely lidded when full. Under the General Hospital Colombo Rehabilitation Project of GOSL, IDA and others, it is understood that a waste separation pilot scheme will shortly be implemented. The objective of the proposal is to separate clinical waste from non-clinical waste at ward/unit level in different coloured polythene bags and then maintain their separation by different handling and storage procedures. Unfortunately, to date, the Ministry of Health and Women’s Affairs have been unable to engage suitably qualified drivers to bring this new transport system into operation.

The bulk of the overall waste stream arising at the hospitals in Colombo consists of non-clinical waste, particularly packaging and food wastes generated by relatives bringing rations to patients. The waste arisings of a clinical nature which therefore require special precautions during disposal, are currently estimated to total approximately 3 tonnes per day (1) (2). An evaluation of the composition of the hospital waste is currently in preparation, with respect to the key materials which require special precautions during disposal, namely:

- **human tissue**, including blood, surgical debris and amputations, used dressings, etc;
- **sharps**, for example, used hypodermic needles, broken glass, etc;
- **disposable medical equipment**, such as contaminated aprons, gloves, etc;
- **disposable urine containers, etc** from infected patients;
- **pharmaceutical wastes**, including spent and out-of-date medicines, etc;
- **special treatment wastes**, such as cytotoxic waste from treatment of cancer;
- **low level radioactive wastes**, from special medical treatments.

At present, much hospital waste is flushed into the sewerage system and does not therefore enter the solid waste stream. The provision of a better collection system may therefore give rise to an increase in the total volumes of hospital waste to be disposed of at the landfill.

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(1) Hospital Waste Management in Sri Lanka, Memorandum to Malcolm Baldwin, leader of NAREPP (Natural Resources and Environmental Policy Project) from members of his International Resources Group, May 1993. NAREPP is a USAID/MEPA project which seeks to improve environmental policy and management in Sri Lanka. The International Resources Group manages the major part of the project.

### Table 3.2d

**Findings of the Survey of Clinical Wastes (August 1993)**

<table>
<thead>
<tr>
<th>Hospital / Type</th>
<th>Number of Beds</th>
<th>Tonnes per Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Hospital, Colombo</td>
<td>2,683</td>
<td>0.9</td>
</tr>
<tr>
<td>Ayurvedic general Hospital</td>
<td>276</td>
<td>0.06</td>
</tr>
<tr>
<td>Castle Street Hospital for Women</td>
<td>416</td>
<td>0.15</td>
</tr>
<tr>
<td>De Soysa Maternity Hospital</td>
<td>336</td>
<td>0.12</td>
</tr>
<tr>
<td>Colombo South General Hospital</td>
<td>624</td>
<td>0.22</td>
</tr>
<tr>
<td>Sri Jayawardenapura general Hospital</td>
<td>876</td>
<td>0.30</td>
</tr>
<tr>
<td>Colombo North General Hospital</td>
<td>1,046</td>
<td>0.33</td>
</tr>
<tr>
<td>Eye Hospital, Colombo</td>
<td>465</td>
<td>0.14</td>
</tr>
<tr>
<td>Cancer Institute, Maharagama</td>
<td>505</td>
<td>0.16</td>
</tr>
<tr>
<td>Fever Hospital, Angoda</td>
<td>272</td>
<td>0.08</td>
</tr>
<tr>
<td>Dental Institute, Colombo</td>
<td>39</td>
<td>0.01</td>
</tr>
<tr>
<td>Police Hospital (New)</td>
<td>125</td>
<td>0.02</td>
</tr>
<tr>
<td>Army Hospital</td>
<td>50 (Est.)</td>
<td>N/A</td>
</tr>
<tr>
<td>Asiri Hospital</td>
<td>102</td>
<td>0.04</td>
</tr>
<tr>
<td>Central Hospital</td>
<td>46</td>
<td>0.01</td>
</tr>
<tr>
<td>Durdans Hospital</td>
<td>123</td>
<td>0.03</td>
</tr>
<tr>
<td>Joseph Fraser Memorial Hospital</td>
<td>18</td>
<td>0.004</td>
</tr>
<tr>
<td>McCarthy Hospital</td>
<td>40</td>
<td>0.008</td>
</tr>
<tr>
<td>Nawaloka Hospital</td>
<td>178</td>
<td>0.07</td>
</tr>
<tr>
<td>Ratnam Private Hospital</td>
<td>63</td>
<td>0.01</td>
</tr>
<tr>
<td>St Michaels Hospital</td>
<td>26</td>
<td>0.005</td>
</tr>
<tr>
<td>Delman Hospital</td>
<td>123</td>
<td>0.03</td>
</tr>
<tr>
<td>St Annes Nursing Home</td>
<td>16</td>
<td>0.004</td>
</tr>
</tbody>
</table>

Source: ERM 1993
3.2.3 Waste Collection

The present system of MSW collection in Colombo has two stages:

- primary collection; and
- secondary collection.

Primary Collection

In the primary collection system, waste is taken from the households by handcarts, operated by local authorities, and deposited at waste collection points. Each neighbourhood is served by its own collection point. Colombo has some 1,004 collection points distributed about the city.

Secondary Collection

The aim of the secondary collection system is to remove the waste from the disposal points and transport it to the disposal site. This is undertaken using a variety of vehicles ranging from 7 or 10 cu m rear-end loading refuse compaction vehicles to side loaders and tractors fitted with trailers. Where containers are used, these are lifted automatically and discharged into the collection vehicle. Normally, some manual clearing is necessary to remove any overspill and garden wastes which could not fit into the containers. Where the waste is in bunkers or on open ground, it is manually handled into the collection vehicle or trailer.

3.2.4 Waste Disposal

A detailed description of current arrangements for the disposal of MSW, similar commercial wastes, solid waste from the EPZs and hospital waste is provided in Annex F.

MSW and Commercial Waste

Currently, MSW and similar waste arising in the Colombo Metropolitan Area is disposed at Wellampitiya landfill site and a number of small, uncontrolled dump sites in the vicinity of Colombo. Around 60 sites in total are operational of which around half are official operations. The vast majority of MSW, including all that arising from the CMC area, is disposed at Wellampitiya. The Wellampitiya site was proposed as a short term (3-5 years) site to demonstrate sanitary landfill practices in Colombo. However, the site preparation and working practices recommended have not been adhered to. As such the Wellampitiya site (as well as around 30 other small dump sites) has not been engineered or operated to modern, international environmental standards, and lacks pollution control and environmental protection measures, such as leachate collection/treatment and landfill gas control. The Wellampitiya site is equipped with a drainage system which collects contaminated rainwater run-off, but the system is open, uncontained and appears to be in continuity with local groundwater. The collected run-off is discharged untreated into a local watercourse.
Wellampitiya is subject to uncontrolled scavenging by the local population, who earn a living from recovering recyclable materials from the waste. Birds and animals (domestic and wild) forage on the site. Urban development is present up to the perimeter of the site, including housing, a school immediately adjacent to the site boundary, and a scavengers' settlement which has become established within the site limits. Operational problems recently encountered at the Wellampitiya include impassable site roads, due to waterlogging in periods of heavy rain, and odour from uncovered waste, due to the lack of suitable materials for use as cover. Wellampitiya and the other dump sites are all associated with significant environmental problems, including pollution of water resources and detriment to local amenity, for example odour, vermin (insects, rats, dogs, cats, etc) and unsightliness.

Solid Waste from the Export Processing Zones (EPZs)

The wastes arising in Katunayake and Biyagama EPZs are disposed at open dumps. One dump is located within each EPZ. The dumps are uncontrolled and are not engineered with any environmental protection measures. Scavenging takes place on both sites, but greater numbers of scavengers work the Katunayake site. The Katunayake site is also commonly on fire, which presents a serious health and safety risk. Katunayake EPZ also has two small, primitive batch-type incinerators ('destructors') located at the dump site. The destructors have insufficient capacity to handle the waste arisings and are not equipped with emissions control equipment. The destructors are unreliable and are frequently not in operation, with the result that most of the waste is dumped.

At Katunayake, women are allowed onto the site on payment of a 15 rupee charge which allows them to scavenge for four hours. They generally scavenge for small pieces of cloth which they make into patchwork for garments and other items. It would appear that there are regularly upwards of 100 scavengers on the site at any one time.

At Biyagama the waste appears to be strewn over a much larger area than at Katunayake, but scavengers are less in evidence and there are no fires at the site. However, the site is extremely unsightly and is currently sterilising (i.e. rendering unusable for other purposes) a large area of land within the EPZ.

Hospital Waste

There is one hospital waste incinerator in Colombo, at Sri Jayawardenapura General Hospital. The incinerator was designed to handle the majority of the waste generated at the hospital. Evidence from ERMs' hospital waste study indicates that the incinerator is not adequately designed and/or operated, such that poor and incomplete combustion of waste generates a continuous plume of black smoke from the incinerator stack.

The remaining waste arisings from other hospitals in the Colombo Metropolitan Area are disposed at Wellampitiya or the other dump sites in the area. Disposal is undertaken with normal MSW, and no special precautions or methods are employed; for example there are no specially
designated areas for hospital waste disposal at the sites and no control of scavenging of the waste. Contact with hospital waste currently presents a serious risk to scavengers.

3.3 'NO ACTION' ALTERNATIVE

The 'no action' alternative is that the existing waste disposal sites (Wellampitya and approximately 30 other small dump sites) continue to be used for the next 15 years.

The 'no action' alternative requires sufficient capacity at the existing waste disposal sites for the next 15 years. However, the Wellampitiya site is expected to have reached its planned design capacity in 1995 and hence, for the 'no action' alternative to be a feasible option, the development of additional disposal capacity is required at either Wellampitiya or one of the smaller dump sites. However, the potential for the availability of additional capacity is restricted by:

- the presence of urban development in the immediate vicinity of the Wellampitiya site: hence, there is no land available for an extension to the ground area of the site;
- the lack of adequate site preparation works and uncertain operational engineering of the existing areas of waste disposal at the Wellampitiya site: land-raising will be difficult and costly to engineer safely, and possibly impracticable due to site instability;
- the 30 (approx.) small dump sites provide only a small proportion of the waste disposal needs for the Colombo Metropolitan Area: the remaining capacity of these sites is not known, due to the uncontrolled nature of the disposal activities undertaken to date, but they are understood to have insufficient capacity, or scope for extension/land-raising, to compensate for the completion of the Wellampitiya site for any significant length of time.

Furthermore, all the existing sites used for disposal of MSW, plus waste from the EPZs and hospital waste, are known to have caused environmental pollution. Any extensions to the sites, particularly Wellampitiya, carry the risk of adding to, and exacerbating, the pollution resulting from the waste disposal activities carried out in the past. The engineering of any extensions to the sites would, hence, require the employment of extensive, and costly, site remediation measures to address the existing environmental problems. For all of the above reasons, it would be very difficult to adapt the existing sites to provide adequate waste disposal facilities for the next 15 years.

Therefore, the 'no action' alternative is not considered to present either a feasible long term solution, or the best practicable environmental option, for the future solid waste disposal in the Colombo Metropolitan Area, for the following reasons:
• shortage of sufficient capacity at the existing disposal sites, particularly at
  the major site at Wellampitiya;

• lack of scope for extension to these sites, particularly Wellampitiya, to
  provide adequate capacity for future disposal operations;

• existing environmental pollution and concerns related to the sites, which
  would require extensive, and, hence, costly remediation for the sites to be
  acceptable for future waste disposal.

3.4 OPTIONS AND TECHNOLOGIES

3.4.1 Choice of Options

There are four primary technical options available for the management of
MSW, EPZ and hospital waste. These are as follows:

• **Materials recovery and recycling**: reusable materials, for example metal and
  glass, are retrieved from the waste stream for reuse, hence producing a
  corresponding reduction in the volume of waste requiring disposal.

• **Composting**: the organic fraction of the waste, for example food waste and
  paper, is biologically decomposed (either aerobically or anaerobically) to
  produce a saleable soil conditioning product and, for anaerobic digestion,
  a biogas fuel. Hence, a reduction is made in the volume of waste
  requiring disposal.

• **Incineration, with or without energy recovery**: waste is burned in a dedicated
  combustion plant to reduce the volume (by up to 90%) and moisture
  content (to a virtually dry condition). With the addition of the
  appropriate technology, heat can be recovered from the incineration
  process to provide a heating and/or electricity supply.

• **Landfill**: waste is placed in an engineered site and covered, whereupon
  internal biochemical processes act to stabilise and break down the waste
  over a period of several decades.

The widely accepted hierarchy of preferred waste management options,
based on the principle of valorising waste and avoiding direct landflling as
far as practicable, is:

• materials recovery and composting;
• incineration with energy recovery;
• incineration without energy recovery;
• landfill.

However, it should be noted that three of the four options, materials
recovery, composting and incineration are only suitable for dealing with
certain components of the overall waste stream. The degree to which they
can reduce the total waste stream depends upon the waste composition, and
the high level of organics in the Sri Lankan waste stream makes composting an attractive option. Nonetheless, none of these options provides a complete solution. In all cases, their application leaves other fractions of the waste stream remaining to be disposed by landfill. Incineration also produces an ash residue, some of which is the result of cleaning the combustion gases (fly ash) and has high concentrations of heavy metals. This ash requires the application of special precautions during disposal. Table 3.4a summarises the types of waste materials which typically remain after materials recovery, composting and incineration have been applied to solid waste.

Modern, integrated MSW management strategies often incorporate several of the above technical options into an overall scheme. For example, materials recovery and composting are undertaken where economic; the reject material is incinerated to recover energy and reduce its volume/moisture content; and, finally, the non-incinerable wastes and incinerator ash are landfilled. In all cases, a universal requirement is the provision of landfill, to provide final disposal of some fractions of the waste stream and unavoidable residues from the materials recovery, composting and/or incineration processes.

The alternatives for solid management in the Colombo Metropolitan Area over the next 15 years are, hence, the development of any combination of the above waste management technologies, at one or more sites. Whatever combination may be chosen, the single common requirement is the provision of new landfill capacity.

Table 3.4a Remaining Types of Waste Materials after the Application of Materials Recovery, Composting or Incineration

<table>
<thead>
<tr>
<th>Process</th>
<th>Remaining Waste Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials recovery</td>
<td>• fraction of the waste stream for which recovery is not feasible (e.g. small pieces of broken glass, soiled plastics, organics etc.)&lt;br&gt;• recoverable materials which are contaminated or heavily soiled&lt;br&gt;• unusable recoverable materials and recoverable materials with no economic market.</td>
</tr>
<tr>
<td>Composting</td>
<td>• non-compostable (inorganic) fraction of the waste stream&lt;br&gt;• compostable materials which are contaminated or heavily soiled, for example with large glass fragments.</td>
</tr>
<tr>
<td>Incineration</td>
<td>• non-combustible fraction of the waste stream, for example building rubble&lt;br&gt;• bulky wastes which cannot be handled by the incinerator furnace&lt;br&gt;• incinerator ash (fly ash and bottom ash/slag).</td>
</tr>
</tbody>
</table>

Government of Sri Lanka (GoSL)
FEASIBILITY OF OPTIONS AND TECHNOLOGIES

A summary of the feasibility of the options for solid waste management in the Colombo Metropolitan Area is shown in Table 3.5a. Each of the options are discussed in turn in the following paragraphs.

Table 3.5a
Summary of the Feasibility of the Options for Solid Waste Management in the Colombo Metropolitan Area

<table>
<thead>
<tr>
<th>Option</th>
<th>Key Factors</th>
<th>Feasibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials recovery</td>
<td>• Already well established in Colombo Metropolitan Area</td>
<td>Not feasible.</td>
</tr>
<tr>
<td></td>
<td>• Very little scope for expansion</td>
<td></td>
</tr>
<tr>
<td>Composting</td>
<td>• No existing operations in Colombo Metropolitan Area</td>
<td>Feasible in the medium and long term.</td>
</tr>
<tr>
<td></td>
<td>• Suitable waste composition (high organic content)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Requires development of markets for compost products</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Strategy for phased development established</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Not suitable for solid waste from the EPZs and hospitals</td>
<td></td>
</tr>
<tr>
<td>Incineration</td>
<td>• Limited existing operations in EPZs and one hospital</td>
<td>Not feasible.</td>
</tr>
<tr>
<td></td>
<td>• Unsuitable MSW waste composition (high organic and low combustible content)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Requires import of technology and expertise</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Reliable, long term operation proven to be difficult</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Expensive to operate</td>
<td></td>
</tr>
<tr>
<td>Landfill</td>
<td>• Existing operation at Wellampitiya</td>
<td>Feasible.</td>
</tr>
<tr>
<td></td>
<td>• Limited technical requirements for development</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Feasibility independent of waste composition - all solid wastes can be handled, with appropriate environmental measures</td>
<td></td>
</tr>
</tbody>
</table>

3.5.1 Materials Recovery

The report on the Metropolitan Colombo Solid Waste Management Study prepared by the Secretariat for Infrastructure Development and Investment (SIDI) of the Government of Sri Lanka (February 1993), concluded that material recycling in the Greater Colombo Municipal Area is currently responsible for a reduction of 28% in the municipal waste stream. This recycling rate is a result of the well-established recyclable market in existence in Sri Lanka, monies gained from which are a major source of supplemental income to the local population. The report stated:
The existing recycling system is responsible for a considerable reduction in the Greater Colombo Municipal Area's waste stream. Only small percentages of recyclable materials were found to be going to landfill for disposal. The recyclable that were in the waste stream consisted primarily of paper that was heavily soiled and has no recycling value.

Only plastic was identified in the report as outstanding as a potential fraction of the waste stream for which material recycling opportunities merit special attention because of its apparently ubiquitous presence at the landfill and its contribution to unsightly littering. However, plastic comprises only 5-7% of the waste stream (see Section 3.2.2), the majority of which is plastic bags and film. The SIDI report indicated that recycling of only 2-3% of this plastic is commercially viable, which constitutes less than 0.1-0.2% of the total waste stream. This situation is similar throughout the Colombo Metropolitan Area.

Therefore, materials recovery in Colombo is well-advanced, and there is very little potential for economically expanding the present system to remove more materials from the waste stream. The development and extension of materials recovery is, hence, not a feasible option for meeting the solid waste disposal needs in the Colombo Metropolitan Area.

3.5.2 Composting

Currently, there is no composting of MSW in the Colombo Metropolitan Area.

The majority of the waste stream sent for disposal is organic and potentially suitable for composting - an average of 83% of household waste and 86% of commercial waste (see Section 3.2.2). This high volume of compostable material establishes composting as a potential option for MSW management. The report by SIDI on the Metropolitan Colombo Solid Waste Management Study (February 1993) recommended that:

*A composting facility should be established in or near the Greater Colombo Municipal Area.*

The report suggested a phased approach, with the ultimate objective of the development of a full-scale composting plant, as follows:

- development of a pilot-scale composting facility (20-30 tonnes per day of waste input, which constitutes 2-3% of the total MSW waste arisings) as soon as practicable (1);

- concurrent with the development of the pilot facility, the undertaking of an evaluation of the markets for compost products (2);

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(1) A pilot-scale demonstration composting plant (10-15 tons/day) at Wellampitiya is currently under construction.

(2) At the time of writing, this market study had just been completed.
on the basis of the technical and economic results of the above, preparation of a full economic analysis of the feasibility of composting, including consideration of different composting technologies and approaches;

assuming that a composting facility is shown to be economically viable, a site investigation and EIA for a full-scale composting facility (250 tonnes per day of waste input, that is 25% of the total MSW waste arisings), together with the preparation of a financing proposal.

The Consultant endorses the conclusions and recommendations presented in the report, and agrees that the apparent suitability and high percentage of organic materials in the waste stream makes composting a potentially viable and favourable option for MSW management for the Colombo Metropolitan Area. However, three comments are relevant:

- For composting to be commercially viable, stable and long-term markets for the compost product must be established in conjunction with the actual composting facilities. The strategy proposed by the Secretariat for Infrastructure Development and Investment addresses this aspect through the adoption of a phased approach to the development of a composting scheme. However, by necessity, the implementation of the strategy is likely to cover several years and, if considered economically feasible, full-scale composting operations are unlikely to start until the medium to long term, well after the completion of the current landfill site at Wellampitiya.

- The current full-scale composting scheme is proposed to handle 250 tonnes of waste per day. This constitutes approximately 25% of the total MSW arising in the Colombo Metropolitan Area. The remaining proportion of the waste arisings will require an alternative disposal outlet. Furthermore, even if the entire MSW stream was subject to composting, alternative disposal would still be required for the 14-17% of the waste which consists of inorganic wastes not suitable for composting, together with the residues/rejects from the compost process.

- Due to the nature and composition of the waste arisings (the low organic content and potential for hazardous materials to be present), composting would not be suitable for application to either the wastes from the EPZs or hospital waste.

Therefore, although composting is potentially a viable component of the MSW management system in the medium term, it is not considered a feasible option either for meeting the major portion of MSW disposal needs of Colombo Metropolitan Area in the shorter term, or, even when fully developed, on its own without supporting facilities to cater for materials unsuitable for or rejected from the composting process.

3.5.3 Incineration

There is no incineration of solid waste (with or without energy recovery) in the Colombo Metropolitan Area, other than the operation of two small
destructors at Katunayaka EPZ and a small incinerator at the Sri Jayawardenapura General Hospital. As a result of their design and mode of working, the destructors and the incinerator are not operated to acceptable environmental standards.

The MSW waste stream has a low proportion (14-15%) of readily combustible material, primarily paper and plastic, and a high percentage (83-86%) of organic material with a high moisture content, as described in Section 3.2.2. Incineration of the bulk of the waste stream will be difficult, if not impossible, to carry out unless co-burnt with support fuels. Overall, the composition of MSW is not appropriate for the application of incineration technology.

The wastes from the EPZs and hospitals are more suitable for incineration, since they contain a significantly higher percentage of combustible material (see Section 3.2.2). From an initial assessment of the various alternatives within Activity 5 three options are under active consideration:

* The construction and operation of a new landfill at each zone to modern acceptable standards
* The construction and operation of a number (minimum two) of small incinerator units at each zone
* The construction and operation of a simple open air, two level compaction transfer station to transport wastes to the Welisara landfill.

Ideally, the preferred disposal route for hospital waste is incineration. Activity 6 is currently considering two key issues:

* the siting of one or more modern clinical waste incineration plants with provision for gas cleaning; and
* the segregation of potentially contaminated clinical wastes from other wastes at ward level.

However, it is not currently proposed to recommend incineration for application as a cost-effective solution for hospital waste in Sri Lanka.

Incineration is a relatively advanced waste management technique, and the record of operation in Sri Lanka, albeit on a small scale, is poor. Hence, its development as a major waste management facility would require the import of plant, equipment and expertise from overseas. Evidence also suggests that the maintenance of an incineration plant in reliable, long-term operation under Sri Lankan conditions is difficult and it would be likely to prove expensive.

Hence, incineration is not considered a viable option for solid waste management in the Colombo Metropolitan Area.

3.5.4 Landfill

Landfilling, albeit below modern international standards, is currently practised at the Wellampitiya site in Colombo. In addition, uncontrolled
dumping occurs at a number of smaller sites elsewhere in the area and within the EPZs.

Worldwide, landfill has traditionally provided the final disposal of components of the waste stream not removed by material recovery, composting and/or incineration, as well as being used as a direct waste disposal route where the above technologies are not practicable or applicable.

The development of landfill capacity requires the engineering of a site to provide containment for the waste. After placement, the waste is covered with an inert material, for example soil; ultimately the site can be restored to a natural outlook or some forms of economic use. In many places, landfills have historically been sited in abandoned quarries and mineral workings, where the deposit of waste has been used to infill the void space and, hence, restore the workings. However, where such void spaces are in limited supply, landfilling directly onto the ground surface to produce an artificial hill (land-raising) has become an established practice. Whereas landfilling results in the infill of an existing void in the ground to its original ground level, a land-raising scheme results in the development of a new permanent topographical feature.

The development of a landfill site has only one requirement - the availability of an appropriate area of land for development of the site. Its technical feasibility is also not restricted by waste composition, and it can be applied to MSW, solid waste from the EPZs and hospital waste (although the nature of the wastes disposed at any site affect the engineering measures, environmental protection and operational practices which need to be employed). In particular, any disposal of hazardous solid waste from the EPZs or hospitals will require special precautions to minimise the potential adverse risks associated with contact with these waste materials.

Hence, landfilling is a viable option for solid waste management in the Colombo Metropolitan Area.

3.6 THE PROPOSED OPTION

Based on the evaluation described in Section 3.5 above, the only feasible option for solid waste management in the Colombo Metropolitan Area is new landfill capacity, and the development of a new landfill site is recommended by the Consultant. This EIA considers the proposal for a new landfill site.

However, it should be noted that composting is identified as a potentially feasible option for longer term development. Composting is higher in the preferred waste management hierarchy than landfill (see Section 3.4) and, therefore, the strategy of establishing economically viable composting should continue to be pursued as a complementary form of waste disposal to help reduce the volume going to the landfill site and prolong its life. The proposed development of new landfill capacity should not adversely affect the future practicability of composting, nor vice versa, and the removal of
organic materials from the waste stream for composting will, in fact, benefit the landfill operation (by reducing leachate generation and extending the life of the landfill site). Nevertheless, it should be noted that, even with a fully-developed composting scheme, the need for landfill remains for disposal of non-compostable materials.

3.7 SITE SELECTION

3.7.1 Background

The National Building Research Organization (NBRO) was commissioned by the Urban Programme Unit (UPU) to undertake a comprehensive study on solid waste management in the Colombo Metropolitan Area (CMA), in 1990. The main focus of the study was to identify suitable land for use as landfill sites for the Colombo Municipal Council and the surrounding local authorities. After screening several hundred potential sites, the NBRO study identified 16 sites that were considered suitable for use as landfills. Of the 16 sites selected, the sites at Hanwella and Welisara were considered to be the sites having the largest void space, thereby placing them high on the list of sites that had the potential of serving the CMA as long-term landfill sites. The findings of the NBRO study were presented to the Government of Sri Lanka (GOSL), in 1992, at which time the site at Hanwella was selected to serve as a long term landfill for the CMA.

However, the site at Hanwella ran into significant public and political opposition virtually from the time of selection. The main causes for opposition to the site, in addition to the ‘Not in my backyard’ (NIMBY) syndrome, was the fact that this site was a few kilometers upstream of the potable water intake at Ambatale, which served as a source of water to part of the City of Colombo. Although a properly engineered sanitary landfill would take adequate precautions to prevent polluting the water source, public perception in Sri Lanka of solid waste disposal is an ‘open dump’. Sri Lanka is yet to have an engineered sanitary landfill. The term ‘sanitary Landfill’ is commonly used for any open dump that uses soil cover on a periodic basis, often once every year. Therefore, when the public of Hanwella were informed that a long term sanitary landfill will be located in the area, they perceived an open dump with occasional soil cover. Significant surface and ground water pollution as well as odour potential are commonly associated with landfill sites in Sri Lanka leading to public reluctance to accept such sites in the vicinity of their residences. In addition, the site at Hanwella serves as a flood retention basin for the Kelani River during heavy rainfall. The public and political leaders of the area had visions of an open garbage dump inundated with water during the floods, upstream of the potable water intake at Ambatale. Thus, significant public and political opposition was experienced at this site. Although attempts, over

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a period of several months, were made to allay the concerns of the public, it proved futile. The political to the site was such that it was virtually impossible to continue exploring the feasibility of this site.

At this stage, the GOSL identified several other sites which were then subjected to an environmental scoping study (conducted by ERM) to assess their potential for use as a long term sanitary landfill site. The six sites that were scoped were Kerawalapitiya, Hanwella, Pitumpe, Hewagama, Morakelle and Welisara.

3.7.2 Review Criteria

The review of the sites considered the following key aspects:

- potential capacity;
- ownership;
- access;
- proximity of habitation and avoidance of involuntary resettlement;
- hydrology;
- geology and hydrogeology;
- biological factors (flora and fauna).

The criteria based on these aspects were as follows:

- **Potential capacity:** the required capacity must be sufficient to cater for solid waste arisings in the Colombo Metropolitan Area from 1995-2010, a fifteen year period. Based on the NBRO estimate of waste arisings, the total capacity of the landfill site is required to be approximately 14 million cubic metres ($14 \times 10^6$ m$^3$).

- **Ownership:** due to the urgent need for the development of a landfill site, the ownership was considered with respect to the availability of the site for acquisition. Public ownership was preferred relative to private, and multiple private ownership was considered least favourable.

- **Access:** the quality of the access to each site was considered by both road and rail. The preferred attributes were close proximity to the local road and/or rail networks and good condition of the access.

- **Proximity of habitation:** the potential impact on human habitation was considered with respect to the number of households within the proposed site boundaries (who would need to be resettled) and the number of households within 200 m (who may suffer adverse impacts, such as nuisance from traffic, noise, etc). The preference is to minimise the number of local households affected and, in particular, to avoid involuntary resettlement.

- **Hydrology:** the presence of surface water courses, both rivers/streams and marshlands, was considered, together with the potential for seasonal flooding. Although a landfill can technically be engineered in virtually
any hydrological conditions, the preference is generally dry conditions and the least sensitive hydrological resources, for example with limited use for potable water supplies.

- **Geology and hydrogeology:** the geological and hydrogeological conditions of the site were considered with respect to the presence of natural materials of benefit to the landfill engineering, for example natural clay which can be used for lining the site, and sensitivity of groundwater, for example its depth and use.

- **Biological factors:** the consideration of biological factors covered the diversity and importance of the habitats and species of flora and fauna present on, and in the vicinity of, the sites.

### 3.7.3 Short-listed Sites

The six short-listed sites considered by the Consultants in the comparative review are as follows:

- **a) Pitumpe:** the Pitumpe site is situated approximately 30 km east of central Colombo and is a natural valley, which would be landfilled.

- **b) Kerawalapitiya:** this site is situated within the Muthurajawela, approximately 10 km north of central Colombo. The Muthurajawela marsh is a coastal wetland which opens to the sea at its northern end. Again, the landfill site engineering would involve a land-raising scheme.

- **c) Hanwella, near Padukka:** the site is an area of flat land, generally abandoned paddy, located approximately 30 km east of central Colombo. Due to the absence of an existing excavated void, the landfill at the site would consist of a land-raising scheme.

- **d) Hewagama:** the site is located approximately 30 km east of central Colombo. The site is a natural valley, which would be landfilled.

- **e) Morakelle:** this site is situated approximately 30 km east of central Colombo. The site is a natural valley, which would be landfilled.

- **f) Welisara:** the site is situated within marshland approximately 10 km north-east of central Colombo. The landfill site would generally be a land-raising scheme, although initial waste placement would take place in excavations made into the marsh as part of the site engineering.

### 3.7.4 Results of the Review

The full results of this review are reported in ERM reports dated October 1993 (1) and March 1994 (2). The relevant parts of the ERM report of

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March 1994 are attached to this final EIA as Annex G. The conclusions reached by the review exercise are summarised in tabular form in Table 3.7a. To assist assimilation of the assessment results, a numerical score has been assigned to each site against each criterion.

GOSL Review of Scoping Report and Final Site Selection

Due to the political and socially sensitive nature of siting a landfill, a Committee was appointed by the Hon Minister for Public Administration, Home Affairs and Provincial Councils to select an acceptable site which could be developed as a long-term sanitary landfill based on the environmental scoping report of the sites. The Committee forwarded the environmental scoping report on the six potential landfill sites to the Secretary of the Ministry of Home Affairs and Provincial Councils (MHA&PC) and the Chief Secretary of the Western Provincial Council (WPC).

The Hon Minister for Home Affairs and Provincial Councils requested the findings of the environmental scoping study to be presented to the Cabinet Sub-Committee on Investment chaired by the Hon Prime Minister. The environmental scoping report revealed that none of the sites could be considered ideal for development as a sanitary landfill. Each site had its advantages and disadvantages. In summary, only three of the sites had sufficient capacity to serve as a long-term sanitary landfill for the CMA. The sites being Hanwella, Welisara and Kerawalapitiya. Welisara and Kerawalapitiya were mainly under public ownership, therefore, subject to satisfactory public consultations, could be used for development without undue delay. Hanwella and Welisara were the sites with the best access. None of the sites appeared to require more than approximately 30 households needing resettlement. When considering the effects of flooding and associated polluting potential, the sites at Hewagama and Morakelle appear capable of development at a reasonable cost. The sites at Kerawalapitiya, Welisara and Hanwella appear capable of being developed at higher cost. Consideration of impacts to local ecology revealed that the sites at Welisara, Hewagama, Morakelle and Hanwella could be developed with little detrimental effect on local ecology.

Deliberations at the Cabinet Sub-Committee focused on scientific criteria as well as political and social acceptability, which resulted in the site at Welisara being perceived as probably the most acceptable site. However, the Hon Prime Minister appointed a Committee chaired by the Secretary, MHA&PC to consult the local community in the Welisara areas and obtain their views on the proposed siting of a sanitary landfill. Two meetings were held with the local community and the findings reported to the Cabinet Sub-Committee. A synopsis of the two meetings are contained in Annex D. Although, the local community objected to the siting of the landfill, their main concerns were more of a technical nature than of social nature. Finally, the Cabinet Sub-committee reached an agreement to approve the Welisara site for use as a long-term sanitary landfill, after guarantees were provided that the design and operation of the landfill site would conform to standards commonly acceptable for sanitary landfills. A decision was also made to hold a public awareness campaign on the difference between open
dumping as it occurs in Colombo, despite its title, and a properly supervised sanitary landfill whose surface would be progressively restored for limited community use. In addition, a guarantee was given that a community development package would be provided to the local community that would be in the vicinity of the landfill. The provision of the community development package would enhance public acceptability of the landfill site due to the immediate benefits accrued by the community.

Subsequent to these guarantees, the Cabinet Sub-Committee approved the selection of the site at Galudupita Road, Welisara as a long-term sanitary landfill site, at a meeting on January 11, 1994. A meeting held on April 9, 1994 with the households to be resettled a large degree of local acceptability was observed after the possible benefits of the project such as the community development program were described to the community. This level of acceptability would never be possible at the site at Hanwella, since the issue is not localized, but would involve larger public involvement due to the site being upstream of the potable water intake point at Ambatale. Additionally, during the period the site scoping study was in progress, the GOSL has passed a Cabinet decision designating the Kelani River basin an environmentally sensitive area, prohibiting the location of any industry that could cause pollution to the Kelani River upstream of the potable water intake point. The site at Hanwella is designated as a most sensitive area under this scheme, eliminating the possibility of using this site as a sanitary landfill regardless to public or political acceptability.
### Table 3.7a Comparison of Alternative Landfill Sites - Technical/Environmental Factors

<table>
<thead>
<tr>
<th></th>
<th>Pitumpe</th>
<th>Kerawalapitiya</th>
<th>Hewagama</th>
<th>Morakelle</th>
<th>Hanwella</th>
<th>WelIsara</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ownership</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Access</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Habitation/Resettlement</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
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<tr>
<td>Hydrology</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Geology/Hydrogeology</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Flora and Fauna</td>
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<td>5</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>25</strong></td>
<td><strong>22</strong></td>
<td><strong>21</strong></td>
<td><strong>20</strong></td>
<td><strong>15</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>

5 = severe  3 = moderate  1 = slight
**DESCRIPTION OF LANDFILL DESIGN AND OPERATION**

4.1 **INTRODUCTION**

This section describes the concept for the design of the landfill site. The following aspects are discussed:

- the overall design philosophy;
- the key constraints affecting the development of the landfill due to the characteristics of the site;
- the concept for the site engineering, taking account of the existing site conditions and environmental requirements;
- the operational issues related to the landfilling of waste, including the method of waste placement, special procedures for the disposal of waste from the EPZs and hospitals, control of scavenging, environmental controls and progressive development of the site;
- phasing of the development of the site infilling and progressive restoration of completed areas.

The design concept described in this section provides the basis for the EIA. The assessment of the environmental impacts resulting from the development of the landfill is described in Section 6.

4.2 **OVERALL DESIGN PHILOSOPHY**

The proposed site at Welisara occupies an area of permanently inundated low-lying marshland that is characterised by low topographic relief, a high groundwater table and periodic flooding in the rainy season. Hence, the development of the site, although technically feasible, is likely to be difficult. The nature and location of the site will necessitate the provision of a suite of engineering measures in order to:

- operate the landfill facility continuously and successfully;
- incorporate the necessary environmental protection measures to minimise the risk of pollution and flooding during site engineering, operation and upon completion.

As a sanitary landfill, a philosophy of 'attenuate and disperse', whereby contaminated liquid generated within the landfill (leachate) is allowed to escape from the site to be diluted and reduced in strength during percolation through the surrounding geology, is not considered appropriate in this location because of the significant risk of pollution of water resources adjacent to, and downstream of, the site. Accordingly, the landfill design...
makes provision for secure containment and effective segregation of the waste and associated leachate from the surrounding environment, in the light of local geological, hydrological and hydrogeological conditions.

In order to generate sufficient capacity, the development of the site will involve the excavation of the superficial deposits present on the site (mainly peat). The resulting void space will be infilled with waste, which will be supplemented by additional waste placement to develop an artificial hill (land-raising).

In total, it is estimated that the site will be engineered to provide approximately $11.6 \times 10^6 \text{ m}^3$ of void space for waste disposal, sufficient to cater for the MSW disposal needs of Colombo Metropolitan Area for 15 years, and a total capacity of approximately $14.0 \times 10^6 \text{ m}^3$, to allow for associated on-site engineering works. Any restrictions on the available land area will have the effect of reducing the available capacity for waste disposal. The design and capacity calculations are based on the full 124 ha being available for tipping and leachate treatment lagoons. If this is not the case, at the detailed design stage, amendments would be required in the briefing for site development provided to the landfill contractor.

Any inputs of industrial wastes from the EPZs and hospital-waste will be in addition to those of the MSW: if these inputs are significant, either additional void space elsewhere will need to be developed or the operating life of the landfill site will be reduced. However, they are currently estimated to represent less than 2% of the MSW quantity.

### 4.3 KEY CONSTRAINTS

#### 4.3.1 Introduction

The physical setting of the site imposes a number of key technical constraints that have a fundamental influence on the overall design and development of the landfill site. These are considered to be:

- the apparent paucity of materials available on-site for landfill engineering works, for example there are limited supplies of clay available for engineering site containment (lining of the bottom and sides of the void space);
- the presence of soft, highly compressible soil (peat) at the existing ground surface level, which needs to be removed prior to constructing the landfill site or pre-compressed in situ;
- high groundwater levels throughout the site area, typically at the ground surface or within 0.3m of the ground surface even during the dry season, necessitating extensive drainage works; and
periodic flooding of the site and the presence of a tributary of the Kalu Oya river traversing the site, such that flood protection is required and the Kalu Oya tributary will need to be diverted.

Each of these key constraints are considered in further detail below, with respect to the critical aspects of site engineering associated with development of the site.

4.3.2 Site Containment

In order to provide a high degree of protection to the surrounding environment it is necessary to segregate and isolate potentially polluting waste from the surrounding strata, surface water and groundwater. The principal means of achieving this are by the provision of low permeability sealing layers (base, sidewalls and top of the landfill) and appropriate operational management of the site in order to minimise:

- the ingress of water into the landfill;
- the production of landfill leachate and its subsequent dispersion into the aquatic environment surrounding the site.

Ideally, low permeability strata, for example clays, would be used to inhibit the inflow of water into the landfill and the outflow of leachate. The results of the geotechnical survey undertaken at the site (see Section 5.4.1) indicate that no suitable low permeability strata occur in situ that naturally could form adequate levels of containment for the landfill. The apparent deficiency of natural low permeability soils in situ dictate that one of the following will be required:

- the importation of low permeability natural clay to line the site to supplement available resources, primarily those found on Illukgoda Island;
- the use of an engineered artificial lining system, for example a synthetic flexible membrane; or
- the improvement of in situ materials to achieve the required permeability characteristics, for example by bentonite enrichment (where the existing materials are treated with bentonite - a type of clay - to reduce the percolation of water through it).

4.3.3 Landfill foundations

The presence of a relatively thick layer of peat across the majority of the site poses significant problems in the construction and engineering of the base of the landfill. The peat is very soft and highly compressible and essentially has no significant bearing capacity - in its current state, it cannot support the weight of loads placed upon it, for example deposited waste, landfill machinery and traffic. This dictates that site engineering must either:
* remove the compressible peat; or
* adopt specialised methods of construction, for example progressive, phased over tipping of peat with bulk fill.

Even if such specialised methods of construction are adopted the following problems may still exist:
* load bearing capacity failure of the foundation soils, hence any sealing layer placed above the peat to provide site containment could be disrupted by failure and dislocation of the foundation soils;
* large vertical and lateral settlements (up to 80% of the in situ thickness of the peat) of the base of the landfill, due to compression of the peat upon placement of the waste - hence any basal sealing layer and internal landfill engineering works could be disrupted.

4.3.4 Leachate and Landfill Gas Control

The development of a sanitary landfill places considerable emphasis upon the control of the potentially polluting products released throughout the life of the landfill by the decomposition of biodegradable/putrescible organic wastes (leachate and landfill gas). Control measures routinely adopted make provision for the minimisation, collection, abstraction and, where appropriate, treatment of both these products.

The installation and construction of landfill leachate and landfill gas control measures requires large quantities of natural materials with specific engineering properties, such as free-draining granular material to promote drainage. The available geological and geotechnical results indicate a shortage of such materials on-site.

4.3.5 Site Drainage and Flood Protection

Site Drainage

The northern tributary of the Kalu Oya flows south-west across the eastern-central part of the site area. This watercourse cannot be retained within the landfill footprint and will need to be re-routed prior to undertaking initial preparatory works for the landfill.

The high levels of incident rainfall are likely to generate large volumes of surface water run-off within and adjacent to the site, particularly during the monsoon periods. Operational difficulties may ensue from surface water run-off, particularly with respect to:
* the segregation of leachate-contaminated waters from clean surface waters;
* the maintenance of the landfilling area dry during the wet season; and
the maintenance of haul road quality within the site.

The site, therefore, will require a network of surface water control measures, designed to accommodate the anticipated volumes of run-off generated during the heaviest rainfalls of the monsoon periods.

On-site Flood Protection

The marshland is prone to flooding periodically during the wet season. The degree, frequency and depth of flooding will present severe operational difficulties unless adequate measures are taken to deal with the flood risk. The measures required to overcome the on-site flood risk comprise either:

- construction of flood protection barriers/bunds around the limits of the landfill; or
- construction of the base of the landfill and the landfill foundations at an elevation above the maximum flood level.

Off-site Flood Protection

The development of the site will result in the removal/cover of peat marshland which currently absorbs rainwater falling on the site and run-off from adjacent areas. Instead, the rainwater will be shed from the site into a local drainage system which will link to local watercourses. The loss of the capacity of the site to absorb rainwater will lead to slightly increased flows in the watercourses downstream of the site, but as described in section 6.3, the loss of this land is not expected to significantly alter the upstream or downstream flooding pattern.

4.4 CONCEPT FOR SITE ENGINEERING

4.4.1 Introduction

To accommodate the key technical constraints to landfill development present at the site, the conceptual design for the proposed landfill addresses the following principal design elements, within an overall concept of phased development:

- the provision of a stable foundation upon which to form the base of the landfill;
- the sourcing of supplies of natural materials for site engineering works, as far as practicable to be met from on-site resources;
- the ‘total’ containment of the landfill site, including the provision of groundwater control measures, a basal lining system and a surface capping layer;
The provision of flood protection bunds around the perimeter of the landfill site, to isolate the site from periodic flooding; and

the re-routing of surface watercourses and the provision of surface water control measures to accommodate surface run-off.

The measures proposed as part of the initial conceptual design of the landfill are described below, with particular emphasis on the measures required to achieve appropriate levels of environmental protection. The measures will be developed in more detail in the conceptual design of the site.

4.4.2 Phasing of Site Engineering

At the outset of the site development, it is envisaged that the site will be divided into a number of areas (perhaps three or four) for phased development. The area designated for the first phase of development will be prepared with the basic site engineering; that is groundwater control measures, flood protection bunds and environmental screening measures. The internal development of the areas would then be conducted by a progressive cellular approach, which would include the in-situ site engineering, for example cell engineering, leachate collection, etc (see Section 4.5.2).

At the outset of the development of the site, a waste reception area, incorporating the provision of a weighbridge, site offices, a compound and a workshop will need to be constructed. These facilities will serve the landfill site throughout its lifespan.

4.4.3 Landfill Foundation Level

The base of the landfill will be developed on stable foundation strata in order to eliminate the risk of disruption to site containment. Accordingly it is proposed that the highly compressible peat will be removed from the site area and the base of the landfill founded on lateritic sands and clays. This will involve the excavation of an estimated $2.6 \times 10^6$ m$^3$ of peat. The excavated peat will be naturally air-dried on-site, through stock-piling into a series of small heaps. When dried, the peat will be used as cover material for site restoration. It is known that peat may impart acidic conditions to water percolating through it thereby resulting in increased potential for leaching of metals present in the waste mass. However, due to the extensive scavenging and informal recycling currently practised in the CMA, the quantity of metals in the waste is extremely low. Indirect sources of metal addition such as leaching from printing inks in paper and packaging should not be significant as there is less than 7% paper and packaging in the waste stream. Therefore, although the potential for metal leaching exists, under actual landfill conditions it is expected that the amount of metals will be minimal. Nevertheless, if this were to be considered of serious concern, trace metal analysis could be included in regular water quality monitoring.

Although alternative methods of site development (other than peat excavation) are feasible, all of these are considered to be too expensive and/or
technologically too demanding. For example, building a platform on the in situ peat would require the importation to the site of very large quantities of a suitable bulk fill to raise the base of the landfill above flood levels, since no materials are available on-site.

Extraction of the peat has the benefit of exposing laterite on the floor of the excavation. Further excavation of the lateritic material will:

- release lateritic sands and clays on-site for subsequent use in other landfill earthworks, thereby minimising the requirement to import bulk fill;
- facilitate grading of the base of the landfill to accommodate leachate drainage and collection measures; and
- release further void space, thereby reducing the overall height of the final restored landfill surface.

Excavation of in situ laterite, to a depth of approximately 2 m over the floor of the landfill (approximately 63 ha), is anticipated to be sufficient to supply most site needs. The proposed floor level of the landfill, therefore, will be, on average, approximately 5.0 m below existing ground surface level. All areas of higher ground within the landfilling area will be excavated progressively to form a continuous floor at this level.

4.4.4 Site Containment

Basal Lining System

There is no low permeability layer present continuously across the site that could be used to provide containment for the base and the sidewalls of the landfill.

To import sufficient quantities of natural clay to the site to provide all site containment needs (base, sidewalls and capping layer) is currently considered infeasible because:

- the volumes of clay required are very large;
- no suitable source of clay has been identified; and
- importation of clay to the site would be expensive.

The use of artificial lining systems, for example flexible synthetic membranes, is not considered appropriate for Sri Lanka for the following reasons:

- the installation of artificial lining systems requires specialist expertise and specialist contractors which are not available in Sri Lanka; and
- the systems are very expensive.

In the light of these considerations and the need to remove the peat (see above), it is proposed that containment for the base of the landfill could be provided by lateritic sands and clays in situ appropriately improved by the introduction and application of an appropriate grade of bentonite in order to
reduce the permeability to a maximum acceptable level. The prime source of suitable material available within the site is found on the island of Illukgoda. The proposed minimum containment standard to be adopted is a maximum permeability of $1 \times 10^{-4}$ m sec$^{-1}$ for an situ thickness of 1m.

**Groundwater Control Measures**

It will be necessary to install groundwater control measures to:

- minimise groundwater inflow into the site;
- permit landfilling into a dry void to minimise leachate production;
- isolate deposited waste within the site from groundwater; and
- to permit excavation of peat and laterite.

It is proposed that groundwater control is provided by a barrier of lateritic clays and sands constructed around the site. If necessary, a core of bentonite-enriched laterite or low permeability clay may be constructed within the central part of the barrier to provide the degree of groundwater control required. This core would key into the underlying foundation strata.

The groundwater barrier will be formed progressively either from excavation and backfilling of a wide trench in the peat or from overtipping and displacement of the peat with laterite. It is envisaged that the platform would be approximately 20-25 m wide at the existing ground surface in order to permit subsequent construction of flood protection measures (see below) on the groundwater barrier.

Dewatering would be undertaken progressively in all areas of the site isolated by the groundwater control measures. A practical dewatering scheme might, for example comprise a system of well points to reduce groundwater levels within the site areas. This system could be combined with sumps in the floor of the areas actively being worked to maintain groundwater levels temporarily below floor level.

**Surface Capping**

To minimise the ingress of water into the site when the site is completed and restored, it is proposed to form a low permeability capping layer from reworked lateritic sands and clays released by the overdiggng of the base of the landfill, treated as necessary with bentonite to reduce its permeability. The final surface profile adopted upon restoration of the site will be designed to shed incident rainfall quickly to minimise the penetration of water through the capping layer.

**Surface Water Control Measures**

**On-site Flood Protection Measures**

Flood protection bunds will be constructed to protect the working areas of the landfill from ingress of flood waters during periods of high rainfall. In addition, these bunds will permit screening, including by planting, of site
activities during the initial stages of filling within each phase of site development. The bunds will be constructed on the groundwater control barrier constructed around the margins of the site. It is anticipated that flood protection bunds will be formed from compacted reworked lateritic sands and clays keyed into the base platform constructed for groundwater control.

**Off-site Flood Alleviation Measures**

The northern tributary of the Kalu Oya is proposed to be re-routed to flow to the east of the landfill. Two options are then feasible:

- To minimise the potential build-up of flood waters upstream of the landfill when the flood protection bunds are constructed, it is proposed that the stream is culverted beneath the railway and channelled, as necessary, to flow on the eastern side of the railway embankment. This will involve significant engineering measures.

- Alternatively, the stream could be channelled between the eastern edge of the landfill and the railway embankment. In this latter case, the potential exists for the build-up of flood water and the possible overtopping of the railway tracks during high flood flows. Hence, additional flood alleviation measures may be required, such as a sluice and/or overflow relief system.

In either case, channel modification will need to be carried out with great care to avoid undesirable impacts on the hydrological regime upstream or downstream. Acceptable methods are available from other countries and Sri Lanka, in particular, has previous experience in re-routing the largest river in the country, the Mahaweli river. Local expertise is therefore readily available to deal with possible problems. Regular stream maintenance could overcome potential sediment deposition problems.

The first approach, diverting the stream under the railway to the east, has been adopted for the conceptual design in this study as the preferred method of managing flood water storage.

**Surface Water Interception Measures and Control**

Peripheral drainage ditches, of an adequate dimension to accommodate surface run-off from peak rainfall events, will be installed around restored parts of the site. In addition, similar surface water interception ditches will be formed on the outside of any screen bunds and flood protection bunds to prevent the ingress of surface water into the active area of the landfill. All surface run-off will be routed to soakaway into the adjoining marshlands.

Clean surface water accumulating within the landfill from incident rainfall and seepage through peripheral barriers will be routed to interception ditches and sumps, segregated from the active landfilling area, and will be pumped out of the landfill into an adjacent surface water storage lagoon. After monitoring it will be discharged from the site into the Kalu Oya and adjacent marshlands.
Landfill Footprint

To accommodate the predicted volumes of waste arising, it is anticipated that the active landfill will occupy approximately 90-95 ha of the site area, with the remainder of the site retained as a marshland incorporating a leachate treatment system. This system will comprise settlement lagoons and a filtration system possibly utilising natural marshland vegetation which is encountered in the locality.

4.5 OPERATIONAL ISSUES

4.5.1 Introduction

Alongside the engineering requirements of the site to provide an effective, long-term landfill with appropriate levels of environmental protection, there are a number of operational issues which will be specifically addressed in the landfill design, namely:

- cellular mode of operation;
- disposal of industrial and hospital waste;
- scavenging and material recovery;
- leachate control;
- landfill gas control; and
- progressive restoration of the site and return to economic use.

These issues are discussed below, and will be developed further in the conceptual design.

4.5.2 Cellular Mode of Operation

The landfill site will be operated on a cellular approach, with the site divided into a series of large operational cells developed within the engineered area(s) described in Section 4.4.2; for example, one cell may be developed corresponding to the void space requirements for disposal of one year's MSW arisings. Each cell will then be sub-divided into a series of smaller working cells, sized to optimise the operational working methods and environmental protection measures, such as leachate and landfill gas control.

At any one time, three large cells will be under development: one being excavated, one under floor preparation and containment engineering and one being infilled with waste. A fourth cell would be under restoration. This philosophy is described further in Section 4.6, and would be refined during the detailed design of the landfill site.

4.5.3 Industrial and Hospital Waste

The evaluation of options for disposal of industrial and hospital waste are the subject of separate activities within the overall solid waste management
project (Activities 5 and 6 - see Section 1.1). The options under consideration
(see ERM Inception Report, August 1993) are:

- For industrial waste:
  - landfill site(s) within the Biyagama and Katunayake EPZs;
  - small incineration plant(s) within the Biyagama and Katunayake EPZs;
  - transfer station(s) and disposal of waste at the Welisara landfill site.

- For hospital waste:
  - a central incineration plant (see Section 3);
  - several small incineration plants.
  - disposal of waste at the Welisara landfill site.

Hence, one of the options for industrial waste under consideration is the use of
the proposed landfill site for disposal of the waste with MSW. The
majority of the industrial waste is garment and cloth off-cuts (55-60%) and
rubber (14-15%), as discussed in Section 5.2.2. Within a properly managed
disposal system, these materials are not normally a major environmental
hazard, and they are recognised as having a high value to scavengers.
Therefore, if not salvaged, these types of industrial waste could be co-
disposed with MSW at the landfill site, with no special precautions.

Other types of industrial wastes, such as chemical wastes, inks, etc, some of
which are generated, albeit in small quantities at Biyagama EPZ, are of
higher concern to the environment and pose risks to scavengers, and these
types of waste, together with hospital wastes, will require special
management practices if disposed of at the landfill.

It should be noted that, although incineration is the focus of the disposal of
hospital waste, provisions for hospital waste disposal should also be made
within the Welisara site, as cover in the event of failure or impracticality of
the options for incineration plants.

A preliminary concept to allow for the disposal of these categories of
industrial and/or hospital wastes at the landfill site is as follows:

- Waste deliveries would be arranged and notified in advance, and
  scheduled for a set time.

- A trench would be dug within the municipal solid waste deposited at the
  landfill site in advance, to accommodate the incoming waste.

- Upon arrival, the waste would be placed immediately into the prepared
trenches and covered.

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(1) Solid Waste Management Component: Colombo Metropolitan Area Environmental Project, Sri Lanka: Inception Report,
Environmental Resources Management, August 1993.
Scavengers would be excluded from access to the prepared trench at all times, especially during and after placement of the waste.

It is recognised that this approach will require close supervision. The disposal of industrial and hospital waste in the conceptual design for the landfill site will be considered in co-ordination with the other strategies for the management of these wastes currently being developed within Activities 5 and 6.

4.5.4 Scavenging and Materials Recovery

The site will be operated to allow controlled scavenging to take place. The preliminary concept for this is the operation of two working faces within the landfill at any one time, based on the following principles:

- A working face would be operated as follows:
  - receive incoming waste;
  - after waste placement, allow a set period for picking by scavengers, during which time incoming waste would be deposited at the second working face;
  - after the allocated scavenging period, compact and cover of the waste.

- The operation of the two working faces would be synchronised so that one face is always open to picking by scavengers.

- During waste placement and compaction/cover, scavengers would be excluded from the working face, to minimise the risk of contact with heavy machinery.

- During any deposit of special or hazardous wastes (which pose a high health risk to scavengers), for example hospital waste, scavengers would be excluded from the working area and the deposited waste will be covered immediately.

This method of operation will require high levels of supervision of site operations, but will enable scavengers to maintain a living from the landfill site, whilst minimising the higher risks associated with accidents involving heavy machinery and/or contact with hazardous wastes. Scavengers will be educated in the operational practices and support facilities such as First Aid will be available.

Within the operation of the landfill site, and the overall waste collection and transfer system, there is also the potential for organised separation of specific waste streams for materials recycling, for example plastic bags, as part of the waste management plan. This separation may be carried out at the landfill site, or more efficiently/cost-effectively during collection and/or at the transfer station(s). The conceptual design proposed by the Consultants for Baseline Road Transfer Station can accommodate manual sorting at that location if preferred by GOSL.
The scope for such activities and an investigation of the available options will be provided as part of Activities 1 and 3 of the overall study, and incorporated into the conceptual design of the landfill, as appropriate.

**Leachate Control**

The site will be operated on the water balance principle in order to minimise the production of leachate during site operation. Temporary daily and intermediate cover, making use as far as possible of air-dried peat and inert construction waste, will be placed over all parts of the landfilling area not actively receiving waste.

Leachate collection will be achieved through gravity drainage by grading the floor of the landfill. Leachate drains will be laid over the floor of the landfill and will connect with leachate sumps and leachate collection chambers. Leachate abstracted from the landfill will be treated on-site in a series of leachate treatment lagoons and/or reed beds comprising local vegetation prior to disposal off-site.

**Landfill Gas Control**

A network of vertical gas chimneys and horizontal gas drains will be formed within each working cell. The gas chimneys will most likely be drilled from the surface after completion of the surface capping layer. Gas vents will pass through the capping layer and permit passive venting to the atmosphere. A permeable gas drain formed of granular material will be laid on the inside of the groundwater control barrier and will inhibit lateral migration of landfill gas.

**PHASED AND PROGRESSIVE DEVELOPMENT AND RESTORATION**

As discussed earlier, the landfill will be developed on a progressive basis, with the site subdivided into a series of areas for site engineering works, (annual) phases for waste deposit and individual, smaller, landfilling cells within each phase.

It is anticipated that no more than 15-20 ha of the landfilling area will be under development at any one time (out of an overall site area of up to 124 ha and a waste placement area of 90-95 ha); the whole of the site, therefore, will not be subject to continuous operations throughout the 15-year life of the landfilling operation. This applies to both the site engineering, development of environmental protection measures and waste placement. It also has operational benefits, spreads the site development costs over the lifetime of the site and allows ongoing environmental monitoring of the impacts of the operations (with the scope to amend/change operations in response to the results of the monitoring). Site restoration will also follow on a progressive basis, allowing the first phases of the landfill completed to be restored and made available for useful purposes whilst the landfill operations continue elsewhere on the site.
The preliminary concept is that the site will initially be developed from the north-east end, and gradually spread south and westwards. At the outset, a waste reception area, incorporating the provision of a weighbridge, site offices, a compound and workshop, will be developed at the central northern end of the site. This facility will be in use throughout the lifespan of the site.

Figure 4.6a illustrates a schematic section through the landfill and shows the concept of the sequence of operations within the site, including:

- progressive extraction of peat and exposure of laterite;
- progressive extraction of laterite to release engineering materials;
- progressive preparation of the floor of the landfill;
- progressive installation of environmental control measures;
- progressive placement of waste in a landfill cell; and
- progressive restoration of landfill cell to a final level.

The process of the progressive development and restoration of the site will be evolved further in the completion of the conceptual design of the site.
5.1 INTRODUCTION

The location of the Welisara site is shown on Figure 5.1a in the context of the Colombo Metropolitan Area. The Welisara site was officially designated by the GOSL as a development area by the serving of a Section 2 Notice under the Land Acquisitions Act in July 1993.

This section describes the results of the surveys and research on the Welisara site. The description covers the key environmental conditions prevailing at the site, namely:

- climate;
- topography and landscape;
- geology;
- hydrology;
- hydrogeology;
- socio-cultural factors and land use;
- biological factors (flora and fauna);
- air quality;
- traffic; and
- noise.

This description illustrates the baseline conditions prevailing at the site, and permits the identification of key characteristics which affect the potential for positive and negative environmental impacts to occur due to the development of the landfill site.

5.2 CLIMATE

The meteorological conditions at the proposed site are generally typical of those encountered in Colombo, although local variations are expected due to its marginally inland and sheltered location. The weather conditions in Colombo are:

- Rainfall: 2,000-2,500 mm per year, with a recent annual mean rainfall of 2,400 mm. Heavy monsoon rainfalls occur twice yearly - in April/May and October/November, during which time approximately 65% of the annual incident precipitation falls. Maximum daily rainfall is up to 340 mm, and maximum four-day rainfall is up to 590 mm (estimated 200 year return period). Rainfall during the dry season (January to March) averages approximately 100 mm per month.

- Humidity and Evaporation: relative humidity of 80-85%, with monthly average evaporation rates of approximately 110 mm (ranging from 90 mm to 125 mm). Rainfall exceeds evaporation throughout the year, except in
Figure 4.6a  Schematic cross-section illustrating phased development of landfill site
January to March. The annual effective rainfall for Welisara is estimated to be approximately 1,250 mm.

- **Temperature**: temperature range from 22°C in January to 31.5°C in April (as mean daily minimum/maximum). The mean temperature is 26-28°C.

- **Winds**: generally light winds (5-16 km hr⁻¹), normally higher in July to September. Wind directions are typically to the north-east/north-west in November-February, and towards the south-west in March-October, veering to the east in the evenings in March-April.

### TOPOGRAPHY AND LANDSCAPE

The proposed site for the landfill covers 124 hectares at Welisara, the majority of which comprises essentially flat, marshy land approximately at mean sea level. Topographic variations are slight with ground surface elevations over most of the site within 0.5 m (²/³) of mean sea level.

The surface of the marsh is punctured by three small islands of slightly elevated ground, rising approximately 2-4 m above the level of the marshlands. These latter areas host shrub and tree vegetation in contrast to the semi-aquatic vegetation, for example reed and sedge, of the low-lying marsh area. Photographs of the site showing these features are presented as Figures 5.3a and 5.3b.

The site is delineated to the east and south-east by the railway line linking Colombo to Kandy to the north-east. The railway is constructed on an embankment of laterite, approximately 2 m above the level of the marshlands. Similar marshlands to those within the site extend to the east of the railway.

The northern, western and southern boundaries of the site are marked by drier, higher ground which rises up to approximately 15 m to 20 m above the level of the marshland. Maximum gradients rising out of the marshland are approximately 1 (vertical) in 7 (horizontal).

The marshland has previously been used for paddy, and currently undergoes attempts at cultivation on about 10% of the land area although we understand that these attempts are largely unsuccessful. An electricity transmission line runs approximately north-south across the site.

The higher ground around the site is generally moderately settled in a semi-rural context with mature and semi-mature trees screening much of the housing from the site. However, the edges of the settlement are visible on the margins of the marshland and intermittently on the higher ground. Some large industrial premises are present to the north of the site, including:

- a Milk Powder Factory, consisting of a large building with a highly visible yellow roof;
- Aztec pipe manufacturers;
- a Government Food Depot, consisting of several large, grey, warehouse-type buildings;

- a Military Barracks, consisting of a variety of buildings and security measures: the perimeter wall and fencing are particularly visible from the site.

The general character of the site and surrounding area is a rural-suburban enclave, on the margins of major urban development with several large industrial enterprises in the proximity. There are no major landscape features, such as industrial stacks or high-rise buildings in the vicinity.

5.4

GEOLOGY

5.4.1

A preliminary geotechnical survey of the site comprising the following principal elements has been undertaken:

- drilling of 20 No. Auger holes and 19 No. Shell and Auger boreholes;
- installation of groundwater monitoring pipes (piezometers);
- in situ testing of soil and rock materials; and
- sampling and subsequent laboratory testing of soil and rock materials.

The field investigations, which are now complete, have permitted the nature, distribution, thickness and continuity of geological materials present beneath the site to be established. The groundwater flow pattern has also been determined and field tests have provided information on the in situ density and permeability of material considered likely to form the foundation of the landfill and to be used in site engineering works.

Laboratory testing, which will provide additional information on the engineering characteristics of site materials, is still in progress. The following range of laboratory tests has been scheduled:

- plasticity tests;
- particle size distribution tests;
- permeability tests (undisturbed and remoulded samples);
- shear strength (undisturbed and remoulded samples); and
- compaction tests;
- California Bearing Ratio tests

The laboratory testing programme is expected to be substantially complete by the end of April 1994.

Data from the geotechnical survey contributes to the definition of the principal technical constraints to site development and permits the assessment and identification of the most appropriate engineering solutions for the proposed landfill at Welisara.
5.4.2 Geological Setting

The site geology comprises a variable sequence of superficial deposits overlying bedrock at depth. Bedrock is inferred to comprise biotite and hornblende granite and granite-gneiss of the Vijayan Series, a low grade metamorphic zone of Pre-Cambrian age. This formation subcrops beneath superficial materials to the north, south and east of the site; bedrock is not exposed within the site.

5.4.3 Superficial Deposits

On the basis of the information currently available from the geotechnical survey, the superficial deposits comprise the following sequence:

- peat,
- clayey sands and sandy clays; and
- lateritic gravelly sands and lenses of lateritic clay passing down conformably into highly weathered, decomposed rock.

Peat appears to be present across the whole of the site area, with the exception of:

- the elevated margins of the site; and
- the higher ground of the islands within the site.

In these latter locations lateritic sands and clays outcrop at the surface. All of the higher ground surrounding the site is believed to be underlain by laterite.

The peat is extremely soft to stiff, blackish grey to black, highly organic and variably fibrous, occasionally sandy and is saturated throughout. The peat is generally immature and comprises a mixture of debris of reed, sedge and marsh vegetation, with zones of more compact and stiffer tree and shrub peat and highly decomposed, humified peat. In situ moisture contents are high, and likely to range between 300% and 1,000% in the extreme.

Alluvial deposits beneath the peat comprise grey to dark grey, loose to very loose, slightly clayey to clayey, fine to coarse sands and soft, occasionally stiff, grey, slightly sandy to sandy clays of low to intermediate plasticity. Locally there is a transitional sequence (transitional deposits) between the alluvial deposits and the overlying peat, represented by interbedded/intermixed peat and sand/clay.

Lateritic materials recorded to date principally comprise loose becoming dense, yellowish brown to grey brown, fine to coarse, sub-angular to sub-rounded sands, with between 20% to 50% moderately plastic fines and a variable gravel content. The lateritic clays are subordinate in occurrence to the sands and appear to be discontinuous.

The peat ranges in thickness from 0.0 m to a maximum proven thickness of 7.0 m, with an average thickness of approximately 3.0 m. The peat is
generally thickest in the south-eastern and southern parts of the site, between the railway line and the Kalu Oya, where it appears to infill a slight topographic hollow in the underlying laterite. Over the majority of the site area the peat is underlain by alluvial deposits and/or transitional deposits, which are up to 9.0 m thick, although typically less than 2.0 m thick. Peat directly overlies laterite only very locally across the site.

The base of the lateritic materials has not been proven in all boreholes. Where proven, the laterite is typically 6.0 m to 10.0 m thick and passes into completely weathered bedrock.

A comparable sequence and range of sediments has been recorded in the Muthurajawela to the west of the site, across the A3 Colombo-Negombo road.

5.5  SOCIO-CULTURAL ENVIRONMENT AND LAND USE

5.5.1 Population and Habitation

The site is located to the north-east of central Colombo. The settlements of Enderamulla, Mabole, Galudupita, Elapitiwela, Halanduruwa and Horape are located on the higher ground surrounding the proposed site (see Figure 5.5a). The fringes of these settlements extend down to the edge of the marshland, and are immediately adjacent to the site. The settlements to the north of the site are moderately populated with approximately 80 houses. To the west the population density is greater. A socioeconomic survey was planned, which would have provided data on the number of houses immediately adjacent to the western border of the site. However, due to strong local feelings against the project it proved impossible to carry out the survey. In addition, there are three small islands (Navamahara; Illukgoda; Duva) of marginally higher ground within the site area. These islands contain settlements, with a total of 25 houses. The site was officially designated as a development area in July 1993 by the serving of a Section 2 Notice under the Land Acquisition Act.

5.5.2 Socio-economics and Culture

Welisara is situated in one of the most densely populated parts of Sri Lanka. Population density in Gampaha District as a whole averages 1,000 persons per square km, whilst in the immediate vicinity the density is reportedly over 5,000 persons per square km. The population of this area is growing rapidly and is expected to double in the decade 1991-2001. Much of this population growth is the result of the rapid rise in land prices in metropolitan Colombo over the last fifteen years. This has led to the development of both residential and industrial areas along the main road linking Colombo with the airport and Free Trade Zone at Katunayake. It appears that the majority of the population in Welisara are relatively recent immigrants from other areas of Sri Lanka. Whereas 20 to 25 years ago there was still major
agricultural sector in Welisara, today agriculture is of minor importance. Land previously under coconut palms is today the site of housing developments, factories and container yards.

The area affected by the project forms a microcosm of the area as a whole. What was two or three decades ago an area of long-established small communities engaged in agriculture has now become an area of dense population in which most people are dependent on wages and salaries for their income. Whilst there are some local industries, for instance the milk factory and the plastic factory, the majority of the working population commute to jobs in Colombo, Katunayake and other centres of employment in the vicinity. Although the Galudupita marsh was used for paddy in the past, problems with drainage have led to paddy cultivation being abandoned. However, there is evidence that intermittent attempts to cultivate paddy are still made on about 10% of the total land area, although these attempts are largely unsuccessful. On drier areas around the islands or at the edges of the site some garden crops currently occur and the marshland is used by some of the local population for water buffalo and cattle grazing, fishing and the harvesting of the wild vegetable kankun and reeds/grasses for basket making. On the higher land coconut palms and tree crops such as mangos are still grown, but these are generally marginal to household incomes. It is believed that none of the families living on or around the site are dependent on marsh resources for their livelihood.

A number of residential zones can be identified in the immediate vicinity of the site.

Zone 1: To the west of the marsh and running as far as the main Colombo-Negombo road is a dense area of mainly middle class housing. Here what were once coconut estates have been sold and split into small blocs for residential use. The majority of the population in this area are relative newcomers to the district. It is difficult to estimate population figures but there are probably over 1,000 households in this area.

Zone 2: To the north of the marsh occupying a narrow strip of land between the marsh and the naval base is a row of around 80 houses. These are generally of lower quality than those in zone 1 and most appear to have been constructed over the last ten years. Most of the occupants are immigrants from outside the immediate vicinity of the site. This area includes an island known as Duva which is occupied by one household.

Zone 3: Immediately to the west of the marsh and occupying one of the islands in the marsh (Illukgoda) is one of the older communities in the area. Once dependent on paddy cultivation, most people now depend on wages and salaries.

Zone 4: By the railway line which forms the eastern boundary of the site are recent immigrants to the area occupying an island known as Navamahara. This is the poorest residential zone. Houses are built
of timber and cadjan and their occupants depend in the main on casual labour supplemented by fishing and other minor activities in the marsh.

Zone 5: To the south of the site is a mixed residential area, mainly consisting of middle and lower-middle class housing.

Except for zones 2 and 4, electricity is widely available, the local authority having installed it over the last few years. Throughout the area households presently depend on well water and most houses have their own wells.

Although important as a source of income in the past, the marsh is now economically relatively unimportant. There is some small-scale fishing, mainly for domestic consumption. Some vegetables are collected, particularly kankun. Cattle and buffalo are grazed within the marsh. For most households these activities are marginal sources of income, but for the poorest, particularly those in zone 4, such sources of food are important during periods of unemployment.

One of the results of the changing demographic structure of the area around the marsh has been a shift in its religious composition. Traditionally, this has been a predominantly Catholic area. However, many of the recent immigrants are Buddhist. Zone 2 is predominantly Buddhist, whilst in zones 1 and 5 Buddhists probably outnumber Catholics. There are at least three small Buddhist temples in the vicinity of the marsh.

As stated in Section 5.5.1 it has proved impossible to carry out a demographic and socioeconomic survey of the area. Preliminary investigations did show the demographic profile of the settlements in the area and can be summarised as follows:

- Income level: moderate;
- Quality of life: moderate;
- Tenure: mixed: private ownership and illegal encroachment;
- Infrastructure and services: moderate on hillsides, low on marsh islands;
- Labour profile: generally manual, some skilled manual and higher.

Overall, the settlements support a mixed standard of living and population: the quality of housing ranges from moderate, middle-class, block-built houses to squatter-type shacks. Often, the different levels of housing are intermixed and there is evidence of ongoing construction of houses in the area (legal and illegal), indicating that the settlements are continuing to develop and grow. Electricity is available to most of the houses on the hillsides.

In July 1993 the marsh was issued a Section 2 Notice under the Land Acquisition Act which earmarks the site for development by the Sri Lankan Land Reclamation and Development Corporation. The site was therefore scheduled for infilling and the loss of wetland. The development of the site as a landfill may necessitate invocation of a Section 38a proviso order of the Land Acquisition Act to acquire and take over the site.
5.5.3 Public Health

Water and Sanitation

The settlements nearest the site, and on the islands within the site, utilise dug wells 3-4 m deep as a source of potable water; sanitation is generally provided by pit-latrines. Commonly, there is one well and pit-latrine per house. It is understood that a mains water supply is available approximately 500 m to the north of the site, laid next to the A3 Colombo-Negombo-Chilaw highway. Due to the limited amount of sociological data it was possible to collect, the extent of the connection of the settlements to this mains supply and the number of households with septic tanks is not known.

Vector Borne Disease

The biological survey at the site has found no mosquito larvae (which could carry malaria, filariasis, or dengue fever) in the marsh plankton samples that have been collected and analysed to date. There is also no evidence that the local population experience a problem with mosquitos. The most likely explanation for this is that although the water appears to be still, it is in fact moving sufficiently to prevent the breeding of mosquitos.

Other vectors such as rats, ferral cats and dogs are not currently thought to pose a threat to public health in excess of that typically found in other semi-rural areas of Sri Lanka.

5.6 Hydrology and Hydrogeology

5.6.1 Hydrology

The site area lies wholly within the valley and catchment of the Kalu Oya, which joins the Kelani Ganga approximately 5 km south-west of the site, via the Old Negombo Canal. The Kalu Oya runs approximately north-east to south-west along the southern and south-western boundaries of the site, with feeder streams running through the site from the north and east. The overall catchment of the Kalu Oya extends to approximately 61 km², of which approximately 50 km² (80%) lies upstream of the site (see Figure 5.6a).

The entire site is permanently inundated, with the exception of the three small islands and some small areas around the site periphery. The feeder stream of the Kalu Oya entering the northern part of the site would appear to have substantial seasonal variations in its flow regime. In the dry season, the stream is characterised by an indistinct channel, low flows and is subject to choking with aquatic growth: water from this watercourse appears to disperse into the main body of the marsh. Photographs of the major surface water features of the site are presented as Figures 5.6b and 5.6c.
The main channel of the Kalu Oya, which borders the southern margins of the site, is more substantial and is approximately 6 m wide where it flows beneath the railway and approximately 8 m wide at the extreme southern limit of the site. Flow rates are generally low, due to the low elevation of the site area. Water levels in the streams are at approximately 0.3 to 0.4 m above sea level.

Much of the marshland is abandoned paddy. The marsh area is known to flood on a regular basis during the wet season, typically during periods of continuous rainfall. Flood levels are understood generally to be 1 m above the existing (dry season) ground surface level, but also rise occasionally to 2 m above the existing ground level.

Downstream of the Welisara site the Kalu Oya maintains a width of approximately 10 m, until widening to 12 m -14 m just before the confluence with the Old Negombo Canal. Along its length the Kalu Oya is normally characterised by slow flows and very flat land on both sides of the river.

The floodplain either side of the river varies from 10 m to 500 m in width before the land rises. Some of this area is marshland, although to the south it is increasingly being cultivated for a variety of different crops such as: rice, herbs and spices and vegetables. These areas are flooded periodically throughout the rainy seasons to a depth of approximately 0.5 m.

The farmers appear to welcome these floods as they provide water for the paddy and the deposited silt is rich in nutrients. The normal level of flooding does not affect the houses on the margins of the flood plain.

Although a detailed hydrological survey of the area has not been undertaken, the marshland is believed to influence the hydrological regime of the Kalu Oya by:

* regulating the water flow of the catchment upstream of the site;
* providing flood storage capacity during periods of high rainfall.

The drainage system of the area north of the Kelani Ganga (river), broadly south of the site area mainly consists of rivers, low lying lands and swamps. Two canals drain from the Muthurajawela swamp into the Kelani Ganga, the Hamilton canal and the old Negombo canal (now partially blocked with vegetation and silt) (1). The Kalu Oya (river) drains into the old Negombo canal, downstream from the blockages. During the rainy season flooding occurs quite frequently in the Local Authorities north of the Kelani Ganga, since most of the area is low-lying.

The flow regime of the Kalu Oya appears to have been influenced downstream of the site by a variety of engineering works which have been gradually introduced since 1956, at its junction with the Old (Dutch) Negombo Canal and the Kelani Ganga. These works comprise a series of flood alleviation measures including:

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(1) There is a Government scheme currently underway to rehabilitate the old Negombo canal, but at the time of writing the blockages had not been cleared.
• a sluice at Mabole to regulate the southerly flow of the Negombo Canal;
• flood protection bunds along the northern bank of the Kelani Ganga;
• a bund with a sluice at Wattala; and
• widening of the southern part of the Old Negombo Canal and the construction of marginal bunds.

These engineering works, many of which are now in a state of disrepair, aim to control flows independently in the Old Negombo Canal and prevent the flooding of the Kelani Ganga.

**Hydrogeology**

Groundwater is recorded in the peat... within the marshland. Within the marshland groundwater is recorded at elevations of approximately 0.2m above mean sea level.

Groundwater flows from the west and north-west of the site towards the Kelu Oya. Within the marshland the groundwater surface is essentially horizontal and as a consequence, the movement of groundwater in the area of the site is likely to be very slow. It is likely that the movement of groundwater within the site is to the south west consistent with the flow direction of the surface water course.

The fact that residents are using groundwater wells as a source of potable water indicates that salt water intrusion is not generally a widespread problem, only occurring periodically during the dry season when the water table is very low.

**BIOLOGICAL ENVIRONMENT**

**5.7 Flora**

Several streams flow through the site area, draining into a tributary of the Kelani Ganga, the Kalu Oya, adjacent to the site. The main streams are the Ja-Oya and the Heen-Oya, and due to partial stagnation of the water in the Ja-Oya certain floral species have flourished there which are of ecological interest as they play an important role in water purification.
The natural aspect of the land is disrupted by the residual evidence of paddy and garden crop cultivation, water buffalo and cattle grazing, fishing and the collection of reeds/grasses and some naturally growing fruit, for example kankun, by the local population. According to the local people the paddy fields were very fertile lands yielding a substantial harvest. However, as the channels became clogged with aquatic vegetation, the paddy cultivation could no longer be maintained. The paddy lands have been taken over by various plant species which are better suited to prevailing conditions. The commonly found species of the marsh are listed in Table 5.7a.

The plant species growing in the marsh are of value to the local community. Pan is used for mat weaving. The young leaves of Wel Gowa, as well as Mukunuwanne and Kankun are edible crops which are harvested daily by the locals for selling. The marsh is also used for grazing of cattle belonging to the local community. The marsh plants are not only of service to the humans but these plants provide food and shelter for many animals especially the herbivorous birds, as well as the fish.

There are patches of various Pan types scattered throughout the area. In some places these are single plants of Gon Kaduru, or in other places patches of Wetakeiya, Ludwigia, We-wal, and Meemana can be seen dispersed among the Pan types. Wel Gowa, Japan Jabara and Lewwa are found scattered among the grasses, the Diya Thana Kola (Brachiaria mutica), Batadella (Isachne globosus), and Uru-Wee (Oryza sativa). At the margin of the streams are Wel-bata, Wel-Atta, Thunhiriya Pan and Wetakeiya.

Interspersed among the vegetative cover of the marsh are pools of water and these are inhabited by Nelum (Nelumbium speciosum), Olu (Nymphaea lotus), Manel (Nymphaea stellata) (Figure 5.7a and 5.7b). The stream which transverses the site area, is very slow flowing due to an abundance of vegetation (see Figure 5.7c). Predominant amongst this vegetation are the Water Hyacinth (Eichhornia crassipes), Wel Gowa, Kankun (Ipomoea aquatica), Mukunuwanne (Alternanthera sessilis) and certain grasses such as the Diya thana kola. The point at which this stream joins the Kalu Oya at the southern boundary of the site is shown in Figure 5.7d.

The waters are rich in phytoplanktons. They are the basic link in the food webs of higher organisms. The dominant phytoplanktons of the study area are Spiragura, Closterium, Pandoria, Cosmarium, Chromococcus turgidus, Anabaena, Oscillatoria, Nostoc, Chlamydomonas, Phacus, Euglena, Skeletonema costatum, Spirulina major.
<table>
<thead>
<tr>
<th>Common Names</th>
<th>Scientific Names</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Marsh species</strong></td>
<td></td>
</tr>
<tr>
<td>Wetakeiya</td>
<td>Pandanus ozyanicus</td>
</tr>
<tr>
<td>Karu Koku</td>
<td>Acorus cymosus</td>
</tr>
<tr>
<td>Gon Kaduru</td>
<td>Cerbera manghas</td>
</tr>
<tr>
<td>Wel Gowa</td>
<td>Limnocharis flava</td>
</tr>
<tr>
<td>Boru-Pan</td>
<td>Eleocharia dulcis</td>
</tr>
<tr>
<td>Thunhuriya-Pan</td>
<td></td>
</tr>
<tr>
<td>Pan-wal</td>
<td></td>
</tr>
<tr>
<td>We-wal</td>
<td></td>
</tr>
<tr>
<td>Madu-wal</td>
<td></td>
</tr>
<tr>
<td>Lewwa</td>
<td></td>
</tr>
<tr>
<td>Demala-wal</td>
<td></td>
</tr>
<tr>
<td>Meemana</td>
<td>Polyalthia korinti</td>
</tr>
<tr>
<td>Nelum</td>
<td>Nelumbium speciosum</td>
</tr>
<tr>
<td>Olu</td>
<td>Nymphaea lotus</td>
</tr>
<tr>
<td>Manel</td>
<td>Eichemaria crassipes</td>
</tr>
<tr>
<td>Water Hyacinth</td>
<td>Ipomora aquatica</td>
</tr>
<tr>
<td>Wel Gowa, Kankun</td>
<td>Alcinanthera sessilis</td>
</tr>
<tr>
<td>Makanuwanne</td>
<td></td>
</tr>
<tr>
<td><strong>Home Gardens</strong></td>
<td></td>
</tr>
<tr>
<td>Jak</td>
<td>Artocarpus heterophyllous</td>
</tr>
<tr>
<td>Mango</td>
<td>Mangifera spp.</td>
</tr>
<tr>
<td>Kaduru</td>
<td>Cerbera manghas</td>
</tr>
<tr>
<td>Papaw</td>
<td>Carica papaya</td>
</tr>
<tr>
<td>Banana</td>
<td>Musa sps</td>
</tr>
<tr>
<td>Ganda pana</td>
<td>Mappia ovata</td>
</tr>
<tr>
<td>Jam</td>
<td>Muntingia calabura</td>
</tr>
<tr>
<td>Guava</td>
<td>Psidium guajava</td>
</tr>
<tr>
<td>Cocoanut</td>
<td>Cocos nucifera</td>
</tr>
<tr>
<td>Rampe</td>
<td>Pandanus latifolia</td>
</tr>
<tr>
<td>Mustard</td>
<td>Brassica juncea</td>
</tr>
<tr>
<td>Katu thampala</td>
<td>Sesbania grandiflora</td>
</tr>
<tr>
<td>Kebralla</td>
<td>Aporosa lindleyana</td>
</tr>
<tr>
<td>Kekeiri</td>
<td>Cucumis melo var agrestis</td>
</tr>
<tr>
<td>Kiri ala</td>
<td>Colocasia esculenta</td>
</tr>
<tr>
<td>Kopi</td>
<td>Coffea arabica</td>
</tr>
<tr>
<td>Lemon</td>
<td>Citrus limon</td>
</tr>
<tr>
<td>Kottang</td>
<td>Terminalia catappa</td>
</tr>
<tr>
<td>Kudametta</td>
<td>Ischaemum indicum</td>
</tr>
<tr>
<td>Balu dan</td>
<td>Ardisia humilis</td>
</tr>
<tr>
<td>Lime</td>
<td>Citrus medica</td>
</tr>
<tr>
<td>Monara kudumbiya</td>
<td>Vernonia cinerea</td>
</tr>
<tr>
<td>Murunga</td>
<td>Moringa oleifera</td>
</tr>
<tr>
<td>Delum</td>
<td>Parna granatum</td>
</tr>
<tr>
<td>Passio Fruit</td>
<td>Passi flora edulis</td>
</tr>
<tr>
<td>Pathuk</td>
<td>Opuntia dellenii</td>
</tr>
<tr>
<td>Pawatta</td>
<td>Pavetta indica</td>
</tr>
<tr>
<td>Black pepper</td>
<td>Piper nigrum</td>
</tr>
<tr>
<td>Chilli pepper</td>
<td>Capsicum sps.</td>
</tr>
<tr>
<td>Pumpkin</td>
<td>Cucurbita maxima</td>
</tr>
</tbody>
</table>
### Common Names and Scientific Names

<table>
<thead>
<tr>
<th>Common Names</th>
<th>Scientific Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Puwak</td>
<td>Areca catechu</td>
</tr>
<tr>
<td>Jambu</td>
<td>Syzygium jambos</td>
</tr>
<tr>
<td>Teak</td>
<td>Tectona grandis</td>
</tr>
<tr>
<td>Pineapple</td>
<td>Ananas comosus</td>
</tr>
<tr>
<td>Beli</td>
<td>Aglae marinae</td>
</tr>
<tr>
<td>Kaju</td>
<td>Anacardium occidentale</td>
</tr>
<tr>
<td>Ambarella</td>
<td>Syzygium intumata</td>
</tr>
<tr>
<td>Bamboo</td>
<td>Pogonatherum spp.</td>
</tr>
<tr>
<td>Del</td>
<td>Artocarpus nobilis</td>
</tr>
<tr>
<td>Miwonna</td>
<td>Polyalthia korinti</td>
</tr>
<tr>
<td>Ambarolla</td>
<td>Nerium oleander</td>
</tr>
<tr>
<td>Lawulu</td>
<td>Chrysophyllum waxburghii</td>
</tr>
<tr>
<td>Brinjal</td>
<td>Solanum melongena</td>
</tr>
</tbody>
</table>

#### Phytoplanktons

- Spirogyra
- Closterium
- Pandoria
- Cosmarium
- Chromococcus turgidus
- Anabaena
- Oscillatoria
- Nostoc
- Chlamydomonas
- Phacus
- Euglena
- Skeletonema costatum
- Spirulina major

### Home Gardens

The home gardens around the northern boundary of the site as far as Sherman's factory, and including the small island within the site, support a large number of edible crops and plants of medicinal value, as well as those grown for scenic value. These are listed in Table 5.7a.

The higher, and drier, ground surrounding the marshland, or on the islands within the marshland, is under settlement, interspersed with trees and shrubs, for example coconut palm. The trees are largely mature or semi-mature, and exceed the height of the houses to provide a low canopy. The trees also provide visual screening of the marshland from the bulk of the settlement (other than those houses on the marshland margins).

#### 5.7.2 Fauna

The marshland provides a habitat which supports a variety of marsh fauna, particularly water birds and waders. The principal species of fauna that occur at the site are shown in Table 5.7b. The disturbance caused by the relatively close proximity of the local population has restricted or prevented the presence of rarer and/or larger animals and birds, particularly those of high sensitivity or vulnerability, for example estuarine crocodile. Although local people claim to have seen crocodiles in the Kalu Oya.
### Table 5.7b

**Common Species of Fauna**

<table>
<thead>
<tr>
<th>Common Names</th>
<th>Scientific Names</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Birds</strong></td>
<td></td>
</tr>
<tr>
<td>Pheasant tailed Jacana</td>
<td>Hydrophasianus chirurgia</td>
</tr>
<tr>
<td>Rudy crane</td>
<td>Amaurornis fuscus zeylonicus</td>
</tr>
<tr>
<td>Seru, Lapwing</td>
<td>Venellus sps.</td>
</tr>
<tr>
<td>Common kingfisher</td>
<td>Alcedo atthis taponbana</td>
</tr>
<tr>
<td>Ukuusa</td>
<td>Pandion haliaetus hallaetus</td>
</tr>
<tr>
<td>Lesser adjutant</td>
<td>Leptopilus javanicus</td>
</tr>
<tr>
<td>Cormorants</td>
<td>Phalacrocorax sps.</td>
</tr>
<tr>
<td>Common Ceylon Mynah</td>
<td>Acridotheres tristi melanosternus</td>
</tr>
<tr>
<td>Egret</td>
<td>Egretta sps.</td>
</tr>
<tr>
<td>Paddy bird</td>
<td>Ardea grayli grayli</td>
</tr>
<tr>
<td><strong>Reptiles</strong></td>
<td></td>
</tr>
<tr>
<td>Calotes sps.</td>
<td>Natrix Piscator asperrimus</td>
</tr>
<tr>
<td>Mabuya sps</td>
<td>Cerberus rhynchos</td>
</tr>
<tr>
<td>Diya Naya</td>
<td>Varenus monitor kabagoya</td>
</tr>
<tr>
<td>Diya bariya</td>
<td>Lissemyx punctata ceylonensis</td>
</tr>
<tr>
<td>Kabargoya</td>
<td>Melanochelys trijuga thermalis</td>
</tr>
<tr>
<td>Kiri Ibbas</td>
<td>Crocodylus palustris kimbula (Reported by local</td>
</tr>
<tr>
<td>Gal Ibbas</td>
<td>residents).</td>
</tr>
<tr>
<td>Ceylon swamp crocodile</td>
<td></td>
</tr>
<tr>
<td><strong>Amphibians</strong></td>
<td></td>
</tr>
<tr>
<td>Rana species</td>
<td>Rachophoridiae</td>
</tr>
<tr>
<td>Tree frogs</td>
<td>Bufoidae</td>
</tr>
<tr>
<td>Toads</td>
<td></td>
</tr>
<tr>
<td><strong>Fish</strong></td>
<td></td>
</tr>
<tr>
<td>Fish found in the stream which</td>
<td></td>
</tr>
<tr>
<td>traverses the site</td>
<td></td>
</tr>
<tr>
<td>Striped snake head which grow</td>
<td>Ophiocophalus stratus</td>
</tr>
<tr>
<td>upto 1.5 ft</td>
<td>Anabus testidines</td>
</tr>
<tr>
<td>Climbing Perch</td>
<td>Heteropneustes fossilis</td>
</tr>
<tr>
<td>Vol-Hunga</td>
<td>Clarias teysmanni brachysoma</td>
</tr>
<tr>
<td>Teysmann’s spotted catfish</td>
<td>Osphronemus goramy</td>
</tr>
<tr>
<td>Giant gourami</td>
<td></td>
</tr>
</tbody>
</table>
Among the fish species found in the main stream flowing south of the site are:

<table>
<thead>
<tr>
<th>Common Names</th>
<th>Scientific Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gourami</td>
<td>Osphromenmus goramy</td>
</tr>
<tr>
<td>Striped snake head</td>
<td>Ophiocephalus striatus</td>
</tr>
<tr>
<td>Spotted catfish</td>
<td>Clarias taysmannii brachysoma</td>
</tr>
<tr>
<td>Armdha</td>
<td>Anguilla spp.</td>
</tr>
<tr>
<td>Climbing Perch</td>
<td>Anabas testudineus</td>
</tr>
<tr>
<td>Butter catfish</td>
<td>Ompok bimaculatus</td>
</tr>
<tr>
<td>Tilapia</td>
<td>Sartherodon mossambicus</td>
</tr>
<tr>
<td>Spotted Ebroplus</td>
<td>Etroplus maculatus</td>
</tr>
<tr>
<td>Catfish</td>
<td>Macrones spp.</td>
</tr>
<tr>
<td>Attentive Carplet</td>
<td>Amblypharyngodon melettinus</td>
</tr>
<tr>
<td>Barb</td>
<td>Puntius spp.</td>
</tr>
<tr>
<td>Prawn</td>
<td>Caridina spp.</td>
</tr>
<tr>
<td>Crabs</td>
<td>Paratelphusa spp.</td>
</tr>
</tbody>
</table>

The fish species found approximately two kilometers downstream from the site include:

<table>
<thead>
<tr>
<th>Common Names</th>
<th>Scientific Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vel-Hunga</td>
<td>Heterpneustes fossils</td>
</tr>
<tr>
<td>Armdha</td>
<td>Anguilla spp.</td>
</tr>
<tr>
<td>Striped snake head</td>
<td>Ophiocephalus striatus</td>
</tr>
<tr>
<td>Climbing perch</td>
<td>Anabas testudineus</td>
</tr>
<tr>
<td>Tilapia</td>
<td>Sartherodon mossambicus</td>
</tr>
<tr>
<td>Gourami</td>
<td>Osphromenmus goramy</td>
</tr>
<tr>
<td>Spotted Ebroplus</td>
<td>Etroplus maculatus</td>
</tr>
<tr>
<td>Prawns and crabs.</td>
<td></td>
</tr>
</tbody>
</table>

**Insects**

<table>
<thead>
<tr>
<th>Common Names</th>
<th>Scientific Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dragon flies</td>
<td></td>
</tr>
<tr>
<td>May flies</td>
<td></td>
</tr>
<tr>
<td>Water beetles</td>
<td></td>
</tr>
<tr>
<td>Mosquitoes</td>
<td></td>
</tr>
<tr>
<td>Butterflies</td>
<td></td>
</tr>
</tbody>
</table>

**Zooplanktons**

<table>
<thead>
<tr>
<th>Common Names</th>
<th>Scientific Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copepods</td>
<td></td>
</tr>
<tr>
<td>Cladocerans</td>
<td></td>
</tr>
<tr>
<td>Juvenile fish</td>
<td></td>
</tr>
<tr>
<td>Larval prawns</td>
<td></td>
</tr>
</tbody>
</table>

**Birds**

The various bird species listed in Table 5.7b were spotted on visits to the site. According to the residents of the area various exotic birds do arrive in the area during the migratory periods.

**Reptiles**

Table 5.7b shows the various species of reptiles that were sighted during the biological survey, or reported by local people. In particular sightings of juvenile crocodiles have been reported by local people in the area close to...
### Table 5.8d: Night-time Traffic Flows on Galudupita Road on Tuesday 8-Wednesday 9 March 1994

<table>
<thead>
<tr>
<th>Time</th>
<th>Vehicle Movements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Heavy Trucks</td>
</tr>
<tr>
<td>19:00-20:00</td>
<td>6</td>
</tr>
<tr>
<td>20:00-21:00</td>
<td>2</td>
</tr>
<tr>
<td>21:00-22:00</td>
<td>2</td>
</tr>
<tr>
<td>22:00-23:00</td>
<td>2</td>
</tr>
<tr>
<td>23:00-00:00</td>
<td>1</td>
</tr>
<tr>
<td>00:00-01:00</td>
<td>1</td>
</tr>
<tr>
<td>01:00-02:00</td>
<td>-</td>
</tr>
<tr>
<td>02:00-03:00</td>
<td>-</td>
</tr>
<tr>
<td>03:00-04:00</td>
<td>-</td>
</tr>
<tr>
<td>04:00-05:00</td>
<td>-</td>
</tr>
<tr>
<td>05:00-06:00</td>
<td>1</td>
</tr>
<tr>
<td>06:00-07:00</td>
<td>2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>17</strong></td>
</tr>
<tr>
<td>Location</td>
<td>Time</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>(1) Railway embankment at north-east corner of site, near to Horape Station (5 m from track)</td>
<td>11:20-11:35</td>
</tr>
<tr>
<td>(2) Railway embankment at south-east edge of site, adjacent to the Kalu Oya (5 m from track)</td>
<td>11:50-12:05</td>
</tr>
<tr>
<td>(3) Access road to small island in marshland at central northern edge of site.</td>
<td>12:45-13:00</td>
</tr>
<tr>
<td>(4) Track to Horape at north corner of site.</td>
<td>13:15-13:30</td>
</tr>
<tr>
<td>(5) Margin of marshland and settlements on north-west edge of site.</td>
<td>13:50-14:05</td>
</tr>
<tr>
<td>(6) Margin of marshland and settlements on western edge of site.</td>
<td>14:20-14:35</td>
</tr>
</tbody>
</table>
where the two streams join, at the southern boundary of the site as well as further downstream beyond this area.

**Amphibians**

This area is well occupied by Rana (frog) species, since it provides water related microhabitats preferred by these animals. Some species prefer open waters, some occupy heavily vegetated pools and others are found among the reeds of the marsh. These wetlands also host a number of tree frogs (Ranophiloridae) as well as toads (Bufonidae).

**Fish**

There is a variety of fish species inhabiting the streams flowing through the marsh. The fish species found in the stream which traverses the site and the main river flowing south of the site are found in Table 5.7b. The local community catch fish from these water bodies for their consumption.

**Insects**

Among the insects found within the area are the dragon flies, may flies, water beetles, mosquitoes and butterflies.

**Zooplanktons**

Copepods, cladocerans, juvenile fish and larval prawns were the major zooplanktons found in ponds and streams within the project site. Among them the cycloid copepods were the most common and abundant. The zooplanktons are a source of food for fish, crustaceans and birds.

**5.8 TRAFFIC**

The site is located off the A3 Colombo-Negombo-Chilaw highway, and is accessed via Galudupita Road. A new road will be constructed off Galudupita Road to provide access to the site.

The A3 Colombo-Negombo-Chilaw highway is a heavily-trafficked major road, which provides a radial route from central Colombo northwards to Negombo, Katunayake International Airport and Chilaw. The road is lined with a variety of small to medium-sized industry, shops and general settlement. Lorry traffic is high, and pedestrians, cyclists and similar traffic are common. Traffic data for the A3 highway are available for a section of the road approximately 4 km south of the Welisara site. The data are recorded for the two-way, two-hour midday peak in 1991, and are presented in Table 5.8a.

On the basis of the data given in Table 5.8a, during peak hours the traffic flow capacity of the A3 highway near central Colombo has been reached. The traffic flows on the A3 highway tend to decrease away from central Colombo, as traffic disperses onto the local road network. The traffic flows
Colombo, as traffic disperses onto the local road network. The traffic flows near to the Welisara site will therefore be somewhat lower than those shown on Table 5.8a, although still heavy. However, the World Bank Colombo Urban Transport Project, Sri Lanka - Staff Appraisal Report (April 1993) reported that average traffic growth on radial routes from Colombo, such as the A3 highway, varied between 6-9% per year between 1985-1991, with the growth in the vehicle fleet averaging nearly 14% between 1981-91. Continuation of this growth in traffic in the future will increase overall traffic flows on the A3 highway, potentially causing congestion on this important route.

Galudupita Road meets the A3 highway at a T-junction; there are no traffic controls or signals at the junction. Galudupita Road is initially straight and on a shallow gradient, which runs down from the junction with the A3 highway towards the site. The upper part of the road (nearest the A3 highway) is macadamised, but further down the road deteriorates in quality, becomes unsurfaced, develops potholes, narrows and ultimately becomes a track. A number of large industrial premises are located on Galudupita Road, including a Milk Powder Factory and Aztec pipe manufacturers near the junction with the A3 highway and, further down, Shermans Welisara Complex and the Government Food Depot. Settlements and shops are also present adjacent to the road on its lower parts.

**Table 5.8a Traffic Data for the A3 Colombo-Negombo-Chilaw Highway, 1991**

<table>
<thead>
<tr>
<th>Type of Vehicle</th>
<th>Traffic Flow (Two-way, Two-hour, Mid-day Peak)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cars and vans</td>
<td>2,275</td>
</tr>
<tr>
<td>Motorised trishaws</td>
<td>275</td>
</tr>
<tr>
<td>Motorcycles</td>
<td>1,475</td>
</tr>
<tr>
<td>Bicycles</td>
<td>875</td>
</tr>
<tr>
<td>Buses - privately owned</td>
<td>675</td>
</tr>
<tr>
<td>Buses - public owned</td>
<td>150</td>
</tr>
<tr>
<td>Trucks</td>
<td>350</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>6,075</strong></td>
</tr>
</tbody>
</table>

*Source: Colombo Urban Transport Project, Sri Lanka - Staff Appraisal Report, World Bank, April 1993*

After Shermans Welisara Complex, the road makes a sharp 90° turn towards the Government Food Depot. Beyond the Depot, the road becomes a narrow track servicing approximately 80 houses on the margins between Halanduruwa and the site. Galudupita Road also serves as an access road to the settlement of Galudupita.

The results of daytime traffic counts on Galudupita Road, carried out on Tuesday 1 and Monday 7 March 1994 near to the junction with the A3 highway, are summarised in Table 5.8b and 5.8c respectively. The night-time traffic movements on Galudupita Road on the night of Tuesday 8 March are
summarised in Table 5.8d. More detailed breakdowns of the traffic flows are provided in Annex H.

Overall, the traffic counts show that Galudupita Road experiences moderate daytime traffic flows, with a regular flow of trucks (servicing the industrial premises) and high numbers of motorcycles/trishaws, pedestrians and cyclists (associated with the settlements in the area). At the bottom of the road, after Shermans Welisara Complex, all types of traffic reduce significantly and trucks are restricted to those related to the Government Food Depot.

During evening and night-time, the traffic numbers on Galudupita Road decrease significantly. However, trucks are currently present on the road up to after midnight, with motorcycles/trishaws, pedestrians and cyclists common up to 23:00 hours. The night-time traffic count also indicates that 06:00 hours is the beginning of notable traffic movements on Galudupita Road.

Although the same depth of data is not available for the A3 highway as for Galudupita Road, it is anticipated that a similar trend in traffic flows is experienced.

In summary, the data available for traffic movements on the A3 highway and Galudupita Road indicate that the traffic conditions are typically as follows:

- Week-days (Monday-Friday) have similar traffic flows.
- The peak periods on the road for non-commercial traffic (motorcycles/trishaws, pedestrians and cyclists) are 07:00-09:00, 13:00-14:00 and 17:00-19:00.
- Commercial traffic (trucks) use Galudupita Road on a regular basis throughout the hours of 10:00-17:00. Trucks are evident on Galudupita Road between 05:00 and 01:00.

In addition, it is understood that Saturday, Sundays and official holidays (Poya, etc) have lower traffic than other days.

5.9 AIR QUALITY

There are no data available on the existing air quality in the area. Although some data are understood to be available for central Colombo, it is unlikely to be representative of the site, which is more characteristic of a rural-suburban area than a dense urban area: the site is expected to have better air quality than a city centre location due to lesser impacts of vehicle emissions. However, indoor air quality may be poor as a result of burning of wood fuel and kerosene for cooking and lighting.

There are no significant sources of industrial emissions to air visible in the vicinity of the site, although small-scale emissions are expected to regularly occur at a low level, and the overall background air quality is good. The
main emissions which affect the area are transient, arising from traffic and train exhausts and, to a lesser degree, marsh gases evolving due to natural decomposition processes in the marshland, for example trace organics associated with emissions of methane (which itself is odourless), and hydrogen sulphide.

5.10 NOISE

A series of sample noise measurements made on the boundaries of the proposed site have been used to determine the typical background noise climate of the area. The results of the monitoring are given in Table 5.10a, and are considered representative of the existing situation.

The measurements of $L_{Aeq}$ and $L_{A10}$ are generally used to indicate the background noise levels at a location. The measurements at locations 1-6 around the site indicate that the existing daytime noise climate is typical of a rural or suburban area. The main sources of noise are natural (birds, insects, etc), noise related to the settlements (voices, dogs, etc) and noise from traffic and transport operations (road traffic, trains, etc).

Sudden, relatively loud, noises occasionally occur from trains, sirens and hooters, all of which are associated with the railway line and stations in the vicinity of the site. Night-time noise levels are expected to be approximately 10 dB(A) lower than the daytime measurements, when many of the traffic and industrial sources of noise will have not be present or in operation.

The noise levels experienced at locations 7-8, both located on Galudupita Road, are dominated by traffic noise. The peak noise levels are at location 8, adjacent to the Milk Powder Factory, due to the higher flows of traffic on this stretch of road.
### Location

<table>
<thead>
<tr>
<th>Location</th>
<th>Time</th>
<th>Measured Noise Levels (dB)</th>
<th>Sources of baseline noise</th>
</tr>
</thead>
<tbody>
<tr>
<td>(7) Access road to the site, at a point adjacent to Shermans Container Transport, 4 m from road centreline</td>
<td>10:45-11:00</td>
<td><strong>67.4</strong></td>
<td><strong>60.5</strong></td>
</tr>
<tr>
<td>(8) Access road to the site, at a point adjacent to, and to the south of, the Milk Powder Factory, 4 m from road centreline</td>
<td>11:05:11:20</td>
<td><strong>69.1</strong></td>
<td><strong>68.5</strong></td>
</tr>
</tbody>
</table>

**Approximate noise levels for comparison purposes:**
- Typical rural night-time background noise at the facade of house: 35-45 dB(A)
- Typical urban day-time background noise at the facade of house: 55-65 dB(A)
- Passing lorry, heard from roadside: 70 dB(A)
- Jet engine at take-off: 120 dB(A)

**Notes:**
- All measurements are free-field, using a calibrated CEL 393A Noise Analyser with the microphone set at a height of 1.0 m.
- Measurements at locations 1-6 were carried out on Tuesday 25 January, in dry and sunny weather with low-moderate wind speeds.
- Measurements at locations 7-8 were carried out on Friday 28 January, in dry and sunny weather with low-moderate wind speeds.
- Measurement parameters are as follows:
  - $L_{eq}$ - Equivalent steady sound level, in dB(A), containing the same acoustic energy as the actual fluctuation level over the measurement period.
  - $L_{A10}$ - Sound level exceeded for 10% of the measurement period.
  - $L_{A50}$ - Sound level exceeded for 50% of the measurement period.
  - $L_{A90}$ - Sound level exceeded for 90% of the measurement period.
6 ASSESSMENT OF ENVIRONMENTAL IMPACTS

6.1 INTRODUCTION

The EIA provides an assessment of the potential positive and negative environmental impacts resulting from the development of a landfill site at Welisara. On the basis of the information available on the site described in Section 5, and the design concept discussed in Section 4, the EIA focuses upon the following:

- the identification of the characteristics of the site with respect to the key environmental issues, namely:
  - socio-cultural factors and land use;
  - hydrogeology and hydrology;
  - biological factors (flora and fauna);
  - air quality;
  - traffic;
  - aesthetics (visual impact);
  - noise;

- the establishment of the sensitivities of the site with respect to the above, and, hence, the scope for environmental impacts;

- an assessment of the magnitude of potential environmental impacts which may occur due to the development of the landfill site;

- the features and mitigation measures which will be incorporated into the site design to minimise potential environmental impacts and ensure that the overall impact of the landfill is not significant.

- the provision of adequate occupational health and safety measures within the context of mitigation of the above categories of environmental impact.

Hence, the EIA provides an appraisal of the environmental acceptability of the Welisara site for the development of the landfill.

6.2 SOCIO-CULTURAL ENVIRONMENT AND LAND USE

6.2.1 Key Issues

The key socio-cultural issues related to the proposed landfill are the following:

- Resettlement of the population directly displaced by the landfill due to the landtake requirements of the landfill site.
Changes to the socio-economic status of the area, due to the positive effect of potential employment for local people generated by the development of the landfill site and following its restoration, and the impact of negative perceptions of the landfill site in the area. Solid waste disposal in Sri Lanka has a poor reputation, due to the pollution caused by the existing landfill site in Colombo. It is also perceived by some as associated with the influx of scavengers and low income populations, who derive income from sorting through the waste for recyclables or hope for resettlement opportunities as the site develops.

Alterations in the public health status of the area as a result of the elimination of water-borne vectors in the marshland area versus the potential increase in other vectors (such as rats, flies, scavenging birds, wild dogs and cats) that may be attracted by the landfill if not properly managed.

6.2.2 Assessment of Impacts

The development of the landfill will have both positive and negative impacts on the socio-economic conditions of the local community. These impacts are summarised in Table 6.2a with respect to the key issues highlighted above, and discussed in greater detail below.

Landtake and Resettlement

The Welisara site had already been officially designated as a development area, long before the site was proposed for the sanitary landfill. Landtake requirements of the landfill site will include three populated islands within the marshland (Navamahara, Illukgoda and Duva) and will necessitate the phased resettlement of 25 households, most of whom own the land that they occupy. Although alternative relocation sites have not yet been identified by the Government, it is intended that the 25 families to be resettled will be provided with upgraded housing on the hillside surrounding the marsh, as close as possible to their existing residences. The Section 2 Notice, served under the Land Acquisition Act in July 1993, has been served on much more land area than required for the site. Therefore, there is land in the immediate area that will be available for resettlement.

Of the 25 families that will need to be resettled, most are engaged in employment activities 'off-site' although some rely on marsh resources to provide part of their income. For example, some families keep water buffalo and graze cattle along the edges of the marsh and are also involved in fishing and the harvesting of the wild vegetable kankun as well as reeds and grasses for basket making. In order to ensure that these families are able to retain their source of income (should they wish to), special consideration will be given to identifying sites on neighbouring marshland where they can continue these activities.

Within the funds available for the development of the landfill site, a significant allocation (US$1 million) has been set aside for the implementation of a community development plan. This fund is in addition
Table 6.2
Summary of Positive and Negative Socioeconomic Impacts

<table>
<thead>
<tr>
<th>Source of Impact</th>
<th>Positive Impacts</th>
<th>Negative Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landtake and Resettlement</td>
<td>Affected families will receive better infrastructure and services</td>
<td>Loss of family home</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Disruption and inconvenience</td>
</tr>
<tr>
<td>Formal Employment Opportunities</td>
<td>Resourced from local labour market where possible</td>
<td>Demand for additional local housing and services by immigrant workers</td>
</tr>
<tr>
<td>Opportunities for Scavengers</td>
<td>Employment for low income families</td>
<td>Degradation of social status of area</td>
</tr>
<tr>
<td></td>
<td>Maximisation of recycling within the waste stream</td>
<td>Public health risk resulting from poor sanitation in squatter communities</td>
</tr>
<tr>
<td>Restoration and Income Generation</td>
<td>Opportunity for economic development and employment</td>
<td></td>
</tr>
<tr>
<td>Prevalence of Pests and Disease Vectors</td>
<td>Possible reduction in aquatic disease vectors due to drainage of the marsh</td>
<td>Possible increase in pests and disease vectors (e.g. rodents, insects, birds, dogs and cats)</td>
</tr>
</tbody>
</table>

...to the provision of new land and housing to those 25 families that must be resettled from the marsh islands. These measures may include:

- the provision of bunding and tree planting to reduce the visual impact of the landfill site as it develops, and to provide a physical barrier to prevent children playing on the site;
- upgrading of existing housing;
- improved infrastructure and services (e.g. water supplies and sanitation, access, electricity);
- training and awareness campaigns in public health and safety;
- support for income generating or other activities on the restored landfill site.

This fund will be administered by the Ministry of Home Affairs & Provincial Councils (MHA&PC). The MHA&PC intend to employ consultants to assist them in the development of an appropriate community development programme.

A resettlement plan for the 25 households displaced by the landfill site, has been prepared in accordance with World Bank guidelines (1), and is included as Annex C.

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Formal Employment Opportunities

The landfill operation will require drainage, site preparation, construction, fill and restoration activities as well as related services over the lifetime of the site. The labour requirements of the landfill development programme closely match the employment profile of the area, in that manual and skilled manual labourers will be in most demand. This will provide significant employment opportunities to local people, but may also attract new immigrants to the area in search of employment. The possibility (and desirability) of providing suitable housing for these immigrants will need to be carefully considered within the context of the community development plan.

Opportunities for Scavengers

It is the policy of the GOSL to allow scavenging for reusable and recyclable materials on landfill sites. This provides a source of earnings to low income families and maximises recycling activities. However, it is unlikely that local low-income families will benefit from scavenging opportunities, as scavenging is an organised, professional activity in Sri Lanka and it is understood that scavengers must be registered. It is therefore likely that the majority of scavengers will migrate towards the new site from further afield, mainly from areas where existing landfill or dump sites have recently closed, primarily Wellampitiya.

Poorly managed scavenging activities could give rise to two main categories of impact:

- **on-site** impacts in the form of occupational health and safety risks to the scavenger population; and

- **off-site** impacts resulting from the growth of squatter communities around the peripheries of the landfill site would degrade the socio-economic status of the area and could pose a public health risk to both existing and squatter communities, due to the lack of water and sanitation facilities typical of informal squatter communities.

Scavenging activities during daylight hours will be carefully controlled. Scavengers will be registered at the gate, and allowed to work whichever of the two active tip faces is not in use by vehicles delivering waste to the site that day. At dusk all scavengers will be required to leave the site, and their exit registered. Screening at the point of exit to ensure that no on-site injuries have occurred could be carried out as an occupational health and safety check. Scavenged material would be removed from the site in acceptable containers, usually 'gunny (jute) bags', and transport to and from the main A3 Colombo - Negombo road could be provided as a means of minimising disruption and pedestrian traffic along the access road.

It will be the policy of the GOSL (Ministry of Housing, Construction and Urban Development) to ensure that illegal squatter settlements do not occur. This will be achieved by making regular patrols of the site peripheries. Local residents will be encouraged to report illegal squatters to designated...
Community Based Organisations (CBOs) who will take the matter up with the site management. It is possible that an area of land will be identified upon which a squatter community would be permitted. However, this will require careful consideration by the GOSL as the potential negative impacts of this policy are significant. The provision of formal housing and infrastructure to an immigrant scavenger community could have the disbenefit to the local population of creating a 'magnet' for low-income families.

Restoration and Income Generation

Once restored, the site will be available for certain types of economic development, which has the potential to generate employment, income and improved facilities for the local population. These opportunities will arise progressively as the site is filled, completed and restored, and can be directed through consultation with the local inhabitants and administered through the proposed Community Development Programme (to be prepared by GOSL consultants during April 1994) (see also Section 7 and Annex C - resettlement plan).

Acceptable uses for the restored site will be agricultural, horticultural, amenity and certain types of commercial and industrial enterprise, although it should be noted that there will be restrictions on the development of buildings and major structures to prevent subsidence, damage to the landfill cap or risks from the accumulation of methane gas in confined spaces. The integrity of the cap must be monitored in order to restrict percolation of rainfall through the cap and into the waste mass to generate leachate. This means that only shallow rooting plants, for example grasses, will be acceptable. Larger trees and shrubs have the potential for root systems perforating the cap as well as causing local drying out of the capping soils and inhibiting surface water run-off. Planting anything which requires working the surface soils (e.g. root vegetables) must also be avoided.

Prevalence of Pests and Disease Vectors

The biological survey has investigated samples of the marsh plankton from around the site and has found no evidence of mosquito larvae. However, it appears that aquatic disease vectors are not prevalent at the site and, therefore, no significant benefit will be derived from draining the marsh land.

Conversely, the potential exists for an increase in pests and other disease vectors (such as rodents, insects, birds, wild dogs and cats) as a result of poor management of the landfill development. To ensure that this negative impact is prevented, care will be taken to minimise the area of active tipping at any one time and ensuring that all newly-tipped waste has temporary cover applied at the end of the working day. The waste will also be compacted to reduce voids in the waste mass. Further measures, for example the use of insecticides, may be necessary on an ad hoc basis in some seasons.
### Table 5.8b  Daytime Traffic Flows on Galudupita Road on Tuesday 1 March 1994

<table>
<thead>
<tr>
<th>Time (1 hour periods)</th>
<th>Heavy Trucks</th>
<th>Medium Trucks</th>
<th>Vans &amp; Pick-ups</th>
<th>Cars</th>
<th>Motorcycles &amp; Trishaws</th>
<th>Bicycles</th>
<th>Pedestrians</th>
<th>Tractors &amp; Trailers</th>
<th>Bullock Carts</th>
</tr>
</thead>
<tbody>
<tr>
<td>07:00-08:00</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>4</td>
<td>58</td>
<td>243</td>
<td>748</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>08:00-09:00</td>
<td>6</td>
<td>14</td>
<td>9</td>
<td>3</td>
<td>40</td>
<td>147</td>
<td>246</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>09:00-10:00</td>
<td>3</td>
<td>14</td>
<td>20</td>
<td>-</td>
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Table 5.8c  Daytime Traffic Flows on Galudupita Road on Monday 7 March 1994

<table>
<thead>
<tr>
<th>Time (1 hour periods)</th>
<th>Heavy Trucks</th>
<th>Medium Trucks</th>
<th>Vans &amp; Pick-ups</th>
<th>Cars</th>
<th>Motorcycles &amp; Trishaws</th>
<th>Bicycles</th>
<th>Pedestrians</th>
<th>Tractors &amp; Trailers</th>
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<td>9</td>
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</table>
6.3 HYDROGEOLOGY AND HYDROLOGY

6.3.1 Key Issues

The key hydrogeological and hydrological issues related to the proposed landfill site are:

- the potential for contamination of water resources (surface water and groundwater), by discharges, for example fuel spillages and waste construction materials, during construction of the landfill site or escape of leachate during operation;

- changes to the flood storage capacity of the catchment of the Kalu Oya (river) and its tributaries, which may lead to increased flooding either upstream or downstream of the site;

- changes to the drainage characteristics of the area, and hence the availability of groundwater for extraction from wells by the local population and industry.

The important aspects of the site with respect to these issues are as follows:

- The local population make use of near-surface groundwater through shallow wells, as well as abstracting water and fishing in the Kalu Oya and its tributaries. It is understood that industrial enterprises in the area may also abstract water via wells for industrial purposes.

- The marsh land present on the site acts, as does most of the land adjacent to the rivers in this particular catchment, as a flow regulating mechanism, by providing flood storage capacity and a buffer during periods of high rainfall. However, the total site area is 124 hectares, which represents only 2% of the total catchment area.

6.3.2 Assessment of Potential Impacts

The protection of groundwater resources in this low lying area, and/or the provision of alternative piped water supplies suitable for potable and industrial uses, is essential. The design of the landfill will incorporate a range of environmental protection measures which will address these issues and minimise the potential impacts.

Potential for Contamination of Water Resources

The engineering design of the landfill site contains a number of measures to minimise rainfall infiltration into the site, to prevent underground seepage of leachates and to contain the lateral movement of leachates into the marsh. These measures are described in detail in Section 4.4.3. A system has also been designed to collect, control and treat the construction and operational effluent and leachate prior to discharge into the Kalu Oya. The system is currently planned to utilise natural biological treatment using local semi-aquatic vegetation (see Section 6.4).
Geotechnical investigations carried out show that any underground seepage of contaminants are also likely to be contained in the immediate area as a result of the extremely low hydraulic gradient of the site area (land drops approximately 0.4 m over the 2 km length of the total marsh area). Seepage of leachate into surrounding shallow wells would be very unlikely not only for the reason given above but also because the local shallow wells are only on areas of higher land where the water table is at a higher level than in the site area. It is improbable that leachate would migrate against the prevailing hydraulic gradient into these water sources, unless abstractions were sufficiently large to reverse the groundwater flow regime.

**Flood Storage Capacity**

The hydrological setting is shown in Figure 6.3a. The potential changes to the flooding regime of the Kalu Oya catchment downstream of the site is an important aspect, especially due to the high density of population in these areas. The result of the bund engineering and redirection of the tributary of the Kalu Oya on the site, together with the loss of the site area which was previously available for flooding, will very slightly increase (3-5%) the flows of water passing downstream after heavy rainfall events. This has the potential to cause higher flood levels downstream, including at the Kelani Ganga, the Old Negombo Canal and also, by back-up of water, upstream of the site itself.

Preliminary studies show that due to the low gradient of the entire catchment area, the areas upstream of the Welisara site provide a substantial amount of flood water storage capacity. The Welisara site itself represents only 2% (130 ha) of the total catchment area (of around 50 sq.km.). During a peak rainfall event, the majority of the flood water will be retained in areas of low lying land and marshes before it reaches the site area. Due to the low gradient of the entire catchment area the total upstream area capable of acting as flood water retention has been calculated from topographical maps. A flood water level has been assumed for each area, becoming progressively higher towards the site where it is taken as 2 m above normal water level (based on field observations and discussions with long-term residents of the area and comparable monitoring data available from the nearby Muthurajawela wetland area across the A3 highway). From these figures the site was found to represent only 8% of the total upstream flood capacity. This fact considerably lessens the impact of removing this area of flood water storage.

Given the existing channel dimensions of the Kalu Oya and its tributaries, removal of the storage capacity of the Welisara site would only result in a rise in water levels during periods of peak flow. Even at these times, the water level would be expected to rise by a maximum of only 10cm above normal flood levels in the Welisara site area, and progressively less
SKETCH MAP OF THE HYDROGICAL SETTING AND PROPOSED MITIGATION MEASURES OF THE WELISARA SITE.
downstream, becoming (relatively) zero at the junction with the Kelani Ganga. This conservative estimate of 10cm was derived from calculations based on the slightly increased flow levels due to the loss of flood storage backing up from the Old Negombo canal in the existing channel dimensions. It is estimated that the maximum flood increase downstream where the Kalu Oya meets the Old Negombo Canal would be approximately 1 - 2cm.

The figures stated above take into account the loss of the entire site as flood storage space. However, it is planned to develop the site in phases, over a 15 year period, starting in the north (see section 4.6). The site will still be acting as flood water storage for 10-15 years and it will take that long for the estimated total 10cm increase in flood water level to be realised. During this time period monitoring of the actual increase in flood water level should take place. Given that there are densely populated areas downstream of the site, and flooding is a very sensitive issue in the north Colombo area, it is recommended that a full hydrological survey is carried out at the detailed design stage, to confirm these preliminary estimates.

A preliminary study of the river Kalu downstream of the site area shows that there are no specific points where the channel is constricted; where there is insufficient clearance under bridges or where a rise in water level of a few centimetres will cause any significant changes to the existing flooding patterns. The development of the Welisara site, due to the existence of a flood plain and cultivation which is largely dependent upon flooding will have minimal impact in the Kalu Oya south of the site. As the loss of the site flood plain is estimated to lead to a maximum increase of only 1cm-2cm water level where the Kalu Oya meets the Old Negombo Canal, the effect on the existing flooding patterns will also be minimal. The upstream flood plain characteristics are similar to downstream. A rise in flood level water, due to backing up of water of approximately 10 cm will not cause any significant changes to the existing flood patterns. Based on the above evaluation no specific offsite flood protection measures are considered to be required as a result of the landfill development. Further details on the calculations undertaken are given in Annex 1.

Any rehabilitation and enhancement of the flood protection measures already installed throughout the area in the Old Negombo Canal and the Kelani Ganga would be a valuable contribution to the residents of areas north of Colombo city, who do suffer flood damage to their properties. However, the measures that need to be taken cannot be related solely to the development of the Welisara site.

**Drainage Characteristics**

The stream which traverses the site will need to be redirected. The most appropriate route for the new channel is under the railway (in a new culvert) to the North East of the site and then discharging into the marsh beyond the railway. This route will allow the marsh to the east and south of the railway to provide flood water retention during times of peak flows. This will help to alleviate flooding downstream and will reduce the risk of
SCHEMATIC SKETCH SHOWING
REROUTING OF STREAM
TRAVERSING LANDFILL SITE
groundwater seepage into the site. Providing additional flood protection to the railway embankment could, potentially, be required by the S.L. Railways, in the form of an abutting bund. However, this is not anticipated to be necessary at this stage. The option of redirecting the stream down the West side of the railway incurs the risk of an extreme flood overtopping and possibly damaging the railway and or the embankment. The land requirement in this option would also reduce the available capacity of the landfill site.

Due to the high water table (typically at the ground surface or within 0.3m of the ground surface even during the dry season) and very low gradient of the site area the movement of both groundwater and surface water across the site will be very slow (with the exception of monsoon periods). The flow path follows the natural slope in a southerly direction, and water flows in other directions will be minimal. The water in local wells is therefore drawn from their immediate vicinity and is not percolating water from the wider marsh area. The abstraction rates from local inhabitants or from local industries are not expected to cause any significant movement of groundwater from below the site area. However, exact abstraction rates and water quality data should be obtained from local industries prior to the commencement of the detailed design work at the site.

It is not expected at this stage that the development of the landfill site will affect water abstraction by local industries or households. However, although risks are minimal, as an added precaution against contamination due to failure of measures to contain the leachate, households in close proximity to the site should be provided with piped water supplies. A mains water supply is located approximately 500m to the north of the site as a possible alternative water supply.

6.4 BIOLOGICAL FACTORS

6.4.1 Key Issues

The key biological issues related to the proposed landfill site are as follows.

- **The landtake requirements for the site**, which will result in a maximum of 124 hectares of marshland being lost to the landfilling operations, with the result that (progressively) drier, more elevated land will be generated as waste is placed, covered and restored in phases.

- **Disturbance to the fauna (though not of significant ecological importance) of surrounding areas near to the landfill site**, due to noise, traffic, etc. associated with the landfilling operations.

- **Disruption to the habitats present on low-lying areas in the vicinity of the site**, due to changes in their drainage characteristics caused by the landfill site altering the hydrology of the area.
• The scope for improving/generating new habitats of conservation interest, as part of the landscaping and restoration of the landfill site, during construction, operation and after the site is completed.

The potential impacts of drainage, traffic and noise are discussed in Sections 6.3, 6.6 and 6.8 respectively. The important aspects of the site with respect to the flora and fauna present are as follows.

• Although the marshland is a wetland habitat, it is not 'virgin', and has been cultivated to a greater or lesser degree for many years. Although large-scale use for paddy discontinued in the 1960s, the biological survey of the site indicated that attempts at cultivation are continuing.

• The marshland area is largely isolated within higher ground which is under settlement, particularly on the upper slopes. It is not contiguous with the ecologically-important Muthurajawela wetlands (see Figure 6.3a), which are located approximately 5 km to the north-west. The habitats present are, hence, already likely to be disturbed by the presence of the local population, including by the grazing of water buffalo and some cattle and the cutting of grass and reeds.

6.4.2 Assessment of Potential Impacts

Due to the facets of the site described in Section 6.4.1 above, it is unlikely that the existing marshland habitats on and in the vicinity of the site are either particularly sensitive to disturbance or contain significant quantities of rare species, for example the larger mammals and reptiles, such as estuarine crocodile. Therefore, the landfill site should not result in a major loss of existing nature conservation value.

However, rerouting of the stream which traverses the site would mean the loss of habitat for animals who have found food, shelter and breeding grounds in this waterway. Construction of the waterway will give rise to temporarily raised sediment loads as well as changes in water quality parameters such as pH and dissolved oxygen, which will cause a temporary loss of fauna in the waterway itself as well as a decrease in the fish fauna downstream. It will take many years before the biological diversity of the stream returns to pre-construction levels.

The diversion of the stream will enable the wetland ecosystem upstream of the site to be preserved as well as potentially enhance the wetlands to the east of the railway. To prevent erosion in the diverted waterway the banks should be stabilised with vegetation or some type of biological cladding which will encourage plant growth over time.

The development of the landfill site will also include measures to compensate the loss of the marshland by the following:

• *creative conservation in the development proposals*, consisting of the use of indigenous species in a landscaping and planting programme for the site, including initial visual screening and subsequent progressive restoration
of the site. The landscaping scheme will include nature conservation as a key component.

- **use of biological systems for leachate treatment**: current research by the University of Colombo in Sri Lanka into the use of wetland plants for treatment of liquid effluent indicates that some of the vegetation identified on the site is suitable for treating the leachate drained from the landfill, and has been applied elsewhere. Hence, this existing vegetation, or a similar type, will be considered for extension onto certain areas of the site for the dual purpose of leachate treatment and nature conservation (see Section 4.3.4).

Hence, the development of the site is not predicted to cause a significant loss of nature conservation value.

### AIR QUALITY

#### 6.5.1 Key Issues

The key air quality issues related to the proposed landfill site are:

- **generation of odour**, due to the production of gases by the decomposition of waste during landfill operations and after it has been deposited. The high organic (putrescible) content of the municipal waste (86%) means that the installation of appropriate measures to minimise odour will be particularly important;

- **suspension of dust**, due to the landfilling activities, especially vehicle movements and operations associated with site preparation, excavation and drying of peat, waste delivery and deposit and cover/restoration;

- **effects of vehicle emissions**, due to the traffic associated with the landfill operations.

The key aspect of the site with respect to these issues is the proximity of settlements near to the site boundaries, which will be sensitive to any loss of amenity due to the above air quality impacts.

#### 6.5.2 Assessment of Potential Impacts

The potential impacts indicated in Section 6.5.1 are controllable to avoid causing nuisance by appropriate design of the landfill, good site and operational management and implementation of mitigation measures during the landfill operations. The measures which will be included in the site design and operation to minimise air quality impacts will be as follows:

- **layout of the site to ensure that spoil heaps, for example of peat, are sited at least 100 m from settlements.** The typical wind speeds in the area are understood to be less than 4.5 ms\(^{-1}\). At these speeds, dust particles of greater than 30 \(\mu\)m are likely to settle out within 100 m from the source.
(with larger particles depositing much closer, for example particles over 100 μm will settle within approximately 10 m). With the bunding and screening of the site also acting as a wind break and, to some extent, as a dust trap, the layout of the site should minimise the potential for nuisance from dust;

- **sheeting and/or covering of waste delivery vehicles**, wherever practicable, to minimise the inadvertent escape of dust and odour from waste being delivered to the site (as well as litter);

- **provision of a bund and buffer zone between settlements and the landfill site**, which will separate the nearest settlements from the operational site by at least 50 m. This separation provides the capacity for any on-site emissions to be dispersed and diluted in the atmosphere, thereby reducing the potential for the emissions to be detectable or cause nuisance at the settlements;

- **regular covering of waste materials after deposit**, to prevent decomposition of waste in the open air causing odour (as well as reducing the potential for windblown litter);

- **development of a gas recovery system**, to collect and dispose of the gas generated by the decomposition of waste within the landfill after placement and covering (for example, by flaring off using pipes inserted into the deposited waste mass).

- **high standard of site supervision, particularly good housekeeping**, to ensure that the mitigation measures are continually employed and the overall site is run efficiently according to good waste management and environmental protection practices. This should include the regular wetting of on-site roads within 100m of settlements.

The incorporation of these mitigation measures into the landfill design and operation, together with the stringent site supervision recommended, is good landfill management practice and considered appropriate to minimise the potential impacts on air quality. These measures should ensure that there is no significant loss of amenity to the nearby settlements.

### 6.6 TRAFFIC

#### 6.6.1 Key Issues

The key traffic issues related to the proposed landfill site are:

- **disturbance to the settlements near to Galudupita Road and the access road to the site**, due to disruption of other road users (congestion, delays, etc), disturbance by engine noise and air pollution from vehicle exhausts.

- **disturbance to local fauna** *(typically common species only)* **near to the access road to the site**, due to engine noise.
The issues related to noise are discussed in Section 6.8. The important aspects of the site with respect to other potential impacts (disruption to road users and air pollution) are as follows:

- Galudupita Road provides access to the large settlement of Galudupita adjacent to the site and, hence, it is frequently used by the local population. Pedestrians and cyclists are relatively common road users.

- There is some settlement and small shops adjacent to the lower stretch of Galudupita Road.

- The industrial premises along Galudupita Road (the Milk Powder Factory, Aztec pipe manufacturers, Shermans Welisara Complex and the Government Food Depot) means that the road is currently in regular use by trucks.

6.6.2 Assessment of Potential Impacts

The presence of settlements near to the road indicates that increases in congestion and the increased risk of accidents, disturbance by noise and the impacts of air pollution are the important traffic issues. These issues will be especially important in relation to the overall delivery of waste, the option of delivering some of the bulk containers of waste from the transfer station in late evening and/or if traffic movements are required over week-ends.

An estimate of the traffic which will be associated with the development and operation of the landfill site is given in Table 6.6a. The key aspects of the scheduling of this traffic are as follows:

- The bulk of the site workers are likely to travel to the site at the start of the daily working period (12 hours between 07:00 and 19:00) and depart at the end.

- Delivery of waste during the daily working period is likely to be approximately evenly spread, although it is conservatively estimated that, in practice, a maximum of 20% of the waste may be delivered in any one hour. Hence, the average number of trucks visiting the site in any one hour, assuming that all the trucks operate during the 12-hour daily working period, will be 12. The maximum number is estimated to be 24.

- It is proposed to schedule bulk haulage deliveries from the transfer station to avoid the morning and evening peak traffic periods. The exact number of vehicles and delivery schedule will depend on the operational system employed, and the number of bulk transfer vehicles available, at the transfer station.

- The tractors and trailers will deliver waste during the daytime following the completion of their collection rounds. On the basis of a 12-hour daily working period at the landfill site, the number of tractors and trailers delivering waste will average 12 per hour with a maximum of 25.
These potential traffic flows should be considered in light of the existing number of truck movements on Galudupita Road, which the traffic counts indicate vary between approximately 10-40 per hour from 06:00 to 23:00. Trucks are also present on the road in the night-time hours immediately preceding and following this period.

The traffic count on Galudupita Road indicates that additional daily vehicle movements during operation of the site, assuming that all vehicles deliver waste during the daytime, will constitute an increase of approximately 75% in medium and heavy truck movements (12-hour daily traffic flows). The average hourly change to truck traffic would also be comparable with this increase. An increase of between 50-100% in flows of heavy vehicles is normally considered to have marginal impacts, although it should be noted that any increase in traffic may lead to additional congestion, particularly at the junction with the A3 highway. In addition, waste may be delivered to the landfill site in up to 150 tractors and trailers per day, which may cause disruption due to their relatively low road speeds. Overall, all the vehicular traffic (trucks, vans and pick-ups, cars and tractors and trailers) associated with the landfill site during operation will generate an increase in total daily (12-hour) traffic flows on Galudupita Road of 113%. The current overall traffic flows are moderate, hence Galudupita Road should be capable of carrying this increased traffic, although it requires improvements to its state of repair.

The traffic data for the A3 highway is more limited than for Galudupita Road (see Section 5.8). Generally, the flows on the A3 highway are high and congestion is apparent, particularly during peak periods and near central Colombo: truck movements recorded over the peak mid-day hours near central Colombo averaged 175. The truck movements and overall traffic conditions ease away from central Colombo (towards the site) with lower traffic flows, but significant overall vehicle and truck movements still occur throughout the day. The increase caused by the landfill site (even assuming that all the trucks deliver waste during the daytime) are estimated to be minor by comparison with the existing flows (a maximum of 10-20% in truck movements and less than 5% in overall traffic) and will not significantly change the existing road conditions. However, due to the existing traffic flows being at, or approaching, the capacity of the highway, the junction of the A3 highway and Galudupita Road is a concern which will require special attention if the disruption to other road users is to be minimised.

Daytime traffic flows on the A3 highway and Galudupita Road due to the landfill site and, hence, the potential for congestion will be reduced with the implementation of the following:

- the avoidance of the peak morning and evening periods and extending delivery of bulk wastes from the transfer station to the landfill reception area either side of the start and finish of the landfill operating hours.

- development of the collection and transfer system for waste, especially the increased use of new or larger vehicles to collect and deliver heavier waste payloads (for example, via bulk transfer operations): these
developments will reduce the use of vehicles with small payloads, slow road speeds and/or in poor condition, for example tractors and trailers, and hence reduce the traffic delivering waste as well as its potential to cause congestion.

The potential impacts of traffic will also be minimised by the following key measures within the development of the landfill site:

- **scheduling of traffic** to avoid the peak periods on the local roads (07:00-09:00, 13:00-14:00 and 17:00-19:00);

- **improvements to Galudupita Road**, such as widening, resurfacing, kerbing, construction of pedestrian walkways, etc, which will increase the carrying capacity of the road and improve road safety, especially with respect to pedestrians and cyclists;

- **bunding, screening and landscaping between the new site access roads off Galudupita Road and the adjacent settlements**, to reduce noise. A minimum separation of 50 m between the site access road and the nearest settlement is proposed.

- **improvements to the junction of Galudupita Road and the A3 highway**, for example widening the turn, new traffic control measures/signals, signs in three languages etc, to ease traffic flows and congestion and improve road safety.
### Table 6.6a Estimated Traffic Associated with the Development and Operation of the Welisara Landfill Site

<table>
<thead>
<tr>
<th>Source of Traffic</th>
<th>Maximum Number of Vehicles per Day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Truck (Heavy and/or Medium)</td>
</tr>
<tr>
<td>Site Preparation:</td>
<td></td>
</tr>
<tr>
<td>Delivery of construction materials and supplies (fuel, etc)</td>
<td>5-10</td>
</tr>
<tr>
<td>Construction workers(^{(0)})</td>
<td>-</td>
</tr>
<tr>
<td>Operation:</td>
<td></td>
</tr>
<tr>
<td>Delivery of waste</td>
<td>120(^{(a)})</td>
</tr>
<tr>
<td>Delivery of materials and supplies</td>
<td>2</td>
</tr>
<tr>
<td>Site workers(^{(0)})</td>
<td>-</td>
</tr>
<tr>
<td>Visitors(^{(0)})</td>
<td>-</td>
</tr>
<tr>
<td>Notes:</td>
<td></td>
</tr>
</tbody>
</table>

\(^{(0)}\) 10% of workers are assumed to travel to work by car. The remainder are assumed to travel by motorcycle, or to walk or cycle.

\(^{(a)}\) The trucks are estimated to consist of the following:
- bulk container vehicles (15 tonnes payload) from the Baseline Road transfer station: 30
- rear compactor vehicles (5 tonnes payload): 50
- rear compactor vehicles (3 tonnes payload): 20
- rear compactor vehicles, skip hoist vehicles and other trucks (1 tonne payload: 20).

\(^{(b)}\) The tractors and trailers typically carry a 1 tonne payload.
With the implementation of these measures and appropriate planning of waste delivery, the impacts on traffic and other road users should be minimised and are not considered likely to be significant.

6.7

AESTHETIC APPEAL

6.7.1 Key Issues

The key aesthetic issues associated with the proposed landfill site are:

- **the visual impact on local settlements**, due to the loss of up to 124 hectares of open marshland and replacement by the operational, and later the restored, landfill site. These impacts may include the loss of landscape features, changes to the overall character of the area and development of new features as a result of the development of the site;

- **the visual impact on travellers on the railway on the eastern boundary of the site**, due to similar reasons to those indicated above;

- **litter nuisance**, due to waste/debris being blown by the wind off the landfill site and from uncovered vehicles delivering waste, for example tractor trailers. The potential effects include direct impacts arising from items of waste being dispersed onto adjacent land-owners properties as well as more general loss of visual amenity from unsightly accumulations of litter.

The key aspects of the site with respect to these issues are as follows:

- The site is currently undeveloped, therefore the landfill site will be a significant alteration to the existing landscape. The landfill will involve land-raising by up to 25-30 m in certain places, and by an average of 15 m over the whole of the site. Therefore, the topography of the site will be changed. It should be noted that the high ground around the site is currently 15-20 m above the height of the site.

- There are large settlements on the higher ground to the south, west and north of the site. These settlements extend to the edge of the site and are elevated compared to it, hence, where screening by trees is restricted, they have broad views over the site. However, it should be noted that the trees which have developed on the higher ground screen the bulk of the settlements.

- The railway on the eastern boundary of the site is the main line from Colombo to the north-east. It is commonly used by tourists visiting the cultural centre of Kandy and to whom visual appearance is an important issue.
There are settlements located adjacent to the site boundary. Their relatively close proximity increases the risk of loss of amenity due to litter nuisance.

6.7.2 Assessment of Potential Environmental Impacts

The aspects of the site and surrounding area described in Section 6.7.1 above mean that aesthetic issues are likely to be important in the development and operation of the landfill site.

In particular, views which will need consideration will be those from the settlements on the margins of the marshland to the north, from the railway to the east, and generally from more distant, elevated locations on the higher ground to the south, west and north. The impact on the aesthetic quality of the area will depend on the ultimate visibility and appearance of the working areas of the landfill site from these key viewpoints.

To minimise the visual impacts of the development of the site, the following design and operational features will be employed:

- **provision of a landscaped bund and buffer zone as screening between the settlements, the railway line and the landfill site,** which will separate the nearest settlements from the operational site by at least 50 m. The bund will be designed to provide screening of the site through its own height and by the planting of appropriate vegetation, for example fast-growing and dense species of flora. The intervening area will be landscaped to preserve the visual amenity of the local settlements as far as possible. It should be noted that, due to the size of the site, waste placement will be undertaken well in excess of 50 m from the nearest settlements during the majority of the life of the landfill.

- **regular covering of waste materials after deposit** which, as well as preventing decomposition of waste in the open air causing odour and minimising windblown litter, will improve the overall appearance of the site.

- **development of the site in discrete stages** (with progressive filling in each stage) which will allow the parts where waste deposit is completed to be covered and restored. This means that the working area, and hence visual intrusion, will be minimised and restricted to only a proportion of the overall site at any one time.

- **restoration and landscaping scheme for the site,** which will ensure that, in the longer term after landfilling operations are complete, the site will be fully restored to a natural outlook and be available for certain types of agricultural, horticultural or commercial development. The landscaping may include the development of natural habitats of nature conservation value, return to agricultural use, development of amenity facilities and/or promotion of commercial enterprises (although the construction of buildings will not be appropriate on the site, due to the potential for subsidence, for damage to be caused to the capping material of the landfill.
and for the risk of explosive concentrations of methane gas building up in confined spaces within structures).

In addition, due to the proximity of the settlements, the prevention of litter nuisance causing a loss of amenity is a significant concern. The high proportion of organics (86%) and, hence, high moisture content of the municipal waste arisings indicates that litter generation should not normally be significant. However, to minimise the potential for any litter nuisance to occur, the development and operation of the landfill site will include the following measures:

- **Sheeting and/or covering of waste delivery vehicles**, wherever practicable, to minimise the inadvertent escape of litter from waste being delivered to the site (as well as reducing odour and dust);

- **Development of the landscaped bund and buffer zone to act as a wind-break and provide screening**, which will minimise the risk of winds entraining litter and also intercept any litter arising from the site operations. The potential nuisance of litter will be reduced by the separation distance of at least 50 m between operational areas of the landfill site and the nearest settlements.

- **Regular covering of waste materials after deposit**, to prevent prolonged exposure of the waste after placement causing litter.

- **Use of litter screens, nets or equivalent** to intercept windblown litter. These measures may include litter screens placed around part, or all, of the site perimeter, working cells or local areas of active waste placement within the site. Local, readily movable litter screens may be temporarily employed during periods of potentially high litter generation, for example in dry spells with high winds.

- **Litter picking**, whereby at periodic intervals, or after events which have led to litter being dispersed (for example, high winds), site workers will be detailed to collect litter from off-site areas and nearby roads. This exercise may also be achieved by the provision of incentives to scavengers to collect litter from access roads and other off-site areas;

- **High standard of site supervision, particularly good housekeeping**, to ensure that the litter control measures are utilised to their full potential.

Hence, the development of the landfill site will incorporate a range of measures to screen the settlements and railway line from the operational areas, preserve the overall appearance of the area and to minimise litter generation and any associated impacts. The scheme will include a range of landscaping proposals which will minimise the visual impact during operation and return the land to a beneficial use upon completion of the landfilling operations. Therefore, although the development will involve a major change to the outlook of the site and immediately surrounding area, the overall proposals are not considered likely to cause a significant impact on the aesthetics of area.
6.8 NOISE

6.8.1 Key Issues

The key noise issues related to the proposed landfill site are:

- *disturbance to people living in the settlements near to the site*, due to noise from on-site activities, for example earth-moving plant, large volume trucks delivering construction materials, plant depositing and covering waste, pumps dewatering the site, etc, as well as traffic entering and leaving the site. This issue is particularly important if evening, night-time or week-end working is undertaken;

- *disturbance to local fauna in the surrounding areas*, due to the on-site activities and traffic.

The important aspects of the site with respect to these issues are as follows:

- The existing noise climate at the site is reasonably low, typical of a rural/suburban area. Hence, changes in noise levels will be more noticeable than in other, more noisy, environments. Along Galudupita Road, the background noise level is higher, due to the movement of traffic, particularly trucks, associated with the Milk Powder Factory, Aztec pipe manufacturers, Shermans Welisara Complex, the Government Food Depot and other industry in the area.

- The site has large settlements along its northern, western and southern boundaries. These settlements will be sensitive to noise impacts.

- The site is not likely to support fauna which has a high sensitivity to disturbance, since noise and disruption by the local population already occurs on its margins and, to a lesser extent, throughout the site area. However, the landfill operations may be expected to discourage some species, for example birds, from using the area, particularly for breeding.

6.8.2 Assessment of Potential Impacts

Due to the aspects of the site described in Section 6.8.1 above, the disturbance of the local settlements by noise is likely to be the main issue. The noise generation at the site will be dependent on a variety of factors, the most important of which will be as follows:

- number, type and design of the plant used on-site;
- use of noise prevention and minimisation measures;
- mode of operation;
- site layout;
- screening and distance from noise-sensitive receptors;
- working hours (daytime, evening, night-time, etc).
The potential impact of the operations will depend upon the noise levels generated in comparison with the existing noise climate experienced at the nearest sensitive receptors (the settlements on the margins of the site).

There are a range of standards which may be applied for the purpose of limiting noise at the site to ensure that no significant noise impacts occur. It is recommended that the following guideline is applicable to candidates at the landfill site, and can generally be considered good standards of noise environment.

- 55 dB L_{Aeq} daytime and 45 dB L_{Aeq} night-time at the nearest off-site house (as an external facade level) due to the site operations.

Noise from the site will be minimised as far as practicable by the incorporation of mitigation measures into the site design and operational procedures, including:

- **provision of a bund and buffer zone between the settlements and the landfill site**, which will separate the working areas of the landfill from the nearest settlement by at least 50 m, serve to screen the site and act as a noise barrier;

- **location of plant as far as practicable from settlements**, for example dewatering pumps, to minimise the effects of noise generation;

- **careful selection and operation of plant**, to avoid the use of unnecessarily noisy plant and ensure that the selection of plant includes consideration of its noise emissions. Where necessary, noise enclosures/screening may be appropriate around unavoidable relatively noisy plant;

- **use of on-site materials as noise screens**, for example the location of spoil heaps of peat between the operational areas and settlements;

- **restriction of operating hours**, to minimise the traffic and site operations during quiet periods (evenings, night-time, week-ends, official holidays, etc with the possible exception of delivery of bulk containers).

- **high standard of site supervision, training and maintenance of plant**, since the site management, appropriate training of workers in plant operation and adequate long term maintenance of plant are all means by which noise emissions from on-site operations can be reduced).

Although it will be difficult to meet the standard of 55 dB L_{Aeq} daytime at all receptors and the proposed landfill, the impacts will be temporary and will follow the progressive development and infilling of the site.

With the application of the above mitigation measures, the noise generated at the landfill site should be minimised. On the basis of the achievement of the noise standards identified as applicable to the site operations (or the meeting of appropriate criteria which may be developed from them), no significant noise impacts are considered likely to arise.
In the event of night-time delivery of bulk container vehicles, a maximum of 3 trucks per hour are anticipated along Galudupita Road, and no landfill to operations activities will take place at night. The noise impact will therefore be restricted to these households along Galudupita Road itself. Given the limited number of receptors, and the significant advantages of night-time delivery in terms of reduced traffic congestion and numbers of haulage vehicles required, these noise impacts are not considered significant.
7.1 INTRODUCTION

This section provides details of the mitigation measures which will be incorporated into the design and operation of the landfill site. The following details of the mitigation measures are provided:

- type of measure (engineering, management, etc);
- budget costs (capital and operating);
- requirements for institutional arrangements;
- ongoing monitoring.

7.2 MITIGATION MEASURES

The proposed mitigation measures to be employed to minimise the environmental impacts of the development of the landfill are briefly summarised in the following sections. These mitigation measures, together with broad cost estimates, institutional responsibilities and monitoring requirements are presented in Table 7.2a.

7.2.1 Socio-cultural factors

- A Resettlement Plan is to be prepared to provide housing and access to livelihood within the Welisara area of at least equal standard to the existing housing quality of life of the population to be resettled (see ANNEX C).

- A Community Development Plan is to be prepared by the MHA&PC to provide compensation to affected families within the designated development area at Welisara. These measures may include:

  - the provision of bunding and tree planting to reduce the visual impact of the landfill site as it develops, and to provide a physical barrier to prevent children playing on the site;
  - upgrading of existing housing;
  - improved infrastructure and services (e.g. water supplies and sanitation, access, electricity);
  - training and awareness campaigns in public health and safety;
  - support for income generating or other activities on the restored landfill site.

- Employment Opportunities will be offered to local people with appropriate skills, as a priority.

- Scavenging Activities will be strictly managed to prevent on-site risks to health and safety, and negative socio-cultural impacts on the existing community. Specifically, the uncontrolled growth of squatter communities
around the periphery of the site will be prevented, and access to and from the site will be managed to prevent congestion and littering of the roads and surrounding area.

- **Provision of new Potable Water and Sanitation** for those households whose existing facilities are at risk from contamination from the landfill site in the unlikely event of a failure of the site containment measures.

- **Prevention of Pests and Disease Vectors** will be achieved by minimising the area of active tipping and ensuring that newly-tipped waste has temporary cover applied at the end of the working day. The waste will also be compacted to reduce voids in the waste mass. Insecticides may be used on an ad hoc basis if necessary.

- **Restoration and Income Generation** opportunities will be administered through the Community Development Plan (see above) and may include horticultural, amenity and certain types of commercial enterprise.

### 7.2.2. Hydrology and Hydrogeology

- **Impermeable lining and cover** will be provided to minimise rainfall infiltration, underground seepage and lateral movement of leachates by achieving a maximum permeability of $10^{-9}$ m sec$^{-1}$.

- The proposed improvements to the existing flood protection bund along the Kalu Oya river, as well as the existing railway embankment to the east of the site (if required), would also serve to prevent pollution of the water course by leachate in the unlikely event of a failure in the leachate containment facilities.

- **Flood control** would be achieved by:
  - redirection of the stream traversing the site to the east of the existing railway line, thereby allowing the marsh to the east and south of the site to provide flood retention capacity during times of peak flows;
  - care will be taken to ensure that this stream is kept free of dogging vegetation;
  - it may be necessary, if required by Sri Lanka Railways, to strengthen the existing embankment by the creation of a bund abutting the embankment.

- A **full hydrological survey** will be a requirement of the detailed design of the landfill site, in order to confirm preliminary evaluations of upstream and downstream flood risk and associated flood control precautions.

- **Provision of new potable water supplies** to households whose existing wells could be contaminated in the unlikely event of a failure of the site containment or failure of the supply as a result of the lowering of the water table from site dewatering activities.
7.2.3 Biological factors

- *Creative conservation in the development proposals* consisting of the use of indigenous species in a landscaping and planting programme for the site, including initial visual screening and subsequent progressive restoration of the site. The landscaping scheme will include nature conservation as a key component.

- *Use of biological systems for leachate treatment:* current research by the University of Colombo in Sri Lanka into the use of wetland plants for treatment of liquid effluent indicates that some of the vegetation identified on the site is suitable for treating the leachate drained from the landfill, and has been applied elsewhere. Hence, this existing vegetation, or a similar type, will be considered for extension onto certain areas of the site for the dual purpose of leachate treatment and nature conservation.

7.2.4 Air Quality

- *Layout of the site to ensure that spoil heaps, for example of peat, are sited at least 100 m from settlements.* The typical wind speeds in the area are understood to be less than 4.5 ms⁻¹. At these speeds, dust particles of greater than 30 μm are likely to settle out within 100 m from the source (with larger particles depositing much closer, for example particles over 100 μm will settle within approximately 10 m). With the bunding and screening of the site also acting as a wind break and, to some extent, as a dust trap, the layout of the site should minimise the potential for nuisance from dust.

- *Sheeting and/or covering of waste delivery vehicles,* wherever practicable, to minimise the inadvertent escape of dust and odour from waste being delivered to the site (as well as litter).

- *Provision of a bund and buffer zone between settlements and the landfill site,* which will separate the nearest settlements from the operational site at least 50 m. This separation provides the capacity for any on-site emissions to be dispersed and diluted in the atmosphere, thereby reducing the potential for the emissions to be detectable or cause nuisance at the settlements.

- *Regular covering of waste materials after deposit,* to prevent decomposition of waste in the open air causing odour (as well as reducing the potential for windblown litter).

- *Development of a gas recovery system,* to collect and dispose of the gas generated by the decomposition of waste within the landfill after placement and covering (for example, by flaring off using pipes inserted into the deposited waste mass).

- *High standard of site supervision,* particularly good housekeeping, to ensure that the mitigation measures are continually employed and the overall site is run efficiently according to good waste management and environmental
protection practices. This should include the regular wetting of on-site roads within 100m of settlements.

7.2.5 Traffic

- **Scheduling of traffic** to avoid the peak periods on the local roads (07:00-09:00, 13:00-14:00 and 17:00-19:00), as well as evenings, night-time and week-ends wherever possible.

- **Improvements to Galudupita Road**, such as widening, resurfacing, kerbing, construction of pedestrian walkways, etc, which will increase the carrying capacity of the road and improve road safety, especially with respect to pedestrians and cyclists.

- **Bunding, screening and landscaping between the new site access roads off Galudupita Road and the adjacent settlements**, to reduce noise. A minimum separation of 50 m between the site access road and the nearest settlement is proposed.

- **Improvements to the junction of Galudupita Road and the A3 highway**, for example widening the turn, new traffic control measures/signals, signs in three languages etc, to ease traffic flows and congestion and improve road safety.

7.2.6 Aesthetics

- **Provision of a landscaped bund and buffer zone as screening between the settlements, the railway line and the landfill site**, which will separate the nearest settlements from the operational site by at least 50 m. The bund will be designed to provide screening of the site through its own height and by the planting of appropriate vegetation, for example fast-growing and dense species of flora. The intervening area will be landscaped to preserve the visual amenity of the local settlements as far as possible. It should be noted that, due to the size of the site, waste placement will be undertaken well in excess of 50 m from the nearest settlements during the majority of the life of the landfill.

- **Regular covering of waste materials after deposit** which, as well as preventing decomposition of waste in the open air causing odour and minimising windblown litter, will improve the overall appearance of the site.

- **Development of the site in discrete stages** (with progressive filling in each stage) which will allow the parts where waste deposit is completed to be covered and restored. This means that the working area, and hence visual intrusion, will be minimised and restricted to only a proportion of the overall site at any one time.

- **Restoration and landscaping scheme for the site**, which will ensure that, in the longer term after landfilling operations are complete, the site will be fully restored to a natural outlook and be available for certain types of agricultural, horticultural or commercial development. The landscaping
may include the development of natural habitats of nature conservation value, return to agricultural use, development of amenity facilities and/or promotion of commercial enterprises (although the construction of buildings will not be appropriate on the site, due to the potential for subsidence, for damage to be caused to the capping material of the landfill and for the risk of explosive concentrations of methane gas building up in confined spaces within structures).

- **Sheeting and/or covering of waste delivery vehicles**, wherever practicable, to minimise the inadvertent escape of litter from waste being delivered to the site (as well as reducing odour and dust).

- **Development of the landscaped bund and buffer zone to act as a wind-break and provide screening**, which will minimise the risk of winds entraining litter and also intercept any litter arising from the site operations. The potential nuisance of litter will be reduced by the separation distance of at least 50 m between operational areas of the landfill site and the nearest settlements.

- **Regular covering of waste materials after deposit**, to prevent prolonged exposure of the waste after placement causing litter.

- **Use of litter screens, nets or equivalent** to intercept windblown litter. These measures may include litter screens placed around part, or all, of the site perimeter, working cells or local areas of active waste placement within the site. Local, readily movable litter screens may be temporarily employed during periods of potentially high litter generation, for example in dry spells with high winds.

- **Litter picking**, whereby at periodic intervals, or after events which have led to litter being dispersed (for example, high winds), site workers will be detailed to collect litter from off-site areas and nearby roads. This exercise may also be achieved by the provision of incentives to scavengers to collect litter from access roads and other off-site areas.

- **High standard of site supervision, particularly good housekeeping**, to ensure that the litter control measures are utilised to their full potential.

### 7.2.7 Noise

- **Provision of a bund and buffer zone between the settlements and the landfill site**, which will separate the working areas of the landfill from the nearest settlement by at least 50 m, serve to screen the site and act as a noise barrier.

- **Location of plant as far as practicable from settlements**, for example dewatering pumps, to minimise the effects of noise generation.

- **Careful selection and operation of plant**, to avoid the use of unnecessarily noisy plant and ensure that the selection of plant includes consideration...
of its noise emissions. Where necessary, noise enclosures/screening may be appropriate around unavoidable relatively noisy plant.

- **Use of on-site materials as noise screens**, for example the location of spoil heaps of peat between the operational areas and settlements.

- **Restriction of operating hours**, to minimise the traffic and site operations during quiet periods (evenings, night-time, week-ends, official holidays, etc) with the possible exception of delivery of bulk containers.

- **High standard of site supervision, training and maintenance of plant**, since the site management, appropriate training of workers in plant operation and adequate long term maintenance of plant are all means by which noise emissions from on-site operations can be reduced).

### 7.3 MONITORING PLAN

Monitoring reports should be sent to the Environmental Unit of the WPC and the CEA. The WPC would oversee the day-to-day operation of the site, but the CEA has overall regulatory responsibility for enforcement. The CEA is also responsible for authorisation of the operation based on an Environmental Protection Licence (EPL) that will only be issued, and subsequently renewed, if the required standards are met. (The WPC is in the process of preparing their own environmental statutes, but CEA remain legally responsible). Due to the nature of the mitigation measures, much of the recommended ongoing monitoring of the site requires regular inspection by the WPC under the supervision of the CEA for waste management, supported by independent annual audits. This emphasises the importance which must be attached to institutional strengthening of the WPC and CEA, in terms of staffing, training and availability of equipment and resources, to enable then to provide the required degree of monitoring and control respectively. Recommended monitoring activities are also shown in **table 7.2a**.

In the event that action needs to be taken against a private sector site operator there are two possible courses of action. The WPC may be able to take action initially on the basis of contractual obligation (ie non-compliance with performance conditions). Alternatively (or additionally) the CEA can take regulatory action against the operator.
<table>
<thead>
<tr>
<th>Issue</th>
<th>Mitigation Measure</th>
<th>Costs (US$)</th>
<th>Institutional Responsibility</th>
<th>Ongoing Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Capital</td>
<td>Annual</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Operating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise (Continued)</td>
<td>Restriction of operating hours, as far as practicable, to within the range 0700-1000, Mondays to Saturdays. Any work required outside this period will be limited to low noise generating activities, for example heavy mobile site machinery will not be used near settlements</td>
<td>NA</td>
<td>NA</td>
<td>Site operator Regular inspection by WPC Annual, independent audit of site operations</td>
</tr>
<tr>
<td></td>
<td>High standard of site supervision, training and maintenance of plant</td>
<td>NA</td>
<td>NA</td>
<td>Site operator Regular inspection by WPC Annual, independent audit of site operations</td>
</tr>
<tr>
<td>Occupational Health and Safety</td>
<td>Provision of education and training for site personnel and scavengers</td>
<td>10,000</td>
<td>NA</td>
<td>Site operator Regular inspection by WPC Annual, independent audit of site operations</td>
</tr>
<tr>
<td></td>
<td>Provision of emergency plans and equipment, for example fire fighting, First Aid at strategic locations</td>
<td>10,000</td>
<td>1,000</td>
<td>Site operator Regular review by WPC Annual, independent audit of site operations</td>
</tr>
<tr>
<td>Issue</td>
<td>Mitigation Measure</td>
<td>Costs (US$)</td>
<td>Institutional Responsibility</td>
<td>Ongoing Monitoring</td>
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<tr>
<td></td>
<td></td>
<td>Capital</td>
<td>Annual</td>
<td></td>
</tr>
<tr>
<td>Occupational Health and Safety (cont.)</td>
<td>Design of site to maximise distance of offices and general access areas from the tipping face</td>
<td>No specific costs in addition to normal site development costs</td>
<td>Design Contractor</td>
<td>Regular review by WPC</td>
</tr>
<tr>
<td></td>
<td>Provision of signs in three languages</td>
<td>NA</td>
<td>NA</td>
<td>Site operator</td>
</tr>
<tr>
<td></td>
<td>Provision of clear labelling of hazards and sign-posting within the site</td>
<td>10,000</td>
<td>1,000</td>
<td>Site operator</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Annual, independent audit of site operations</td>
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<tr>
<td>Issue</td>
<td>Mitigation Measure</td>
<td>Costs (US$)</td>
<td>Institutional Responsibility</td>
<td>Ongoing Monitoring</td>
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<tr>
<td></td>
<td></td>
<td>Capital</td>
<td>Annual Operating</td>
<td>(WPC would have day-to-day responsibility for operation, and CEA is regulatory authority in all cases)</td>
</tr>
<tr>
<td>Air quality (Continued)</td>
<td>Site management to ensure regular and prompt covering of waste</td>
<td>NA</td>
<td>NA</td>
<td>Site operator</td>
</tr>
<tr>
<td></td>
<td>Provision of a landfill gas control and flaring system</td>
<td>This measure is a necessity within the engineering of the site, therefore it is not considered on a separate cost basis as a mitigation measure</td>
<td>Site operator</td>
<td>Annual, independent audit of site operations</td>
</tr>
<tr>
<td></td>
<td>Good housekeeping (including wetting of on-site roads within 100 m of settlements)</td>
<td>NA</td>
<td>NA</td>
<td>Site operator</td>
</tr>
<tr>
<td>Traffic</td>
<td>Scheduling of traffic to avoid peak periods on the local roads - particularly bulk haulage vehicles from the transfer station</td>
<td>NA</td>
<td>NA</td>
<td>Site operator</td>
</tr>
<tr>
<td></td>
<td>Provision of improvements to Galudupita Road and its junction with the A3 highway, for example traffic controls, widening, resurfacing, sign-posting, etc</td>
<td>180,000</td>
<td>0</td>
<td>Site operator, in consultation with Western Provincial Council</td>
</tr>
<tr>
<td>Issue</td>
<td>Mitigation Measure</td>
<td>Costs (US$)</td>
<td>Institutional Responsibility</td>
<td>Ongoing Monitoring</td>
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<td></td>
</tr>
<tr>
<td>Traffic (continued)</td>
<td>Provision of an undeveloped buffer zone of 50 m between site operations and the nearest settlement</td>
<td>NA</td>
<td>NA</td>
<td>Site operator</td>
</tr>
<tr>
<td></td>
<td>Physical screening of the site from settlements by construction of a bund, landscaping and planting of appropriate vegetation</td>
<td>The construction of a bund is a necessity within the engineering of the site; the additional costs of planting and landscaping are marginal</td>
<td>Site operator</td>
<td>Regular inspection by WPC</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>Provision of litter screens, nets and similar equipment to catch windblown litter</td>
<td>30,000</td>
<td>0</td>
<td>Site operator</td>
</tr>
<tr>
<td></td>
<td>Provision of an undeveloped buffer zone of 50 m between site operations and the nearest settlement</td>
<td>NA</td>
<td>NA</td>
<td>Site operator</td>
</tr>
<tr>
<td></td>
<td>Visual screening of the site from settlements by construction of a bund, landscaping and planting of appropriate vegetation</td>
<td>The construction of a bund is a necessity within the engineering of the site; the additional costs of planting and landscaping are marginal</td>
<td>Site operator</td>
<td>Regular inspection by WPC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Issue</td>
<td>Mitigation Measure</td>
<td>Costs (US$)</td>
<td>Institutional Responsibility</td>
<td>Ongoing Monitoring</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------</td>
<td>-------------</td>
<td>------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Capital</td>
<td>Annual</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Operating</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Provision of a leachate collection and treatment system using settlement lagoons and a biological reed bed system</td>
<td>1,100,000 (over site life)</td>
<td>50,000</td>
<td>Site operator</td>
</tr>
<tr>
<td></td>
<td>Flood control by redirection of the stream, and bunding.</td>
<td>This measure is a necessity within the engineering of the site, therefore it is not considered on a separate cost basis as a mitigation measure. Total capital costs not expected to exceed US$1,000,000.</td>
<td>Detailed design contractor</td>
<td>Monthly monitoring of water levels in redirected stream and control of clogging vegetation.</td>
</tr>
<tr>
<td></td>
<td>Full hydrological survey at detailed design stage</td>
<td>To be developed</td>
<td>NA</td>
<td>Detailed design contractor</td>
</tr>
<tr>
<td></td>
<td>Provision of new potable water supplies for households whose current supplies may be significantly affected</td>
<td>To be developed</td>
<td>To be developed</td>
<td>MHA&amp;PC</td>
</tr>
<tr>
<td>Issue</td>
<td>Mitigation Measure</td>
<td>Costs (US$)</td>
<td>Institutional Responsibility</td>
<td>Ongoing Monitoring</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>---------------</td>
<td>-------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Biological factors</td>
<td>Appropriate landscaping around the site and in site restoration if desired.</td>
<td>To be developed</td>
<td>Site operator</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Possible planting of medical herb garden on restored site.</td>
<td>To be developed</td>
<td>Site operator</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Use of a natural biological system for leachate treatment, with habitat creation value</td>
<td>Cost is considered in the provision of leachate treatment to protect hydrogeology and hydrology (see above)</td>
<td>Site operator</td>
<td>NA</td>
</tr>
<tr>
<td>Air quality</td>
<td>Location of spoil heaps, for example of peat, away from settlements</td>
<td>NA</td>
<td>Site operator</td>
<td>Regular inspection by WPC.</td>
</tr>
<tr>
<td></td>
<td>Covering of waste delivery vehicles.</td>
<td>NA</td>
<td>Site operator</td>
<td>Annual, independent audit of site operations</td>
</tr>
<tr>
<td></td>
<td>Provision of a bund and buffer zone of 50 m between site operations and the nearest settlement</td>
<td>NA</td>
<td>Site operator</td>
<td>Annual, independent audit of site operations</td>
</tr>
</tbody>
</table>
### Table 7.2a  Mitigation Measures Incorporated within the Development of the Welisara Landfill Site

<table>
<thead>
<tr>
<th>Issue</th>
<th>Mitigation Measure</th>
<th>Costs (US$)</th>
<th>Institutional Responsibility</th>
<th>Ongoing Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Capital</td>
<td>Annual Operating</td>
<td></td>
</tr>
<tr>
<td>Socio-cultural factors</td>
<td>Resettlement plan for households living within the marsh area</td>
<td>To be developed</td>
<td>0</td>
<td>MHA&amp;PC</td>
</tr>
<tr>
<td></td>
<td>Community Development Plan for households in the Welisara development area</td>
<td>1 million</td>
<td>NA</td>
<td>MHA&amp;PC</td>
</tr>
<tr>
<td></td>
<td>Generation of employment opportunities for local population</td>
<td>NA</td>
<td>NA</td>
<td>Site operator</td>
</tr>
<tr>
<td></td>
<td>Strict management of scavenging activities and growth of squatter communities</td>
<td>NA</td>
<td>Negligible</td>
<td>Site operator</td>
</tr>
<tr>
<td></td>
<td>Provision of new potable water supplies and sanitation for households</td>
<td>To be developed</td>
<td>To be developed</td>
<td>MHA&amp;PC</td>
</tr>
<tr>
<td></td>
<td>whose existing facilities may be significantly affected</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prevention of pests and disease vectors through good site practices</td>
<td>NA</td>
<td>Negligible</td>
<td>Site operator</td>
</tr>
<tr>
<td></td>
<td>Generation of economic opportunities in the use of the site following restoration</td>
<td>NA</td>
<td>NA</td>
<td>Western Provincial Council</td>
</tr>
</tbody>
</table>

(WPC would have day-to-day responsibility for operation, and CEA is regulatory authority in all cases)
<table>
<thead>
<tr>
<th>Issue</th>
<th>Mitigation Measure</th>
<th>Costs (US$)</th>
<th>Institutional Responsibility</th>
<th>Ongoing Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Capital</td>
<td>Annual</td>
<td>Ongoing Monitoring</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrogeology and hydrology</td>
<td>Engineering of containment of the site</td>
<td>Site operator</td>
<td>Monthly groundwater</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>monitoring in four</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>groundwater boreholes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Parameters</td>
<td></td>
</tr>
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<td></td>
<td>- pH</td>
<td></td>
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<td></td>
<td>- BOD</td>
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<td></td>
<td>- suspended and</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>dissolved solids</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>- ammonia</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- heavy metals</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Monthly surface water</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>monitoring in the Kalu</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Oya upstream and</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>downstream of the site</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Parameters</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- pH</td>
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<td></td>
<td>- BOD</td>
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<td></td>
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<td>- suspended and</td>
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<td>dissolved solids</td>
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<td></td>
<td>- ammonia</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- heavy metals</td>
<td></td>
</tr>
</tbody>
</table>
Annex A

Environmental Review of
the Baseline Road Transfer
Station
ANNEX A:

ENVIRONMENTAL IMPACT ASSESSMENT - BASELINE ROAD TRANSFER STATION

PROJECT DESCRIPTION

As part of the upgraded waste management system for the CMA, a refuse transfer station is to be established at Baseline Road at which municipal solid wastes will be transferred into 15 tonne payload bulk haulage vehicles for onward road transport and disposal at the Welisara landfill site.

The facility will be designed to handle a maximum throughput of 1,000 tonnes per day (tpd) and sufficient landtake and infrastructure will be incorporated at the outset. Any expansion of hauling capacity will be achieved by adding berths to the fenced area. No extension of the initial landtake requirement is anticipated for expansion and will not impinge on any existing settlements. However, initial throughput following commissioning is anticipated to be around 550 tpd.

Refuse collection vehicles (compactors, sideloaders and tractor/trailers) will bring collected wastes and, after passing over a weighbridge at the site entrance, discharge their loads into waiting ISO-type (International Standards Organisation) containers located beneath a raised ramp. When full, the (enclosed) ISO containers will be transported by road to Welisara.

BASELINE DESCRIPTION OF THE SITE

SITE LOCATION AND AREA

The site is located on Baseline Road in central Colombo, adjacent to Baseline Road rail station. The site was chosen by GOSL to provide flexibility for road or rail transfer to a site outside the city, initially to a proposed landfill 40 km east of the city. The total existing site area, including a slaughter house, is 7.5 acres and is owned by the GOSL. The area required for the transfer station will be confirmed during the ongoing conceptual engineering design but is currently expected to occupy around 50% of the whole site. The Terms of Reference for the Site Studies are included in Attachment 1 to this Annex. The site is bounded to the north by a canal which meets Baseline Road Culvert at one end and Baseline Lane Culvert at the other end. To the east is Baseline Lane. On the southern boundary is the railway track including Baseline Road station and level crossing. To the west is Baseline Road itself.
2.2 **CLIMATE**

Climatic conditions at the site will be as outlined for Colombo in general in the main text of this report. *(See Section 5.2)*

2.3 **TOPOGRAPHY AND LANDSCAPE**

The site is located in a gently sloping area. The railway line boundary is two to three metres higher than the canal. Opposite the station there is an area of raised ground, some six metres higher than the canal. This represents the highest point on the site and currently is occupied by a bungalow housing a local veterinary surgery and the quarters of the Chief Veterinary Surgeon serving the slaughterhouse.

A detailed topographic survey of the site was completed in May 1993 for the Urban Programme Unit (of the Ministry of Policy Planning and Implementation of the GOSL) and includes a contour plan (at 1 metre intervals) for the site area at 1:1,000 scale. In addition, a 1:2,500 scale plan was prepared to identify major land use within 250 metres of the site boundary.

2.4 **GEOLOGY**

A geotechnical survey is planned to confirm ground conditions and establish structural design parameters. This survey will confirm the site geology. However, preliminary site observations suggest the existence of limited soil cover over lateritic bedrock. The raised area referred to above enables the strata to be observed, and this mound can be seen to be laterite. At this stage, therefore, no problems are expected concerning the loadbearing properties of the site. The presence and stability of the adjacent railway line, which is carrying loads in excess of those for the transfer station on the same strata, supports this confidence.

2.5 **HYDROGEOLOGY**

The groundwater level can be observed in a (dilapidated) dug well in the vegetable garden area in the north of the site. Groundwater level is at around 0.5 metres below ground level. The water is used for irrigation of the gardens.

2.6 **HYDROLOGY**

As mentioned in Section 1 the site is bordered to the north by a canal from culverts in Baseline Road and Baseline Lane. The canal is primarily a drainage channel and is not used for water abstraction in this area.
2.7 **Socio-Cultural Environment and Landuse**

Within the 7.5 acre site area the present land use comprises the following:

- Colombo Municipal Slaughter House
- Cattle transfer shed
- Chief Veterinary Surgeon’s quarters
- Vegetable gardens on the open land along the canal
- Approximately ten shanties built along the canal in the south eastern part of the site

Outside the site boundary, within 250 metres are:

- the GOSL Railway quarters;
- four schools;
- one temple;
- a muslim cemetery;
- two playgrounds;
- two petrol stations;
- a cinema; and
- a hume pipe factory.

In addition, an estimated 317 shanties (with 563 dwellers) occupy this zone outside of the site boundary.

2.8 **Biological Environment**

The site contains a number of mature trees and small shrubs. However, they are all species which are common throughout the neighbouring area and in other parts of the country. Similarly, whilst possibly providing an urban habitat for small faunal species within a surrounding built-up area none of interest are known to have colonised the site.

There are also birds, notably crows, which are attracted to scavenge on the waste generated by the present slaughterhouse activities. As mentioned above parts of the site area are currently under small-scale cultivation of vegetables - karikum, mukunuwanne and Phampala. The canal bordering the site to the north and east (primarily a drainage channel) is, it is reported, inhabited by a number of common fish species. Nevertheless the canal also conveys sewage from nearby residential property and the slaughterhouse effluent. The canal ultimately flows into the Kelani Grange.

2.9 **Traffic**

Baseline Road is a major thoroughfare carrying a wide range of commercial and other traffic throughout the day. The road is lined with a variety of small to medium-sized industry, shops and general settlement. The results of the traffic counts on Baseline Road, carried out on the 3 March during the day and 11/12 March during the night are summarised in Tables 2.9a and 2.9b respectively. More detailed breakdowns of the traffic flows are provided in Annex H.
Table 2.9a shows that day-time traffic levels on Baseline Road are very high, for all types of motorised vehicles, especially trucks, vans and cars. The presence of the level crossing at the corner of the site, is a potential cause of congestion at the planned transfer station access point and this issue will need to be considered very carefully in the detailed design of the transfer station site. Table 2.9b shows that during evening and night-time, the traffic flows on Baseline Road decrease significantly, particularly for motorised vehicles.

In summary, the data available for traffic movements on the Baseline Road indicate that the traffic conditions are typically as follows:

- Week-day traffic flows are heavy, and problems of traffic congestion already exist.
- Flows of all types of traffic flows are more or less continuous throughout the day time period.
- Night-time traffic flows are much lower than day time flows, and flows of heavy and medium trucks decline to almost nothing between the hours of 23.00 and 04.00.

2.10 AIR QUALITY

The present air quality is largely influenced by three sources; exhaust emissions from heavy Baseline Road traffic and from the railway, and odours from the slaughter house.

2.11 NOISE

The present noise environment is influenced by rail and road traffic, the slaughter house activities and disparate other commercial and domestic sources. As such, the daytime ambient noise levels are characteristic of an active urban commercial district.
Table 2.9a  Daytime Traffic Flows on Baseline Road on 15 March 1994

<table>
<thead>
<tr>
<th>Time (1 hour periods)</th>
<th>Vehicle Movements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Heavy Trucks</td>
</tr>
<tr>
<td>07:00-08:00</td>
<td>107</td>
</tr>
<tr>
<td>08:00-09:00</td>
<td>139</td>
</tr>
<tr>
<td>09:00-10:00</td>
<td>84</td>
</tr>
<tr>
<td>10:00-11:00</td>
<td>79</td>
</tr>
<tr>
<td>11:00-12:00</td>
<td>95</td>
</tr>
<tr>
<td>12:00-13:00</td>
<td>77</td>
</tr>
<tr>
<td>13:00-14:00</td>
<td>88</td>
</tr>
<tr>
<td>14:00-15:00</td>
<td>73</td>
</tr>
<tr>
<td>15:00-16:00</td>
<td>92</td>
</tr>
<tr>
<td>16:00-17:00</td>
<td>99</td>
</tr>
<tr>
<td>17:00-18:00</td>
<td>71</td>
</tr>
<tr>
<td>18:00-19:00</td>
<td>57</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1066</td>
</tr>
</tbody>
</table>
### Table 2.9b  
**Night-time Traffic Flows on Baseline Road on 11 March 1994**

<table>
<thead>
<tr>
<th>Time (1 hour periods)</th>
<th>Vehicle Movements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Heavy Trucks</td>
</tr>
<tr>
<td>19:00-20:00</td>
<td>31</td>
</tr>
<tr>
<td>20:00-21:00</td>
<td>26</td>
</tr>
<tr>
<td>21:00-22:00</td>
<td>13</td>
</tr>
<tr>
<td>22:00-23:00</td>
<td>11</td>
</tr>
<tr>
<td>23:00-00:00</td>
<td>2</td>
</tr>
<tr>
<td>00:00-01:00</td>
<td>-</td>
</tr>
<tr>
<td>01:00-02:00</td>
<td>-</td>
</tr>
<tr>
<td>02:00-03:00</td>
<td>-</td>
</tr>
<tr>
<td>03:00-04:00</td>
<td>-</td>
</tr>
<tr>
<td>04:00-05:00</td>
<td>3</td>
</tr>
<tr>
<td>05:00-06:00</td>
<td>16</td>
</tr>
<tr>
<td>06:00-07:00</td>
<td>25</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>127</td>
</tr>
</tbody>
</table>
3 ASSESSMENT OF ENVIRONMENTAL IMPACTS

The Baseline Road site is located in a busy urban commercial environment, with heavy road traffic, a railway and existing shanty settlements along the boundaries of the site, as well as a slaughterhouse located within the site boundary. In general, the development of the site for a sanitary transfer station is unlikely to cause any significant environmental impacts except those related to increased traffic congestion. The various categories of potential impact, and the proposed design features that will be adopted to mitigate these impacts, are discussed below.

3.1 SOCIO-CULTURAL ENVIRONMENT AND LANDUSE

The development of the transfer station will not involve removing the Chief Veterinary Surgeon’s quarters or the three GOSL residues at the site. The slaughterhouse will also require relocation either because of landtake or the problems of access once the transfer station buildings and associated facilities are constructed to the front of the site. However, provision has been made in the transfer station design to retain on undeveloped area for animal inspection pens in the South East part of the present site. The slaughterhouse is owned and operated by GOSL and an alternative location has been found by them nearby, on the western side of Baseline Road. Therefore, none of the existing buildings will require reconstruction elsewhere on the Baseline Road site as a result of the Transfer Station development. Their reconstruction at the new location will be the responsibility of GOSL and will be undertaken according to its own procedures. It will, thus, not form part of this Project Component.

Any demolished buildings on the site will involve the disposal of the associated waste materials in a safe manner. We recommend that a detailed investigation be undertaken to identify the presence of any contamination on the site, particularly in the active operational areas of the slaughterhouse. The latter should include testing for the presence of anthrax spores unless there is epidemiological evidence available to confirm that this is not required. On the basis of the results of this investigation, a specification for any specific required remediation/clean-up works should be prepared, together with any health and safety procedures to be followed during the redevelopment of the site. All materials taken off-site for disposal from the slaughterhouse area should be disinfected prior to transport. All materials should be disposed of to a landfill, adopting necessary sanitary landfill practices.

There has been some encroachment onto the site by squatters in the south eastern corner. This area is not required for transfer station development and therefore they could remain. No relocation is envisaged to be necessary beyond the eventual developed transfer station area. The perimeter will be fenced to inhibit subsequent encroachment onto the transfer station site.
Adjacent landuses which could be affected by the transfer station development include two schools across the canal. However, given their current immediate proximity to the slaughterhouse this change of use will have, arguably, less impact than development of otherwise vacant land. The greenleaf vegetables grown on the site near the canal may represent a source of livelihood for the gardeners. These gardens would have to be removed to allow development of the transfer station and the provision of suitable land elsewhere should be considered by GOSL. There are many similarly cultivated plots in the surrounding area.

A positive impact will be that employment will be created for labourers, drivers, maintenance and supervisory staff, who could, wherever possible, be recruited from the local area. It is not currently planned to permit scavenging activities at the Transfer Station. However, the conceptual design proposed would enable these activities to be incorporated if required within the layout developed.

### 3.2 HYDROLOGY AND HYDROGEOLOGY

The main hydrological feature of relevance to the site is the canal bordering the site to the north and east. The canal is primarily a drainage channel and the water quality (although not analysed) appears to be poor. However, there are plans to upgrade the urban Colombo canal network. Nonetheless, the transfer station design provides for the interception of surface drainage for disposal to sewer. This will require careful attention to developed ground surface contours, since as noted earlier, the natural gradient is towards the canal. The transfer station operation should not, therefore, in any case affect current canal water quality. During the construction works stage arrangements will be made to intercept surface run-off and prevent contaminated residues entering the canal.

There are GOSL plans to widen the canal system in many areas of Colombo. If the stretch of canal adjacent to the site is to be widened there would be advantage in undertaking these works prior to transfer station development in order to facilitate easy access to canalside work areas and minimise disturbance to transfer station operations and installed services, particularly drainage. We recommend that the GOSL consider this.

The geotechnical survey will establish whether or not groundwater is present within 5 m of the surface. In the event that groundwater is encountered the detailed design will include measures to ensure that no contamination takes place. In particular, operational areas where waste will be loaded/unloaded will be on paved, drained surfaces. This, together with adequate operational management and attention to regular maintenance of the paving and drainage system, should result in minimal opportunity for discharge of contaminated waters to the groundmass and, thence, to groundwater.
3.3 **BIOLOGICAL ENVIRONMENT**

No species of flora or fauna of importance are known to exist within the site. However, the transfer station footprint has been designed to retain as many of the existing mature trees as possible, primarily in the area adjacent to the railway line. The existing vegetable gardens will need to be removed, but there are many plots where these varieties of vegetables are cultivated in the surrounding area. The operation of the site, if not adequately managed, offers the potential for attracting increased numbers of scavenging birds, rats and other vermin. This issue is addressed later under Public Health impacts.

3.4 **TRAFFIC**

The increased traffic along Baseline Road associated with the operation of the transfer station will contribute to local congestion. Given the congested nature of Baseline Road, and the difficulties that this may cause for site access, good operational reasons exist to design the transfer station in such a way that these impacts are minimised.

Around 50 bulk haulage and a further 150 of a range of collection vehicle trips will occur initially, growing to perhaps 70 and 300 respectively over the life of the transfer station, the latter being dependent upon the existence, or otherwise of additional transfer stations elsewhere. In order to minimise the contribution to further congestion on Baseline Road it is planned to extend the working day for the bulk haulage vehicles, with each vehicle carrying out one journey to the landfill from 06.00 to 07.00 in the morning and also delivering to the landfill reception area between 1900 and 2200 hrs in the evening. The morning and afternoon peaks can thus be avoided. As a result, the additional daytime (12 hour) traffic would comprise 150 to 300 miscellaneous collection vehicles plus around 30 bulk haulage vehicle trips. This constitutes increases of 3-6% heavy truck movements. The additional congestion would thus be marginal and mainly associated with the need to turn into the site from (and across) the already busy Baseline Road. There are plans by CMC to construct a flyover to replace the existing railway level crossing adjacent to the site. If this proceeds then the needs of transfer station access should be addressed at the same time and smooth entry/exit facilitated. A one-way (in/out) system will be adopted at the site entrance to minimise conflict between collection and bulk haulage vehicles entering/exiting the site and the design brief includes careful consideration of the layout of the junction with the highway together with appropriate warning signage utilising readily recognisable international symbols.

In the early morning and late evening periods the additional heavy goods vehicle traffic on Baseline Road from transfer bulk haul vehicles would represent around 25% increase. These percentage increases are not generally considered to be significant.

The potential for disturbance to nearby settlements due to increased engine noise and air pollution from vehicle exhausts will be insignificant, as there
are no residential properties close to the access point of the transfer station site, and the additional contribution made by vehicle travelling to and from the transfer station will not be significant.

The additional traffic also has the potential to result in increased accidents, especially around the site entrance. The design of the entrance will need to achieve adequate site lines to maximise visibility for both drivers and cyclists/pedestrians using the area.

**AIR QUALITY**

The transfer station has the potential to adversely affect present air quality with the emissions of dust and odours from on-site activities, in addition to exhaust emissions from both collection and bulk haul vehicles.

Control of dust can be achieved, at a cost, by totally enclosing the discharge/loading operation in a negative pressure building. Given the high moisture content of CMA municipal solid waste, this is not considered necessary. However, it is proposed that the discharge operation takes place under at least, a roofed structure in order to minimise contaminated run-off during adverse weather conditions. This, together with side panelling, should prove sufficient. The conceptual design will review this and the need, if any, for use of sprays or other devices to limit dust generation at source, which, if required, will be incorporated into the design.

The generation of odours on-site will depend on a variety of factors but primarily on the nature of the waste delivered and the storage/handling system on-site. In particular, if wastes are not collected promptly from the point of production and are older (more "mature") on receipt at the transfer station, they will typically be more malodorous. Equally, if wastes are temporarily stored at the transfer station for extended periods prior to despatch to Welisara odour levels will increase. Therefore, the primary mitigation measure is a smooth collection/transfer operation. Physical measures which can be adopted in addition include enclosing the waste handling operation and siting this activity away from sensitive off-site receptors, for example the two schools across the canal. It is planned that the main operational areas will be in the south west of the site at the furthest distance, some 100m, from the nearer school.

**NOISE**

As noted in section 2.11, the ambient noise environment is typical of an active commercial urban area. The noise sources associated with the transfer site, primarily traffic-related, are not expected to change the noise environment for receptors on Baseline Road. Sensitive receptors include the two schools across the canal to the north-east and a temple located just beyond the south-east extremity of the site. The increase in background noise levels at these locations are not anticipated to be unduly intrusive. This will be confirmed following the results of more detailed assessment.
3.7 **PUBLIC HEALTH**

The establishment of the transfer station offers the potential for public health hazards if not properly managed. These relate to the potential for vermin (rats, mice, stray dogs, flies and other disease vectors) to be attracted to the site and a food source. These risks will be minimised by containment of wastes awaiting despatch, avoiding storage of wastes on-site uncontained for extended periods and washing down/disinfecting operational areas at regular intervals, together with attention to good housekeeping practice (for example sweeping areas where refuse can collect-in corners, between containers following spillage etc.). The potential residual public health impacts associated with redevelopment of the slaughterhouse area were addressed in Section 3.1. As with the suppression of odours the key mitigation measure to safeguard public health is the timely transfer of wastes, supported by general hygiene/housekeeping.

3.8 **AESTHETIC ASPECTS**

The nature of the transfer station buildings, no more than two storeys in height, will blend naturally into the immediate, primarily commercial surroundings. There are no raised areas which overlook the site, with the exception of one house located beyond the railway station to the south west (which currently overlooks the veterinary surgery). Passengers waiting to board trains will be able to observe the loading operations. However, it is considered preferable to have this transitory visual impact than locate the operations further across the site where permanent daytime receptors (e.g. the schools) would be more greatly affected.
3.1 PURPOSE

The purpose of the conceptual engineering work required is to prepare waste management facility layout containing sufficient information to demonstrate the validity of the concept proposed and to permit more reliable cost estimates to be prepared for financing purposes.

3.2 INTRODUCTION

It is intention of the COSL and the World Bank to engage Consultants to conduct a program of work to establish conceptual layout for solid wastes transfer station facilities at Baseline Road and proposed engineered landfill at Padukka. The layout will utilize the topographical mapping and results of ground and hydrogeological investigations. Subsequently, the layout will be used as a central feature of the environmental impact assessments to be performed.

The scope of the work required for each site includes the tasks listed as follows:

- conceptual site layout and storage areas
- traffic flow patterns
- identification, including quantities, of general site preparatory works and derivation of a preliminary schedule of the main works, and outline specifications to assist in the future detailed engineering and construction of the proposed transfer and landfill facilities.
- compilation of specific unit costs and derivation of more representative engineering-related capital cost estimates.

No waste management activities currently take place at the sites under investigation.

3.3 GENERAL SCOPE OF THE CONCEPTUAL SITE STUDIES

The Consultant shall provide experts with knowledge in engineering, waste management and costs to develop preliminary facility layout at Baseline Road and Padukka to demonstrate the credibility of the proposed waste management system. The Consultant shall support their written findings with sketches, detailed drawings, calculations and data listings for each of the tasks comprising this project.
It is emphasized that the conceptual site studies would make provision for both road and rail transfer of wastes from Baseline Road to Padukka. The final choice of the transfer mode of transport will not be selected until after this sub-activity is completed.

(i) Conceptual Design Layout

Preliminary block diagram layout and engineering drawings shall be prepared to illustrate the access, buildings, services and storage areas at the Baseline Road transfer station. In addition, the sources of on-site cover material, waste emplacement, phasing, drainage, gas and leachate management and restoration profiles should be provided in outline for Padukka.

The facilities depicted for the Baseline Road site should be consistent with the development of a 2 story waste transfer operation with top loading of demountable 20' ISO containers receiving waste from a variety of refuse collection vehicles. The Containers, once full, would be transferred by fork lift to a storage area for night time transfer by road/rail to the Padukka landfill. No mechanical compaction into containers is envisaged at the present time.

The facilities to be depicted at the Padukka site should be all of the principal features consistent with the development of a modern sanitary (controlled) landfill, whose general design is sustainable using the resources available in Sri Lanka at the present time. The preparation of detailed engineering drawings and the identification equipment suppliers, etc., are NOT sought in this project study.

The operations at Baseline Road are expected to receive initially around 550 tonnes per day waste input, rising to perhaps 1000 tonnes per day in 10 years time. Sufficient capacity to handle the initial waste input, and sufficient space for possible future expansion should be included in the layout.

The Consultant should liaise with the NER0 and review their recent reports on waste management for Colombo.

(ii) Traffic Flow Patterns

At Baseline Road a wide variety of collection vehicles will bring solid waste for transfer. A smooth one way traffic flow pattern, including the possible provision of weighbridge and wheel washing facilities, should be suggested and depicted on site plans. In addition, the on-site movements of fork lift trucks and building haulage by road or rail transport must be conveniently accommodated. Details of minimum turning circles and similar
necessary information will be indicated by the Consultant in conjunction with the NBRO.

At Padukka the suggested traffic flow patterns should accommodate the smooth operations of container off-loading from road vehicles or railway wagons by fork fitted lift trucks. In turn, containers would be transferred to all terrain “slave” vehicles fitted with tipping equipment for carriage to the tipping face and discharge. It is possible that in the future some direct haul of waste in collection vehicles may commence from nearby municipalities. However, for the purposes of this project task this eventually does not need to be specifically addressed, but sufficient flexibility in the conceptual layout should be included to handle small quantities of directly-hauled waste.

(iii) Site Preparatory Works

Preliminary estimates are required for each site to indicate the locations and approximate volumes of earthworks, i.e. re-grading, stockpiling, drainage and similar operations.

In addition, the Consultant should provide a preliminary schedule of works for the development of the principal facilities at Baseline Road and Padukka, as well as indicating those developments likely to be on the “critical path”.

The Consultant should also list the general design assumptions and specifications used, as well as those that must be defined before future detailed site engineering can begin.

(iv) Derivation of Specific Costs

Once the Consultant has completed the preliminary works set out in Tasks (i) to (iii), more reliable set of unit costs and quantities for the major engineering-related site developments can be compiled. In turn, the Consultant should use these derived values to prepare revised, representative estimates of the major engineering-related capital costs for the proposed transfer station and landfill developments.

(v) Operating Arrangements

The Consultant shall develop and propose alternative institutional arrangements for regional management of waste collection, transfer and disposal (landfill), including possible private sector participation. The Consultant shall develop staffing and training requirements.
3.4 PROJECT TEAM

The preparation of the conceptual site studies defined in this Terms of Reference will require a combination of specialists from Sri Lanka and abroad. As a minimum, the Consultant will provide (or have access to) expertise in the following disciplines:

- waste transfer and landfill civil and mechanical engineering
- design and architecture
- draughting
- engineering cost estimation
- transport planning

3.5 REPORTING

The conceptual site layout and supporting engineering, traffic management and costing data will be presented in a two-volume report. The first volume will refer to the Baseline Road transfer station and build haulage operation, and the second volume will refer to the Padukka landfill site. In addition, specific appendices containing, but not confined to, the following are required to be appended to the draft final report:

1. Sources of published and information used
2. Listings of all data collected.
3. References cited.
4. Record of meetings.

The progress of work will be monitored by an organization nominated by the GOSL, in consultation with the World Bank. The Consultant will be required to submit 10 copies of both volumes of the draft final report, and subsequently, 20 copies of the agreed final report. The reports will be jointly evaluated by the GOSL and the World Bank.
Annex B

Terms of Reference for Transfer Station Site Selection and EIA
ANNEX B

TERMS OF REFERENCE

SELECTION AND ENVIRONMENTAL ASSESSMENT OF SOLID WASTE TRANSFER SITES IN METROPOLITAN COLOMBO

BACKGROUND TO SOLID WASTE MANAGEMENT IN COLOMBO

Municipal solid waste in Colombo and collected by the Colombo Municipal Council for final disposal at the Welisara landfill site. Currently wastes are deliveries to the site, where haulage distances are sufficiently short, by the collection vehicle (tractor trailers, side loading trucks and compaction vehicles). In addition, 550 Tonnes per day of waste are transported in bulk haulage by road to Welisara via the Baseline Road Transfer Station.

As part of the development of the solid waste management system in metropolitan Colombo, the need has been identified to establish one (or more) additional transfer stations to serve the southern part of the area (exact catchment to be determined in this study).

SCOPE OF THE TERMS OF REFERENCE

These terms of reference relate to the identification of potential locations for transfer stations, their evaluation (in economic, socio-economic and environmental terms) the selection of proposed site(s) and the execution of site-specific investigation, preparation of conceptual designs, costs and environmental impact assessment(s).

The required study comprises six main activities.

Activity 1: Initial site selection.
Activity 2: Review of socio-economic setting and surrounding land use.
Activity 3: Comparative evaluation of road and rail transport.
Activity 4: Geotechnical investigations at the selected site(s).
Activity 5: Conceptual site studies.
Activity 6: Environmental assessment of the transfer station site(s) and any additional associated landfill site facilities, combining the results of Activities 1 - 5.

The content of each activity is summarised below.
ACTIVITY 1

INITIAL SITE SELECTION

1.1. Purpose

The purpose of this activity is to identify feasible locations on technical/physical grounds for siting one or more transfer stations to optimise the overall cost of collection and transfer of municipal solid waste from Metropolitan Colombo to the Welisara landfill site. Activity 1 is the first of two activities (1 & 2) leading to the identification of a site(s) for detailed investigation and assessment for development.

1.2. General Scope

The activity will involve the following tasks:

Task IA: Composition of catchment area of Baseline Road transfer station and review of present design, operation and practices to delineate geographical area of site search and other experience to support subsequent design.

Task IB: Review of available data on current waste arisings (including weighbridge records at Welisara and Baseline Road) and waste projections for the next 15 years prepared in previous studies to estimate the design projection (tonnes per day) for the additional transfer station(s) and the distribution of waste production across the area to be served. From the results of this task and Task IB estimate the physical site area likely to be required.

Task IC: Prepare "long list" of potential locations for either road or rail transfer with consideration to the following.

* For Rail Only: Land adjacent to the rail track with easy road access for collection vehicles and sufficient space for creating sidings and transfer station, associated structures based on results of Task IB.

* For Both Road And Rail: Site ownership (Public, Private, Multiple)

Task ID: Review long list and rank the sites according to the factors given in Task IC in liaison with GOSL representatives on issues of policy (changing present land use, ownership issues etc.) Remove any sites failing GOSL policy criteria.
ACTIVITY 2

REVIEW OF SOCIO-ECONOMIC SETTING/SURROUNDING LAND USE

2.1. Purpose

The purpose of this activity is to assess the short-listed sites resulting from Activity 1, and conduct a comparative review of socio-economic and land use factors affecting the final choice of site.

2.2. General scope

This activity involves an iterative process to subject the short-listed sites to increasingly detailed scrutiny on the factors already considered above in Task 1D but more specifically conducting a comparative environmental review to rank the sites on their acceptability on a range of environmental and public health issues. Specific attention will be required to be given to socio-cultural issues including the need, if any, for involuntary resettlement associated with the transfer station development.

2.3. Reporting

A comprehensive report will be prepared detailing the assessment methodology used and the one, or more, sites proposed for GOSL consideration for transfer station establishment.
3.1 Purpose

The purpose of this activity is to establish the relative costs of road and rail transport from identified feasible transfer station locations to the Welisara landfill site.

3.2 General Scope

This activity comprises the following tasks.

Task 3A: Establish capital and operating costs over a 15 year period of establishing and operating road and rail transport facilities at the selected location(s) together with rail-head facilities at Welisara. The costs to be based on a given design capacity with attention to phasing installed capacity if worthwhile. Reference may be made to reports prepared in 1994 by ERM under contract to the World Bank for the solid waste component of the Metropolitan Environment Improvement Programme.

Task 3B: Prepare a DCF analysis of each approach over a 15 year life in accordance with World Bank guidelines. Undertake sensitivity analysis on key factors including, but not limited to, changes in waste generation and throughput at the site.

3.3 Reporting

Prepare a comprehensive report with conclusions and recommendations for the proposed transport method. All assumptions, baseline data and methodologies used should be clearly stated in supporting annexes.
ACTIVITY 4

GEOTECHNICAL SURVEYS

4.1 Purpose

The purpose of the required geological survey(s) is to determine the details of the physical integrity of the proposed transfer station(s) site to establish sufficient data to facilitate conceptual engineering and foundation characteristics.

4.2 General Scope

Ground Soils Survey,

The consultant shall undertake a ground soils survey using shallow trial pits (to a depth of up to 3m) to determine the general nature of the underlying ground conditions across the site. This information will be used subsequently, by Civil Engineers, to prepare waste management concept site layout. The ground soils survey should include, but not be limited to, the provision of data on:

- detailed logging of soils, geological layers and water strikes in each trial pit;
- two particle size analyses in each trial pit, one at the ground surface and one at approximately 2m depth;
- if liquids are present, basic chemical analyses should be conducted on two samples from each trial pit to determine pH, sulphate concentration, conductivity and total organic carbon concentration. The analyses on each sample should be completed within 24 hours of sampling;
- at least 10 static load bearing tests at agreed locations across the site.

The consultant should liaise with GOSL, Geological Survey Department.

4.3 Reporting

The findings from each task specified above will be presented in detail in a draft final report, accompanied extensively with listings of historic data, field and analytical results, large scale site mapping, drawings, cross-sections and pictorial records, and numerical and comparative descriptive information. In addition, specific appendices containing, but not limited to, the following are required to be appended to the draft final report.

1. Sources of published and available data and information used;
2. Listing of all data collected;
3. References cited; and
4. Record of meetings.
The progress of work will be monitored by an organisation nominated by GOSL, in consultation with the World Bank. The consultant be required to submit 10 copies in two volumes of the draft final report (one volume should be dedicated to each site), and subsequently, 20 copies of the agreed final report. The reports will be jointly evaluated by the GOSL and the World Bank.
ACTIVITY 5

CONCEPTUAL SITE STUDIES

5.1 Purpose

The purpose of the conceptual engineering work is to prepare facility layouts containing sufficient information to demonstrate the validity of the concept proposal, and to permit more reliable cost estimates to be prepared for financing purposes.

5.2 General Scope of the Conceptual Site Studies

(i) Conceptual design layout:

As a first stage, the consultant should review the design of the Baseline Road transport station and (for road transport) determine whether the concept is appropriate for the site in question albeit for a different throughput. If so, any amendments necessary should be incorporated to complete this sub task.

Preliminary block diagram layout and engineering drawings shall be prepared to illustrate the access, buildings, services and storage areas at the Baseline Road transfer station. In addition, the sources of on-site cover material, waste emplacement, phasing, drainage, gas and leachate management and profiles should be provided in outline for Padukka.

The facilities depicted for the site should be consistent with the development of a 2 storey waste transfer operation with top loading of demountable 20' ISO containers receiving waste from a variety of refuse collecting vehicles. The containers, once full, would be transferred by fork lift to a storage area for transfer by road/rail to the Welisara landfill. No mechanical compaction into containers is envisaged at the present time.

The consultant should liaise with the NBRO and review their recent reports on waste management for Colombo.

(ii) Traffic Flow Patterns:

A wide variety of collection vehicles will bring solid waste for transfer. A smooth one way traffic flow pattern, including the possible provision of weighbridge and wheel washing facilities, should be suggested and depicted on site plans. In addition, the on-site movements of fork-lift trucks and build haulage by road or rail transport must be conveniently accommodated. Details of minimum turning circles and similar necessary information will be indicated by the Consultant in conjunction with the NBRO.

(iii) Site Preparatory Works:

Preliminary estimates are required for each site to indicate the locations and approximate volumes of earthworks i.e. regrading, stockpiling, drainage and similar operations.
In addition, the Consultant should provide a preliminary schedule of works for the development of the principal facilities at the site(s), as well as indicating those developments likely to be on the "critical path".

The consultant should also list the general design assumptions and specifications used, as well as those that must be defined before future detailed site engineering can begin.

(iv) Derivation of Specific Costs:

Once the Consultant has completed the preliminary works set out in Tasks (i) to (iii), more reliable set of unit costs and quantities for the major engineering-related site developments can be compiled. In turn, the Consultant should use these derived values to prepare revised, representative estimates of the major engineering-related capital costs for the proposed transfer station and landfill developments.

(v) Operating Arrangements:

The Consultant shall develop and propose alternative institutional arrangements for regional management of waste collection, transfer and disposal (landfill), including possible private sector participation. The Consultant shall develop staffing and training requirements.

5.3 PROJECT SCOPE:

The Consultant will:

- assess quantity, composition, nature and sources of the solid waste generated. He will make the necessary visits to the industrial areas.

- outline options to handle the waste. He will be fully aware of laws to protect the environment and existing Government laws regarding private sector ownership and participation.

- ascertain the diversity of the waste and recommend a strategy for the physical handling of it (eg. segregation, incineration, treatment, etc.).

- evaluate the options; recommend a strategy and the institutional framework under which this strategy is to be implemented. He will consider private sector participation and the incentives needed; he will consider as well the methodology of disposal (eg. fully integrated treatment centres) and methodology of contracting.

- prepare the TORs needed as a result of the implementation of the strategy.
ACTIVITY 6

ENVIRONMENTAL IMPACT ASSESSMENT

6.1 Purpose

The purpose of the Environmental Impact Assessments (EIAs) is to ensure that the proposed waste management developments under consideration at Baseline Road and Padukka are the most satisfactory for the management of waste and likely to cause the least potential effect upon the local environment. In addition, the EIAs will identify the various environmental and community consequences of the proposed development, in order to:

- ensure the resolution of potential environmental issues early in the implementation of the proposed waste transfer and landfill disposal facilities;

- avoid delays and extra costs which may subsequently arise due to unanticipated environmental problems;

- demonstrate by providing a formal methodology that environmental issues are being treated as a high priority in the development of a comprehensive solid waste management system for the Colombo Metropolitan Area; and

- ensure that the concerns of residents and communities are addressed and plans are made for the resettlement of those residing in and around the selected sites for development. The EIA must be prepared in accordance with the World Bank guidelines and GOSL requirements.

The latter includes

(i) National Environment Act No: 47 of 1980 as amended by Act No: 56 of 1988; and


6.2 General Scope of the EIA

The EIA should be in strict compliance with GOSL: World Bank on EA’s (OD4.01) and Involuntary Resettlement and Community Consultation (OD4.30) or revised directives. The EIA is required to cover the transfer station site together with any associated changes in the reception arrangements at the landfill. For example, if road transport is selected, there will be fewer but larger vehicle movements at Welisara. If rail transport is selected, the rail head reception facility will represent an additional source of impacts.

The EIA Report shall follow the general structure specified below.
The EIA prepared in 1994 by ERM for the Baseline Road transfer station may be used as a model for structure and content.

6.3 Specific Data Requirements

In order to produce the EIA report the following data requirements should be included as part of the baseline environmental survey. Data maybe collected from currently available sources, or collected by the consultant in the field, or derived by extrapolation from experience elsewhere providing it is based on the professional judgement and justification of the consultant.

The data requirements specified here should be regarded as the minimum to be considered by the consultant for each site, i.e.:

- Outline engineering details, visual appearance and specifications known for the proposed waste transfer, haulage and landfill disposal facilities.

- Local topographical, geological and hydrological information compiled.

- Quantitative and qualitative background data on existing and potential noise levels around the site;

- Quantitative and qualitative details of the local flora and fauna, potential pests and vectors, local ecosystems and habitats and nearby sites of ecological or conservation interest;

- Details of the type and quantity of wastes to be delivered to the transfer station. Details of waste handling, waste storage and management procedures to be used, and so on;

- Proximity of the site to:
  - housing
  - flight paths and airport approaches, also radio masts and radar installations (particularly with regard to environmental impacts of microwave radiation).
  - 'sensitive' buildings such as schools, churches, hospitals, old peoples' homes, children's homes, children's nurseries, etc.
  - cultural and archaeological sites, forests, national parks, etc.
  - installations considered to be 'major hazards' by virtue of the operations carried out at these facilities. For example, explosive manufacturing facilities or petro-chemical plants.
  - public utilities and services,
  - small and medium scale manufacturing industries,
  - mining and quarrying activities;
• Expected emissions, if any, and quantitative details directly relating to the performance of the waste transfer or disposal operation or haulage operation. This should include estimated numerical details on likely:

- solid and liquid discharges, including leachate;
- dust and particulate emissions;
- vapour and odour discharges;
- noise and vibration
- gaseous discharges

• Details on known past uses of the site and soil or groundwater contamination that may have arisen;

• Review of relevant prevailing environmental legislation;

• Identification of the capability of local and regional transport routes and urban infrastructure to accommodate waste management operations and additional traffic:

• Social and cultural details including:

- present population and employment trends in communities in the vicinity of each site;
- distribution of income, goods and services;
- typical geographical distances to work;
- community structures, attitudes and customs;
- recreational opportunities;
- relocation issues;

• Local meteorology

The Consultant will be expected to provide full details of all data collected in appendices to the EIA reports, and supplemented with maps, drawings, figures, photographs, tabulations and results of predictive modelling as appropriate. Some site details may be available, from national and local government departments, and other public sources in Sri Lanka.
Annex C

Resettlement Plan for the residents of the three small islands of high ground within the Welisara site
INTRODUCTION


This report outlines a resettlement plan for up to 25 households displaced by the Welisara Landfill Development. The process of resettlement will be handled by a Resettlement Assistant who works to the District Secretary, Wattala, who is responsible for all aspects of the resettlement process. A package of benefits for households displaced by the project is outlined including not just compensation for lost assets but also significant resettlement allowances. It also outlines the role of the resettlement assistant in facilitating the resettlement process and encouraging the active participation of households who have to be relocated. An estimate of costs is presented in Section 10 and an outline schedule for resettlement is given in Section 15.

BACKGROUND

Walisara is situated in one of the most densely populated parts of Sri Lanka. Population density in Gampaha District as a whole averages 1,000 persons per square km whilst in the immediate vicinity the density is reportedly over 5,000 persons per square km. The population of this area is growing rapidly and is expected to double in the decade 1991-2001. Much of this population growth is the result of the rapid rise in land prices in metropolitan Colombo over the last fifteen years. This has led to the development of both residential and industrial areas along the main road linking Colombo with the airport and Free Trade Zone at Katunayake. It appears that the majority of the population in Welisara are relatively recent immigrants from other areas of Sri Lanka. Whereas 20 to 25 years ago there was still a major agricultural sector in Welisara, today agriculture is of minor importance. Land previously under coconut palms is today the site of housing developments, factories and container yards.

The area affected by the project forms a microcosm of the area as a whole. What was two or three decades ago an area of long established small communities engaged in agriculture has now become an area of dense population in which most people are dependent on wages and salaries for their income. Whilst there are some local industries, for instance the milk factory and the plastic factory, the majority of the working population commute to jobs in Colombo, Katunayake and other centres of employment in the vicinity. Agriculture is now of minor importance. Although the Galudupita marsh was used for paddy in the past, problems with drainage have led to paddy cultivation being abandoned. On the higher land coconut
palms and tree crops such as mangos are still grown, but these are generally marginal to household incomes.

A number of residential zones can be identified in the immediate vicinity of the site.

**Zone 1:** To the west of the marsh and running as far as the main Colombo-Negombo road is a dense area of mainly middle class housing. Here what were once coconut estates have been sold and split into small blocs for residential use. The majority of the population in this area are relative newcomers to the district. It is difficult to estimate population figures but there are probably over 1,000 households in this area.

**Zone 2:** To the north of the marsh occupying a narrow strip of land between the marsh and the naval base is a row of around 80 houses. These are generally of lower quality than those in zone 1 and most appear to have been constructed over the last ten years. Most of the occupants are immigrants from outside the immediate vicinity of the site. This area includes an island known as Duva which is occupied by one household.

**Zone 3:** Immediately to the west of the marsh and occupying one of the islands in the marsh (Illukgoda) is one of the older communities in the area. Once dependent on paddy cultivation, most people now depend on wages and salaries.

**Zone 4:** By the railway line which forms the eastern boundary of the site are recent immigrants to the area occupying an island known as Navamahara. This is the poorest residential zone. Houses are built of timber and cadjan and their occupants depend in the main on casual labour supplemented by fishing and other minor activities in the marsh.

**Zone 5:** To the south of the site is a mixed residential area, mainly consisting of middle and lower-middle class housing.

These zones are shown in Figure C1, in the context of the proposed phased development of the landfill sites. Except for zone 2 and 4, electricity is widely available, the local authority having installed it over the last few years. Throughout the area households presently depend on well water and most houses have their own wells.

Although important as a source of income in the past, the marsh is now economically relatively unimportant. There is some small-scale fishing mainly for domestic consumption, and some vegetables are collected, particularly kankun. Cattle and buffalo are grazed within the marsh. For most households these activities are marginal sources of income, but for the poorest, particularly those in zone 4, such sources of food are important during periods of unemployment.
One of the results of the changing demographic structure of the area around the marsh has been a shift in its religious composition. Traditionally, this has been a predominantly Catholic area. However, many of the recent immigrants are Buddhist. Zone 2 is predominantly Buddhist, while in zones 1 and 5 Buddhists probably outnumber Catholics. There are at least three small Buddhist temples in the vicinity of the marsh.

ATTITUDES TOWARDS THE PROJECT

In the vicinity of the site there is general antipathy towards the project amongst those who will need to be relocated and those who will remain in the area. This antipathy centres around a number of themes.

- The general environmental impact on the area. These include the possibility of bad odour from the site, unsightliness of the waste to be landfilled there, noise from increased transport, loss of well water and dangers of flooding.

- A potential drop in land values. It is felt that the proximity of an area of solid waste will depress land and property values in the adjacent area and thus lead to a general depreciation in asset values.

- Negative social impacts. There is a fear that the establishment of the landfill site will attract groups of scavengers to the area and the possible establishment of shanty settlements. Also there is some fear that a group of noisy and potentially undesirable boutiques will grow up around the entrance to the landfill site and function throughout the night.

The initial public reaction was based on a misconception of the nature of a properly managed sanitary landfill and a lack of appreciation of the plans for other forms of community upgrading. Following meetings at which the proposals have been explained, some of the existing residents of the area now understand the nature of the planned operations. However, there is little faith in the ability of the authorities to control potential negative impacts. An outline of how these problems may be addressed is given in the main report. In so far as resettlement may take place within the environs of the project, these worries are shared by those households which will have to be resettled, but these families are generally preoccupied by strong feelings about resettlement.

Amongst all those households liable for resettlement there is a general feeling that they are having to bear the costs for benefits which will accrue to others, most notably the rubbish producers of Colombo. Put crudely, their argument is that Colombo should deal with its own rubbish. Many have invested heavily in their property over the last few years and are unwilling to give up what they see as a salubrious and relatively quiet mode of life in what is otherwise an extremely crowded part of Sri Lanka. There is also a sense of powerlessness in that they see no way in which they can
effectively oppose the decision to go ahead with the project. Finally, few believe that they will be adequately compensated for their loss of assets, loss of what they see as a congenial place to live, and the disruption to their lives which the project will involve.

Amongst those who have lived in the area all their lives, such as many of the inhabitants of Illukgoda, there is a further sense of loss in that this is their ancestral land.

In order to address such concerns, it is necessary that the resettlement package finally negotiated with those households which have to be moved is more than that prescribed as the legal minimum (see Section 10 below). The proposals which follow outline a proposed resettlement package. An estimate of potential costs is given in Section 10 and the outline schedule for the resettlement process is given in Sectio 15.

**GUIDING PRINCIPLES AND CRITERIA**

The guiding principles and criteria which should be adhered to are set out below.

- None of the families to be resettled will be rendered economically worse off by their relocation (cash compensation alone is not usually sufficient to create a well integrated resettled community).

- Alternative resettlement sites will be identified on the hillsides surrounding the Galudupita Marsh site at Welisara, with the aim of minimising physical and social disruption to the resettled families.

- Resettled families will be provided with housing of at least equal quality to that from which they have been resettled. Infrastructure and services (electricity, improved water supply and sanitation, improved access to schools, transport and medical facilities) should be of at least equal quality to those available in their original location.

- Those households which currently derive a significant proportion of their income from exploitation of marsh resources, should be offered the option of relocation to other nearby marsh land (for example, to the east of the railway tracks).

- The families to be resettled, together with families within the host communities, will benefit from the provisions of the Community Development Plan, as well as plans for landscaping and restoration of the landfill site.

- The details of the resettlement plan, and the Community Development Plan, will be developed over time in full consultation with the local
population, through the strengthening of Community Based Organisations (CBOs).

- The resettlement of the 25 families will not bring about any degradation to the social or environmental well-being of the host communities.

ORGANISATIONAL RESPONSIBILITIES

The project as a whole will be implemented by the Western Provincial Council (WPC) acting under the Ministry of Home Affairs and Provincial Councils (MHA&PC). Responsibility for the acquisition of lands and the resettlement of the households involved lies with the Divisional Secretary (DS) based at Wattala. He acts as the Acquiring Officer (AO) on behalf of the Minister of Lands in the acquisition of lands within the site and is also responsible for obtaining alternative lands for those displaced by the project. In this he is assisted by the Land Officer stationed at the Divisional Secretariat. All matters concerned with valuation and the payment of compensation pertain to the DS.

Given the small number of households involved it is unnecessary to create a special unit to deal with resettlement. However, given the many other roles of the DS, it will be necessary to appoint a resettlement assistant (RA) to the DS immediately. The role of the RA will be to expedite all matters concerned with resettlement. An outline work programme for the RA is shown in Figure C2.

COMMUNITY PARTICIPATION AND INTEGRATION WITH HOST COMMUNITIES

One of the roles of the RA will be to ensure that those who will be resettled are fully informed and consulted during the resettlement process. There have already been two public meetings aimed at the wider community which were intended to introduce the overall project concept and to answer questions and allay fears about the environmental impact of the landfill design. Since preparation of the draft EIA (March 1994), a third meeting has been held, (9 April 1994) aimed specifically at the families to be resettled. This meeting was generally reported to have gone well, with a considerable degree of acceptance being achieved amongst residents of the two smaller islands, following full explanation of the potential resettlement and community development packages. The residents of the largest island, Illukgoda apparently still prefer to remain in situ during the early stages of landfill construction, and wish to defer a discussion about relocation until the impacts associated with their proximity to the landfill site become fully
### Figure C2 Workplan for the Resettlement Assistant

<table>
<thead>
<tr>
<th>Task</th>
<th>Month</th>
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<tr>
<td>Public consultation and information</td>
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<td>Identification of potential relocation sites</td>
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<tr>
<td>Individual and group discussions with affected families</td>
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<tr>
<td>Protect the interests of women and the poorest households</td>
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<tr>
<td>Negotiation of compensation packages for affected families</td>
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</tr>
<tr>
<td>Expedite compensation</td>
<td></td>
</tr>
<tr>
<td>Facilitation of construction of sites, houses and infrastructure</td>
<td></td>
</tr>
<tr>
<td>Supervise transfer of population</td>
<td></td>
</tr>
</tbody>
</table>

(months following the "Day Zero" effective date of the project)
apparent. This approach has several operational and logistical disadvantages, and is discussed further in Section 15 below. There remains a need for further consultation and negotiation with the people of Illukgoda on this subject, and with all the families to be resettled who will all need to be informed and advised on a separate and regular basis.

At present, the process of identifying sites for relocation is in its early stages (see section 9). The RA will be involved in identifying these sites and discussing with the resettlers where they wish to be resettled.

Whether or not people wish to be resettled in groups is unclear. It is likely that some households will prefer to relocate on sites of their own choice, for instance on land they own elsewhere or on land bought privately. The RA will discuss such issues with displaced households on an individual and group basis and facilitate their decisions through these discussions.

**SOCIOECONOMIC SURVEY**

At the time of writing, it had not been possible to carry out a detailed socioeconomic survey of the island communities due to strong localised feelings against the project, especially on the large island of Illukgoda. In large measure this is a result of a lack of understanding of how generous the relocation package will be and the difference between an open dump and a sanitary landfill, which is virtually unknown in Colombo. Before any future attempt is made to carry out such a survey the RA will have to ensure that there is an effective information campaign to explain the nature of the resettlement package. Whilst relocation may never be popular with those who are being resettled, particularly those living in Illukgoda, relocation will be attainable if a sufficiently generous level of compensation is offered.

In summary, the 25 households to be resettled live on three small islands located within the Galudupita marsh (Walisara site) on land which is privately owned. Most of these families derive their income from employment outside the marsh area. Only a few families derive significant proportion of their income from exploitation of the marsh resources in the form of cattle grazing, fishing and a variety of cottage industries including basket making from reeds and grasses and the collection of wild vegetables (kankun).

**LEGAL FRAMEWORK**

The legal framework for land acquisition and compensation for loss of assets is laid down in the Land Acquisition Act of 1950 and the amendments of 1983 and 1986.
Although the WPC will be the project implementing agency, land is a reserved function of central government. Thus the WPC will have to formally approach the MHA&PC which will then request the Ministry of Lands to issue a notice that the land is required for a public purpose. This will be done by the DS acting as the MOL's acquiring officer (AO). In July 1993 a Section 2 notice was served on an area which included the project site on behalf of the Sri Lanka Land Reclamation and Development Corporation. (However, with a change in land use it may be necessary to issue a new Section 2 notice).

Once the notice has been issued and publicised through public notices, the Government Gazette and newspapers, objections can be raised to the acquisition during a period of not less than 14 days. This period has now passed with respect of the Welisara site. These objections have to be made to the relevant ministry, in this case the MHAPC. The decision whether or not to accept the objections is taken by the relevant minister.

The next stage (which has not yet taken place at Welisara) is for the acquiring officer to request the Survey Department to carry out a detailed survey of the land. This includes such matters as the boundaries between crown and private land, the borders of individual plots of land and the names of claimants when known. The result is an acquisition plan which is sent to the AO. The AO then publishes a notice of acquisition which is also exhibited by the village headman (Grama Niladharis), and sent to known individual claimants. All claimants have at least 14 days in which to register their claim and to make their own assessment of the value of the land. These claims are then sent to the Valuation Department.

During this period, the Valuation Department is also determining its own valuation of land to be acquired. The details of this process are given in section 45 of the act and in general are determined by present market values in the area in question. Various sorts of information are used in this process, not just the prices which appear in transfer deeds but also those paid by commercial companies and those set in auctions.

Once this process is complete, the AO holds an inquiry into claims for compensation. This is concerned with both title to land and levels of compensation. Where there are disagreements over title the AO's decision can be appealed to the District Court and the Court of Appeal. Where there are disagreements over the valuation and compensation payable, the plaintiff can appeal to the Board of Review from which there can be no appeal except over points of law. The same general process is followed for other assets, for instance houses and trees.

The procedure can take an extremely long time, depending on the number of appeals that are made and the complications of the cases involved, for instance large numbers of shareholders in undivided plots of land. Twelve to eighteen months is not unusual. However, there is a shortened process of land and property acquisition possible under section 38A of the Act. This in effect allows the Government to acquire land before title and value have been ascertained. There is, however, a general feeling that such a process...
contravenes the rights of landholders and thus can only be used in very particular circumstances.

Within the legal framework, all that is required in cases of land acquisition by Government is that compensation be paid. There is no necessity that part of this compensation should take the form of land. However, it is widely accepted by GOSL that where it is possible, land should be offered as part of a compensation package.

The process described above is also required where the state is obtaining land from private owners on which to resettle displaced persons, unless of course the land is being purchased from a voluntary seller. Where state land is used for resettlement, for instance land held by various ministries, the Land Commission is responsible for the alienation of the land to the allottees. Where the land is controlled by the Land Reform Commission then the Land Commission does not need to be involved.

These procedures for land acquisition refer to freehold land or more generally to land where there is title. In terms of the Land Acquisition Act squatters are not entitled to compensation, although squatters who have improved land are entitled to compensation for the improvements, and they are also entitled to compensation for property such as houses etc. Similarly monthly tenants are excluded from the compensation process as outlined in the Act although lessees are entitled to compensation.

In practice, however, GOSL policy over relocation of squatters and tenants is to treat them broadly in the same way as freeholders. Such compensation is, however, ex gratia and not legally required. Although the Valuation Department may informally advise on the scale of compensation it cannot make official recommendations.

To sum up, there is a clear legal framework covering the acquisition of land by the state. There is a firm set of processes in place to arrive at estimates of levels of compensation, and there are appeals procedures in cases which cannot be agreed. However, the process can be slow and procedures which speed up the process of acquisition do so at the cost of limiting the rights of those who are involuntarily moved. Although legally only those with clear title are entitled to compensation, in practice others do receive compensation.

The RA will ensure that all households subject to relocation are fully aware of their legal rights. The RA will also explain in detail the process of valuation as there are a number of misconceptions current as to how values are arrived at. Where necessary the RA will assist in negotiations between the relocated households and the AO and ensure that the acquisition and compensation process is expedited in a timely fashion. Given that no more than 25 families are to be resettled, it is not anticipated that longer than the typical 12-18 months will be required.
ALTERNATIVE SITES AND SELECTION

Precise sites which will be offered to the displaced household have yet to be identified. This area of Sri Lanka is very densely populated and land is scarce. But the households involved in relocation are not dependent on farming and thus the primary need is for residential space, which is available in the area.

So far, three potential sites have been identified by the DS. The first of these consists of coconut land held by the Land Reform Commission. The second is a Government farm. Both of these sites are within two km of the project site and there will be no problems with acquisition. However, in both sites infrastructure, notably roads, water supply and electricity, will have to be installed prior to resettlement. The third option is to purchase private lands which are available within three km of the project site. If bought through the market rather than through compulsory purchase the transfer of private lands can be completed quickly.

The institutions involved in resettlement aim to give the displaced families a choice as to which lands (if any) they wish to receive in compensation for land lost to the project. A role of the RA will be to facilitate this consultation process and to ensure that resettled households are aware of their options.

VALUATION OF AND COMPENSATION FOR LOST ASSETS

The legal framework for valuation and compensation for lost assets is discussed above in Section 8. Those households which are eligible for resettlement and compensation have already been identified and there are no cases where households will become economically non-viable but will not receive compensation. An influx of non-residents attempting to take advantage of the compensation arrangements will not be accepted since all eligible households (see Figure C1) have already been identified.

During the acquisition process, one of the tasks of the RA will be to ensure that the interests of both men and women in the resettled households are recognised and represented in the resettlement process. Thus at all points in the consultation process the RA will ensure that women are aware of the various options and that they concur with the decisions which are made.

The RA will also ensure that the poorest and most marginal households involved in resettlement are also fully involved in the process. The RA will ensure that in the case of households which do not have title to land their usufruct rights are fully recognised and that they receive full compensation for their losses.
Besides the legal minimum compensatory arrangements outlined in Section 8, further compensation should be made available to ensure the speedy expedition of the process of resettlement, to compensate for the disruption caused by resettlement and to minimise the sense of loss which will be experienced by those resettled. These measures may include the following.

- A new residential site in addition to compensation for land lost to the project. Where households do not wish to be awarded a new piece of land they should be offered cash equivalent in value to that of the offered land.
- A disruption allowance paid to all households to compensate for the time and negative experiences of being resettled.
- Low interest housing loans through the National Housing Development Authority to assist in the construction of new houses.
- The supply of seedlings etc for the establishment of home gardens in the new residential sites.
- The offer of training facilities to those who require it (see Section 12).
- Free transport to the site of relocation for the transfer of property including any building materials from the acquired house which households wish to take with them.

Estimates of the costs involved in all of these measures are given in Table C1. A major task of the RA will be to facilitate negotiations, on behalf of GOSL, over these benefits and to ensure that these are acceptable to the resettled households. In this context the RA must take full cognisance of the interests of women. It is understood that resettled households are eligible for twelve months food aid from the World Food Programme. If so, the RA should ensure that this aid is obtained.

The three largest variables, and the three greatest uncertainties, in the cost estimates at this stage are:

- the value of the land currently occupied by the families to be resettled.
- the value of the properties currently occupied by the families to be resettled.
- the location and therefore the value/purchase cost of the land to be provided to the resettled families.

The first and second of these variables have been estimated based on discussions with the Divisional Secretary, Wattala. These land and property prices are thought to be higher than might be otherwise expected, due to the popularity of the land in this area, which is convenient for Colombo yet in a relatively peaceful, mixed rural/residential setting.

For the same reasons, the provision of alternative land in the area around the marsh is also likely to be relatively expensive, particularly land within easy reach of the main road. At the time of writing no decision had been reached as to which land would be allocated to the resettled families, and it
### Table C1: Iterative Costs

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<th>Item</th>
<th>Budget (Rs)</th>
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<tr>
<td>Value of land acquired (1)</td>
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<tr>
<td>Value of property acquired (2)</td>
<td>5,100,000</td>
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<tr>
<td>Value of new residential sites (3)</td>
<td>22,000,000</td>
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<tr>
<td>Cost of infrastructure (4)</td>
<td>2,500,000</td>
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<tr>
<td>Resettlement allowance (5)</td>
<td>125,000</td>
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<tr>
<td>Cost of loans (6)</td>
<td>625,000</td>
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<tr>
<td>Cost of trees etc (7)</td>
<td>5,000</td>
</tr>
<tr>
<td>Cost of retraining (8)</td>
<td>200,000</td>
</tr>
<tr>
<td>Cost of transport to relocation site (9)</td>
<td>25,000</td>
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<tr>
<td>Resettlement Assistant (10)</td>
<td>240,000</td>
</tr>
<tr>
<td>Publicity, meetings etc</td>
<td>50,000</td>
</tr>
<tr>
<td>Administration costs</td>
<td>50,000</td>
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<tr>
<td>Contingencies at 10%</td>
<td>4,112,000</td>
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<tr>
<td><strong>Total (Rs)</strong></td>
<td><strong>45,232,000</strong></td>
</tr>
</tbody>
</table>

**Total US$** 904,640

### Notes

1. Land valued at average of Rs. 15,000 per perch, assuming average holdings of 25 acre (40 perch) value is Rs. 600,000 (The island of 8 hours are encroachers and therefore, there will not be a cost involved for purchasing the land from them)

2. Houses and associated property valued at average of Rs. 300,000 each

3. Land valued at average of Rs. 22,500 per perch, assuming average holdings of 25 acre

4. Infrastructure at Rs. 100,000 per household

5. Resettlement allowance of Rs. 5,000

6. Subsidy to NHDA amounting to Rs. 50,000 per household, assuming a 50% take up rate

7. Rs. 200 per household

8. Rs. 40,000 per household, assuming a 20% take up rate

9. Rs. 10,000 per household

10. Rs. 20,000 per month for 12 months
has not therefore been possible to put exact costs on land to be provided for this purpose.

Once GOSL endorsement of the outline resettlement plan is obtained, and land has been allocated for the families to be resettled, it will be possible to begin to attach exact costs to these and other items through a process of negotiation with the families concerned and the current owners of land to be purchased for resettlement purposes.

**LAND TENURE, ACQUISITION AND TRANSFER**

These topics have been covered in Section 8. It should be stressed that even though some households do not have legal rights to land they will be compensated as if they did have legal ownership. This will imply a major improvement in the control of assets to the poorest households involved in the resettlement.

**ACCESS TO TRAINING, EMPLOYMENT AND CREDIT**

Given the small number of households involved, their dependence on waged and salaried employment, and the short distances which are envisaged in the relocation process, there should be relatively little disruption to the economic life of most households. However, amongst the poorest households for whom informal activities such as fishing and vegetable collecting in the marsh are important, there may be a greater negative impact. Thus members of relocated households should be offered the opportunity of vocational training. This will be organised by the RA.

**SHELTER, INFRASTRUCTURE AND SOCIAL SERVICES**

Once sites for resettlement have been agreed with the relocated households, it will be ensured that basic infrastructure such as roads, electricity and piped water supply are in place. As it is planned to offer households alternative sites within the immediate vicinity, social services such as hospitals, other health care facilities, schools, churches and temples are already available.

Resettled households should be allowed to decide for themselves the types of houses they wish to construct once resettled and if they so wish engage their own contractors. A reasonable period of time should be allowed between the completion of negotiations over the scale of compensation, choice of relocation sites and payment of compensation on the one hand,
Figure C3 Early Resettlement Implementation Schedule

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<th>Task</th>
<th>Month</th>
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and the date of relocation on the other. It is suggested that six months are allowed.

The RA will facilitate the process of constructing new houses. If required, the RA will assist households to engage contractors and to plan new houses as well as assisting households in managing the financial aspects of resettlement.

**ENVIRONMENTAL PROTECTION AND MANAGEMENT**

Given the nature of the relocation process, no environmental pollution or management problems resulting from resettlement are envisaged. The number of households is small and resettlement will only have a marginal impact on the environment of the area. As has already been mentioned, trees will be offered to relocated households which can be used to create home gardens. Here, the RA will approach the Participatory Forestry Project of the Forest Department for assistance. This project is already involved in encouraging tree planting in home gardens.

**IMPLEMENTATION SCHEDULE, MONITORING AND EVALUATION**

Given that there is no agreed start date for the project, an indicative schedule only can be provided at present. The overall timetable for resettlement is shown in Figure C3 and assumes an expedited schedule of 12 months. "Day zero" is defined as the effective date of the proposed Project, and all subsequent timings then relate to this reference start date. As explained in Section 8 there are two main points at which a delay to implementation could occur. The first is in the acquisition of land and agreement of compensation for land. The second is the process of negotiation with households to be relocated over the total package of compensation being offered. The RA will be responsible for ensuring that once the project is approved by the World Bank and the GOSL, and a target start date for construction has been set, that this schedule is presented to the families to be resettled so that negotiations can be completed on this basis. At that stage the detailed timing for preparation of relocation sites, services and housing construction can be planned to dovetail with the design, construct operate schedule set by the landfill contractors and the GOSL.

As already mentioned in Section 6 above the families of the island of Illukgoda are reluctant to discuss relocation until construction of the third phase of the landfill becomes necessary. Although it is not essential that all households living in the project area should leave before construction of Phase I commences, it is preferable that all resettlement takes place at the beginning of the project for the following three reasons.
• This approach will ensure the presence of the RA to facilitate matters.

• Early relocation will ensure that all negotiations are completed and do not delay the project at a later date.

• The island of Illukgoda represents the major source of clay for site development, and if this cannot be utilised until the final phase of the landfill development, an alternative source of clay will need to be identified and brought into the site by truck. There are potentially significant environmental impacts associated with sourcing and transporting clay under this scenario.

Monitoring of the process of resettlement should be handled by the general project administration. Given the numbers of households involved any complex monitoring system is unnecessary. However, if early resettlement of all 25 families takes place, it will be necessary to ensure that the land that has not yet been taken up for landfill development, remains unoccupied.

**Phased Resettlement**

If opposition to early resettlement by the residents of the island of Illukgoda is sufficiently strong, it would technically be possible to delay the resettlement of these families until such time as a start date for Phase 3 of the landfill development becomes clear. This is estimated to be 10 to 15 years from the commencement of construction work at the site. However, the compensation package would be fixed during the first phase of landfill development (years 1 to 5) and firm commitment to resettle would also need to be given at this time, even if actual relocation was to occur later in the development programme. An indefinite period of "Wait and see" is not feasible.

*Figure C1* shows the location of the three small marsh island communities to be resettled in relation to the proposed phasing of the landfill development. It follows that the exact dates for the resettlement of each community would depend upon the rate of landfill development, which in turn depends upon the actual rate of waste generation. However, in general terms, it can be seen from *Figure C1* that the northernmost island community (Navamahara), comprising 8 households will need to be resettled as planned by Year 1 when site preparation and drainage works begin on Phase I of landfill development. The second marsh island to be affected (Duva) comprises only 1 household, which if not resettled along with Navamahara, will need to be resettled in Year 4 or at the beginning of Phase II of landfill development (whichever is the later). The third, and largest, of the island communities (Illukgoda) comprises 16 households, but will not need to be relocated until Year 13 of the beginning of Phase III (whichever is later). This information is summarised on *Table C2* below.

The decision as to whether or not to proceed with resettlement during the first year, or whether to take a phased approach over the lifetime, will ultimately need to be taken by GOSL in consultation with the local...
community, and bearing in mind the operational difficulties and additional traffic impacts associated with the phased approach.

### Approximate Phased Resettlement Implementation Schedule

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<tr>
<th>Community</th>
<th>Phase of Works</th>
<th>Approximate Year of Relocation</th>
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<tr>
<td>Navamahara (8 households)</td>
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<tr>
<td>Duva (1 household)</td>
<td>II</td>
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<tr>
<td>Illukgoda (16 households)</td>
<td>III</td>
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Annex D

Public Consultation and Awareness Campaign
1

PUBLIC CONSULTATION

RECORD OF PUBLIC FORUM MEETINGS HELD TO DATE

Author: Sumith Pilapitiya - National Programme Coordinator (MEIP)

The public were consulted during the process to identify a suitable site for a long term sanitary landfill for the Colombo Urban Area (CUA). This was the first attempt in Sri Lanka at consultations with the public prior to selection of a landfill site. Two public meetings were held under the chairmanship of the Secretary to the Ministry of Provincial Councils and Home Affairs (M/PC&HA) on December 12, 1993 and December 22, 1993 at the Office of the Divisional Secretary in Wattala, to discuss the use of the Galudupita Road Marsh in Welisara as a potential site for a sanitary landfill. Letters of invitation for the two meetings were hand delivered to the residents in the immediate vicinity of the potential site in Welisara, by the Divisional Secretariat in Wattala. In addition, public notices were put up in the Welisara area announcing the two meetings.

1.1.1 First Public Meeting: 12 December 1993

The first meeting was attended by residents of the immediate surroundings of the site as well as representatives from the commercial establishments and warehouses situated along the approach road to the site. The GOSL was represented by officials from the M/PC&HA, the Ministry of Fisheries and Aquatic Resources, the Sri Lanka Land Reclamation and Development Corporation, the Divisional Secretariat of Wattala and the MEIP. Prior to the commencement of the meeting, the public was very concerned with the possibility that the site at Welisara would be used for the disposal of garbage. Sri Lanka does not yet have a properly engineered sanitary landfill for waste disposal, so the public are unable to distinguish between a sanitary landfill and an open dump as is the common practice in the country.

The Secretary to the M/PC&HA commenced the meeting with a detailed explanation of the proposed project. He outlined the serious problems experienced by the GOSL in the area of solid waste management, the lack of disposal space and the necessity for identifying suitable land for a long term sanitary landfill. The site selection process was explained to the participants. The benefits to society at large of a sanitary landfill was explained with due consideration given to the adverse environmental conditions that could be experienced by the community in the immediate vicinity of the site. Sensitive issues such as possible re-settlement were discussed in depth. In the discussion that ensued, it was apparent that the participants could not distinguish the difference between a sanitary landfill and an open dump. The National Program Co-ordinator of MEIP was called upon to explain the principles behind the design of a sanitary landfill and the precautions that would be taken to minimize adverse environmental effects due to the project.
There was a prolonged discussion, where the participants were able to express their concerns with regard to the project. Some of the major concerns expressed were:

- the possibility of re-location;
- adequate compensation for land currently under private ownership;
- the adverse effects of having a landfill in the vicinity; and
- possible end use of this after the landfill has reached capacity.

It was explained to the people that site would be suitable for agricultural purposes or for recreational use once the landfill was closed. The people were made aware of the fact that this particular site had been served a Section 2 Notice under the Land Acquisitions Act in July 1993 and the site was no longer available for private development. The representatives of the GOSL addressed the concerns raised by the public during the discussions with no issue left unanswered. The meeting was concluded with a date set for another public meeting on December 22, 1993 in the hope of reaching a larger audience than present at this meeting. The consensus emerging from this meeting was the public was concerned about the possibility of a solid waste disposal site in their neighbourhood, however, they realised the urgency of the GOSL to develop an environmentally acceptable solution to the problem. Once they realised that the landfill will be based on sound scientific and engineering principles and not the usual open dump commonly visible, they were more amenable to accept the landfill than before the meeting.

1.1.2 Second Public Meeting: 22 December 1993

The second public meeting was also held at the Office of the Divisional Secretary in Wattala. The location of the meeting was only a few kilometers away from the potential site. This meeting was also chaired by the Secretary to the M/PC&HA. The GOSL representatives were the same as Meeting No 1 with the addition of the Chairman of the Central Environmental Authority. The public were predominantly people in the Welisara area but largely not from the immediate vicinity of the site. There were very few representatives from the commercial establishments and warehouses in the area present. The Secretary M/PC&HA made a presentation similar to the previous meeting covering all issues relating to the proposed project. A lengthy discussion ensued with the participants expressing basically the same concerns with the addition of concerns with regard to the potential for ground water contamination and site management. It was explained that the precautions for ground water contamination would be taken during the design of the landfill and such issues will be addressed in the Environmental Impact Assessment (EIA). The public seemed to be convinced that the landfill would be designed in such a manner that would minimize potential adverse environmental impacts, however, they had serious concerns on the management of the site. They wanted some assurance that the site would be managed properly and strict enforcement of the environmental standards would be ensured.
An issue that was raised several times at both meetings was the necessity to use this site when there were several thousands of acres of uninhabited land in Muthurajawela, a few kilometers west of this site. The participants did not appear to understand the significance of preserving Muthurajawela due to it being an ecologically diverse wetland, currently designated as conservation area. A major factor that led to their opposition to the use of the Galudupita Road site in Welisara as a landfill site was the availability of uninhabited land in Muthurajawela. Many unsuccessful attempts were made to explain the significance of preservation of ecologically sensitive areas such as Muthurajawela. After much discussion the meeting was concluded with the public unanimously opposing the development of the site in Welisara as a sanitary landfill site when sufficient land was available in the Muthurajawela Marsh for disposal of garbage in the Colombo Urban Area.

1.2 ONGOING PUBLIC CONSULTATION PLANS

Further public consultations will be held as and when necessary as the project progresses.

2 PUBLIC AWARENESS

Author: Ravi Pereira - Senior Environmental Specialist (MEIP)

2.1 INTRODUCTION

The general public, despite their enviably high literacy rate, is woefully under-informed of even the basic issues and consequences of environmental degradation and as a result of this ignorance is a significant contributor to the existing problem. In addition, there is a tendency towards negatively prejudging and intractably opposing technologies such as sanitary landfilling, out of hand, without having actually understood what it is, much less weighing its pros and cons impartially.

A public awareness programme, aimed at both raising collective environmental consciousness and creating a sensitivity towards the specific issues that need to be addressed, is therefore of crucial importance to the overall success of potentially unpopular public works such as a solid waste disposal/landfill site despite the proposed use of mitigatory measures for anticipated environmental damage.

The important issues must be skillfully put across in the most palatable manner through a variety of ways so that the basic concepts become virtually ingrained. The high literacy of the public would definitely be an advantage here provided the will also exists. With children the problem is somewhat simpler as they have fewer preconceived and set ideas unlike adults who often must overcome hanging onto lifelong misconceptions and
reassess cherished old wife's tales that have been handed down over generations. Most importantly the concept of "individual and cumulative irresponsibility" towards pollution, i.e. the ideas such as one's own contribution's insignificant and/or if one's neighbour does it why can't one etc., must be vehemently discouraged.

2.2 TARGET GROUPS

- General public
- Specific Community Groups
  - merchants (sales/clients)
  - businesses, offices (production/supply)
  - residents
  - schools
  - health care delivery
  - religious groups
  - civic groups
  - other NGO's
  - government officials

2.3 APPROACH AND OUTCOMES

2.3.1 Education System

E.g. approach to primary, secondary, university and others through poster contests, developing recycling/waste minimization guidelines; curricula design; scholarships. Raising general awareness through walkathons, bicycle race sport meets on a regional level.

2.3.2 Community

- religious (emphasize idea of stewardship of living in harmony with the environment propounded by all religious teachers),
- civic, community activities (shramadana - self-help)
- merchants: corporate support (billboards, posters, bus stops, litter baskets, tee shirts), waste minimization processes
- businesses/offices: corporate support (billboards, posters, bus stops, litter baskets, tee shirts), waste minimization processes

2.3.3 Public Media

- radio: sponsored spots, broadcast contests
- newsprint: sponsored ads, advertise/report on contests
- TV: sponsored ads; special reports by the station; soap-operas and short features; broadcast contests
Annex E

Waste Analysis
### Table 2-6

**COMPARISON OF WASTE CHARACTERIZATION STUDIES**  
1980 – 1993

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**Notes:**  
(1) Source of information is the December 1980 Japanese Survey.  
(2) Source of information is the October 1981 SWMC Survey.  
(3) Source of information is the January 1993 SIDI Study.  
(4) The source for the commercial waste percentage is from the day collection.  
(5) Average data developed in Table 2-4.  
(6) Average data developed in Table 2-5.
Annex F

Background Information from ERM Inception Report
INTRODUCTION

This Section describes the assessment made by the Project Management Team in relation to the various Activities covered by the Project following their initial visit. The various sections refer to the study Activities as follows:

- Sections 3.2 and 3.3 - Activity 1
- Section 3.4 - Activities 2 & 3
- Section 3.5 - Activity 5
- Section 3.6 - Activity 6

3.2 CONTRACTS WITH THE PRIVATE SECTOR

3.2.1 General Contract Forms

The TOR requires ERM, under Activity 1 to prepare model contracts for various waste management services to be determined during the course of the study. As a precursor to this, we have carried out a preliminary assessment of contract types and procedures which are already in general use in Sri Lanka, on which we aim to base our own model forms.

The Government of Sri Lanka has well established contract procedures, and the Consultants and Contractors working in the country are already very familiar with these procedures and the more common international model forms of contract are in everyday use. These include the forms issued by the Institution of Civil Engineers in the UK and the International Federation Internationale Des Ingenieurs Conseils (FIDIC). These typically relate to works of civil engineering construction on lump sum and measurement methods of payment.

There is also some local experience in the use of the Institution of Mechanical Engineers (I Mech E) Model Forms for mechanical and electrical engineering projects. The newly introduced New Engineering Contract (NEC) of the Institution of Civil Engineers which can be used on management, cost reimbursable and target cost contracts is being discussed and debated at seminars in the country.

Some of the international model forms have been adapted to suit local conditions and an example of this is the Institute of Construction Training and Development (ICTAD). This model form is required to be used on all central government financed projects and contains features of the FIDIC and ICE model forms. In addition the Government has issued guidelines for implementing Build, Own and Operate (BOO) and Build Operate and Transfer (BOT) contracts for infrastructure development and investment.
Specific Model Forms

It is against this background of knowledge and the procedures of the World Bank that ERM will develop the model forms of contract on this project.

Almost all the model forms currently in use in Sri Lanka relate to construction contracts. Where more specialized forms have been required such as design and construct, design construct and operate, design construct, operate and finance and franchise arrangements these have usually been adaptations of the more common construct only model forms. However some specialist forms of contract for the private competitive tender of municipal services such as waste collection, disposal, vehicle maintenance, ground maintenance and catering have been developed as these services have been exposed to competition throughout the developed world.

In the United Kingdom, as an example, where the Local Government Act 1988 set in place a comprehensive programme of compulsory competitive tendering for a range of services, particular model forms of contract were developed by the Municipality and local government associations such as the Association of County Councils, Association of District Councils and the Association of Metropolitan Authorities. The UK Government issued regulations under the Act on how competitive tendering was to be managed and tenders analysed and assessed. The Audit Commission in the UK issued Codes of Practice and guidelines on tender analyses and reported on the general progress in the country. Several thousand tenders have been issued and contracts awarded under these arrangements and the private sector has secured about 25-30% of the market. ERM will bring the best of this contractual experience to bear in its work.

3.3
CURRENT MUNICIPAL WASTE MANAGEMENT SYSTEM

During our initial visit we held a number of meetings with Colombo Municipal Council officials and undertook a tour of the municipal area to view various aspects of the existing waste management operation. This included viewing waste collection points in different income areas, cleansing depots and the existing landfill at Wellampitiya.

The system presently adopted by Colombo Municipal Council and, as far as can be determined at this early stage, the other local authorities in the Colombo Metropolitan Area, comprises a two stage collection system followed by direct disposal to landfill or open dump.

3.3.1 Collection

The collection system generally has two stages:

- Primary collection; and
- Secondary collection.
## ANNEX H: TRAFFIC COUNT DATA

[Traffic Counts on Horace Road - Tuesday 1 March 1994, daytime (07:00 - 19:00)]

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</table>
Primary Collection

In the primary collection system, waste is taken from the households by handcarts, operated by the local authorities, and deposited at waste collection points. Each neighbourhood is served by its own collection point. Colombo has some 1,004 collection points distributed about the City.

The collection points in and around Colombo take a number of forms. Colombo Municipal Council (CMC) recently took delivery of some 300 1 cu m capacity, unlined, wheeled containers and currently have 250 more on order for delivery later this year. These are used either singly or in multiples at collection points in most upper income and some middle income areas. CMC estimate that they will need around 1,320 to meet the needs of all collection points in the city, which is their aim. A typical collection point in a high income area is shown in Figure 3.3a.

Figure 3.3a  A typical collection point in a high income area in Colombo
At some of the larger collection points, 5 cu. m skips have been supplied. These require an alternative type of vehicle to allow transport to the landfill.

The containers generally provide adequate and tidy storage of the waste prior to collection for disposal, although they are unlidded and the contents are therefore open to insects, birds and other vermin. Also, it was seen that frequently other types of waste, generally building rubble, is illegally dumped close to the containers, which, together with overspill from the containers themselves, can give many of the collection points an unsightly appearance. However, the containers do appear to offer adequate storage and their contents can be efficiently loaded by automatic means into the secondary collection vehicles.

In most low and some middle income areas in the CMC area, the other main type of collection point provided consists of a three sided concrete bunker. From these, wastes have to be hand-loaded into the secondary collection vehicle. These collection points can be fairly unsightly, are open to foraging animals and again attract the illegal dumping of other wastes. Such a collection point is shown in Figure 3.3b.

Outside of the CMC area, waste collection points generally appear to be little more than open patches of ground on which the waste is dumped. Some of these areas were observed to be on fire and cows, chickens and small herds of pigs and goats seen feeding on the wastes is commonplace. Again, the wastes require to be hand-loaded onto secondary transport. Figure 3.3c indicates such a collection point.
It appears that the number of waste collection points made available in an area is determined by a combination of demand for the facility, in terms of waste generated, coupled with the availability of suitable sites. In Colombo, many collection points, particularly in higher income areas, consist of just one container. Elsewhere, as many as six containers are located together to serve a much larger area, signifying that other suitable sites in the local area are not available.

Secondary Collection

The aim of the secondary collection system is to remove the waste from the disposal points and transport it to the disposal site. This is undertaken using a variety of vehicles ranging from 7 or 10 cu. m rear end loading refuse compaction vehicles to side loaders and tractors and trailers. Where containers are used, these are lifted automatically and discharged into the collection vehicle. Normally, some manual clearing is necessary to remove any overspill and garden wastes which could not fit into the containers. Where the waste is in bunkers or on open ground, it is manually handled into the collection vehicle or trailer. One of the new 10 cu. m capacity vehicles is indicated in Figure 3.3d.

**Figure 3.3d** New 10 cu. m capacity REL Collection Vehicle used by CMC
A list of the vehicles used by CMC is given in Table 3.3a.

**Table 3.3a**  
**Vehicles in use by CMC**

<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>No of vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compactor truck (11 cu. m)</td>
<td>44</td>
</tr>
<tr>
<td>Compactor truck (7 cu. m)</td>
<td>14</td>
</tr>
<tr>
<td>Tipper truck (3 cu. m)</td>
<td>6</td>
</tr>
<tr>
<td>Skip hoist trucks (used for 5 cu. m skips)</td>
<td>3</td>
</tr>
<tr>
<td>Tractors (used to tow 3 cu. m, 5 cu. m trailers)</td>
<td>51</td>
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</tbody>
</table>
3.3.2 Disposal

In the CMC area, waste from the secondary collection service is taken to a site at Wellampitiya. Although some of the other local authorities in the study area also use this site for disposal, the remainder tend to use local uncontrolled dumps.

Wellampitiya

The Wellampitiya site was identified as a potential landfill in a previous study carried out by ERM (as ERL). At that time, ERM made a number of recommendations on how the site should be developed. Whilst an attempt has been made to put some of these recommendations into practice, the current operation falls some way short of the standards envisaged.

There appears to have been little preparation work to the site base in terms of containment and surface water management. There are also no signs of either leachate or gas control or monitoring systems, although ditches have been constructed to collect contaminated surface water at certain points within the site. However, it could not be said that the surface water drainage system is either comprehensive or adequate. Water levels in one of the ditches near the site entrance appears to be maintained at local water table level and there appears to be no method of preventing contaminated liquid seeping into the local aquifer.

A spine road has been constructed on waste down the centre of the site for about two thirds of its length and waste bunds have been formed in a herring bone pattern leading off from the road. The bunds have been formed to near final level height for the finished landfill and provide the equivalent of a series of tipping cells. A number of residential dwellings and a school are close to the site perimeter.

Considerable difficulty was encountered in the operation of the site during the recent rainy season, when the central spine road deteriorated to a state where it could no longer be used by vehicles delivering waste. Waste then had to be tipped in a fairly uncontrolled fashion much nearer to the site entrance. The problems were exacerbated by the breakdown of the tracked bulldozer, used for spreading the wastes in the tipping area and maintaining the surface of the haul road. An attempt was made to use the landfill compactor for these purposes which, in the conditions prevailing, worsened matters considerably. Up to this time the haul road had been maintained using a clay bound material. This has now been substituted with one which is of a free draining sandy nature, in the hope that, during the next wet season in November, the same problems will not be encountered.

No cover material is available at the site and the waste generally remains uncovered. Flocks of crows are seen permanently at the site and it is certain that other vermin are equally present. The site also exudes considerable odour, which has resulted in many complaints from nearby residents,
particularly so during the recent problem period when waste had to be tipped much closer to the housing than normal.

A considerable number of scavengers are present on the site, continuously moving around the waste delivery trucks as they unload and the spreading and compacting machinery. Whilst the current practises in relation to these scavengers is far from desirable, both on public health and safety grounds, at the present levels of enforcement and regulation in Sri Lanka, it is unreasonable to expect that their activities could or should be banned.

Whilst the above summary details an operation far below that which could be described, certainly in Western terms, as modern sanitary landfilling, it is felt that an attempt has been made to move forward from what can be termed "uncontrolled dumping". Tipping is generally confined to a single area and there appears to be a general plan for phased development. Records of vehicles delivering the wastes and the amounts carried are kept at the site office and an electronic weighbridge is presently under construction, which will further enhance the value of these records. The operation is therefore seen as far from ideal but aspects indicate that the desire for improvement are present and, with further training, a considerable improvement in understanding and improvement could be achieved.

Figures 3.3e, 3.3f and 3.3g provide views of the existing landfill.

*Figure 3.3e*  View of main access road through to Wellampitiya
LOCATION OF PROPOSED TRANSFER STATION AND LANDFILL SITES

Baseline Road

The location identified for a road or rail transfer station, on the assumption that final disposal will occur at the Padukka clay pit site in Hanwella, is on the site currently partly occupied by the City’s abattoir, opposite Baseline Road Railway Station. Vehicular access to the site is directly from Baseline Road. Excluding the main abattoir buildings, the size of the site indicated in the NBRO report ‘Feasibility Study of Rail Transfer to Padukka Site’ dated September 1991, is 1.66 hectares. If the abattoir buildings were included, the land available would increase to around 3.0 hectares.

The site was chosen because of its central location and direct access to the Kelani Valley railway line, which is presently being widened to broad gauge. Figures 3.4a and 3.4b provide general views of the area as it is currently.

The NBRO report also suggests that a site at Madampitiya Road has been identified for a northern transfer station to serve the north part of the area and recommends that a road based transfer facility be constructed at Model Town Road in the north of Moratuwa UC, to serve Moratuwa UC and the Dehiwela and Mount Lavinia MC in the south of the area. It is assumed that both of these transfer stations will feed pre-containerised waste into Baseline Road TS if the rail option to Padukka is chosen.
From inspection, the geology at the Baseline Road site appears to be latterite from close to the surface down to granitic bedrock at a lower depth. This is likely to provide more than adequate bearing pressures for the low rise structures and paved areas anticipated for the transfer station construction. Initial expectations in relation to the load bearing capacity of the ground are further enhanced by the fact that the existing Kelani Valley railway line passes along one edge of the site on simple ballast and sleeper foundations. On this basis, the Consultant’s are seeking agreement to amend their initial proposals with regard to Activity 2 - Geotechnical Investigations and redistribute the resources available to allow greater emphasis to be placed on the geotechnical investigation at the proposed landfill site.

It is therefore proposed that the geotechnical investigation at Baseline Road be restricted to confirming that latterite does indeed underlie the site close to the surface across the whole site and to check that its load bearing capacity is adequate and consistent. New proposals will be put forward on this basis for approval as soon as Baseline Road is confirmed as the location for the transfer station.

3.4.2 Landfill Sites

At the time of writing, three potential locations have been identified for consideration as landfills. These locations are as follows:

- Hanwell, near Padukka
- Wellisara
- Kerawalapitiya

A proposal to identify a fourth site in an area of rubber plantations, again close to Padukka, which was requested by MEIP, has been prepared by ERM and is currently being considered by the World Bank, as described in Section 1.2.1.

Hanwell, near Padukka

This site is located within Colombo district along High Level Road, east of Hanwell bridge where High Level Road meets Low Level Road. The site is generally a low level area to the south of High Level Road, consisting mainly of abandoned rice paddy, with areas excavated for brick making and for domestic horticulture. According to local residents, the rice paddy was abandoned some 10 years ago due to frequent flooding of the area during the wet seasons and water scarcity during the dry season. This problem has apparently arisen following the construction of a road along the western border of the site.

Power lines and cast iron water mains which bring water from the reservoirs further east to the City of Colombo, traverse the site. A large stream which feeds into the Kelani Ganga (river) also passes through the site on the eastern side and is the main source of the frequent flooding of the area. Views of part of the site area are indicated in Figures 3.4c, which is a view...
from High Level Road, and Figure 3.4d, taken from the interior of the site looking towards High Level Road in the distance.

The geology of the site includes a natural clay layer at or near the surface which has provided some attraction as a potential landfill as it is possible that this could be engineered to provide a natural barrier at the bottom and sides of the site to prevent seepage of pollutants into surface and underground waters.

Residential dwellings are situated around some of the borders of the site, especially along High Level Road and a side road which cuts through the eastern border of the site and joins High Level Road.
Wellisara

The Wellisara site is situated within about 3 km of the Government Food Store Complex at the end of Galudupita Road, Wellisara. The site is in the Gampaha District and can be described as a wetland marsh.

The topography is generally low level and flat, with water at the surface over much of the area. Little in the way of agricultural practices were noted during visits to the site by the Team, apart from the grazing of water buffalo. Due to continuous or periodic inundation of the area with water, no serious agriculture is possible. It is of interest to note that the Central Environmental Authority maintains that the area falls within the Wetlands Conservation Project.

The precise geology of the site is unknown at this stage of the study, but in line with similar wetland areas, the surface substrate is soft and rich in decomposing organic matter which is mixed with mineral soils. It is likely that engineering costs to establish the site as suitable for landfilling will be high.

The site appears to be generally uninhabited although there are residences close the boundaries on the western side of the site, which include a school. The main railway line from Colombo to Negombo passes to the east of the site.

Kerawalapitiya

The Kerawalapitiya site is situated in the Muthurajawela marsh in the administrative district of Gampaha. The Muthurajawela marsh is a coastal wetland which opens to the sea at the northern end and is fed by Dandugam Oya.

The area was a rice paddy tract during the period of Kotte kingdom, but was later abandoned due to salt intrusion. In the area identified for the landfill there are four canals running east to west, draining into the main Hamilton Channel which runs north/south to the west of the area. The Old Negombo Channel runs north/south to the east of the area. A view of some of the dwellings typically situated along the channels are shown in Figure 3.4e and a general view of the area in Figure 3.4f.

Most areas of the Muthurajawela marsh are water logged for at least part of the year and the substrate remains moist to saturated throughout. The soils of Muthurajawela have been classified as not suitable or marginally suitable for conventional land use practices as rice and leafy vegetable cultivation. Salinity and flooding are two of the main reasons for this unsuitability. However, coconut appears to tolerate these conditions, as considerable numbers can be seen in the area.
There appear to be a considerable number of illegal dwellings within the area and there are plans to by the Ministry of Housing to build residential estates within or close to the proposed landfill site.

Fourth Site near Padukka

Until the exact location of the fourth site has been established, it is not possible to give any detailed description. However, the area visited by the team and members of MEIP on 6 August generally comprises a series of hills and valleys in an area covered by rubber plantations. The areas are picturesque but are not accessible to the general public. Habitation is minimal, being generally confined to estate workers. The soils appeared to be weathered laterite, which is cohesive and could probably be worked so that, in combination with other engineering measures, it could provide a degree of impermeability which may be acceptable for purpose of pollution prevention from landfilling activities.

EXPORT PROMOTION ZONES

Both the Export Promotion Zones (EPZs), at Katunayake and Biyagama, were visited by the Project Manager during mobilisation and the current disposal situation inspected.

3.5.1 Katunayake

A large proportion of the wastes generated at Katunayake emanate from garment factories and consist of cloth off-cuts. A composition analysis supplied by BOI is given in Table 3.5a. The wastes are collected daily from each of the factories by contractors using hand or bullock carts and taken to a disposal site within the curtilage of the estate. The contractors charge each factory around Rs 12,500 per month for this service.

Table 3.5a Composition of Combustible Wastes at Katunayake

<table>
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<tr>
<th>Description</th>
<th>Weight Arising/Day (tonnes)</th>
<th>Percentage of Total</th>
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<tr>
<td>Fabric Off-cuts</td>
<td>12.0</td>
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<tr>
<td>Rubber and Rubber Based Items (inc Synthetics)</td>
<td>3.0</td>
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<tr>
<td>Paper and Cardboard</td>
<td>1.6</td>
<td>8</td>
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<tr>
<td>Putrescible Wastes (Canteen wastes, etc)</td>
<td>1.4</td>
<td>7</td>
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<tr>
<td><strong>TOTALS</strong></td>
<td><strong>18.0</strong></td>
<td><strong>100</strong></td>
</tr>
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</table>
The disposal site consists of an open dump on which are situated a rooted shelter, for the storage of items such as cardboard packaging, and two extremely primitive batch type incineration units. One of the units, considered a 'destructor' rather than an incinerator, was out of action during the visit. Neither unit appeared to have any form of emission control equipment and, indeed, on inspection it was found that the flue gas pipes were not connected into the stack. Also, the stack height was lower than cliffs only some 100-200m away and it is unlikely that adequate dispersal of any plume would be achieved, even if the stack was operative.

Because of the lack of capacity of the incineration units compared with the amount of waste produced, most of the material is dumped in an area adjacent to the units. This has in turn been set alight and fires are burning right across the area, enveloping the entire area in palls of acrid smoke. From discussions with some of the personnel at the site, it appears extremely likely that the fires have spread underground and are burning on the materials that have been dumped there since Katunayake first started operating as an export promotion zone. If this is the case, the fires could burn for some considerable time, causing both a pollution and health and safety hazard. Figure 3.5a provides a graphic description of the situation at the site.

Figure 3.5a  General view across the uncontrolled landfill at Katunayake
can be seen, the health hazard aspect of the site is considerably worsened by the encouragement of the Zone management to scavenging at the site. Women are allowed onto the site on payment of a 15 rupee charge which allows them to scavenge for 4 hours. They generally scavenge for small pieces of cloth which they make into patchwork for garments and other items. They are allowed to take away as much as they can physically carry. It would appear that there are regularly upwards of 100 scavengers on the site at any one time. Men are generally prohibited from scavenging to avoid aggressive behaviour, although some men were seen helping to handle stacked cardboard and move dumped metals to a holding area adjacent to the main dumping ground.

Biyagama

The waste produced at the Biyagama EPZ is somewhat different in composition to that produced at Katunayake. Whilst there are still considerable amounts of material off-cuts to be seen at the dump site within the Zone area, there are also sizeable amounts of other wastes including reject rubber goods, cashew husks and a variety of ceramic and other process sludges. A composition analysis provided by BOI is given in Table 3.5b.

The waste appears to be strewn over a much larger area than at Katunayake but scavengers are less in evidence and there are no fires at the site. However, the site is extremely unsightly and is current sterilising a large area of land within the EPZ. This can clearly be seen in Figure 3.5b.

General view across the uncontrolled landfill at Biyagama
Table 3.4b

Composition of Combustible Wastes at Biyagama

<table>
<thead>
<tr>
<th>Description</th>
<th>Weight Arising/Day (tonnes)</th>
<th>Percentage of Total</th>
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</thead>
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<tr>
<td>Waste Rubber</td>
<td>32.070</td>
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<tr>
<td>Polythene Bags</td>
<td>0.100</td>
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<td>Paper/Cardboard</td>
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<td>Wood</td>
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<tr>
<td>Food Wastes</td>
<td>33.178</td>
<td>13.46</td>
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<td>Pile Clothing</td>
<td>121.080</td>
<td>52.56</td>
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<tr>
<td>Sponge/Nylon/Plastic</td>
<td>23.120</td>
<td>9.98</td>
</tr>
<tr>
<td>Leather Off-cuts</td>
<td>0.249</td>
<td>0.11</td>
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<tr>
<td>Cotton/Polyester</td>
<td>4.737</td>
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<td><strong>TOTALS</strong></td>
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<td><strong>100.00</strong></td>
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</table>

3.6  HOSPITAL WASTES

3.6.1  Information Sources

In order to obtain an appreciation of current practices in hospital waste management, a visit was made by the Project Manager during the initial phase of the project to the Colombo General Hospital, which is Sri Lanka's largest and premier teaching hospital. The hospital complex covers some 28 acres and provides 2,300 beds.

The visit included the following:

- an interview with Mr Liyanage, Chief Administrative Officer at the hospital;
- viewing existing waste management storage, handling and transportation systems;
- a walk round several of the ward areas, which included short discussions with some of the nursing staff;
- a visit to the radiological department, which included viewing storage facilities for short lived radio-active substances; and
- discussions with infection control nursing staff.
Included in the visit was a discussion with Dr Lucian Jayasuriya, who is Director of the Project Implementation Unit for the General Colombo Rehabilitation Project, which is jointly funded by Finland and the Government of Sri Lanka.

In addition to visiting the Colombo General Hospital, discussions were held with Mr Malcolm Baldwin, Chief of Party of the Natural Resources and Environmental Policy Project (NAREPP), who have undertaken some recent work in relation to hospital waste in the Colombo area.

**Findings at Colombo General**

Waste management practices at the hospital currently fall far below acceptable Western and World Health Organisation standards for the handling, transportation, treatment and disposal of clinical waste. At ward level, the segregation of sharps has recently been introduced, although storage is generally unacceptable. As can be seen in Figure 3, storage is in unlabelled standard cardboard containers in which other materials have been delivered, which can be filled to overcapacity as shown in Figure 4. It is now generally accepted that sharps should be stored in purpose made containers which allow used items to be placed into them, but not subsequently withdrawn, and then securely lidded when full.

**Storage of sharps at Colombo General Hospital**
The internationally accepted method of disposal for sharps is by incineration, with landfill disposal of the residues. As no suitable incineration facilities are currently available to the Colombo General to allow such disposal, nursing staff are disposing of the sharps by soaking them in kerosene and setting fire to them. This occurs within the hospital grounds at weekends when there is less chance of complaint from the general office and administrative staff.

*Other Wastes*

Segregation of other clinical wastes from non-clinical wastes is not attempted. In most wards, wastes, other than sharps, are stored in galvanised steel or plastic containers as indicated in Figures 3.6b and 3.6c. These wastes consist mainly of unwanted food brought by relatives for the patients, which could generally be considered as non-clinical waste and constitute about 85% of the waste generated. This is supplemented by dressings, swabs, and other clinical wastes, together with the associated packaging from those items. Some of the containers are loosely lidded, others are not.
Storage, Transportation and Disposal

The containers are transported on flat bed, unsided trolleys through the hospital complex to a central point in which is situated an open trailer supplied by CMC. Containers are hand unloaded on to the trailer and, once waste in the trailer has reached a certain level, this unloading process involves a man climbing on to the waste to have the container lifted up to him for emptying. Figure 3.6d shows the trailer where waste is stored and Figure 3.6e provides a close up picture of the types of waste placed in the trailer. Blood soaked dressings can be clearly seen amongst the wastes. It is understood that scavenging of wastes in the trailer often takes place, with plastics and other recyclables being removed.

The trailer is supposed to be replaced twice each day by CMC, although collection is somewhat irregular, which often leads to it being overfilled. The contents are taken by CMC to the municipal landfill at Wellampitiya for disposal. As far as could be ascertained, no special measures or precautions are taken by CMC in either ensuring that only dedicated trailers are used for hospital waste transportation or in carrying out disposal of the hospital waste at the landfill.
Radioactive Wastes

A small amount of low level radioactive waste is generated by the hospital's Pathology and Radiography Departments. The liquid component of this waste is disposed of in a well which has been constructed in accordance with specifications set down by the Atomic Energy Authority. The well is situated within the hospital grounds. Sampling from nearby tube wells, which is carried out on a periodic basis, has given no indication of radioactivity permeating from the disposal point through the movement of ground water.

The solid component of this waste is retained at the hospital on the basis that it has a fairly short half-life. The manufacturer's recommendations are apparently that the waste should be stored for a period of about two years, by which time it will be rendered virtually harmless. The storage conditions for this waste are indicated in Figure 3.6f. Whilst it was difficult to ascertain precise details, it is likely that all of the solid waste generated in the past four years has been retained in the store room shown.
Information from Other Sources

NAREPP

Information supplied by NAREPP (1) indicates that the total volume of hazardous wastes generated by the Colombo group of hospitals is relatively small. A report prepared by them in 1992 (2) suggests that this can be estimated at around 3 tonnes per day. In 1992 a proposal was put forward to build a central hospital waste incinerator to serve both public and private hospitals in the Colombo area and funds of Rs 56 million were made available to CMC for its construction. Tenders were prepared and bids received. However, agreement could not be reached on, amongst other things, a suitable location for the facility and the fund was eventually withdrawn by the Treasury.

Only one hospital in the Colombo area has an incinerator and this is at the Sri Jayawardunapura, which has some 700 plus beds. It was built with the intent that it would handle the majority of the combustible waste generated at the hospital. However, from evidence of a constant black plume, which indicates inadequate and incomplete combustion, it would appear that the facility is poorly designed or poorly managed or a combination of both and therefore does not offer a satisfactory solution to the safe and proper disposal of potentially hazardous hospital waste.

General Hospital Colombo Rehabilitation Project

Under the General Hospital Colombo Rehabilitation Project, it is understood that a waste separation pilot scheme will shortly be implemented. The objective of the proposal is to separate clinical waste from non-clinical waste at ward/unit level in different coloured polythene bags and then maintain their separation by different handling and storage procedures. Bag holding units and sufficient bags for two months have been ordered by the project and the Department of Health has promised to make funds available for the further supply of bags.

A tractor with two fully enclosed trailers have been supplied by the Project for the transport of the clinical waste bags for disposal, together with a secure garaging facility. Unfortunately, to date, the Ministry of Health and Women’s Affairs have been unable to engage suitably qualified drivers to bring this new transport system into operation.

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KEY ISSUES

INTRODUCTION

There are a number of key issues which have been identified at this initial stage of the project and the purpose of this Section is to bring them to the attention of our client, The World Bank, and MEIP as the local representatives of our client. Where possible, we have stated the future course of action we intend to take, subject to client approval. Our purpose in this is to establish an agreed basis on which work will proceed, enabling us realistically to meet the requirements of the Terms of Reference for the study, and avoid abortive work. Where we are unclear on the way to proceed, we have asked for clarification.

We consider that we have already established a good working relationship with officials of MEIP and the World Bank Mission, which was in Sri Lanka during much of July, and the continuation of this productive relationship will greatly enhance the prospects of a successful conclusion to the study.

This Section firstly highlights our overriding concerns at this early stage of the project and then discusses the key issues which we have identified, Activity by Activity.

4.2 MAIN CONCERNS

ERM have identified three key issues which they find of particular concern following this initial phase of the study. These are;

• identification of a suitable landfill location;

• the method of funding to be adopted by the World Band for development of the landfill; and

• establishment of the waste throughput tonnage for the proposed Baseline Road Transfer Loading Station, on the basis of which the facility will be designed.

4.2.1 Landfill Location

The original TOR for the study required us to undertake a detailed geotechnical investigation, conceptual design and Environmental Impact Assessment for a landfill site to be located to the south of High Level Road near Hanwella Bridge, close to the settlement of Padukka. Closely following the acceptance of our proposal by the World Bank in May 1993, it became apparent that some local opposition was growing to the Padukka site. During initial discussions with the National Programme Coordinator of MEIP in Sri Lanka, it was agreed that the TOR would be broadened and that two
other sites should be considered, as discussed in Section 3.4.2, and these sites, together with the site at Padukka, subjected to an environmental scoping exercise. On the basis of the results of this environmental scoping, a site would be put forward for political consideration and agreement by the Government.

Subsequently, after the scoping exercise had been started, one of the sites, that at Mahara Quarry was dismissed as not providing sufficient capacity and a location at Wellisara was substituted. Some two weeks later, MEIP requested the inclusion of a further site, which has yet to be precisely identified, but will be located in the rubber plantation area adjacent to the settlement of Padukka.

Whilst ERM fully understand the difficulties that have arisen in identifying a suitable site for the landfill and are happy to respond to the additional requirements of the World Bank, the location exercise has become protracted and has necessitated considerable additional work to that originally planned and agreed. The lack of a suitable site has also meant that a number of the Activities incorporated into the project are or will be delayed, which may mean that previously agreed deadlines may need to be further revised. These delays are addressed in detail in Section 5 of this report.

Method of Funding for the Landfill

ERM have been informed that the World Bank will expect our financial evaluation for implementation of the project recommendations to indicate that around 75% - 80% of the total capital required would be spent within the first three years of the implementation phase of the project and the remainder within the following four years. (It is understood that the World Bank funding agreement is for seven years.) The landfill design is to provide capacity for the Metropolitan Colombo area for a fifteen year period.

The type of funding arrangement suggested above is perfectly acceptable for much of the proposed project. For example, the development of the transfer station will entail capital expenditure for the design, construction and equipping of the facility during the first year to eighteen months of the implementation phase. The facility would be expected to be operational after that sort of timescale, requiring revenue expenditure to maintain day to day operations, but little further capital. Expansion to meet future increases in waste generation could be accommodated within the requirements for early completion of the capital expenditure by building in the future capacity at the start. Planned replacement of mechanical equipment could, to some extent be met, by ensuring that major spare parts are included in the original capital requirements.

The same is true for the transport system. Some additional equipment and vehicles would be required to meet increased demand from time to time, but the major capital investment would be at the beginning in providing the vehicles and facilities to meet the initial operational requirements.
However, the same is unlikely to be true for development of the landfill. From our initial assessment, the landfill is likely to cover up to 80 ha of land. To enable the landfill to progress in a planned and satisfactory manner in line with modern landfill techniques, it will need to be developed in phases. Phasing provides for only part of the site to be prepared and operational at any one time, thus reducing impact on local inhabitants and the environment. Phasing also reduces the technical problems in having to protect prepared but non-operational areas from the effects of weather, flooding and accidental damage by operational machinery. It also allows lessons learnt during the progress of one phase to be incorporated into the next.

Therefore, whilst there will be the need for a considerable capital outlay at the start of the landfill development, further substantial capital payments are likely to be required at the start of each subsequent phase and these will continue throughout much of the operational life of the site.

In addition to this, the closure of the landfill, the final restoration and continued monitoring and aftercare is also likely to require substantial funding. Liabilities in relation to the long term pollution potential of landfills are now considered with such concern, that arrangements for funding this final stage cannot be ignored and provision within the project must be made.

Having aired this concern at this early stage, ERM would welcome a dialogue with World Bank officials on how staged capital payments over the life of the landfill can best be accommodated within the remit of the Bank's procedures.

42.3 Design Throughput for Baseline Road

In reading through the NBRO report entitled 'Feasibility Study of Rail Transfer to Padukka Site' dated September 1991, on the evaluation of a solid waste transfer option at Baseline Road, it is clear that a possible need for two other transfer station sites has been identified. These are described in Section 3.4.7. When the NBRO study was commissioned, it would appear that it was the intention that alternative landfills would be developed in the north and south of the area, to which the waste received at these two transfer stations would be sent. Now it appears to be the intention that all wastes generated in the Metropolitan area are to disposed of at the new single landfill, once its location has been agreed.

However, from ERM's experience elsewhere, it would seem that such an arrangement utilising more than one transfer station may still be justifiable on economic grounds. Justification would be on the basis of the likely considerable journey times for the collection vehicles from both the north and south of the area through the congested urban streets to Baseline Road. This would also have the effect of reducing the productivity of the vehicle fleet.
Whilst consideration of such a strategy is beyond the terms of reference for this study, the fact that such a strategy appears to make some sense and may at some point in the future need to be implemented, means that its implications need to be addressed and guidance sought. At present, it is not possible for ERM to determine, should additional transfer facilities become operational, how much of the estimated (1) 890 tonnes of waste generated in the Metropolitan area per day, will pass through the Baseline Road facility, either for bulking into containers or simply for loading onto rail transport, if that is seen to be the preferred option. Therefore, we do not have a firm answer on one of the fundamental criteria on which the Baseline Road facility will be designed, namely the estimated throughput.

At this stage two options appear to be possible:

- Ignore the prospect of other transfer stations coming into operation in the area and design the Baseline Road facility to accept the total waste which will be generated daily during the operational period.

- Undertake a short and approximate operational research study to determine, on the basis of economics, how much waste should be handled by each facility. Examples of the various options that are possible are given and discussed in more detail in Section 4.6.

ERM therefore seek guidance on the most appropriate way forward on this issue. Obviously the first option may lead to capital expenditure in excess of what is strictly necessary, whilst the second option will lead to work which is additional to that required by the TOR and may lead to further delays in the progress of the study, although we would obviously seek to minimise these if additional work was required.

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LEGAL, INSTITUTIONAL AND CONTRACTUAL ISSUES

Legislation and Municipal Powers

Initial observation by ERM indicate that there is a need to clarify the duties of the Provincial Councils and any potential overlap between these and the present duties of municipal and urban councils and other bodies on waste collection and disposal. ERM has had sight of the 13th Amendment to the Constitution (1987), decentralising power to the provinces and the Provincial Councils Act No 42 of 1987. It has also noted the Conservancy and Scavenging powers set down for the municipal and urban councils in The Municipal Councils Ordnance (Volume 18 Cap 576-579) of the Legal Enactments of the Democratic Socialist Republic of Sri Lanka 1980. In this, the municipal and urban councils have the powers to collect and dispose of waste, that such waste is the property of the councils and that they have the power to sell or dispose of all such matter and retain any income therefrom, (XVIII/38, paragraphs 129,130 and 131).

The councils have complementary powers for sweeping, cleansing, prevention of nuisances and the provision of places convenient for the proper disposal of all street refuse, house refuse, night soil and similar matter. This could be taken to mean ownership and operation of transfer stations. If it is the ultimate intention of this project that the Employer on any contract or contracts may be entities other than the municipal and urban councils, these legal powers may need to be clarified for the avoidance of doubt. A reference to the Attorney General has been suggested and ERM request confirmation of whether this approach should be initiated by themselves or by MEIP.

Once the role of Employer has been clarified, it is the intention of ERM, in conjunction with MEIP, to organise meetings with representatives of the relevant authorities, to discuss the most suitable arrangements for the future provision of services, where appropriate, involving the private sector.

**Liabilities**

Although strictly not within the scope of this project, ERM considers it prudent to raise the question of liabilities, particularly in respect of landfill operations. Landfill sites can present some unique and long term risks to adjoining landowners, the public at large, as well as surface and groundwaters. These may arise principally through the migration from the site of leachate and landfill gas, but may be compounded by public health risks due to smell, vermin and other manifestations, if the sites are not well managed. While good design, engineering and operations can substantially alleviate these problems; and well run landfills can be good neighbours; some residual risks and liabilities remain. The more serious of these risks is to groundwater and adjoining land through leachate and landfill gas migration. Surface water pollution can also contribute to the risks, but is more amenable to an engineering solution.

The question arises as to what is an equitable balance and sharing of liabilities between the Employer and the Contractor. The latter will argue that the decision on site selection was not his and he may have had limited control over the fundamental concepts of site design and the specifications for dealing with the potential source of liabilities. The Contractor may more readily accept liability for incidents caused by operational failures over which he has had control. Some contractors may also seek to limit liability for harm caused by unauthorised wastes; for example, hazardous wastes being illicitly deposited on a site designed for household wastes. While the conditions of contract may be drafted to place all such responsibilities on the contractor, they may be difficult to enforce.

These questions of liability caused considerable debate in the recently awarded (1992-1993) strategic landfill contracts in Hong Kong which were on a design, construct, operate, restore and aftercare basis. They will need to be considered on this project by the appropriate departments of Government.
Contractual and Institutional Issues

Options

Under Activity 1, ERM will address the various options that are available in the execution of the landfill and transfer station contracts. In the case of the landfill contract these will include design only, design and construct, design construct and operate and design construct operation and restoration variants.

It will also be necessary to address the question of the aftercare of the landfill site and how this is to be managed. Some of these options also apply to the transfer station. In this instance, it will be necessary to debate whether the bulk transfer to landfill should be integrated with or separated from the transfer station operation. The same would apply to other waste management processes such as clinical waste incineration.

A choice will have to be made as to the form of the specification in each case. This can be based on a detailed design or a performance specification laying down a set of guidelines, physical and environmental standards and criteria allowing the tenderer (under supervision) to exercise skill and judgement in complying with the conditions of the contract. Waste collection and cleansing contracts are perhaps the best documented with many hundreds of contracts already operating throughout the world, but ERM will need to consider how these can be sensibly applied say within a ward or wards of Colombo Municipal Council on an experimental basis.

Institutional Issues Relating to Contracts

ERM also require guidance on several key institutional matters and these have been mentioned at the meeting held at the office of the Metropolitan Environmental Improvements Programme (MEIP) offices on Thursday, 5 August 1993. These include:

- The preferred grouping of the design, construct, operate and other elements of the contract.

- The identification of the Employer (the party to the contract) in each case.

- The necessity for an agreement between the 31 authorities to cooperate in and utilize the contract facilities.

- Any additional principles to be followed in the contractual relationship between the Employer and Contractor.

- Adherence to World Bank guidelines and regulations. The identification of the body to take overall responsibility for all financial and contractual relations with the World Bank.
• The detailed nature of World Bank financial support for the project and access to any Appraisal Reports that have been produced.

• The acquisition of land for the project. The identification of the body to initiate and manage the procedures set out in the Land Acquisition Act 1956 Revision (and later revisions).

• The phasing of capital investments in the landfill site need to be considered. Most landfills require investment for initial development, in set phases during the operation of the site, on completion and restoration of the site and possibly in the aftercare period. Is the World Bank supporting all or part of these investments and in what form?

• It is normal for landfill operating contractors to receive a monthly fee, usually tonnage related and with a fixed and variable element. If the contract is to be for the life of the site, price fluctuation clauses will need to be considered. If the Contractor is to fund some capital investments, the costs of these will also need to be reflected in the fees charged. Are there preferred World Bank policies in these matters?

• What systems are to be used and through which parties will World Bank funds be paid to the Contractor? These will need to be defined in the General Conditions of Contract.

Although work can proceed on the production of model contract documents for the landfill, transfer station and waste collection services, these cannot of course, be completed until the location of the landfill and the type of transfer operation required has been finalised.

It should also be noted that, as required by the Terms of Reference for the project, we will be preparing Model Forms of Contract for the services recommended, which will require additional working up into Definitive Contract Documents against which the various services can be tendered. Any additional work required by the World Bank beyond the preparation of Model Forms of Contract will need to be negotiated with ERM.

Form of Contract

There is a considerable amount of common ground in all the contract forms discussed in Section 3.2, relating to the basic laws of contract and the form of the principal clauses and terms. There is nothing to be gained from reinventing them for this particular project. The major effort needs therefore to be concentrated on the special conditions attached to waste management operations, which makes them substantially different from the construction type contracts that are well known in Sri Lanka. These range from the materials movement, transport and labour dominated features of waste collection contracts to the particular needs of a landfill development and operation contract. Landfill contracts require an appreciation of the contractual implications of site design, development, operation, restoration and after care of the site and its potential for long term liabilities to be
incurred. In every case the general and special conditions of contract will require to be supported by carefully framed specifications describing how the works are to be executed. An appropriate method of payment for the contractors will need to be devised.

In general, all the model contract documents will take the following generic form which is commonly in use in Sri Lanka, although the order may vary from case to case:

- ERM will provide a model for each element of the document but the General Conditions of Contract will draw substantially on approved terms and conditions already in use in public contracts in Sri Lanka. Where appropriate standard forms of tender, bonds and guarantees will be used.

- The general form of the documents in each case will be:
  - Instructions to Tenderers
  - General Conditions of Contract
  - Special Conditions of Contract
  - Specification of the Works & Services
  - Schedules of Resources
  - Bills of Quantities and/or
  - Summary of Prices
  - Form of Tender
  - Appendix to the Form of Tender
  - Form of Agreement
  - Form of Bonds
  - Form of Guarantees
  - Appendices & Drawings

In relation to meeting the requirements of the TOR, ERM’s interpretation of a "Model Contract" is a document in which all the key elements of the required contract are defined and from which the definitive contract documents can be developed and completed by the Government or its consultants.

4.4 IDENTIFICATION OF INTERESTED PRIVATE SECTOR COMPANIES

As required by the TOR, we have identified a number of local private companies who are or may be interested in providing waste management services. These are listed in Table 4.4a.

Unless otherwise instructed, it is from this list of companies that we will select those to approach in our endeavours to analyse the extent of potential private sector involvement in waste management in Sri Lanka and the incentives required to promote such participation.
### Table 4.4a  Companies Potentially Interested in Providing Waste Management Services

The following companies have already shown interest to CMC in providing waste management services.

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<th>Company</th>
<th>Contact</th>
<th>Address</th>
<th>Phone Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Finance Company Ltd</td>
<td>Mr Sanka Wijesinghe</td>
<td>3rd Floor, Ceyline House, 69 Jawadhipathi Mawatha, Colombo 1</td>
<td>Tel 323861, 323862</td>
</tr>
<tr>
<td>Maharaja Organisation Ltd</td>
<td>Neville T Weerasinghe</td>
<td>146 Dawson Street, Colombo 2</td>
<td>Contact 448354, 448399</td>
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The following companies have been identified as potentially having an interest in providing waste management services.

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<th>Phone Numbers</th>
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</thead>
<tbody>
<tr>
<td>W A Perera &amp; Co</td>
<td>Mr Sanjeeva Ranasinghe</td>
<td>152 Galle Road, Colombo 4</td>
<td>Tel 585666, 586063</td>
</tr>
<tr>
<td>Hokandara</td>
<td>Mr Sanka Wijesinghe</td>
<td>325 Sri Sangaranja Mawatha, Colombo 10</td>
<td>Tel 432525, 447585</td>
</tr>
<tr>
<td>Jayagiri Transporters Ltd</td>
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</tr>
<tr>
<td>Tel 561239</td>
<td></td>
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<tr>
<td>Type Land &amp; Machinery</td>
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<td>D P Jayasinghe</td>
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<tr>
<td>Tour &amp; Transport Co Ltd</td>
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<tr>
<td>716 Dr Danister de Silva Mawatha</td>
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<td>Colombo 9</td>
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<tr>
<td>S D Welgama &amp; Company</td>
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<tr>
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<td>S A Welgama &amp; Sons Ltd</td>
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<td>164 Messenger Street</td>
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<td>Nawaloka Group of Companies</td>
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<td>Link (Engineering) Ltd</td>
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<td>291 Modern Street</td>
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<tr>
<td>Tel 580017, 580022, 580025</td>
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<td>Type Landfilling &amp; Machinery</td>
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<tr>
<td>Contact Mr Gerard Fernando</td>
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</table>
We have assumed that the intention will be to involve only local companies in the tendering exercises and our model contract documentation will be developed with this in mind. However, if it is the intention to open the tenders to international competition, then the form that the model contract documents take may need to be quite different. This is because international waste management companies will be attracted by much longer contract periods and a different, more encompassing form of contract to local companies, who will probably be unhappy to put themselves at risk over a long period in a type of contract with which they are unfamiliar.

ERM require confirmation that their assumptions are correct.

4.5 WASTE GENERATION STATISTICS AND DENSITIES

4.5.1 Waste Generation

The NBRO reports listed in Section 2.3, provide a considerable wealth of information on waste generation statistics until the year 2010. These are generally based on estimates of current or previous generation rates, grossed up on population predictions. As no waste is currently weighed in Colombo and it is outside the scope of this study to carry out a waste survey, it is difficult to judge how accurate these statistics are. Certainly the per capita generation rate of 0.98 kg/day in 1990 for the CMC area (1), on first sight appears high. However, this figure is derived on the basis of the resident population. The figure includes for the waste generated by Colombo’s commuting population which swells the number of people in the city daily by about 40%. It also includes for commercial, industrial and institutional waste generation.

In conversation with members of CMC staff, the actual waste generation per person in Colombo is estimated at around 0.4 kg/day.

In the same NBRO report, the equivalent generation rate for the local authority areas outside the CMC area is taken as 0.6 kg/day. The report also states that actual waste generation per person outside the main city area is around 0.3 kg/day.

The growth rate for per capita waste generation within the city area is taken as 1% per year until 2010. Outside the city area the growth rate is taken as 2%.

Using population predictions based on the 1980 population census survey and these annually growing generation rates, total waste generation figures have been calculated from 1990 to 2010. Based on these figures, which are provided in Annex 5 of the NBRO report, for the period 1995 to 2010 and accepting the assumptions given below from the report, the volume of

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(1) NBRO Identification of Land for Solid Waste Disposal, June 1991

Environmental Resources Management Inception Report, Solid Waste Management Component, Colombo
landfill void for the fifteen year period can be estimated. The figure is 10,863,226 cubic meters. The assumptions are that:

- 10% of the waste generated will be recovered for recycling prior to disposal throughout the period.
- The finally achieved density of the waste in the landfill will be 0.8 tonnes/cu. m.

Based on experience in the UK and elsewhere in relation to waste tonnage calculations based on volume estimates which have subsequently been found to be high, it is likely that this figure will also be found to be high. However, in the light of no better information, we intend to formulate our designs on the basis of the various predictions given in the report.

It is of interest to note that CMC are currently in the process of installing a weighbridge at the existing Wellampitiya landfill and it is possible that more accurate weight statistics will be available in the future. Whilst this is unlikely to be of benefit directly to this project, bearing in mind the relatively short time scale allowed, the Bank should bear in mind that appropriate adjustments may be possible at the detailed design stage of the transfer and disposal facilities in the light of more accurate information.

4.5.2 Waste Densities

A number of waste densities are quoted in the NBRO reports:

From "Identification of Land for Solid Waste Disposal"
- Density at collection 250 kg/cu m
- Final landfill density 800 kg/cu m

From "Feasibility Study of Rail Transfer to Padukka Site"
- Containerised density for transfer 250 kg/cu m

Whilst ERM consider the densities for collection and in the landfill to be consistent with what they would expect from their experience elsewhere, they consider that the density assumed for containerised waste at the transfer station is considerably less than could be expected. For a standard 20’x 8’x 8’, which equates to a container capacity of some 36 cu m, at a density of 250 kg/cu m the net payload of the container would be 9 tonnes.

The purpose of containerisation and transfer is to provide a more efficient and economic system for transporting the waste to landfill. In order to achieve this, the waste will need to be bulked up to provide a payload in this size of container of between 15 and 16 tonnes. We will therefore be looking to implement systems at the transfer station to achieve a containerised
density of around 450 kg/cu m to produce a 15 to 16 tonne payload per container.

Bearing in mind that, for the size of container quoted, payloads of this order are regularly achieved in the UK and elsewhere, with wastes which on collection are only half the density of collected wastes in Sri Lanka, it is considered that achieving the level of payload indicated should not be difficult. For calculation of transport requirements from the transfer facility we therefore intend to assume a containerised density of 450 kg/cu m.

4.6 POTENTIAL TRANSFER STATION AND LANDFILL SITES

4.6.1 Additional Transfer Stations

In Section 4.2, ERM has indicated its concern over the uncertainty in the waste management strategy being proposed for the Metropolitan Colombo area, in relation to the introduction of transfer facilities in other parts of the city. If it is the intention to introduce other transfer facilities, this could have a marked effect on the waste throughput figures on which the design of the Baseline Road facility should be based.

If no other transfer stations are to be built and local cleansing services to the north and south of the area continue to accept that their collection vehicles will not be available for waste collection for a significant proportion of each working day, due to travelling between their collection area and the Baseline Road facility, the transfer operation will need to be based on the total tonnage of waste generated in the Metropolitan area. If one or both of the other proposed transfer stations comes into operation, then it is possible that the design concept of the Baseline Road facility would need to change or the design capacity be reduced, with a potential saving in capital cost.

There are a number of scenarios that could be possible if transfer stations in addition to Baseline Road were brought into operation. The potential consequences to the Baseline Road facility are illustrated by the following two examples.

If the rail option from Baseline Road was recommended and accepted as the best option, then it is possible that waste could be transported in bulk by road from the outlying transfer stations to Baseline Road for transfer by rail to landfill. It would seem sensible that the containerised system compatible with a rail transfer operation adopted at Baseline Road would also be adopted at the outlying stations. This would mean that whilst the container handling system to load the train would need to be able to cope with the full amount of waste generated in the Metropolitan area, the collection vehicle reception and container packing systems would only need to be of sufficient capacity to deal with the tonnage delivered directly to Baseline Road by the collection vehicles from the centre of the area.
If the road option was chosen, then it is unlikely that it would be economic or desirable to transport the waste from the outlying stations to be reloaded and transported from Baseline Road. Rather, the waste would be transported to the landfill directly from each of the transfer stations.

4.6.2 Choice of Location of Baseline Road

Both of the above examples are put forward on the basis that the landfill finally chosen will be to the east of the city, based on current options, near to Padukka. However, ERM would like to bring to the attention of the World Bank another of its concerns. If one of the sites to the north of the city, at Welisara or Kerawalapitiya were chosen as the preferred site for the landfill, then, in ERM’s opinion, the location of Baseline Road for the establishment of a transfer station is called into question.

The Baseline Road location is fairly central to the total area, which makes ideal if the landfill is to be to the east. However, if the landfill was to be to the north and a lot less distant than the sites proposed for the east, then a preferred strategy would probably be to have a transfer facility located in the southern side of the area, to which all waste collected in the south would be delivered. Waste collected in the northern half of the area would be delivered direct to landfill.

Obviously, until the location of the preferred landfill has been finalised, the situation with regard to whether Baseline Road is the best position for the transfer station remains academic. However, it is another point to be borne in mind during assessment of the results of the scoping exercise.

4.6.3 Scavenging

Whilst scavenging at landfill sites in developing countries has been seen as an unacceptable practice in the past, it is now recognised that a considerable number of families rely on these activities for their existence. Scavenging is also recognised as a valuable means of ensuring the recovery of at least a portion of the waste for recycling.

Scavenging is considered bad practice and has been banned in many developed countries because it is seen to be dangerous and hazardous to health. There have been many cases cited where scavengers have been badly or fatally injured by moving landfill machinery and vehicles. While walking and picking over wastes, they will often suffer cuts and bruising. Due to the contaminated nature of the wastes, the cuts may easily become infected, leading to more serious problems. Wastes are also associated with the transmission of diseases, including Leptospirosis which is carried by rats.

However in Sri Lanka, realistically, there is unlikely to be either Government commitment or the necessary enforcement to prevent scavenging, certainly in the short to medium term. The recycling aspect of scavenging is also looked upon locally in a positive light.
In a brief discussion on the subject between ERM's Project Manager and Lea Donaldson, the World Bank Mission Leader, it was agreed that scavenging was an important aspect of recycling in Sri Lanka and would need to be adequately addressed by the project. ERM will therefore look towards innovative approaches to accommodating scavenging at both the landfill and at the two industrial zones, whilst aiming to provide more acceptable conditions than at present. The objective will be to allow scavenging in a more controlled manner to promote recycling whilst improving the health and safety aspects of the current situation.

An example of such an approach would be to provide two tipping areas at the landfill. The operating procedures would be laid down such that waste could be discharged at one of the areas and controlled scavenging take place. After say 3 hours, tipping and scavenging would be diverted to the other area whilst landfilling machines spread and compacted the waste on the first area. With some control over the scavenging, this type of approach is seen as considerably reducing the risk of vehicle/scavenger accidents.

**INDUSTRIAL WASTE MANAGEMENT**

Section 3.5.1 describes the existing waste disposal situation at the Katunayake EPZ. It is beyond the scope of the study to put forward methods for rehabilitating the existing waste management site, which is of considerable environmental concern to both local inhabitants and the airport, which has made frequent complaints about the hazard of smoke drifting across the path of incoming planes. However, ERM would like to emphasise the considerable hazard that underground fires at landfills constitute. They recommend that action is taken immediately to assess the extent of the fires and find the most appropriate method for putting them out. Steps should also be taken to bring in interim arrangements for disposing of the wastes until a more acceptable system can be put into operation.

The site at Biyagama does not appear, from initial inspection, to be a cause for such concern, although the site is extremely unsightly and is sterilising a considerable area of land which could be used for future industrial development.

From our initial assessment of the various alternatives for more acceptable and appropriate methods of solid waste disposal at both sites, we have identified the following three options as worthy of further assessment under Activity 5 of the study:

- The construction and operation of a new landfill at each zone to modern acceptable standards. The construction and operation to be undertaken by the private sector under the management of BOI. Industries would have to pay BOI the full costs of the disposal of their wastes. BOI would act as the "Employer" as far as the contract was concerned and would be responsible for the payment of the contractor. Allowance would need to be included in the operational procedures to allow safe scavenging prior to final disposal. The operation of two landfill faces; ie one where tipping
and scavenging is being undertaken and the other where compaction and covering is taking place; may be a solution to this.

The site would need to be designed to accept both solid wastes and sludges from water treatment works.

- The construction and operation of a number (minimum two) of small incineration units at each zone. (This is the option favoured by the Executive Director of Zones). There would need to be a large concrete apron in front of each incineration unit to allow scavengers to sort through the waste prior to incineration. Again, the installation and operation could be contracted to the private sector under the management of BOI.

- The construction and operation of a simple open air, two level compaction transfer station. Compactors (minimum 2) would be fixed, the containers at the lower level would move (by rope and tirfur operation). A large apron at the higher level would allow segregated tipping of the hand carts and relatively safe scavenging. Allowance would need to made for the accommodation of sludge disposal from in-house waste water treatment plants. It is suggested that open top containers could be utilised for this and it would be possible to draw up a conceptual design for a facility to handle both compacted and non-compacted wastes. The wastes would be transported to the new municipal landfill.

Containers would need to be sealable by customs officials as the waste, on which no import duty has been paid, will be disposed of outside the EPZ. The containers would be taken to the new municipal landfill where they could be received by customs officials if necessary, prior to disposal. Industry would meet the costs of the transfer and transport operation. Landfill costs could either be met by the municipalities or be charged back to BOI.

4.8 HOSPITAL WASTE MANAGEMENT

From our initial evaluation there appear to be two main key issues in relation to hospital waste management. These relate to the following:

- the siting of one or more clinical waste incineration plants; and

- the segregation of potentially contaminated clinical wastes from other wastes at ward level.

4.8.1 Siting

In Section 3.6.3, we have already referred to the proposal by CMC to build a centralised clinical waste facility in 1992 which had to be cancelled due to, amongst other things, the lack of an acceptable location. In initial discussions at the Colombo General Hospital, it appears that finding an
acceptable location may still be a major stumbling block in the provision of an adequate centralised facility for the disposal of, what are potentially dangerous wastes in terms of public health, from the area’s hospitals.

Whilst ERM are happy to go through a technical exercise to establish potential locations for either a centralised facility or several strategically positioned smaller units as set out in the TOR, they realise that political considerations are likely to play a major role in the reaching of any agreement on a final location or locations. In the light of the protracted processes which are currently underway regarding the location of the municipal landfill site, ERM seek guidance on the most appropriate way forward to avoid a similar situation occurring with the clinical waste facility.

4.8.2 Segregation

In relatively industrialised societies, ERM have normally taken the view that segregation at ward level in hospitals is unrealistic and have based segregation on the types of waste produced in various areas of the hospital. Hence ward waste, because of the risk of contaminated material being disposed of in the wrong bin, would always be treated as clinical waste. Whereas waste from a kitchen or administrative area, where no clinical waste was produced, would be classified as non-clinical waste.

In Sri Lanka, based on what was observed and heard by the Project Manager on his visit to the Colombo General Hospital, this approach would not be appropriate. Food for patients tends to be brought to the hospital by relatives and the majority of waste generated at ward level consists of the uneaten portion of this food and the packaging it came in. In comparison to this, clinical type waste is but a small proportion of the total waste generated. Estimates undertaken by NAREPP/IRG staff estimate that this may be as little as 2.5 tonnes/day from hospitals in the Colombo group.

In order that an appropriate facility/facilities can be provided at an acceptable cost, it is therefore important that other arrangements are made at ward level for the disposal of food and other wastes not generated by the medical staff and which could not be considered to be clinical wastes. As stated in Section 3.6.3, ERM are aware of the segregation trial proposed under the Rehabilitation Project at the Colombo General Hospital, using yellow bags for clinical waste, and will take into account any results that can be made available during the time frame of this project. However, they are also aware that such bags may be viewed by some as a useful commodity (and as such are prone to be removed for alternative purposes, within or outside the hospital) and this type of system, whilst used extensively elsewhere, may not be appropriate at present in Sri Lanka.

1) Hospital Waste Management in Sri Lanka, Memorandum to Malcolm Baldwin from members of his team at NAREPP, 12 May 1993.
Annex G

Selection of the Welisara Landfill Site
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INTRODUCTION

THE REVIEW EXERCISE

This Annex basically revisits the site selection exercise which was carried out in August to October last year and summarises the main aspects of the report which was issued in October 1993. Where new material has become available since then, this has been included in the text. Under Section A2 Description of Sites, each site is described under a number of headings as follows:

- general description;
- potential capacity;
- ownership;
- access;
- habitation;
- hydrology;
- geology and hydrogeology;
- flora and fauna;
- other relevant aspects.

In Section A3, tables are produced under each of these headings to allow comparison of the sites. Section A4 then draws conclusions. Recommendations for the site at Welisara, which is considered in substantially more detail in the main body of this report, are given in Section 2.3.

LANDFILL VOID SPACE REQUIREMENTS

As discussed in the study Inception Report presented by ERMECL in August 1993, a number of previous waste management studies have been undertaken in recent years. The most relevant to this study were prepared by the National Building Research Organisation (NBRO), which is attached to the Ministry of Policy Planning and Implementation. These studies appear to have been undertaken between July 1990 and February 1993. Based on the information presented in these reports and accepting the assumptions from the NBRO reports given below, it has been possible to estimate the volume of landfill space required for the fifteen year period. The figure is about 12.8 million cubic meters. The assumptions are that:

- 10% of the waste generated will be recovered for recycling prior to disposal throughout the period.
- The finally achieved density of the waste in the landfill will be 0.8 tonnes/cu. m.

As discussed in ERM’s Inception Report, based on experience in the UK and elsewhere in relation to waste tonnage where calculations formulated on
...volume estimates have subsequently typically been found to be high, it is likely that this figure will also be found to be high. However, in the absence of other sources of information, we intend to formulate our designs on the basis of the various predictions given in the NBRO reports.

The landfill area required to accept this volume depends on the average depth of the area filled. Table A1.2a indicates the area requirements for different average depths.

<table>
<thead>
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<th>Average depth of fill (m)</th>
<th>Landfill Requirements (ha)</th>
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<tr>
<td>3</td>
<td>428</td>
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<tr>
<td>10</td>
<td>128</td>
</tr>
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<td>30</td>
<td>43</td>
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Whilst the sites at Hanwella, Welisara and Kerawalapitiya are extensive, the three sites close to Padukka (sites d, e and f) are discrete valleys. In order to be able to determine the potential capacity of these valleys, an outline level survey was carried out at each of the three sites, starting during the week beginning 16 August 1993. The surveys were considered necessary due to the lack of availability of appropriate scale contour maps of the area. The aim of the surveys was to provide longitudinal and cross-section levels from the head of each valley for a distance down the valley of around 600 to 1000 metres, from which approximate contours could be derived. The surveys were of necessity limited due to time constraints, but it was hoped they would provide a sufficient basis on which preliminary designs could be based and potential capacities estimated.

Having obtained outline level data for the sites, computerised ground models for each site were produced. Using computer aided-design (CAD) techniques, two site development approaches involving different final surface levels of the completed landfill were superimposed on the ground models. For each of these approaches, the volume between the existing ground levels and the proposed final levels were calculated to provide an assessment of the available void space. The first approach took a fairly conservative view regarding the available floor areas of the sites and the final level contours. The second approach used a more extreme assumption of both available floor area and final levels, aimed at maximising void space. These are referred to as Approach 1 and Approach 2 in the following text.

Approach 1 takes a fairly conservative view of final land forms, blending finished levels with those of the existing area. The final landform is raised above existing surrounding levels only to the extent that sufficient falls are provided to allow surface water to be shed so that it does not enter the landfill.
Approach 2 is based on the implementation of the latest practice in western landfill technology and land restoration techniques. From an aesthetic viewpoint, this approach may not leave visually pleasing final land forms. As an indication, for the site at Morakelle, maximum waste depth in the centre of the site would be in the region of 70m and the maximum height of the final landform would be around 40m above existing land levels.

The estimated void space calculated for each approach is given in the text appropriate to each site.

Realistically, in Sri Lanka, where good engineering skills are available but there is limited experience in modern landfiling techniques, a scenario somewhere in between the two described, would probably be a realistic premise on which to base volume estimates.

A1.3 CLIMATE

The climate is generally similar at all proposed sites. Rainfall ranges from 1400 to 3700mm per year and average temperatures from 25-27.5 degrees Celsius. Wind speed is generally light (>16km/hr) and higher during July to September. Wind direction is variable, according to the season. Any variation on this general description is covered under the specific site.
DESCRIPTION OF SITES

As described in Section 2.2, six potential locations were short-listed for consideration. Their positions are indicated on the maps in Figures 2.2a and 2.2b.

SITE A) - HANWELLA, NEAR PADUKKA

General description

This site is located within the Hanwella Division of Colombo District directly to the south of High Level Road, east of Hanwella bridge where High Level Road meets Low Level Road. (Grid reference 126191). The site is generally a low level area consisting mainly of abandoned rice paddy, with areas excavated for brick making and for domestic horticulture. It is in the flood plain of the Kelani Ganga and Wak Oya and covers an area of more than 80 ha.

Whilst the area under consideration for the landfill is flat, the topography to the south and south-east of the site consists of undulating countryside with small hills and shallow valleys. High Level Road has been constructed on a 3 m high embankment directly to the north of the site.

Potential Capacity

Development of the site would need to take the form of a landraising scheme rather than landfilling. To accommodate the volume of waste which will be generated during the next 15 years (some 13 million m$^3$ in total), the final levels will need to rise above the level of High Level Road. However, discounting at this stage other engineering requirements, it would appear reasonable to reflect the landforms to the south and south-east of the site; that is, some discrete raised sections within the general area; to accommodate the necessary volume.

Ownership

It is understood that the site is in private ownership, possibly including a number of smallholders, although these might be tenants.

Access

There is direct access to the Hanwella site from High Level Road, which is one of the main routes going east from Colombo. The route is heavily used and becomes congested during rush hour as it nears Colombo. However, in the vicinity of the site, traffic is relatively light for much of the time.

Access can also be gained to the site from the narrow gauge Kelani Valley Railway Line, which passes to the south and to the east of the area and is
linked directly with the proposed transfer station site at Baseline Road. The line is currently being widened to standard gauge and this should be completed between Colombo and the site before the site would become operational. In order to gain rail access, a spur would need to be constructed, possibly either at Padukka or Waga, and the line extended to a suitable reception point where the containerised waste could be off-loaded from the train onto rough terrain vehicles for transport to the landfill face.

**Habitation**

It is difficult to determine the number of people that will have to be resettled from the proposed landfill sites since in most cases, the site boundaries have not been determined. It is estimated that the following numbers of people will be affected by the development of a landfill site at Hanwella.

- 10 households are present within the site and will be have to be relocated.
- 30 households are found within 200m of the site.

Most people living on or near the site appear to be employed either in the agriculture sector or in brick making. The homesteads within the site tend to lie close to the site boundary and many have groundwater wells which supply potable water.

**Hydrology**

Within the boundary of the site there is an embanked stream, the Wak Oya, of variable width (>3m) for which no flow or discharge data currently exist. It is used by local residents for washing and recreation and by some for potable use. A pond and wetland area also exists in the middle of the site.

The Wak Oya flows into the Kelani Ganga a short distance to the north of the site. Several kilometres downstream at Ambatale there is a potable water intake to supply part of the city of Colombo. The Hanwella site is reported to flood on a fairly frequent basis and is within the flood plain of the Kelani.

In addition to these natural features, three cast iron water mains pass through the site, partially underground, conveying water to Colombo. Two irrigation canals of recent construction also pass through the site.

**Geology and Hydrogeology**

In the Hanwella area, the geology consists mainly of Vijayan Series granite and granitic gneiss which has extensively weathered to clay in much of the area. Conical hills and flat fluvial plains dominate the landscape. Fluvial deposits occur in the lower valley areas. The base rock has very low permeability.

Preliminary site investigations indicate that the water table lies close to the surface. During the wet season, it probably reaches the surface leading to
localised flooding at the site. There do not appear to be any existing data on groundwater quality or direction of flow in the area.

Flora and Fauna

Agriculture (principally rice and coconut) and silviculture (rubber) dominate the general area. The hills bordering the site to the south are under rubber plantation whilst, in the site itself, some clay excavation and brick making activities are carried out. In the site there is past evidence of rice cultivation although we understand that this practice has now been abandoned due to drainage problems. The vegetation within the area is mainly secondary, consisting of grasses, sedges, herbs and trees along the stream. A total of 54 species have been noted; many of which are of household or medicinal value. None of these species is considered rare or endangered.

With regard to fauna, the site has low diversity and abundance. The area has been highly degraded as a result of long human settlement and little exists of the indigenous communities which one might expect to find in an area unaffected by human habitation. The ponds and stream in the site support several species of fish and amphibia and aquatic invertebrates, several of which are endemic although not rare.

Other Aspects

* Climate The rainfall is slightly higher in the Hanwell-Padukka area (2500-3000mm) which is attributable to the higher altitude (about 100m) compared to the sites nearer the coast.

* Power Supplies Two high tension power lines currently pass through the site. However, we understand these could be re-routed outside of the landfill area if the site were to be developed for that purpose.

* Tourism The A4 road is the main road connecting Colombo with the central uplands area and as such is used by many tourists. Currently it is on embankment as it passes the site and provides travellers with a view over the whole area. If the site were to be developed, consideration would need to be given to careful screening of the operations with a mixture of vegetation and embankments.

SITE B) - WELISARA

General Description

The Welisara site is situated within the wet marsh land about 3 km from the Government Food Store Complex at the end of Galudupita Road, Welisara, in the Gampaha District. (Grid reference 105203). The potential site area is essentially flat marshy land of around 100 ha, which is subject to frequent flooding. Surface water run-off from a large catchment area to the east drains through the site, which acts as a retention area during times of high rainfall. A number of water courses pass through the site, two of which are
significant and form part of the Kalu Oya, which eventually drains into the Negombo Canal, south-west of Mabole. This in turn flows into the Kelani Ganga. The land around the site generally rises up and to the north, in the area of the Naval Base, rises to about 15m above the general site level. The main Colombo-Kandy railway line passes to the east of the site, dividing the site from a similar but smaller area of land which currently appears to be under agricultural use by small-holders.

**Potential Capacity**

The disposal of wastes at the site would again involve a land raising scheme rather than landfiUling, as there is no void space as such. However, with the land area now known to be available for the development, it is likely that final restored levels of the site will raise the area above the levels of the surrounding raised ground. However, final landforms could be designed blend in the site as sympathetically as possible to the general surroundings.

**Ownership**

It is understood that much of the proposed site area is in public ownership, although some small areas may be in private hands.

**Access**

The Welisara site is located off the A3 Colombo-Negombo-Chilaw highway just before Mattumagala. Access is gained from Horape Road. Horape Road is macadamised and is approximately 3.6 m wide. It will require considerable upgrading to make it suitable for the amount of container traffic which would be generated in transferring bulk waste loads to the site.

To the south of the site the main line rail connection to the east (Ragama) passes from Colombo, being a major tourist route. However, this line is not connected directly to the narrow gauge line which passes through Baseline Road station and it is unlikely that the line could be used for transport of the waste from the proposed Baseline Road transfer facility.

**Habitation**

Warehouses, a defence establishment and a milk factory are located within 500m of the proposed site. Some 25 households are located on 'islands' of higher ground within the site area and around 80 households are located on the northern boundary of the site. Further residential areas are located south and west of the site. As a minimum, the 25 households within the perimeter of the site area would require relocation prior to the site development.

**Hydrology**

As previously discussed, the site acts as a water storage area during the monsoon periods, probably preventing serious flooding nearer to Colombo where there is a natural restriction in the flood plain. The site is thought to
be less than 5m above sea level. Much of the site remains waterlogged for
the greater part of the year and there are two water courses which carry
water through the site area, into which the land drains.

An unpaved access road has recently been constructed to the smaller of the
two islands within the site and this appears to have significantly altered the
hydrology of parts of the site, preventing some parts from draining.

Geology and Hydrogeology

The site is basically a laterite basin overlying granitic bedrock. The laterite

certainly outcrops north of the site, forming the high area on which the
Naval Base stands, and probably outcrops elsewhere beyond the site

perimeter. In the site area, the laterite is overlain with peat, up to 6m deep

in places but generally in the order of 1-3m, with a thin layer (0.3m) of clay

found under the peat in the centre of the site. There is ground water in the

peat and in the laterite, although at this stage it is not clear whether they are

linked and how far the water in the laterite extends.

Flora and Fauna

The area is dominated by reed beds and areas of open water supporting

submerged aquatic plants. Fifty plant species were noted at the site, none of

which are considered rare or endangered. The dominant species are water

grasses, sedges and lilies. Maps from the 1960s indicate that at that time the

land was used for paddy production. Since that time, drainage

characteristics of the area have changed (see Section 3 of the main body of

the report) and the land is now used primarily for grazing water buffalo.

Many of these vegetation types found at the site are ideal habitats for

aquatic birds and waders, which abound in the area. However, based on

observations at the site, the disturbance caused by the relatively close

proximity of the local population is likely to have restricted or prevented the

presence of rarer and/or larger animals and birds.

Other Aspects

- Power Supplies A high tension power line crosses the site from east to

  west and this will have to be diverted prior to any development at the

  site.

A2.3 SITE C) - KERAWALAPITTIYA

General Description

This site is situated in the Muthurajawela marsh in the administrative district

do Gampaha. The Muthurajawela marsh is a coastal wetland covering some
3,000 ha, which is considered to be of major environmental significance. The
marsh area drains into the sea at the northern end and is fed by Dandugam

Oya, (Grid reference 103203). The Old Negombo and Hamilton canals pass
directly to the east and west of the area respectively. Kerawalapitiya is situated towards the southern end of the marsh area and is crossed from east to west by a number of small waterways which link the two canals.

The surrounding topography is generally flat with little in the way of rising ground into which a landraising scheme could be blended. The land area suggested for the site appears to be generally unsuitable for agricultural development, although there is evidence of some occasional coconut.

**Potential Capacity**

As with both the Hanwella and Welisara sites, any waste disposal activities would need to involve landraising rather than landfilling. Although the site boundaries have not been defined, it is likely that a scheme could be devised on the site to accommodate the volume of waste being considered.

**Ownership**

It is understood that the site is in public ownership although it is inhabited by a large number of squatters.

**Access**

Access can be gained to the site from the A3 Colombo-Negombo-Chilaw Highway along Gunasekera Mawatha, which is a macadamised road about 3.6 m wide. The site is located about 1.25 km from the A3. There is a container depot already located at the north-east corner of the proposed landfill area, but it is considered that Gunasekera Mawatha is not wide enough, according to normal standards, for container traffic. The Consultants anticipate that some upgrading of this road will be necessary if waste is to be transferred to the site by this route.

**Habitation**

The area has traditionally been dominated by agricultural and fishing activities although some industrial development has taken place. Fisheries production in the wetland is estimated at 100kg/ha/yr and is valued at approximately Rs 100 million. About 3000 fisher-folk are supported by the fishery. Land use maps of the total area indicate the area consists of marsh, built-up land, homesteads, paddy and cropland. Principal crops are coconuts, pineapple and cashew.

Population density and settlement patterns are variable, increasing in size to the south.

A comprehensive land use plan for the Muthurajawela-Negombo lagoon area has been prepared which delineates conservation and residential areas, the latter zone coinciding with the site of the proposed landfill area.

The proposed general area for the landfill is inhabited by low income groups principally involved in agricultural labouring and daily wage labour in
nearby urban centres. The unemployment rate in the area is estimated at 30%, compared to a national average of 20%. The quality of life is generally low with most of the inhabitants living below the poverty line, many receiving food stamps. Most houses have dug wells or use standing pipes as a primary water source. Kerosene is use for lighting and fuelwood for cooking.

It is estimated that the following households would be affected by site establishment.

- 10 households within the site (which would have to be relocated).
- 40 households within 200m.
- 10 households along the potential access road.

**Hydrology**

The area is a generally flat marsh area with channelled waterways (elas) running in an east-west direction. The main surface water features in the project area are the following.

- Dandugam Oya.
- Negombo lagoon.
- Muthurajawela marshes.
- Old Negombo and Hamilton Canal (used for transport).
- Subsidiary canals (elas).

The elas generally tend to link the Old Negombo and Hamilton Canals.

Surface water quality in the marsh is acidic whilst in the lagoon it is alkaline. It is estimated that the water retention time in the marsh is about 7 days.

**Geology and Hydrogeology**

Geologically the area consists of recent sediments, mainly fluvial and marine in origin. The wetland sediments are less than 6000 years old. Soil profiles examined in the vicinity of the site indicate that silt and a thick layer of peat occur (>8m). The peat consists of tree, reed and humus remains, below which can be found silty sand and a black organic clay.

An indication of groundwater quality is provided by data collected from a well in the vicinity. In general it appears satisfactory for domestic purposes, with low concentrations of dissolved salts.

**Flora and Fauna**

The ‘Environmental Profile of Muthurajawela and Negombo Lagoon’ prepared by Euroconsult in 1991 provides much detailed information on the natural habitats, flora and fauna of the Kerawalapitiya site. For comparative purposes, however, we present here only the same level of detail on this site that is available for the other potential sites.
The wetland/marsh and lagoon areas constitute a complex ecosystem which is linked to the marine environment. The main habitat types include seagrass beds in the lagoon, mangroves, freshwater marsh and open water areas. In the marsh the vegetation is dominated by grasses, reeds, sedges and cattails, whilst in the open-waters are found mainly lilies and submerged aquatics. On the water margins are found various tree and shrub species. In the lagoon area, the mangroves and seagrass communities predominate.

No rare endemic or threatened species are reported in the area, although the plant communities are important ecologically as fish breeding and nursery grounds.

The diversity of plant communities is reflected in faunal diversity. Birds, reptiles, amphibia and fish species are numerous and abundant. Amongst the 96 mammal species are 31 which are reported to be threatened. These include the painted bat, slender loris, wild cats and mouse-deer. There are 94 species of reptile considered threatened (several of which are quite rare), 22 species of amphibia and 57 bird species which are considered vulnerable or under severe threat. A diverse invertebrate fauna has also been documented in the area.

**Other Aspects**

- **Planning** - The Negombo-Muthurajawela marsh area has been extensively studied in recent years and both an environmental profile and a land-use master plan have been produced for the area. The master plan has been approved by the Cabinet of Ministers and incorporates the following zones.
  - Low, moderate and high density residential zones.
  - Tourism and fishing zone.
  - Mixed urban zone.
  - Conservation zone.
  - Recreational zone.
  - Utility corridor.
  - Water buffer zone.

It would appear that the area identified as having potential for development as a landfill is classified as a residential zone in the master plan.

**SITE D) - HEWAGAMA**

**General Description**

This site falls within the Hanwella Division of Colombo District and is located by travelling 3 km along Meepe-Ingiriya Road and turning left into the Hewagama Estate Road. The site area is a natural valley, the head of which is located about 1 km into the Hewagama Estate, (Grid reference 128183). The estate is mainly concerned with the growing of rubber. The
rubber plantation extends down the sides of the valley but the base area is used for paddy production, apparently by a number of small-holders. Small watercourses down each side of the valley floor drain surface water run-off from the valley slopes during the wet seasons, the water finally finding its way into the Wak Oya and, thence, into the Kelani Ganga.

**Potential Capacity**

Based on an outline level survey undertaken by the Consultants and consequent outline computer aided design as described in Section A1.2, two potential capacities have been estimated for the valley. These are as follows:

<table>
<thead>
<tr>
<th>Approach 1</th>
<th>Approach 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>m³</td>
<td>m³</td>
</tr>
<tr>
<td>1,950,000</td>
<td>5,740,000</td>
</tr>
</tbody>
</table>

**Ownership**

The slopes of the valley are known to be in the ownership of the Hewagama estate. However, it is likely that the base of the site is owned by a number of smallholders.

**Access**

The main road between Meepe and Ingiriya is capable of taking container traffic, but the Hewagama Estate road would need extensive improvement to bring it up to the required standard.

There is no access to the site at present by rail, but the narrow gauge railway from Baseline Road, which is currently being upgraded to standard gauge, is located some 2 km south-east of the railway crossing on the Meepe-Ingiriya Road.

Rail access starting from a point close to Angampitiya rail halt and following the boundary of paddy lands is feasible. This route would be some 2 km in length. The track would need to cross a ridge for about 0.5 km with a cutting of about 2 m to 5 m in depth. The track would affect some housing and it is estimated that some 10 families would require relocation. The entire track length would require the acquisition of land currently in private ownership.

**Habitation**

There are about 100 houses in the vicinity of the site, many of them in a small village located towards the lower end of the valley, some 7.5 km from the valley head. In this village there are a temple, a school and a cooperative store.

Up to 50 farmers are said to farm the land within the valley.
Hydrology

Small streams run along the length of the valley floor at this site, on either side of the area worked for paddy. The survey indicated a drop of some 17 m in the level of the stream beds over a distance of about 800 m. The catchment area for the streams is very local and any storm flow will be discharged immediately. Flood afflux during storm conditions is likely to be of short duration and be dispersed within a few hours.

Assuming a design rainfall intensity of 50mm per hour and a run-off coefficient of 0.40, it would be technically feasible to design an interceptor drain to divert surface water from higher ground away from the proposed landfill area.

Geology and Hydrogeology

According to the Avissawella Geological Survey sheet applicable to this area, the locations of all three sites within the Padukka area, namely Hewagama, Pitumpe and Morakelle, fall within the Migmatite Zone. This means that at all three locations, the underlying rock strata is Biotite and/or Hornblend with grey white Feldspar. In general, this type of rock has low permeability.

The hydrogeology of all three sites is also somewhat similar. At this site the depth of overburden (the topsoil and completely weathered rock layer) is about 2 m. As the underlying rock is of low permeability, it is the overburden which is the water-bearing strata. From observations made at dugwells located close to the site, it would appear that the water table is almost at the ground surface.

The rapid fluctuation of water table with rains reveals that the rate of infiltration through the overburden is very high, indicating high permeability. There are a significant number of domestic dugwells drawing water from this shallow aquifer for drinking and other domestic purposes and, without adequate safeguards, the impact of a landfill operation on the quality of these water sources would be of serious concern.

Flora and Fauna

This site is situated in a valley where paddy cultivation is actively practised. The site is currently covered by uniform vegetation, dominated by grass with some occasional hardwood. Abundance is high, whereas diversity is low, which is to be expected with land used for cultivation.

Birds and butterflies were observed at the site, but there were no fish in the stream on the periphery of the valley floor, possibly as a result of the use of pesticides and fertilizers.

The area surrounding the valley floor forms part of a rubber plantation. No evidence was detected of important habitats or threatened plant and animal species.
SITE E) - PITUMPE

General Description

This site, adjacent to Pitumpe, is another natural valley site which falls within the Hanwella Division of the Colombo District. It is located about 0.4 km along the road leading to Waga after turning left off the Meepe-Ingiriya Road, (Grid reference 126184). The sides of the valley do not appear to extend to the same height as at the Hewagama site. Again, the valley floor is used for paddy cultivation, but the slopes sustain a mixture of woodland rather than just rubber. A considerable amount of residential development appears to be located amongst these woodlands. Drainage waters again find their way into the Wak Oya and, thence, into the Kelani Ganga.

Road access to the site is generally poor but the narrow gauge Kelani Valley railway is located only some 0.4 km from the site.

Potential Capacity

This site is another natural valley which is located towards Waga off the Meepe-Ingiriya Road. Again, the bottom of the valley is used for growing paddy and the slopes are wooded. Based on the same methodology undertaken for the previous site, the two potential capacities have been estimated for the valley as follows:

<table>
<thead>
<tr>
<th>Approach 1 (m³)</th>
<th>Approach 2 (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>420,000</td>
<td>1,230,000</td>
</tr>
</tbody>
</table>

Ownership

It is understood that ownership of the site area is in the hands of a large number of smallholders.

Access

From the Meepe-Ingiriya Road the Waga Road would need considerable improvement to accept container traffic. This improvement is likely to involve the acquisition of a considerable amount of residential property and the relocation of the families from those properties.

There is no access to the site at present by rail, but the narrow gauge railway is located about 0.4 km north-west of the rail crossing on the Meepe-Ingiriya Road.

Rail access would need to start at a point between Angampitiya and Pinnewala rail halts and would be about 1 km in length. Along its length, the track will need to cross a stream, which will need to be either culverted or bridged over, and will need to cross a road and a paddy field.
Although the site is closer to the railway line than the other two sites, providing rail access will involve problems including a deep cutting and the acquisition of private land and property. These problems are likely to be more severe than those for either Hewagama or Morakelle.

**Habitation**

Comparatively, the area surrounding this site is more developed and populated than the other two potential sites in the vicinity. There are a significant number of houses, many with wells, located within and adjacent to the site.

**Hydrology**

As with the previous valley, this valley also contains a small stream with a bed level difference of some 6 m along its length. Again, the catchment area for the stream is very local. However, storm flow will be discharged at a slower rate than the site at Hewagama, but here too, the flood afflux will not be sustained for long periods.

Assuming a design rainfall intensity of some 50 mm per hour and a run-off coefficient of 0.40, interceptor drains would appear to be technically feasible at this site to prevent surface run-off from the valley sides from entering the landfill.

**Geology and Hydrogeology**

This site is located in sloping terrain. Dugwells located close to the site reveal that the overburden comprises of about 1.5 m of soils and subsoils, below which there is about 3 m of weathered rock. The water table fluctuates between about 2 m and 4 m below ground level, depending on the season. There are also seepage springs on the hill slopes surrounding the valley bottom.

**Flora and Fauna**

This site is situated by the side of the Waga Road and the main vegetation in the valley floor is again paddy. The surrounding area is inhabited and contains various tree species including Jak, Coconut and Areconut.

Birds and butterflies were observed at the site. Again, no evidence was detected of important habitats or threatened plant and animal species.

**SITE F) - MORAKELLE**

**General Description**

Again this site is a natural valley, falling within the Hanwella Division of the Colombo District and is located by travelling about 2.5 km along the Pitumpe-Waga Road to Pinnawela and then along the Pinnawela-Lodakanda.
gravel road for about 1.5 km, (Grid reference 127187). The site is similar in general appearance to the site at Pitumpe, having slopes sustaining mixed woodland with paddy being grown in the valley floor. Drainage of the area again flows into the Wak Oya.

Road access to the site is very poor and substantial highway improvement would be necessary if the site were to be developed. However, the narrow gauge Kelani Valley railway line is within 0.5 km of the site.

Potential Capacity

This site is a further natural valley which is located off the Pinnawela-lodakanda gravel road. Again, the bottom of the valley is used for growing paddy and the slopes are wooded. Based on the same methodology undertaken for the previous two sites, the two potential capacities have been estimated for the valley as follows:

<table>
<thead>
<tr>
<th>Approach 1 m²</th>
<th>Approach 2 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,900,000</td>
<td>6,730,000</td>
</tr>
</tbody>
</table>

Ownership

It is understood that ownership of the site area is in the hands of a large number of smallholders.

Access

Both the Pitumpe-Waga and the Pinnawela-lodakanda roads would require extensive improvement before they would be capable of accepting the level of container traffic anticipated for the landfill facility.

The site is located very close to the main railway line and rail access is feasible starting from a point close to the road crossing at Pinnawela. The length will be about 0.5 km, running mostly in flat terrain. This site appears to be the easiest site for rail access of the three sites under consideration in this area.

Habitation

About 25 houses were observed on the high land immediately surrounding the site during the Consultants’ site visit.

Hydrology

At this site, the surveyed stream bed levels indicates little difference along its length, but the valley is narrow and deep. Here too, the catchment for the stream is local and interceptor drains are technically feasible. The flood afflux may be sustained for longer periods than for the previous two sites.
due to the proximity of the valley to the Wak Oya, which is a tributary of the Kelani River and is the substantial stream which flows around the eastern perimeter of the site at Hanwella.

A design rainfall intensity of 50 mm per hour and a run-off coefficient of 0.40 are recommended for this site, in line with the recommendations for the other two sites.

Geology and Hydrogeology

This site is located in a fairly steep valley. The water table is almost at surface level and, as already stated, there is a perennial stream which runs along the valley floor. There is comparatively little overburden at the site, comprising of top soil and weathered rock to 2 m in depth.

Flora and Fauna

The dominant vegetation at this site was again paddy surrounded by a rubber plantation. On one side, Coconut, Jak and Breadfruit trees were also observed. Birds and butterflies were seen at the site, but no evidence was detected of important habitats or threatened plant and animal species.
COMPARATIVE ASSESSMENT

A3

METHODOLOGY

This section compares the various technical, environmental and planning characteristics of each of the sites and highlights the advantages and disadvantages of each. The comparison is summarised in tabular form, where possible on a quantitative basis, although, due to the nature of this preliminary work, the lack of consistent data largely precludes this. The sites are compared under the same series of headings as in the last section.

A3.2 POTENTIAL CAPACITY

The potential capacity of the sites is summarised in Table A3.2a below.

Table A3.2a Potential Capacity of Sites

<table>
<thead>
<tr>
<th>Site</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanwella, near Padukka</td>
<td>$14 \times 10^6$ m$^3$</td>
</tr>
<tr>
<td>Welisara</td>
<td>$14 \times 10^6$ m$^3$</td>
</tr>
<tr>
<td>Kerawalapitiya</td>
<td>$14 \times 10^6$ m$^3$</td>
</tr>
<tr>
<td>Hewagama</td>
<td>$4.0 - 4.5 \times 10^6$ m$^3$</td>
</tr>
<tr>
<td>Pitumpe</td>
<td>$0.8 \times 10^6$ m$^3$</td>
</tr>
<tr>
<td>Morakelle, near Padukka</td>
<td>$4.7 - 5.3 \times 10^6$ m$^3$</td>
</tr>
</tbody>
</table>

The sites at Hanwella, Welisara and Kerawalapitiya are all large, relatively flat areas of land which, it is thought, could be engineered to provide sufficient volume to meet the disposal requirements of the Colombo area for the next 15 years. Each of the schemes would take the form of landraising rather than landfilling, as there is no void as such to fill. At both Hanwella and Welisara there is rising ground adjacent to the proposed site areas and landforms could be so designed to blend with the general topography of the area. At Kerawalapitiya there is no rising ground and it will be difficult to blend with local topography. For this reason, a landraising scheme at Kerawalapitiya may be seen as unacceptable on the grounds of visual impact.

The remaining three sites at Hewagama, Pitumpe and Morakelle, near to Padukka are located in valleys and as such their capacity is limited. The aim of the landfilling exercise will be to fill the valley, if necessary raising the filled section significantly above the existing valley ridges to maximise void space and provide adequate run-off for surface water. The two approaches adopted in our assessment of volume potential at these sites looked at two extremes of this final contouring potential.
The first approach took a very conservative view of final levels, filling the valleys to not exceed existing high points. The second approach was based on what was possible using the latest western practices in landfilling technology rather than maintaining a pleasing landform. Realistically, in Sri Lanka, where good engineering skills are available but there is limited experience in modern landfilling techniques, volume estimates somewhere between the two extremes quoted are likely to provide a reasonable premise on which to proceed.

On this basis, it can clearly be seen that none of the three remaining sites on their own is likely to have sufficient capacity to provide the long term disposal security required. However, as the sites are relatively close together, it may be a reasonable strategy to develop more than one of the sites to approach the capacity required. This may of course have implications as far as World Bank funding of the development of the sites is concerned, as it would be desirable to develop them consecutively, with the second (and possibly third) coming on stream as the first (or second) nears completion.

A3.3

**OWNERSHIP**

*Table A3.3a* indicates the ownership situation at each of the sites as it is understood by the Consultants. In order to avoid public concern, direct information from owners has not been sought and the information shown is based on local knowledge and conversations with some local residents.

**Table A3.3a**  
**Ownership of Site Areas**

<table>
<thead>
<tr>
<th>Site</th>
<th>Ownership Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanwella, near Padukka</td>
<td>Private</td>
</tr>
<tr>
<td>Welisara</td>
<td>Generally public, possibly some smallholders own parts of the site</td>
</tr>
<tr>
<td>Kerawalapitiya</td>
<td>Public but high number of squatters on the site</td>
</tr>
<tr>
<td>Hewagama</td>
<td>Estate ownership of the slopes, smallholdings on the valley floor</td>
</tr>
<tr>
<td>Pitumpe</td>
<td>Private, many smallholdings</td>
</tr>
<tr>
<td>Morakelle</td>
<td>Private, many smallholdings</td>
</tr>
</tbody>
</table>

The table shows that only two sites are in public ownership, Welisara and Kerawalapitiya. The remaining sites are in private ownership and delays in the development of the sites could be encountered in the negotiation of agreements for purchase or letting of the sites for landfill purposes.

A3.4

**ACCESS**

Access options for the sites are summarised in *Table A3.4a*. Rail access is assessed on the basis that waste will be delivered from a transfer loading
station located at Baseline Road, adjacent to the narrow gauge Kelani Valley railway line.

**Table A3.4a**  
**Access Options**

<table>
<thead>
<tr>
<th>Site</th>
<th>Rail Access</th>
<th>Road Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanwella, near Padukka</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Welisara</td>
<td>Difficult</td>
<td>Local roads require upgrading</td>
</tr>
<tr>
<td>Keravalapitiya</td>
<td>Not possible</td>
<td>Local roads require upgrading</td>
</tr>
<tr>
<td>Hewagama</td>
<td>Good</td>
<td>Local roads require upgrading</td>
</tr>
<tr>
<td>Pitumpe</td>
<td>Good</td>
<td>Local roads require upgrading</td>
</tr>
<tr>
<td>Morakelle</td>
<td>Good</td>
<td>Local roads require upgrading</td>
</tr>
</tbody>
</table>

**By Rail**

Four of the six landfill sites under consideration, which are to the east of Colombo, are within about 3 km of the Kelani Valley railway line as it passes from Padukka to Waga, some 40 km to the east of Colombo. The two remaining sites, those at Welisara and Keravalapitiya which are to the north of Colombo, are not directly accessible from this line, although the Colombo-Ragama line passes close to the site at Welisara. It is thought that a link could be built near to Colombo central to enable trains to move from one line to another, but at this stage, such a possibility has not been pursued. It is also considered that as both the Keravalapitiya and Welisara sites are less than 20 km from Colombo, transfer by rail would not be an economic proposition.

**By Road**

Road access is possible to all of the sites, although roads local to all but the Hanwella site will probably require considerable upgrading to accommodate the considerable amount of container and other traffic which will be generated by the development and operation of the facility. There is a proposal to build a Colombo-Katunayake Expressway to the east of the Welisara site, which could improve future access to that area.
HABITATION

Table A3.5a summarises the number of households in and around each of the potential sites.

Households Potentially Affected by the Landfill

<table>
<thead>
<tr>
<th>Site</th>
<th>Households within the site</th>
<th>Other households potentially affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanwella, near Padukka</td>
<td>10</td>
<td>30 within 200 m</td>
</tr>
<tr>
<td>Welisara</td>
<td>25</td>
<td>80 within 200 m</td>
</tr>
<tr>
<td>Kerawalapitiya</td>
<td>10</td>
<td>40 within 200 m</td>
</tr>
<tr>
<td>Hewagama</td>
<td>about 5</td>
<td>5 within 200 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>150 in village at the end of the valley</td>
</tr>
<tr>
<td>Pitumpe</td>
<td>unknown, but significant</td>
<td>unknown, but significant</td>
</tr>
<tr>
<td>Morakelle</td>
<td>about 5</td>
<td>30 - 25 within 200 m</td>
</tr>
</tbody>
</table>

It should be noted that figures given in this table are indicative only.

Families living within the boundaries of the proposed site will need to be relocated. Mitigation measures may be possible to protect those living close to the boundaries and avoid the need for their relocation. Such mitigation measures would typically take the form of earth screening bunds and dense vegetation to protect against noise and visual impact. Ideally a protection zone of some 200-300 m around the site would be desirable, but it is realised that this may mean that a large number of residents may still need to be relocated. This could delay the implementation of site development.

Alternatively, the area of the site could be reduced to accommodate the zone, which in all cases would mean a loss in available void capacity to a point where it is unlikely that any of the sites could be sensibly engineered to meet the required capacity. Such a protection zone is therefore likely to be unrealistic. However, it is considered that a zone of at least 50 m should be retained to enable some form of realistic screening.

With recent delineation of the boundaries around Welisara, it has been found that more households than initially anticipated will be affected by any development at the site, especially around the northern boundary. The area around Pitumpe was also seen to be fairly developed and may well have the greatest number of households that would be affected of all the sites considered. The village at the bottom of the valley at Hewagama is also of significance. It is possible that the landfill could be engineered and adequate measures taken to mitigate many of the effects, but it is likely that the inhabitants will oppose the development.

Early consultations with local residents and NGOs are recommended prior to development at any of the sites.
HYDROLOGY

Hydrological aspects of the sites are summarised in Table A3.6a.

**Table A3.6a Hydrological Aspects of the Sites**

<table>
<thead>
<tr>
<th>Sites</th>
<th>Hydrological Aspects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanwella, near</td>
<td>• in the flood plains of the Kelani and Wak Oya and subject to frequent flooding</td>
</tr>
<tr>
<td>Padukka</td>
<td>• landfill development likely to affect flood patterns in other areas</td>
</tr>
<tr>
<td></td>
<td>• leachate seepage may have an affect on water quality at the Ambatalo</td>
</tr>
<tr>
<td></td>
<td>intake on the Kelani</td>
</tr>
<tr>
<td>Welisara</td>
<td>• marsh area with constantly high water table and surface water present at all times</td>
</tr>
<tr>
<td></td>
<td>• acts as a flood water retention area during monsoon periods</td>
</tr>
<tr>
<td></td>
<td>• streams running through the site will require diversion around the site boundaries</td>
</tr>
<tr>
<td>Kerawalapitiya</td>
<td>• wetlands area with constantly high water table and surface water present at all times</td>
</tr>
<tr>
<td></td>
<td>• wetlands habitats generally under threat in Sri Lanka</td>
</tr>
<tr>
<td></td>
<td>• habitat for some rare species of fauna</td>
</tr>
<tr>
<td>Hewagama</td>
<td>• subject to high run-off during wet seasons</td>
</tr>
<tr>
<td></td>
<td>• seasonal stream runs through the base of the site</td>
</tr>
<tr>
<td>Pitumpe</td>
<td>• subject to high run-off during wet seasons</td>
</tr>
<tr>
<td></td>
<td>• seasonal stream runs through the base of the site</td>
</tr>
<tr>
<td>Morakelle</td>
<td>• subject to high run-off during wet seasons</td>
</tr>
<tr>
<td></td>
<td>• seasonal stream runs through the base of the site</td>
</tr>
<tr>
<td></td>
<td>• stream may feed into Wak Oya, a tributary of the Kelani</td>
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</tbody>
</table>

The hydrology at each of the sites varies considerably. Kerawalapitiya is part of a coastal wetlands area. Welisara used to be used for agriculture but this has now been abandoned due to frequent flooding of the area, possibly following the construction of the railway embankment on the eastern boundary of the site. The Hanwella site is in the flood plain of the Kelani Ganga and Wak Oya and is subject to flooding several times each year. The three sites around Padukka are valley sites, which, due to the heavy seasonal rainfall in Sri Lanka, are subject to high run-off into the valley floors and seasonal streams run through each of the sites.

Modern landfill engineering and operating techniques can provide solutions in relation to the control and management of surface waters. These are aimed at minimising the potential of the landfill to pollute. Such measures include the maintenance of separate drainage systems for surface waters and leachate within the site, leachate control and treatment facilities and surface water monitoring programmes. Such measures are normally combined with those to protect ground waters.

It is therefore theoretically possible to provide a considerable measure of protection to surface waters at any of the sites under consideration. However, depending upon the level of measures that need to be taken, their implementation can be expensive and require a high level of skill and
knowledge by the operating staff. The sites at Welisara, Kerawalapitiya and Hanwella, which are subject to frequent flooding, are likely to be difficult sites to manage with regard to the prevention of water pollution and measures to safeguard against potential pollution are likely to be expensive. Great emphasis will also need to be placed on the adequacy of the management of the landfill development and operations if future problems are to be avoided.

Development of the Hanwella site has other associated problems in relation to surface waters. The site is in the flood plain of the Kelani. Any developments in the flood plain which changes its ability to accommodate flood waters are likely to have affects both up-stream and down-stream of the site and areas not presently subject to flooding may well start to experience it. Also, the Ambatale water supply intake from the Kelani is some 10 kilometres downstream of the site and there are fears amongst the local population and staff of the water supply authority that pollution from the site, if the site is not properly managed, may enter the water supply to Colombo. At this stage it is not possible to characterise or predict such an impact.

The Welisara site currently acts as a retention basin for flood waters brought down through the site by the Kalu Oya and its tributaries from a large catchment area to the east. Some form of constriction in the vicinity of where the Kalu Oya meets the Old Negombo canal and subsequently the Kelani Ganga means that water backs up into the site during the monsoon seasons. If a landfill is developed at Welisara, the final finished landform will be well above flood levels and be impervious to water penetration. The area will no longer therefore be able to retain flood waters and additional flooding is likely to occur both upstream and downstream of the site without additional protective measures. If the site is developed for landfilling, it is recommended that a study be commissioned to determine what measures, if any, can be implemented downstream of the site to improve capacity during the wet seasons.

The three sites near to Padukka are likely to cause less of a problem in their development in relation to the protection of surface waters. Cut-off drains would almost certainly need to be constructed around the perimeters of the sites to intercept water flowing towards the sites from the surrounding areas and to take uncontaminated surface waters from finally restored areas as the sites develop. Phasing measures would also need to be designed to ensure that contaminated waters are kept separated from surface waters in the valley floors.
Table A3.7a summarises some of the main geological and hydrogeological features of the sites.

### Geological and Hydrogeological Aspects of the Sites

<table>
<thead>
<tr>
<th>Sites</th>
<th>Geological and Hydrogeological Aspects</th>
</tr>
</thead>
</table>
| Hanwella, near Padukka |  - site appears to have natural low permeability clay lining  
|                     |  - groundwater pollution could affect water quality of the Kelani Ganga and Wak Oya and could affect the Ambatale intake  
|                     |  - groundwater pollution may affect local potable supplies from the river and local dugwells                                                                 |
| Welisara            |  - some clay is apparent in substrata, but is limited  
|                     |  - bedrock is laterite which may have or could be engineered to have low permeability  
|                     |  - polluted groundwaters may affect local potable supplies from dugwells in the laterite and may be transported downstream in the Kalu Oya towards the Old Negombo canal |
| Kerawalapitiya      |  - clay is apparent in substrata  
|                     |  - polluted groundwaters may affect local ecosystems  
|                     |  - groundwater pollution may affect local potable supplies from the river and local dugwells |
| Hewagama            |  - clay substrata is not apparent, bedrock is likely to be of low permeability  
|                     |  - local aquifer is contained in overburden and could be subject to rapid transmission of pollution |
| Pitumpe             |  - clay substrata is not apparent, bedrock is likely to be of low permeability  
|                     |  - local aquifer is contained in overburden and could be subject to rapid transmission of pollution |
| Morakelle            |  - clay substrata is not apparent, bedrock is likely to be of low permeability  
|                      |  - local aquifer is contained in overburden and could be subject to rapid transmission of pollution  
|                     |  - aquifer may feed into Wak Oya |

The geology and hydrogeology varies considerably at the various sites. The Hanwella site was originally favoured by the Sri Lankan authorities because the geology is natural clay overlying granite and granitic gneiss bedrock. Clay can form a good natural liner for a landfill site to contain leachate and help prevent ground and surface water pollution. If it is present at the site, it enables the site to be developed cost effectively compared to sites where clay has to be imported or another form of synthetic lining material used. Clay is also found at the sites at Kerawalapitya and Welisara, although at Welisara it is known that the quantities available are insufficient to meet the needs of a clay liner. The suitability of the clay at both of these potential sites has also not yet been determined.

The geology at the three valley sites at Padukka consists of top soil and weathered rock overlying bedrock of Biotite and/or Hornblend. The bedrock
is likely to be impervious and almost certainly the overburden would need to be removed if any of the sites were to be developed as landfills.

The reason for considerable emphasis being placed on finding sites where an underlying strata is of low permeability is to prevent leachate, which is formed within the landfill, mainly during the degradation of the organic fraction of the waste, and which is highly polluting, from entering groundwaters which are used as a potable supply. The significance of groundwater pollution depends to a large extent upon the existing and proposed use of the water resource. Key factors determining the probability of groundwater pollution are as follows.

- The thickness and integrity of the impervious clay or other lining of the landfill site designed to prevent groundwater pollution.

- Hydrogeological and hydrological conditions in the area, such as the degree of groundwater movement in relation to existing and potential wells.

It is difficult at any of the sites to predict and characterise the impact on groundwaters without a full geotechnical investigation. This forms part of Activity 2 of the original study TOR and is currently being undertaken at the Welisara site only. However, the sensitivity of some of the receptors is readily apparent. Should hydraulic continuity exist between groundwater which has become polluted and the wetland system at Kerawalapitiya (Muthurajawela system), significant damage to the local ecosystem could arise. Pollution of the groundwaters at Hanwella, assuming continuity with sources feeding into the Kelani Ganga, could have a significant impact on plant and wildlife both in and around the river. Such pollution could also have a marked impact on local inhabitants, both in their use of the river and in the wells they use for their potable supplies.

Similarly, pollution of groundwater at Welisara could have a significant impact on local potable water supplies and on plant and wildlife in the Kalu Oya. It is known that piped water is available in the vicinity of the site, and this will almost certainly have to be extended to households likely to be affected.

The sensitivity at the three Padukka sites is more difficult to determine at this stage. It is apparent that the local aquifer is contained in the shallow overburden overlaying the bedrock and any pollution escaping from the sites could quickly affect local abstraction points. However, because of the terrain, these aquifers are likely to be fairly localised and the extent of any problems caused may be limited. If any of these sites were chosen this aspect would require further investigation. Alternative water supplies may need to be provided for those households affected.

It is thought likely that the aquifer from the Morakelle site may feed in to the Wak Oya, which is reasonably closeby, and this in turn feeds in to the Kelani. Again, if this site were chosen, this aspect would warrant further investigation.
FLORA AND FAUNA

Key aspects relating to flora and fauna at the sites are highlighted in Table A3.8a.

Aspects Relating to Flora and Fauna

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<thead>
<tr>
<th>Sites</th>
<th>Aspects relating to flora and fauna</th>
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<tbody>
<tr>
<td>Hanwell, near Padukka</td>
<td>• medium diversity of flora, some species of household and/or medicinal value</td>
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<tr>
<td></td>
<td>• low diversity of fauna, some endemic aquatic species</td>
</tr>
<tr>
<td>Welisara</td>
<td>• medium diversity of flora, no rare or endangered species</td>
</tr>
<tr>
<td></td>
<td>• medium diversity of fauna, no rare or endangered species</td>
</tr>
<tr>
<td>Kerawalapitiya</td>
<td>• high diversity of flora, important plant communities ecologically</td>
</tr>
<tr>
<td></td>
<td>• high diversity of fauna, many species rare and threatened</td>
</tr>
<tr>
<td>Hewagama</td>
<td>• low diversity of flora due to cultivation</td>
</tr>
<tr>
<td></td>
<td>• low diversity of fauna</td>
</tr>
<tr>
<td>Pitumpe</td>
<td>• low diversity of flora due to cultivation</td>
</tr>
<tr>
<td></td>
<td>• low diversity of fauna</td>
</tr>
<tr>
<td>Morakelle</td>
<td>• low diversity of flora due to cultivation</td>
</tr>
<tr>
<td></td>
<td>• low diversity of fauna</td>
</tr>
</tbody>
</table>

Some of the sites show considerable diversity in the flora and fauna they support. Kerawalapitiya is situated in a natural wetlands and, as has already been stated, wetland habitats are diminishing in Sri Lanka due to land conversion. The remaining wetland sites are therefore of increasing conservation value since they support many endemic species (many of which are rare) and, in addition, they are important roosting sites for birds and spawning grounds for fish. The Muthurajawela marsh and Negombo lagoon support a significant fishery which contributes substantially to local livelihoods.

Welisara appears once to have been part of the Muthurajawela system, but in more recent times has been used for cultivation. Works in the vicinity of the junction of the Kalu Oya with the Old Negombo canal appear to have excluded salt water intrusion into the area and have isolated the Kalu Oya from the Muthurajawela marsh system. The conservation value of the area has therefore, in recent times, been greatly diminished.

The sites at Hanwell, Hewagama, Pitumpe and Morakelle, are located in an area which has been subject to human habitation over a long period and has been extensively degraded ecologically over time. The area now appears to offer little of conservation or habitat value. Generally these areas have been subject to cultivation and both flora and fauna display resulting low diversity and abundancy.
CHOICE OF SITE FOR FURTHER STUDY

INTRODUCTION

From the discussion in the preceding sections it is readily apparent that none of the sites fall into the category of what would be considered an 'ideal' site. They each exhibit a number of disadvantages relating to capacity, access and environmental or socio-economic factors. However, from previous similar studies undertaken by the Consultants in Sri Lanka, it is considered that a so-called 'ideal' site does not exist, certainly not within economic transport distance from Colombo. It is therefore apparent that some compromise solution will need to be found that will meet the disposal needs of the Greater Colombo area whilst providing adequate protection to local communities and the environment.

In theory, engineering solutions can be found for most problems relating to landfill development. This may be an oversimplification but in many respects it can be true. However, in practical terms, some such solutions are accomplished at considerable cost, both in terms of resources and in the skills and knowledge required to implement and maintain them. Even in industrialised countries economic considerations often rule out such solutions.

The aim of the solution must be to provide the security of disposal necessary at reasonable cost, both in financial terms and in terms of any negative impacts on the community. This must be accomplished at a level of engineering and operation that can be sustained in line with the current knowledge and expertise available.

This section therefore assesses the information discussed previously and presents the conclusions reached and proposed recommendations. In reaching the conclusions, we have considered the following criteria:

- capacity;
- availability;
- access, including transport factors;
- habitation;
- the potential for water pollution and flooding;
- impacts on wildlife habitats and biodiversity.

CONCLUSIONS

Capacity

Section A3.2 sets out details of the anticipated capacities of the six sites. This shows that only three of the sites appear to have sufficient capacity to meet the required needs. These are the sites at Hanwella, Welisara and Kerawalapitiya. Of the sites in the vicinity of Padukka, Pitumpe has a
comparatively very small potential capacity and can be ruled out on this basis. Neither of the remaining two Padukka area sites (Sites d and f) have sufficient capacity on their own to meet the stated requirements. The only way they can remain in consideration is if they are regarded together as a single strategy. Even on this basis, the available void would only appear to be of the order 8.7 to 9.8 x 10^6 m$^3$, as against a total requirement, including cover, bunds and earthworks, which could approach 14 x 10^6 m$^3$. However, based on experience in the UK and elsewhere where waste arising calculations formulated on volume estimates have subsequently been found to be high, it is possible that the capacity of the two sites combined might be found to be closer to meeting the requirements than seems apparent.

On this basis, in considering the potential capacity of the sites, we can summarise our conclusions as follows.

- **The following sites appear to be capable of being engineered to provide sufficient capacity:**
  - Hanwella, near Padukka;
  - Welisara;
  - Kerawalapitiya.

- **The following sites together may be capable of being engineered to provide a combined capacity approaching the required needs:**
  - Hewagama and Morakelle.

- **The following site appears to have insufficient capacity to justify the costs of development and should be discounted:**
  - Pitumpe.

### Availability

Ownership of the land is a major factor in considering how quickly each of the sites could be developed. If the sites are in public ownership, development should be able to proceed reasonably smoothly, assuming that adequate consultations take place with those who live close to the site or have some other interest that may be affected by the development. Negotiating for the purchase of land in private ownership, especially where there are a large number of owners, could cause considerable delay to development, possibly to the point where the development of the site becomes untenable.

On this basis, our conclusions are fairly straightforward and are as follows:

- **The following sites are in public ownership and, subject to satisfactory public consultations, development could proceed without undue delay.**
  - Welisara and Kerawalapitiya
The following sites are in private ownership and extended delays to development may occur due to negotiations with landowners.

- Hanwella, Hewagama, Pitumpe and Morakelle

Access

Table A3.4a shows that rail transfer is not possible from Baseline Road to the Kerawalapitiya site and is difficult, although not impossible, to Welisara. Access by rail to Welisara would probably require a link being constructed adjacent to the central railway depot in Colombo, so that trains could readily transfer from one line to the other. Due to the short distance (less than 20 km) from central Colombo to the Welisara site, it is however, unlikely that rail transfer would be an economic proposition for the site.

Rail access to all the remaining sites, which are close to the narrow gauge Kelani Valley line, will require the construction of a branch line into the site or to a suitable point where a reception terminal can be built to allow the waste to be off-loaded onto rough-terrain vehicles for delivery to the landfill face. The cost of the branch line and reception terminal will need to be taken into account in the financial analysis of the final proposed development, which will form part of the overall study.

In relation to transport of containerised waste by road, access to the Hanwella site, which uses High Level Road from Colombo, is likely to have the least impact in relation to traffic generation. High Level Road is one of the main arteries out of Colombo and is of a good standard. However, journey times are likely to be more than one hour in each direction and longer during peak traffic periods. Road access to the Welisara and Kerawalapitiya sites is gained via the main Colombo-Katunayake road, and, if built, the proposed Colombo-Katunayake Expressway is planned to run just east of the Welisara site, which could improve road access to that site.

All the remaining sites are currently accessible using local roads, which, in some cases, will need considerable upgrading. This will add to the cost of developing those sites and would also be included in the final financial analysis, if appropriate.

Because no decision has yet been made with regard to which method of transport should be used, none of the sites at this stage can be discounted on the basis of access. It is unlikely that transfer by rail would be an economic option for either the sites at Welisara or Kerawalapitiya due to their close proximity to the Colombo area.

Habitation

The need for the resettlement of those households affected by the landfill development is a significant consideration of the World Bank and the Sri Lankan authorities. The development of a resettlement plan is one of the study requirements as part of the Environmental Impact Assessment.
As far as the sites still under consideration are concerned, it would appear from our initial investigations that at none of the sites is the number of households to be relocated likely to be greater than 30.

In addition to this, the alignment of access routes would inevitably affect some households and some further resettlement may be required. However, careful route alignment would minimise this.

In summary, the requirement to resettle households affected by the landfill development and the access routes to it does not appear to be of great relative significance when comparing one site with another and no particular site appears to be particularly better or worse than the others in this regard.

**Pollution Potential and Flooding**

The potential pollution of ground and surface waters from the release of leachate is one of the greatest concerns in relation to the development of a landfill site. However, the pollution potential can be mitigated by providing the site with an impervious liner so that the leachate is contained.

At the Hanwella site there is a natural band of clay at the surface which, it is thought, could be engineered to provide a natural containment liner. Clay is also present in the substrate of the Welisara and Kerawalapitiya sites, but it is suspected that this may not be in large enough quantities and may be fragmented with alluvial deposits which would be of a higher permeability. Its use as a natural lining material is therefore precluded. Development of these two sites would require considerable engineering, possibly involving measures to decrease permeability over the base of the site and the construction of waterproof bunds. These options are likely to be of significant expense in terms of total development costs and potentially could make them considerably more expensive to develop than some of the other options.

At the remaining sites at Hewagama and Morakelle there is a relatively thin layer of overburden above impervious bed rock. In the development of these sites, the overburden would need to be removed and the site founded on the bedrock. Assuming that the bed rock is not excessively fissured, it should therefore be possible to install low cost pollution prevention measures at these sites.

For the development of all the above sites, once the leachate has been contained, it will require proper management and treatment. This treatment may take a number of forms, but it is understood that the cost of an appropriate leachate treatment facility has been included in the initial implementation budget by the World Bank. The aim of the treatment facility will be to treat the leachate to a level of purity at which it can safely be discharged to surface waters without significant adverse affect.

The establishment of a landfill may disrupt local drainage patterns. At the Hewagama and Morakelle sites, cut-off drains will need to be constructed around the perimeter of the sites to intercept surface waters from the
surrounding areas and divert them away from the landfill so that they do not add to the leachate problem. This is likely to be a significant expense in the total development budget of these sites.

At both the Hanwella and Welisara sites, the whole potential site areas are subject to flooding on a frequent basis. Considerable engineering will be required to protect the landfill from these flood waters and any major breach of the site's flood defences, once either of the sites has been operational for some time, would almost certainly lead to a major pollution incident in the area. The construction of a landfill in either location is also likely to have an affect on flood characteristics locally, potentially leading to the flooding of areas not currently subject to it. If either of these sites is to be developed as a landfill, a further study would be required to consider the upstream and downstream effects of the development.

On this basis, in considering the potential of the sites to cause pollution and the effects of flooding both on the sites and in the surrounding areas we draw the following conclusions.

- The following sites appear to be capable of development at reasonable cost incorporating measures to contain leachate and prevent pollution of local surface and ground waters;
  - Hewagama and Morakelle.

- The following sites appear to be capable of development at higher cost incorporating measures to contain leachate and prevent pollution of local surface and ground waters;
  - Kerawalapitiya;
  - Welisara;
  - Hanwella.

- The following sites, if developed, are likely to cause flooding of areas not currently subject to flooding and could present a significant risk of pollution at some time in the future if they are not adequately managed;
  - Welisara;
  - Hanwella.

A4.2.6 Impacts on Wildlife Habitats and Biodiversity

The only significant loss of natural habitat would occur at Kerawalapitiya. This is considered significant due to the diminishing extent of such habitat in the country and there would be little scope to mitigate this impact. Similarly, the presence of threatened and rare endemic species at this site is a significant concern. It is theoretically possible to adopt site management practices to minimise disturbance to the local fauna. However, the success of such measures cannot be evaluated at this stage.
Also, the lining of a large area of this site with an impermeable membrane is likely to alter the hydrogeological characteristics in the Negombo-Muthurajawela area, with ensuing effects on plants and wildlife. Should the lining system fail at any point in the future, the sensitivity of the receptors is such that the release of leachate could have a significant detrimental impact on the ecology of the area.

Our conclusions in relation to the effect of the development of the sites on local ecology is as follows.

- **The development of the following sites is likely to have little detrimental impact on local ecology:**
  - Welisara;
  - Hewagama and Morakelle;
  - Hanwella.

- **The development of the following site is likely to have significant detrimental impact on local ecology.**
  - Kerawalapitiya.
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**Key**

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2 = Medium Goods Vehicles (MGVs)
3 = Vans and Pick-ups (LGVs)
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Key

1 = Heavy Goods Vehicles (HGVs)
2 = Medium Goods Vehicles (MGVs)
3 = Vans and Pick-ups (LGVs)
4 = Cars
5 = Motorcycles and tricycles
6 = Bicycles
7 = Pedestrians
8 = Tractors and trailers
9 = Bullock carts
Traffic Counts on Baseline Road
## Traffic Count Data from Baseline Road

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Key:

1 = Heavy Goods Vehicles (HGVs)
2 = Medium Goods Vehicles (MGVs)
3 = Vans and Pick-ups (LGVs)
4 = Cars
5 = Motorcycles and tricycles
6 = Bicycles
7 = Pedestrians
8 = Tractors and trailers
9 = Bullock carts
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Key:

1 = Heavy Goods Vehicles (HGVs)
2 = Medium Goods Vehicles (MGVs)
3 = Vans and Pick-ups (LGVs)
4 = Cars
5 = Motorcycles and tricycles
6 = Bicycles
7 = Pedestrians
8 = Tractors and trailers
9 = Bullock carts
Annex I

Off-site Hydrological Impacts of Landfill Development
OFF-SITE HYDROLOGICAL IMPACTS OF LANDFILL DEVELOPMENT

This annex summarises the calculations undertaken to make an initial assessment of the likely impacts on the existing hydrological regime of the area following the (progressive) development of the landfill at Welisara.

**STORAGE CAPACITY CALCULATIONS**

**Catchment Data**

- Total Catchment area which contains Welisara: 61 Km$^2$
- Catchment area upstream of the site: 50 Km$^2$
- Area of Landfill site: 1.1 Km$^2$
- The maximum flood level at the Welisara site above the normal water surface level: 2 m

**Storage Capacity of the landfill site area**

The maximum water storage capacity of the landfill site is 1.1 Km$^2$ x 2 = 2.2 Million cubic meters (m$^3$).

**Storage Capacity of the upstream catchment area**

Using topographical maps, the total length measured of the rivers upstream from the site is 48.5 km.

Based on the very small gradient, approximately 1/5000, over the catchment and knowledge of the locality the average width of the flood plain of these rivers is estimated to be 0.4 Km. This takes into account the land on both sides of the river. It is also estimated that the height of flood storage water will be progressively greater downstream towards the site and, therefore, an average height of 1.5 m has been taken.

The area of land acting as upstream storage is therefore 48.5 x 0.4 = 19.4 Km$^2$

Total storage capacity = 48500 x 400 x 1.5 x m$^3$
= 29.1 M m$^3$

The storage capacity lost due to the development of the landfill, 22 M m$^3$ is approximately 8% of the total upstream storage capacity, 29.1 M m$^3$.

**PEAK FLOW DISCHARGE CALCULATIONS**

Using Dicken's Formula run-off equation, using an appropriate coefficient, the present volumes of run-off after a peak rainfall event can be calculated.

Flood Peak Q = CM$^{34}$
C = 850, the coefficient for flat gradient streams
M = 19.5, the catchment area in Square miles

\[ Q = 850 \times (19.5)^{\frac{3}{4}} \]
\[ = 7885 \text{ Cu Secs} \]
\[ = 223 \text{ m}^3 \text{s}^{-1} \]

Since the catchment has such a low gradient, we may assume that the flood flow is partly absorbed by the flood retention basin. If we assume the flood retention is 50% then the Peak Runoff in the area of the site will be:

\[ Q = 50\% \times 223 \]
\[ Q = 112 \text{ m}^3 \text{s}^{-1} \]

This means that, although an additional 2.2 million cubic metres of water will be added to the system, due to the large amount of upstream storage space it will be released gradually.

*Calculations determining the rise in water level due to the loss of flood retention area*

Using Manning’s Equation for open channels it is calculated that this extra volume of water, given the existing channel dimensions, will cause the water to rise by 5 to 6 cm. The calculations are shown below.

Manning’s Equation

\[ Q = \frac{1}{n} AR^{\frac{2}{3}} S^{\frac{1}{2}} \]

\( Q = \) discharge \( m^3 \text{s}^{-1} \)
\( n = \) Manning’s roughness coefficient
\( R = \) hydraulic radius \( m = \) Cross sectional area \( (A) \)/Wetted Perimeter \( (P) \)
\( S = \) water surface slope = \( F/L \) where \( F \) is the fall over length \( L \)

At times of peak flow the channel and the flood plain both sides of the river act as a water conduit.

\[ A = 2(200 \times 2) + (4 \times 20) + \frac{2}{2}(2 \times 4) = 888 \text{ m}^2 \]
\[ P = 200 + 2.3 + 20 + 2.3 + 200 = 424 \text{ m} \]
\[ R = \frac{A}{P} = \frac{888}{424} = 2 \]
\[ n = 0.02 \]
\[ S = \frac{1}{5000} \quad S^{1/2} = 0.014 \]

\[ Q = \frac{1}{0.02} \times 888 \times 2^{1/2} \times 0.014 \]
\[ Q = 989 \text{ m}^3 \text{ s}^{-1} \]

During peak flow it is estimated that an extra 112 m$^3$ s$^{-1}$ will be added to the peak water flow in the area of the site. This would increase the discharge to 1101 m$^3$ s$^{-1}$.

\[ 1101 = \frac{1}{0.02} \times A \times 1.5^9 \times 0.014 \]
\[ A = 915 \text{ m}^2 \]
\[ A = (424 \times h) + (20 \times 2) + 2/2(2 \times 2) \]
\[ h = 2.05 \text{ m} \]

h in the previous calculation was 2.00 m

Therefore, an increase in discharge of 112 m$^3$ s$^{-1}$ will cause the height of the water to rise by 5 cm. In the main report the figure of 10 cm has been used as a conservative value due to the assumptions and approximations that have been made.

In a similar manner, Manning's Equation can also be used to show that due to the progressively increasing water volumes downstream the effect of increasing the discharge by 112 m$^3$ s$^{-1}$ at peak flow becomes insignificant. Therefore, the flooding/backing up of water will not alter significantly from the present.

All the calculations are based on the stated estimations and assumptions. At present there are no water monitoring stations along the Kalu River and no precise figures on the peak flow characteristics for this particular catchment. A detailed hydrological survey would be required over a full season in order to give a more complete review of the hydrological situation.
Annex J

Proposal for the Establishment of an Environmental Unit within the Western Provincial Council
PROPOSAL FOR THE
ESTABLISHMENT OF AN ENVIRONMENTAL UNIT
WITHIN THE WESTERN PROVINCIAL COUNCIL

1. PREAMBLE

The Western Provincial Council (WPC), one of the eight provincial councils in the island, was sanctioned by the Thirteenth Amendment to the Constitution which introduced the Provincial Council system to the administrative structure of Sri Lanka in November 1987. Environmental protection is a subject devolved to the Provincial Councils and the WPC has to provide leadership in this field. As the island's most densely populated province, which includes the Colombo Metropolitan Area (CMA) comprising the City of Colombo, and several large suburbs such as the Dehiwela-Mt Lavinia municipal areas, the WPC's responsibility in protecting the environment is of paramount importance, compared with other provincial councils.

The Government of Sri Lanka (GOSL) has made a commitment to achieve a Newly Industrialized Country (NIC) status by the year 2000. This will undoubtedly stress the carrying capacity of the urban ecosystems in the province to the fullest. It is anticipated that most of the development will be in the WPC due to the current insufficiency of required infrastructure services in the other parts of the country. The industrialization of the two free trade zones, which are within the CMA and the rapid population growth in the suburban areas of the city have created severe problems with regard to collection and disposal of solid wastes and the treatment and disposal of industrial effluents. This has resulted in significant deterioration of the quality of the local water resources, land and air. Therefore, preparation of suitable administrative and legal infrastructure to handle environmental concerns is an essential step that should be taken without further delay.

Additionally, due steps taken to protect the environment would, in the long run, be beneficial to the provincial economy through sustained development and increased productivity of the labour force as a result of the improved health conditions and quality of life of the people in the area. Timely investment in the protection of environment would ultimately lead to human resource development and enhancement in the quality of life.

2. POPULATION

The Western Province contributes 26.4 per cent to the country's total population. The Colombo District in itself accounts for 11.5 per cent of the total population. The population density of the province is 1,174 persons per sq. km (1992). The Colombo district where the hub of economic activity is concentrated in the island has a density of 2,891 persons per sq. km. Other two districts in the province—Gampaha and Kalutara—show a lower density of 1,067 and 570
persons per sq. km. respectively. The City of Colombo, which is the most densely populated urban center in the country has a density of 16,313 persons per sq km. (Additional information on population distribution by Divisional Secretary Divisions is in Figure 1).

3. ADMINISTRATIVE BACKGROUND

The Western Province consists of three administrative districts namely Colombo, Gampaha and Kalutara. These three districts comprise 34 Divisional Secretary Divisions (Figure 2). The province has 2,493 Grama Niladhari Divisions, which is the smallest administrative unit. The Local Government Administration of the province is inclusive of 3 Municipal Councils (MC), 14 Urban Councils (UC) and 28 Pradeshiya Sabhas (PS).

3.1 ADMINISTRATIVE STRUCTURE OF THE WESTERN PROVINCIAL COUNCIL

The WPC is a 101 member Council, consisting of elected representatives, and has legislative power over the devolved functions in the first list of the Thirteenth Amendment to the Constitution of the Democratic Socialist Republic of Sri Lanka. The Governor, appointed by the President, exercises executive authority through the Board of Ministers. The Board of Ministers, is headed by the Chief Minister who is responsible for the implementation of council decisions. The Board of Ministers are collectively responsible and answerable to the Provincial Council. The WPC consists of five members on the Board of Ministers, each having separate functions in the respective ministries. The functions of each ministry is listed in Annex 1.

The Chief Secretary, with a rank similar to a Cabinet Ministry Secretary, is the chief executive of the Provincial Council. Four Deputy Secretaries, namely Deputy Secretary (Planning), Deputy Secretary (Finance), Deputy Secretary (Administration) and Deputy Secretary (Engineering) are in-charge of each division. The Secretaries of the five Provincial Ministries are responsible for implementation of the functions assigned to each Ministry.

4. JUSTIFICATION

The CMA accounts for nearly 70 percent of the total urban population and 80 percent of industrialization. The pattern of development has been changing periodically and there has been no consistent plan towards ensuring environmentally sustainable development. The past development has left behind several environmental scars in the Colombo Metropolis which now requires immediate remedy. In addition, the Government of Sri Lanka has embarked on a strategy of industrialization to raise the income levels and foster further economic development in the country. This Industrialization Strategy is nationwide. However, with most of the existing industrial base in the CMA,
it is natural that most of the industrial growth will occur in that region in order to capitalize on existing infrastructure and supporting services. This would result in rapid urban growth and associated environmental problems that plague other cities in developed and developing countries.

The signs of environmental stress in the Western Province are now cause for serious concern. They include loss of natural and vegetative cover of lands, contamination of waters, degradation of soil and pollution of air.

Colombo, the principal city of the Western Province has serious problems in disposing of urban waste which include:

(a) Sewage
(b) Liquid waste from industrial processes
(c) Wastewater from kitchens and industries
(d) Garbage and industrial solid waste
(e) Urban stormwater run-off that carries a variety of wastes
(f) Hazardous Waste and Infectious Waste

Problems of waste disposal in Colombo are compounded, because 50 percent of the population belong to the low-income category, of which many are shanty dwellers. They occupy stream and canal reservations and usually have no access to sewer services and their sewage and garbage are dumped directly into surface water.

According to 1989 statistics, approximately 10-15 percent of the estimated inhabitants in the City of Colombo discharge sewage directly into the surface water network. In addition, industries and domestic wastewater also regularly enter and pollute the canal network of the city. Organic pollution from sewage accounts for at least 60 percent of the total waste load discharged into the canal network in Colombo.

Industrial waste in Sri Lanka is virtually not subject to treatment prior to discharge. Most of the industries discharge their liquid effluent directly into the surface drainage network or onto the land, where it pollutes the ground water table and enters the nearest waterbody. Data on industrial pollution has been limited, but it appears to be of serious concern as the information base needs to be improved. The 1989 survey conducted by the CEA in Colombo and Gampaha districts identified 115 significant polluters. But, by 1990, the CEA estimated that well over 230 industries may be significant polluters, including public as well as private companies.
With the impending devolution of powers to the local authorities to regulate environmental functions under the National Environmental Act No. 47 of 1980 as amended by No. 56 of 1988 (NEA), the local bodies must be in a position to assume the responsibilities. When this happens the WPC should also be in a position to implement the tasks conferred upon Local Authorities by the NEA. A first step in this direction would be the establishment of an Environmental Unit within the WPC.

5. MANDATE OF THE ENVIRONMENTAL UNIT

The mandate of the Environmental Unit will be:

To advise the Hon. Chief Minister and the Hon. Ministers in charge of Local Government in the WPC on matters pertaining to the protection, management, enhancement, regulation, maintenance and preservation of the environment around the CMA and to prevent, control and abate pollution.

6. POWERS AND OBJECTS OF THE ENVIRONMENTAL UNIT AT THE WPC

- To make recommendations to the Hon. Chief Minister and Minister in charge of Local Government on matters pertaining to environmental issues.

- To develop a management structure for solid waste, taking into account the collection, segregation and sanitary disposal of solid waste, including medical and hazardous waste, and the need for constructing a new sanitary landfill site common to all Local Authorities. Special consideration will be given to the recycling of organic waste.

- In collaboration with the other Local Authorities in the CMA, to develop policies to facilitate cost recovery of implementing the solid waste project.

- To act as the main co-ordinating unit for proposed programs on air, water and soil pollution, evaluation of environmental impact assessments, clean settlements and slum and shanty upgrading, and eradication of the mosquito menace.

- To promote public awareness of environmental issues and act as a repository of information to the public.
Proposal for the Establishment of an
Environmental Unit within the WPC

- To liaise with the Central Environment Authority, other Provincial
  Councils, Divisional Secretariats, International Organizations Professional
  Bodies and any person with respect to environmental protection and
  Management.

- To call for the participation of the private sector and other organizations
  interested, to help in the protection of the environment, where feasible.

7. FUNCTIONS OF THE ENVIRONMENTAL UNIT

7.1 SOLID WASTE MANAGEMENT

The management of solid waste has characteristically been a function of the
local authorities. The CMA generates approximately 800 tons/day of municipal
solid waste (MSW). The wastes generated in the City of Colombo is disposed
of in the Wellampitiya landfill which is expected to reach capacity by the end
of 1994. The other local authorities are known to dispose of their wastes in an
ad hoc manner in various small scale open dumps. The World Bank, through
the Colombo Environment Improvement Project (CEIP), plans to establish a
sanitary landfill and a waste transfer station for MSW in the CMA. A
composition study of the solid wastes in the CMC revealed that 85 percent of
the waste stream at the landfill is organic waste. This waste would serve as an
ideal resource for composting. The resulting compost could be used as a soil
conditioner for agricultural purposes. A demonstration project to determine the
feasibility of composting is underway with the intention of attracting private
sector participation in the waste management system.

Since the overall SWM system would encompass CMC and surrounding local
authorities, the WPC would have to play a key role in co-ordinating such
activities. The functions requiring attention from the WPC would include
monitoring the functions of the sanitary landfill site and the waste transfer
station, the co-ordination of waste collection among the local authorities for
disposal at the central landfill site, facilitating public-private partnerships in
waste collection and treatment technologies such as composting and the
management of industrial solid wastes. The WPC would have to co-ordinate
and supervise the activities of local authorities to prevent ad hoc dumping of
MSW. The CEIP includes an incinerator for medical and abattoir wastes. The
role of co-ordinating the segregated collection of these wastes from hospitals in
the entire CMA would rest with the WPC.
Technical solid waste management expertise is available within the Deputy Municipal Engineer (Solid Waste Management) Department. Therefore, the WPC would be in a position to draw upon this expertise with additional input from MEIP, where necessary, in its co-ordinating operations. The WPC's legislative jurisdiction over local authorities would provide it with the ability to utilize the expertise available within the CMC to better manage solid wastes in the entire Province. While the CEA plays a regulatory role in SWM, the entire responsibility for co-ordination of the SWM system in the CMA would rest with the WPC.

7.2 Clean Settlements Program

The objective of this program is to upgrade the standards of living of the low-income population of the CMA and thereby improve environmental and health standards.

The following criteria have been identified for implementing the program:
(a) improving physical, social and economic conditions
(b) improving the capabilities of local government authorities in undertaking and sustaining these efforts
(c) establishing community based organizations to manage and carry on the programs.

7.3 AIR POLLUTION

Government of Sri Lanka has developed an action plan to address air quality in the CMA - known as the Clean Air 2000 - Action Plan (CA2AP). An Implementation Committee under the chairmanship of the Secretary to the Ministry of Environment and Parliamentary Affairs has been appointed to implement various actions relating to the Plan. This Plan includes a comprehensive approach to air quality management in the CMA. While industrial air pollution is of concern, the dominant source of air pollution is attributable to automotives. With 50 percent of the vehicles registered in the country plying the roads of the CMA, it is conceivable that the WPC would be called upon to implement certain components of the CA2AP.

While the CEA would be providing a regulatory role in the area of air pollution, in-house technical expertise would be necessary in the WPC to partake in policy initiatives of the central Government, which may have a direct bearing on the Western Province.
A key area the WPC would be called upon to provide leadership is in coordinating the development and zoning activities of the local authorities.

7.4 INDUSTRIAL WASTE MANAGEMENT

The Western Province is the most industrialized province in the country. Two free trade zones and dense industrial concentrations in areas such as Ekala/Ja-Ela and Ratmalana/Moratuwa cause large scale industrial pollution management problems in Sri Lanka. An on-going study to develop an Industrial Pollution Management (IPM) Strategy for Sri Lanka has identified the use of centralized wastewater treatment plans as a feature for current and future industrial development. The devolution of power from the CEA to the local authorities is anticipated to call upon the WPC to provide management and policy guidance in implementing the IPM Strategy and even in areas such as the siting of new industrial estates.

The option of central wastewater treatment plants that may cater to industries located across local authority boundaries would require the WPC to provide leadership and co-ordination in the areas such as plant siting and the possible connection of domestic sewage into the industrial sewerage network. However, while in-house technical expertise in these areas are essential, the WPC should play a co-ordination role, at least in the near term.

7.5 WATER MANAGEMENT

The Western Province which consists of three coastal districts—Colombo, Gampaha and Kalutara—comprise a large population of residents belonging to low-income groups who have no proper sanitary facilities. In these districts, a significant portion of the population use wells, rivers and springs for water supply. Most of these water sources are unprotected, as a result, a high proportion of the population is exposed to health risks associated fecally contaminated water, either through groundwater pollution or from surface contamination. The poor water supply and sanitation have resulted, the large population being affected by typhoid, amoebic and bacillary dysentery infections, hepatitis, worm infections, etc.

There has been virtually no studies conducted on the capacity of groundwater aquifers and its pollutant potential in the CMA. Uncontrolled extraction of groundwater—possibly at a rate greater than re-charge—could result in critical water management problems in the future. The current problems associated with flooding and drainage entails significant work in this area, which would
require WPC involvement, at least on a marginal basis. Policy decisions such as tariffs on groundwater usage may become a reality in the future, and WPC input in the policy making process would require the necessary expertise be developed within the Council.

7.6 AGRICULTURE-RELATED POLLUTION

Agricultural waste results from agricultural practices and agro and livestock based industries such as pig and poultry farms. Examples of environmental problems resulting from agricultural practices are the silt carried through run-off, and fertilizers and pesticides contamination of ground and surface waters.

Agricultural pollution is an area thus far receiving little, if any, attention from the relevant authorities. While the polluting potential from agricultural sources can be significant, the problem is made significantly more complex by the fact that most agricultural pollution originates from non-point sources. Control of non-point source pollution is virtually impossible. Better management practices would result in minimal non-point source pollution.

Gampaha and Kalutara districts and Hanwella and Homagama Divisional Secretary Divisions in Colombo district are the main areas of irrigated paddy cultivation practised in the Western Province.

The major upstream factors affecting the performance of these irrigation systems are deforestation and vegetation loss in catchment area. Deforestation causes the acceleration of soil erosion, leading to the siltation of streams in lower reaches. It is observed in the Kalutara district that, most of the streams and stream banks are eroded, while stream beds are deepened due to run-off rates which cause much erosion. This process has led to problem of collapsing of bridge abutments, inability to retain water levels in surrounding paddy fields for cultivation and lowering of water table in the surrounding wells.

Since the Western Province is under considerable agricultural production, the WPC should be in a position to initiate better policy and management practices to reduce agricultural pollution within the Province.

7.7 ENVIRONMENTAL IMPACT ASSESSMENT

It is now a legal requirement that all development projects be subjected to an Environmental Impact Assessment (EIA). Several ministries and agencies have been designated as Project Approving Agencies (PAA) by the CEA.
responsibility of a PAA would include the drafting of ToRs for the EIA, evaluation of an EIA and subsequent monitoring of compliance. While the WPC has not been designated a PAA as yet, there appears a good likelihood of it occurring in the future, especially with the extent of devolution of powers to the provincial councils. In the event the WPC is designated a PAA, it is mandatory that it has its own EIA Cell within the Council.

Even if the WPC is not designated a PAA, the Council should have the technical expertise to comment on the EIAs of development projects within the Western Province. Any EIA is open for public scrutiny for a 30-day period. This would be the opportunity for the WPC to comment on a project that may be adverse to the local environment.

7.8 PUBLIC HEALTH

Since all environmental issues are directly or indirectly linked to public health, the WPC should have the capability to address public health issues related to environment. The local authorities currently address this issue through its Public Health Inspectors (PHIs). The WPC needs to act as a technical support service to the PHI network in environmental issues and its implications in larger public health concerns. Areas of water supply, sanitation and eradication of the mosquito menace could be issues to be addressed by this Unit.

8. INSTITUTIONAL ARRANGEMENTS
OF THE ENVIRONMENTAL UNIT

8.1 PROVINCIAL ENVIRONMENTAL ADVISORY COUNCIL

The Environmental Unit will be given policy guidance by a Provincial Environmental Advisory Council consisting of the following members:

(a) Chief Secretary - Chairman
(b) Deputy Chief Secretary (Planning) or his nominee - Member
8.2 STAFFING OF THE ENVIRONMENTAL UNIT

One Consultant (solid waste management) will be working for two years with six full-time professionals from the WPC. The Consultant will work together with the local staff and train them over the period of two years, after which the Unit will function on its own. The Colombo Environmental Improvement Project (CEIP) will finance the Unit in the first two years of operation.

The following six professionals have been identified as full-time employees of the Unit.

(a) Two Engineers
(b) One Scientist
(c) Two Social Scientists
(d) One Administrator

9. TRAINING

Training and attending workshops and seminars will be an important integral function of the full-time members. Training needs will be determined in consultation with the consultant and other experts.

10. LEGISLATION

An Environmental Statute has been drafted for the Western Province taking into consideration the establishment of an Environmental Unit. We felt a statute is necessary to confer statutory and enforcement powers on the Environmental Unit and act as a regulatory authority within the Province. If not the powers and functions of the Unit will not have a legal basis or be enforceable. However, this is not an immediate priority.
The CEA, through the National Environment Act (NEA) has jurisdiction over the entire island. Under Section 26(1) of the NEA these powers, duties and functions can be delegated to other Government and Statutory bodies including Local Authorities. Therefore, the need for a separate Provincial Environment Statute to establish an Environmental Unit within the WPC capable of administering environmental issues.

Protection of the environment within the province is devolved to the Provincial Councils under list I. However, environment is also a subject under list III (concurrent list). Therefore, it may be necessary to have Parliament ratify the statute once it has being approved by the Province.

10.1 DRAFT STATUTE

A draft statute has been prepared and will be presented to the Provincial Council subsequent to the establishment of the Environmental Unit.

10.2 STEPS IN APPROVING A PROVINCIAL STATUTE

(i) Purpose of having a Statute
(ii) Obtain approval from the Board of Ministers to draft a Statute
(iii) Draft the Statute
(iv) Refer to AG for comments
(v) Final draft
(vi) Approval of the final draft by the Board of Ministers
(vii) Forward the approved draft to the Governor
(viii) Present same to the Provincial Council for approval
(ix) Assent of the Governor

Additional steps to be taken if subject is in the List III (concurrency list):

(x) Forward the approved statute to the relevant Cabinet Minister and Minister of Provincial Councils
(xi) Present same to the Cabinet and the Parliament

11. BUDGET

Budget (Revised)

(A) Recurrent Expenditure

<table>
<thead>
<tr>
<th></th>
<th>1st Year</th>
<th>2nd Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salaries and allowances</td>
<td>1,002,000</td>
<td>1,152,300</td>
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</table>
**Proposal for the Establishment of an Environmental Unit within the WPC**

<table>
<thead>
<tr>
<th>Category</th>
<th>2023</th>
<th>2024</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overtime and Holiday pay</td>
<td>63,000</td>
<td>72,450</td>
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<tr>
<td>Entertainment Expenses</td>
<td>32,000</td>
<td>36,800</td>
</tr>
<tr>
<td>Travelling Expenses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Local</td>
<td>44,000</td>
<td>50,600</td>
</tr>
<tr>
<td>• Foreign</td>
<td>425,000</td>
<td>488,750</td>
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<tr>
<td>Stationary and Office requisites</td>
<td>220,000</td>
<td>253,000</td>
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<tr>
<td>Fuel</td>
<td>157,000</td>
<td>180,550</td>
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<tr>
<td>Transport</td>
<td>18,000</td>
<td>20,700</td>
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<tr>
<td>Communication</td>
<td>150,000</td>
<td>172,500</td>
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<tr>
<td>Utility Services</td>
<td>19,000</td>
<td>21,850</td>
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<tr>
<td>Maintenance of Vehicles</td>
<td>125,000</td>
<td>143,750</td>
</tr>
<tr>
<td>Training and Seminars</td>
<td>250,000</td>
<td>287,500</td>
</tr>
<tr>
<td>Incidental Expenses</td>
<td>32,000</td>
<td>36,800</td>
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<tr>
<td></td>
<td>2,537,000</td>
<td>2,917,550</td>
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**(B) Capital Expenditure**

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<tr>
<th>Category</th>
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<th>2024</th>
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</thead>
<tbody>
<tr>
<td>Office Equipment and Furniture</td>
<td>344,000</td>
<td>100,000</td>
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<tr>
<td>Telephones</td>
<td>62,000</td>
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</tr>
<tr>
<td>Research and Development</td>
<td>188,000</td>
<td>203,040</td>
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<tr>
<td>Vehicle - 1 Van</td>
<td>1,900,000</td>
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</tr>
<tr>
<td></td>
<td>1,894,000</td>
<td>303,040</td>
</tr>
<tr>
<td></td>
<td>4,431,000</td>
<td>3,220,590</td>
</tr>
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### Revised Budget for the Staff of the Proposed Environmental Unit - WPC

<table>
<thead>
<tr>
<th></th>
<th>Position</th>
<th>Revised</th>
<th>Additional</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Consultant (contract basis only for first two years)</td>
<td>360,000</td>
<td>414,000</td>
</tr>
<tr>
<td>2</td>
<td>Scientist (1 post)</td>
<td>60,000</td>
<td>69,000</td>
</tr>
<tr>
<td>3</td>
<td>Social Scientist (2 posts)</td>
<td>120,000</td>
<td>138,000</td>
</tr>
<tr>
<td>4</td>
<td>Engineer (2 posts) Civil/Mechanical</td>
<td>120,000</td>
<td>138,000</td>
</tr>
<tr>
<td>5</td>
<td>Assistant Director (1 post) CMS II/II</td>
<td>60,000</td>
<td>69,000</td>
</tr>
<tr>
<td>6</td>
<td>Accountant - part time basis</td>
<td>30,000</td>
<td>34,500</td>
</tr>
<tr>
<td>7</td>
<td>Senior Clerk (G C S II/A)</td>
<td>40,000</td>
<td>46,000</td>
</tr>
<tr>
<td>8</td>
<td>Clerk (2 posts)</td>
<td>70,000</td>
<td>80,000</td>
</tr>
<tr>
<td>9</td>
<td>Stenographer (2 posts) (Sinhala/English)</td>
<td>76,000</td>
<td>87,400</td>
</tr>
<tr>
<td>10</td>
<td>Driver (1 post)</td>
<td>34,000</td>
<td>39,100</td>
</tr>
<tr>
<td>11</td>
<td>Peon (1 post)</td>
<td>32,000</td>
<td>36,800</td>
</tr>
</tbody>
</table>

**Total**

1,002,000 1,152,300
FUNCTIONS OF THE BOARD OF MINISTERS
OF THE WESTERN PROVINCIAL COUNCIL

CHIEF MINISTER
MRS CHANDRIKA KUMARANATUNGA

Subjects:
Law and Order; Finance and Planning; Education; Employment; Cultural Affairs

MINISTER OF AGRICULTURE,
PROVINCIAL ADMINISTRATION AND CO-OPERATIVES
MR RATNASIRI WICKREMANAYAKE

Subjects:
Agriculture; Irrigation and Lands; Local Government; Provincial and Divisional Administration; Co-operatives; Youth Affairs and Sports; Rural Development and Rural Institutions

MINISTER OF TRANSPORT, HOUSING AND CONSTRUCTION
MR ABDUL HAMEED MOHAMMED FOWZIE

Subjects:
Transport; Housing and Construction; Roads; Electricity; Town Planning

MINISTER OF HEALTH AND FISHERIES
MR PREMARATNE GUNASEKERA

Subjects:
Health; Fisheries; Womens’ Affairs

MINISTER OF INDUSTRIES, TOURISM AND SOCIAL SERVICES
MR BERNARD SOYZA

Subjects:
Industries; Tourism; Social Services; Child Care and Probation
ADMINISTRATIVE STRUCTURE OF
THE PROVINCIAL ENVIRONMENTAL UNIT

It is proposed that the Environmental Unit be established under the Provincial Ministry of Local Government, Agriculture and Co-operatives. Monitoring of the solid waste disposal project would also come under this Ministry. It was decided to appoint an Advisory Council within the WPC to co-ordinate environmental issues. The composition and functions are outlined in the draft Statute.
Annex K

List of References
REFERENCES

EMSO Ltd, Solid Waste Disposal Project in the Greater Colombo Metropolitan Area, Sri Lanka. (January 1993)


Environmental Resources Management, Terms of Reference, Project Preparation solid waste component, Colombo Metropolitan Area Environmental Project.(Date)


Secretariat for Infrastructure Development and Investment Promotion of Private infrastructure Project, Metropolitan Colombo Solid Waste Management Study, February 16, 1993
Figure 5.1a  Outline of the Welisara Site
.1~~~~~~r

Issue

__YJt

NMitigationMeasure

Costs (USS)
Capital

Aesthetic(Continued)...

Regular covering of waste after
deposit to prevent odour and
windblown litter

U

-_1Lfi

NA

Annual
Operating

Negligible

U

Ut,_1
U

V U

Institutional
Ongoing Monitoving
Responslbllbty
(WPC would have day-today responsibility fot
operation, and CEA is
regulatory authority in all
cases)
Site operator

Regular inspection by
WPC
AnnuaL independent
audit of site operations

Stageddevelopment of the site

NA

NA

Site operator

NA

Incentives to scavengers for litter
contml

NA

Negligible

Site operator

Regular inspection by
WPC
Annual, independent
audit of site opeations

Covering of waste delivery
vehicles

NA

NA

Site operator

Regular inspection by
WPC
Annual independent
audit of site operations

Good housekeeping

NA

NA

Site operator

Regular imspection by
WPC
Annual, independent
audit of site operations

Extensive landscaping scheme for
progtessive testoration of the
completed site

To be
developed

0

Site operator in
consultation with
Westem Provincial
Council

WPC

U


<table>
<thead>
<tr>
<th>Issue</th>
<th>Mitigation Measure</th>
<th>Costs (US$)</th>
<th>Institutional Responsibility</th>
<th>Ongoing Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Capital</td>
<td>Annual</td>
<td>Operating</td>
</tr>
<tr>
<td>Noise</td>
<td>Screening of the site from settlements by construction of a bund, landscaping and planting of appropriate vegetation</td>
<td>The construction of a bund is a necessity within the engineering of the site; the additional costs of planting and landscaping are marginal</td>
<td>Site operator</td>
<td>Regular inspection by WPC</td>
</tr>
<tr>
<td></td>
<td>Provision of a buffer zone of 50 m between site operations and the nearest settlement</td>
<td>NA</td>
<td>NA</td>
<td>Site operator</td>
</tr>
<tr>
<td></td>
<td>Selection of inherently quiet equipment and vehicles and operational techniques, for example the fitting of silencers to vehicle exhausts, and location of noisy plant away from settlements</td>
<td>Plant and vehicles are an operational requirement of the development of the site; the additional cost of the selection on the basis of noise mitigation is marginal</td>
<td>Site operator</td>
<td>Regular inspection by WPC</td>
</tr>
<tr>
<td></td>
<td>Use of on-site materials as noise screens</td>
<td>NA</td>
<td>NA</td>
<td>Site operator</td>
</tr>
</tbody>
</table>
SKETCH MAP OF THE HYDROGICAL SETTING OF THE WELISARA SITE.