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GUYANA

**GEORGETOWN SOLID WASTE MANAGEMENT PROGRAM
– GSWMP –
(GY-0055)**

**ENVIRONMENTAL IMPACT ASSESSMENT
– EIA –**

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EXECUTIVE SUMMARY

An Environmental Impact Assessment (EIA) report has been prepared for the proposed Sanitary Landfill at Haags Bosch, Guyana to meet requirements of the Guyana Environmental Protection Agency (EPA) and those of the funding agency, the Inter American Development Bank (IDB). The base report was initially prepared by Ground Structures Engineers Consultants Inc. Trow International Ltd. (Trow) in association with Conestoga Rovers & Associates (CRA) was retained by the Government of Guyana (GOG) to undertake due diligence and modify/complete the document to meet specific issues raised by the IDB. This report reflects those modifications by The Trow Team.

BACKGROUND

The Municipality of Georgetown (GM), Guyana needs an integrated waste management system to handle generated municipal solid wastes. Currently, significant waste is dumped in open vacant lots instead of official disposal sites. Even when disposal sites are used, these sites are operated in a manner that makes no provisions for impact mitigation of leachate, wind blown waste, odour, rodents and birds etc. In Georgetown, the refuse disposal site is on Mandella Avenue, initiated as a demonstration landfill. This site has not been appropriately designed or operated and has outlived its effective life. The site is unwholesome, ridden with human and animal scavengers and poses serious environmental and health risks to the communities.

In surrounding National Democratic Councils (NDC), the situation is similar with solid waste burned or dumped in the open with no provisions for mitigation of environmental, health and safety impacts.

The GOG requested IDB assistance to solve the acute solid waste disposal problem for Georgetown and Environs. From subsequent discussions a plan was formulated to effect safe and environmentally sound closure of the existing dump site at Mandela within a short time frame and undertake studies to identify design and develop a new safe disposal facility that met international technical and environmental standards.

The characterization and assessment of the problem identified sanitary landfill as the minimum cost solution to dispose of the city's solid waste and private sector participation in the execution as desirable and necessary. Formal sitting assessments identified the area near Eccles as the preferred landfill site. Community participation and public awareness programs were initiated and final designs and complementary

studies for the landfill site including Environmental Impact Assessments (EIA) were commissioned.

PURPOSE, METHODOLOGY, AND SCOPE

The **purpose** of this study is to undertake a program of sufficient technical and environmental investigation and sufficient public consultation to identify, evaluate and present corrective/mitigate actions for potential negative environmental impacts and to enhance positive impacts of the proposed landfill site development at Haags Bosch. Environmental resources and elements at risk need to be described and evaluated. Opinions and conclusions need to be independently verified to create transparency and security for all stakeholders, permitting the project to proceed.

The **methodology** used for the environmental impact assessment was the identification of predictable effects of the proposed sanitary landfill on various components of the environment, the estimation of environmental effects, the evaluation of significance and importance of those effects and the incorporation of proposed mitigation measures to eliminate or minimize these environmental effects. The approach also included a comprehensive public participation programme during the scoping, study preparation and review stages.

The **scope** of the assessment was to identify interactions of the project with the natural and social environment and Valued Ecosystem Components. The nature of each of the interactions was evaluated, its magnitude and significance determined and where appropriate, mitigation measures recommended. The valued ecosystem components judged to be of greatest importance are identified through broad criteria of Community and Environmental Health, Safety and Prosperity. Parametres considered under these criteria include: air quality, noise, groundwater, surface water, soil, humans, fish, mammals including birds, vegetation and socio-economic status. In this connection, the current negative impacts on all of these valued ecosystem components resulting from current poor waste collection and disposal at the Mandella site and the positive impacts that would be realized by closing dumps such as Mandella, if safe and environmentally sound landfilling could be done, is also of importance.

PROJECT DESCRIPTION

The current waste collection and disposal system in Georgetown and Environs has continuing negative effects on human health and the environment. Water and soil are contaminated from run-off and leachate from garbage at roadsides in poorly operated dump sites. People and animals near these sites are exposed to contaminants and disease causing pathogens. Potentially toxic fumes from waste fires can cause respiratory illnesses. Living conditions for humans and the negative impacts on the environment will get worse over time particularly as Guyana is opened to more tourism and trade. There is a clear need for a suitable waste management system that deals with growth and development and protect the environment and residents of Georgetown and Environs.

The landfill will provide an environmentally sound location, which will accommodate waste generated by GM and the surrounding NDCs. The proposed site will also alleviate problems associated with municipal waste disposal at other dumping grounds in these areas. The project description discusses the design, construction and operation of the sanitary landfill to assist the reader in understanding the short and long term waste management and environmental control strategies. The landfill will be constructed in accordance with international criteria in order to effectively protect the surrounding environment from any of the environmental impacts that have in the past been typically associated with poorly constructed and operated landfill sites. Section 2 of the report provides more details of the project. The following summarizes some key points:

- the site has been moved to the east of the initially proposed location to provide optimum separation/buffer zone from residences in the Eccles area as part of the response to concerns arising from the public participation process;
- base design and preparation requirements provide sound leachate control and mitigation against significant groundwater impacts, and adequate factors of safety with respect to native soil shear strength and stability;
- surface water management features have been developed in accordance with applicable local regulation and good practice to control water quality and quality disposed to receiving canals to acceptable levels;
- berm heights at leachate treatment ponds are set to separate leachate from stormwater even during high rainfall periods such as those experienced in January 2005;
- a leachate treatment system is included;

- an area of the site has been allocated for simple composting operations;
- landfill gas control area designed including possible incorporation into an energy producing project;
- scale facilities are included;
- facilities for administrative activities are provided;
- fixed accommodation and related facilities have been provided for licensed waste pickers;
- all weather site access is included as well as security fencing;
- monitoring programs for verification of compliance during operations have been developed;
- provisions for compaction, daily and final cover are incorporated in the plans;
- consideration of ultimate closure is in place; and
- the incorporation of private participation, cost recovery and sustainability is given high importance.

LEGAL AND INSTITUTIONAL FRAMEWORK FOR EIA

The specific terms of reference (TOR) for the development, execution and documentation of the EIA and associated reports, required as part of the proposed Haags Bosch Landfill development including the legal and Institutional Framework is presented in detail in Section 3 of this report. The process adheres to international and national policies established for the suitability and effective management of the environment in the context of specific development proposals. The roles of the National Environmental Protection Agency (EPA) have been presented. Specific requirements of the funding agency, the Inter-American Development Bank (IDB), which encompass those of the named local environmental agencies, have been included. Pertinent regulations include the Environmental Protection Act, the Town and Country Planning Act, the Public Health Ordinance and the Occupational Health and Safety Act of Guyana.

PHYSICAL ENVIRONMENT

The physical environment of Haags Bosch and its immediate environs will be impacted by the project. Haags Bosch and its environs are considered to be represented by the

landfill site, its buffer zone and the adjacent housing areas within 2.5 km (one and one-half miles) of the facility. These housing areas include the New Eccles Housing Development, Republic Park, Continental Park, Nandy Park and Bagotstown.

The proximity of the landfill site to the surrounding communities is shown on Figure 2.

The subject site (Haags Bosch) is set within the Coastal Plain. Typically, the subsoils consist of at least 20m of very soft to firm bluish grey silty clay with occasional silt seams and organic inclusion overlaying the firm to hard yellowish grey silty clay of the Coropina Formation. Low or relatively impermeable materials extend to at least 30m depth below grade. Groundwater in the area is recovered from wells screened in confined sand aquifers under artesian conditions at depths of about 160 m. Surface water occurs in ditches, canals and small drains and the levels in these units reflect controlled drainage and irrigation in the specific area, as well as seasonal fluctuations. The Georgetown area receives an average of about 2 m of rainfall per year. In the month of January 2005, greater than 1m was experienced, resulting in significant and prolonged flooding; temperature in the area ranges between 25 and 35°C. Land use in Haags Bosch area is agricultural with industrial and residential units about 2 km removed.

The development of a landfill at Haags Bosch would permit cessation of operations at uncontrolled dumps such as that existing at Mandella Ave (within the confines of Georgetown) which is currently the prime recipient of solid waste from the Greater Georgetown Area. The physical environment at Mandella is similar to that of Haags Bosch with the following exception. The surface water is contaminated with leachate from the uncontrolled waste dumping; land use of immediately adjacent areas include the long operated cemetery and residential development.

SOCIO-CULTURAL ENVIRONMENT

The proposed project will impact waste generation and management activities in GM and the NDCs. In Region 4, socio-cultural data has been compiled for GM and NDCs to define baseline conditions prior to implementation of the project. This data is detailed in the body of the report. A socio-cultural overview presents data as follows:

- **Population and household characteristics:** Data from the most recent census (1991) has been presented. The bureau of Statistic Guyana maintains census related activities in intercensal periods. Recent estimates indicate a population for Guyana

of about 720,000 to 750,000. Georgetown and Region 4 NDCs are estimated to have a population of between 310,000 and 350,000

- **Economic activities and employment:** The Guyanese Economy exhibited moderate economic growth in 2001-02, based on expansion in the agricultural and mining sectors, a more favourable atmosphere for business initiatives, a more realistic exchange rate, fairly low inflation, and the continued support of international organizations. Growth then slowed in 2003. Chronic problems include a shortage of skilled labour and a deficient infrastructure. The government is juggling a sizable external debt against the urgent need for expanded public investment. The bauxite mining sector should benefit in the near term by restructuring and partial privatization.
- **Social and Economic well being:** Poverty and unemployment showing declining features; life expectancy 65 years (male 62, female 68); literacy 98%; gender gap in favour of males for higher education; collapse of infrastructure in 1990's showing signs of improvement. Teachers and nurses earning minimum wage of approximately US \$100/month is a concern.

ENVIRONMENTAL IMPACT AND ASSOCIATED RISK

As a result of constructing, operating and maintaining a landfill there are potential environmental impacts and associated risks to the local community, wildlife, above and below ground environments and staff who will be required to operate the Site and associated control systems. This construction will permit closure of uncontrolled dumps with associated net environmental and socio-economic benefits. A systematic review of potential physical, biological, cultural and site specific impact has been undertaken as part of the EIA study. Each identified impact has been systematically categorized and where appropriate, provision has been made for mitigation within the Environmental Management Plan. Contingencies and/or redundancies are incorporated. Details are provided in the body of the report and brief summaries provided in tables following the text of this Executive Summary.

The assessments cover the "do nothing" option and clearly support the construction and operation of a state of the art landfill with the appropriate controls and contingencies.

The socio-cultural environment was examined and potential impacts from the construction, operation, closure and post closure of the proposed landfill at Haags Bosch identified. These impacts were categorized for character (beneficial or detrimental)

significance duration, reversibility, risk of occurrence and zone of influence. A summary of the key assessments is tabulated at the end of this executive summary section.

ECONOMIC ANALYSIS OF ENVIRONMENTAL IMPACTS AND RISKS

The costs and benefits of undertaking the landfill project at Haags Bosch and for continuing the waste disposal at Mandella have been examined. A number of the items are subjective and difficult to quantify with a reasonable level of accuracy based on their nature and quality of available information. However, the analysis clearly indicates that there is a substantial net cost to continuation of the status quo i.e., continuing to dispose of solid waste at Mandella. The cost is estimated to be in the order of US \$20,000,000 over the 20 year life cycle considered.

On the other hand, executing the new landfill at Haags Bosch in the manner intended results in a net benefit of about 5 to 10 million US dollars over the same period based on the issues quantified. Additional significant benefits associated with tourism, returning residents etc. would significantly enhance these benefits. This project is therefore considered viable, and indeed necessary.

ALTERNATIVES TO THE PROJECT

A formal sequence of studies covering problem characterization and assessment (including review of available disposal options) identified sanitary landfill as the least cost solution to the solid waste problem in Georgetown and Environs, and the Eccles area as the preferred location. An EA complemented the pre-feasibility siting studies. The alternative to this proposed project would be the "do nothing" option i.e., maintain the current systems of garbage collection and disposal. The negative impacts of this current system on the environment and human health would increase over time resulting in continued degradation and increased disease, illness and possible death to impacted residents. The process has had the benefit of significant stakeholder input. The proposed landfill project at Haags Bosch is technically feasible, financially viable and sustainable and socially and environmentally effective in reducing future degradation to Georgetown on environments. It is therefore a robust option and certainly the preferred approach to "do nothing".

ENVIRONMENTAL MANAGEMENT PLAN

The purpose of the Environmental Management Plan (EMP) is to clearly address and discuss preventative and contingency measures, which will be established to mitigate environmental impacts and associated risks for the Project. In Section 6 of the EIA report actions related to the Project were systematically assessed and categorized based on potential to create an environmental impact and or associated risk for each individual phase of the Project.

The environmental management plan has been created to mitigate any potential environmental impact and associated risk. In the unlikely event that the mitigation measures established do not function as intended contingency plans have also been prepared to address impacts related to the landfill. Extensive monitoring programs have been established to confirm that the control systems constructed are operating as intended and prevent environmental impact to the local human and wildlife population and other valued ecosystem components. In addition quality control and assurance programs have been prepared and will be followed during the construction program to confirm that the site is constructed in accordance with the technical specifications and detailed design drawings.

Programs have been established and will be implemented throughout the operating lifespan of the site to keep local residents and environmental groups/agencies apprised of any potential and/or real impacts related to the construction, operation and maintenance of the site. The design teams retained to complete the design and oversee construction and operation of the Site must clearly understand the importance of being a good neighbor. Staff training and worker health and safety is of paramount importance in the successful construction and operation of the Site and have also been clearly addressed through all portions of the project as documented.

It is concluded that all potential impacts have been identified and an effective and sound environmental management plan has been established to protect the human and animal population and other valued ecosystem components.

MONITORING PLAN FOR OPERATIONAL COMPLIANCE

The monitoring program will provide data, which would serve as the basis to determine the environmental performance of the systems. The facility will be monitored to confirm its adherence to sound environmental management practices and contractually

established operational standards. Monitoring will be conducted during the construction, operation, closure and post closure phases of the project. The monitoring program is designed to ensure that the trends for specific parameters are tracked. It will also provide information on compliance with legislation, guidelines and contractual requirements for the construction, operation, closure and post-closure maintenance of the facility. Specific items of monitoring in the plan include:

- soil/waste volumes;
- surface water quality;
- groundwater quality;
- leachate system monitoring including head in landfill cells;
- landfill gas; and
- complaints monitoring.

PUBLIC PARTICIPATION

Public participation has been accomplished throughout the Haags Bosch EIA Process to date in general conformance with GOG and IDB requirements. Opportunities for further public participation are in place as part of the follow-up programmed. This process included both affected and interested parties. Participation techniques included assemblies, surveys, interviews, meetings consultation forums, and information dissemination techniques such as pamphlet, panels, leaflets and media communications. Key public concerns centered around the proximity of housing to the proposed landfill, with attendant possible decrease in property values, odour, dust and noise issues, open fires, loss of peace and tranquility, traffic, impact on groundwater, the presence of unwanted or questionable characters in the area and the long term sustainability in terms of funding, resolve and regulatory framework. Consultants' response to these issues covered sound design, and operations practices and procedures, mitigation and environmental management plans, regulatory framework and complaints response programmes, and examples of successful similar operations. The final site location was moved significantly to the East of developed areas based on input from the public participation process. Details of the public interaction programs, including tabulated public concerns and consultants responses are presented in Section 14 of the report. The transcripts from the public sessions are appended.

SUMMARY OF KEY RECOMMENDATIONS

There is a need to change the current system of waste disposal in Georgetown and Environs to protect the environment, the people and animals that live there. A sanitary landfill site at Haags Bosch presents an environmentally sound, sustainable and cost effective component of an integrated waste management plan for Georgetown. The following summarizes some key recommendations arising from the EIA process related to this project.

- Proceed with the Haags Bosch State-of-the-Art landfill. A site operations Manual is appended and conveys all key activities including health and safety issues.
- Consider combining disposal construction and operation to create a more viable project for potential international bidders with appropriate experience and expertise.
- Minimum guarantees ("put or pay" options) may be required to cover fixed basic costs for private operators.
- BOT approach would optimize economic outlays and provide optimum sequencing and reduced potential impacts.
- Funds should be guaranteed or escrowed to permit safe and effective closure operations at key life cycle points.
- Strict adherence to EMP and related QA/QC issues is required.
- Continuation of the community participation program is recommended throughout the life of the landfill. This should include public liaison committee, public information office, meetings and publications. A semi-annual newsletter covering waste management issues is recommended. The public complaint mechanism must be maintained. Community awareness of waste management issues strengthened.
- Training and institutional strengthening is of paramount importance.
- Other key elements of an integrated waste management approach should be actively pursued.
- It is recommended that the Government of Guyana formally commit to the support of any necessary financial guarantees and legislation to ensure project viability and environmental compliance over the full life cycle including post closure periods.

Summary of Impact Assessment on Valued Ecosystem Components

<i>Area of Study</i>	<i>Design</i>	<i>Construction</i>	<i>Operation</i>	<i>Post Closure</i>
Physical Environmental Impacts	Action	Action	Action	Action
Site Conditions	No Impact	Impact	Impact	Impact
Animal Habitat and/or Population	No Impact	Impact	Impact	Impact
Plant Species and /or Vegetation	No Impact	Impact	No Impact	Impact
Surface Waterways	No Impact	Impact	EMP	Impact
Noise and Odour	No Impact	EMP	EMP	EMP
Biological Environmental Impacts				
Air Quality	No Impact	EMP	EMP	EMP
Surface Water Quality	No Impact	EMP	EMP	EMP
Groundwater Quality	No Impact	No Impact	EMP	EMP
Native Soil Quality	No Impact	EMP	EMP	EMP
Human Health	No Impact	EMP	EMP	EMP
Social and Cultural				
Opposition	Impact	EMP	EMP	EMP
Staffing	No Impact	EMP	EMP	EMP
Health and Safety	No Impact	EMP	EMP	EMP
Public Involvement and Notification	Impact	EMP	EMP	EMP
Archeological and Heritage Issues	No Impact	No Impact	No Impact	No Impact
Environmental Control Systems				
Waste Containment Cell(s)	No Impact	EMP	EMP	EMP
Leachate Collection and Treatment	No Impact	EMP	EMP	EMP
Landfill Gas Collection and Treatment	No Impact	EMP	EMP	EMP

No Impact. The action has no negative environmental impact. Where the action had no impact and/or associated risk no mitigation and/or contingency measures are developed.

Impact. The action has an environmental impact but no associated risk. The environment is permanently changed as a result the action. Through the lifespan of the Site environmental conditions will be monitored and corrected in response to potential negative impacts.

EMP - Environmental Management Plan. There is a potential for the action to negatively impact the environment and there is an associated risk. The EMP has been prepared to mitigate environmental impact and risk throughout the operating lifespan of the Site. If an environmental impact occurs as a result of the action, even though mitigation measures have been developed and followed a contingency plan is prepared and executed to prevent damage to adjacent environment and residents.

Summary of Some Key Socio-Economic Risks/Impacts of completing the Haags Bosch Landfill

<i>Impact</i>	<i>Character (1)</i>	<i>Disturbance (2)</i>	<i>Significance (3)</i>	<i>Duration</i>	<i>Reversibility (4)</i>	<i>Risk of Occurrence</i>	<i>Zone of Influence</i>
Resettlement of Waste Pickers	Positive	Important	High	Permanent	Reversible	Very Probable	Specific
Economic Benefits of New Employment For Cons/Operation of new landfill	Positive	Regular	Low	Permanent	Reversible	Very Probable	Local
Sensitizing Residents of benefits of Effective Waste Management	Positive	Important	High	Permanent	Partially Reversible	Very Probable	Regional
Effective Closure of Mandella and Similar sites	Positive	Regular	High	Permanent	Reversible	Very Probable	Regional
Disturbance during construction	Negative	Important	High	Temporary	Reversible	Unlikely	Local
Disturbance during operation	Negative	Important	High	Permanent	Reversible	Unlikely	Local
Decreased Property Value near Haags Bosch	Negative	Important	High	Average/short	Reversible	Unlikely	Local
Increase Property value near existing Dump Sites	Positive	Important	High	Permanent	Partial	Probable	Local
Impact on Tourism	Positive	Regular	Medium	Permanent	Partial	Probable	Regional
Retarding of further Industrial Development	Positive/Negative	Important	High	Average	Reversible	Unlikely	Regional
Cost of Waste Disposal (fees)	Negative	Important	High	Permanent	Partial	Very Probable	Regional

Summary:

From the Socio-Economic perspective, the construction of this project as outlined has significant net benefits to Georgetown and Environs. It will contribute to improvement of health and welfare. Negative impacts are mainly temporary and/or limited or reversible, and can be mitigated with appropriate measures.

1. **Character** – Nature of Impact (beneficial or detrimental).
2. **Disturbance** – Extension/Quality.
3. **Significance** – e.g.: ecological importance, intensity of toxicity.
4. **Reversibility** – Returning to previous conditions with or without human impact.

Summary of Key Public Concerns and Consultant's Responses – Public Participation Process

<i>Concerns</i>	<i>Consultant's Response</i>
Proximity to housing	Technically Landfill can be designated to mitigate potential impact. Examples of Keele Valley in Toronto and other similar landfill proximity condition in developing countries cited. Other points of note: Buffers and screens included Increase separation of about 2m by proposed site relocation further East.
Unwanted/questionable characters	The landfill site would be fenced and security installed. Waste pickers would be licensed and controlled.
Open fires at Landfill	A strict program of fire prevention and elimination would be included in the design and operation protocols. Procedures would include prohibition of open fires, designated smoking areas, procedures to contain and eliminate any fires etc.
Decrease in property values	The landfill would be operated in an environmentally sound manner. Buffers and screens would be in place. The final relocation further to the East would be favourable.
Loss of Peace and Tranquility	Sound operation and management should not significantly impact this item. The plans and commitment are in place for such management.
Management of Hazardous Waste	At this time the management of hazardous waste is not proposed for the Haags Bosch site. A plan to study the requirement for hazardous waste control is being developed. All attendant hearings and related EIA requires to be executed as part of the overall waste management strategy for Guyana.
Impact on the Cricket Stadium	No significant impact is indicated for a well designed and operated landfill facility as planned and sited. Example of sport stadium in St. Lucia, where the landfill successfully operates with 100m of stadium was presented. St. Vincent also presented as example.
Location of Access	Access through the East-West road at Eccles from the existing East bank road will not significantly affect traffic. Flow plans are to use the Southern by-pass as access as soon as it is constructed.
Impact on Groundwater	Wells in the area are screened in aquifers more than 150m below grade. The landfill proposed has been modeled for all potential operating conditions and no significant impact determined given the favourable geologic/hydrogeologic setting and landfill design approach. Monitoring plans within contingencies are in place. Action plans with a regulatory framework are part of overall strategy.
Long term financial viability when no IDB funds available	Funds from the IDB loans are earmarked for the upgrading of institutional capacity to service environmentally sound and sustainable landfill activities.

1.0 INTRODUCTION

This Environmental Impact Assessment (EIA) was undertaken for a sanitary landfill to be constructed and operated at Haags Bosch on the East Bank Demerara as a component of the Georgetown Solid Waste Management Programme. The Environmental Protection Act, No. 11 of 1996, established that Environmental Impact Assessment (EIA) are required for projects which may potentially affect the environment. The Guyana Environmental Protection Agency (EPA) has determined that construction and operation of the sanitary landfill, proposed by this project, may potentially impact the environment and has mandated that an EIA be conducted.

This EIA, which has been prepared for the Ministry of Local Government and Regional Development, also conforms to the policy of the IDB. This EIA describes the physical, biological, social and economic environment within the study area that are relevant to the Project. The assessment identifies the Project-environment interactions during design, construction, operation and closure phases of the sanitary landfill. Mitigation measures and costs associated with mitigation of adverse environmental are also presented in this report.

The proposed sanitary landfill will serve Georgetown (GM) and surrounding Neighborhood Democratic Councils (NDCs). The sanitary landfill site (Site) will be owned by the Guyana Land and Survey Commission (L & SC) through the MoLGRD, and leased to the Georgetown Municipal Solid Waste Management Department (MSWMD), for landfilling operations. The regional Site area and Site location is shown on Figure 1.1 (Appendix A). A more detailed Site location is shown on Figure 1.2 (Appendix A), which also identifies adjacent land uses.

The contractor to construct the sanitary landfill and the Site operator (Operator) will be selected based on International Competitive Bidding. The sanitary landfill will be managed by the Municipal Solid Waste Management Department (MSWMD). Funds for design of the sanitary landfill have been provided by the IDB. Funds for payment of the Operator will be generated by tipping fees payable for waste disposed at the site. Waste tipping fees are expected to cover operation and maintenance costs with any surplus being used to cover capital costs for the landfill.

The new landfill has been designed to provide adequate capacity for twenty six years of operation. The design includes topographic and geotechnical surveys and soil testing, and preparation of bidding documents for hiring of a Construction Contractor and Site Operator.

Georgetown is comprised of Central Georgetown and several surrounding areas referred to as Greater Georgetown with a total area of approximately 22 km². The city is located in Region 4 which has 15 Neighborhood Democratic Councils (NDCs) in addition to Georgetown. Thirteen of these NDCs and two NDCs from Region 3 will have access to the sanitary landfill at Haags Bosch. These NDCs are Grove/Haslington, Enmore/Hope, Buxton/Foulis, Mon Repos/Le Reconnaissance, Beterverwagting/Triumph, Better Hope/La Bonne Intention, Industry/Plaisance, Ramsburg/Eccles, Little Diamond/Herstelling, Mocha/Arcadia, Golden Grove/Diamond Place, Caledonia/Good Success, Soesdyke/Huist Te Coverden in Region 4 and La Grange/Nismes and Malgre Tout/Meer-Zorgen in Region 3. The locations of the NDCs relative to Georgetown are shown on Figure 1 (Appendix A).

Waste from GM will be delivered directly to the landfill by waste collection companies contracted by MSWMD. Licensed collection companies will collect waste from large commercial and industrial generators for delivery to the facility. Waste from NDCs will be delivered by tractor trailers or horse drawn carts to transfer stations for recovery by waste collection companies contracted by the MSWMD. Hazardous and healthcare wastes will not be disposed at the sanitary landfill. Hazardous and healthcare wastes will be disposed in a facility developed for such wastes using funds provided by the IDB.

To ensure effective management of solid waste in GM and environs the Municipal Solid Waste Management Department (MSWMD) has been created and funds will be provided through the Institutional Strengthening and Capacity Building component of the Georgetown Solid Waste Management Programme to improve the capabilities of this department.

Georgetown (GM) uses an open dump west of Mandela Avenue (Mandela Site) for solid waste disposal. Health care waste and waste from GM abattoir are burned in a waste incinerator sited in the municipality compound at Princess Street. Upgrades will be provided at the Mandela site to effect environmental safeguards at the open dump. Continued demand for solid waste disposal area will be met in the short term by expanding the Mandela Site approximately 4 hectares (ha) west of the current dump

using funds provided by the IDB. This site will be closed after waste management operations commence at the Haags Bosch Site.

Inappropriate environmental measures are also used to dispose of waste in the NDCs surrounding Georgetown. These NDCs extend over an area from Timehri on the East Bank Demerara to Haslington on the East Coast Demerara and to points on the western bank of the Demerara River. Wastes generated in the NDCs are typically disposed in dumps immediately adjacent to residences and into drainage canals. Eccles/Ramsburg NDC, however, utilizes the Mandela Site on a regular basis.

Both GM and the NDCs paid for solid waste management operations using funds paid into their treasuries as property taxes or as subventions from the Government of Guyana (GOG). Residents are not independently billed for waste management services. This system lacks accountability and transparency. Waste management costs for GM fall into three main areas; waste collection, waste disposal and administration. Collection, disposal and administration approximate to 71, 20 and 9 percent respectively of waste management charges for GM. Similar information is unavailable for NDCs surrounding Georgetown.

Prior to September 2003, the Cleansing Department (CD) within GM Public Health Department managed solid waste collection and disposal services in Georgetown. A new department, the Municipal Solid Waste Management Department (MSWMD) has been developed to supersede the CD and will function at the same level as the public health department. The MSWMD is now independent of the Public Health Department and has its own decision making mechanisms which are subject to approval of an Advisory Board.

Waste collection in GM occurs with major involvement from the private sector. The collection system is divided into 11 zones. Collection in 10 zones is contracted to the private sector. The MSWMD collects waste from one zone and manages operations at the Mandela Site. Earthmoving equipment is contracted from the private sector for actual landfilling operations. Approximately 90% of Georgetown inhabitants are served by scheduled collection services. The remainder lives in inaccessible areas and non-legalized squatter settlements in the city.

GM collects solid waste daily, bi-weekly or weekly based on the nature of the collection zones. Waste consists of residential, commercial and markets waste. Waste collection vehicles are mostly rear-loaded compaction type trucks. Residential waste bins are mainly 25 gallons (98 liters) circular bins of metal or plastic. These bins are carried and

emptied manually by collection staff, most of who are provided with minimal personnel protection equipment. Wheeled 400 liters mini-containers and skip-hoist containers are used for waste storage in markets and in certain residential areas. The waste collection service is relatively satisfactory. Citizens, however, complain about infrequent collection in zones served once per week and littering left behind by the collection staff.

Several waste pickers operate an informal recycling operation at the Mandela Site. Items recovered for recycling include paper and cardboard, glass and metals (copper, brass, iron and aluminum). All recycled items are exported except paper and cardboard which are sold to a paper recycling plant just outside of Georgetown. GM estimates that recycling generates in excess of sixty million Guyana dollars for the informal recyclers. A survey of the recyclers working conditions, conducted in December 2003, indicates that approximately 80 individuals are involved.

At present formal waste collection occurs in eight of the fifteen NDCs surrounding GM. NDCs which collect waste use either tractor and trailer or horse and cart. Residents of all NDCs burn or bury a large fraction of their waste and all waste generated is not captured by the collection service. Lack of collection has resulted in dumping activities in NDCs.

The Georgetown Solid Waste Management Programme (The Programme) has the following components:

Part 1: Institutional Strengthening and Capacity Building for Solid Waste Management.

Part 2: Community Participation and Public Awareness Program.

Part 3: Design, Construction and Operation of a Sanitary Landfill.

Effective implementation of The Programme will alleviate waste disposal problems in GM and in NDCs surroundings GM. It will improve the quality of life and aesthetics of residents of Georgetown and surrounding NDCs. The Programme will also protect public health and the environment in Georgetown and in the surroundings NDCs.

This Environmental Impact Assessment (EIA) and its associated public consultation is a part of the design sub-component of Part 3 of The Program. The Environmental Impact Assessment objective is a systematic study, analysis and evaluation of the potential environmental and social impacts related to project execution. The assessment includes an evaluation of the environmental and social costs and benefits, as well as the economic implications of The Programme and its alternatives including the no action alternative.

This remainder of this EIA will be developed in the following sequence:

Chapter 2: Description of the proposed project.

Chapter 3: Legal and institutional framework.

Chapter 4: Description of the physical environment.

Chapter 5: Description of the socio-cultural environment.

Chapter 6: Physical environmental impacts and risks of the proposed action.

Chapter 7: Socio-cultural impacts and risks of the proposed action.

Chapter 8: Alternatives to the project, and their environmental and socio-cultural impacts.

Chapter 9: Economic Analyses of the environmental impacts and risks.

Chapter 10: Environmental Management Plan (EMP).

Chapter 11: Resettlement Plan for waste pickers at the Mandela Site.

Chapter 12: Institutional framework for project execution and supervision.

Chapter 13: Monitoring Plan for operational compliance.

Chapter 14: Public Participation.

Chapter 15: Summary of Key Recommendations.

This EIA is based on data provided in several studies undertaken for solid waste management in GM. These include the following:

- Pre-Investment Study for Georgetown Solid Waste Management Program: Waste Characterization and Facility Siting – Brown, Vence and Associates, Inc. May 2000.
- GY-0055 – Georgetown Solid Waste Management Program. Revised Profile II. – July 25, 2003.
- Pre-Investment Study for Georgetown Solid Waste Management Programme – ERM, November 2003.
- Draft Plan for the Georgetown Solid Waste Management Department – ERM, September 2003.
- Report on the Georgetown Solid Waste Management Department – ERM, November 2003.
- Draft Operation Plan Eccles Landfill Guyana – ERM November 2003.
- Report on the Georgetown Solid Waste Management Department – ERM, December 2003.

- Final Report on Survey of the Informal Recyclers Working Conditions at The Mandela Solid Waste Disposal Site in Georgetown, Guyana, Philip Walcott, December 31, 2003.
- Visit Report – ERM February 2004.
- Detailed Engineering Design of the New Sanitary landfill for the Georgetown Waste Disposal Project: Inception Report – Trow, CRA and E&A, February 2004.
- Visit Report – ERM, March 2004.
- Detailed Engineering Design of the New Sanitary landfill for the Georgetown Waste Disposal Project: Conceptual Design and Operations Report – Trow, CRA and E&A, March 24, 2004.
- Draft Detailed Design and Operations Report For The New Sanitary Landfill Site In Eccles – Trow, CRA and E&A, September 06, 2004.
- Draft Site Operating Manual - Trow, CRA and E&A, March 2005.

2.0 DESCRIPTION OF PROPOSED PROJECT

Design, construction and operation of a sanitary landfill are needed to ensure conformance with the agreement between the GOG and the IDB for the Georgetown Solid Waste Management Program. The landfill would provide environmentally sound management practices for waste generated by GM and the surrounding NDCs and would alleviate problems associated with municipal waste disposal in these areas. The purpose of the proposed action is therefore the development of a Sanitary Landfill to service the Municipality of Georgetown and NDCs surrounding the city.

The initial schedule for project approval and implementation is based on the Aide Memoire developed as result of the IDB Special Mission to Guyana of November 22-26, 2004.

2.1 FINAL DESIGN AND COMPLEMENTARY STUDIES

The landfill will be separated from both the residential housing area and the industrial area in Eccles by a very large buffer zone that is more than 120 hectares. In addition, the buildings in the industrial area itself will provide a further buffer for the inhabitants of the residential area. The Site is bordered on the north, south, and west sides by cane fields, and there is virtually no window where the public will be able to have any sustained sight line impacts associated with landfilling operations. For completeness all of the relevant figures, tables and drawings extracted from the detail design reports are provided in Appendix A.

A proposed bypass road (highway) will be constructed across the existing cane fields to the west of the proposed Site. A 12.5 hectare (30 acre) buffer will be established between the highway right-of-way and the limit of the proposed landfill area. This will ensure that adequate screening and separation will be maintained between the new landfill and the new bypass road that will become the primary access to the Site.

For more complete details on the final project design and complementary studies undertaken the reader is referred to the document entitled "Detailed Design and Operations Report for a New Sanitary Landfill in Haags Bosch", which was prepared by Trow International Ltd., in association with Conestoga-Rovers and Associate and EA Consultants and prepared for the Ministry of Local Government and Local Development and submitted under a separate cover on December 2004.

2.2 SITE PREPARATION AND DEVELOPMENT

The native soil conditions underlying this Site represented by two competent and relatively consistent soil units both having a very low permeability give the Site an excellent natural protection against leachate migration and groundwater quality impacts. The native clay encountered beneath the proposed waste fill area will serve as the base material for the proposed Site. The clay present on the Site has a low permeability that is suitable for use as the base of the landfill. The base preparation grades for the Site have been designed to optimize the landfilling capacity consistent with all of the above-noted factors, while providing an adequate factor of safety with respect to native soil shear strength.

The landfill consists of four stages, which will be developed progressively to coincide with the rate of waste disposal. Each subsequent stage, or portion of a stage of the proposed Site will be inspected and certified by a qualified engineer prior to the placement of the specified engineered systems. Care will be exercised at the transition and tie in to new preparation areas to ensure effective continuity of the engineered systems and to limit sediment loss into the active disposal area from excavation activities.

2.3 FINAL SITE CONTOURS

The maximum design elevation at Site closure is approximately 10 metres above the existing ground elevation. The maximum side slope around the perimeter of the four stages of the landfill will be 4:1 (25 percent) and has been established based on slope stability analyses and a reasonable factor of safety for saturated conditions. The proposed top slope of 20:1 is the minimum slope required to maintain surface water runoff.

The total estimated volume of the Site will be approximately 2,338,000 m³.

The initial review of site capacity and available soils from the excavation areas to construct the Site indicates that there should be adequate quantities of native materials to provide the cover systems requirements. Alternative daily cover materials (ADC), which can viably augment the daily cover systems are also expected to be utilized to cover waste on a daily basis.

2.4 SOIL MATERIAL REQUIREMENTS

The soil required for construction of the Site includes daily cover, final soil cover, and soil for separation berms between the progressive development areas of the Site. The minimum total volume of soil required to complete these activities is expected to exceed 550,000 m³.

Daily cover is the term used for materials placed on the waste as filling progresses. Daily cover is applied at the end of operating day to cover the waste material, which in turns prevents blowing litter and pest infestation.

Interim cover is a term used to apply to an area that is not yet completed but is expected to be inactive for waste filling for 6 months or more. In these areas a thicker layer of interim cover will be placed on the waste in the range of 300 mm in thickness. The interim cover materials will be removed to the extent practicable, prior to placing the next lift of waste to try to ensure good hydraulic connection through the waste.

The final cover soils excavated from the base excavation will be used to construct a low permeable cover over completed areas of the Site. The final cover will consist of a minimum of approximately 700 mm of low permeable soils and a minimum thickness of 100 mm of vegetated topsoil.

Temporary berms constructed of low permeability material will be used for interim stormwater management. The total quantity of material that will be required is approximately 4,000 m³.

Topsoil will be stripped from the cell areas and stockpiled for future use for planting of the vegetative screens and final cover.

2.5 WASTE VOLUMES AND SITE LIFE PROJECTIONS

The volume of waste and daily cover was estimated by comparing the base contours to the final contours. Based on expected compaction effort and operating practices, the initial waste density was assumed to be approximately 0.600 tonnes/m³. Due to the expected moisture content of the landfill, the waste will experience significant biological degradation. As such, the landfill is expected to settle significantly during the active

development phase of each stage. It was therefore assumed that the ultimate average density of the landfill mass prior to placing final cover will be 0.850 tonnes/m³.

A conservative waste density value of 0.750 tonnes/m³ was used for the Site life projection. Based on a waste density of 0.750 tonnes/m³ and a calculated waste volume of 2,338,000 m³, the Site will provide capacity for approximately 1,741,550 tonnes of waste. Thus, the available air space volume will meet and exceed the target Site life requirement of at least 25 years. The actual life of the Site will be a function of the waste density achieved and waste quantities received.

2.6 SURFACE WATER HANDLING

The final detailed design of the surface water management (SWM) features for the Site has been developed in accordance with all applicable local regulations. The geographic region of the proposed Site experiences a high rate of rainfall, approximately 2 m/year, accompanied by a high relative humidity throughout the entire year. In addition, evaporation is fairly consistent throughout the year recording in excess of 1.6 m/year.

The primary design stormwater management features for the Site includes three stormwater sedimentation and control ponds (two located to the east and west of the waste fill area) and perimeter drainage ditches. The stormwater sedimentation and control ponds are designed to provide both water quality control and water quantity control of surface water runoff. The combined volume of the three stormwater sedimentation and control ponds is based on the runoff from the 10-year 24-hour storm event. The perimeter drainage ditches are sized to accommodate the peak flow generated from the 10-year 24-hour rainfall event. This 10-year 24-hour rainfall event is consistent with local design criteria for drains and canals. The ditches are designed to convey stormwater runoff to the stormwater sedimentation and control ponds.

2.7 LEACHATE TREATMENT

The four main stages of leachate treatment will be:

- aerobic equalization;
- secondary biological treatment;

- clarification; and
- discharge to stormwater sedimentation and control pond.

The following briefly describes each of the above mentioned stages of leachate treatment.

2.7.1 AEROBIC EQUALIZATION

The leachate to be treated consists of both raw leachate from the closed cells and lightly waste-impacted stormwater that will be collected in the cells when new disposal areas are commissioned. In order to effectively treat both influent streams with such differing characteristics, as well as to stabilize flows within the treatment process, they will be mixed and stored in the aerobic equalization lagoon. The purpose of the aerobic equalization lagoon is to provide additional storage capacity for the leachate treatment facility under heavy rainfall conditions which exceed the design capacity of the facility. Under normal operating conditions, collected leachate may be discharged directly to the leachate treatment facility, i.e., the aerobic equalization lagoon will be bypassed.

2.7.2 SECONDARY BIOLOGICAL TREATMENT

The leachate to be treated consists of both raw leachate from the closed cells and lightly waste-impacted stormwater that will be collected in the cells when new disposal areas are commissioned. In order to effectively treat both influent streams with such differing characteristics, as well as to stabilize flows within the treatment process, they will be mixed and stored in the aerobic equalization lagoon. The purpose of the aerobic equalization lagoon is to provide additional storage capacity for the leachate treatment facility under heavy rainfall conditions, which exceed the design capacity of the facility.

The aerobic equalization lagoon will be equipped with aeration equipment to control odour issues, and has been sized to accommodate the potential leachate collected in a stage generated from a peak 10-year 24-hour storm event. The maximum design pumping rate of leachate from the aerobic equalization lagoon to the leachate treatment facility is 1,500 m³/day.

2.7.3 CLARIFIER

The clarifier will be designed to remove to the extent possible suspended solids and particulate remaining in the effluent after biological treatment. The final effluent from the clarifier will be directed to the stormwater pond for final polishing prior to discharge to the drain canal. The clarifier, which will handle treatment flows from both anoxic/oxic trains from the secondary biological treatment stage, thus has a nominal maximum treatment capacity of 1,500 m³/ day.

2.7.4 SLUDGE STORAGE

The biological treatment process and the clarifier will produce some sludge and solids that will be disposed of in the active landfill area. The peak volume of the sludge disposal is estimated to be approximately 25 m³/day. Prior to disposal in the active landfill, the sludges will be treated by aerobic sludge digestion. Sludge dewatering will not be necessary, and the sludge can be conveyed periodically to the active landfill via a pump truck. The discharge of the small quantities of sludge are fully compatible with the natural decomposition processes ongoing within the landfill and will only have the effect of supporting the natural processes and slightly increasing the landfill gas generation in the Site.

2.8 LANDFILL GAS ASSESSMENT

For the purpose of mitigating LFG migration and odour issues, an active collection system can be an effective strategy, which can be integrated into the LFG management plan. Furthermore, the implementation of an active LFG collection system is an important first step, which could be fully compatible with implementing a LFG utilization project in the future. The need for an active LFG control system was reviewed and it has been determined that the Site may have the potential to become an odour source by the time the landfill reaches the mid-point in its total Site life. An active LFG control system has been developed and would be implemented upon reaching specified triggering levels or conditions that would initiate the installation and operation of the LFG collection and flaring system. The Site will have the potential for further upgrade to become a possible source of renewable energy for electrical power generation or other similar uses, however, this would be a purely optional development and would be considered and initiated only if there is financial viability for the energy utilization project.

2.9 CONSTRUCTION OF SANITARY LANDFILL

The development sequence for the Site will effectively utilize the capital resources available to the Municipality for the initial development phase of the work to establish most of the supporting infrastructure necessary to operate and maintain all of the necessary components of the Site.

Stage 1 will be opened and ready to receive waste at some time in late 2005 or early 2006. The entire base of Stage 1 will be filled with two lifts of waste or until a level slightly above the existing ground level is achieved. When the second lift of waste is almost finished being placed into Stage 1, the first portion of Stage 2 would be excavated and prepared to receive waste. Stage 2 will be progressively excavated and opened in years 3, 4, 5, and possibly 6. As soon as this first portion of Stage 2 is ready to receive waste, the primary tipping face would then move to Stage 2. The base of the prepared area in Stage 2 would then be filled as outlined for Stage 1. Separation between an active stage and the preparation of an adjacent stage will be maintained by utilizing separation berms approximately 1 m in height along the base. Temporary separation berms will also be utilized to divert stormwater from the active tipping face and waste picker areas. Separation berms will minimize the volume of surface water contacting waste and leachate that would ultimately require treatment.

The following table provides a simple breakdown of the anticipated landfilling sequence, which will occur at the Site over the next 15 years.

	<i>Stage 1</i>	<i>Stage 2</i>	<i>Stage 3</i>	<i>Stage 4</i>
Year 1	Landfill	Dormant	Dormant	Dormant
Year 2	Landfill	Dormant	Dormant	Dormant
Year 3	Landfill	Prepare	Dormant	Dormant
Year 4	Landfill	Prepare	Dormant	Dormant
Year 5	Landfill	Prepare	Dormant	Dormant
Year 6	Landfill	Landfill	Dormant	Dormant
Year 7	Landfill	Landfill	Dormant	Dormant
Year 8	Landfill	Landfill	Dormant	Dormant
Year 9	Landfill	Landfill	Dormant	Dormant
Year 10	Landfill	Landfill	Prepare	Dormant
Year 11	Landfill	Landfill	Prepare	Dormant
Year 12	Landfill	Landfill	Landfill	Prepare

Year 13	Landfill	Landfill	Landfill	Prepare
Year 14	Landfill	Landfill	Landfill	Prepare
Year 15	Landfill	Landfill	Landfill	Landfill

The proposed Leachate Collection System (LCS), will be constructed in stages in conjunction with the development of each of Stages 1 through 4. Waste filling in each individual stage will commence in the low point in the vicinity of the pump stations in order to provide a good working base.

In order to construct the Site it is necessary to prepare engineering specifications and design drawings. The technical specifications and engineering drawings required to tender, administer and construct and develop the Site over the initial construction period and operating lifespan are provided in the document entitled "Construction of Sanitary Landfill in Haags Bosch, Specifications, Book B ", which was prepared by Trow International Ltd. in association with Conestoga-Rover and Associates and EA Consultants Limited and submitted under a separate cover on October 2004..

2.10 ADMINISTRATION AND OPERATIONS COMPOUND AREA

All of the main support services necessary to operate and maintain the landfill will be constructed within the proposed Site at the east end of the Property. The administration building will consist of a two-storey office and administration area complete with reception areas. The main building will also house the equipment maintenance facilities and all other staff facilities. The maintenance garage area will be as a repair area for Site equipment and waste hauling trucks. The equipment garage is large enough to service all equipment needed for maintenance of the landfilling operations equipment.

Site utilities including electricity, washroom facilities, potable water, and telephones will be installed as part of the initial development of the Site facilities. Primary electrical power and phone services to the Site will be provided via overhead lines run from the industrial area and along the new access road which will be constructed along the drain canal berm along the south limit of the Site. The new electrical service will be sized for all of the present and future electrical servicing demands for the Site and will also be constructed in a manner that will allow for the potential future export of electrical power from a future landfill gas utilization facility. A portable fuel tank will be provided for vehicle fuelling. A storage area has been allocated in the maintenance garage for lubricant and other fluid storage

Non-potable process water will be provided via a 100 mm diameter high density polyethylene (HDPE) forcemain from the industrial area in Eccles to the administration/maintenance building. Potable water for the proposed Site will be provided via standard practice of bottled water. Sanitary services for the washrooms in the administration building will be managed via a septic holding tank. Wash water from the floor drains of the maintenance garage will be discharged through an oil/ water separator prior to being treated at the leachate treatment facility.

2.11 LINER AND LEACHATE COLLECTION SYSTEM (LCS)

The base liner and LCS for the Site will consist of the following components:

- Geoweb Support Layer - bi-axial geosynthetic soil reinforcement layer to provide structural support for installation of the engineered systems on the soft marine clay base.
- Drainage Layer - 300 mm thick continuous clear stone drainage blanket in the vicinity of the leachate collection sumps underlain and overlain by continuous nonwoven geotextile filter fabric (separation layer). The drainage layer will convey leachate to the perimeter collection system and will provide short-term leachate storage capacity within the landfill.
- Geocomposite Drainage Layer – HDPE geomat to convey leachate to the drainage layer and subsequently to the perimeter collection piping.
- Separation Layer – non-woven filter fabric to limit the migration of fine materials into the drainage layer and geocomposite.
- Ballast Layer – 300 mm thick continuous sand layer to provide protection of base liner and LCS from potential physical damage resulting from placing the first lift of waste materials.
- Operations Layer – single lift of segregated waste materials (approximately 2 m thick) to provide transition and additional protection between base liner and main waste mass.
- Perforated 150 mm diameter HDPE perimeter header pipes along the downgradient perimeter of each of the four stages of the landfill.
- Perforated 150 mm diameter leachate collector pipes above the cell base and connected into the header piping.
- Collection and header pipe cleanouts.
- Leachate collection sump and associated pump stations in Stages 1 to 4.

The initial base slopes will be constructed at a minimum 0.5 percent slope draining to four perimeter leachate collection piping and pump stations. Leachate levels will generally be maintained at low levels within the waste such that there will typically be an inward gradient towards the landfill cells. The landfill cell can also be used for short-term interim storage of leachate during periods of high rainfall and infiltration into the cells as they are being developed. A leachate collection header and base piping grid as described below will be tied in to the leachate pumping system.

If leachate were not removed from the waste fill area of the landfill, it is estimated that it would take approximately 6 days before storage capacity of the landfill is exceeded upon analysis of the peak 5- and 10-day storm events. The storage capacity of the landfill can be extended by an additional 1.25 months if a temporary berm of up to 1.0 m in height is utilized around the perimeter of the stage, allowing minimum 0.3 m freeboard.

2.12 SURFACEWATER MANAGEMENT

Stormwater will be collected into one of three stormwater sedimentation and control ponds that are designed for both sedimentation and interim storage prior to release to the canal system. The main stormwater sedimentation and control pond on the west side of the disposal area may also be used to provide additional polishing and acclimatization of waters received from the leachate treatment lagoons prior to discharge to the drainage canals and ultimately the Demerara River.

A fundamental principle of the SWM plan is that any water that has been in contact with the waste will not be discharged directly to the stormwater management pond and shall be treated as leachate. Rainwater that has accumulated in any open excavations that have not received any waste will be discharged via one of the three stormwater management ponds and released from the system to the adjacent canals or drainage ditches. Isolation of inactive areas will be accomplished by the use of temporary berms and intermittent pumping during large storm events.

2.12.1 STORMWATER CONTROL PUMP STATION

A stormwater control pump station will be provided for each of the three stormwater sedimentation and control ponds to drain the pond. The pumps will be duplex systems and can achieve a pumping rate of more than 4,000 m³ per day. At this pumping rate, the runoff of the 10-year 24-hour storm event can be drained in less than 4 days. Ponds 1 and 3 will discharge into the north drainage canal and Pond 2 will discharge into the south drainage canal.

2.12.2 EMERGENCY OVERFLOW STRUCTURE

In addition to the stormwater control pump station, an emergency overflow structure will be provided for each pond. Water will drain by gravity from the ponds to the canal system. Ponds 1 and 3 will drain to the north drainage canal and Pond 2 will drain to the south navigation canal. When the water level rises above the invert of the emergency overflow structure, water will drain from the pond to the respective canal.

2.12.3 SEDIMENT AND EROSION CONTROL

The stormwater sedimentation and control ponds will be constructed to promote settling of suspended particulate and to minimize re-suspension of the solid matter. The settling action will reduce suspended soil particles and also other pollutants which may be in particulate form and/or adhered to the soil particles through the implementation of forebays, volume, shape, and extended flow path in the design.

A forebay has been designed for the stormwater sedimentation and control pond. The forebay will provide sediment removal prior to water being discharged from the ponds during both the operational period and post-development conditions of the Site. The forebay is separated from the main quantity pond by an earthen berm.

The perimeter ditch network and stormwater management pond will be maintained by removal of collected sediment on an as-required basis, to ensure that the ditches and pond continue to operate as designed. Accumulated sediment will be removed when the storage capacity of a channel or the respective ponds is reduced by one third. All sediment removed during the operating life of the landfill will be returned to the active disposal area, stockpiled, or used for berms. Subsequent to landfill closure, all removed

sediment that originated from the final cover will be returned to the landfill and placed as final cover soil. Sediment transport from the landfill area will decrease as the vegetative cover over completed areas of the landfill is established. Additional measures will be employed to minimize sediment transport at the source, and to prevent runoff that has contacted landfilled waste from migrating from the landfill area.

2.13 LEACHATE TREATMENT AND DISPOSAL

At the proposed Site, leachate generated from the active waste fill areas and the stormwater that accumulates in the active disposal cells during the preparation of each stage base will be collected in the LCS at the base of the landfill. This liquid will be collected at each of four leachate pumping stations corresponding to the low points of each stage, and conveyed via a common forcemain to the leachate treatment system. Collected liquid will be routed either through the leachate treatment system or directly to the stormwater sedimentation and control pond depending upon whether the stage is actively accepting any waste and if the liquid has contacted any of this waste. Any liquid that has contacted waste will be routed through leachate treatment system.

Flow through the treatment process will be achieved by gravity, however final discharge of the treated effluent to the primary stormwater sedimentation and control pond will be achieved by pump system. During the initial operation of the landfill, i.e., first 1 to 2 years of operation, it is expected that the quantity of the leachate collected from the active landfill mixed with stormwater from other open stages may create a chemical profile that will allow the leachate to be discharged directly to the primary stormwater sedimentation and control pond following pre-treatment in the aerobic equalization lagoon. Leachate from the aerobic equalization lagoon will be pumped to the primary stormwater sedimentation and control pond. Field measurements of collected waters in the aerobic equalization lagoon will be taken in order to ensure that the chemical profile of the leachate is suitable for bypass of the leachate treatment facility.

A complete discussion of leachate treatment process is provided in Appendix B.

2.13.1 LINER AND LEACHATE COLLECTION SYSTEM (LCS)

The primary objective of the combined liner and leachate management systems is to collect and contain leachate to mitigate against any potential environmental impacts to surface water and groundwater quality. The initial base slopes will be constructed at a minimum 0.5 percent slope draining to four perimeter leachate collection piping and pump stations. A geoweb support layer will be installed on the prepared base to improve structural stability and workability of the material and aid in maintaining the basic molded base and sides. Aggregate and geocomposite drainage layers will be placed above the support layer to convey leachate to the perimeter collection system. A continuous nonwoven geotextile filter fabric will be installed over the aggregate and geocomposite drainage layers to prevent clogging due to the deposition of fines or biological fouling within the drainage material. Initially select waste will be placed above the aggregate and geocomposite drainage layers to provide protection of these drainage layers and to enhance the drainage capacity of the LCS.

A leachate collection header and base piping grid as described below will be tied in to the leachate pumping system.

2.13.2 LCS PIPING AND PUMP STATIONS

The leachate collector drains installed at the base of each stage and the perimeter header at the toe of the downgradient slope will be installed to collect leachate at the low points of the cell. The leachate collection system (LCS) piping has been designed and will be constructed to facilitate regular cleaning and inspection. Regular cleaning and inspection can identify evidence of blockages in the system and help to ensure that the pumping station chambers are kept operating efficiently. If a portion of the LCS piping becomes plugged, flushing of the lines will be completed to remove the blockage within the pipes. If this does not correct the situation and leachate mounding occurs within the waste irrespective of pumping efforts, then the toe drain in that area will be excavated and either removed or replaced.

Leachate collected by the base collector and perimeter header pipes will be transferred to the on-Site leachate treatment facility via forcemain from each of the leachate/stormwater pump stations. The leachate/stormwater pump station will be equipped

2.14 LANDFILL GAS SYSTEM

An active landfill gas (LFG) collection and flaring system would be installed based upon a phased implementation plan. The first phase of the LFG system construction is expected to be completed approximately 10 years after commencement of site development activities. The LFG management facility would be constructed to coincide with the completion of the first phase of the progressive closure.

The LFG extraction field would include:

- perforated vertical and/or horizontal extraction piping;
- valving/monitoring assemble to control and monitor gas flow; and
- buried solid perimeter and internal piping to convey collected gas.

The primary components of the LFG management facility include the following:

- condensate knock-out pot (KOP);
- piping and valves;
- LFG instrumentation (quantity and quality);
- LFG extraction blower; and
- flare.

A complete discussion of the landfill gas system is provided in Appendix C.

2.15 SANITARY LANDFILL OPERATION

Landfilling activities will be staged based on best management practices for landfilling. The operational phase of the works will be the primary focus for an Operator hired to operate the various facilities and systems at the proposed Site. Some specific administration and other tasks may be undertaken by employees of the municipality.

For more complete details on the sanitary operation and closure of the Site the reader is referred to the document entitled "Site Operations Manual, Sanitary Landfill in Haags Bosch", which was prepared by Trow International Ltd., in association with Conestoga-Rovers and Associate and EA Consultants and prepared for the Ministry of

Local Government and Local Development and submitted under a separate cover in March 2005.

The flow of waste from site entrance to landfill is described in Appendix D.

2.15.1 SITE ACCESS

Access to the Site would be from the west along the extension of the south service road from the new bypass highway that is to be constructed to the west of the Site. The south service road will extend from a new intersection with the bypass highway along the top of the existing drainage canal berm adjacent to the south Property boundary. The service road extension will be paved to the Site entrance and inside the Site to the area surrounding the weigh scale. A second emergency gate and Site entrance will be located at the northwest corner of the Site to give access to the canal berm on the north side of the property. There will be some future upgrades to this canal berm on the north side of the Site to allow it to be used as an emergency access point into the landfill.

For construction and maintenance support services, an extension of the southernmost service road (south service road) from the East Bank Road in Eccles will be utilized during construction of the new landfill and for the connection of the watermain to the new administration building at the landfill.

To the extent practicable, the public will be encouraged to use the transfer stations that will be located within their individual neighborhoods, as they are progressively developed in the waste management programs for the various NDCs that will rely on the new Site. Most of the traffic entering the Site is expected to be commercial vehicles, vehicles from the various transfer stations, some self-haulage of various solid wastes by the public, particularly construction and demolition wastes. A small vehicle drop off area and bins for small quantities of household wastes from private vehicles will be maintained in the waste picker area to minimize the extent of private vehicles into the actual landfill area.

The landfill Operator will be required to clean and maintain these Site access facilities as a requirement of the operations contract that will be issued independently from the landfill construction contract.

2.15.2 SITE SUPERVISION AND STAFFING REQUIREMENTS

The Site would be operated by competently trained personnel. As part of Site operations, staff will be trained and required to handle a number of tasks that are categorized into specific areas as below.

2.15.3 SITE SECURITY AND SCALEHOUSE OPERATIONS

Staff will be trained and required to complete the following site security and scalehouse operations.

- Control Site entrance gates and prevent access by unauthorized vehicles and/or people.
- Prevent unauthorized waste scavenging and assist in managing the waste picker activities within authorized areas.
- Prevent burning or open flames except within authorized areas.
- Monitor quantities and types of waste entering the Site to ensure adherence to the acceptance of approved materials and the rejection or rerouting of any disallowed materials.
- Screen and prohibit off-loading of wastes not approved for disposal at the Site, including:
 - hazardous wastes;
 - liquid waste unless specifically authorized as in the case of some present/future biological sludges;
 - medical and pathological waste;
 - any banned materials (note that a listing of banned materials may develop over time as various recycling, recovery and reuse programs evolve); and
 - radioactive waste or other wastes not permitted for disposal in the site.

There will be a limited screening process developed for the scalehouse operators to use for all incoming waste vehicles. Site security personnel, the scalehouse operators, and the staff in the administration buildings will be in radio contact at all times to ensure adherence to the screening process, and rerouting of any materials which may be prohibited.

2.15.4 ADMINISTRATIVE AND SUPERVISORY OPERATIONS

Staff will be trained and required to complete the following administrative and supervisory operations.

- General administrative functions.
- Record and track waste disposal and accounts.
- Provide reception services for public inquiries.
- Invoice and account management for the tipping fees that may be assigned to some or all of the commercial and industrial users of the Site.
- Supervise purchasing and requisitions for materials and equipment for operating and maintenance functions.
- Supervise and communicate with all of the other portions of the waste management division that are not resident at the Site.

It is expected that the administrative and supervisory functions noted above will be undertaken by full time staff of the MSWMD who have been trained for the specific activities listed.

2.15.5 WASTE DISPOSAL OPERATIONS

Staff will be trained and required to complete the following waste disposal operation.

- Complete all landfilling operations including control of the tipping face.
- Waste placement and compaction.
- Daily, interim and final cover placement.
- Maintain and construct temporary on-Site haul roads.
- Place and cover special wastes.

These activities would be the responsibility of the Operator hired to operate the site.

2.15.6 SITE DEVELOPMENT, CONSTRUCTION, AND MAINTENANCE

The following provides a number of anticipated development, construction and maintenance activities, which will be required over the operating lifespan of the Site:

- Complete construction of new cell areas.
- Complete construction of stormwater management ponds.
- Extend and maintain perimeter service roads.
- Maintain and clean main access road into Site.
- Complete progressive placement of final cover as areas become ready.
- Repair all leachate seeps.
- Control surface water runoff.
- Divert surface water away from the waste.
- Contain surface water that has come in contact with waste and treat as leachate.
- Clean and maintain leachate collection piping.

Some of these activities would be the responsibility of an independent contractor hired by the MSWWD. The actual scope of work would be detailed in the operations contract.

2.15.7 LEACHATE AND STORMWATER MANAGEMENT SYSTEMS

Staff will be trained and required to complete the following leachate and stormwater management activities.

- Operate and maintain the pumping systems that comprise the stormwater discharge systems.
- Operate and maintain the leachate pumping stations.
- Operate and maintain the leachate treatment system.
- Complete field laboratory testing and analyses for the leachate treatment facility.

These activities would be the responsibility of the Operator hired by the MSWMD. The final scope of work is detailed in the operations contract.

2.15.8 LANDFILL GAS CONTROL

Operations and maintenance of LFG management systems will be a future function required when these facilities become necessary and are constructed in future.

2.15.9 MONITORING PROGRAMS

Groundwater, surface water, and LFG monitoring will be a specific activity that will require fully trained on-Site staff. Some of these activities may be combined with the operations of the associated leachate, stormwater, and LFG management systems. These activities would be the responsibility of the Operator hired by the MSWMD. The final scope of work is detailed in the operations contract.

2.15.10 HOURS OF OPERATION

The Site would be open to receive waste from 7:00 a.m. to 5:00 p.m. Monday to Friday and from 7:00 a.m. to 2:00 p.m. on Saturdays. Operating hours may be extended up to 2 hours to allow for preparation of areas for waste disposal and compaction of waste/daily cover subsequent to dumping of waste; however, no Site operations will take place outside of daylight hours. The Site operating hours will be posted at the Site entrance.

Loads that are unavoidably delayed by specified conditions may be received after normal operating hours (5:00 p.m.), provided that competently trained Site personnel are available to ensure proper placement of the waste and record their receipt.

2.15.11 PUBLIC COMMUNICATIONS PLAN

The Municipality has made significant efforts to involve the local community with current Site operations, and waste collection. These efforts will continue for the proposed Site. A public information session was held in September 2004 to provide the public with the design and operations information pertinent to the proposed Site and to allow input into the system and infrastructure before the design is issued for bid.

2.15.12 COMPOST

An area of the Site is expected to be allocated for composting. The success of the composting operation is dependent on proper separation of suitable materials at the source, rather than capture of compostable materials at the Site. No separation of materials for composting materials will be undertaken at the Site. Materials transported to the landfill as waste is unlikely to be appropriate to try to set up composting operations. The initial composting program will therefore focus on leaf and yard waste materials that can be handled in a relatively straightforward windrow operation. Composting may become a larger component after source separation becomes a more formalized aspect of waste management.

2.15.13 RECYCLERS

Surveys of recycling activities over the period of December 2003-June 2004 have determined that there are 121 individuals working as informal recyclers at the Mandela site. Recycling is done by either a single individual or in some instances, groups of individuals working in partnerships to recover bottles, metals, wood, cardboard, and other items of value. Recovered materials are stored and sold near the entrance to the landfill.

Waste pickers working at the Mandela Site up to the cutoff date of June 24, 2004 will become members of a cooperative society which will be relocated to and authorized to continue recycling operations at the Haagebosch Site. The cooperative will be established in accordance with The Cooperative Societies Act Cap 88:01. To confirm to the requirement of the Act the group shall be formed in the presence of an officer designated by the Commissioner of Cooperative Development to assess the cooperative society suitability for registration.

2.16 SITE CLOSURE

The following briefly describes key site closure issues that will be implemented.

2.16.1 FINAL COVER SYSTEM

The final cover would be installed as a progressive rehabilitation activity as portions of the landfill are completed to their final grade and are ready for closure. The vegetative layer will be developed on the surface of the landfill cover system. This layer is integral in maintaining the long-term effectiveness of the landfill cover system. The plant species would also have the ability to thrive in low nutrient soils with minimum nutrient addition, and to survive and function with little or no maintenance. The vegetative layer would be developed such that root penetration remains within the cover topsoil and not into the depth of the cover drainage layer or low permeability layer. Should a deeper root system be required, the depth of the topsoil may be increased to accommodate this accordingly. The perimeter drainage layer would provide a safety measure to protect against localized slope failure resulting from localized saturated conditions.

2.16.2 LANDFILL SETTLEMENT

The total waste fill area will experience two types of landfill settlement. Load related settlement will occur relatively rapidly as a function of self consolidation, the weight of additional lifts of waste as they are placed, and the weight of moisture that accumulates as the field capacity of the waste is attained. Decomposition related settlement will occur from the progressive anaerobic decomposition of the organic matter that comprises much of the total waste mass.

In order to minimize the impact of waste settlement on the integrity of the final cover, the complete final cover system, including vegetative and drainage layers, would be progressively completed in the year following the final placement of any wastes and application of interim cover in each respective area or stage. Interim cover consisting of minimum 300 mm compacted clay will be placed over any area that is not expected to receive any waste for an extended period of time (i.e., 6 months).

2.16.3 SITE END USE

At present, the intended final end use for the Site is for passive recreation, e.g., as a parkland, or other aesthetically pleasing natural setting. The performance monitoring for the Site following closure will continue at the same frequency as that during active Site operations for an initial period of 2 to 5 years. After this time, there may be a

reduction in the frequency of monitoring required. However the number and location of monitoring points will remain the same.

The proposed post-closure monitoring requirements would be revisited closer to the time of Site closure in order to reevaluate the recommendations based on regular operations and performance of the Site.

3.0 LEGAL AND INSTITUTIONAL FRAMEWORK FOR EIA

3.1 INTRODUCTION

The Environmental Protection Agency mandates that an Environmental Impact Assessment is required for any project which has the potential to impact the environment. Construction and operation of a sanitary landfill at Haags Bosch will have impacts on the environment and consequently this statutory requirement must be met. International, National and Local level policy statements, legislation and regulations are also relevant to the environmental impacts of the development and implementation of this project. This section of the EIA presents the policies, statutory requirements and guidelines which impact the environmental assessment process relevant to the construction and operation of a sanitary landfill at Haags Bosch.

3.2 INTERNATIONAL POLICY

In 1992, the United Nations Conference on Environment and Development (UNCED) held in Rio De Janeiro adopted a program of action for the 21st Century. Twenty-seven (27) environmental principles were outlined at the UNCED conference as an attempt to enshrine a charter for the protection of the Earth. The environmental impact assessment process for this development falls directly under Chapter 21: Environmentally sound management of solid wastes and sewage-related issues.

Chapter 21 was incorporated in response to General Assembly resolution 44/228, section I, paragraph 3, in which the Assembly affirmed that the Conference should elaborate strategies and measures to halt and reverse the effects of environmental degradation in the context of increased national and international efforts to promote sustainable and environmentally sound development in all countries, and to section I, paragraph 12 (g), of the same resolution, in which The Assembly affirmed that environmentally sound management of wastes was among the environmental issues of major concern in maintaining the quality of the Earth's environment and especially in achieving environmentally sound and sustainable development in all countries.

Chapter 21 further states that environmentally sound waste management must go beyond the mere safe disposal or recovery of wastes that are generated and seek to address the root cause of the problem by attempting to change unsustainable patterns of production and consumption. Accordingly, the framework for action should be

founded on a hierarchy of objectives and focused on four major waste-related program areas, as follows:

- minimizing wastes;
- maximizing environmentally sound waste reuse and recycling;
- promoting environmentally sound waste disposal and treatment; and
- extending waste service coverage.

All four major waste-related program areas are included in the proposed sanitary landfill. The mix and emphasis given to each of the four program areas will vary according to the local socio-economic and physical conditions, rates of waste generation and waste composition.

3.3 NATIONAL POLICY

In the National Environmental Action Plan (NEAP), 2000, the Government of Guyana has outlined its environmental policy objectives for the sound management of the environment and natural resources. Twelve policy objectives were outlined. Those applicable to the proposed sanitary landfill are listed below.

1. Ensure prior environmental assessments of proposed activities, which may significantly affect the environment.
2. Raise consciousness of the population on the environmental implications of economic and social activities through comprehensive education and public awareness programs.

To ensure the performance of environmental assessments of activities which may affect the environment, The Environmental Protection Act was made law in June 1996 and the legal framework for undertaking environmental impact assessments was outlined. The Act also established the Environmental Protection Agency and outlined the legal process for undertaking sustainable and effective management of the environment.

3.4 EPA'S ROLE IN EIAS

The Environmental Protection Act mandated four functions for the EPA which relate to environmental assessment. These are:

- to take such steps as are necessary for the effective management of the natural environment so as to ensure conservation, protection and sustainable use of natural resources;
- to promote the participation of members of the public in the process of integrating environmental concerns in planning for development on a sustainable basis;
- to ensure that any development activity which may cause an adverse effect on the natural environment be assessed before such activity is commenced and that such adverse effect be taken into account in deciding whether or not such activity should be authorized; and
- to give development consent which entitles the developer to proceed with the project.

The Agency is required to implement several principles of environmental management as part of this process. These principles are:

- The "polluter pays principle": the polluter should bear the cost of measures to reduce pollution;
- The "precautionary principle": where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing measures to prevent environmental degradation;
- The "strict liability" legal principle: any person who contravenes this Act or regulations shall be liable to the penalties prescribed thereafter;
- The "avoidance" principle: it is preferable to avoid environmental damage, as it can be impossible or more expensive to repair rather than prevent damage; and
- The "state of technology" principle: measures protecting the environment are restricted by what is technologically feasible and as technology improves, the improved technology should be used to prevent and repair environmental damage.

3.5 THE EIA PROCESS

A series of studies were undertaken to develop an appropriate solution for the solid waste problem in Georgetown (GM) and its environs. The first of these was the Solid Waste Management Pre-Identification Study for Georgetown, undertaken by an individual consultant retained by the IDB in 1998. The conclusions of that study were (i) GM institutional arrangements and technical capabilities were inadequate to manage its solid waste problems following internationally accepted technical and environmental standards, (ii) sanitary landfill is the minimum cost solution to dispose of GM waste (iii) Private Sector Participation (PSP) is necessary to operate GM future landfill.

This was followed by a Waste Characterization and Facility Siting Assessment conducted by Brown and Vence Associates in 2000. This study developed waste characterization data for GM waste and examined several locations for siting the landfill. The IDB subsequently held an open seminar to assess the willingness of the Private Sector to participate in the Georgetown Solid Waste Management Project and PSP emerged as a feasible option.

Based on Terms of Reference (TOR) prepared by the individual consultant, studies financed through the Pre-Investment Studies for the Georgetown Solid Waste Management Program (ATN/SF-6858-GY) were executed in the period February to June 2002. These studies examined Institutional and Cost Recovery issues for landfill operations and prepared bidding documents for PSP including the performance criteria for the technical, environmental and social aspects of the operation. The findings of the studies were presented at a workshop on May 8, 2003 at which conclusions were defined.

Those conclusions were submitted by the GOG represented by the Ministry of Local Government and Regional Development (MoLGRD), to the IDB on May 13, 2003 and include (i) an institutional model, (ii) creation of a separate account for waste management and (iii) separate bidding for design, construction and operation of a sanitary landfill at Eccles. The IDB developed an Action Plan on the basis of that submittal and has undertaken to provide funds for a program to solve Georgetown and Environs solid waste disposal problems through the construction and operation of a sanitary landfill.

The Environmental Protection Agency has indicated that an environmental impact assessment is a mandatory requirement for the issuance of an environmental authorization for the operation of the proposed sanitary landfill. Commencement of the

environmental impact assessment process must be preceded by an application for an environmental authorization and a summary of the project including information on the site, design and size of the project, possible effects on the environment and a non-technical explanation of the project.

After this submission, the EPA publishes a notice of the project in at least one daily newspaper. A summary of the project is made available to members of the public for a period of 28 days. Within this period the EPA accepts written submissions to the Agency related to the project. These submissions detail questions and matters which members of the public consider relevant to the deliberations of the EIA. A public consultation meeting is held after this 28 day period. Additional concerns of the public are noted at this forum and the EPA provides comments to the EIA Consultants for finalization of the Terms of Reference (TOR) of the EIA.

During the environmental impact process the Developers and Consultants are required to consult members of the public, interested bodies and organizations and also provide to members of the public on request, and at no more than reasonable cost, copies of information obtained for the purpose of the EIA. The Developer and Consultant must submit to the EPA, the EIA report along with an Environmental Impact Statement (EIS) for evaluation and recommendations. Every environmental impact assessment is required to contain a description of the project, an outline of the main alternatives studied and reasons for choices, a description of significant effects of the development on the environment, an indication of any difficulties encountered by the developer in compiling information for the EIA, a description of the best available technology, a description of any hazards or dangers which may arise and a risk assessment of same, a description of mitigation measures for any adverse effects, a monitoring plan and an emergency response/contingency plan and a program for rehabilitation and restoration. The decision by the Agency to grant an environmental authorization for a project shall be subject to conditions, which are reasonably necessary to protect human health and the environment.

The project summary and a draft TOR were submitted to the EPA on December 19, 2003. Two public meetings, chaired by the Environmental Assessment Board (EAB) were held with residents of communities in proximity to the facility on January 19 and February 08, 2004. The Environmental Assessment Board (EAB) is a body which provides an independent contribution to the development and finalisation of the EIA and makes recommendations which uphold the principles of the EP Act in the context of the interests of the developer, the public and the regulatory agencies. In order to carry out its functions, the EAB is involved in the development of the EIA from the point of

EIA scoping to establishing conditions for the issuance of an Environmental Permit. The EPA provided comments on the draft TOR on February 12, 2004. Those comments mandated the inclusion of several additional issues in the TOR. The final TOR was submitted and approved by the EPA on February 20, 2004.

The preliminary environmental assessment for a sanitary landfill at Eccles had identified proximity to surrounding residents as one of the non-conformance criteria for the Eccles Site. Significant opposition was expressed by residents in proximity to Eccles during two public consultations held by the Environmental Assessment Board (EAB). A decision was consequently made to both allay fears of residents and to gain greater conformance to the siting criteria and the landfill site was relocated to Haags Bosch, an area approximately 1.5 kilometres east of the initially proposed location and some 2.0 km from the nearest residents.

The new location at Haags Bosch has essentially the same physical and environmental characteristics as the initially proposed site. The most significant distinction between Haags Bosch and the former site is its greater isolation from residential area and potential receptors. The new location will practically eliminate any potential impacts to residents and is directly responsive to the concerns expressed by the community. Further, the validity of conclusions of the environmental assessment for the former site is applicable to Haags Bosch since the physical environmental conditions of the former site are replicated at Haags Bosch.

The EIA is prepared for a sanitary landfill, to be sited at Haags Bosch, on the basis of the TOR agreed to with the EPA. The TOR agreed to with the EPA was also modified to include the specific issue related to the welfare of informal waste pickers currently operating at the Mandela Dump site to conform to IDB guidelines.

The EIA must be completed to conform to the TOR and copies submitted to the EPA for review and public comment. The EPA subsequently publishes a notice in at least one daily newspaper notifying the public of the submission of the EIA. The public has 60 days from the publication date of the notice to make submissions to the EPA and/or the EAB related to the EIA. The EPA, along with relevant sector agencies review the EIA during this sixty day period to ensure that the EIA is in line with any plans, guidelines, regulations or codes of practice developed by the EPA and sector agencies. Copies of the EIA and the findings of the review by EPA and sector agencies are passed to the EAB for review and recommendation.

A public meeting, chaired by the EAB is held at the end of the 60 days period. Additional comments are provided by members of the public at this meeting. The key objectives of public involvement in the EIA process are to:

1. give the public a voice in project planning;
2. obtain local knowledge, information and ideas;
3. provide information to the people on planned activities to stimulate local interest and involvement in the project;
4. ensure early detection of environmental and social impacts arising from the project; and
5. initiate and establish mechanisms and procedures to enable local people to participate in all phases of the project.

A final EIA is then prepared to address the comments of the EPA, the sector agencies, the public and the EAB to address issues in the TOR initially agreed to but excluded from the EIA. The EAB will then recommend to the EPA whether the EIA is acceptable and the conditions to be attached to the Environmental Permit, should it be granted.

The EPA takes into account the recommendations of the EAB and sectoral agencies, comments of the public and its own review, and decides whether or not the project should be approved. For approved projects, the EPA issues an Environmental Permit with the terms and conditions necessary to effectively manage the environment. If an Environmental Permit is not granted, the developer can file an appeal within 28 days with the Environmental Appeals Tribunal (EAT). The EAT is a superior court of record and has in addition to the jurisdiction and powers conferred by the EP Act, all the powers inherent in such a court. The Tribunal has the power to enforce its own orders and judgements and the same power to punish contempt as the High Court of Justice. The EAT has the jurisdiction to hear and determine appeals against:

1. the refusal of an Environmental Permit;
2. the requirement of an Environmental Permit; and
3. cancellation or suspension of an Environmental Permit.

Prior to submission of the Draft Environmental Impact Assessment report, it was determined that the TOR approved by the EPA was not in conformance with IDB guidelines. A new TOR was prepared for IDB approval. This new TOR, which has two components, is attached as Appendix E.

3.6 ENVIRONMENTAL PROTECTION REGULATIONS

Regulations on Hazardous Waste Management, Water Quality, Air Quality and Noise Management were established under the Environmental Protection Act. These pollution management regulations were developed to regulate and control the activities of developmental project during construction and operation. These regulations are applicable to this project and a summary of each regulation is reproduced below.

3.7 HAZARDOUS WASTE MANAGEMENT REGULATIONS

These regulations outline the rules and procedures for transport, storage, treatment and disposal of hazardous wastes. These regulations are intended to ensure that operations which generate, transport, treat, store and dispose of hazardous wastes are managed in a manner that protects human health and the environment. An emergency preparedness plan is required for anyone who operates a hazardous waste facility.

3.8 ENVIRONMENTAL PROTECTION WATER QUALITY REGULATIONS 2000

These regulations mandate registration and environmental authorization by any operation whose construction, installation, operation, modification or extension of any facility cause the discharge of effluents. These regulations cover parametre limits for effluent discharges, new sources of effluent discharges, fees for registration and environmental authorization, sampling points, records and reports and general provisions for the registration of water effluent, biological integrity, spills or accidental discharges and standard methods of analysis. Guidelines on the discharge of effluents and disposal of sludge are detailed in these regulations.

No standards are proposed for management of landfill leachate. The EPA has indicated, in consultations, that standards proposed by the USEPA Code of Federal Regulations (CFR) 258.40 are acceptable for this project. These regulations mandate that the concentration values listed in Table 1 shall not be exceeded in the uppermost aquifer at the relevant point of compliance. The relevant point of compliance is considered to be the monitoring wells installed onsite.

Table 1: Permissible Limits at Point of Compliance (CFR 258)

<i>Chemical</i>	<i>MCL (mg/L)</i>
Arsenic	0.50
Barium	1.0
Benzene	0.005
Cadmium	0.01
Carbon tetrachloride	0.005
Chromium (hexavalent)	0.05
2,4-Dichlorophenoxy acetic acid	0.1
1,4-Dichlorobenzene	0.075
1,2-Dichloroethane	0.005
1,1-Dichloroethylene	0.007
Endrin	0.0002
Fluoride	4.0
Lindane	0.004
Lead	0.05
Mercury	0.002
Methoxychlor	0.1
Nitrate	10.0
Selenium	0.01
Silver	0.05
Toxaphene	0.005
1,1,1-Trichloromethane	0.2
Trichloroethylene	0.005
2,4,5-Trichlorophenoxy acetic acid	0.01
Vinyl Chloride	0.002

3.9 ENVIRONMENTAL PROTECTION AIR QUALITY REGULATIONS 2000

These regulations detail requirements for registration and environmental authorization by facilities which emit air pollution from any process into the atmosphere. Parameter limits on air contaminants and emission sampling are detailed in the regulations. The list of air contaminants for which parameter limits are to be set by the Agency are also detailed in the regulations. No air quality standards are established for emission from waste management facilities in these regulations. The EPA considers the ambient air quality guidelines developed by the World Health Organization (Table 2) as being acceptable for this project.

Table 2: Summary of WHO Ambient Air Guidelines

<i>Compound</i>	<i>Guideline Value</i>	<i>Averaging Time</i>
Ozone	120 µg/m ³ (0.06 ppm)	8 hours
Nitrogen dioxide	200 µg/m ³ (0.11 ppm) 40 to 50 µg/m ³ (0.021 to 0.026 ppm)	1 hour Annual
Sulfur dioxide	500 µg/m ³ (0.175 ppm) 125 µg/m ³ (0.044 ppm) 50 µg/m ³ (0.017 ppm)	0 min 24 hours
Carbon monoxide	100 mg/m ³ (90 ppm) 60 mg/m ³ (50 ppm) 30 mg/m ³ (25 ppm) 10 mg/m ³ (10 ppm)	15 min 30 min 1 hour 8 hours
Lead	0.5 to 1.0 µg/m ³	Annual

In instances where a standard has not been promulgated by the WHO, such as for particulates, the USEPA standards are considered acceptable. USEPA standards for particulates considered applicable to this project are presented in Table 3.

Table 3: USEPA Particulate Air Quality Standards

<i>Pollutant</i>	<i>Standard Value</i>	<i>Standard Type</i>
Particulate (PM 10) Particles with diametres of 10 micrometres or less		
Annual Arithmetic Mean	50 µg/m ³	Primary & Secondary
24-hour Average	150 µg/m ³	Primary & Secondary
Particulate (PM 2.5) Particles with diametres of 2.5 micrometres or less		
Annual Arithmetic Mean	15 µg/m ³	Primary & Secondary
24-hour Average	65 µg/m ³	Primary & Secondary

Odours may be emitted by landfill operations. The WHO standards for sensory effects including odour annoyance which are considered applicable to this project are presented in Table 4.

Table 4: Rationale and Guideline Values Based on Sensory Effects or Annoyance Reactions, Using an averaging Time of 30 minutes

<i>Substance</i>	<i>Detection Threshold</i>	<i>Recognition Threshold</i>	<i>Guideline value</i>
Carbon disulfide (index substance for viscose emissions)	200 µg/ m ³	-	20 µg/ m ³
Hydrogen sulfide	0.2–2.0 µg/ m ³	0.6–6.0 µg/ m ³	7 µg/ m ³
Formaldehyde	0.03–0.6 mg/ m ³	-	0.1 mg/ m ³
Styrene	70 µg/ m ³	210–280 µg/ m ³	70 µg/ m ³
Tetrachloroethylene	8 mg/ m ³	24–32 mg/ m ³	8 mg/ m ³
Toluene	1 mg/ m ³	10 mg/ m ³	1 mg/ m ³

3.10 ENVIRONMENTAL PROTECTION NOISE MANAGEMENT REGULATIONS 2000

Operations that emit noises are required to apply to the Agency for an environmental authorization. The Guyana National Bureau of Standards has established standards for permissible noise levels in industry, construction and other areas. No noise level standards are established for waste management facilities. However, the ambient noise level which is considered for this operation for both day and night would be 70 decibels (Industrial and Commercial Standards, World Bank 1998) at the property line.

3.11 LANDFILL SITING CRITERIA

The EPA has drafted Criteria for the Identification and Approval of Landfill Sites for Solid Waste Disposal in Guyana which provides initial screening and site selection guidelines for landfill facilities. These guidelines have, however not yet been promulgated. These guidelines have several elements which are similar to location restrictions adopted by the USEPA. Consultations with the EPA have therefore resulted in the adoption of location restrictions applicable to sanitary landfills in the United States. Restrictions on landfill sites are based on the site location relative to the following:

1. airports;
2. flood plains;
3. wetlands;

4. fault areas;
5. seismic impact zones;
6. unstable areas;
7. critical habitat; and
8. sensitive hydrogeologic environments.

Details of the requirements for each criterion are presented below.

3.11.1 AIRPORTS

The airport constraint mandates that no new or lateral expansion of an existing municipal solid waste landfill should be located within an eight kilometre radius of any airport runway end used by turbojet or piston-type aircraft. If the proposed new or lateral expansion of an existing municipal solid waste landfill is within 10,000 feet (3,048 metres) of any airport runway end used by turbojet aircraft, or 5,000 feet (1,524 metres) of any airport runway end used by only piston-type aircraft, the landfill shall be designed and operated so that the landfill does not pose a bird hazard to aircraft.

3.11.2 FLOODPLAINS

The flood plain constraint mandates that no new or lateral expansion of an existing solid waste landfill shall be located in a 100-year floodplain. If this constraint is not satisfied, the landfill shall be designed to ensure that it will not restrict the flow of the 100-year flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste that poses a hazard to human health, the environment, wildlife, or land or water resources

3.11.3 WETLANDS

The wetlands constraint mandates that no new or lateral expansion of an existing municipal solid waste landfill shall be located in wetlands. If the landfill is located in wetlands, it shall not cause or contribute to significant degradation of the wetlands. Wetlands are identified based on the presence of hydric soils, hydrophytic vegetation, and the wetland hydrology. These characteristics affect the functional value of a

wetlands in terms of its role in supporting fish and wildlife habitats, providing aesthetic, scenic, and recreational value, accommodating flood storage, sustaining aquatic diversity, and its relationships to surrounding natural areas through nutrient retention and productivity exportation (e.g., releasing nutrients to downstream areas and providing transportable food sources)

3.11.4 CRITICAL HABITAT

The critical habitat constraint mandates that no new municipal solid waste landfill unit should be located where landfill activities could cause or contribute to the reduction of the likelihood of survival and recovery of a threatened or endangered species. If the landfill is located in a critical habitat measures shall be taken to protect the species.

3.11.5 FAULT AREAS

The fault area constraint mandates that no new municipal solid waste landfill unit shall be located in an area, if faults having displacement in Holocene time, are likely or have been identified in the vicinity of the proposed new municipal solid waste landfill unit. If so, the landfill shall be more than 200 feet (60 metres) away from the fault that has had displacement in Holocene time, or if this constraint is not satisfied then it should be demonstrated that an alternative setback distance of less than 200 feet (60 metres) will prevent damage to the structural integrity of the landfill unit and protect human health and the environment.

3.11.6 SEISMIC IMPACT ZONES

No new or lateral expansion of an existing municipal solid waste landfill shall be located in a seismic impact zone. If so, all containment structures shall be designed to resist the maximum horizontal acceleration in lithified earth material for the site. The expected peak ground acceleration from a maximum strength earthquake that could occur in the area shall be determined. The facility shall be designed for site-specific seismic hazards such as soil settlement and to withstand the expected peak ground acceleration. A Seismic Impact Zone is an area with a ten percent or greater probability that the maximum horizontal acceleration in lithified earth material expressed as a percentage of the earth's gravitational pull (g) will exceed 0.10g in 250 years.

3.11.7 UNSTABLE AREAS

New landfill shall not be located in an unstable area. If so, engineering measures shall be incorporated into the design to protect the structural integrity of the landfill. The factors that shall be considered when determining whether an area is unstable must include on-site or local soil conditions that may result in significant differential settling, on-site or local geologic or geomorphologic features, and on-site or local man-made features or events.

3.11.8 SENSITIVE HYDROGEOLOGIC ENVIRONMENTS

No landfill shall be located in a sensitive hydrogeologic environment. Sensitive hydrogeologic environments are defined as gravel pits excavated into or above a water table aquifer, areas underlain by a sole source aquifer or other sensitive aquifer, and designated wellhead protection areas.

The location identified for the facility does not contravene any of the siting restrictions and is acceptable based on locations restrictions only.

3.12 OTHER SECTORAL NATIONAL POLICY AND LEGISLATION

3.12.1 TOWN AND COUNTRY PLANNING ACT

This Act regulates development planning and land use development control. The Central Housing and Planning Authority implements planning and exercises control based on the Town and Country Planning Act.

3.12.2 PUBLIC HEALTH ORDINANCE

This ordinance delegates authority for implementation and enforcement of its provisions regulating environmental health conditions to local health authorities. The ordinance prescribes requirements for inspection of districts, nuisance abatement, offensive trades, sanitary control, removal of refuse, and control of water pollution.

3.12.3 OCCUPATIONAL SAFETY AND HEALTH ACT 1997

The Occupational Safety and Health Act 1997, Section 6 states that any person who intends to erect or cause to be erected a new industrial establishment appurtenant to any existing industrial establishment shall, before the erection of such industrial establishment, give notice in writing to the Authority of his intention as aforesaid, and shall furnish the Authority with such drawings, plans or specifications that are required by the Authority. In addition in Section 52 the owner of an industrial establishment that is not a construction site must ensure the following:

- health and safety facilities are provided;
- any facilities provided are maintained; and
- the industrial establishment complies with the regulations.

To ensure conformance with this act procedures will be established to monitor and manage occupational health and safety during sanitary landfill construction and operation.

3.12.4 WASTE MANAGEMENT LEGISLATION

There is a lack of legislation in this jurisdiction in respect of waste management. The relevant legislation is as follows:

1. The Local Democratic Organs Act 1980;
2. Municipal and District Councils Act 28:01;
3. The Public Health Ordinance Chap 145, 1953 Ed.;
4. City of Georgetown (Collection and Disposal of Waste) By.laws 1981; and
5. Delegation of Powers under section 118 by Minister to Regional Democratic Councils BLS 25th June 1983 under Local Democratic Organs Act 1980.

There are provisions for waste generators with responsibilities under the By-Laws of 1981. These provisions specify the type and number of waste receptacles per household and for public places. There is a requirement for draining and wrapping of wet garbage. In accordance with these acts waste must be placed in a convenient location for collection and is not to be thrown about or dumped in any public place.

Subject to the Public Health Ordinance Chap 1945 the Municipality and local Government under the provisions of the Municipal and District Councils Act are responsible for establishing, maintaining and carrying out sanitary services for the removal and destruction of or otherwise dealing with all kinds of garbage and effluent.

There is no legislation in place mandating citizens or commercial entities to use any specific waste collection and disposal enterprise. The Civil Law Act of Guyana Chap 6:01, s.22 and the Schedule thereto render monopolies contrary to the laws of Guyana and to be void. Municipalities and local Government are required to tender contracts necessary for the discharge of their functions subject to certain exceptions such as:

- the case of persons nominated as Council contractors;
- in cases of emergency;
- contracts for produce or perishable goods; and
- purchase entered into as a result of bidding at auction.

The Municipality is authorized to prescribe fees and charges and to issue licences or permits and impose conditions in respect of sanitary services among other things under the Municipal and District Councils Act Chap 28:01. Fees that may be charged are stipulated in the By-Laws No.1 of 1981, e.g., the Cleansing Officer may charge a small fee for removal and disposal of a carcass, a fee may be charged for the disposal of commercial waste at any controlled landfill operated by the City Council or incinerator.

Enforcement mechanisms are provided for in By-Laws No. 1 of 1981 made under the provisions of Chap 28:01 and the Environmental Protection Act No.11 of 1996. Cleansing Officers, Local Government Officers in the service of the City Council, any member of the City Constabulary or Police Force, the Environmental Protection Agency or a person authorized by the Minister are authorized to institute proceedings for breach of the bylaws or offences under the Act respectively with respect to collection and disposal of waste and littering. The City Council may also recover in Court the expenses incurred as a consequence of the breach.

3.13 SUMMARY

The legal and Institutional Framework for the execution of the Environmental Impact Assessment in the proposal Haags Bosch landfill has been discussed. The process

adheres to international and national policies established for the suitability and effective management of the environment in the context of specific development proposals. The roles of the National Environmental Protection Agency (EPB) have been presented. Specific requirements of the funding agency, the Inter-American Development Bank (IDB), which encompass those of the named local environmental agencies, have been included. This section covers the specific terms of reference (TOR) for the development, execution and documentation of the EIA and associated reports, required as part of the proposed Haags Bosch Landfill development. The institutional framework for project execution is discussed in section 12 of this report.

4.0 DESCRIPTION OF PHYSICAL ENVIRONMENT

The physical environment of Haags Bosch and its immediate environs will be impacted by the project. Haags Bosch and its environs are considered to be represented by the landfill site, its buffer zone and the adjacent housing areas within one and one-half miles of the facility. These housing areas include the New Eccles Housing Development, Republic Park, Continental Park, Nandy Park and Bagotown. The proximity of the landfill site to the surrounding communities is shown on Figure 4 (Appendix A). The subject site (Haags Bosch) is set within the Coastal Plain. Typically, the subsoils consist of 20 m of very soft to firm bluish grey silty clay with occasional silt seams and organic inclusion overlaying the firm to hard yellowish grey silty clay of the Coropina Formation. Low or relatively impermeable materials extend to at least 30m depth below grade. Groundwater in the area is recovered from wells screened in confined sand aquifers under artesian conditions at depths of about 160 m. Surface water occurs in ditches, canals and small drains and the levels in these units reflect controlled drainage and irrigation in the specific area, as well as seasonal fluctuations.

The baseline physical environment is detailed below.

4.1 CLIMATE AND AIR QUALITY

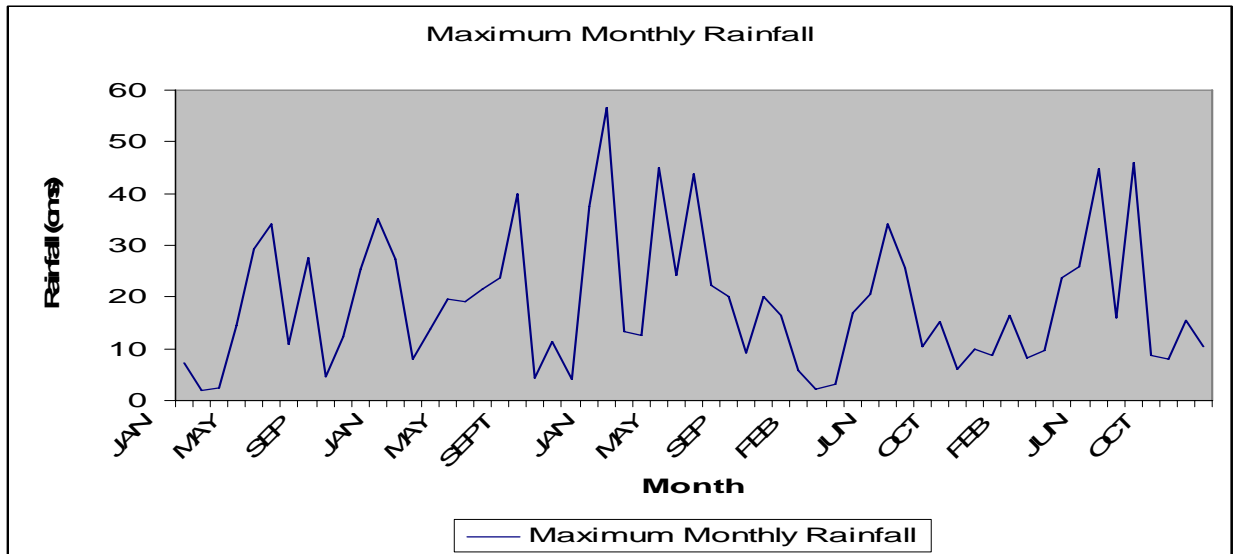
Guyana is located in the Equatorial Trough Zone (ETZ) and its weather and climate are influenced primarily by seasonal shifts of the ETZ and its associated rain-bands called the Inter Tropical Convergence Zone (ITCZ). Secondary influences on the climate are of Pacific origin. Formation of El Niño and La Niña can disturb the regular location of the ITCZ and thus result in higher or lower than normal rainfall at specific locations. The El Niño/La Niña is primarily responsible for inter-annual variation in rainfall.

No site specific climatic data is available for Haags Bosch. Climatic data was reviewed for the Botanic Gardens. This data is considered to be representative of the subject site. Daily precipitation data was reviewed for the period January 1998 to December 2003. Evaporation, daily sunshine and temperature and relative humidity data were reviewed for the period 2000 to 2003. For the period of record, the maximum monthly and daily rainfalls were respectively 565 and 334 mm. The maximum monthly and daily rainfall occurred in January 2000 and August 2002, respectively. The highest rainfall was recorded during the months of May to July and November to January. The months of February-March and September-October are the months of low rainfall.

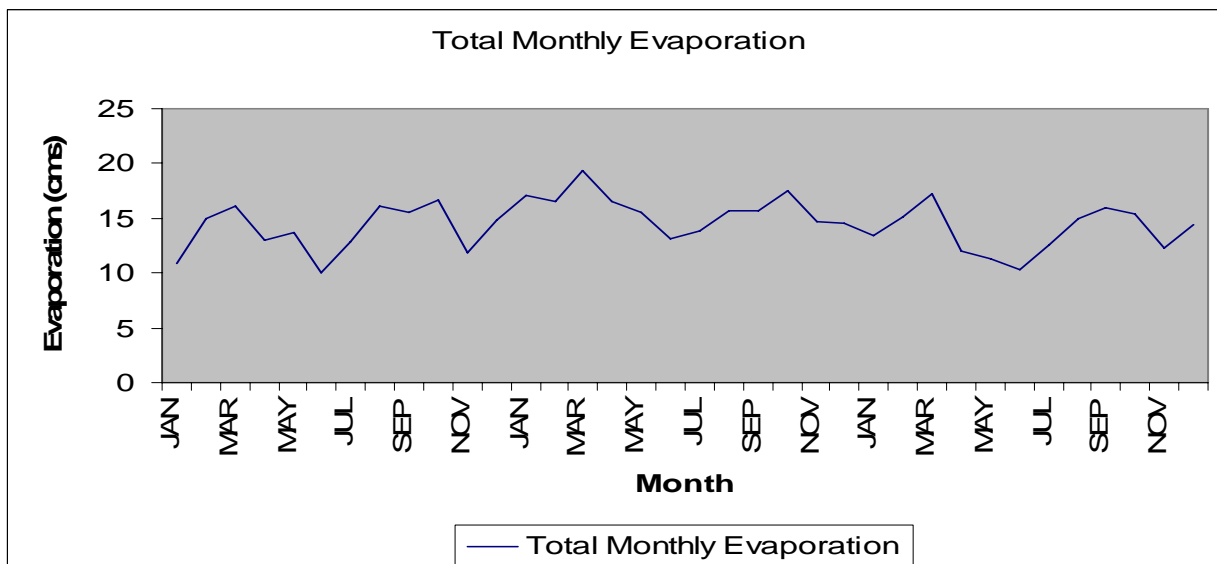
4.2 JANUARY 2005 RAINFALL

In January 2005, 1033 mm of rainfall occurred. A review of data from 1983 indicates that this represented about twice the highest recorded monthly rainfall in the period (565 mm in January 2000.) Further, the 5 day total in January 2005 is 590 mm exceeding the monthly figure for January 2000.

Data for Georgetown indicate maximum monthly temperatures in the study area range between 29° and 35°C. The highest temperature occurs during the September-November period. The lowest temperature occurs in the January-March period. The monthly minimum temperatures vary between 25° and 30°C. For the period of record, the maximum monthly and daily evaporation were respectively 194 and 11 mm. The minimum recorded monthly evaporation was about 100 mm in June 1999. Monthly rainfall and evaporation for each month of the period of record are presented as Graphs 1 and 2.



Graph 1: Maximum Monthly Rainfall January 1998 – December 2002



Graph 2: Maximum Monthly Evaporation January 2000 – December 2002

Wind speeds for the Botanic Gardens reveal that the winds blow primarily from the northeast and east. Winds speeds are highest in March and lowest in July. The average of the higher wind speeds is 7.7 knots. The average of the lower wind speeds is 4.8 knots.

Air emissions at Haags Bosch result from traffic along roads in the study area. Only unleaded fuel is used in Guyana. Consequently aerial emissions from traffic include carbon monoxide, exhaust hydrocarbons, nitrogen oxide, sulphur dioxide, aldehydes and particulates. The sulphur emissions are not expected to be in excess of the World Bank guidelines of 500 tonnes/day. Airborne discharges and particulate matter are not monitored in the Haags Bosch area. Some fugitive dust emissions occur in the New Eccles Housing Scheme itself due to the presence of several unsurfaced roads. Some emissions, primarily dust emanate from the Eccles Industrial Estate. Aerial emissions are also associated with GuySuCo aerial spraying of agricultural lands. Herbicides, ripeners and urea are applied by aerial spraying of sugarcane. This has short-term impacts on air quality.

4.3 REGIONAL GEOLOGY

The Study area is Guyana Coastal Plain. Sediments of the Coastal Plain together with those of the White Sand Series, referred to as the Coastal Sediments, gave rise to the artesian conditions on which the coastal water supply depends. The true sedimentary nature of these beds was first recognized by Bracewell in 1927, and a subsequent study of some 58,000 ft. of water well cores by Granthman and Noel-Paton in 1936 together with detailed analysis of cores from the Rose Hall test well by Trinidad Leaseholds Ltd. in 1942 have resulted in identification of four formations in the Coastal Plain. These have been identified to be the Demerara Clay, Coropina Formation, White Sand Series and Berbice Formation. The Demerara Clay formation, Coropina, and the White Sand Series are considered to be of Plio-Pleistocene to recent age, the lowest members of the White Sand Series being tentatively placed in the Pliocene. There is a scarcity of fossils, except for Recent and Pleistocene molluscs in the upper portion of the Demerara Clay. Petrological examination of cores from the Rose Hall test well showed the entire sequence of beds penetrated consisted of unconsolidated sands and clays which showed few signs of diagenesis or lithification. The sediments were considered to represent one cycle of deposition, the time limit for which was short and probably did not extend further back than the Pliocene.

At the close of the White Sands period tilting on a continental scale is postulated, which elevated the White Sands sheet to its present position inland (maximum elevation 450 ft.) and allowed a marine transgression to take place. Erosion of the shallow sea floor in front of the White Sands produced sand bars, spits and barrier islands which caused the formation of lagoons and tidal flats on their landward side. A large supply of sediment from the major rivers caused rapid silting on the landward side and the development of a series of bars and spits seawards.

In probably late Pleistocene times the sea receded and the soft tidal flat deposits and sand bars were subjected to strong erosion and weathering. The clays became oxidized and firmer in consistency with loss of water and the sandy areas podsolised; these are mapped as the Coropina Formation.

In the Demerara Clay zone many traces are seen of old river channels and levees. Along the coast there is a belt of stranded beach ridges extending from the Corentyne River to the North West Coast. In the field the Coropina Formation outcrops in a narrow belt between the Demerara Clay and the White Sand Series. It is distinguished from the soft grey blue clays of the Demerara Clay by its highly mottled colors and silt content; its

weathered nature invariably gives it an acid reaction while the Demerara Clays are more frequently neutral to alkaline.

Towards its contact with the White Sands a number of transition zones occur with increasing sand content. Owing to the low, gently undulating topography and poor drainage properties of these sediments, planosolic soils frequently develop and these areas usually form open savannahs supporting only poor grasses and sedges. Further to the north and east the higher parts of the Coropina topography stand out as forested islands surrounded by herbaceous and Ite palm swamps on the often pegassy surface of the Demerara Clay.

The White Sand Series has a sharp, irregular contact with the more recent formation, behind which it gives rise to the First Savannah zone. Here almost pure white sands support sparse vegetation of stunted bush, poor grasses and sedges. There is some evidence that further to the south towards the rim of the basin these coarse White Sands give way to brown and yellow sands and sandy clays which may be the lateral equivalent of a somewhat different facies of the Intermediate Clays and Lower Sands encountered in coastal wells.

4.4 SURFICIAL GEOLOGY

Haags Bosch is located within Guyana Coastal Plain. Clays of the Demerara Clay and Coropina Formation underlie the Coastal Plain, which lies near sea level. This area is crossed by old shorelines and ridges mostly parallel with the present shoreline. The Coastal Plains occupy a strip approximately 38 kilometres wide along the entire Guyana coast (Bleackley, 1956). In probably late Pleistocene times, the sea receded and the soft tidal flats and sandbars were subjected to strong erosion and weathering. The clays became oxidized and firmer in consistency by loss of water and the sandy area podsolised resulting in what is now mapped as the Coropina Formation. A rise in sea level in post glacial times to practically its former level caused inundation of the Coropina Formation and the laying down of soft clays of the Demerara Formation surrounding Coropina islands and filling river valleys. The younger parts of the Demerara Clay formation are recent in age and clay indistinguishable from the Demerara Clay is being added at the present time to parts of the coast.

4.5 SEISMICITY

The seismicity of the Study Area is very low. A search of the National Oceanic and Atmospheric Administration Earthquake database, which includes data on a half-million earthquakes dating back to 2100 B.C. reveals only 5 events have occurred in recorded history within 296 kilometres of Georgetown. Within this radius, the greatest magnitude recorded was 4.0 on the Richter scale in 1969.

4.6 WATER RESOURCES

4.6.1 GROUNDWATER

The coastal artesian basin consists of a recharge or catchment area, which coincides roughly with the exposed area of the White Sand Series, and an area of confinement, which is overlain by the Coropina Formation and Demerara clay and accordingly has the same extent as the coastal plain. Confinement in the "A" sand unit is caused by relatively impermeable fine-grained sediments in the overlying intermediate clay unit, the southern extent of which is not known. Similarly, no surface geological data are available concerning the catchment area of the "A" sand. The base of the groundwater basin is at the base of the White Sand Series, except where the sediments in the deeper part of the basin contain saline water which forms the lower limit of the usable supply. A cross-section through the coastal artesian aquifer is shown on Figure 4 (Appendix A). The Peters Hall well which services communities in the Eccles area is screened at a depth of approximately 160 m and is located at a distance greater than 1.5 km from the site. The location of the well at Eccles relative to the sanitary landfill at Haags Bosch is shown on Figure 5 (Appendix A).

Recharge from rain and seepage loss from streams in the catchment area replenishes the groundwater reservoir. Although there are no well data in the catchment area it is logical to assume that groundwater moves generally northward, a part entering the permeable sections of the White Sand Series and a part probably being rejected, at least in the extremely wet seasons of the year as discharge to creeks and streams along the inland edge of the Coropina Formation. The part moving northward in the confined aquifers is discharged through the artesian wells, or seeps through the confining beds, being discharged by flow into streams or by evaporation and transpiration, or by submarine discharge some distance offshore. All wells that have been completed at a depth greater than the base of the Demerara Clay are flowing artesian wells. In general, the head in the upper sand unit has ranged from 1.0 to 1.5 m above ground level.

Groundwater elevation in the vicinity of the sanitary landfill ranges from 14.726 metres Georgetown Datum (GD) to 15.573 metres GD, which is approximately 0.30 to 1.64 metres below existing ground surface. The horizontal flow gradients determined from water levels at monitoring wells in the vicinity of the sanitary landfill range from 3.31×10^{-4} to 6.62×10^{-4} . Groundwater flow is to the north-northeast. Wells at both Agricola and Eccles are located west of the site and upgradient of the regional groundwater flow direction. While groundwater is present in the clay formation, none can be recovered from that formation due to the impermeable nature of the clays underlying the site.

Groundwater is recovered for drinking purposes from two wells within three kilometres of the proposed sanitary landfill. These wells are located at Eccles, approximately 2600 metres from the sanitary landfill boundary and at Agricola, approximately 3.0 kilometres from the sanitary landfill boundary. No data is available on the depth at which the Eccles well is screened. The well at Agricola is screened at a depth interval of 158.5 to 179.0 metres. A geological survey study (Worts, 1958) reports an average artesian head of 2.9 metres in wells on the East Bank Demerara. The current artesian head at Agricola and Eccles are expected to be less than 2.9 m, however artesian heads are still reported to be present at both locations.

4.6.2 GROUNDWATER QUALITY

Groundwater quality was determined during the environmental assessment conducted at the site, in Eccles, initially proposed for the sanitary landfill in 2000. Analytical tests were conducted on groundwater samples recovered from two wells in the area. One sample was recovered from a well located in one of the cultivated fields (MW-2). The other sample was recovered from the well in the field immediately adjacent to the industrial park (MW-1). The results of the analyses are considered to be representative of groundwater quality in the Haags Bosch area. The results are presented in Table 5.

Table 5: Results of Analyses on Ground Water Samples

<i>PARAMETRE</i>	<i>SAMPLE</i>		<i>USEPA Primary/Secondary Water Standard</i>
	<i>MW - 1</i>	<i>MW - 2</i>	
Total Dissolved Solids (mg/l)	3000	7364	500
Calcium (mg/l)	76.08	76.49	-
Magnesium (mg/l)	193.0	161.0	-
Dissolved Oxygen (mg/l)	4.02	4.04	5
Chemical Oxygen Demand (mg/l)	96	160	-

Sodium (mg/l)	1100	2500	-
Chloride (mg/L)	1212	3006	250
Iron (mg/l)	6.40	1.18	0.3
Lead (mg/l)	0.19	0.19	0.015
Phosphorus (mg/l)	1.94	3.93	-
Total Kjeldahl Nitrogen (mg/l)	2.83	5.52	-
Nitrate (mg/l)	n. d	n. d	10
PH	7.05	7.04	6.5 – 8.5
Total Suspended Solids (mg/l)	35	63	25
Electrical Conductivity (mS/cm)	5.14	10.98	-

Several water quality parameters are exceeded based on comparison with the USEPA Primary and Secondary Drinking water standards. These standards are, however, not applicable in this instance since the samples of groundwater analyzed were recovered from the relatively impermeable silty clays present exactly below the base of the proposed sanitary landfill and these clays are too impermeable to yield potable water.

4.6.3 SURFACE WATER

Several canals flow through the proposed site in a north-south direction. These canals discharge to a main east-west canal on the south side of the area to be developed. The east-west canal is part of GuySuCo navigation network and leads back to the La Bonne Intention sugar factory approximately twenty kilometres east of the landfill site. The cane fields themselves discharge through a series of box culverts to an east-west canal on the north side of the site. This canal, which is lower than the navigation canals, discharges to the Demerara River. None of these canals provide a source of drinking water or industrial water downstream of the proposed landfill site.

The drainage network around the Haags Bosch site is separated from the drainage network around the Eccles Housing development and the industrial estate. Some fishing is done in canals within and bordering the proposed site by residents in the Eccles-Nandy Park-Bagotown area. The soils present at ground surface are clays and there is very little infiltration. Precipitation at the site is intercepted by existing vegetation or results in runoff. GuySuCo records indicate the site has never flooded.

4.6.4 SURFACE WATER QUALITY

Surface water quality in the canals was determined by recovering a sample of surface water from the main east-west canal on the southern boundary of the proposed site. Results of analytical tests on the surface water sample are detailed in Table 6. A comparison of the canal water quality to Canadian Irrigation Standards indicates that surface water satisfies irrigation requirements. The nearest resident is a minimum distance of 2.5 km from the site. Residents of the area use none of the water from these canals.

Table 6: Results of Analyses on Surface Water Samples

<i>Parametre</i>	<i>SW - 1</i>	<i>Fao Irrigation Standards</i>
Total Dissolved Solids (mg/l)	139	500 - 3500
Calcium (mg/l)	4.65	-
Magnesium (mg/l)	3.79	-
Dissolved Oxygen (mg/l)	4.20	-
Chemical Oxygen Demand	72.00	250
Sodium (mg/l)	13.06	-
Chloride (mg/l)	21.00	100 - 700
Iron (mg/l)	2.90	5
Lead (mg/l)	<0.19	-
Phosphorus (mg/l)	0.10	-
Total Kjeldahl Nitrogen (mg/l)	3.22	-
Nitrate (mg/l)	Nd	-
PH	6.95	6.5 - 9.0
Total Suspended Solids (mg/l)	44	-
Electrical Conductivity (mS/cm)	0.12	-

4.7 LAND USE

There is no established future land use plan for the Haags Bosch area. The site is currently used for agricultural purposes. The Ministry of Housing has developed an area approximately 2200 m west of the sanitary landfill site for middle and low-income housing. A total of 698 housing lots have been earmarked for that area. Approximately 162 of those lots have been identified for middle income housing. The remaining 536 lots have been identified for low income housing. The Ministry of Trade has developed an area 2000 m west of the landfill site for an industrial estate. The industries to be sited in the industrial estate include food processing (mainly fish and shrimp),

beverage, pharmaceuticals, furniture, garments and bag manufacturing, wood processing, cement bagging, and steel fabrication.

GuySuCo has historically cultivated sugar cane on lands identified for the landfill and on lands between the industrial estate and the site. In the absence of a land use plan the area could therefore be classified as a mixed housing, industrial and agricultural lands.

4.8 BIOLOGICAL RESOURCES

The entire area of approximately 40 hectare (100 acres) proposed for sitting the sanitary landfill is cultivated with sugar cane (*Saccharum officinarum*). Other vegetation present in the area include black sage (*Cordia macrostachya*), a woody perennial shrub found mostly at the edges of the area. Some antidesma (*Antidesma ghaesambilla*) intersperse the area together with giant shame bush (*Mimosa pigra*), *Chamaesyce hyssopifolia*, baby sumutoo (*Passiflora foetida*), gripe weed (*Phyllanthus rinaria*), bango palm (*Bactris Brongniartii*) and wild eddo (*Caladium bicolor*).

Birds are not plentiful in the area because the dominant crop is not the flowering type that attracts birds neither does it bear fruits. The dove (*Columbigallina passerina*), a species that feeds on the ground was seen along the peripheral dam. Microinvertebrates were fairly numerous especially on the access road to the site. Butterflies, moths, pond flies, wasps and ants were dominant while the chirps of crickets and grasshoppers were heard in the night.

Fish are assumed to be present in the canals within the project area, but these canals are overridden with weeds such as Water hyacinth, Water lettuce, Alligator eye, Para grass, Wild eddoe, Mocca Mocca and Sleep and Wake bush. It was therefore not possible to use the cast net to attempt to determine the presence of fish onsite.

No reptiles were observed during the field inventorization. Isolated sightings of the toad (*Bufo sp.*) were made during the day. Larges animals were not observed to be present at the site. Their absence may be due to the effectiveness of the regime of rodenticide application by GuySuCo.

A summary of flora and fauna encountered in the Haags Bosch area is detailed in Table 7 below.

Table 7: Flora and Fauna at Haags Bosch Site

FLORA	
<i>Scientific Names</i>	<i>Common Names</i>
ARACEAE Alocasia macrorrhiza Montrichardia aborescens Pistia stratiotes	Wild eddo Moko Moko Water Lettuce
ALISMATACEAE Sagittaria guyanensis	Duck weed
ASTERACEAE Vernonia cinerea Wedalia trilobata	Inflammation bush Daisy
BOMBACACEAE Ceiba petandra	Silk cotton tree
BORGANACEAE Cordia macrostachya Cordia tetrandra	Black sage Clammy cherry, Pasie
CAESALPINIACEAE Cassia obtusifolia Cassia occidentalis Senna alata	Money bush Wild coffee Carrion Crow Bush
COMMELINACEAE Commelina diffusa	Caner grass
CONVOLVULACEAE Ipomoea aquatica	Morning glory
CUSCUTACEAE Cuscuta australis	Dodder
CUCURBITACEAE Luffa cylindrica	Ninwah
CYPERACEAE Cyperus rotundus Eleocharis elegans	Nut grass Bisi Bisi
EUPHORBIACEAE Antidesma sp. Caperonia palustris	Antidesma Wild Green Tea
FABACEAE Pterocarpus Officinalis	Cork Tree Purple Fling
HELICONIACEAE Heliconia psittacorum	Heliconia
MIMOSOIDAE Mimosa pigra Mimosa pudica	Giant Shame Bush Sleeping baby
MYRTACEAE	

Syzyclium cumini	Jamoon			
NYMPHACEAE Nelumbium nelumbo	Water lily			
ONAGRACEAE Ludwigia ieptocarpa	Clove Bush			
POACEAE Axonopus compressus Brachiaria mutica Cenchrus echinatus Cynodon dactylon Imperata brasiliensis Paspalum conjugatum Paspalum virgatum Sporobolus jacquemonti	Carpet grass Para grass Burr grass Bahama grass Jew grass Sour grass Razor grass Iron grass			
PONTE DERIACEAE Eichhornia crassipes	Water hyacinth			
SALVINIACEAE Salvinia auriculata	Alligator eye			
SAPINDACEAE Cardiosperum halicacabuna	Bishop cap			
VERBENACEAE Lantana camara	Sweet sage			
FAUNA				
<i>Class</i>	<i>Order</i>	<i>Family</i>	<i>Scientific Name</i>	<i>Common Name</i>
AVES		Accipitridae Ardeidae	Buteo magnirostris Bulbucus ibis	Snail Crane
AMPHIBIA			Hyla sp.	Frog
REPTILIA			Anolis sp.	Lizard
INSECTA	Odonata Hymenoptera Hymenoptera Diptera Diptera Lepidoptera Lepidoptera	Fomicidae Culicidae Pyralidae Pyrolidae		Pond fly Marabunta Ants Flies Mosquito Butterflies Moths

4.8.1 THREATENED AND ENDANGERED SPECIES

No threatened or endangered plant or animal species or rare ecosystem is known to occur or is associated with the Haags Bosch site.

4.8.2 NOISE, ODOUR, AND DUST

The primary source of noise is traffic along the East Bank Demerara road. Some noise is also generated from activity in the industrial estate. Transient noise emanates from periodic aerial spraying by GuySuCo. The noise is however not audible over most of the area proposed for sanitary landfill. There are no odours or dust associated with the activities for which the site is currently utilized. Odours and dust however emanate from operations in the industrial estate. The volumes and concentrations however are not known.

4.8.3 CULTURAL AND ARCHAEOLOGICAL RESOURCES

The area has been traditionally used for sugar cane cultivation. While GuySuCo has several unique drainage structures such as aqueducts within some areas, none are present in the area to be developed into the sanitary landfill.

4.8.4 TRAFFIC

The facility will be accessed by the existing East Bank Demerara Roadway. This road was designed for 70 equivalent axle loads (EALs) per day. The most recent census for this roadway (1993) indicates that the roadway is presently subject to approximately 120 EALs per day. The design capacity of the roadway is therefore exceeded due to current traffic levels only. The Government of Guyana recently signed a contract to construct a four lane road between Georgetown and Peter's Hall on the East Bank of Demerara. This road will extend beyond the access to the proposed site and has been designed for 250 equivalent axle loads (EALs) per day.

4.9 RELATED SITES

The development of a landfill at Haags Bosch would permit cessation of operations at uncontrolled dumps such as that existing at Mandella Ave (within the continues of Georgetown) which is currently the prime recipient of solid waste from the Greater Georgetown Area. For information, the following physical environment summary for Mandella is provided.

General – Mandella Site

Regional Geology , climate surface geology and seismicity settings are essentially the same as described for Haags Bosch. The Mandella site was used in part as a cemetery since the 1800's.

Groundwater levels are expected to be similar i.e., close to ground surface in the upper clayey soils. Drinking water in the area is recovered from confirmed sand aquifers at depths exceeding 200 m.

Surface water at and near Mandella occurs in canals and depressions on and adjacent to the site. Leachate from the dump site is not controlled and flows directly into the adjacent canal systems. This has impacted water quality, created entropic conditions and led to overgrowth and impairment of canal flows.

An emissions result from dust, gases from vehicular traffic and waste handling equipment. Uncontrolled fires produce smoke and carbon monoxide. Landfill gases including methane, and non methane organic compounds (NMOC) which certain organic hazardous air pollutants (HAP) and volatile organic compounds, currently discharged to the atmosphere. Significant odours are generated from uncovered waste. Some noise is generated from waste dumping activities.

5.0 DESCRIPTION OF SOCIO-CULTURAL ENVIRONMENT

5.1 ADMINISTRATIVE STRUCTURE

The Regional Democratic Council of Region 4 is composed of GM and 15 NDCs. All NDCs implement responsibilities delegated by the Minister of Local Government. GM is directly answerable to the Minister of Local Government. The NDCs are answerable to the Regional Democratic Council for expenditures greater than \$G180,000.00, for the passage of their budgets, for the expenditure of subventions provided by the Ministry to each NDC and for the employment of certain categories of staff. Thirteen NDCs in Region 4, from Haslington/Grove on the East Coast Demerara to Soesdyke on the East Bank Demerara have signaled their intent to use the Haags Bosch sanitary landfill. Two NDCs in Regions 3 on the West Bank Demerara have also signaled their intent to use the proposed facility. Each NDC is provided a yearly subvention of \$3,000,000.00. This subvention is supplemented by property tax revenue collected by each NDC.

5.2 OVERVIEW OF SOCIO-ECONOMIC CONDITIONS

The proposed project will impact waste generation and management activities in GM and the NDCs. Socio-cultural data has been compiled for GM and NDCs to define baseline conditions prior to implementation of the project. Data on specific characteristics of areas impacted by the project are detailed after presentation of a socio-cultural overview. The socio-cultural overview presents data on as follows:

- population and household characteristics;
- economic activities and employment; and
- social and economic well being.

The data for individual NDCs and GM include general characteristics, access and drainage infrastructure, waste management infrastructure and cost recovery mechanism for waste management.

5.3 POPULATION CHARACTERISTICS

In the 1991 Census, the national population was about 724,000. The population growth in the intervening years has been very low, often as little as 0.1-0.5% per year. Other estimates for 2002 indicate a population of about 749,000** for all Guyana. The primary

reason for this slow growth is the high levels of emigration from Guyana. The average size of household is 4.7 persons. Nearly one-third of all households are headed by women with the trend being more pronounced in Georgetown. Approximately one-third of the population is younger than 14 years. The ratio of men to women in the population is about 0.97. The ethnic composition of Guyana includes East Indians (49%), Africans (36%), Amerindians (7%), mixed races (7%) and Chinese, Europeans and others (1%).

The population of GM determined by the most recent census (1991) was approximately 152,000. A summary of the population of the NDCs in GM environs, recorded by the 1991 census is shown in Table 8 below.

Table 8: Summary of Population of NDCs in GM environs

<i>Neighborhood Democratic Council</i>	<i>Population</i>
Enmore/Hope	6741
Buxton/Foulis	17158
Mon Repos/Le Reconnaissance	13058
Beterverwagting/Triumph	7945
Better Hope/La Bonne Intention	15858
Industry/Plaisance	11427
Ramsburg/Eccles	7973
Little Diamond/Herstelling	7231
Mocha/Arcadia	2217
Golden Grove/Diamond Place	8377
Caledonia/Good Success	6967
Soesdyke/Huist Te Coverden	5519
La Grange/Nismes	6849
Malgre Tout/Meer-Zorgen	5075
Hastlington - Groove	N/A ~ Est. 19000

This would infer Georgetown and the Region 4 NDCs having a total population of about 295,000 at the time of the 1991 census. More current estimates (2002) would put this figure between 310,000 and 350,000.

5.4 ECONOMIC DEVELOPMENT

Currently, Guyana's GDP is US\$1.8 billion or US\$2,500 per capita.* The key sectors of the GDP include (1998 estimate): agriculture: 34.7%; industry: 32.5% and service: 32.8%. The main export products are bauxite, gold, rice, rum, seafood, sugar and wood and the main export markets include USA (22%), Canada (22%), UK (18%) and the Netherlands Antilles (11%). Sugar, rice and bauxite account for more than 75% of the export earnings, however the performance of these exports is subject to the external factors of the global marketplace, making these major sectors of the national economy highly vulnerable to fluctuations. The country is indebted to various international financial organizations with a total foreign debt of US\$1.1 billion (2000 estimates). Industrial estates are being established to facilitate the further development of value-added activities (e.g., furniture, textiles and food processing). Tourism is presently underdeveloped in Guyana although it represents an integral part of the national economic development strategy.

5.5 EMPLOYMENT AND INCOMES

In 1995, the labour force of Guyana numbered 350,000, with an overall participation rate of 62.5% of the population over 15 years of age. Among employed persons, approximately one-third worked in each of the sectors of industry and commerce, agriculture and services. In 1993, the unemployment rate was approximately 11%. However, the combined impact of underemployment along with unemployment is estimated to affect 30% of the labour force.

Among men, the labour force participation rate in 1995 was 86.4%. Women, on the other hand, had a participation rate of 39.2%, with most other women remaining in the home. Employed men tended to work in agriculture (34%), manufacturing (15%), trade (13%) and mining (8%). Over 40% of employed women worked in either trade or commercial services. In 1992, 8% of men were unemployed, compared with 18% of women.

Data on wage levels are limited to information on the official GoG minimum wage (UNDP, 1996). In 1996, the minimum wage was the equivalent of US\$2.98 per day, a low wage in absolute terms. It was also only two-thirds of the level in 1980, that is, the equivalent of US\$4.52. The public sector minimum monthly wage in 1996 was G\$7,337; in 2003, it was G\$18,000 (BOS, 2003). Remittances from overseas Guyanese are a major source of income for many households.

5.6 SOCIAL AND ECONOMIC WELL BEING

Life expectancy at birth averages 64.8 years for the total population. For men, it is 61.5 years and for women, 68.2 years. The overall literacy rate for people over 15 years of age is 98.3%, with rates of 98.8% for men and 97.8% for women. The combined gross enrolment ratios for all levels of school are 66% for the entire population and for men and 65% for women.

Although school enrolment rates for women are nearly equal to those for men, women do not appear to have equal access to higher education, or to high technology or other well-paid jobs. The large gender gap noted above in labour force participation rates is, in fact, worse among young adults with 83% of men and only 24% of women who are economically active. In general, the absence of child care and responsibilities for the elderly tend to limit women's access to formal sector employment. For example, only 34% of female household heads are employed, compared with 84% of male household heads. As a consequence, a large percentage of women work in the informal sector characterized by very low wages and lack of income security.

In recent years, there have been improvements in a number of public health indicators in Guyana. The total fertility rate dropped from 6.1 in 1960 to 2.3 in 1997. The number of births attended by trained medical personal rose in the 1990's from 88% to nearly 93%. In that same period, infant and child mortality rates also declined. In rural areas, more than 90% of the population has access to safe water and more than 80% to adequate sanitation. In urban areas, nearly 100% of the population has access to both safe water and proper sanitation.

Guyana recorded negative growth during the 1980s and the first half of the 1990s. During this decline, the social service sector collapsed, the physical infrastructure and utilities deteriorated, migration increased, the Guyanese dollar was significantly devaluated, unemployment and inflation rose to high rates and real wages dropped. To combat these negative trends, the Structural Adjustment Development Program was launched which managed to turn decline into growth by mid-1990s. Although the beginning of the new century has again been accompanied with negative growth rate, the government's forecast expects growth to quickly pick up rates as high as 4.8 percent by 2005 and 7.0 percent by 2010 (GPRSP, 2000). These optimistic forecasts are based on the new liberal, market and private investment oriented economic policy of the Government. The level of private sector investment is expected to rise from 0.5 percent

of the GDP in 2000 to 14.8 percent by 2010 (4.8 percent by 2005). The economic growth in the 1990s resulted in declines in the number of people in Guyana living below the poverty line, from 43% in 1993 to 35% in 1999. The largest decline in poverty levels occurred in the Georgetown area, from 29% to 16%. Nonetheless, approximately 20% of the population of Georgetown live below the poverty level, primarily in squatter settlements.

Parallel to the current growth trends, both poverty and unemployment shows declining features. In 1993 more than 29 percent of the population lived below the official poverty line and 21 percent in Georgetown, which is the political as well as the economic center of the country. By 1999, when the most recent Living Conditions Survey (LCS) was completed, there were significant reductions in the poverty levels. Georgetown in particular showed high reduction in the incidence of poverty. Economic activity is 60 percent in Guyana i.e., 60 percent of the population has been on the labour market (39 percent of all women).

In Guyana, the minimum wage is currently G\$18,000 (US\$95) per month (also the tax threshold) and many teachers, nurses and some public servants receive this amount each month. The average household size is 4.15 persons with one-salary earner in the majority of the typical 3-5-person family. Only 27 percent of all households have 2 earners. However, there is a large informal private sector in Guyana, which is primarily engaged in trading, although a significant proportion is occupied in manufacturing and as craftsmen (carpenters, masons etc.).

The instability of the Guyanese dollar has led to increased living costs in the country and in particular in the capital. In Georgetown, the highest price increase was observed in housing (183 percent increase between 2001 and 1994), transport and communication (188.6), medical and personal care (186.4), food (163.0) and education, recreation and culture (154.3) (Statistical Bulletin, 2001). In the two most recent household surveys it was found that food was still the dominant type of expenditure throughout the county while in Georgetown it was housing costs.

5.7 MANDELA SITE ENVIRONS

The wards of GM in Mandela Site Environs are La Penitence, Ruimveldt and Lodge. La Penitence is constituted of La Penitence itself, East, West and North East La Penitence and Tucville. Ruimveldt is comprised of Riverview, Alexander Village, East, West, South and North Ruimveldt, Festival City, Roxanne Burnham Gardens and Guyhoc

Gardens. Lodge consists of Lodge itself, Meadow Brook Gardens, Lodge and Durban Backlands and Lodge Housing Scheme.

The location of all areas relative to the Mandela Site is provided on Figure 3 (Appendix A).

5.8 LA PENITENCE

La Penitence is located immediately beyond the western limits of the Le Repentir Cemetery in which the Mandela Site is located. It is an area of residential, commercial and institutional development. This area of approximately 2 sq. miles is densely populated compared to elsewhere in Guyana with a population of approximately 15000 persons and with 2724 houses. Residences in the area range from small squatter settlements along the embankment of the canal that separates La Penitence from the cemetery to middle income homes in Tucville. Approximately 65 percent of the homes are undivided private homes. A small percent (2%) are multiple family dwellings. Some residents have modified their homes to provide some rental capacity and additional income.

Housing plots in the area tend to less than 400 m² and the room between adjacent houses is quite limited. Some residents have added second homes on single lots to provide additional rental income or to provide room for extended families. House types range from single level concrete dwellings to two storey buildings. Some of the homes date back to the early 1960 and includes several townhouses built by the GoG for low income residents. The Ministry of Housing has sold most of these townhouses to their former tenants. Several of the houses in Tucville were built in the late 70s – early 80s using self help labour. A large fraction of the original owners have migrated and many residents of the area are tenants of these absentee landlords.

There is a small fraction of open space in La Penitence. Some lands in open spaces are used as playgrounds by residents in close proximity to these grounds, however the level of maintenance is low and these lands tend to be covered with scrub vegetation in most instances.

Communities in La Penitence are primarily Afro-Guyanese with a small percentage of Indo-Guyanese and mixed ethnicity of varying social status and means. Practically all residents have at least a primary education. Some residents are university educated.

Residents are professionals, GoG employees, small businessmen, and skilled and unskilled blue-collar workers.

There are some family owned businesses in La Penitence. These businesses, which are mostly service oriented, include a funeral home, night clubs, grocery and general stores, mechanic shops, restaurants, a fuel station, supermarket and pharmacies. Unemployment levels in this area are relatively high compared to elsewhere in Guyana. The market which services the area is located on the southern limit of the area just north of the East Ruimveldt Front road.

Public institutions in the area include the La Penitence Police Station and several nursery and primary schools. Secondary schools are located in the adjacent wards. Social amenities available to the area include telephone and facsimile services provided by GT&T, electricity services provided by GP&L and potable water provided by Guyana Water Inc.

5.8.1 ACCESS AND DRAINAGE

Primary access to any of the wards of La Penitence is either by way of Mandela Avenue or Cemetry Road (extended Vlissengen Road). Cemetry Road links with Mandela Avenue at its extreme southern end and to the East Coast Demerara Highway at its extreme northern end. Mandela Avenue links to the East Bank Demerara road which provides access to both downtown Georgetown and the East Bank Demerara area including the proposed site at Haags Bosch. There are several additional roads passing through La Penitence which can be used to provide access to both the East Coast and East Bank roads including Middle Road and North East La Penitence Front Road.

Mandela Avenue is maintained by the Ministry of Public Works and was initially built as a road to bypass central Georgetown. There is consequently a steady flow of local traffic combined with larger trucks, buses and private vehicles traveling on this road through Georgetown which runs east of the Mandela Site. The GoG has proposed the development of major new roads in the East Coast/East Bank area to improve transport conditions and to promote economic development. Roads are proposed to link Cheddi Jagan International Airport with Mandela Avenue and the East Coast Highway to this newly proposed road and with the existing Demerara Harbor Bridge to facilitate transit movements that now must pass through Georgetown. These roads may create additional traffic in the Mandela Avenue area if plans to enhance and upgrade the tourism sector are realized.

There are internal roads in each ward of La Penitence. These roads are well laid out and generally run in a regular north to south and east to west network. The primary access roads are relatively well maintained, however secondary roads are in poor condition. All roads in the area were initially paved or concreted, but the pavements have deteriorated both as a result of poor maintenance and inadequate drainage.

Drains in La Penitence run parallel to the primary internal roads. These drains all discharge to the Demerara River to the west of GM. Drains are maintained by the City Engineer's Department. Squatters are however congregated on embankments adjacent to these drains. Waste is thrown into the canals in squatting areas. Efforts to clear the drainage ditches are impeded by both the squatters and by the presence of waste.

5.9 RUIMVELDT

Ruimveldt is located south and east of La Penitence and approximately 1.5 - 2.0 km from the Mandela Site. It is an area of residential, commercial and institutional development. This area of approximately 8 sq. miles is densely populated compared to elsewhere in Guyana with a population of approximately 30000 persons and with 5631 houses. Residences in the area range from small squatter settlements along the East and West Ruimveldt Front Roads to upper middle income homes in South and North Ruimveldt and Roxanne Burnham Gardens. Approximately 80 percent of the homes are undivided private homes. A small percent (2%) are multiple family dwellings. Some residents have modified their homes to provide some rental capacity and additional income.

Housing plots in the area tend to less than 500 m² and the room between adjacent houses is quite limited. House types range from single level concrete dwellings to two storey buildings. Some of the housing dates back to the early 1960 and includes several townhouses built by the GoG for low income residents. The Ministry of Housing has sold most of these townhouses to their former tenants. Several of the houses in North Ruimveldt and Festival City were built in the early 70s using self help labour. Houses in South Ruimveldt were built by a private developer and sold to residents. Roxanne Burnham Gardens was built in the 1980s both by private individuals and by self-help. A large fraction of the original owners of homes in all wards have migrated and many residents are tenants of these absentee landlords. Some residents have modified their homes to provide some rental capacity and additional income.

The Ruimveldt Industrial Estate is located in this area. It is home to several large industrial establishments including Banks (DIH) Limited, Continental Industries, AH&L Kisson, John Fernandes Ltd. and BK Construction Company. Business activities in this estate include paint and furniture manufacturing, food processing, warehousing and construction support services.

There is a small fraction of open space in Ruimveldt. Some lands in open spaces are used as playgrounds by residents in close proximity to these grounds, however the level of maintenance is low and these lands tend to be covered with scrub vegetation in most instances.

Communities in Ruimveldt are primarily Afro-Guyanese with a small percentage of Indo-Guyanese and mixed ethnicity of varying social status and means. Practically all residents have at least a primary education. Some residents are university educated. Residents are professionals, GOG employees, small businessmen, and skilled and unskilled blue-collar workers.

There are some family owned businesses in these wards. These businesses which are mostly service oriented, include night clubs, grocery and general stores, mechanic shops, restaurants, supermarket and pharmacies. Unemployment levels in this area are relatively high compared to elsewhere in Guyana.

Public institutions in the area include a police outpost and several nursery and primary schools. Both the Ruimveldt Multilateral School and East Ruimveldt Secondary schools are located in wards of Ruimveldt. Social amenities available to the area include telephone and facsimile services provided by GT&T, electricity services provided by GP&L and potable water provided by Guyana Water Inc.

5.9.1 ACCESS AND DRAINAGE

Primary access to any of the wards of Ruimveldt is by way of Mandela Avenue and Cemetery Road. Mandela Avenue links to Cemetery Road and to Sheriff Street which both of which link to the East Coast Demerara Highway. Mandela Avenue is also linked to the East Bank Demerara road which provides access to both downtown Georgetown and the East Bank Demerara area including the proposed site at Haags Bosch. There is one additional road passing through Ruimveldt which can be used to provide access to the East Bank road; East and West Front Roads.

Mandela Avenue is maintained by the Ministry of Public Works and was initially built as a road to bypass central Georgetown. There is consequently a steady flow of local traffic combined with larger trucks, buses and private vehicles traveling on this road through Georgetown which runs just east of the Mandela Site. The GoG has proposed the development of major new roads in the East Coast/East Bank area to improve transport conditions and to promote economic development. Roads are proposed to link Cheddi Jagan International Airport with Mandela Avenue and the East Coast Highway to this newly proposed road and with the existing Demerara Harbor Bridge to facilitate transit movements that now must pass through Georgetown.

There are internal roadways in each of the wards of Ruimveldt. These roads are well laid out and generally run in a regular north to south and east to west network. The primary access roads and roads in South and North Ruimveldt are relatively well maintained, however secondary roads are in poor condition. All roads in the area were initially paved or concreted, but the pavements have deteriorated both as a result of poor maintenance and inadequate drainage.

Drains in Ruimveldt run parallel to the primary internal roads. These drains all discharge to the Demerara River to the west of GM. The drains are maintained by the City Engineer's Department. Squatters are however congregated on embankments adjacent to these drains. Waste is thrown into the canals in squatting areas. Efforts to clear the drainage ditches are impeded by both the squatters and by the presence of waste.

5.10 LODGE

Lodge is located north and east of the Mandela Site. Some areas in Lodge are 50 m away from the dump. Lodge is an area of residential, commercial, and institutional development. This area of approximately 1.5 sq. miles is densely populated compared to elsewhere in Guyana with a population of approximately 12000 persons and with 1780 houses. Residences in the area range from small low income homes along Princess and Norton Streets to high income homes in Meadow Brook and Durban Backlands. Approximately 65 percent of the homes are undivided private homes. A small percent (5%) are multiple family dwellings. Some residents have modified their homes to provide some rental capacity and additional income.

Housing plots in the low income areas of Lodge itself tend to be less than 200 m² and several residents have added second houses to these lots either for rental or for family

members. As a result the housing density in Lodge itself is quite high. In the other wards of the area considered as Lodge lots are greater than 400 m² in size and the areas are better laid out with more space between adjacent homes. In Lodge proper, homes range from single level concrete dwellings to two storey buildings. In Durban Backlands and Meadow Brook homes are essentially single family dwellings. These homes were constructed in the early 1970s. Like elsewhere in Georgetown a large fraction of the original owners of homes in all wards have migrated and many residents of the area are tenants of these absentee landlords.

There is a relatively large open space in Lodge compared to elsewhere in Georgetown. Open spaces include the former Durban Park Turf Club and areas in Durban Backlands. These open spaces are, however poorly maintained and lands are covered with scrub vegetation in most instances. There are several sport and recreational facilities located in Lodge. These facilities include the National Sports Hall and Gymnasium. The facilities of the National Communication Network and the National Frequency Management Authority are also in this area.

Communities in Lodge are primary Afro-Guyanese with a small percentage of Indo-Guyanese and mixed ethnicity of varying social status and means. Practically all residents have at least a primary education. Some residents are university educated. Residents are professionals, GoG employees, small businessmen, and skilled and unskilled blue-collar workers.

There are some family owned businesses in these wards. These businesses which are mostly service oriented, include a funeral home, night clubs, grocery and general stores, mechanic shops, restaurants, supermarket and pharmacies. Unemployment levels in this area are relatively high compared to elsewhere in Guyana.

Public institutions in the area include the Guyana Lands and Surveys Commission, The National Cultural Center and several nursery and primary schools. Social amenities available to the area include telephone and facsimile services provided by GT&T, electricity services provided by GP&L and potable water provided by Guyana Water Inc.

5.10.1 ACCESS AND DRAINAGE

Primary access to any of the wards of Lodge is either by way of Mandela Avenue or Cemetery Road (extended Vlissengen Road). Lodge can also be accessed from

downtown Georgetown by Princess, Durban, Norton or Hadfield Street. These streets all link to Mandela Avenue at their extreme eastern end. Mandela Avenue provides access to both the East Coast and East Bank Demerara Highways.

There are internal roadways in each of the wards of Lodge. Several of these roads including Norton and Durban Streets were recently rehabilitated. Roads in the wards are well laid out and generally run in a regular north to south and east to west network. The primary access roads and roads in Durban Backlands and Meadow Brook are relatively well maintained, however some secondary roads are in poor condition. All roads in the area were initially paved, concreted or covered with clay bricks. Some pavements have deteriorated.

Drains in Lodge run parallel to the primary internal roads. These drains all discharge to the Demerara River to the west of GM. The drains are maintained by the City Engineer's Department. Drains bordering the Mandela Site are sometimes clogged with waste and with aquatic vegetation possibly as result of nutrients discharged from the dump to these drains. This leads to flooding in some wards during periods of heavy rainfall.

5.10.2 WASTE MANAGEMENT INFRASTRUCTURE

GM is divided into eleven collection zones. Ruimveldt, Lodge and La Penitence are located within Zones 5, 6, and 8, respectively. Waste is collected once per week from each community in these wards, by contracted waste haulers, and taken to the Mandela Site for disposal. Waste disposal costs are paid out of property taxes (PT) collected by GM. PT are established as a function of the rental value of properties. An appraisal is currently in progress to update the assessed value of properties in each ward of GM.

5.11 ECCLES/RAMSBURG NDC

Eccles/Ramsburg NDC is a mix of residential, industrial and commercial development. This NDC of approximately 2 sq. miles has about 6000 houses with a population of 20000 persons. The greater percent of homes in this NDC are single family homes. Major industries in the NDC include several gas stations, Noble House Seafoods, Sterling Products Limited, Georgetown Seafood and Trading Company and Demerara Oxygen Company Limited. An industrial estate was recently commissioned in Eccles. It is sited immediately east of the Eccles New Housing Scheme. Industries in the estate include garment manufacturing, engineering, electronics, pharmaceutical, food

processing, wood processing, chemical/plastic manufacturing and production of cement products (TPAS, 2001).

Lands in open spaces are either vacant/cultivated agricultural and pasture land and scrub vegetation. The largest land owner in this NDC is GuySuCo and sugar cane cultivation continues in the area formerly referred to as Diamond Estate. GuySuCo is one of the larger rate payers in the NDC.

Residents of this NDC work in Georgetown, for GuySuCo and for industries located in the NDC. Public sector jobs within the NDC are primarily in the educational, security and health sectors. In addition to the manufacturing and industrial sectors, commerce in the NDC is related to the operation of several family owned businesses. These businesses include used car dealerships, groceries, restaurants, supermarkets, hardware stores, and lumber yards.

There are several middle and upper income communities in this NDC. These include:

- Nandy Park;
- Republic Park;
- Continental Park;
- Eccles New Housing Scheme;
- New Providence; and
- Greenfield Park.

Nandy Park is a middle income area located to the west of Republic Park, just off the East Bank Public Road. Republic Park is a middle to upper income housing development which was established in the early 1970's and is located east and north of Nandy Park. This development consists of three distinct phases that are reflective of the time of construction. Continental Park is an upper income community located to the northern end of Phase Three of Republic Park. Section AA of the Eccles New Housing Scheme is a upper income development located immediately east of the East Bank Demerara Highway. New Providence and Greenfield Park are middle to upper income communities located at the extreme southern end of the NDC and east of the East Bank Demerara Highway.

The remainder of the NDC consists of a mix of low to middle income homes. These low and middle income homes are located mainly in Bagotstown, Peters Hall and Old Eccles.

There are several nursery and primary schools but no secondary school in this area. There is a single community center and five playgrounds that serve as public open spaces in this NDC.

The area is provided with potable water by Guyana Water Inc. (GWI) and telephone services are provided by GTT. Cellular phone services are also available in this area. Electricity services are provided by the Guyana Power and Light Company (GPL). There is no sewerage service in the area and sanitary facilities are either pit latrines or individual septic tanks.

5.11.1 ACCESS AND DRAINAGE

Access into this NDC is by the East Bank Highway. The East Bank Highway links Georgetown to communities along the East Bank Demerara and points further south and west including Linden and Lethem. There is a steady flow of local traffic combined with larger trucks, buses and private vehicles traveling on this major road through the NDC. The GoG has proposed the development of major new roads in the East Coast/East Bank area to improve transport conditions and to promote economic development. Roads are proposed to link Cheddi Jagan International Airport with Mandela Avenue and the East Coast Highway to this newly proposed road and with the existing Demerara Harbor Bridge to facilitate transit movements that now must pass through Georgetown. The eastern end of the Demerara Harbour Bridge is located in this NDC. These roads will enhance access to this NDC. There are several internal road networks in the communities of this NDC. A large fraction of these internal roads are paved.

The drainage infrastructure for the communities generally parallels the internal road network. These drains all discharge to the Demerara River to the west of the NDC. Complementary drainage capacity is provided for the NDC by GuySuCo drainage facilities that flow through the area. Some restrictions have, however, been imposed by GuySuCo to minimize the quantity of water from the NDC which flows into their system.

5.11.2 WASTE MANAGEMENT INFRASTRUCTURE

This NDC has contracted a waste hauler to pick up waste once every two weeks from communities within the NDC. This service is, however, only provided to paying customers in the Eccles New Scheme since this scheme has not been handed over to the

NDC and residents pay no property taxes. Wastes collected in this NDC are disposed at the Mandela Site. A tractor and trailer staffed by a crew of six individuals is used to pick up waste from inaccessible areas of the NDC. This waste is deposited at collection points for retrieval by the contracted waste hauler. This tractor and trailer is also used to clean roadway and verges of litter. Three truck loads of waste are collected every two weeks from serviced areas. Residents of un-serviced areas burn and/or bury their waste. Commercial generators and industries provide their own waste disposal services.

Waste disposal costs are paid out of property taxes (PT) collected by the NDC. PT are established as a function of the assessed value of properties. The date of the last property appraisal is not known, however a new valuation would be completed by December 2004. Property tax rates are respectively 15%, 45%, 60%, and 100% of the assessed value for residential, commercial, industrial and vacant land and farmlands. Waste management charges for the current year have been budgeted at approximately US \$16,500.00.

5.12 LITTLE DIAMOND/HERSTELLING NDC

Little Diamond/Herstelling NDC is a mix of residential and commercial development. This NDC of approximately 2 sq. miles has about 1000 houses with a population of 7500 persons. A large percentage of the houses are single family homes. Some residents of the NDC have modified their homes to provide rental capacity and additional income. Major industries in the NDC include Guyana Pharmaceutical Company (GPC), SAPIL, Guyana Stockfeeds, The National Edible Oil Company and National Hardware. There is a large fraction of open space in this NDC. Lands in open spaces are either vacant/cultivated agricultural and pasture land and scrub vegetation. The largest land owner in this NDC is GuySuCo and sugar cane cultivation continues in the area formerly referred to as Diamond Estate. GuySuCo is the largest rate payer in the NDC.

Residents of this NDC work in Georgetown, for GuySuCo and for industries located in the NDC. Public sector jobs within the NDC are primarily in the educational and health sectors. In addition to the manufacturing and industrial sectors, commerce in the NDC is related to the operation of small family owned businesses. These businesses include auto mechanic repairs shops, hardware stores and groceries.

This NDC consists of low to middle income communities. There is a community center, playground and other public open spaces in this NDC. There are several housing areas

within this NDC that were created by GuySuCo under the Sugar Industry Labour Welfare Fund (SILWF). These are low and middle income houses and are located mainly in Herstelling. There are several nursery and primary schools but no secondary school in this area.

The area is provided with potable water by Guyana Water Inc. (GWI) and telephone services are provided by GTT. Cellular phone services are also available in this area. Electricity services are provided by the Guyana Power and Light Company (GPL). There is no sewerage service in the area and sanitary facilities are either pit latrines or individual septic tanks.

5.12.1 ACCESS AND DRAINAGE

Access into this NDC is by the East Bank Highway. The East Bank Highway links Georgetown to communities along the East Bank Demerara and points further south and west including Linden and Lethem. There is steady flow of local traffic combined with larger trucks, buses and private vehicles traveling on this major road through the NDC. There are internal road networks in the NDC communities. A large fraction of the internal roads are paved as a result of work done under SILWF.

The drainage infrastructure for the communities generally parallels the internal road network. These drains all discharge to the Demerara River to the west of the NDC. Complementary drainage capacity is provided for the NDC by GuySuCo drainage facilities that flow through the area.

5.12.2 WASTE MANAGEMENT INFRASTRUCTURE

A tractor and trailer are used for waste collection. The trailer is manned by a driver and three labourers who are provided with cloaks and gloves. Four to five full loads are picked up each day. A large percentage of the waste is burned and buried by residents. There are frequent complaints from residents related to smoke and fumes from burning of waste. Every community in the area is serviced once per week with the exception of Herstelling which is serviced twice per week. Commercial generators and industries provide their own waste disposal services. Disposal of waste picked up by the NDC is in pits excavated adjacent to canals in the community. Waste is also periodically burned in these pits. The pits are monitored for vermin and vectors and are covered when full.

Waste disposal costs are paid out of property taxes (PT) collected by the NDC. PT are established as a function of the assessed value of properties. The last property appraisal was conducted two years ago and the PT rates as percentages of the assessed values are 0.375% for residential, 0.5% for commercial and 2.5% for industrial properties. PT collection rate is approximately 50%. The primary defaulters are the industries located in the NDC. Waste management charges for the immediate previous year were approximately US \$6,850.00.

5.13 MOCHA/ARCADIA NDC

Mocha/Arcadia is a residential development of approximately 600 houses and 2800 persons. A large percentage of the houses are single family homes. There are no industries in this NDC. There is a large fraction of open space in this NDC. Lands in open spaces are either vacant/cultivated agricultural and pasture land and scrub vegetation. The largest land owner in this NDC is GuySuCo and sugar cane cultivation continues in the area formerly referred to as Diamond Estate.

Residents of this NDC work in Georgetown, for GuySuCo and for industries located outside the NDC. Public sector jobs within the NDC are primarily in the educational and security sectors. Commerce in this NDC is related to the operation of small family owned businesses. These businesses are small groceries and an auto mechanic repairs shop.

The area is provided with potable water by Guyana Water Inc. (GWI) and telephone services are provided by GTT. Cellular phone services are also available in this area. Electricity services are provided by the Guyana Power and Light Company (GPL). There is no sewerage service in the area and sanitary facilities are either pit latrines or individual septic tanks.

5.13.1 ACCESS AND DRAINAGE

Access into this NDC is by the East Bank Highway and the Mocha/ Arcadia Access road. The community is isolated from the other areas on the East Bank Demerara and traffic flow to and through the area is minimal. The GoG has proposed the development of major new roads in the East Coast/East Bank area to improve transport conditions and to promote economic development. Roads are proposed to link Cheddi Jagan International Airport with the Mandela Avenue. The road to the Cheddi Jagan

International Airport will pass closer to this NDC than the current East Bank Demerara Highway and will enhance access to this NDC. There are internal roads in the NDC. The roads are relatively well maintained.

The drainage infrastructure for the communities generally parallels the internal road network. These drains all discharge to what is referred to as the No. 3 Canal before discharge to the Demerara River to the west of the NDC.

5.13.2 WASTE MANAGEMENT INFRASTRUCTURE

The NDC does not offer any waste management services to residents. Residents burn and/or bury their waste. There is some dumping of waste along parapets in the NDC. These are cleaned by residents as community projects. After removal the illegally dumped waste is burned. This is done on a quarterly basis. The waste dumped is primarily plastics, tins and other household waste. The volume of illegally dumped waste has increased greatly over the last two years. The access road to the NDC is a GoG road. There is a large quantity of dumping on this road by non residents of the NDC and by some waste collection companies. Waste disposed along the access road includes septic tank waste, auto bodies and construction debris.

5.14 GOLDEN GROVE/DIAMOND PLACE NDC

This NDC is a mixture of residential, commercial and industrial development. The NDC, with a total area of approximately 3 sq. mi. has approximately 2000 houses and a population of approximately 10000 persons. Approximately 500 of these houses are located in squatting areas. A large percentage of the houses are single family homes. Some residents of the NDC have modified their homes to provide some rental capacity and additional income. Major industries in the NDC include Demerara Distilleries (DDL) and GuySuCo. There is a large fraction of open space in this NDC. Lands in open spaces are either vacant/cultivated agricultural and pasture land and scrub vegetation. The largest land owner in this NDC is GuySuCo and sugar cane cultivation continues in the area formerly referred to as Diamond Estate. DDL is the largest rate payer in the NDC.

Residents of this NDC work in Georgetown, for GuySuCo and for industries located in the NDC. Public sector jobs within the NDC are primarily in the educational, health and security sectors. In addition to the manufacturing and industrial sectors, commerce in

the NDC is related to the operation of small family owned businesses. These businesses include auto mechanic repairs shops, furniture stores, auto and hardware stores and groceries.

This NDC consists of low to middle income communities. There is a community center, playground and other public open spaces in this NDC. There are several housing areas within this NDC that were created by GuySuCo under the Sugar Industry Labour Welfare Fund (SILWF). There are several nursery and primary schools but no secondary school in this area.

The area is provided with potable water by Guyana Water Inc. (GWI) and telephone services are provided by GTT. Cellular phone services are also available in this area. Electricity services are provided by the Guyana Power and Light Company (GPL). There is no sewerage service in the area and sanitary facilities are either pit latrines or individual septic tanks.

5.14.1 ACCESS AND DRAINAGE

Access into this NDC is by the East Bank Highway. The East Bank Highway links Georgetown to communities along the East Bank Demerara and points further south and west including Linden and Lethem. There is steady flow of local traffic combined with larger trucks, buses and private vehicles traveling on this major road through the NDC. The GoG has proposed the development of major new roads in the East Coast/East Bank area to improve transport conditions and to promote economic development. A road is proposed to link Cheddi Jagan International Airport with Mandela Avenue. This road will enhance access to this NDC. There are internal road networks in the NDC communities.

The drainage infrastructure for the communities generally parallels the internal road network. These drains all discharge to the Demerara River to the west of the NDC. Complementary drainage capacity is provided for the NDC by GuySuCo drainage facilities that flow through the area.

5.14.2 WASTE MANAGEMENT INFRASTRUCTURE

Solid waste is collected once per week from each community in the NDC. The program was developed after a pilot program was conducted in the NDC to determine waste

generation rates and the resources needed to manage that waste. As a result of that pilot study, a tractor and trailer was acquired and three labourers and a driver were hired on a full time basis for waste management. All waste management personnel are provided with personnel protective equipment which consists of raincoats, long boots, respirators and gloves. Approximately 2 – 2.5 tonnes of waste are collected each day. About 60% of waste collected is food waste.

There is very little burning or burying in the NDC since residents are aware of the pickup schedule and put out their waste for collection. The roads are in fair enough condition to enable access to all locations even during poor weather conditions. Waste is deposited in an open excavation about 200 m from residences. However the site is shielded from residents by a tree line. A waste monitor is posted at the site. A second waste monitor travels through the NDC to identify illegal waste disposal operations and to effect corrective actions.

There is a small amount of illegal dumping by people driving through the NDC. Waste disposal costs are paid out of property taxes (PT) collected by the NDC. PT are established as a function of the assessed value of properties. The last property valuation was conducted in 2003. PT rates range from 5% to 47% of assessed values for residential and commercial rate payers respectively. The largest rate payers in this NDC are Demerara Distilleries Limited (DDL) and GuySuCo. Waste management charges have been budgeted at approximately US \$12,300.00 for this year.

5.15 CALEDONIA/GOOD SUCCESS NDC

Caledonia/Good Success NDC is a mix of rural residential and commercial development. This NDC of approximately 30 sq. miles has about 2000 houses with an estimated population (2002) of approximately 7500 persons. A large percentage of the houses are single family homes. Large commercial establishments in the NDC include Barama Company Limited (BCL) and Gafoor and Sons. Lands in open spaces are either vacant/cultivated agricultural and pasture land and scrub vegetation. Several residents rear farm animals and also maintain kitchen gardens and cultivated fruit trees adjacent to their homes.

This is a large farming community. Some residents, however, work in Georgetown and for industries located in the NDC. Public sector jobs within the NDC are primarily in the educational sectors. In addition to the manufacturing and industrial sectors,

commerce in the NDC is related to the operation of small family owned businesses and farming. Family owned businesses are primarily groceries.

This NDC consists of low to middle income communities. Squatting is minimal in this NDC. There is a community center and playground and other public open spaces in this NDC. There are several schools in this area.

The area is provided with potable water by Guyana Water Inc. (GWI) and telephone services are provided by GTT. Cellular phone services are also available in this area. Electricity services are provided by the Guyana Power and Light Company (GPL). There is no sewerage service in the area and sanitary facilities are either pit latrines or individual septic tanks.

5.15.1 ACCESS AND DRAINAGE

Access into this NDC is by the East Bank Highway. The East Bank Highway links Georgetown to communities along the East Bank Demerara and to points further south and west including Linden and Lethem. There is a steady flow of local traffic combined with larger trucks, buses and private vehicles traveling on this major road through the NDC.

There are internal road networks in the NDC communities. A small fraction of the internal roads are paved. The greater percentage of the internal road network are dirt roads which are potholed and are only capable of providing fair weather access. In addition, some roads are only wide enough to accommodate the passage of traffic in one direction. Drainage infrastructure for the communities generally parallels the internal road network. These drains all discharge to the Demerara River to the west of the NDC.

5.15.2 WASTE MANAGEMENT INFRASTRUCTURE

There is no structured solid waste management in this NDC. BCL has indicated a willingness to donate 20 acres (8 ha) of land to the NDC for waste disposal. The EPA advice on landfilling requirements has resulted in the costs for development being prohibitive. Residents either burn or bury their waste. The NDC collects waste illegally dumped in the NDC using a tractor and trailer. This waste which is primarily plastic, paper and cardboard is burnt. Volume estimates for waste generated by the NDC is not available due to lack of structured collection.

Golden Grove/Diamond NDC has invited this NDC to share its dump. That dump abuts several houses and the option was not exercised. The culture of burning and burying is well established in this NDC and consequently internal drains are free of waste.

The NDC has a program of interaction with school and plans to donate bins to each school as part of their efforts to modify attitudes about waste management. Enforcement against illegal dumping is minimal since no facility is available for public use. Large businesses truck their waste to Mandela Site.

5.16 SOESDYKE/HUIST TE COVERDEN NDC

Soesdyke/Huist Te Coverden NDC is a mixture of rural residential and small commercial development. This NDC of approximately 5 sq. miles has about 1200 houses with an estimated population of approximately 7000 persons. A large percentage of the houses are single family homes. There are no large commercial/industrial establishments in this NDC. Lands in open spaces are either vacant/cultivated agricultural and pasture land and scrub vegetation. Several residents rear farm animals and also maintain kitchen gardens and cultivate fruit trees adjacent to their homes. There are two sawmills and six poultry farms in the area.

This is a large farming community. Some residents, however, work in Georgetown and for industries located in the NDC. Public sector jobs within the NDC are primarily in the educational sectors. Commerce in this NDC is related to the operation of small family owned businesses and farming. Family owned businesses are primarily groceries, sawmills and poultry farms. This NDC consists of low to middle income communities. There are no community centers or public playgrounds in this area. However there are several open spaces in this NDC. There are two primary schools in this area, one community high school and a single private school providing nursery, primary and secondary education. There are two hotels in this NDC; The Prairie Inn and La Chalet.

The area is provided with potable water by Guyana Water Inc. (GWI) and telephone services are provided by GTT. Cellular phone services are also available in this area. Electricity services are provided by the Guyana Power and Light Company (GPL). There is no sewerage service in the area and sanitary facilities are either pit latrines or individual septic tanks.

5.16.1 ACCESS AND DRAINAGE

Access into this NDC is by the East Bank Highway. The East Bank Highway links Georgetown to communities along the East Bank Demerara and to points further south and west including Linden and Lethem. There is a steady flow of local traffic combined with larger trucks, buses and private vehicles traveling on this major road through the NDC.

There are no internal road networks in this NDC. Communities are concentrated along the East Bank Demerara Highway. Drainage infrastructure for the communities generally runs perpendicular to the East Bank Demerara Road. These drains all discharge to the Demerara River to the west of the NDC.

5.16.2 WASTE MANAGEMENT INFRASTRUCTURE

There is no structured solid waste management in this NDC. Residents either burn or bury their waste. There is significant dumping of waste in drains in the NDC. This waste is primarily plastic, paper and cardboard. The NDC does not have a program to collect illegally disposed waste since it lacks any waste collection plant. Volume estimates for waste generated by the NDC are not available due to lack of structured collection.

5.17 LA GRANGE/NISMES NDC

La Grange/Nismes NDC is primarily rural residential and small scale commercial development. This NDC of approximately 6 sq. miles has about 3000 houses with an estimated population of approximately 9000 persons. A large percentage of the houses are single family homes. A very small number of residents of the NDC have modified their homes to provide some rental capacity and additional income. There are no large commercial enterprises in this NDC. Commercial enterprises consist of a furniture factory, a food processing plant, a lumber yard and several small machine shops. Lands in open spaces are either vacant/cultivated agricultural and pasture land and scrub vegetation. Several residents rear farm animals and also maintain kitchen gardens and cultivate fruit trees adjacent to their homes.

This is a large farming community. Rice farming is the primary agricultural activity. Approximately 55% of employed residents works in Georgetown, 35% are involved as farmers and the remainder is involved in family run businesses. Family owned businesses are primarily groceries. Public sector jobs within the NDC are primarily in the educational sectors.

Communities in this NDC are mostly low to middle income. There is a small squatting area of about 20 homes in an area referred to as Riverview. There is one community center, two playgrounds and other public open spaces in this NDC. There are no secondary schools in this area, however there are three nursery and three primary schools in this NDC.

The area is provided with potable water by Guyana Water Inc. (GWI) and telephone services are provided by GTT. Cellular phone services are also available in this area. Electricity services are provided by the Guyana Power and Light Company (GPL). There is no sewerage service in the area and sanitary facilities are either pit latrines or individual septic tanks.

5.17.1 ACCESS AND DRAINAGE

The NDC is on the West Bank Demerara and it is accessed by the West Bank Demerara Road which is linked to Georgetown and Eccles by the East Bank Highway and the Demerara Harbour Bridge. The West Bank Highway links this NDC to other NDCs in Region 3 and to Parika on the Essequibo River.

There are few internal roads in this NDC. Homes are located mainly along the main roadway. Access to the few internal roads is poor during wet periods. These roads are dirt roads which are only wide enough to accommodate the passage of traffic in one direction. Drainage infrastructure for the communities generally parallels the internal road network. These drains all discharge to the Demerara River to the east of the NDC.

5.17.2 WASTE MANAGEMENT INFRASTRUCTURE

There is no structured solid waste management in this NDC. Residents burn and bury most of their waste. Some plastic and paper is improperly disposed in drains. Volume estimates for waste generated by the NDC are not available due to lack of structured collection. Commercial establishments dispose of waste in back of their properties.

Enforcement against illegal dumping is minimal since no facility is available for public use.

5.18 MALGRE TOUT/MEER-ZORGEN NDC

Malgre Tout/Meer Zorgen NDC is a mix of rural residential and commercial development. This NDC of approximately 8 sq. miles has about 4000 houses with an estimated population of approximately 15000 persons. Major industries in this NDC include a rice milling complex and a power generating station owned and operated by Guyana Power and Light Inc. There is a large fraction of open space in this NDC. Lands in open spaces are either vacant/cultivated agricultural and pasture land and scrub vegetation. Several residents rear farm animals and also maintain kitchen gardens and cultivate fruit trees adjacent to their homes. The largest land owners in this NDC are rice farmers. Sugar cane cultivation was discontinued in the area.

Residents of this NDC work primarily in Georgetown. There are some public sector jobs within the NDC in the educational, health and security sectors. Commerce in the NDC is related primarily to the operation of small family owned businesses. These businesses include auto mechanic repairs shops, hardware stores and groceries.

There are several middle and upper income communities in this NDC. These include as follows:

- Roraima Housing area; and
- Crystal Springs Gardens.

Both are located west of the West Bank Demerara roadway. There are several additional well-established areas of low and middle-income housing, a community center, two playgrounds and other public open spaces in this NDC. There is one large squatting area of about 145 house abutting the West Bank Demerara Road in this NDC. There are several housing areas within this NDC that were created by GuySuCo under the Sugar Industry Labour Welfare Fund (SILWF). There are several nursery and primary schools but no secondary school in this area.

The area is provided with potable water by Guyana Water Inc. (GWI) and telephone services are provided by GTT. Cellular phone services are also available in this area. Electricity services are provided by the Guyana Power and Light Company (GPL).

There is no sewerage service in the area and sanitary facilities are either pit latrines or individual septic tanks.

5.18.1 ACCESS AND DRAINAGE

The NDC is on the West Bank Demerara and it is accessed by the West Bank Demerara Road which is linked to Georgetown and Eccles by the East Bank Highway and the Demerara Harbour Bridge. The West Bank Highway links this NDC to other NDCs in Region 3 and to Parika on the Essequibo River. There is steady flow of local traffic combined with larger trucks, buses and private vehicles traveling on this major road through the NDC. The GoG has proposed the development/reconstruction of the major road through this NDC to improve transport conditions and to promote economic development. These roads will enhance access to this NDC.

There are few internal roads in this NDC. Homes are located mainly along the main roadway. Access to the few internal roads is poor during wet periods. These roads are dirt roads which are only wide enough to accommodate the passage of traffic in one direction. Drainage infrastructure for the communities generally parallels the internal road network. These drains all discharge to the Demerara River to the east of the NDC.

5.18.2 WASTE MANAGEMENT INFRASTRUCTURE

There is no structured solid waste management in this NDC. Residents burn and bury most of their waste. Some plastic and paper is improperly disposed in drains. Volume estimates for waste generated by the NDC are not available due to lack of structured collection. Enforcement against illegal dumping is minimal since no facility is available for public use.

5.19 HASLINGTON/GROVE NDC

Haslington/Grove NDC is a mixture of rural residential and commercial development. The NDC has a total area of 16 mi² with 6000 houses. The population of the area is approximately 20000 persons. A major proportion of the houses are single family homes. There is a large fraction of open space in this NDC. Lands in open spaces are either vacant/cultivated agricultural and pasture land and scrub vegetation. This NDC is primarily a farming community, however, irrigation and drainage facilities are in a

state of disrepair and this has reduced farm output and has resulted in high unemployment in the NDC. Several residents rear farm animals and also maintain kitchen gardens and cultivate fruit trees adjacent to their homes. The largest land owner in this NDC is GuySuCo and sugar cane cultivation continues in the area formerly referred to as Enmore Estate.

Residents of this NDC are either self-employed or work in Georgetown and for GuySuCo. There are some public sector jobs within the NDC in the educational, health and security sectors. Commerce in the NDC is related primarily to the operation of small family owned businesses. These businesses include auto mechanic repairs shops, groceries, an internet cafe, auto dealership and furniture manufacturing.

There are several well-established areas of low and middle-income housing, two community centers, five playgrounds and other public open spaces in this NDC. There are several nursery and primary schools and three secondary schools in this area including the highly regarded President's College.

The area is provided with potable water by Guyana Water Inc. (GWI) and telephone services are provided by GTT. Cellular phone services are also available in this area. Electricity services are provided by the Guyana Power and Light Company (GPL). There is no sewerage service in the area and sanitary facilities are either pit latrines or individual septic tanks. There are several cemeteries in this NDC affiliated to the various faiths.

5.19.1 ACCESS AND DRAINAGE

Access into this NDC is by the East Coast Highway. The East Coast Highway links Georgetown to communities along the East Coast of Guyana such as Mahaica, New Amsterdam, Rose Hall and Corriverton. As such, there is a steady flow of local traffic combined with larger trucks, buses and private vehicles traveling on this major road through the NDC.

There are several internal road networks in the NDC communities. A small fraction of the internal roads are paved. The greater percentage of the internal road network are dirt roads which are potholed and are only capable of providing fair weather access.

The drainage infrastructure for the communities generally parallels the internal road network. There are thirty one primary drainage canals in this NDC which all discharge

to the Atlantic Ocean. The Drainage and Irrigation Board is responsible for maintenance of all these canals. The NDC maintains several shallow drains which discharge to the primary canals. There is, however, some flooding in the area during heavy rainfall periods.

5.19.2 WASTE MANAGEMENT INFRASTRUCTURE

The NDC does not provide a formal waste collection service to residents at present. It is proposed to commence waste collection services in January 2005. The NDC has a tractor and trailer which will be used for waste collection after this program commences. A schedule will be developed to ensure service is provided to all communities in the NDC. A fee will be attached to the property taxes to cover waste management. A preliminary assessment has established that residents are willing to pay G\$500/month for waste disposal. Waste will be disposed in an abandoned canal or in a pit excavated on NDC land.

A waste hauler presently offer waste collection services in the NDC and along the East Coast Demerara. A fee of G\$700/month is charged for a once per month pickup. It is estimated that approximately 3 tonnes of waste is picked up each month by this service provider. Residents in the NDC who do not use the waste hauling service generally burn their waste. However a large amount of waste is dumped in the area at street corners and in canals. No service is provided to clean up these areas and waste stays in place at these points.

5.20 ENMORE/HOPE NDC

Enmore/Hope NDC is a mixture of rural residential, institutional and commercial development. The NDC has a total area of 2.5 mi² with 1100 houses and a small squatting area of 30 houses. The population of the area is approximately 7000 persons. A major proportion of the houses are single family homes. There is a large fraction of open space in this NDC. Lands in open spaces are either vacant/cultivated agricultural and pasture land and scrub vegetation. Several residents rear farm animals and also maintain kitchen gardens and cultivate fruit trees adjacent to their homes. The largest land owner in this NDC is GuySuCo and sugar cane cultivation continues in the area formerly referred to as Enmore Estate. The company however no longer has any sugar processing capacity in the area.

Residents of this NDC work in Georgetown and for GuySuCo. There are some public sector jobs within the NDC in the educational, health and security sectors. Commerce in the NDC is related primarily to the operation of small family owned businesses. These businesses include auto mechanic repairs shops, hardware stores, groceries, lumber yards and furniture manufacturing, with the largest of these being the Enmore Ice Company and Shiva Woodworking Establishment. Guyana Telephone and Telegraph Company (GTT) and Celstar both have a repeater station in this NDC.

There are several well-established areas of low and middle-income housing, a community center, playground and other public open spaces in this NDC. Newer residences and several small shops have been built along the Railway Embankment Road since its construction. There are several housing areas within this NDC that were created by GuySuCo under the Sugar Industry Labour Welfare Fund (SILWF). These are low and middle income houses and are located mainly in Enmore. There are several nursery and primary schools but no secondary school in this area.

The area is provided with potable water by Guyana Water Inc. (GWI) and telephone services are provided by GTT. Cellular phone services are also available in this area. Electricity services are provided by the Guyana Power and Light Company (GPL). There is no sewerage service in the area and sanitary facilities are either pit latrines or individual septic tanks. A cemetery is located on the East Coast Highway in Enmore.

5.20.1 ACCESS AND DRAINAGE

Access into this NDC is by either the East Coast Highway or the Railway Embankment Road. Rehabilitation of the East Coast Highway entailed abandonment of a section of this road and creation of a new alignment through this NDC. The construction of the Railway Embankment Road between Enmore and Georgetown has provided an alternate route between Georgetown and the NDC. This route has contributed to reduced travel times and traffic congestion, for residents and industries in this area. The East Coast Highway and the Railway Embankment Road both link Georgetown to communities along the East Coast of Guyana such as Mahaica, New Amsterdam, Rose Hall and Corriverton. As such, there is steady flow of local traffic combined with larger trucks, buses and private vehicles traveling on the major roads in the NDC.

There is an internal road network in the NDC communities. A small fraction of the internal roads are paved. The greater percentage of the internal roads is dirt roads which are potholed and are only capable of providing fair weather access.

The drainage infrastructure for the communities generally parallels the internal road network. These drains all discharge to the Atlantic Ocean. Complementary drainage capacity is provided for the NDC by GuySuCo drainage facilities that flow through the area. There is, however, some flooding in the area during heavy rainfall periods.

5.20.2 WASTE MANAGEMENT INFRASTRUCTURE

Waste is collected by tractor and trailer four days each week with each community being serviced once weekly. Two labourers are employed to load waste onto the trailer. Approximately 16 tonnes per month of waste is collected for disposal with 70% being organic waste, 10% being plastic waste and the remainder being commercial and construction and demolition debris. Labourers are provided with gloves, long boots, cutlasses, respirators and picks and shovels. Waste is disposed in an area adjacent to Enmore Sugar Factory and to the GWI wellhead. The waste is periodically burned when weather conditions permit. Illegal dumping occurs in the NDC in spite of collection services. Most illegal dumping is by commercial establishments in the NDC. A recent development has seen the dumping of used imported tyres on roads running through the NDC. A significant quantity of old car chassis and other waste has been dumped along the abandoned section of the former East Coast Highway. Drainage problems occur due to disposal of waste and plastics in drainage canals. The canals must be cleared every month to ensure effective drainage.

Waste disposal costs are paid out of property taxes (PT) collected by the NDC. PT are established as a function of the value of properties. The rate is currently 0.45% of property values. The last valuation was conducted in 1975. At that time the total assessed value of all properties was \$2,500,000.00. The rate of PT collection ranges from 80 – 85 percent.

No enforcement action is undertaken by NDC since the costs for enforcement including legal fees are significantly less than penalties meted out to defaulters. The NDC has attempted to sensitize people to waste management problems by distributing pamphlets in homes in the NDC, but has seen no improvements in the attitude of residents as a result of this program.

5.21 BUXTON/FOULIS NDC

Buxton/Foulis is a mixture of residential, institutional and commercial development. The NDC has a total area of approximately 16 square miles with 7000 houses. The population of the NDC is approximately 21000. A major proportion of the houses are single family homes. Some residents in the lower income areas of the NDC have modified their homes to provide some rental capacity and additional income.

The Coldingen Industrial estate and several new housing developments are located in this NDC. Industries located in the Coldingen Industrial Estate include Guyana Brake and Clutch Company, Denmor Garment Factory, GuySuCo Stores and Warehouse, Dipcon Engineering Services, Gayadin Concrete Block Factory and the Rubex Aluminum Window Factory.

There is a large fraction of open space in this NDC. Lands in open spaces are either vacant/cultivated agricultural and pasture land and scrub vegetation. Several residents rear farm animals and also maintain kitchen gardens and cultivate fruit trees adjacent to their homes. The largest land owner in this NDC is GuySuCo and sugar cane is cultivated in the backlands of the NDC. The company, however, has no sugar processing capacity in the area.

Residents of this NDC work primarily in Georgetown, for GuySuCo and for industries in the area. Several residents are also self-employed as farmers. There are some public sector jobs within the NDC in the educational, health and security sectors. Commerce in the NDC is related primarily to the operation of small family owned businesses. These businesses include auto mechanic repairs shops, hardware stores, groceries, fuel stations, bars and restaurants.

There are several middle income communities in this NDC. These include as follows:

- Non Pariel East;
- Naitram Housing Development;
- Enterprise and
- Dazell Scheme.

Non Pariel East and Enterprise east are middle income housing areas created by the GoG housing drive. Non Pariel east was initially a series of prefabricated houses built under contract. These houses have been significantly modified and upgraded.

Additional houses were built in the area both by a developer and by individuals provided with land as part of the GoG housing drive. Naitram Housing Development is located south of the East Coast Demerara Highway. This area was created by a private developer and homes were sold to individuals who upgraded several of these houses. Dazell Scheme was built by a cooperative society and consists of low and middle income homes west of the Embankment road.

There are several well-established areas of low income housing, a community center, playground and other public open spaces in this NDC. Newer residences and several small shops have been built along the Railway Embankment Road since its construction. There is some squatting primarily in areas abutting the Railway Embankment Road. There are several nursery and primary schools in this area. The Bladen Hall Multilateral School is located in this NDC.

The area is provided with potable water by Guyana Water Inc. (GWI) and telephone services are provided by GTT. Cellular phone services are also available in this area. Electricity services are provided by the Guyana Power and Light Company (GPL). There is no sewerage service in the area and sanitary facilities are either pit latrines or individual septic tanks. Cemeteries are located on the East Coast Highway in Friendship and Paradise.

5.21.1 ACCESS AND DRAINAGE

Access into this NDC is by either the East Coast Highway or the Railway Embankment Road. The East Coast Highway and the Railway Embankment Road both link Georgetown to communities along the East Coast of Guyana such as Mahaica, New Amsterdam, Rose Hall and Corriverton. As such, there is steady flow of local traffic combined with larger trucks, buses and private vehicles traveling on the major roads in the NDC. There are internal roads in the NDC communities. A small fraction of the internal roads are paved, with areas of paved roads being primarily Melanie Damishana, Enterprise and Enterprise East. In general paved roads tend to run between the East Coast Highway and the Embankment road. Unpaved roads in the NDC are surfaced either with burnt earth or sand and loam. These roads are potholed in places and are only capable of providing fair weather access.

The construction of the Railway Embankment Road between Enmore and Georgetown has provided an alternate route between Georgetown and the NDC. This route has contributed to reduced travel times and traffic congestion, for residents and industries in

this area. The driveways of homes in The Naitram Housing area lead directly to the East Coast Highway and access unto this roadway by residents has tended to cause localized traffic bottlenecks in the area.

The drainage infrastructure for communities generally parallels the internal road network. These drains all discharge to the Atlantic Ocean. Complementary drainage capacity is provided for the NDC by GuySuCo drainage facilities that flow through the area. In spite of the complementary capacity flooding still occurs in most communities within the NDC.

5.21.2 WASTE MANAGEMENT INFRASTRUCTURE

The NDC collects waste five days each week using a tractor trailer. Each community is serviced at least once per week. However no service is provided in the new housing areas and the industrial estate since these areas have not been "handed over" to the NDC and do not pay property taxes. This lack of services has induced some dumping of waste in areas within and adjacent to communities such as Non Pariel East, Enterprise and Dazell Scheme.

The waste collection trailer is manned by 2 labourers who are provided with gloves, long boots and rain coats. Waste generation rate is approximately 2 - 2.5 tonnes/day. All waste generated in serviced areas is not collected since a large proportion of the waste is either burned or buried by residents. There is significant illegal dumping by residents of the area. Waste collected by the NDC is disposed in pits excavated adjacent to the foreshore and in a trench GuySuCo has identified for filling in one of the communities of the NDC.

Waste disposal costs are paid out of property taxes (PT) collected by the NDC. PT are established as a function of the rental value of properties. An appraisal was last conducted in 2001. The range of property taxes is Guy\$1000 - Guy \$5000 per year. The collection rate for property taxes is approximately 80%. No enforcement action is undertaken by NDC since the costs for enforcement including legal fees are significantly less than penalties meted out to defaulters. This NDC was unable to provide a cost for waste management services.

5.22 MON REPOS/LE RECONNAISSANCE NDC

Mon Repos/Le Reconnaissance NDC is a mixture of residential, institutional and commercial development. The number of residences in this NDC is approximately 2200 with an estimated population of 15000. A major proportion of the houses are single family homes. Some residents in the lower income areas of the NDC have modified their homes to provide some rental capacity and additional income. Commercial enterprises in the NDC are primarily family owned businesses. Family owned businesses include lumber and concrete block yards, hardware, furniture and grocery stores, bars and restaurants, an internet café, a car wash, several used car and truck dealers and a large auto spares warehouse. Major industries in this NDC are GuySuCo, IEL, Uniplastics and General Fiberglass Works.

There is a large fraction of open space in this NDC. The Lusignan Golf Club is located in this NDC. Lands in open spaces are either vacant/cultivated agricultural and pasture land and scrub vegetation. Several residents rear farm animals and also maintain kitchen gardens adjacent to their homes. The largest land owner in this NDC is GuySuCo and sugar cane is cultivated in the backlands of the NDC. The company, however, has no sugar processing capacity in the area.

Residents of this NDC work in Georgetown, for GuySuCo and are self employed as farmers and shopkeepers. There are some public sector jobs within the NDC in the educational and agricultural sectors. Commerce in the NDC is related primarily to the operation of small family owned businesses. These businesses include auto mechanic repairs shops, hardware stores and groceries.

There are several new communities in this NDC. These are located immediately west of the embankment road in Annandale and Lusignan and east of the Mon Repos Access road. All are low income housing areas created by the GoG housing drive. There are several well-established areas of low and middle-income housing, a community center, playground and other public open spaces in this NDC. Newer residences and several small shops have been built along the Railway Embankment Road since its construction. There is some squatting primarily in areas abutting the Railway Embankment Road. There are several housing areas within this NDC which were created by GuySuCo under the Sugar Industry Labour Welfare Fund (SILWF). There are several nursery and primary schools in this area. A private school in this NDC; Central Demerara Academy; provides nursery, primary and secondary education.

The Guyana School of Agriculture and the National Agricultural Research Institute (NARI) are located in Mon Repos. The area is provided with potable water by Guyana Water Inc. (GWI) and telephone services are provided by GTT. Cellular phone services are also available in this area. Electricity services are provided by the Guyana Power and Light Company (GPL). There is no sewerage service in the area and sanitary facilities are either pit latrines or individual septic tanks. A cemetery is located on the East Coast Highway in Lusignan. The Lusignan Prisons are also located in this NDC.

5.22.1 ACCESS AND DRAINAGE

Access into this NDC is by either the East Coast Highway or the Railway Embankment Road. The East Coast Highway and the Railway Embankment Road both link Georgetown to communities along the East Coast of Guyana such as Mahaica, New Amsterdam, Rose Hall and Corriverton. The Mon Repos market is located on the East Coast Roadway and tends to impede the passage of traffic on weekends. The construction of the Railway Embankment Road between Enmore and Georgetown has provided an alternate route between Georgetown and the NDC. This route has contributed to reduced travel times and traffic congestion, for residents and industries in this area. As such, there is steady flow of local traffic combined with larger trucks, buses and private vehicles traveling on the major roads in the NDC.

There are internal roads in the NDC communities. A small fraction of the internal roads are paved. In general the paved roads all extend from the East Coast Highway to the embankment roadway. The greater percent of the internal roads are dirt roads which are potholed and are only capable of providing fair weather access.

The drainage infrastructure for the communities generally parallels the internal road network. These drains all discharge to the Atlantic Ocean. Complementary drainage capacity is provided for the NDC by GuySuCo drainage facilities that flow through the area.

5.22.2 WASTE MANAGEMENT INFRASTRUCTURE

The NDC shares a waste disposal site with BV/Triumph NDC. Two tractor trailers are used for house to house collections, with collection taking place once every two weeks. Approximately 4-5 tonnes/day of waste are collected. A backhoe is also available to the NDC to aid with waste management operations. A driver and two labourers are

assigned to each tractor and trailer. Labourers are provided with gloves, long boots, respirators, forks and baskets for retrieval of plastic bottles from drains. Some residents still burn garbage in spite of waste collection.

Commercial generators are allowed to use the waste dump. However they are responsible for hauling their own waste or must pay a separate fee for collection and disposal. There is considerable illegal dumping on both roads and in the cemetery in the NDC. One person is employed on a full time basis to clean drains primarily because of plastic bottles.

Waste disposal costs are paid out of property taxes (PT) collected by the NDC. PT are based on a classification of the size of the property. The last valuation was conducted in 1975. The rate collection is approximately 56% with most of the funds coming from the large rate payers such as GuySuCo and IEL. A total of approximately US \$16,162.00 was expended on waste management services for 2003.

No enforcement action is undertaken by NDC since the costs for enforcement including legal fees are significantly less than penalties meted out to defaulters. The NDC has attempted to sensitize people to waste management problems by distributing pamphlets in homes in the NDC, but has seen no improvements in the attitude of residents as a result of this program.

5.23 BETERVERWAGTING/TRIUMPH NDC

Beterverwagting/Triumph NDC is a mixture of residential, institutional and commercial development. The area of BV/Triumph NDC is approximately 12 mi². It has a total of 2000 houses and a population of approximately 20000 persons. A major proportion of the homes in this NDC are single family homes. Some residents of the NDC have modified their homes to provide some rental capacity and additional income. Major industries in this NDC include the Guyana Furniture Manufacturing Company and a large bakery (Bakewell). GTT also has a large installation in this NDC. A telecenter; Atlantic Telecenter Inc. is also located in the area.

There is a large fraction of open space in this NDC. Lands in open spaces are either vacant/cultivated agricultural and pasture land and scrub vegetation. Several residents rear farm animals and also maintain kitchen gardens and cultivate fruit trees adjacent to their homes. The largest land owner in this NDC is GuySuCo and sugar cane cultivation continues in the area. GuySuCo has no sugar processing capacity in the area.

Residents of this NDC work primarily in Georgetown, for GuySuCo or are self-employed. There are some public sector jobs within the NDC in the educational, health and security sectors. Commerce in the NDC is related primarily to the operation of small family owned businesses. These businesses include auto mechanic repairs shops, hardware stores, groceries and a television station.

There are several areas of low and middle-income housing, a community center, playground and other public open spaces in this NDC. Newer residences and several small shops have been built along the Railway Embankment Road since its construction. There are several nursery and primary schools but no secondary school in this area.

The area is provided with potable water by Guyana Water Inc. (GWI) and telephone services are provided by GTT. Cellular phone services are also available in this area. Electricity services are provided by the Guyana Power and Light Company (GPL). There is no sewerage service in the area and sanitary facilities are either pit latrines or individual septic tanks. A cemetery is located on the East Coast Highway in Triumph and on the Embankment Roadway in Betoverwagting.

5.23.1 ACCESS AND DRAINAGE

Access into this NDC is by either the East Coast Highway or the Railway Embankment Road. The East Coast Highway and the Railway Embankment Road both link Georgetown to communities along the East Coast of Guyana such as Mahaica, New Amsterdam, Rose Hall and Corriverton. The construction of the Railway Embankment Road between Enmore and Georgetown has provided an alternate route between Georgetown and the NDC. This route has contributed to reduced travel times and traffic congestion, for residents and industries in this area. As such, there is a steady flow of local traffic combined with larger trucks, buses and private vehicles traveling on the major roads in the NDC.

There are internal roads in the NDC. A small fraction of the internal roads are paved. The greater percentage of the internal road network are dirt roads which are potholed and are only capable of providing fair weather access.

The drainage infrastructure for the communities generally parallels the internal road network. These drains all discharge to the Atlantic Ocean. Complementary drainage capacity is provided for the NDC by GuySuCo drainage facilities that flow through the

area. The area west of the embankment road experiences some flooding in spite of the additional drainage capacity provided by GuySuCo.

5.23.2 WASTE MANAGEMENT INFRASTRUCTURE

Waste is collected by a tractor and trailer. The NDC employs four labourers for waste pickup. Labourers are provided with gloves, long boots, respirators and raincoats. The frequency of pickup is once weekly. Approximately 2.5 tonnes/day of waste are collected each day. The collection equipment cannot access several locations. However, NDC employees are paid an additional fee for removing waste from such areas. Residents pay a waste disposal levy of \$100/month or \$1000/year for collection and disposal. Compliance is approximately 50%. Some residents do not pay since they claim to burn and bury their waste. There are, however, several complaints from residents about the burning of waste. The NDC maintain a crew specifically for cleaning drains which are cleaned 12 times/year because of illegal dumping. A sum of approximately US \$4,900.00 was expended on waste management services in 2003.

5.24 BETTER HOPE/LA BONNE INTENTION NDC

Better Hope/La Bonne Intention (LBI) is a mixture of residential, institutional and commercial development. The NDC has a total area of approximately 4 square miles with 9000 houses. The population of the NDC is approximately 30000. A major proportion of the houses are single family homes. Commercial enterprises in the NDC are primarily family owned businesses. Family owned businesses include gas stations, lumber yards, hardware and grocery stores, bars and restaurants.

Several industrial establishments are located in this NDC. These industries include Courts Furniture Warehouse, mmC Group headquarters, food processing companies, and an agricultural parts and machinery distribution company. The Grand Coastal Inn is located on the East Coast Highway. GuySuCo LBI sugar factory is located in this area and is the only processing facility in East Demerara.

There is a large fraction of open space in this NDC. Lands in open spaces are either vacant/cultivated agricultural and pasture land and scrub vegetation. Several residents rear farm animals and also maintain kitchen gardens adjacent to their homes. The largest land owner in this NDC is GuySuCo and sugar cane is cultivated in the backlands of the NDC.

Residents of this NDC work primarily in Georgetown, for GuySuCo and for industries in the area. There are some public sector jobs within the NDC in the educational and health sectors. Commerce in the NDC is related primarily to the operation of small family owned businesses. These businesses include auto mechanic repairs shops, hardware stores, groceries and fuel stations.

There are several middle to upper income communities in this NDC. These include as follows:

- Atlantic Gardens;
- Happy Areas;
- Felicity East; and
- Earls Courts.

Atlantic Gardens and Happy Acres are located south of the East Coast Demerara Highway. Felicity East is located north of the East Coast Demerara Highway and Earls Court is located south of the new roadway built along the former East Coast Railway embankment and east of the LBI estate Access Road.

There are several well-established areas of low income housing, two community centers, two playgrounds and other public open spaces in this NDC. Newer residences and several small shops have been built along the Railway Embankment Road since its construction. There is some squatting primarily in areas abutting the Railway Embankment Road. There are several nursery and primary schools in this area, but no secondary school. The Apex Academy and the Islamic Academy provide private education in this area.

The area is provided with potable water by Guyana Water Inc. (GWI) and telephone services are provided by GTT. Cellular phone services are also available in this area. Electricity services are provided by the Guyana Power and Light Company (GPL). There is no sewerage service in the area and sanitary facilities are either pit latrines or individual septic tanks.

5.24.1 ACCESS AND DRAINAGE

Access into this NDC is by either the East Coast Highway or the Railway Embankment Road. The East Coast Highway and the Railway Embankment Road both link Georgetown to communities along the East Coast of Guyana such as Mahaica, New Amsterdam, Rose Hall and Corriverton. As such, there is steady flow of local traffic combined with larger trucks, buses and private vehicles traveling on the major roads in the NDC. There are internal roads in the NDC communities. A small fraction of the internal roads are paved. In general paved roads tend to run between the East Coast Highway and the Embankment road. Unpaved roads in the NDC are surfaced either with burnt earth or sand and loam. These roads are potholed in places and are only capable of providing fair weather access.

The construction of the Railway Embankment Road between Enmore and Georgetown has provided an alternate route between Georgetown and the NDC. This route has contributed to reduced travel times and traffic congestion, for residents and industries in this area.

The drainage infrastructure for the communities generally parallels the internal road network. These drains also discharge to the Atlantic Ocean. Complementary drainage capacity is provided for the NDC by GuySuCo drainage facilities that flow through the area. In spite of the complementary capacity flooding still occurs in most communities within the NDC.

5.24.2 WASTE MANAGEMENT INFRASTRUCTURE

This NDC recently recommenced waste collection services. Services were suspended by virtue of an order from the EPA directing the NDC to discontinue use of a site in Chateau Margot. A new site has been provided by GuySuCo on the LBI sugar estate access road. Waste is collected using a tractor and trailer and it is estimated that approximately 20 tonnes of waste are collected each month. The NDC employs four labourers for waste pickup. Labourers are provided with gloves, long boots, respirators and raincoats. Waste is disposed in an abandoned trench and is burnt during the dry season. Maintenance works at the site include works on the site access road.

The NDC has relatively high PT charges and these are considered adequate to cover waste management fees. The charges for waste management approximates to US \$400

per week. This charge, however, excludes depreciation charges for the tractor trailer used for waste pickup.

5.25 INDUSTRY/PLAISANCE NDC

Industry/Plaisance NDC is a mixture of residential, institutional and commercial development. There are approximately 2300 homes in this NDC. A major proportion of the houses are single family homes. Some residents in the lower income areas of the NDC have modified their homes to provide some rental capacity and additional income. Major industries in this NDC include the Ogle Aerodrome Corporation and GuySuCo. There is a large fraction of open space in this NDC. Lands in open spaces are either vacant/cultivated agricultural and pasture land and scrub vegetation. Several residents rear farm animals and also maintain kitchen gardens and cultivate fruit trees adjacent to their homes. The largest land owner in this NDC is GuySuCo and sugar cane cultivation continues in the area formerly referred to as Ogle Estate. The company, however, no longer has any sugar cane processing capacity in the area.

Residents of this NDC work primarily in Georgetown. There are some public sector jobs within the NDC in the educational, health and security sectors. Commerce in the NDC is related primarily to the operation of small family owned businesses. These businesses include auto mechanic repairs shops, hardware stores, groceries and fuel stations.

There are several middle and upper income communities in this NDC. These include as follows:

- Ogle Housing area;
- Goedverwagting Estates;
- Oleander Gardens;
- Shamrock Gardens; and
- Courida Park.

The Ogle Housing area is located south and east of the Ogle Aerodrome and includes several houses built and maintained by GuySuCo for its staff members. GuySuCo headquarters are also located in this area. Goedverwagting Estates is located south of the new roadway built along the former East Coast Railway embankment and east of the Ogle Aerodrome Access road. Oleander and Shamrock Gardens are located south of the East Coast Demerara Highway and Courida Park is north of that highway.

There are several well-established areas of low and middle-income housing, a community center, playground and other public open spaces in this NDC. Newer residences and several small shops have been built along the Railway Embankment Road since its construction. There is some squatting primarily in areas abutting the Ogle Aerodrome. There are several housing areas within this NDC that were created by GuySuCo under the Sugar Industry Labour Welfare Fund (SILWF). These are low and middle income houses and are located mainly in Industry. There are two furniture factories in this area. There are several nursery and primary schools but no secondary school in this area. A hotel was recently constructed on the East Coast Demerara Highway in Ogle.

The area is provided with potable water by Guyana Water Inc. (GWI) and telephone services are provided by GTT. Cellular phone services are also available in this area. Electricity services are provided by the Guyana Power and Light Company (GPL). There is no sewerage service in the area and sanitary facilities are either pit latrines or individual septic tanks.

5.25.1 ACCESS AND DRAINAGE

Access into this NDC is by either the East Coast Highway or the Railway Embankment Road. The East Coast Highway and the Railway Embankment Road both link Georgetown to communities along the East Coast of Guyana such as Mahaica, New Amsterdam, Rose Hall and Corriverton. As such, there is steady flow of local traffic combined with larger trucks, buses and private vehicles traveling on the major roads in the NDC. There are internal road networks in the NDC communities. A small fraction of the internal roads are paved. The greater percent of the internal roads are dirt roads which are potholed and are only capable of providing fair weather access.

The construction of the Railway Embankment Road between Enmore and Georgetown has provided an alternate route between Georgetown and the NDC. This route has contributed to reduced travel times and traffic congestion, for residents and industries in this area. There has, however, been significant new development along this road that has tended to cause localized traffic bottlenecks in the area.

The drainage infrastructure for the communities generally parallels the internal road network. These drains also discharge to the Atlantic Ocean. Complementary drainage

capacity is provided for the NDC by GuySuCo drainage facilities which flow through the area.

5.25.2 WASTE MANAGEMENT INFRASTRUCTURE

Waste is collected once weekly from all areas within the NDC. A cart and horse is contracted to remove waste. It is staffed by three labourers paid by the NDC and provided with minimal personnel protective equipment (PPE); gloves and long boots. Access problems are encountered by the cart during the wet season and the frequency of pick up decreases. Approximately 6 tons per week of waste are collected by the cart. A large percentage of waste generated in the NDC is burned by its residents. All waste is disposed in Southern Ogle in a pit excavated on land owned by the Ogle Aerodrome. Several squatters live in the vicinity of the disposal area. The Aerodrome has served notice on the NDC to vacate the site but an alternative location is unavailable. Waste disposal costs are paid out of property taxes (PT) collected by the NDC. PT are established as a function of the rental value of properties. A valuation is currently in progress. This, however, only addresses new building or buildings that have been renovated. The last valuation for other properties was conducted in 1977. The PT are charged as 21%, 24.5%, and 28% of the rental values for residential, commercial and industrial properties.

5.26 SUMMARY

The following table summarizes available information on current population estimates, waste disposal sites, collection rates and costs for Region 4 NDCs and Georgetown area.

<i>Neighborhood Democratic Council (NDC)</i>	<i>Population</i>	<i>Collection rate of wastes(% and tones)</i>	<i>Disposal sites</i>	<i>Costs</i>
Eccles/Ramsburg	20000	Once every two weeks	Mandela Site	PT – 15%, 45%, 60%, 100% for residential, commercial, industrial, vacant/ farmland, respectively Waste Management Cahrge \$16,500USD for the year
Little Diamond/Herstelling	7500	Once a week (except Herstelling) Most residents burn and/or bury		PT – 0.375%, 0.5%, 2.5% for residential, commercial, industrial, respectively
Mocha/Arcadia	2800	Residents burn and/or bury		
Golden Grove/Diamond Place	10000	Once a week		PT – 5%-47% for residential and commercial, respectively Waste Management budgeted at \$12,300USD for the year
Caledonia/Good Success	7500	Residents burn and/or bury	BCL indicated donation of 20 acres (8ha) of land	
Soesdyke/Huist Te Coverden	7000	Residents burn and/or bury		
La Grange/Nismes	9000	Residents burn and/or bury		
Malgre Tout/Meer-Zorgen	15000	Residents burn and/or bury		
Haslington/Grove	20000	Set to start January 2005 Currently 3 tons/month at East Coast Demerara		\$500GUY/ month (2005) Currently \$700GUY/ moth along East Coast Demerara
Enmore/Hope	7000	Four days each week 16 tons/month		PT – 0.45% (rate of collection 80-85%)
Buxton/Fouils	21000	Five days each week		PT - \$1000GUY - \$5000GUY (rate of collection 80%)
Mon Repos/Le Reconnaissance	15000	Once every two weeks 4-5 tons/day	Shared with BV/Triumph	PT (rate of collection 56%)
Beterverwagting/Triumph	20000	Daily 2.5 tons/day		\$100/month or \$1000/year (50% compliance)
Better Hope/La Bonne Intention	30000	20 tons/month		\$400USD/week
Industry/Plaisance	N/A	Once a week 6 tons/week	Southern Ogle	PT – 21%, 24.5%, 28% of the rental values for residential, commercial and industrial properties

6.0 **PHYSICAL ENVIRONMENTAL IMPACTS AND RISKS OF THE PROPOSED ACTION**

The purpose of this section of the EIA is to clearly identify potential environmental impacts and associated risks for actions undertaken during the lifetime of the Project. The prevention, management and mitigation of potential environmental impacts are discussed in Section 10 of the EIA.

Environmental impacts and associated risk can potentially occur throughout the operating lifespan of the Site through the following phases of the Project.

- Design.
- Construction.
- Operation.
- Post Closure

This assessment will focus on four major areas of study as they directly relate to each of the above-noted Project phases.

- Physical Environment.
- Biological Environment.
- Social Issues and Human Resource.
- Environmental Control Systems.

For each of the above-noted areas of study there may be associated impacts that are universal throughout the lifespan of the Project, or specific to certain phases of the Project. Each Project phase will be independently assessed to ascertain if and/or how that action impacts each of the above-noted areas of study.

For the purposes of this Project assessment physical environment impacts are considered to be those that affect the immediate and local surroundings and include:

- site conditions;
- animal habitant and/or population;
- plant species and/or vegetation

- surface waterways; and
- noise and odour.

For the purposes of this Project assessment biological environment impacts are considered to be those that can impose a biological change and include:

- air quality;
- surface water quality;
- groundwater quality;
- native soil quality; and
- human health.

For the purposes of this assessment social issues and human resources are considered to be those that can impose a change to way of life or human resource and include:

- opposition to proposed Site;
- staffing;
- health and safety;
- public involvement and notification; and
- archeological and heritage issues.

For the purposes of this assessment environmental control systems are considered to be those that provide protection to the local surroundings and environment and include:

- waste containment;
- leachate collection and treatment;
- landfill gas collection and treatment.

6.1 DESIGN IMPACTS

For more complete details on the final project design and complementary studies undertaken the reader is referred to the document entitled "Detailed Design and Operations Report for a New Sanitary Landfill in Haags Bosch", which was prepared by Trow International Ltd., in association with Conestoga-Rovers and Associate and E A

Consultants and prepared for the Ministry of Local Government and Local Development and submitted under a separate cover on December 2004.

6.1.1 PHYSICAL ENVIRONMENTAL IMPACTS

This sub-section discusses potential physical environment impacts, which may potentially result through the action of designing the Site.

6.1.1.1 SITE CONDITIONS

In order to assess the soil conditions of the Site geotechnical drilling was undertaken. Design activities included drilling boreholes for the geotechnical/hydrogeological investigations and topographic surveys of the area. Access to the site for drilling and topographic surveys was by four-wheel drive vehicles. Some clearing of vegetation was required to establish lines of sight for surveying equipment. All boreholes were drilled using water as the drilling fluid. No oil and/or fuel were allowed to enter the boreholes during drilling, thereby eliminating any negative impact on groundwater quality in the immediate vicinity of the boreholes themselves.

There are no environmental impacts or risk associated with the Project design.

6.1.1.2 ANIMAL HABITANT/POPULATION

Animal habitant/population has been accounted for in the Project design. There are no direct environmental impacts imposed and/or associated risks to animal habitant/population resulting from the action of completing the design of this Project, which is essentially a desk-top study.

6.1.1.3 PLANT SPECIES/VEGETATION

Plant species/vegetation has been accounted for in the Project design. There are no direct environmental impacts imposed and/or associated risks to plant species/vegetation resulting from the action of completing the design of this Project, which is essentially a desktop study.

6.1.1.4 SURFACE WATER

Surface water has been accounted for in the Project design. There are no direct environmental impacts imposed and/or associated risks related to surface water from the action of completing the design of this Project, which is essentially a desktop study.

6.1.1.5 NOISE AND ODOUR

Noise and odour has been accounted for in the Project design. There are no direct environmental impacts imposed and/or associated risks related to noise and odour resulting from the action of completing the design of this Project.

6.1.2 BIOLOGICAL ENVIRONMENTAL IMPACTS

This sub-section discusses potential biological environment impacts, which may result through the action of designing the Site.

6.1.2.1 AIR QUALITY

Air quality has been accounted for in the Project design. There are no direct environmental impacts imposed and/or associated risks to animal habitant/population resulting from the action of completing the design of this Project, which is essentially a desk-top study.

6.1.2.2 SURFACE WATER QUALITY

Surface water quality has been accounted for in the Project design. There are no direct environmental impacts imposed and/or associated risks to surface water quality resulting from the action of completing the design of this Project, which is essentially a desk-top study.

6.1.2.3 GROUNDWATER QUALITY

Groundwater quality has been accounted for in the Project design. There are no direct environmental impacts imposed and/or associated risks to groundwater quality resulting from the action of completing the design of this Project, which is essentially a desk-top study.

6.1.2.4 NATIVE SOIL QUALITY

Native soil quality has been accounted for in the Project design. There are no direct environmental impacts imposed and/or associated risks to native soil quality resulting from the action of completing the design of this Project, which is essentially a desk-top study.

6.1.2.5 HUMAN HEALTH

NDCs identified as users of the proposed facility do not have access to a proper waste disposal facility. Waste is disposed along earthen embankments and immediately adjacent to waterways in practically all instances. This has led to clogging of canals in NDCs. Residents of the NDCs fish in the canals and use canal water for washing and bathing in some instances.

The availability of the Site is a positive environmental impact in that it will reduce the unregulated disposal of waste in NDCs and reduce the likelihood of impaired health due to improper disposal of waste.

6.1.3 SOCIAL ISSUES AND HUMAN RESOURCE

This sub-section discusses potential social issues and human resource, which may result through the action of designing the Site.

6.1.3.1 OPPOSITION

Landfills are associated with negative impacts on human health and the environment. As a result, there is often opposition from stakeholders and the general public, during the selection of a new landfill site. Education and proper communication with

stakeholders and the general public are important elements for addressing concerns and issues.

If opposition to a proposed landfill is successful in preventing construction there is a chance that an existing landfill without proper environmental controls will continue to be operated or there will be no sanitary landfill available. The impact to the environment will be continued placement of waste in poorly designed and operated dumps and/or uncontrolled dumping. The associated risk is unsafe living conditions for residents, wildlife and environment.

6.1.3.2 STAFFING

Staffing for the Site has been accounted for in the Project design. There are no direct environmental impacts imposed and/or associated risks with respect to staffing resulting from the action of completing the design of this Project, which is essentially a desk-top study. Staff who completed this document are not expected to be working at the Site.

6.1.3.3 HEALTH AND SAFETY

Health and Safety has been accounted for in the Project design. There are no direct environmental impacts imposed and/or associated risks with respect to health and safety resulting from the action of completing the design of this Project, which is essentially a desk-top study.

6.1.3.4 PUBLIC INVOLVEMENT AND NOTIFICATION

There will be an environmental impact to inadequate and untimely response to environmental incident notification in that it can potentially lead to public distrust and can compromise the environmental soundness of the landfill operation. Inadequate dissemination of information on sanitary landfill operations can potentially generate animosity between communities in proximity to the landfill operations, NDCs, MSWMD and the Operator. In either event any number of conditions that govern responsible operation of the Site are violated and the Site is subsequently closed and/or there are fines.

The impact to the environment will be continued placement of waste in poorly designed and operated dumps and/or uncontrolled dumping. The associated risk is off-site receptors can be detrimentally affected.

6.1.3.5 ARCHAEOLOGICAL AND HERITAGE

No cultural or archaeological resources are known to be present at the Site. There will be no significant cultural and archaeological resource impacts associated with the construction program.

6.1.4 ENVIRONMENTAL CONTROL SYSTEMS

This sub-section discusses the environmental control systems, which are designed to minimize impact to the local surroundings, air and sub-surface environment

6.1.4.1 WASTE CONTAINMENT CELL(S)

Waste containment has been accounted for in the Project design. There are no direct environmental impacts imposed and/or associated risks related to waste containment resulting from the action of completing the design of this Project.

6.1.4.2 LEACHATE COLLECTION AND TREATMENT

Leachate collection and treatment has been accounted for in the Project design. There are no direct environmental impacts imposed and/or associated risks related to leachate collection and treatment resulting from the action of completing the design of this Project.

6.1.4.3 LANDFILL GAS COLLECTION AND TREATMENT

Landfill gas collection and treatment has been accounted for in the Project design. There are no direct environmental impacts imposed and/or associated risks related to landfill gas collection and treatment resulting from the action of completing the design of this Project.

6.2 CONSTRUCTION

The technical specifications and engineering drawings required to tender, administer and construct and develop the Site over the initial construction period and operating lifespan are provided in the document entitled "Construction of Sanitary Landfill in Haags Bosch, Specifications, Book B ", which was prepared by Trow International Ltd. In association with Conestoga-Rover and Associates and E & A Consultants Limited and submitted under a separate cover on October 2004.

6.2.1 PHYSICAL ENVIRONMENTAL IMPACTS

This sub-section discusses potential physical environment impacts, which may result through the action of constructing the Site

6.2.1.1 SITE CONDITIONS

Erosion

There will be controls in place to prevent erosion. However, during construction operations there is a potential for erosion to occur during heavy rainfall events.

There is an environmental impact in that erosion of the Site can lead to sediment loading of adjacent waterways. The risk is that off-site receptors can be detrimentally affected.

Dust

Dust emissions will be produced by vehicles using the site roads and from cover material stockpiles during loading of material to and from the cover material stockpiles, equipment traffic in the area, and wind erosion of cover materials in stockpiles.

Dust emissions would be produced by vehicles using the site roads and from cover material stockpiles. Dust emissions from cover material stockpiles would result from the following:

- Loading and reloading of material unto and from the cover material stockpiles;
- Equipment traffic in the area; and
- Wind erosion of cover materials in stockpiles.

The dust likely to be emitted during operations was estimated using AP-42 Emission Factors for Aggregate and Storage Piles and for Unpaved Roads. The analysis for stockpiles assumed maximum wind speeds of 30 kph, soil moisture content of 5% and 2000 tons of stockpiled material. Dust emissions for these conditions are expected to range from 1 to 4 kilograms per day. The estimate of dust emissions from unpaved roads was based on the surficial soils having a silt content of 20%, average vehicle weight being 15 tons, and a surficial soil moisture content of 20 percent with the total distance traveled by vehicles each day at the site being equal to 300 km. The dust emitted was computed for different sizes of particulates, PM-2.5, PM-10 and PM-30, where PM-2.5 refers to particulate matter smaller than 2.5 microns.

The dust emissions expected from the unpaved roads are detailed in Table 9.

Table 9: Emissions from Unpaved Roads

<i>Parametre</i>	<i>Quantity Emitted(kg/day)</i>
PM-2.5	25
PM-10	170
PM-30	484

There is an environmental impact in that local site workers and residents will on occasion be exposed to dust particles in the air. Other than minor discomfort there is no associated risk with dust emissions.

Traffic

Materials used for constructing the Site will be hauled utilizing tractor-trailers and tandem vehicles. Access will be via the new bypass highway and south service road. The south service road will be extended from the intersection with the new bypass highway and will be constructed along the top of the drainage canal berm adjacent to the south Property boundary. Site construction and landfilling operations will not generate any traffic through housing areas. The quietude of residents of the housing area will not be impacted. All onsite roads are more than 1.5 km away from residential areas.

On-Site access roads are defined as primary and secondary access roads. Primary roads will be used for construction and will provide access to all four stages of the landfill, administration buildings, the leachate pump stations, leachate treatment facilities and lagoons, the stormwater sedimentation and control pond, and the future LFG management facility.

The environmental impact of traffic is that Site workers and local residents are exposed to heavy equipment and trucks. The risk is harm and bodily injury.

6.2.1.2 ANIMAL HABITANT AND/OR POPULATION

There are no threatened and endangered species present in the area. However, during design, construction and operation of the Site the local wildlife will be affected by actions undertaken. The following describes the environmental impact and associated risk as it pertains to wildlife habitant, population and scavenging.

Construction of the Site will result in loss of habitat for some terrestrial mammals that currently live in the project area. Aquatic mammals, amphibians and reptiles will be impacted by filling of canals in the area lose their habitat, food and breeding areas. It is anticipated that all wildlife, which inhabit the proposed landfill area will migrate to similar surrounding habitats.

There will be an environmental impact in that existing wildlife will lose existing habitant over the short term. There are no associated risks.

6.2.1.3 PLANT SPECIES/VEGETATION

The area to be cleared is approximately 40 ha Site clearing operations will permanently alter the vegetative cover over a relatively small area of the total area available for sugar cane cultivation. Surficial geology at the site consists of desiccated silty clays overlying very soft silty clays. Construction will remove soils present at ground surface and some canals will be filled to create the landfill footprint. Construction works will permanently alter vegetation at the site.

The environmental impact is that existing vegetation will change permanently. There is not expected to be any risk.

6.2.1.4 SURFACE WATER

Canals will be filled to create the landfill footprint. The configuration of GuySuCo cultivation does not allow stormwater discharge to these canals. Some storage capacity will be lost over the area of the canals themselves. This capacity is small in comparison

to the remainder of the area. The impact is permanent; however, filling the canals will not greatly reduce the capacity for stormwater management from the area during construction.

The entire area must be cleared of vegetation during construction. Site clearing will produce increased stormwater discharge to surface water and decreased interception and evapotranspiration. Additional inflows may result in short term increases in surface water levels in the canals surrounding the area. Canals will be filled progressively from one direction to allow fish to relocate to the main East-West canal.

There will be permanent surface water controls established and maintained at the Site. Provided that the surface water controls are maintained there will be no environmental impact or associated risk.

6.2.1.5 NOISE AND ODOUR

Noise

Noise levels above the tolerable threshold of 72 decibels can cause/result in fatigue, tiredness, low morale and decreased production levels and productivity. Noise levels above the alert threshold of 86 decibels and hazard threshold of 95 decibels will be produced from earthmoving equipment. Exposure to noise levels above the internationally accepted level of 90 decibels can cause noise induced hearing loss. Tired workers are also prone to accidents and this can contribute to an increase in accidents in the working environment.

There is a noise impact related to operation of heavy equipment during operation of the Site and an accompanying risk to equipment operators, workers and supervisory staff involved in the project. There is no environmental impact and/or risk for off-site receptors.

Odour

There are no odour impacts or risk associated with Project construction.

6.2.2 BIOLOGICAL ENVIRONMENTAL IMPACTS

This sub-section discusses potential biological environment impacts, which may result through the action of constructing the Site

6.2.2.1 AIR QUALITY

During construction exhaust emitted from heavy construction equipment may impact air quality to a degree. The assessment of air quality impacts associated with air emissions from heavy earthmoving equipment operations, conservatively assumed that 5 pieces of equipment, each rated at 600 horse power, operating collectively and burning diesel fuel for a maximum of eight hours each day. The USEPA AP-42 Emission Factors for diesel industrial engines were used to estimate emissions from construction equipment.

The estimated emissions from equipment are shown in Table 10.

Table 10: Estimated Total Emissions from Construction Equipment

<i>Constituent</i>	<i>Quantity Emitted (kg/day)</i>
Nitrates	142
Carbon Monoxide	60
Sulphates	88
Particulates less than 10 µm	8
Carbon Dioxide	12,628
Aldehydes	8

Dispersion of these emissions was further modeled to estimate concentrations at receptors downwind from the Site. Emissions were modeled as being from a point source to simulate the extreme situation. A prevailing wind speed of 6.1 msec⁻¹, equivalent to the higher value of wind speeds available for Georgetown, was used for the analysis. The analysis indicates emissions from landfill hauling and construction equipment will not impact air quality at distances in excess of 160 m from the site. The nearest receptors are located more than 1500 m from the site.

The distance at which maximum dispersed concentrations are lower than acceptable air quality are detailed in Table 11. USEPA Ambient Air Quality Standards for constituents emitted from construction and trucking equipment are also detailed in Table 11.

Table 11: Estimated Emissions Concentrations from Construction Equipment

<i>Constituent</i>	<i>Distance (m)</i>	<i>Concentration ($\mu\text{g}/\text{m}^3$)</i>	<i>USEPA Ambient Air Quality Standard ($\mu\text{g}/\text{m}^3$)</i>
Nitrates	160	2736	None
Carbon Monoxide	160	1158	10000 – 8 hour average
Sulphates	160	1703	None
Particulates less than 10 μm	160	147	150 – 24 hour average
Carbon Dioxide	160	244153	None
Aldehydes	160	148	None

There are no air quality impacts and/or health risks to the local community associated with the operation of heavy equipment during Site construction.

6.2.2.2 SURFACE WATER QUALITY

An environmental impact to surface water quality could possibly arise during construction from uncontrolled discharge of fuel or lubricants onsite and its subsequent discharge to any of the canals around the site. The risk is that off-site receptors and/or site workers could be detrimentally impacted.

6.2.2.3 GROUNDWATER QUALITY

There are no environmental impacts or risk associated with Project construction with respect to groundwater.

6.2.2.4 NATIVE SOIL QUALITY

An environmental impact to native quality could possibly arise during construction from uncontrolled discharge of fuel or lubricants onsite and its subsequent discharge to any of the canals around the site. The risk is that off-site receptors and/or site workers could be detrimentally impacted.

6.2.2.5 HUMAN HEALTH

There is a potential for harm and/or bodily injury for site workers. Within this section of the EIA report environmental impact and associated risk as they apply specifically to different areas are addressed separately.

6.2.3 SOCIAL ISSUES AND HUMAN RESOURCES

This sub-section discusses potential social issues and human resource impacts, which may result through the action of constructing the Site

6.2.3.1 OPPOSITION

There are no environmental impacts or risk associated with Project construction related to opposition.

6.2.3.2 STAFFING

There is a potential impact to the environment and associated risk to site workers if there are safety concerns. See following section.

6.2.3.3 HEALTH AND SAFETY

During construction of the Site all personnel working on the project should follow a site specific Health and Safety Plan.

An environmental impact could be exposure to an unsafe working condition. The risk is bodily harm and injury.

6.2.3.4 ARCHEOLOGICAL AND HERITAGE

There are no environmental impacts or risk associated with Project construction since the area has already been researched. In the event that any unusual objects are exposed during excavation of the landfill cells they should be brought to the attention of the Owner.

6.2.4 ENVIRONMENTAL CONTROL SYSTEMS

This sub-section discusses impacts to the environment, which will result through the action of constructing the environmental control system at the Site.

6.2.4.1 WASTE CONTAINMENT

The environmental impact of an improperly constructed waste containment facility is that collected and treated leachate and impacted surface water will not meet the discharge criteria for the Site. The risk is that there would be a release of effluent to the local environment, which would exceed effluent discharge criteria and could detrimentally affect off-site receptors. There is also a health risk for sick personnel who do not follow the appropriate health and safety regulations specifically parallel for the site.

6.2.4.2 LEACHATE COLLECTION AND TREATMENT

The environmental impact of an improperly constructed treatment facility is that collected and treated leachate and impacted surface water will not meet the discharge criteria for the Site. The risk is that there would be a release of effluent to the local environment, which would exceed effluent discharge criteria and could possibly endanger local wildlife and residents. There is also a health risk for sick personnel who do not follow the appropriate health and safety regulations specifically parallel for the site.

6.2.4.3 LANDFILL GAS COLLECTION AND TREATMENT

Landfill (LFG) gas will not be encountered during initial construction of the Site. If a LFG management system is constructed at some future time the following applies. Provided that a HASP program is prepared and followed there are not expected to be any health and safety risks associated with LFG during construction of the facility. Provided that a monitoring program is established to monitor LFG presence in the air and in the sub-surface environment at the property boundary there are not expected to be any related health and safety risks. The long-term strategy for continued operation of

the Site beyond 10 years will be to install and operate a LFG collection and flaring station. Active collection of LFG will further minimize health/safety and environmental risk.

The environmental impact of an improperly constructed LFG system is that there can be flaws in the final system and gas will not be effectively collected and/or destroyed resulting release of methane and carbon dioxide to the atmosphere and/or subsurface environment. The risk is that there would be a contribution of green house gas to atmosphere combined with the creation of unstable working and living conditions in and around the Site due to the presence of LFG. There is also a health risk for sick personnel who do not follow the appropriate health and safety regulations specifically parallel for the site.

6.3 OPERATION

For more complete details on the sanitary operation and closure of the Site the reader is referred to the document entitled "Site Operations Manual, Sanitary Landfill in Haags Bosch", which was prepared by Trow International Ltd., in association with Conestoga-Rovers and Associate and E A Consultants and prepared for the Ministry of Local Government and Local Development and submitted under a separate cover in March 2005.

6.3.1 PHYSICAL ENVIRONMENTAL IMPACTS

This sub-section discusses potential physical environmental impacts, which may result through the action of operating the Site

6.3.1.1 SITE CONDITIONS

Traffic

Waste will be delivered to the landfill utilizing tractor-trailers and tandem vehicles. Access to the landfill will be via the new bypass highway and south service road. The south service road will be extended from the intersection with the new bypass highway and will be constructed along the top of the drainage canal berm adjacent to the south Property boundary. All onsite roads are more than 1.5 km away from residential areas.

On-Site access roads are defined as primary and secondary access roads. Primary roads will be used for landfill maintenance purposes and will provide access to all four stages of the landfill, administration buildings, the leachate pump stations, leachate treatment facilities and lagoons, the stormwater sedimentation and control pond, and the future LFG management facility. Secondary access roads will be used to access waste disposal areas. Locations of the secondary access roads would be governed by the waste disposal activities and these roads would be constructed and progressively extended and relocated as required.

The environmental impacts of traffic is that Site workers and local residents are:

- exposed to heavy equipment and trucks; and
- improper maintenance could cut off access to key Site locations.

The associated risks are:

- bodily harm and injury; and
- site controls are inoperable resulting in off-site impact.

6.3.1.2 ANIMAL HABITANT/POPULATION

Population

Waste will contain organic matter and food and will attract insects, birds and animals that feed on waste. Food in the waste may contribute to the growth of large populations of some scavenger species. Stormwater and leachate management ponds may provide new wetland habitats and associated changes in the wildlife species.

There will be an environmental impact in that the Site will be populated with new species. There are not expected to be any associated risks.

Scavenging

The operations may provide an environment conducive to the proliferation of vermin and vectors. Vector and vermin refer to objectionable insects, rodents, and birds that establish habitat at a landfill.

There will be an environmental impact in that vector and vermin can spread disease. The risk is that local on-site workers, wildlife, residents and pets could contract disease.

6.3.1.3 PLANT SPECIES/VEGETATION

During operation of the Site vegetation of completed areas will need to be progressively undertaken.

If vegetation is not established and maintained there is an environmental impact in that soil erosion can occur, which can lead to exposed waste, potential slope failure and sediment loading of adjacent waterways.

6.3.1.4 SURFACE WATER

Erosion

There will be controls in place to prevent erosion. However, during operation of the Site there is a potential for surface water erosion to occur during heavy rainfall events.

There is an environmental impact in that erosion of the Site can lead to exposed waste, potential slope failure and sediment loading of adjacent waterways. The risk is that any of the above-noted occurrences could affect the local environment, wildlife species and local residents.

Sediment Loading

There will be controls in place to prevent sediment loading of adjacent waterways. However, during construction and operation of the Site there is a potential for erosion to occur during heavy rainfall events.

There is an environmental impact in that sediment loading of adjacent waterways may affect the water quality adjacent to the Site.

6.3.1.5 NOISE AND ODOUR

Noise

Noise levels above the tolerable threshold of 72 decibels can cause/result in fatigue, tiredness, low morale and decreased production levels and productivity. Noise levels above the alert threshold of 86 decibels and hazard threshold of 95 decibels will be produced from earthmoving equipment. Exposure to noise levels above the

internationally accepted level of 90 decibels can cause noise induced hearing loss. Tired workers are also prone to accidents and this can contribute to an increase in accidents in the working environment.

There is a noise impact related to operation of heavy equipment during operation of the Site and an accompanying risk to equipment operators, workers and supervisory staff involved in the project.

Odours

Nuisance odour related to landfill gas generation is specifically addressed later within this section. There is an odour impact related to landfilling and operation of the leachate treatment system and settling ponds. Nuisance odours will be generated by the leachate ponds and by uncovered waste. These impacts will extend over the duration of the Site operation and into the post closure period.

The environmental impact of nuisance odour is that they affect Site workers and adjacent residents way of life in that the smells are offensive. There is no associated risk with nuisance odours.

6.3.2 BIOLOGICAL ENVIRONMENTAL IMPACTS

This sub-section discusses potential biological environmental impacts, which may result through the action of operating the Site.

6.3.2.1 AIR QUALITY

Gaseous emissions of carbon monoxide and unburned hydrocarbons would occur from bulldozers and waste hauling equipment. Decay of landfilled waste could generate explosive gases. Air quality impacts due to waste hauling and bulldozers were estimated based on all equipment being diesel driven. The assessment assumed approximately 15 pieces of equipment, each rated at 600 horse power and burning diesel fuel would be operated at the site for a maximum of eight hours each day. The USEPA AP-42 Emission Factors for diesel industrial engines were used to estimate emissions. The estimated emissions from equipment are shown in Table 12.

Table 12 Estimated Total Emissions from Construction Equipment

<i>Constituent</i>	<i>Quantity Emitted (kg/day)</i>
Nitrates	425
Carbon Monoxide	180
Sulphates	264
Particulates less than 10 µm	23
Carbon Monoxide	37,885
Aldehydes	23

Concentrations of these emissions were estimated at receptors downwind from the site. Emissions were modeled as being from a line source with the source assumed to be the open face of the landfill. Further it was assumed that the maximum open face will be one-eighth of a hectare. A prevailing wind speed of 6.1 msec⁻¹, equivalent to the higher value of wind speeds available for Georgetown, was used for the analysis. The distances at which maximum dispersed concentrations are lower than acceptable air quality are detailed in Table 13. USEPA Ambient Air Quality Standards for constituents emitted from bulldozers and trucking equipment are also detailed in Table 13. The analysis indicates emissions from landfill operation equipment will impact air quality at distances of less than 350 m from the site.

Table 13: Estimated Emissions Concentrations from Construction Equipment

<i>Constituent</i>	<i>Distance (m)</i>	<i>Concentration (µg/m³)</i>	<i>USEPA Ambient Air Quality Standard (µg/m³)</i>
Nitrates	350	2793	None
Carbon Monoxide	350	1182	10000 – 8 hour average
Sulphates	350	1738	None
Particulates less than 10µm	350	150	150 – 24 hour average
Carbon Dioxide	350	249198	None
Aldehydes	350	151	None

Residents are located within 50 m of the site and their ambient air quality would be impacted by the operations. These impacts would extend over the duration of operations and may have residual effects.

6.3.2.2 SURFACE WATER QUALITY

Wastewater at the site will consist of leachate from the landfill and stormwater, which contacts waste and which will be treated as leachate. All wastewater generated within the landfill will be conveyed to the leachate treatment facility and treated to meet minimal discharge criteria before it is released into local waterways. Stormwater will include water from non-waste handling areas contiguous to waste operations and runoff from developed areas including the weight station and other onsite buildings and roads. Stormwater will be handled independently of leachate. Soil berms will be constructed around operational waste areas to prevent stormwater from contacting waste. Stormwater will be fed to the stormwater sedimentation and control ponds and sediment in stormwater will be retained prior to discharge to local waterways.

There would be an environmental impact related to surface water quality if the leachate treatment facility fails. Additional environmental impact is related to a failure of the sedimentation/stormwater management ponds, which can result in a discharge of sediment to surface water. The risk of either of the above scenarios is that overloading local waterways with compound concentrations that exceed the local environmental guidelines. This could result in local animal species and or residents being exposed to unhealthy and/or sediment impacted water.

6.3.2.3 GROUNDWATER QUALITY

During operation of the Site there will be waste placed on leachate collection system (LCS) underdrain. The LCS is designed to convey surface water, which comes in contact with the waste and/or leachate to the treatment facilities. There is an engineered barrier between the waste and the underlying native soil that prevents leachate from coming in direct contact with the local water aquifer. In the event that the LCS and/or the barrier fails and leachate begins to build up on the engineered liner there is a potential for leachate to leak through the liner.

There can be an environmental impact in that the local groundwater aquifer could become contaminated over time. The risk is that should contamination of the local aquifer occur off-site receptors could be affected.

6.3.2.4 NATIVE SOIL QUALITY

During operation of the Site there will be waste placed on leachate collection system (LCS) underdrain. The LCS is designed to convey surface water, which comes in contact with the waste and/or leachate to the treatment facilities. There is an engineered barrier between the waste and the underlying native soil that prevents leachate from coming in contact with underlying native soil. In the event that the LCS and/or the barrier fails and leachate begins to build up on the engineered liner there is a potential for leachate to leak through the liner.

There can be an environmental impact in that the soil can become contaminated over time. The risk is that should contamination of the soil occur off-site receptors could be affected.

6.3.2.5 HUMAN HEALTH

During Operation of the Site there are a number of ways that human health can be jeopardized. Direct contact with waste, leachate and landfill gas can potentially pose a hazard to health for workers and visitors. There is also a potential for harm and/or bodily injury for site workers. Within this section of the EIA report environmental impact and associated risk as they apply specifically to different areas are addressed separately.

6.3.3 SOCIAL ISSUES AND HUMAN RESOURCE

This sub-section discusses potential social issues and human resource impacts, which may result through the action of operating the Site.

6.3.3.1 OPPOSITION

Opposition to the Site is addressed in the design stage of the project. There is a continued social and cultural impact in not operating the Site properly in that local residents could have legitimate complaints with the Site. In this instance the environmental impact could possibly be premature closure of the Site with subsequent risks as previously identified.

6.3.3.2 STAFFING

During operation of the Site there will be extensive operation, supervisory and working staff work at the Site. Staff will be responsible for a number of activities including equipment operation, surveying, scale operation, control system operations, supervision and clerical work. If any Site staff are improperly trained and/or ignore any training provided there are a number of environmental impacts, which could occur as follows:

- unsafe working condition;
- control system malfunction; and
- security breach.

The associated risks are;

- injury and/or illness;
- exceedance of acceptable water/air compound concentrations; and
- theft, sabotage, and vandalism.

6.3.3.3 HEALTH AND SAFETY

During operation of the Site all personnel working on the project should follow a site specific Health and Safety Plan (HASP).

Not following the HASP could lead to exposure of unsafe working conditions. The risk is bodily harm and injury.

6.3.3.4 PUBLIC INVOLVEMENT

There is a social and cultural impact in not keeping local resident and groups apprised of violation notices etc. in that there would be mistrust in the Site operations and could have legitimate complaints with the Site. In this instance the environmental impact could possibly be premature closure of the Site with resulting risks.

6.3.3.5 ARCHEOLOGICAL AND HERITAGE

No environmental impact or associated risk.

6.3.4 ENVIRONMENTAL CONTROL SYSTEMS

This sub-section discusses potential impact to the environment, which may result through the action of operating the environmental control systems at the Site.

6.3.4.1 WASTE CONTAINMENT CELL(S)

Unacceptable Waste

The Operations Plan for the landfill proposes to redirect unsuitable (hazardous, healthcare and offsite liquids) waste away from the sanitary landfill. There are no waste treatment or disposal facilities elsewhere in Guyana. Generators of unsuitable waste will have no access to appropriate disposal facilities. This poses the risk of clandestine disposal of hazardous waste in GM and/or NDCs. This risk will be mitigated by developing appropriate systems and technology for the disposal of hazardous, healthcare and offsite liquids waste using funds provided by the IDB. This facility is expected to be operational at the commencement of operations at the Haags Bosch Sanitary Landfill.

This is a short-term risk, which can have residual effects if the hazardous and healthcare waste facility is not available at the time operations commence at the sanitary landfill.

Unacceptable waste delivery could potentially impact the environment by:

- creating unsafe working condition;
- causing a fire;
- impacting surface and/or groundwater quality; and
- impacting air quality.

The associated risks are:

- bodily harm and injury;
- injury and/or smoke inhalation;
- exceedance of water use criteria; and
- exceedance of air quality criteria.

Waste Placement

Improper waste placement and cover operations that could potentially impact the environment include:

improper compaction;
improper cover placement; and
dangerous waste picking conditions.

The associated risks are:

- misuse of available airspace;
- exposed waste; and
- bodily harm and injury.

Litter

Wind blown and other litter from the landfill and from waste truck can potentially negatively impact aesthetics around the landfill perimeter. There is no associated risk.

Fires

Fires at the landfill site can potentially impact the environment by:

- creating an unsafe working condition;
- causing a control system malfunction; and
- impacting air quality.

The associated risks are:

- bodily harm and injury;
- exceedance of acceptable water/air quality criteria; and
- smoke inhalation.

Final Cover

Improperly placed final cover can potentially impact the environment by:

- exposing waste;
- creating leachate seepage;
- preventing vegetative cover establishment; and
- slope instability.

The associated risks are:

- surface water contact with waste;
- exceedance of off-site water criteria;
- erosion leading to waste exposure and leachate seepage; and
- slope failure.

6.3.4.2 LEACHATE COLLECTION AND TREATMENT

Provided that a HASP program is prepared and followed there are not expected to be any health and safety risks associated with leachate during operation of the Site.

The environmental impact of an improperly operated leachate collection and treatment facility is that leachate and impacted surface water will not meet the discharge criteria for the Site. The risk is that there would be a release of effluent to the local environment, which would exceed effluent discharge criteria and could possibly endanger local wildlife and residents. There is also a safety risk to operators and Site workers.

6.3.4.3 LANDFILL GAS COLLECTION AND TREATMENT

If a landfill gas (LFG) management system is constructed during the Site operating phase the following applies. Provided that a HASP program is prepared and followed there are not expected to be any health and safety risks associated with LFG during operation of the Site. Provided that a monitoring program is established to monitor LFG presence in the air and in the sub-surface environment at the property boundary there are not expected to be any related health and safety risks. The long-term strategy for continued operation of the Site beyond 10 years will be to install and operate a LFG collection and flaring station. Active collection of LFG will further minimize health/safety and environmental risk.

The environmental impact of an improperly operated LFG system is that the gas will not be effectively collected and/or destroyed resulting release of methane and carbon dioxide to the atmosphere and/or subsurface environment. The risk is that there would be a contribution of green house gas to atmosphere combined with the creation of unstable working and living conditions in and around the Site due to the presence of LFG.

6.4 POST CLOSURE

For more complete details on the post closure maintenance requirements for the Site the reader is referred to the document entitled " Site Operations Manual, Sanitary Landfill in Haags Bosch", which was prepared by Trow International Ltd., in association with Conestoga-Rovers and Associate and E A Consultants and prepared for the Ministry of Local Government and Local Development and submitted under a separate cover in March 2005.

6.4.1 PHYSICAL ENVIRONMENTAL IMPACTS

This sub-section discusses potential physical environment impacts, which will result through the action of maintaining the Site.

6.4.1.1 SITE CONDITIONS

Primary roads will continue to be used for landfill maintenance purposes and will provide access to all four stages of the landfill, administration buildings, the leachate pump stations, leachate treatment facilities and lagoons, the stormwater sedimentation and control pond, and the future LFG management facility. There will continue to be a requirement to maintain the primary roads following Site closure.

There is an environmental impact in that if the roads are not continually maintained access to the environmental control systems and post closure monitoring locations may be blocked preventing access. This could result in maintenance and/or monitoring activities not being performed with failure of the environmental control systems and/or insufficient confirmation monitoring being performed. The risk is exposure to off-site receptors with related to physical and/or biological impacts.

6.4.1.2 ANIMAL HABITANT/POPULATION

There is no environmental impact and/or associated risk to local animal habitant/population as a result of Site closure.

6.4.1.3 PLANT SPECIES/VEGETATION

There is no environmental impact and/or associated risk to local plant species/vegetation as a result of Site closure.

6.4.1.4 SURFACE WATER

There will be controls in place to prevent erosion. Following closure of the Site a potential will remain for surface water erosion to occur during heavy rainfall events.

There is an environmental impact in that erosion of the Site can lead to exposed waste, potential slope failure and sediment loading of adjacent waterways. The risk is that any of the above-noted occurrences could affect the local environment, wildlife species and local residents.

6.4.1.5 NOISE AND DUST

There is no environmental impact and/or associated risk associated with noise and/or odour as a result of Site closure. The post closure activities at the Site will be limited to maintenance and monitoring.

6.4.2 BIOLOGICAL ENVIRONMENTAL IMPACTS

This sub-section discusses potential biological environment impacts, which will result through the action of maintaining the Site.

6.4.2.1 AIR QUALITY

Air quality issues would be related solely to landfill gas emissions, which are discussed in more detail in environmental system controls.

6.4.2.2 SURFACE WATER QUALITY

Wastewater at the site will consist of leachate from the landfill. Leachate will be conveyed to the leachate treatment facility and treated to meet minimal discharge criteria before it is released into local waterways. Stormwater will be handled independently of leachate and fed to the stormwater sedimentation and control ponds and sediment in stormwater will be retained prior to discharge to local waterways.

There would be an environmental impact related to surface water quality if the leachate treatment facility fails. Additional environmental impact is related to a failure of the sedimentation/stormwater management ponds, which can result in a discharge of sediment to surface water. The risk of either of the above scenarios is that overloading local waterways with compound concentrations that exceed the local environmental guidelines. This could result in local animal species and or residents being exposed too unhealthy and/or sediment impacted water.

6.4.2.3 GROUNDWATER QUALITY

Following closure of the Site leachate will continue to be collected through the leachate collection system (LCS) underdrain. The LCS is designed to convey leachate to the

treatment facilities. There is an engineered barrier between the waste and the underlying native soil that prevents leachate from coming in direct contact with the local water aquifer. In the event that the LCS and/or the barrier fails and leachate begins to build up on the engineered liner there is a potential for leachate to leak through the liner.

There can be an environmental impact in that the local groundwater aquifer could become contaminated over time. The risk is that should contamination of the local aquifer occur off-site receptors could be affected.

6.4.2.4 NATIVE SOIL QUALITY

Following closure of the Site the leachate collection system (LCS) underdrain will continue to operate. The LCS is designed to convey leachate to the treatment facilities. There is an engineered barrier between the waste and the underlying native soil that prevents leachate from coming in contact with underlying native soil. In the event that the LCS and/or the barrier fails and leachate begins to build up on the engineered liner there is a potential for leachate to leak through the liner.

There can be an environmental impact in that the soil can become contaminated over time. The risk is that should contamination of the soil occur off-site receptors could be affected.

6.4.2.5 HUMAN HEALTH

There will continue to be an environmental impact and associated risk with respect to ongoing maintenance and monitoring activities carried out in the post closure period.

6.4.3 SOCIAL ISSUES AND HUMAN RESOURCE

This sub-section discusses potential social issue and human resource impacts, which may result through the action of maintaining the Site.

6.4.3.1 OPPOSITION

No environmental impact and/or associated risk.

6.4.3.2 STAFFING

Following closure of the Site there will continue to be ongoing maintenance and monitoring activities carried out by qualified staff. If any Site staff are improperly trained and/or ignore any training provided there are a number of environmental impacts, which could occur as follows:

- control system malfunction; and
- security breach.

The associated risks are;

- exceedance of acceptable water/air compound concentrations; and
- theft, sabotage and vandalism.

6.4.3.3 HEALTH AND SAFETY

Following closure of the Site all maintenance and monitoring should follow a site specific Health and Safety Plan.

Not following the HASP could lead to exposure to unsafe working conditions. The risk is bodily harm and injury.

6.4.3.4 PUBLIC INVOLVEMENT AND NOTIFICATION

There is a social and cultural impact in not keeping local resident and groups appraised of environmental impact issues related to post closure of the Site.

6.4.3.5 ARCHEOLOGICAL AND HERITAGE

No environmental impact or associated risk.

6.4.4 ENVIRONMENTAL CONTROL SYSTEMS

This sub-section discusses potential impact to the environment, which may result through the action of maintaining the environmental control systems at the Site.

6.4.4.1 WASTE CONTAINMENT

Following formal closure of the Site, waste will no longer be placed within the waste containment facility. A layer of highly impermeable clay will be placed and compacted over the complete surface area of the waste containment cell(s). Following placement of the clay cap topsoil will be placed and the landfill area will be completely vegetated. There are a number of environmental impacts, which may be encountered if the final cap is not maintained in perpetuity following closure of the Site. These include:

- waste exposure;
- leachate seepage;
- vegetative cover loss; and
- slope instability.

The associated risks are:

- surface water contact with waste;
- exceedance of off-site water criteria;
- erosion leading to waste exposure and leachate seepage; and
- slope failure.

6.4.4.2 LEACHATE COLLECTION AND TREATMENT

Provided that a HASP program is prepared and followed there are not expected to be any health and safety risks associated with leachate during operation of the Site.

The environmental impact of an improperly operated leachate collection and treatment facility is that leachate and impacted surface water will not meet the discharge criteria

for the Site. The risk is that there would be a release of effluent to the local environment, which would exceed effluent discharge criteria and could possibly endanger local wildlife and residents. There is also a safety risk to operators and Site workers.

6.4.4.3 LANDFILL GAS COLLECTION AND TREATMENT

Provided that a HASP program is prepared and followed there are not expected to be any health and safety risks associated with LFG during operation of the Site. Provided that a monitoring program is established to monitor LFG presence in the air and in the sub-surface environment at the property boundary there are not expected to be any related health and safety risks. The long-term strategy for continued operation of the Site following closure will be to continue to operate a LFG collection and flaring station. Active collection of LFG will further minimize health/safety and environmental risk.

The environmental impact of an improperly operated LFG system is that the gas will not be effectively collected and/or destroyed resulting release of methane and carbon dioxide to the atmosphere and/or subsurface environment. The risk is that there would be a contribution of green house gas to atmosphere combined with the creation of unstable working and living conditions in and around the Site due to the presence of LFG.

6.5 SUMMARY

Real environmental impact will be to the local animal and plant species in that their habitat will definitely change. The impact has no associated risk in that the animal and plant species will naturally adapt to the physical changes that will occur as a result of building the Site. However, the alternative is to not construct a state-of-the-art sanitary landfill site that will in the long run create a more environmentally unfriendly environment that will detrimentally affect local wildlife and plant species.

The same can be said of residents that live in close proximity to the proposed landfill. Their way of life will be changed in that the landfill will now be constructed and operated in close proximity to their properties. Even though these residents way of life will be changed not building the sanitary site will have more devastating health effects on peoples who live in close proximity to existing waste dump areas were there are no controls established.

There are potential environmental impacts and associated risks with building and operating a sanitary landfill that cannot be overlooked. However, a systematic review of potential physical, biological, cultural and site specific impacts has been undertaken as part of this EIA study. Each potential impact, regardless of how remote, has been identified and systematically categorized. Each potential impact has been addressed in the Environmental Management Plan as requiring mitigative and contingency measure to minimize environmental risk to the fullest extent and to have a contingency plan in order in the unlikely event that the mitigative measures fail.

The following table presents a summary of potential and real environmental impacts, which will require an action.

<i>Area of Study</i>	<i>Design</i>	<i>Construction</i>	<i>Operation</i>	<i>Post Closure</i>
<u>Physical Environmental Impacts</u>	Action	Action	Action	Action
Site Conditions	No Impact	Impact	Impact	Impact
Animal Habitat and/or Population	No Impact	Impact	Impact	Impact
Plant Species and /or Vegetation	No Impact	Impact	No Impact	Impact
Surface Waterways	No Impact	Impact	EMP	Impact
Noise and Odour	No Impact	EMP	EMP	EMP
<u>Biological Environmental Impacts</u>				
Air Quality	No Impact	EMP	EMP	EMP
Surface Water Quality	No Impact	EMP	EMP	EMP
Groundwater Quality	No Impact	No Impact	EMP	EMP
Native Soil Quality	No Impact	EMP	EMP	EMP
Human Health	No Impact	EMP	EMP	EMP
<u>Social and Cultural</u>				
Opposition	Impact	EMP	EMP	EMP
Staffing	No Impact	EMP	EMP	EMP
Health and Safety	No Impact	EMP	EMP	EMP
Public Involvement and Notification	Impact	EMP	EMP	EMP
Archeological and Heritage Issues	No Impact	No Impact	No Impact	No Impact
<u>Environmental Control Systems</u>				
Waste Containment Cell(s)	No Impact	EMP	EMP	EMP
Leachate Collection and Treatment	No Impact	EMP	EMP	EMP
Landfill Gas Collection and Treatment	No Impact	EMP	EMP	EMP

No Impact - The action has no negative environmental impact. Where the action had no impact and/or associated risk no mitigation and/or contingency measures are developed.

Impact - The action has an environmental impact but no associated risk. The environment is permanently changed as a result the action. Through the lifespan of the Site environmental conditions will be monitored and corrected in response to potential negative impacts.

EMP - Environmental Management Plan. There is a potential for the action to negatively impact the environment and there is an associated risk. The EMP has been prepared to mitigate environmental impact and risk throughout the operating lifespan of the Site. If an environmental impact occurs as a result of the action, even though mitigation measures have been developed and followed a contingency plan is prepared and executed to prevent damage to adjacent environment and residents.

Conclusion and Recommendation

It is concluded that a thorough review of all potential impacts has been undertaken in conjunction with the various undertakings that have been documented in the reports referenced within this EIA. It is recommended that the EPA/IDB accept that all potential environmental impacts have been identified and effectively categorized in order to establish action that will prevent those impacts from creating a risk to human and animal life.

7.0 SOCIO-CULTURAL IMPACTS AND RISKS OF THE PROPOSED ACTION

Analysis of social impacts of the Haags Bosch Sanitary Landfill is presented in terms of three principal issues. In order of priority, these are:

- socio-economic impacts;
- construction impacts; and
- landfill operations impact.

A summary of potential impact is tabulated at the end of this section.

7.1 SOCIO-ECONOMIC IMPACTS

Three mechanisms were utilized to ascertain socio-economic impacts associated with the project. The first involved stakeholder consultations with NDCs far removed from the sanitary landfill site and unlikely to be directly impacted by physical works at the site or the closure of the Mandela Site. During these consultations indirect impacts associated with the development of the facility were also determined. The second mechanism consisted of stakeholder consultations with GM, members of the MSWMD and Eccles/Ramsburg NDC. The final mechanism consisted of detailed consultations with residents of communities in proximity to Haags Bosch. The final mechanism was documented by responses to a questionnaire administered to residents of Eccles, Bagotstown, Nandy Park, Continental Park and Republic Park. These communities were identified for detailed consultation since the communities are downwind of the proposed sanitary landfill and short term and immediate access to the facility may be by a road separating Eccles from Bagotstown.

Questionnaires were administered by random sampling in these communities. There was some lack of adherence to the random sample method in Republic and Nandy Parks primarily because individuals refused to participate, or perceived that participation amounted to a waste of time since a decision had already been made. The method was therefore modified in the Republic and Nandy Park areas to every house where someone was willing to participate in the survey. Detailed analyses of responses to the questionnaires are presented in Appendix F.

7.2 ECCLES AND ENVIRONS

Direct economic benefits will result from expenditures made by the Contractor and Operator of the Haags Bosch Sanitary Landfill. The benefits will include payroll and benefits associated with a workforce, as well as capital and operating expenditures. The benefits of employment at the site will develop gradually as operations progresses. Construction and operation of the facility will reduce unemployment in Eccles and its environs if the Operator hires employees primarily in this area. This will result in income generation in Eccles and its immediate vicinity. Indirectly, small family owned businesses would also benefit by providing services to the landfill employees.

No facility is currently available for the sound environmental management of solid waste generated in any of the communities around Eccles. Some waste from these communities is informally disposed at the Mandela facility. There is also a large and unsightly open dump on the access road to the proposed landfill. There are indirect costs to health associated with open dumping of waste. Creation of the sanitary landfill will provide for permanent cost effective waste management for Eccles and its environs.

Absence of a proper waste management facility for the Eccles Industrial estate can threaten its long term viability. Residents may move to court to halt operations in the industrial estate since the absence of a waste management facility may threaten human health and the environment in Eccles and its environs. This problem will be further exacerbated if Georgetown moves to restrict the disposal of waste generated outside its boundaries. The environmental management plan for the industrial estate proposes the installation of an incinerator and a small landfill. Access to the proposed facility will permanently eliminate the need for these facilities and will reduce the operational costs for industries in the estate.

7.3 GEORGETOWN MUNICIPALITY (GM)

GM does a relatively good job of collecting refuse from city wards. Adequate environmental controls are, however, not exercised over disposal of waste at the Mandela site. This results in refuse flows to the canals around the site. Waste from the site, coupled with eutrophication induced by discharge from the site, clog these canals and result in flooding of areas around the dump. Closure of the dump after the Haags Bosch Sanitary Landfill is commissioned will permanently reduce the incidences of flooding in areas around the Mandela Site. Flooding results in lost productivity and reduced wages because of reduced accessibility for residents in area adjoining the dump.

The productivity and consequently the wages of residents in the vicinity of the Mandela Site will increase with operation of the Sanitary Landfill at Haags Bosch.

Operation of the Mandela Avenue dump has resulted in decreased property values in areas surrounding the site. There are several upscale living areas immediately east of the dump including Meadow Brook Gardens and Durban Backlands. Closure of the Mandela dump will lead to increased property values in areas surrounding the Mandela dump. This impact is expected to be permanent in duration.

In the past residents of Georgetown did recreational fishing in canals in the city. This practice has abated primarily because of the presence of waste in canals in the city and because of the perception of residents that the operation of the Mandela Site affects most of the surface water facilities in the city. Operation of the Haags Bosch Sanitary Landfill may result in the return to recreational fishing by some residents in the short term and by most residents in the long term after it has been demonstrated that an effective waste management program has been established and is working.

Both foreign and local visitors to Georgetown tend to reduce the length of their stay in the city because of improper waste disposal practices. Several canals in the down town area of the city are clogged with plastic bottles. These bottles also affect the functional effectiveness of the sanitary sewer and storm water management systems in the down town area. This leads to flooding in the down town area of the city. Implementation of effective waste collection and disposal practices in Georgetown will permanently decrease the incidences of flooding and backed up sewer lines in the down town area resulting in a significantly more aesthetically pleasing environment. This may lengthen the time local and foreign visitors spend in Georgetown and increase both municipal and government revenues associated with extended stays. In addition, incidences of reduced flooding in down town Georgetown and its immediate environs may result in increased property values in the down town area.

Several people gain their livelihood by collecting waste from the Mandela Avenue dump for sorting and sale of objects and materials such as glass, metals, plastics, paper/cardboard and textiles. A well-organized system for collection, sorting and reutilization has developed and large amounts of materials are collected for sale to manufacturing and small-scale industries. A system has evolved where a number of contractors use scavengers to collect items for recycling. The entire range of activities, most of which is unhygienic, provides work and income for several persons. The activity also offers manufacturing and small-scale industries low priced raw materials, which saves the national economy relatively large sums of foreign exchange in connection with

purchase of imported goods. Closure of the Mandela Avenue dump and operation of the Sanitary Landfill at Haags Bosch will result in permanent cessation of this activity and permanently displace persons who currently earn a livelihood from scavenging. A Resettlement Plan is detailed in Chapter 11 for these persons.

7.4 NEIGHBORHOOD DEMOCRATIC COUNCILS

Current waste disposal practices in NDCs are characterized by dumping without environmental controls and open burning of waste. Open dumping compromises the surface water drainage infrastructure. This creates additional economic hardships for the NDCs since scarce resources must be allocated to maintenance of drainage infrastructure clogged by waste. Open burning has also led to tension in some communities quite apart from exacerbating health and environmental risks in these communities. Operation of the Sanitary Landfill will permanently eliminate open dumps used by NDCs and will contribute to improved aesthetics in these communities. It will also reduce the expenditure for maintenance of drainage infrastructure, compromised by illegal waste dumping, in NDCs.

Imposition of new waste fees may not be easily acceptable to residents of the NDCs. Property tax payment are below acceptable standards and residents are likely to view additional taxes for waste management with some cynicism. Infrequent and unreliable property tax payments will imperil NDCs ability to pay tipping fees to the Operator. This can threaten the entire viability of the Program. This can be mitigated by strengthening anti-littering legislation and vesting authority for enforcement and collection of penalties in the NDCs. A public awareness program should also be undertaken in each NDC to sensitize residents to the benefits to be gained from effective waste management.

There are several communities within NDCs which are new housing developments. These areas have not been officially placed under the jurisdiction of the NDCs. As a result residences in these areas pay no property taxes. No waste management services are provided to these areas since they fall outside the purview of the NDCs. Residents in these areas are very likely to continue to dispose of their waste in an unsound manner after commencement of the project. This is a short duration impact with no residual effects. It can be mitigated by the development of a special waste collection fee for areas not yet under NDCs jurisdiction.

7.5 CONSTRUCTION IMPACTS

Construction impacts are related to construction and operation of the Sanitary Landfill at Haags Bosch and to closure of the Mandela Site. Both facilities are sited too far away from the all NDCs, except Eccles/Ramsburg to have any direct impacts on these NDCs. The following discussion is therefore restricted to Eccles/Ramsburg and GM only.

Construction works will include construction of the landfill and its appurtenant facilities and construction of the site access road. The sanitary landfill site is far removed from residents and work at the site itself will have no impacts. Works on the south service road will generate a range of impacts that can disrupt residential and other sensitive activities located in close proximity to the road. Potential impacts related to the service road construction include:

- noise and increased air emissions caused by the operation of heavy equipment;
- increased movement of heavy vehicles;
- runoff of contaminated water from construction; and
- disruption of traffic movements and access to the industrial estate.

These impacts are temporary in duration, with no long-term residual effects. These impacts can be minimized by the implementation of mitigation measures. These measures will comprise an integral part of the contractor specifications and include, among others, specifications for the noise performance of heavy equipment, curfews on the operation of heavy equipment and vehicles, establishment of equipment and vehicle parking and maintenance areas away from adjacent residential areas, and drainage and dust control measures. During road works, contractors will be required to maintain minimum traffic flows, as well as temporary access to the industrial estate.

Construction works will create employment for local residents and construction materials will be purchased from local suppliers. These project benefits are temporary for the duration of construction works.

7.6 LANDFILL OPERATION IMPACTS

The results of consultations with residents in the Eccles area indicate that perceptions of the project are fueled by their knowledge of the Mandela Site operations. The Sanitary Landfill at Haags Bosch is approximately 2.0 km from the nearest housing area. The

primary impact of landfilling activities is due to landfill service vehicles passing along the road that separates Eccles from Bagotstown. These trucks may emit noise above levels common to the area. The landfill service traffic flow is expected to approximate to less than one truck per day.

The East Bank Highway is the only artery into Georgetown. All construction trucks hauling aggregate for construction of the four lane roadway linking Georgetown to Peters Hall, Mahaica to Rosignol and for construction of bridges between Georgetown and Rosignol use this artery. The number of service vehicles each day accessing the landfill site will be significantly less than those hauling aggregate. Noise will be mitigated by incorporating specific equipment performance criteria in waste hauling equipment.

There is a significant amount of burning of waste by residents in Eccles and its environs. Burning of municipal waste coupled with open dumping on the access road to the Eccles Industrial Estate presents health risks to residents of the community. The illegal dump is easily accessible to people, especially children. Rodents, insects, and other vermin attracted to the open dump pose health risks. Operation of the landfill will eliminate open burning and illegal dumping of waste and their associated threats to health and the environment.

Several roads in NDCs are fair weather roads that are impassable during the rainy season. Some of these areas are also flood prone. This may prevent the collection of waste from some areas during times when these areas are flooded and impassable. Residents may resort to burning waste when this occurs. This may lead to a drop in waste generation rate during rainy seasons and an associated decrease in tipping fees payable to the Operator of the landfill site. Yearly recurrence of this drop in volume of landfilled waste may threaten the ability of the Operator to make a suitable return on his investment. Burning of waste during these periods may also lead to some health problems in NDC communities.

Several of the NDCs are uncomfortable with the waste transfer stations proposed to be incorporated into the Program since it is felt that this will lead to double handling and increased waste management costs. It is felt that garbage trucks should be used for waste pickup and movement directly to the Sanitary Landfill. The streets in several NDCs are only wide enough to support one-way vehicular traffic and were not designed for the heavy wheel loads imposed by garbage trucks. The use of garbage trucks may lead to structural collapse of streets in NDCs.

Commercial and industrial waste generators in NDCs are unaccustomed to paying a waste tipping fee. Imposition of waste tipping charges may lead to illegal dumping of waste in NDCs by commercial and industrial waste generators.

7.8 KEY ISSUES

The potential impacts resulting from the proposed landfill project on the socio-cultural environment, have been examined. These impacts were re-evaluated for character, disturbance, significance, duration, reversibility and sphere of influence. Key issues are summarized in the following table.

<i>Impact</i>	<i>Character (1)</i>	<i>Disturbance (2)</i>	<i>Significance (3)</i>	<i>Duration</i>	<i>Reversibility (4)</i>	<i>Risk of Occurrence</i>	<i>Zone of Influence</i>
Resettlement of Waste Pickers	Positive	Important	High	Permanent	Reversible	Very Probable	Specific
Economic Benefits of New Employment For Cons/Operation of new landfill	Positive	Regular	Low	Permanent	Reversible	Very Probable	Local
Sensitizing Residents of benefits of Effective Waste Management	Positive	Important	High	Permanent	Partially Reversible	Very Probable	Regional
Effective Closure of Mandella and Similar sites	Positive	Regular	High	Permanent	Reversible	Very Probable	Regional
Disturbance during construction	Negative	Important	High	Temporary	Reversible	Unlikely	Local
Disturbance during operation	Negative	Important	High	Permanent	Reversible	Unlikely	Local
Decreased Property Value near Haags Bosch	Negative	Important	High	Average/ short	Reversible	Unlikely	Local
Increase Property value near existing Dump Sites	Positive	Important	High	Permanent	Partial	Probable	Local
Impact on Tourism	Positive	Regular	Medium	Permanent	Partial	Probable	Regional
Retarding of further Industrial Development	Positive/ Negative	Important	High	Average	Reversible	Unlikely	Regional
Cost of Waste Disposal (fees)	Negative	Important	High	Permanent	Partial	Very Probable	Regional

7.9 SUMMARY

From the Socio-Economic perspective, the construction of this project as outlined has significant net benefits to Georgetown and Environs. It will contribute to improvement of health and welfare. Negative impacts are mainly temporary and/or limited or reversible, and can be mitigated with appropriate measures

1. **Character** – Nature of Impact (beneficial or detrimental)
2. **Disturbance** – Extension/Quality
3. **Significance** – e.g., ecological importance, intensity of toxicity
4. **Reversibility** – Returning to previous conditions with or without human impact

8.0 ALTERNATIVES TO THE PROJECT

8.1 BACKGROUND

A series of studies were undertaken to develop an appropriate solution for the solid waste problem in Georgetown (GM) and its environs. The first of these was the Solid Waste Management Pre-Identification Study for Georgetown, undertaken by an individual consultant retained by the IDB in 1998. This was followed by a Waste Characterization and Facility Siting assessment conducted by Brown and Vence Associates (BVA) in 2000. The BVA study developed waste characterization data for GM waste and examined several locations for siting the landfill. The waste characterization study results are presented in Table 14.

Table 14: Results of Waste Characterization Study

<i>Waste Category</i>	<i>%</i>	<i>Ton/Year</i>
Paper		
Cardboard, Uncoated and Corrugated	12.3	4709
Newspaper	6.6	2541
Office Paper	1.4	553
Remainder/Composite Paper	3.5	1342
Glass		
Beverage	1.2	468
Remainder/Composite Glass	0.5	190
Metal		
Tin/Steel	1.3	516
Aluminum/Other Metal	0.2	60
Remainder/Composite Metal	0.2	78
Plastic		
Plastic Containers	2.9	1125
Film Plastic	5.2	2007
Durable Plastic	0.7	287
Remainder/Composite Plastic	1.3	504
Other/Organics		
Food	41.7	15890
Landscape & Agriculture	1.0	395
Bone	0.2	60
Textiles	4.2	1621
Remainder/Composite Organics	1.7	667

Other		
Construction & Demolition	1.8	688
Soil	0.1	44
Ash	0.0	0
Special Waste		
Tires	0.0	0
Mixed Residue	11.7	4481
Hazardous Waste (Med & Household)	0.1	25
TOTAL	100	38,340

BVA undertook a study to examine the suitability of six sites identified by the GoG as possible locations for development of solid waste disposal and transfer facilities. During the study, BVA examined four landfill sites, two transfer station sites, and one incinerator site. The site assessment was separated into two phases. Phase 1 of the assessment involved an initial assessment of each of the six sites to identify fatal flaws which could warrant its elimination from future consideration. Phase 2 involved a detailed assessment of the most suitable site, including a field investigation of the geologic, geophysical, hydrogeologic, soils, meteorological, atmospheric, and topographic conditions and an environmental review.

BVA study was preceded by GM, MoLGRD and the EPA constituting a committee to identify possible landfill, transfer station, and incinerator sites for management of GM waste. The Solid Waste Management Pre-Identification Study for Georgetown done by Sandra Cointreau-Levine also identified possible solid waste facility sites. A list of possible sites was compiled from the results of these two studies. The six sites identified for waste management and the possible use of each site are as detailed in Table 15.

Table 15: Sites Considered during Assessment of waste Disposal Options

<i>Site</i>	<i>Possible Site Use</i>
Municipal Incinerator Site	Transfer Station, Incinerator
Eccles	Transfer Station, Incinerator, Landfill
Golden Grove	Landfill
Linden Mines	Landfill
Omai Gold Mines	Landfill
Tidal Lands	Landfill

The Incinerator site was evaluated for siting a transfer station or for installation for a modern incinerator. The Eccles Site is approximately 4 kilometres from geographic

center of Georgetown. The property is rectangular and generally flat, low-lying lands surrounded by berms and water canals. It is characterized by clay soil materials and a high groundwater table. An industrial area, covering approximately 64 acres, is located along the western boundary of the area considered for the landfill and residential housing at Eccles is west of the industrial area. A new road extends from the East Bank Highway to the industrial park on the south side of Eccles and was constructed to provide access to the industrial area. This road can be extended to serve the solid waste facility. Sugar cane fields border the site to the north, east, and south. Availability of daily, intermediate, and final cover materials used in landfill operations is limited on-site. This site was evaluated as a possible transfer station, incinerator, or landfill site.

The Golden Grove site is approximately 300 acres of sugar cane fields owned by GuySuCo. The site which is similar to the Eccles site in soil, groundwater, topography, and current land use, is bordered to the west by a sizeable squatter community and to the north, east, and south by sugar cane fields. The Golden Grove water treatment plant is located west of the site in the residential housing area. Development of a solid waste facility would require construction of an access road approximately 2,400-feet long and two or three bridges to span canals and trenches. This site, which was considered as a possible landfill site, is located approximately 13 kilometres from Georgetown.

The Linden Mine Sites are located in the town of Linden, approximately 90 to 100 kilometres south of Georgetown. The development of this site for a landfill will require the development and operation of a transfer station in or near Georgetown to consolidate waste into large trucks that would transport the waste to Linden. Barge transportation of waste from Georgetown to Linden, Mackenzie may be possible. One area which may be suitable for a cut-and-cover type of landfill operation was identified west of the North East Kara Kara pit, north of the tailing pond and south of Kara Kara Creek. This area, which is used for dumping and burning of waste from the town of Linden, includes natural conditions and stockpiles of sand and clay from pit excavations. After a site visit, BVA determined that the majority of the abandoned mine pits at Linden Mines are not appropriate landfill sites. During the visit, it became evident that the majority of the abandoned mining pits were excavated to depths 30 metres or more below the groundwater table and now are filled with water. Dewatering the pits for the purposes of constructing a landfill is not practical.

The Omai Gold Mine, located on the Essequibo River approximately 200 kilometres south of Georgetown, is a swampy area converted into hundreds of acres of actively used property, including mining pits, waste rock piles, tailing ponds, roadways, and support facilities. The Omai River runs through the site and drains into the Essequibo

River. It is in a very remote location, a one and a half to two hour drive from Linden, and requires traveling on a well-maintained dirt road and crossing the Essequibo River by barge.

The area consists of 30- to 40-metres of sand above a weathered profile of saprolite and transition saprolite/laterite above hard rock. Mining pits are excavated to depths of several hundred metres, which is 100 metres or more below groundwater levels. During mining operations, the mining pits are dewatered. After mining work is completed the pits fill with groundwater. Landfilling of Georgetown's municipal solid waste in the Wenot Pit may be possible after mining operations in that area are discontinued if the landfilling operation is coordinated with backfilling of the pit using mine tailings; however, the high groundwater table is a significant concern.

The Wenot Pit has tremendous capacity, it is approximately 1,600 metres long, 350 metres wide, and 200 metres deep. Use of the Omai Mine site would require development and operation of a transfer station in or near Georgetown to consolidate waste into large trucks that would drive to Omai. The travel time from Georgetown to Omai Mines is approximately four and a half to five hours and includes approximately one and a half to two hours of driving on unpaved roads between Linden and Omai and a barge crossing at the Essequibo River. Both the unpaved road between Linden and Omai and the barge crossing are maintained by Omai Gold Mines Limited. When Omai Gold Mines Limited ceases its mining operation in 2005, the costs of the road maintenance and barge service to accommodate waste transport vehicles will need to be addressed.

The sixth site considered were tidal lands north of the seawall along the Atlantic Ocean on the northern side of Georgetown. Residential housing at Kitty is south of the seawall and residents illegally dumped refuse and rubbish in tidal areas north of the sea wall. A small mudflat has formed on the eastern side of the man-made jetty along the seawall. During high tide conditions, the mudflat and beach typically are not exposed; waves often crest over the sea walls. Creating a landfill to accommodate 20 years of capacity would require filling the tidal areas and open ocean areas.

Each site was screened based on the following criteria:

1. Area is not within watersheds designated for drinking purposes or aquifer recharge.
2. Area is of sufficient size to provide 20 years of landfill life or to accommodate a transfer station and incinerator.

3. Area is not subject to frequent flooding which cannot be mitigated with practical design and construction methods.
4. Area does not have high groundwater.
5. Area is not within 300 metres of bodies of water or wetlands.
6. Area is where geologic formations will provide adequate support.
7. Area is not within 3 km of a licensed operating runway.
8. Area is not likely to be cost prohibitive based on construction, transportation and mitigation requirements.
9. Area is not in close proximity to sensitive receptors.

The phase 1 assessment indicated Eccles as being the most suitable site for a transfer station or incinerator. All sites except the incinerator site were evaluated for siting the landfill. Eccles fulfilled five of the screening criteria. Concerns associated with this site included frequent flooding, proximity to groundwater, proximity to canals and proximity to residents. The Golden Grove site has the same impediments as the Eccles site. Use of this site will however, entail additional transportation costs. Both the Linden and Omai Mine sites were eliminated due to the significantly greater costs of waste transportation costs. The tidal site fulfilled only two of the site screening criteria. The assessment of site resulted in Eccles being identified as the most appropriate site of the six considered.

Phase Two of the BVA study consisted of an environmental assessment of the Eccles site. The Environmental Assessment considered land use, geology and soils, air quality, noise, odours, water resources, biological resources, floodplain/wetlands, cultural resources, socioeconomic conditions, traffic and health and safety. The Environmental Assessment identified no fatal flaws and Eccles was identified as the location for a sanitary landfill for GM and its environs. The IDB subsequently held an open seminar to assess the willingness of the Private Sector to participate in the Georgetown Solid Waste Management Project and PSP emerged as a feasible option.

8.2 ALTERNATIVES TO THE PROPOSED ACTION

This alternative analysis examines other options for management of municipal waste generated by GM and the NDCs. The analysis identifies alternative disposal methods which will attain the same objectives as the proposed action. The rationale for choosing each alternative is initially detailed.

8.3 JUSTIFICATION OF ALTERNATIVES

The Coastal Plain Physiographic Province of Guyana has significant thickness of high plasticity, low permeability clays ($k < 10^{-7}$ cm/s) at ground surface. The minimum thickness of these clays exceeds 150 m in GM and in the NDCs being considered by this EIA. Records of wells recovering potable water in the County of Demerara (Worts, 1958) indicate potable water is recovered from a minimum depth of 161.6 m in the Eccles area. Hydrogeologic conditions are therefore ideal for a sanitary landfilling. Landfill constructed using technically sound design approaches employing either the area or trench fill method can minimize the open waste area and provide easy control over vectors and vermin.

If the Program is not implemented, GM will have to continue utilization of the Mandela Site without any environmental upgrades. GM is unlikely to accept waste from NDCs if this is the only alternative available. NDCs will therefore continue to utilize their current waste management option. This alternative is considered as the No Action Alternative.

The alternatives to be considered are therefore the following:

1. A Natural Attenuation Landfill and burial of waste.
2. Continued use of Mandela Site (No Action).

Impacts on the physical and socio-cultural environment associated with each alternative are detailed in this section.

8.4 TECHNICALLY SOUND SANITARY LANDFILL

The Design Phase includes drilling on site to determine geotechnical and hydrogeological parameters for the site and the development of a suitable and technically sound design. Construction will include excavation to the landfill subgrade level, excavation for stormwater management facilities, construction of site support buildings and installation of groundwater and landfill gas monitoring wells. Solid waste operations will include landfilling, including compaction and daily cover, separation of valuable materials from municipal waste and maintenance of stormwater and leachate management facilities. Compliance with good practice is monitored through processes in the EMP. Closure will entail the placement of a final cap on the landfill and

maintenance of the stormwater management facilities. Environmental impacts and risks associated with each project phase are presented below.

8.5 DESIGN IMPACTS

Design activities will consist of boreholes for the geotechnical/hydrogeological investigations and topographic surveys of the area. Access to the site for these exercises will be by four-wheel drive vehicles. Some clearing of vegetation will be required to establish lines of sight for surveying equipment. Design impacts will be limited to potential impacts on groundwater and on vegetation. Boreholes will be drilled using water as the drilling fluid. However, if oil and/or fuel are allowed to enter the borehole during drilling, this will negatively impact groundwater quality in the immediate vicinity of the borehole itself. This risk can be managed by prohibiting the onsite disposal of oil and/or fuel during site investigations.

Vegetation in the area is composed of sugar cane fields. Clearing for sight lines will minimally reduce the quantities harvested for production by GuySuCo. Removal of this vegetation will have no environmental impacts either for its commercial value or for its ecological uniqueness.

Natural attenuation will decrease the land take required for the facility since area would not be needed for the Leachate Treatment System included in the proposed action.

8.6 CONSTRUCTION IMPACTS

Construction will include site clearing, construction of stormwater and sediment control ponds, leachate and gas collection systems, excavation to landfill subgrade, construction of internal and site access roads and construction of site support buildings. During construction heavy earthmoving equipment would be operated onsite and construction materials, such as steel, concrete and timber must be imported to the work site. Impacts and risks to the environment during the construction phase of the sanitary landfill at Haags Bosch are detailed below.

8.6.1 AIR QUALITY

During construction, gaseous emissions of carbon monoxide and unburned hydrocarbons would impact air quality. Engines on heavy earthmoving equipment are diesel driven. Air quality impacts were estimated by assuming 5 pieces of equipment, each rated at 600 horse power would be operated at the site for a maximum of eight hours each day. The USEPA AP-42 Emission Factors for diesel industrial engines were used to estimate emissions. Estimated emissions from equipment are shown in Table 16.

Table 16: Estimated Total Emissions from Construction Equipment

<i>Constituent</i>	<i>Quantity Emitted (kg/day)</i>
Nitrates	142
Carbon Monoxide	60
Sulphates	88
Particulates less than 10µm	8
Carbon Dioxide	12628
Aldehydes	8

The dispersion of these emissions was computed to determine the concentration at receptors downwind from the site. Emissions were modeled as being from a single point source to simulate the extreme situation. A prevailing wind speed of 6.1 msec⁻¹, equivalent to the higher value of wind speeds available for Georgetown, was used for the analysis. The analysis determined the variation of concentrations with distance from the equipment being operated. The distances at which maximum dispersed concentrations are lower than acceptable air quality are detailed in Table 17. USEPA Ambient Air Quality Standards for constituents emitted from construction and trucking equipment are also detailed in Table 17. The analysis indicates emissions from landfill hauling and construction equipment will not impact air quality at distances in excess of 160 m from the site.

Table 17: Estimated Emissions Concentrations from Construction Equipment

<i>Constituent</i>	<i>Distance (km)</i>	<i>Concentration ($\mu\text{g}/\text{m}^3$)</i>	<i>USEPA Ambient Air Quality Standard ($\mu\text{g}/\text{m}^3$)</i>
Nitrates	160	2736	None
Carbon Monoxide	160	1158	10000 – 8 hour average
Sulphates	160	1703	None
Particulates less than 10 μm	160	147	150 – 24 hour average
Carbon Dioxide	160	244153	None
Aldehydes	160	148	None

These impacts are temporary in duration, with no long-term residual effects. They can be minimized by specifying the use of fuel efficient construction equipment.

8.6.2 SOILS

Construction will remove soils present at ground surface. In addition, several canals will be filled to create a continuous landfill footprint. The surficial geology of the area consists of a desiccated silty clay overlying a very soft silty clay. Construction works will alter the surficial soils at the site. These impacts will be permanent. However they will be partly mitigated by the final cover placed over the area after its useful life.

8.6.3 SURFACE WATER FLOW

Several canals will be filled to create a continuous landfill footprint. The configuration of GuySuCo cultivation does not allow stormwater discharge to these canals. Some storage capacity will be lost over the area of the canals themselves. This capacity is small in comparison to the remainder of the area. The impact is permanent, however, filling the canals will not greatly reduce the capacity for stormwater management from the area during construction. It will be mitigated by the construction of stormwater ponds.

The entire area must be cleared of vegetation prior to construction of the facility and its appurtenant structures. Site clearing will produce increased stormwater discharge to surface water and decreased interception and evapotranspiration. The additional inflow may result in short term increases in surface water levels in the canals surrounding the area. Filled canals will permanently reduce the area available to fish. However canals

will be filled progressively from one direction. This will allow fish to relocate to the main East-West running canal.

A risk to surface water quality would arise during construction from uncontrolled discharge of fuel or lubricants onsite and its subsequent discharge to any of the canals around the site. A system of berms will be used around active construction areas and equipment storage and service areas to preclude spills from impacting surface water.

8.6.4 TERRESTRIAL RESOURCES

Construction and its associated site clearing operation will permanently alter the vegetative cover over a relatively small area of the total area available for sugar cane cultivation. The area to be taken out of cultivation is approximately 40 ha. Wildlife that transiently uses this area would be displaced to similar surrounding habitat.

Removal of the vegetation cover would result in a change of mean temperatures, humidity and wind speed. Vegetation in the area lacked adequate height to significantly impact temperature, humidity and wind speed. However, any altered effects will be moderated by the project proximity to the Demerara River. The vegetation in the area is composed totally of sugar cane fields at the site itself and in surrounding areas. The loss of vegetation from the area will have no major environmental significance for its commercial value or for its ecological uniqueness.

Clearing lands will result in loss of habitat for some mammals whose primary habitat is land based, in the project area. Some aquatic mammals will be impacted by filling of canals in the area. Amphibians and reptiles present in the area will lose their habitat, food and breeding areas. This impact will be short term and temporary since animals will move to adjacent areas that are exactly the same ecologically as this area. Terrestrial mammals will move to nearby habitats already occupied by their kind. This will put pressure on the carrying capacity of the nearby areas. It is possible that, in the short-term during this migration process, the carnivores would fare better due to the presence of more prey in smaller areas than before, but the time-frame for an increase in their population sizes would be too short for any significant long-term impact.

During construction works access to the site may not be controlled. Access may be provided to areas formerly restricted to employees of GuySuCo only. People may use the road to fish within GuySuCo cultivation. Fish populations may therefore decrease.

This impact is temporary in duration and can be mitigated by restricting access to the area during construction.

8.6.5 THREATENED AND ENDANGERED SPECIES

No threatened and endangered species are present in the area. There is therefore no impact to threatened and endangered species.

8.6.6 NOISE, ODOUR, AND DUST

During construction, fugitive dust would be emitted from earth-moving equipment. Emissions would be short-term, sporadic, and localized at the landfill site, and off-site impacts to ambient air quality would not result. Noise levels above the alert threshold of 86 decibels and hazard threshold of 95 decibels will be produced from earthmoving equipment. Exposure to noise levels above the internationally accepted level of 90 decibels can cause noise induced hearing loss. Noise levels above the tolerable threshold of 72 decibels can cause/result in fatigue, tiredness, low morale and decreased production levels and productivity. Tired workers are also prone to accidents and this can contribute to an increase in accidents in the working environment. No odours would be generated by construction operations.

These impacts are temporary in duration, with no long-term residual effects. They can be minimized by incorporation of requirements into the contractor specifications. Contractor specifications will include parameters for the noise performance of heavy equipment, curfews on the operation of heavy equipment and vehicles, and dust control measures.

8.6.7 CULTURAL AND ARCHAEOLOGICAL RESOURCES

No cultural or archaeological resources are known to be present at the site. Cultural and archaeological resources, if determined to be present during construction, are unlikely to be significantly affected by the construction. Landscape impacts would result from the clearing of vegetation and the disturbance of soil and surficial material. Further, there would be a general change in the total floristic composition.

8.6.8 TRAFFIC

Construction material will be hauled to the site primarily by 18-kip single axle trucks. An extension of the southernmost service road (south service road) from the East Bank Road in Eccles will be utilized during construction of the new landfill and for the connection of the watermain to the new administration building at the landfill. Construction traffic will not pass through housing areas. The quietude of residents of the housing area will not be impacted.

Construction work may impact traffic to and from the Eccles Industrial Estate. This impact will be short term and temporary in duration, with no long-term residual effects. During road works, the contractor will be required to maintain minimum traffic flows, as well as temporary access to the industrial estate.

8.7 OPERATION IMPACTS

Operation of a sanitary landfill at Haags Bosch will include receiving and landfilling municipal solid waste at the site. The operation will include recycling of valuables recovered by waste pickers relocated from the Mandela Site. Recycling of materials from waste will result in longer facility life. The following sections detail the environmental consequences of the operation of a natural attenuation landfill.

8.7.1 CLIMATE

During landfilling several ponds will be used for stormwater and sediment control. These surface water bodies will result in increased evaporation in the immediate area of the ponds themselves. This may impact the microclimate of the project area by lowering temperatures in the site area. These impacts will extend over the duration of landfilling and after site closure. These impacts will be minimal since this site may already be subject to higher evaporation due to the presence of GuySuCo drains and irrigation canals. The existing drainage network may have already created an altered microclimate in the project area. In addition, impacts will be further minimized by increased exposure of the area, due to clearing for landfilling operations. Clearing may result in a rise in temperatures in the area and counteract any temperature decrease due to increased evaporation.

8.7.2 AIR QUALITY

During operations gaseous exhaust consisting primarily of carbon monoxide and unburned hydrocarbons would be emitted by landfilling and waste hauling equipment. Decay of landfilled waste could potentially generate explosive gases. Carbon dioxide and water will be produced by the composting operations.

Air quality impacts due to waste hauling and landfilling equipment used during operations were estimated based on all equipment being diesel driven. The assessment assumed approximately 25 pieces of equipment, each rated at 600 horse power and burning diesel fuel would be operated at the site for a maximum of eight hours each day. The USEPA AP-42 Emission Factors for diesel industrial engines were used to estimate emissions. The estimated emissions from equipment are shown in Table 18.

Table 18: Estimated Total Emissions from Construction Equipment

<i>Constituent</i>	<i>Quantity Emitted (kg/day)</i>
Nitrates	708
Carbon Monoxide	299
Sulphates	440
Particulates less than 10µm	38
Carbon Dioxide	63141
Aldehydes	38

The dispersion of these emissions was computed to determine the concentration at receptors downwind from the site. Emissions were modeled as being from a line source with the source assumed to be the open face of the landfill. Further it was assumed that the maximum open face will be one-fourth of a hectare. A prevailing wind speed of 6.1 msec⁻¹, equivalent to the higher value of wind speeds available for Georgetown, was used for the analysis. The analysis determined the variation of concentrations with distance from the open face. The distances at which maximum dispersed concentrations are lower than acceptable air quality are detailed in Table 19. USEPA Ambient Air Quality Standards for constituents emitted from earthmoving and trucking equipment are detailed also in Table 19. The analysis indicates emissions from landfill operation equipment will not impact air quality at distances in excess of 700 m from the site.

Table 19: Estimated Emissions Concentrations from Construction Equipment

<i>Constituent</i>	<i>Distance (km)</i>	<i>Concentration ($\mu\text{g}/\text{m}^3$)</i>	<i>USEPA Ambient Air Quality Standard ($\mu\text{g}/\text{m}^3$)</i>
Nitrates	0.7	2685	None
Carbon Monoxide	0.7	1136	10000 – 8 hour average
Sulphates	0.7	1671	None
Particulates less than 10 μm	0.7	145	150 – 24 hour average
Carbon Dioxide	0.7	239621	None
Aldehydes	0.7	146	None

These impacts would extend over the duration of landfilling operations but will have no residual effects. They will be minimized by appropriate specifications for landfilling equipment.

8.7.3 GROUNDWATER FLOW

Excess pore water pressures from landfilling will create a groundwater mound. Pore water pressures will decrease outwards from the center of the mound. Groundwater flow direction in the upper clays will be influenced by these pore pressures and will vary from that currently existing at the site. Landfilling will therefore produce a permanent localized groundwater flow regime different from the surrounding area within the landfill footprint only. The landfill will be designed as a hydraulic trap resulting in localized flow gradient into the cells. Inflows will be very small noting the low permeability of the host soils.

The first potable water aquifer is located at a depth greater than 150 m, landfilling operations will not alter groundwater flow directions in that aquifer since the pressure imposed by landfilling operations is a very small fraction of the existing overburden pressure at that depth.

8.7.4 SURFACE WATER FLOW

The waste which will temporarily replace the soil at ground surface is significantly more porous than these soils. A larger proportion of precipitation will therefore be retained by the waste resulting in lower surface runoff. This impact would be temporary in duration and localized to active fill areas only.

8.7.5 SURFACE WATER QUALITY

All leachate generated by the landfill will be collected from its base and treated to meet international standards. Waste operations will have no impacts on water quality. Stormwater will include water from non waste handling areas contiguous to waste operations. It will include runoff from developed areas such as the weight station and other onsite buildings and roads. Soil berms will be constructed around operational waste areas to prevent stormwater from contacting waste. Stormwater will be fed to the stormwater sedimentation and control ponds and sediment in stormwater will be retained in the forebay in each pond prior to discharge during operation of the facility.

8.7.6 WILDLIFE

Waste will contain organic matter and food. The landfill will attract insects, birds and animals that feed on the waste. Food in the waste may contribute to the growth of large populations of some species, which will displace other species present in areas adjacent to the facility and so imbalance the local ecosystem. Species displaced by the increased presence of those associated with waste operations, may have constituted a part of the nutritional base for other species in the area. These species may also be displaced. These impacts are temporary in duration, with no long-term effects. They can be minimized by the application of daily cover to active waste areas.

The stormwater management ponds may provide new wetland habitats. The diversity of avifauna may change as a result, with increased populations of waterfowl and waders. These impacts will extend over the life of the operations and into the post closure phase.

8.7.7 BIRDS

The landfill will provide a ready source of food. The number and abundance of bird species at the site will consequently increase. The carrying capacity of areas that these species move into would be placed under pressure in the short-term. If birds feed on contaminants present in the waste, the effects of bioaccumulation may spread across enormous distances and affect stocks of birds and mammals which live and breed far

away from the project area. These impacts are temporary in duration, with no long-term effects. They can be minimized by the application of daily cover to active waste areas.

8.7.8 NOISE, ODOUR, AND DUST

Dust emissions would be produced during the landfilling operation by vehicles using the site roads and from cover material stockpiles onsite. The dust emissions from the cover material stockpiles would result from the following:

- Loading and reloading of material unto and from the cover material stockpiles;
- Equipment traffic in the area; and
- Wind erosion of cover materials in stockpiles.

The dust likely to be emitted during operations was estimated using AP-42 Emission Factors for Aggregate and Storage Piles and for Unpaved Roads. The analysis for stockpiles assumed maximum wind speeds of 30kph, soil moisture content of 5% and 2000 tons of stockpiled material. Dust emissions for these conditions are expected to range from 1 to 4 kilograms per day. The estimate of dust emissions from unpaved roads was based on the surficial soils having a silt content of 20%, average vehicles weight being 15 tons, and a surficial soil moisture content of 20 percent with the total distance traveled by vehicle each day at the site being equal to 300 km. The dust emitted was computed for different sizes of particulates, PM-2.5, PM-10 and PM-30, where PM-2.5 refers to particulate matter smaller than 2.5 microns. The dust emissions expected from the unpaved roads are detailed in Table 20.

Table 20: Emissions from Unpaved Roads

<i>Parametre</i>	<i>Quantity Emitted kg/day</i>
PM-2.5	25
PM-10	170
PM30	484

Noise levels above the alert threshold of 86 decibels and hazard threshold of 95 decibels will be produced from landfilling equipment operation. Exposure to noise levels above the internationally accepted level of 90 decibels can cause noise induced hearing loss. Noise levels above the tolerable threshold of 72 decibels can cause/result in fatigue, tiredness, low morale and decreased production levels and productivity. Tired workers

are also prone to accidents and this can contribute to an increase in accidents in the working environment.

These impacts will extend over the duration of the operation and will have no long-term residual effects. These impacts will be minimized by implementing mitigation measures. These measures will include dust control measures and specifications for the noise performance of heavy equipment.

8.7.9 TRAFFIC

Refuse will be hauled to the landfill primarily by 18-kip single axle trucks. Access to the landfill will ultimately be via the new bypass highway and south service road. The south service road will be extended from the intersection with the new bypass highway and will be constructed along the top of the drainage canal berm adjacent to the south Property boundary. Initially, access will be from the established road at Eccles/Bogottsville. Landfill operations will not generate any traffic through housing areas. The quietude of residents of the housing area will not be significantly impacted. All onsite roads are more than 1.5km away from residential areas and dust emissions from these roads will have no impact on residents of surrounding communities.

8.8 CLOSURE IMPACTS

8.8.1 SURFACE WATER QUALITY

The stormwater and sediment control ponds will remain operational after site closure. A risk is posed by failure of the forebay of the sedimentation/stormwater management ponds which will result in a discharge of sediment to surface water.

8.8.2 LANDFILL GAS

Landfill gas will be generated by the landfill under anaerobic conditions after closure. Methane (CH₄) and carbon dioxide CO₂ are the primary constituents of landfill gas (LFG). Methane gas may displace oxygen and cause suffocation of workers at the site. Methane is explosive and its accumulation in MSWM structures may result in fire and explosions that can endanger employees, users of the disposal site, and cause damage to landfill containment structures. LFG will also contain a small amount of non-methane

organic compounds (NMOC). This NMOC fraction will contain organic hazardous air pollutants (HAP), greenhouse gases (GHG) and compounds associated with stratospheric ozone depletion. The NMOC fraction will also contain volatile organic compounds (VOC).

Uncontrolled emissions of the various compounds present in LFG were estimated by determining the total landfill gas emissions. Details of the analysis are presented in Appendix G. The hourly emission rate of CH₄, CO₂, N₂ and 2-Propanol after 20 years of landfilling operations are detailed in Table 21.

Table 21: Rate and Constituents of Uncontrolled Emissions from Landfill

<i>Year</i>	<i>Q_{CH₄}(kg/hour)</i>	<i>Q_{CO₂}(kg/hour)</i>	<i>N₂(kg/hour)</i>	<i>2-Propanol (kg/hour)</i>
20	316	1193	50	0.108

Emissions were modeled as being from a line source with the source assumed to be the open face of the landfill. The emission rate at the end of the twenty year design life was used in the analysis. A prevailing wind speed of 6.1 msec⁻¹, equivalent to the higher value of wind speeds available for Georgetown, was used for the analysis. The analysis was conducted to determine the variation of concentrations with distance from the open face. The distances at which maximum dispersed concentrations are lower than acceptable air quality are detailed in Table 22.

Table 22: Concentration of Constituents of Uncontrolled Emissions from Landfill

<i>Constituent</i>	<i>Distance (m)</i>	<i>Concentration <i>n</i> (µg/m³)</i>
Methane	1000	415
Carbon Monoxide	1000	13760
Nitrogen	1000	576
NMOCs	1000	1.25

Landfill gas will have no impact on receptors at distances of more than 1.0 km from the landfill. The risks associated with generation of methane gas will be mitigated by installing an active LFG management system at the landfill.

8.8.3 ODOURS

The constituents in LFG for which odour standards are established are hydrogen sulfide and carbon disulfide. The quantities of both of these gases estimated to be generated after closure of the landfill are detailed in Table 23.

Table 23: Quantities of Hydrogen Sulfide and Carbon Disulfide Generated by Landfilling

<i>Year</i>	<i>Hydrogen Sulfide(kg/hour)</i>	<i>Carbon Disulfide (kg/hour)</i>
20	0.043	0.00158

The concentrations of these constituents were determined to assess their impacts on odour and annoyance levels based on the WHO guidelines. The concentrations and the associated WHO standards are presented in Table 24.

Table 24: Estimated Concentration of Odourous Emissions from Landfill Operations

<i>Parametre</i>	<i>Distance to Receptor (m)</i>	<i>Concentration ($\mu\text{g}/\text{m}^3$)</i>	<i>WHO Guideline ($\mu\text{g}/\text{m}^3$)</i>
Hydrogen Sulfide	100	3.43	7.0
Carbon Disulfide	100	0.13	20.0

Odours levels below WHO guidelines would occur within 100 m of the property boundary. Odours will consequently be of minimal impact. Odours will be mitigated by installation of the active LFG gas management system.

8.9 CONTINUED USE OF MANDELA SITE (NO-ACTION ALTERNATIVE)

If the project is not undertaken (No-Action) waste disposal will continue at the Mandela Site and GM will continue to operate the incinerator at Princess Street. The environmental problems related to these operations will be exacerbated by their continued use with no environmental controls. The environmental impacts and risk of the No-Action Alternative are detailed below.

8.9.1 CLIMATE

Uncontrolled fires often occur at the Mandela Site. These fires are likely to continue. Smoke and carbon monoxide produced by landfill fires will impact the microclimate of the area by restricting the passage of light. During fires, temperatures in areas immediately adjacent to the dump will exceed those occurring under normal circumstances.

8.9.2 AIR QUALITY

Optimal combustion conditions are not present during fires at the dump and harmful micro pollutants generated by these fires will negatively impact air quality. Organic gases and other toxins, injurious to health are also generated in low concentrations by the fires. Air quality is also impacted by gaseous emissions from waste hauling equipment and bulldozers. Air quality impacts related to emissions from equipment were estimated based on 15 pieces of equipment, each rated at 600 horse power being operated on the site for a maximum of eight hours each day. Total emissions were estimated based on the USEPA AP-42 Emission Factors for diesel industrial engines. Daily emissions from equipment are shown in Table 25.

Table 25: Estimated Total Emissions from Construction Equipment

<i>Constituent</i>	<i>Quantity Emitted (kg/day)</i>
Nitrates	425
Carbon Monoxide	180
Sulphates	264
Particulates less than 10µm	23
Carbon Dioxide	37885
Aldehydes	23

Concentrations of gaseous emissions at receptors located at various distances from the source were modeled with the source assumed to be the open face of the landfill for a prevailing wind speed of 6.1 msec⁻¹. The distances at which maximum dispersed concentrations are lower than acceptable air quality are detailed in Table 26. USEPA Ambient Air Quality Standards for these gaseous emissions are also detailed in Table 26. The analysis indicates emissions from landfill hauling and construction equipment will impact air quality at distances less than 350 m from the site. Several residences are located within a distance of 100 m of the current site. Residents of these areas will experience negative impacts related to emissions of particulates during operations.

Table 26: Estimated Emissions Concentrations from Construction Equipment

<i>Constituent</i>	<i>Distance (m)</i>	<i>Concentration ($\mu\text{g}/\text{m}^3$)</i>	<i>USEPA Ambient Air Quality Standard ($\mu\text{g}/\text{m}^3$)</i>
Nitrates	350	2793	None
Carbon Monoxide	350	1182	10000 – 8 hour average
Sulphates	350	1738	None
Particulates less than 10 μm	350	150	150 – 24 hour average
Carbon Dioxide	350	249198	None
Aldehydes	350	151	None

Methane (CH_4) and carbon dioxide CO_2 , the primary constituents of landfill gas (LFG) will be generated by waste landfilled at the site. These gases will be produced by microorganisms within the landfill under anaerobic conditions. LFG also contains small amounts of non-methane organic compounds (NMOC). NMOC contain organic hazardous air pollutants (HAP), greenhouse gases (GHG), volatile organic compounds (VOC) and compounds associated with stratospheric ozone depletion. Uncontrolled emissions of compounds present in landfill gas were estimated. Generation of CH_4 was estimated using a theoretical first-order kinetic model of methane production developed by the USEPA. Details of the analysis are detailed in Appendix C. This facility has been in existence for 10 years. Generation levels are detailed for years 10 through 20 of operations at the site in Table 27.

Table 27: Rate and Constituents of Uncontrolled Emissions from Landfill

<i>Year</i>	<i>Q_{CH4}</i> <i>(kg/hour)</i>	<i>Q_{CO2}</i> <i>(kg/hour)</i>	<i>N₂</i> <i>(kg/hour)</i>	<i>2-Propanol</i> <i>(kg/hour)</i>
10	189	377	30	0.065
11	204	407	32	0.070
12	219	436	35	0.075
12	232	463	37	0.079
14	246	491	39	0.084
15	259	516	41	0.088
16	271	541	43	0.093
17	283	565	45	0.097
18	294	587	47	0.101
19	305	609	48	0.104
20	316	1193	50	0.108

The results of dispersion analyses of these gases and the distances at which maximum dispersed concentrations are lower than acceptable air quality are detailed in Table 28.

Table 28: Concentration of Constituents of Uncontrolled Emissions from Landfill

<i>Constituent</i>	<i>Distance</i> <i>(m)</i>	<i>Concentration</i> <i>(µg/m³)</i>
Methane	30	14335
Carbon Monoxide	30	475040
Nitrogen	30	19909
NMOCs	30	43

Some residents along Princess Street live within 30 m of the site. LFG emissions will have significant impacts on air quality within this distance.

Incinerator operations will continue to take place with no environmental controls. Emissions from uncontrolled firing of medical and abattoir waste include acid gases such as hydrogen chloride, sulphur oxides, nitric oxides as well as other harmful components such as polyaromatic hydro carbons (PAH) and various halogenated compounds such as dioxins. While quantities fired do not exceed 5 tonnes per day, it is highly likely that air quality would be compromised during firing in areas adjacent to the incinerator.

These impacts will extend over the duration of continued operations at the site and are very likely to have long-term residual impacts on residents of communities located adjacent to the site.

8.9.3 GEOLOGY

Canals west of the current fill area must be filled for continuous development of the dump. Surficial geology of the area consists of desiccated silty clays overlying very soft silty clays. The operations will cover the area with a heterogeneous mix of solid waste and will alter the surficial soils at the site. The modification of surficial soils will influence the water balance in the area since the waste would be significantly more porous than the clays soils.

The dump does not have stable slopes and this can lead to failure of the dump slopes and alteration of ground cover in areas adjacent to the dump. The operations have changed the topographic height, slope relief intensity, degree of shaping and exposure of the area. These impacts will extend over the duration of continued operations at the site and are very likely to have long-term residual impacts on communities located adjacent to the site.

8.9.4 WATER RESOURCES

Wastewater from the site consists of leachate from the dump and stormwater runoff. Stormwater flows through uncovered waste prior to discharge to surface water around the dump. Leachate breaks out the sides of the dump and flows to drains bordering the site. Surface water quality is therefore retarded by discharges from waste fill areas. These impacts will extend over the duration of continued operation at the site and are very likely to have long-term residual impacts on surface water quality around the site.

8.9.5 GROUNDWATER FLOW

Operations will produce a localized groundwater flow regime different from the surrounding area within the landfill footprint only. This impact would extend over the duration of the operation, but would have no residual effects.

8.9.6 GROUNDWATER QUALITY

Potable groundwater is recovered from wells screened at depths of more than 250 metres. The wells in closest proximity to the site are those located in Tucville and Guyana Water Inc complex on Vlissengen Road more than 1500 metres away from the site boundary. The clays at the site have relatively high cation exchange capacities (CECs). Travel times for contaminated groundwater from the dump to potable groundwater exceed 1250 years based on a vertical hydraulic gradient of 0.1. This coupled with the high CECs will immobilize practically all contaminants present in leachate. The dump would not adversely impact groundwater quality.

8.9.7 SURFACE WATER FLOW

Site clearing will produce increased discharge to surface water flow since interception and evapotranspiration will be reduced. As operations progress, surface runoff volumes will decrease since water will be retained in the porous fill. Surface water flow will consequently only be altered in the short term by extension of the dump.

8.9.8 SURFACE WATER QUALITY

Precipitation may leach chemicals from uncovered waste. Surface runoff from uncovered waste with water-soluble substances and heavy metals will degrade surface water quality. Surface runoff from the dump will introduce sediments and nutrients loads into surface water. The rate of nutrient addition by material from the dump, such as waste food, may exceed the natural rate and contribute to eutrophication in surface water around the dump. These impacts will extend over the duration of continued operations at the site and are very unlikely to have long-term residual impacts on surface water quality around the site since surface water quality has already been imperiled by septic tank discharges.

8.9.10 TERRESTRIAL RESOURCES

Continued operations will clear more areas west of the current area. The project will result in a change in vegetation cover over a relatively small area of the total area available. The dump is surrounded by several housing areas and a cemetery. Land use conflicts related to the current use of the area will be exacerbated by continued use of the

facility for landfilling operations. In addition, development plans for the City of Georgetown makes no allowances for landfilling operations in this area. Continued operations will therefore conflict with the Master Plan for Georgetown.

8.9.11 WILDLIFE

Waste contains organic matter and food and will continue to attract insects, birds and animals which feed on waste. Insects and some animals, such as rats, will breed in the waste and will continue to represent a health problem to residents of the area because of their proximity to the dump. Pollution of watercourses and canals can cause damage to vegetation, fish and fauna. These impacts will extend the duration of operations and may have residual impacts on stocks of birds and mammals which live and breed far away from the dump.

8.9.12 THREATENED AND ENDANGERED SPECIES

No threatened and endangered species are present in the area. There are therefore no impacts on threatened and endangered species.

8.9.13 NOISE, ODOUR, AND DUST

Fugitive dust and wind blown garbage would be emitted from the site. Noise levels above the alert threshold of 86 decibels and hazard threshold of 95 decibels will be produced from heavy-duty equipment operation. Exposure to noise levels above the internationally accepted level of 90 decibels can cause noise induced hearing loss. Waste decomposition will generate offensive odours. Daily cover is not provided at the dump, landfill gases generated by waste have strong odours which will cause discomfort to residents around the dump. These impacts will extend the duration of the operations.

8.9.14 HEALTH AND SAFETY

Several scavengers presently work at the dump. Scavenging operations will continue. Scavengers will be exposed to sharp and pointed objects, infectious matter and dust which can cause respiratory diseases. These impacts will extend the duration of the operations and can have long term residual impacts.

8.9.15 SOCIOECONOMIC CONDITIONS

Operations at the Mandela Site consist of open dumping and open burning of waste with significant uncontrolled scavenging. The continued open dumping and open burning of waste will further exacerbate health and environmental hazards to the communities surrounding the site and associated with the site operation. The health risks associated with illegal dumping are significant. The dump is easily accessible to people, who are vulnerable to physical objects such as protruding nails or sharp edges and chemical such as harmful fluids contained in the improperly disposed waste. Rodents, insects, and other vermin attracted to the open dump also pose health risks. Scrap tires in the dump provide an ideal breeding ground for mosquitoes, which can multiply 100 times faster than normal in warm stagnant water. Severe illnesses, including encephalitis and dengue fever, have been attributed to disease-carrying mosquitoes originating from scrap tire piles.

A USEPA study indicated that dioxin emissions from open burning of garbage in one day by four families could equal the emissions from a municipal solid waste incinerator burning 200 tons per day. Fires occur quite often at the Mandela site and are significantly greater in their impacts than those impacts associated with open burning of garbage by four families. The emissions from open fires at Mandela will significantly impact the health of people in the surroundings. Emissions will include dioxins which are known to suppress the immune system, disrupt hormonal balance and promote carcinogenesis. Additional emissions resulting from open burning and their associated health risks include:

- benzene (leukemia);
- toluene diisocyanate (asthma);
- nitrogen dioxides (lung damage); and
- nitrile compounds (metabolic poisons and carcinogens).

Burning household garbage can also produce emissions of formaldehyde, hydrochloric and sulphuric acids, hydrogen cyanide, polycyclic aromatic hydrocarbons, cadmium, lead, mercury and chromium. This will further exacerbate health and environmental risks in these communities and create economic hardships since scarce resources will have to be allocated to management of these risks. These impacts will extend the

duration of the operations and may have long term residual impacts on the health of residents of Lodge.

Absence of a proper waste management facility can threaten the long term viability of waste disposal in GM. Residents may move to court to halt operations due to threats to human health and the environment in the Mandela Site vicinity. This problem will be exacerbated if Georgetown moves to restrict the disposal of waste generated outside its boundaries. Lack of access to a disposal facility will increase the costs for waste disposal for GM and the NDCs. It may also exacerbate problems with illegal dumping in GM.

The lack of adequate environmental controls may increase refuse flows to canals around the site. Waste from the site, coupled with eutrophication induced by discharge from the site, clog these canals and result in flooding of areas around the dump. Flooding will result in lost productivity and reduced wages because of reduced accessibility for residents in areas adjoining the dump. Continued operation of the dump will further decrease property values in areas surrounding the site. The impact will extend over the duration of the operations and can have long-term residual impacts.

Several canals in the down town area are clogged with plastic bottles and this leads to flooding. Absence of an effective waste management strategy will exacerbate this problem. This will further degrade the aesthetics of the downtown area and may lead to less visitors to the area and associated decreased spending and loss of revenue. In addition, continued flooding in down town Georgetown and its immediate environs may result in decreased property values in the down town area. These impacts will extend over the duration of the operations and can have long-term residual impacts.

Waste disposal practices in NDCs are characterized by dumping without environmental controls and open burning of waste. These practices will continue and will create economic hardships for the NDCs since scarce resources will be allocated to maintain drainage infrastructure clogged by waste. Open burning of waste will continue to lead to tension in some communities quite apart from exacerbating health and environmental risks in these communities. Aesthetics in these communities will also be impacted by the continuation of the current disposal practice. These impacts will extend over the duration of the operations and can have long-term residual impacts.

8.10 SUMMARY AND CONCLUSIONS

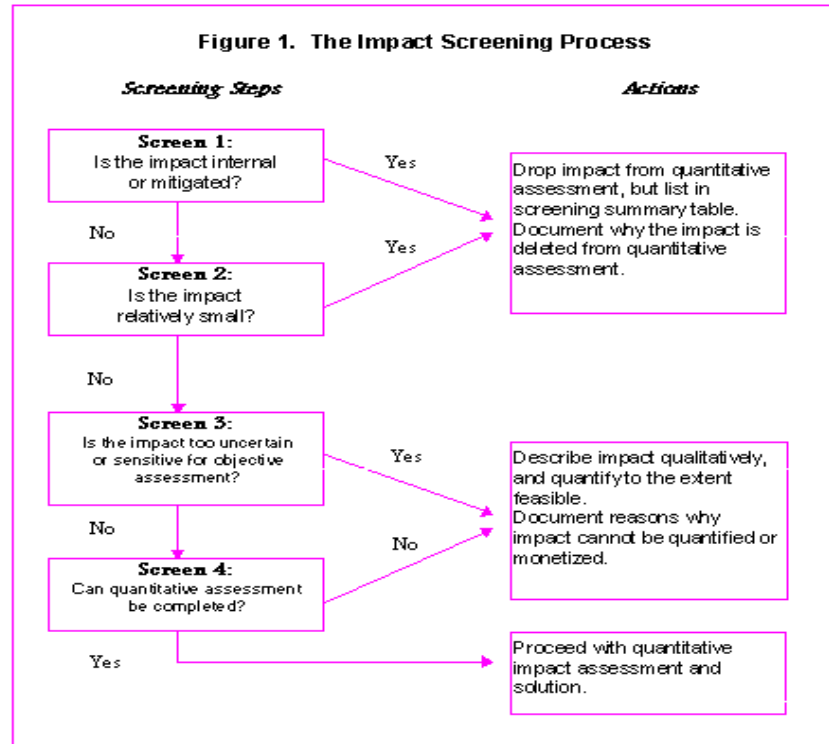
A formal sequence of studies covering problem characterization and assessment (including review of available disposal options) identified sanitary landfill as the least cost solution to the solid waste problem in Georgetown and Environs, and the Eccles area as the preferred location. An EA complemented the pre-feasibility siting studies. The alternative to this proposed project would be the "do nothing" option i.e., maintain the current systems of garbage collection and disposal. The negative impacts of this current system on the environment and human health would increase over time resulting in continued degradation and increased disease, illness and possible death to impacted residents. The process has had the benefit of significant stakeholder input. The proposed landfill project at Haags Bosch is technically feasible, financially viable and sustainable and socially and environmentally effective in reducing future degradation to Georgetown on environments. It is therefore a robust option and certainly the preferred approach to "do nothing".

9.0 ECONOMIC ANALYSES OF ENVIRONMENTAL IMPACTS AND RISKS

The analyses of environmental costs and benefits require definition of the boundaries of the affected area, the time frame for the economic analyses and the developing the basis for assigning economic values of environmental and socio-cultural effects.

The boundary for the analysis is defined to consist of the entire area of Georgetown and the adjacent NDCs that are expected to be serviced by the new sanitary landfill at Haags Bosch. The time frame for the economic analysis is equated to the project life of twenty five years plus an additional ten years for maintenance of the facility closure systems. A discount rate of 12 percent, equivalent to the rate used for the pre-investment study, was used to compute the net present values of the environmental costs and benefits.

Economic valuation of environmental impacts were compared for the proposed sanitary landfill at Haags Bosch and the existing status quo, which is defined as the continued expansion and operation of the Mandela dumpsite and other existing dumpsites managed by the NDCs. This assessment was conducted based on "The Economic Valuation of Environmental Impacts: A Workbook, 1996", Office of the Environment and Social Development, Asian Development Bank. The four-step screening process detailed in the figure, reproduced as follows, was used to identify environmental impacts that required quantification and a determination of their monetary value. Several potential impacts were not translated into quantitative terms because of either insufficient data or uncertainty attached to these impacts.



The economic value of environmental benefits and costs were estimated in United States currency, derived from financial costs using conversion factors and shadow prices. Land was valued at its opportunity cost. The economic analyses of the environmental consequences of the project examined benefits and costs both with and without the proposed project. As noted above, the without project scenario is based on continued waste disposal at the Mandela Site and at open dumps in NDCs. The other alternatives to the landfill option are so cost prohibitive as to not be realistic for economic comparison to the proposed Haags Bosch Landfill. The most cost effective of the available technology options that could, at least theoretically, be used to manage solid waste have a minimum tipping fee cost of at least \$50 per tonne and a total present value cost approaching \$100 million dollars. As a result the continued use of the Mandela dumpsite was the alternative used for comparative purposes.

9.1 CONTINUED WASTE DISPOSAL AT MANDELA DUMPSITE AND OTHER NDC DUMPSITES

9.1.1 COSTS

The direct cost of continued filling at the Mandela dumpsite is low at less than \$3.00 per tonne. This direct cost represents only the direct costs of clearing new landfill area and filling the dumpsite in accordance with current practice. For ease of comparison it will be assumed that there is adequate lands within the vicinity of the Mandela dumpsite to continue the current inadequate waste disposal practice for the same term that would be available for the proposed Haags Bosch Landfill. Waste is presently disposed at the Mandela Site and on embankments and canals in NDCs. In fact, it is estimated that more waste is placed within the NDCs and the canals throughout Georgetown than is presently placed within the Mandela dumpsite.

The health impacts associated with continued filling at the Mandela dumpsite represents a very large economic and social loss to the community. It is difficult to assign a realistic economic value or loss associated with health related impacts to the community associated with: the water quality deterioration; diseases associated with the deteriorated local water quality; and the continued waste filling of the canals throughout the area in an uncontrolled and unhygienic manner. Lost work time and losses related to illness for local residents are likely the largest costs and social impact. The real cost for this item is likely in the millions of dollars annually.

Operations at the Mandela Site have decreased property values in wards of Georgetown in the environs of the site. Expanded operations at the site will further lower property values in these areas. Lack of waste management facilities in NDCs may also decrease property values in large portions of the NDCs. Widespread disposal of solid wastes in canals and along roadsides is rampant. Animals and vectors are allowed to forage through these wastes in many locations further aggravating the situation and increasing the potential for the spread of health related problems.

As a secondary social concern, expanded operations at the Mandela dumpsite will remove more burial plots from the Le Repentir Cemetery. Again this factor is difficult to assign an economic value, however it is clearly a significant social issue with regards to the local residents and those with family members buried at this location.

Assessments have indicated that methane gas generated by the Mandela Site could be used to generate approximately 0.7 - 1 MW of electrical power. For the purposes of this

assessment, the LFG item will be treated as a neutral factor that would be undertaken only if it could be self supporting economically and it is equally applicable to the current disposal site or the new landfill. There would be some secondary benefits associated with reduced odours but this factor has not been assigned an economic value.

Several NDCs have absolutely no waste management infrastructure and no modern disposal facilities. All of the problems attributable to the Mandela dumpsite also apply to all of the NDCs.

Another factor that is almost as significant as the health related impact potential is the loss of any potential for developing and revitalizing the tourist industry and encouraging visitors from entering and spending any time in Georgetown and in Guyana. Assigning a dollar value to this consideration is beyond the scope of this report but it represents a significant lost opportunity for revenue and improved quality of life, employment and improved economic conditions. This lost potential could easily represent millions of dollars each year.

9.1.2 BENEFITS

It is difficult to assign any benefits or merits to the continued waste disposal at the Mandela dumpsite and random dumping throughout the community. There are some apparent capital and operating cost savings or benefits if a new landfill operation is not developed at the Haags Bosch Site. This is not a sustainable approach and it is difficult to treat a lack of any development to manage the solid wastes as responsible or proactive. Continued operations at the Mandela Site will provide benefits to a few waste recyclers working at the site. However, the new landfill was going to establish similar opportunities for waste pickers but under much improved hygiene conditions that would be safer and which would reduce the costs of injury and lost time due to illness. For the purposes of this assessment, it is assumed that the future value of any recovered materials is similar for both the existing dumpsite and the new landfill. In fact, this will likely prove to be a net benefit for the new landfill operation. .

The only truly identifiable benefit associated with continued filling at the Mandela dumpsite is a marginal savings in fuel and vehicle related costs for the transport vehicles to take the waste to the new landfill. This cost savings is in the range of \$10,000 per year and is spread amongst the municipality and the private sector that would deliver the waste to the landfill.

9.1.3 HUMAN HEALTH

Monetary values for health impacts were used to obtain costs related to continued diminished water and air quality in NDCs and in areas in the environs of the Mandela Site. Cost-of-illness (COI) estimates were used to estimate the value of avoiding adverse health effects associated with poor water and air quality. The COI reflects the out-of-pocket costs of being sick. The COI was used as a proxy for the value of lost work time and decreased productivity because of illness.

Data from the Ministry of Health for the years 2002 and 2003 is represented by the summary of Table 29 for illnesses related to poor water and air quality in Regions 3 and 4.

Table 29: Incidences of Diarrheal and Acute Respiratory Infections in Regions 3 and 4

<i>Year</i>	<i>Region</i>	<i>Under 5 Years Old</i>	<i>More than 5 Year Old</i>	<i>Total</i>
Diarrheal Diseases				
2002	3	985	775	1760
	4	3973	1187	5160
2003	3	1063	1039	2102
	4	3556	1147	4703
Acute Respiratory Illnesses				
2002	3	1246	1591	2837
	4	1102	1618	2720
2003	3	2104	3953	6057
	4	1884	2516	4400

Malgre Tout/Meer Zorgen and Nismes/La Grange are located in Region 3. The data for Region 4 is assumed to incorporate these two NDCs and data from Region 3 is neglected from further consideration. The data is inadequate to determine losses in productivity related to these illnesses. There is no available data to establish the increase in incidents immediately adjacent to Mandella. However, there is anecdotal evidence of increased incidents that is consistent with expectation form over exposure to such poor conditions. For purposes of quantifying the effects the following approach is used.

Typical costs for oral rehydration for diarrhea range from US \$4.50 to US \$7.00 each. An average cost of US \$5.75 was assumed and two treatments are assumed to be provided to each infected individual. The COI for diarrheal infections equates to US \$56,713.00/year based on an average for the two years. Similarly typical costs for treatment of acute respiratory infections range from US \$12.00 to US \$17.00 per

occurrence. The COI for treatment of acute respiratory infections equates to US \$51,620.00/year based on the average number of infections for the two years of data. There is no baseline data for pristine conditions on Guyana where health related incidents are unaffected by poor water and air quality resulting in major part from poor waste disposal practices. Such poor practices occur in Regions 3 and 4. The human health cost associated with continued operations at the Mandela Site and at open dumps in the NDCs is therefore US \$108,333.00 per year.

9.1.4 ENVIRONMENTAL VALUES

The United Kingdom Department for Environment, Food and Rural Affairs (DEFRA) undertook a study that examined the impacts of landfill proximity to property values. The study looked at over half a million sales of houses situated near UK landfill sites and found that those properties sited within half a mile of a landfill site suffer statistically significant disadvantages. The results of the study relating distance from landfills to loss in property values are presented in Table 30 below taken from that study.

Table 30: Regional Percentage Change in House Prices by Proximity to Landfill

<i>Region</i>	<i>Miles from Landfill</i>				
	<i>0 – 0.25</i>	<i>0.25 – 0.5</i>	<i>0.5 – 1.0</i>	<i>1 -2</i>	<i>2+</i>
South West	1.11	-0.05	0.43	-0.04	0.00
West Midlands	-1.45	-2.73	-0.98	0.24	0.00
South East	-1.25	-0.55	-0.58	-0.15	0.00
East	-4.88	5.55	1.50	0.06	0.00
East Midlands	-10.01	-8.75	20.93	9.89	0.00
Yorks and Humber	0.45	-1.22	1.38	2.16	0.00
North West	-1.52	-0.88	2.92	0.50	0.00
North East	0.7	1.07	0.96	1.82	0.00
Wales	-1.15	-1.13	0.46	-0.94	0.00
Scotland	-41.27	-7.73	-3.01	-2.67	0.00
South of England	-1.39	0.63	0.03	-0.01	0.00
North of England	-0.34	-0.53	2.01	1.14	2.23
Wales and Midland	-5.39	-5.65	5.89	3.66	0.00
Average Great Britain	-7.06	-2.0	1.04	0.70	0.00

Cost in terms of decreased property values would result from continued operations at the Mandela Site. The results of the study were used to determine the cumulative decrease in value of properties that would result from continued operations at the Mandela Site. To conform to the study it was assumed that properties located more than one-half mile away will not experience any decreases in value.

GM provided data on the number of properties in Ruimveldt, La Penitence and Lodge and the assessed rental values of those properties. That data is reproduced as Appendix H. A summary of distance from the Mandela Site, the number of properties located within each distance and the rental values of all the properties within that specific distance is provided in Table 31.

Table 31: Summary of Properties and Rental values in Mandela Site Environs

<i>Location</i>	<i>Distance from Closed Site (miles)</i>	<i>Number of Properties</i>	<i>Rental Value/month (\$US)</i>	<i>Change in Value %</i>
Lodge	0 – 0.25	906	124242.00	-7.06
Lodge	0.25 – 0.5	854	85852.00	-2.0
La Penitence	0.25 – 0.5	1526	129883.00	-2.0

Rental charges per month in Guyana are 1 to 2 percent of property values. This analysis assumed rental charges are one and one-half percent of property values. The environmental costs in terms of decreased property values associated with operation at the Mandela Site equates to US \$10,468,984.00 based on this assumption.

GM has seven pump stations. A permanent staff of three labourers is employed fulltime to clear blockages at five of these pump stations associated with blocks created by plastic waste. A truck is employed fulltime to transport material recovered from these outfalls to the Mandela Site. In addition, an average of three grills and two pump impellers must be replaced each year because of damage due to waste in outfall canals. These costs will continue to be incurred by operations at the Mandela Site. The environmental costs associated with damages to pumps and maintenance of outfalls were computed based on the following costs provided by GM.

- Labourers Salary G\$ 1500/day, 6 days per week;
- Truck Rental G\$ 1500/hr; 10 hours/day; 6 days per week;
- Pump Grills G\$ 20,000.00 each; and
- Pump Impeller G\$ 60,000 each.

This environmental cost equates to US \$31,636.00 per year.

The GoG has sold housing plots in Diamond and Eccles of approximately 465 m² for prices ranging between US \$450 and US \$3500.00 each. The costs were based on the level of infrastructure development provided. Some NDCs are relatively rural compared to Diamond and Eccles. It was assumed that the average price of a plot of land of 465 m² would be US \$1500.00. Seven NDCs have no waste management facility. Typical area of waste dumps in NDCs is approximately 2 acres (0.8 ha). The total land taken for facilities for these NDCs would be 5.6 ha. This equates to an environmental cost of US \$180,645.00. NDCs spend practically no money on maintenance of open dumps. A minimal sum of US \$5000/year is considered to adequately represent maintenance expenditures by all NDCs.

Benefits related to savings from tipping fees and transport by both Georgetown and NDCs were computed based on the proposed tipping charge of US \$8.60 per tonne at the sanitary landfill at Haags Bosch and from transport charges obtained from a waste hauler. Georgetown will guarantee delivery of 120 tonnes/day of waste to the sanitary landfill at Haags Bosch. Discussions with NDCs indicate that waste generation rates in NDCs range from 2.5 to 5 tonnes/day. An average value of 3 tonnes/day was assumed applicable to all NDCs. Tipping fees for 165 tonnes/day of waste will be saved if the facility is not built. The savings related to tipping fees equates to US \$517,935.00/year in apparent savings. However, this cost is related to building and operating the new landfill. There are presently costs to operate the existing Mandela dumpsite. If similar standards were to be applied to continued development of this site, the costs would be much higher than to develop the Haags Bosch Landfill. This apparent savings is not real and does not represent a comparative assessment of the real costs.

9.2 SANITARY LANDFILL AT HAAGS BOSCH

9.2.1 PROJECT COSTS

Environmental costs of a sanitary landfill at Haags Bosch consist of: capital costs of the project and the associated yearly maintenance costs; the costs of 40 ha of agricultural land taken for the facility; and resettlement and compensation costs for waste pickers currently working at the Mandela Avenue dump.

Land is valued in terms of its opportunity cost, that is, what it could earn in the next best alternative use. The construction of enhanced access to Georgetown both along the current East Bank Demerara roadway and a road adjacent to the western boundary of the sanitary landfill will increase demands for residential land in the project area. Thus, it is likely that the next best alternative use for the land would be for residential/commercial purposes.

Several studies have established that property values decrease based on their proximity to landfill sites. In general values depreciate for homes located less than within 0.5 miles of a landfill. No homes are located within 0.5 miles of the proposed facility and may decrease in value due to the project.

The sanitary landfill at Haags Bosch will enable power from landfill gas generated at Haags Bosch to be combined with that from the Mandela site to provide a longer term power generation option for project stakeholders. This item is treated as a neutral situation because the resource could be developed in a similar manner at either site and would only be undertaken if the project was self-sustaining.

Several individuals earn a livelihood from recycling valuables from the Mandela Site. Closure of the Mandela Site and operations at Haags Bosch will entail relocating these individuals to the new operations. Relocation of these individuals and provision of resources for their use represents a small cost of the project but is far outweighed by the health and safety benefits that will be recognized by the workers.

9.2.2 PROJECT BENEFITS

The project will mitigate health impacts and associated costs to residents of NDCs and areas in the environs of the Mandela Site.

This project will provide sound environmental management for waste generated by GM and the NDCs. NDCs will no longer need to continue current disposal practices and those NDCs with no waste management infrastructure would no longer need to develop these facilities. The development cost of waste management infrastructure and the yearly maintenance cost for such a facility by NDCs without waste management infrastructure are environmental benefits provided by this project.

Closure of the Mandela Site will result in increased property values in areas of Georgetown in the environs of the site. The increases in property values are

environmental benefits of the proposed action. The project will also reduce incidences of flooding due to blocked drains and culverts in Georgetown and NDCs. Reduced flood incidences will result in increased productivity since less time will be lost. The absence of waste in canals may result in increased recreational fishing in Georgetown and NDCs thereby producing a recreational benefit to these communities. The improvements in the quality of canal water will provide better water for irrigation and improve the aesthetic quality of the waterways, which will benefit those living nearby and those using the canals for agriculture and recreation. No attempt was made to quantify these environmental benefits since data is not maintained for lost workdays related to flooding and on water fees for irrigation.

Without the project GM will continue to expend resources on maintenance of outfalls clogged by improper waste disposal. Maintenance costs for sewerage management systems in Georgetown clogged by improperly disposed waste would also continue at present levels or be increased without the project. Environmental benefits associated with the project will include less spending both on outfall maintenance and on sewerage management system maintenance.

9.2.3 ECONOMIC VALUATION OF ENVIRONMENTAL IMPACTS

The economic value of environmental impacts was estimated using three categories human welfare, human health, and environmental values. Certain benefits were not valued. These include improvements in water used for industrial purposes, which is very minimal and reduction of pollution loads in the coastal zone of the Demerara River. No attempt was made to value changes in the biological environment or the benefits associated with enhanced aesthetics of areas adjacent to waterways clogged by improper waste disposal. Increased property values in NDCs were not valued since these properties are removed from direct proximity to the proposed action and hedonic pricing would not adequately represent any changes in values since other factors may be more relevant to altered values at these locations. In addition, charges related to industries relocating from the Eccles site were not considered as a quantifiable benefit since it would entail an assumption that all businesses are successful.

9.2.4 HUMAN WELFARE

Sanitary landfill capital and operation and maintenance costs are respectively US \$10.00 and US \$5 to 6 per tonne. (ERM, 2002). A waste filling rate of 220 tonnes/day was used

to estimate the investment and maintenance costs for the proposed facility. These costs equate to approximately US \$15,000,000 and US\$690,580/year for investment and operation costs for twenty years of landfill life. This operation costs include costs for waste tipping charges and transport.

The project will eliminate recycling activities at the Mandela Site but it is assumed that equivalent or improved recycling will take place at the new landfill. As such this item is treated as neutral in the assessment of the alternatives.

9.2.5 HUMAN HEALTH

Monetary values for health impacts were used to obtain benefits related to improvements in water and air quality in NDCs and in areas around the Mandela Site. Cost-of-illness (COI) estimates were used for the value of avoiding adverse health effects associated with poor water and air quality. The COI reflects the out-of-pocket costs of being sick. The COI was used as a proxy for the value of lost work time and decreased productivity because of illness. This benefit equates to the costs for illnesses related to poor water and air quality for continued operations at the Mandela Site. The human health benefits associated with operations at the Haags Bosch Site are therefore US \$108,333.00 per year.

9.2.6 ENVIRONMENTAL VALUES

The inverse of decreases in property values and distance from landfills was used to compute benefits associated with increases in property values due to closure of the Mandela Site. To conform to the findings of the study properties, which are located more than one-half mile away will not experience any increases in value. The increase in property values benefits in Georgetown related to operations at Haags Bosch equates to the losses in property values for continued operations at the Mandela Site. The environmental benefits in terms of increased property values associated with closure of the Mandela Site are therefore US \$10,468,948.00. Properties in Eccles and its environs are further away than one mile from the proposed landfill. No environmental costs are associated with losses in property values for Eccles and its environs.

GM has seven pump stations. A permanent staff of three labourers is employed fulltime to clear blockages at five of these pump stations associated with blocks created by plastic waste. A truck is employed fulltime to transport material recovered from these pumps

to the Mandela Site. In addition, an average of three grills and two pump impellers must be replaced each year because of damages due to waste in outfall channels. The project will provide an effective mechanism for waste management and eliminate these costs. Environmental benefits associated with damages to pumps and maintenance of outfalls were computed based on the following costs provided by GM.

- Labourers Salary G\$ 1500/day, 6 days per week;
- Truck Rental G\$ 1500/hr; 10 hours/day; 6 days per week;
- Pump Grills G\$ 20,000.00 each; and
- Pump Impeller G\$ 60,000 each.

This environmental benefit equates to US \$31,636.00 per year.

The value of agricultural land lost to the new landfill is small and will readily be offset by the increased land values in the industrial area. As such this item will be conservatively treated as revenue neutral even though a net benefit will result from the new landfill site.

Seven NDCs would not need to develop waste management facility in the event of the project. Typical area of waste dumps in NDCs is approximately 2 acres (0.8 ha). The total land taken for facilities for these NDCs would be 5.6 ha. This equates to an environmental benefit of US \$180,645.00 based on a unit price of US\$ 1500.00 for a 465m² plot of land. NDCs expend minimum sums on the maintenance of open dumps. A sum of US \$5000/year is considered to adequately represent maintenance costs savings for open dumps in NDCs related to the project.

9.3 COSTS -BENEFITS SUMMARY OF LANDFILL AT HAAGS BOSCH

The costs and benefits of undertaking the landfill project at Haags Bosch and for continuing the waste disposal at Mandella have been examined. A number of the items are subjective and difficult to quantify with a reasonable level of accuracy based on their nature and quality of available information. However, the analysis clearly indicates that there is a substantial net cost to continuation of the status quo i.e., continuing to dispose of solid waste at Mandella. The cost is estimated to be in the order of US \$20,000,000 over the 20 year life cycle considered.

On the other hand, executing the new landfill at Haags Bosch in the manner intended results in a net benefit of about 5 to 10 million US dollars over the same period based on the issues quantified. Additional significant benefits associated with tourism, returning resident etc. would significantly enhance these benefits. This project is therefore considered viable, and indeed necessary.

10.0 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

Section 6 of the EIA identified environmental impacts and associated risks that can potentially be encountered as a result of designing, constructing, operating and closing the Site. The purpose of the Environmental Management Plan (EMP) is to clearly address and discuss preventative and contingency measures, which will be established to mitigate environmental impacts and associated risks for the Project. In Section 6 of the EIA report actions related to the Project were systematically assessed and categorized based on potential to create an environmental impact and or associated risk for each individual phase of the Project. Although the assessment was somewhat redundant in that similar impacts can be attributed to different phases it was a very important exercise in that all potential actions through all phases of the Project were thoroughly explored. In this section of the EIA report, to avoid repetition, mitigating and contingency measures are established for only those actions, which can potentially impact the environment. The order established in Section 6 is continued in this section.

This EMP discusses mitigation and contingency measures, which will be established and executed during the Project to address those actions, which can potentially impact the environment throughout the operating lifespan of the Site and during the following phases.

- Design.
- Construction.
- Operation.
- Post Closure.

For selected areas of study noted above mitigating and contingency measures have been established for actions related to the project, which have a potential to create an environmental impact and associated risk. The EMP will identify strategies for the mitigation of environmental impacts and associated risks and establish contingency planning for those actions, which directly relate to Site conditions noted below.

- Physical Environment.
- Biological Environment.
- Social Impact and Human Resource.
- Environmental Control Systems.

For the purposes of the EMP physical environment impacts that must be managed are considered to be those that affect the immediate and local surroundings and include:

- site conditions;
- animal habitat and/or population;
- plant species and/or vegetation
- surface water; and
- noise and odour.

For the purposes of the EMP biological environment impacts that must be managed are considered to be those that can impose a biological change and include:

- air quality;
- surface water quality;
- groundwater quality;
- native soil quality; and
- human health.

For the purposes of the EMP social and cultural impacts that must be managed are considered to be those that can impose a change to way of life or human impact and include:

- opposition to proposed Site;
- staffing;
- health and safety;
- public involvement and notification; and
- archeological and heritage issues.

For the purposes of the EMP environmental control systems are considered to be those that provide protection to the local surroundings and environment and include:

- waste containment;
- leachate collection and treatment;
- landfill gas collection and treatment.

10.1 DESIGN

For more complete details on the final project design and complementary studies undertaken the reader is referred to the document entitled "Detailed Design and Operations Report for a New Sanitary Landfill in Haags Bosch", which was prepared by Trow International Ltd., in association with Conestoga-Rovers and Associate and E A Consultants and prepared for the Ministry of Local Government and Local Development and submitted under a separate cover on December 2004.

10.1.1 PHYSICAL ENVIRONMENT

No physical environmental impacts and/or risks noted in design phase.

10.1.2 BIOLOGICAL ENVIRONMENT

No biological environmental impacts and/or risks noted in design phase.

10.1.3 SOCIAL ISSUES AND HUMAN RESOURCES

This sub-section discusses management of social issues and human resources during the design program.

10.1.3.1 OPPOSITION

An ongoing management mechanism will be established to respond to concerns that arise in surrounding communities, NDCs and GM that are related to solid waste management and operation of the facility. The committee will be comprised of members of the communities around the facility, residents of NDCs and members of the Advisory Board. This committee will meet quarterly or with greater frequency if circumstances dictate, to discuss issues and concerns related to waste management and operations at the landfill. At a minimum the committee will conduct periodic stakeholder and facility management reviews. The stakeholder review will entail continuous monitoring and review of communities, NDCs, commercial/industrial generators and other stakeholders to identify new or evolving issues as well as knowledge and perceptions

about landfill operations and waste management. The landfill management review will entail continuous monitoring and review of management systems to identify objectives, strategies, procedures and attitudes conducive to effective responses and constructive community relations.

Communities will be encouraged to report instances of waste trucks passing along non designated site access roads and illegal dumping by waste haulers or generators. Results of environmental monitoring will be made available for review by members of adjacent communities. Members will also be informed of all incidents during operations that do not conform to sound environmental practice and specified operational environmental standards as set forth in the management, mitigation, emergency and Health and Safety plans, and of mitigation and management measures implemented to prevent or remedy such occurrences and to counter their reoccurrence. Reports will be issued quarterly or upon occurrence of a violation and will be publicly and easily available from the Operator or MSWMD upon request.

During community consultations residents expressed concerns about the long term management and maintenance of the facility and cost recovery mechanisms to ensure its long term viability. The community outreach program will include providing data on equipment availability and on the progress of the Institutional Strengthening aspect of the project. The cost recovery mechanism and inputs by GOG to the project to ensure its continued viability will also be made public. The resources and capability of the regulatory agency such as the EPA to ensure environmental compliance would be periodically discussed and updated with surrounding communities.

10.1.3.2 PUBLIC INVOLVEMENT AND NOTIFICATION

The communities will be encouraged to become directly involved in community clean-up campaigns in public open spaces such as parks, school zones, and canals and to monitor the behavior of commercial and industrial waste generators, haulers and landfill operators and their compliance with the objectives of the project.

The Operator will provide plans to MSWMD, for approval, to deal with environmental incidents that may harm the environment or demonstrate that the resources are readily available to implement those plans. The MSWMD will review all plans to ensure conformance to the quality assurance and quality control aspects of the project and will supervise the operator and enforcement of aspects of the plan including remediation measures required for non-compliance incidents.

The plans, prepared by the operator will include details on how the public would be provided with information on environmental incidents and dangerous releases on the site. Plans will include the methodology for providing warnings and information to the public by press and radio and for disseminating information to the site environs prior to press and radio announcement.

The plans will also include specific procedures to enforce remedial action for non-compliance issues such as failure of landfill slopes, failure of the leachate containment pond and landfill fires. The Plan will define responsibilities and provides procedures designed to identify unusual and unlikely conditions which may endanger the facility in time to take preventive and remedial action and to notify the appropriate public officials of possible, impending, or actual imperilment of the environment. The plan will also contain notification procedures to safeguard the lives, health, safety and property of citizens and site personnel and to safeguard the environment in areas adjacent to the site in the event an emergency develops.

10.1.4 ENVIRONMENTAL CONTROL SYSTEMS

No environmental control system impacts and/or risks noted in design phase.

10.2 CONSTRUCTION

The technical specifications and engineering drawings required to tender, administer and construct and develop the Site over the initial construction period and operating lifespan are provided in the document entitled "Construction of Sanitary Landfill in Haags Bosch, Specifications, Book B", which was prepared by Trow International Ltd. In association with Conestoga-Rover and Associates and E & A Consultants Limited and submitted under a separate cover on October 2004.

10.2.1 MANAGEMENT OF PHYSICAL ENVIRONMENT

This sub-section discusses management of the physical environment during the construction program.

10.2.1.1 SITE CONDITIONS

Erosion

Erosion will be mitigated during construction operations through the use of siltation fencing and temporary surface water controls as identified in the construction specifications. Continued construction inspection will be undertaken to ensure compliance.

Dust

Dust will be mitigated during construction operations through the use of water sprinkling as identified in the construction specifications. Continued construction inspection will be undertaken to ensure compliance.

Daily and interim cover soils for the active disposal area will be excavated during the preparation of adjacent landfill stages and transported directly to the location where it is required to minimize double handling of soils and the quantities of materials that may need to be stockpiled. Active stockpiles of cover materials required for the proposed Site operations will be oriented and operated from the lee side of the stockpiles. The exposed inactive faces of all stockpiles will be provided with interim vegetation to minimize wind erosion concerns to the extent practical.

Traffic

Traffic planning and control will be addressed in the construction specifications. Continued construction inspection will be undertaken to ensure compliance.

10.2.1.2 ANIMAL HABITANT/POPULATION

Habitant

Wildlife habitant will be monitored during construction and operation of the Site. Although unexpected, if construction and/or operation of the Site has a detrimental affect on local wildlife habitant restoration of disturbed areas will be considered and implemented as necessary in accordance with local wildlife management agencies.

Population

Wildlife population will be monitored during construction on operation of the Site. Although unexpected, if construction and/or operation of the Site has a detrimental affect on local wildlife population restoration of disturbed areas will be considered and implemented as necessary in accordance with local wildlife management agencies

10.2.1.3 PLANT SPECIES/VEGETATION

Plant species will continue to be monitored through construction, operation and post closure. Although unexpected, if construction and/or operation of the Site has a detrimental affect on plant species restoration of disturbed areas will be considered and implemented as necessary in accordance with local wildlife management agencies.

10.2.1.4 SURFACE WATERWAYS

The design of the Site accounts for any changes and diversion of surface water. The contractor will be held accountable for constructing and maintaining surface water controls in accordance with the technical specifications and drawings.

10.2.2 MANAGEMENT OF BIOLOGICAL ENVIRONMENT

This sub-section discusses management of the biological environment during the construction program.

10.2.2.1 AIR QUALITY

The Site has been relocated approximately 1.5 km from the closest population center. This distance will serve to mitigate any potential impacts associated with emissions from construction equipment. Contract specifications will mandate that equipment be maintained in good working order with all the manufacturer supplied systems.

The landfill will be buffered by approximately 121 hectares of cane fields. Dust generation will be localized and removed from potential receptors and, based on prevailing weather conditions at the Site location is expected to be very infrequent.

10.2.2.2 SURFACE WATER QUALITY

Replacement oils and fluids inventory would be monitored to ensure no more than reasonable quantities are on hand. These materials would be stored in a cool, dry area in a separated area or room away from regular maintenance activities. Used oils and fluids

would be stored in approved containers to be emptied periodically by a licenced waste hauler. Oils and fluids would be stored so that any spills or leaks are contained and spilled materials can be treated with absorbents suitable for their clean up. Welding or other activities that could create heat or sparks and set off a fire would be carried out away from the oil and fluid storage area. Fire extinguishers would be located throughout the building so that personnel can attack a small fire. Open flame shall only be permitted within the designated maintenance areas of the main building.

Compressed gases used for cutting and/or welding would be stored in racks and chained to ensure safe storage. Tanks, when transported to a work area, would be chained into a carrier with valve covers in place, and not allowed to free stand as they could fall or be knocked over resulting in potential damage to the tank valve assembly which could lead to an explosion and/or fire. Only gases in use would be in the work area, with both spare and spent tanks stored away from the work area. A portable fuel tank will be kept on Site for refueling equipment. The portable tank shall be a dual walled tank or a secondary containment area shall be provided.

10.2.3 MANAGEMENT OF SOCIAL ISSUES AND HUMAN RESOURCES

This sub-section discusses management of social issues and human resources during the construction program.

10.2.3.1 STAFFING

Contractors will be required to employ competent and/or licensed staff to construct the Site in accordance with the technical specifications and drawings. Continued construction inspection will be undertaken to ensure compliance.

10.2.3.2 HEALTH AND SAFETY

Contractors will be required to adhere to a site specific health and safety plan (HASP) in accordance with the technical specifications. Continued administration and construction inspection will be undertaken to ensure compliance.

10.2.4 MANAGEMENT OF ENVIRONMENTAL CONTROLS

This sub-section discusses management of environmental control during construction.

Contractors will be required to employ competent and/or licensed staff to construct environmental control systems in accordance with the technical specifications and drawings. Continued construction inspection will be undertaken to ensure compliance.

A Construction Quality Assurance Plan developed for the Site presents the construction quality assurance/quality control procedures to be implemented during the construction. Specifically the following construction components will be dealt with:

- Construction facilities and temporary controls;
- Base of landfill grading and preparation;
- Sand and aggregate liner materials and installation;
- Geocomposite liner materials and installation;
- Stormwater collection system materials and installation;
- Leachate collection and treatment system equipment, materials and installation; and
- LFG collection system piping materials and installation.

The objective of the CQA plan is to ensure that the above components are constructed to meet all material and design criteria, as laid out in the approved drawings and specifications. Throughout construction there will be numerous inspections and testing requirements for specific work tasks. The inspection and testing requirements will ensure compliance with the specifications, as well as completion of the work tasks to the highest level of quality. Inspections and testing will provide a qualitative means of monitoring the quality and progress of work performed.

10.3 OPERATION

For more complete details on the sanitary operation and closure of the Site the reader is referred to the document entitled "Site Operations Manual, Sanitary Landfill in Haags Bosch", which was prepared by Trow International Ltd., in association with Conestoga-Rovers and Associate and E A Consultants and prepared for the Ministry of Local Government and Local Development and submitted under a separate cover in March 2005.

10.3.1 MANAGEMENT OF PHYSICAL ENVIRONMENT

This sub-section discusses management of the physical environment during the Site operations program.

10.3.1.1 SITE CONDITIONS

Traffic

The Site operator will be responsible for traffic planning and control in accordance with the Site Operations Manual. Continued operation inspection will be undertaken to ensure compliance.

10.3.1.2 ANIMAL HABITANT/POPULATION

The following operational and management measures will be utilized to effectively control vector and vermin at the Haags Bosch Site.

Flies and Insects

Normal landfill operation procedures such as covering the waste material on a daily basis reduces the number of flies at a landfill because the layer of cover material and the steadily advancing active face prevents mature flies from being able to leave the waste material. Should an outbreak of flies occur at the Site, an insect exterminator would be used as an interim measure to control the flies at the source. Daily cover will be applied over waste at the end of each day and the amount of time allotted for the waste pickers to carry out recycling activities will be controlled and enforced.

Rodents

Uncovered wastes will not be allowed for any extended periods to allow rodent populations to develop. Occasional rodents and other vermin may occur at the landfill site, but the active waste face would be moving on a regular basis and these animals will not find the landfill operations conducive to stable habitation. Should an outbreak of rodents or other vermin occur at the Site, the vermin will be exterminated or controlled as an interim measure. The extermination of rodents would be conducted by a licenced exterminator in a manner that is appropriate for the vermin in question. Regular

placement of cover and good control of the waste picker areas such that waste is not kept exposed for extended periods will be enforced to control rodents.

As the use of transfer locations that will route waste to the Site increases, measures will be enacted to control the length of time and condition in which the transferred waste is delivered to the Site. Inactive portions of the landfill will be inspected to ensure that the interim cover is adequately maintained and that rodent populations are not allowed to develop in those areas.

Birds

Various bird species may be present at the landfill site due to the presence of food wastes. As with the other vectors, the application of daily cover will reduce access to food scraps and other attractive material available to the local bird population. Consistent implementation of this measure would help to limit the local bird population in the vicinity of the Site. The stormwater sedimentation and control ponds that are constructed on the Site would also be operated and maintained in a manner that does not encourage resident bird populations. The stormwater sedimentation and control ponds will provide an alternative location for local birds to reside, and would disperse the birds over a larger area further away from the active landfill area. Re vegetation of disturbed or completed areas will be undertaken as quickly as practicable to reduce the loafing areas that are cleared of vegetation.

Waste Hauling Vehicles

The mode and timing of transfer station operations may result in infestation of waste hauling vehicles by vermin and vector. There will be a requirement that waste hauling vehicles conform to specific design standards and that all vehicles are included in the vector control program. The requirements will include that all vehicles be washed with water at high pressure and be disinfected at least twice each week and that all wash water be drained to the LTS.

10.3.1.3 NOISE AND ODOUR

Noise

Potential noise impacts from the Site will result from operation of landfill equipment. The operation of this equipment will be conducted in such a manner as to minimize noise impacts, wherever possible. Haags Bosch is a considerable distance from the closest residential area (more than 1,500 m). This significantly reduces the likelihood that residents would be impacted by the noise produced by the operation of equipment. In

addition, noise from landfill operations will be limited to the daylight hours. Given the Site location, vegetated screens and setback distances, noise is not considered to be a significant issue for this Site. In accordance with good practice all equipment being utilized at the Site will be maintained in good condition with all sound suppression systems or components (e.g., muffler systems) in a good state of repair in accordance with the manufacturer's specifications.

Odour

Leachate related odours are associated with open exposure to raw leachate in the landfill cells or in the LCS. This will be controlled by ensuring that exposed standing leachate in the base of the cells is not permitted for any extended period and that the pump station manholes are properly constructed and vented. The leachate treatment system addresses odour concerns with the treated leachate.

Waste odour generated by recently disposed waste will be controlled by effective management of the tipping face, by keeping the size and open area controlled, and by the application of daily cover. Masking agents and odour control agents will be used on an as needed basis. Care will be taken to not leave residual wastes in the waste picker area for any extended periods since this will lead to odour problems and to problems with rodents and other vectors.

Dispersion analyses of odour emissions indicate attainment of WHO standards within 100 m of the site boundaries. There are no receptors within 1.5 km of the site boundaries and these impacts are unlikely to be experienced by residents of surrounding communities. Several odour emitting facilities are located in the industrial estate which is upwind of the Eccles New Housing Scheme. A public outreach program will be mounted in the areas adjacent to the industrial estate to sensitize residents to the potential odours emissions of the industrial estate to eliminate the possibility of perceptions developing that the odours are attributable to landfill operations.

10.3.2 MANAGEMENT OF BIOLOGICAL ENVIRONMENT

This sub-section discusses management of the biological environment during Site operations.

10.3.2.1 AIR QUALITY

The Site has been relocated approximately 1.5 km from the closest population center. This distance will serve to mitigate any potential impacts associated with emissions from construction equipment. Specifications will mandate that equipment be maintained in good working order with all the manufacturer supplied systems.

The landfill will be buffered by approximately 121 hectares of cane fields. Dust generation will be localized and removed from potential receptors and, based on prevailing weather conditions at the Site location is expected to be very infrequent.

Daily and interim cover soils for the active disposal area will be excavated during the preparation of adjacent landfill stages and transported directly to the location where it is required to minimize double handling of soils and the quantities of materials that may need to be stockpiled. Active stockpiles of cover materials required for the proposed Site operations will be oriented and operated from the lee side of the stockpiles. The exposed inactive faces of all stockpiles will be provided with interim vegetation to minimize wind erosion concerns to the extent practical.

10.3.2.2 SURFACE WATER QUALITY

Surface water control in the proposed landfill Site will be achieved through the construction of temporary berms around the base excavations and the upper limits of the active disposal area. All surface water contacting exposed waste will be collected by the LCS and treated as leachate. The facility will be designed, constructed and maintained with a run-on control system to prevent flow onto the active portion of the landfill during the peak discharge from a 10-year storm and with a run-off control system from the active portion of the landfill to collect and control at least the water volume resulting from a 24-hour, 10-year storm.

When waste contours have reached the proposed top of waste/daily cover elevation, interim cover of at least 300 mm in depth will be placed and maintained. Final cover for the completed areas will be placed within 12 months of an area reaching final grade and being deemed ready for closure. The surface water from these areas will be drained directly to the stormwater sedimentation and control pond, since exposed waste will not be present. When any section of final cover or ditch is at its final grade, the area would be revegetated. Until the vegetation is fully established in that area and upstream drainage areas, silt control fences or other similar measures shall be put in place to

minimize silt losses into the stormwater management swales and ponds. Periodically on an as needed basis, the silt will be removed and placed into the landfill.

Potential operational issues that may lead to contamination of surface water features at and adjacent to the Site may include the following:

- Overload of leachate treatment facility;
- Bypass of leachate treatment facility; and
- Flooding of leachate collection and holding facilities.

In addition effluent will be monitored at a number of locations around the Site. The trigger levels for surface water quality will be set at the following:

- The average annual concentration of any parametre measured at a downstream surface water monitoring location in the north and south drainage canals exceeds the average annual concentration at the corresponding upstream location (i.e., background) by 33 percent; and
- The discrete concentration of any parametre measured at a downstream surface water monitoring location in the north and south drainage canals exceeds the discrete concentration at the corresponding upstream location by 50 percent.

Surface Water Contingency

Inherent contingencies have been built into the design of the leachate treatment facility in order to address the situation of a power failure. Generator connection points have been designed into the system for prolonged power outages that could shut down the pumps and cause overflow of the system. Short term power outages (i.e., those expected to last for no more than 24 hours) are acceptable due to the storage capacity of the landfill and leachate treatment facility. The design incorporates redundant pumping capacity and also requires that backup pumps be kept available at all times.

The purpose of the surface water contingency plan is to illustrate the surface water trigger levels and contingency measures to be implemented due to potential contamination of surface water features on and adjacent to the Site.

Trigger Criteria – Water Quality

The trigger levels for surface water quality will be set at the following:

- The average annual concentration of any parametre measured at a downstream surface water monitoring location in the north and south drainage canals exceeds the average annual concentration at the corresponding upstream location (i.e., background) by 33 percent; and
- The discrete concentration of any parametre measured at a downstream surface water monitoring location in the north and south drainage canals exceeds the discrete concentration at the corresponding upstream location by 50 percent.

The upstream and downstream surface water monitoring locations are indicated on Figure 13.1 (Appendix A). Should any of the trigger levels be exceeded, the notification and response process discussed above will be set in motion. Contingency measures may include actions such as:

- Improving interim or final cover over landfilled areas;
- Implementation of berms to ensure surface water runoff from active disposal areas does not contact non active areas; and
- Ensuring that effluent from the leachate treatment facility that is released to the primary stormwater sedimentation and control pond meets discharge criteria.

Treatment of water at the Site depends on how it is classified, and improper classification can lead to contamination and improper discharge. Once surface water has reached a certain trigger level, or has been contacted with an active waste area in the landfill it will automatically be diverted to leachate treatment instead of stormwater.

10.3.2.3 GROUNDWATER QUALITY

The landfill is designed as a hydraulic trap. The leachate flow has been modeled for all operating conditions, including post closure conditions, including post closure conditions with leachate collection system not operating. These assessments show containment of major contaminants at relatively shallow depths in the surficial aquitard of low permeability clays. The aquifer used for groundwater recovery is at a depth of 160 m. The facility will therefore have no impacts on groundwater quality. An engineered base and leachate collection system will be installed below the area to be landfilled to recover and to direct leachate to the LTS. The purpose of groundwater

monitoring is to demonstrate how to readily identify and respond to any potential groundwater quality issues at the Site. The hydraulic performance of the Site is the most reliable and readily definable indicator of the effective overall performance of the Site.

The water levels monitored both within the Site and in the buffer zones will provide the earliest possible indicator that the Site is not performing as designed allowing any remedial actions to be taken before there is any evidence of any off-Site impacts. Trigger levels and a contingency response plan will ensure that the hydraulic trap at the base of the landfill is effectively maintained

Potential conditions that could, if not remedied, compromise the hydraulic trap condition resulting in unexpected degradation of the groundwater quality at and adjacent to the Site, flooding of landfill stages, and leachate seeps may include the following:

- Improper operation of the part or all of the LCS; or
- Loss of the hydraulic capacity of the LCS.

In order for the leachate collection system to continue to function as designed through the life of the Site regular video inspection, flushing and cleaning of the underdrain system will be completed.

The trigger level for the leachate elevation within the waste fill area has been set at approximately 1 m below the corresponding groundwater elevation for the Site, i.e., approximately 2 m below ground surface.

Leachate Management/Groundwater Contingency

The purpose of the leachate management/groundwater Contingency Plan is to demonstrate how to readily identify and respond to any potential groundwater quality problems at the Site. The hydraulic performance of the Site is the most reliable and readily definable indicator of the effective overall performance of the Site.

Trigger Criteria

The trigger level for the leachate elevation within the waste fill area has been set at approximately 1 m below the corresponding groundwater elevation for the Site, i.e., approximately 2 m below ground surface. Should trigger levels for leachate be exceeded, the following contingency measures may be implemented, as appropriate:

- Due to improper operation of the LCS (i.e., insufficient pumping of leachate), the LCS will be pumped more aggressively to remove built up leachate; and
- Due to leachate mounding within specific areas (e.g., Stage 1) due to localized LCS failure, the LCS piping will be inspected and attended to as needed to ensure that there are no blockages in the system.
- Upon inspection, if a portion of the LCS piping is found to be plugged, flushing of the lines will be completed in order to remove the blockage within the pipes. If flushing of the lines proves to be ineffective, and leachate elevations within the landfill continue to rise irrespective of precipitation and leachate pumping rates, then a localized failure of the leachate collection piping is to be suspected and it must be excavated and either repaired or replaced.

10.3.2.4 NATIVE SOIL QUALITY

A construction Quality Assurance (Q/A) plan will be developed for the Site to confirm assurance/quality control procedures are implemented during the construction.

Specifically the following construction components will be dealt with:

- Construction facilities and temporary controls;
- Base of landfill grading and preparation;
- Sand and aggregate liner materials and installation;
- Geocomposite liner materials and installation;
- Stormwater collection system materials and installation;
- Leachate collection and treatment system equipment, materials and installation; and
- LFG collection system piping materials and installation.

The objective of the Q/A plan is to ensure that the above components are constructed to meet all material and design criteria, as laid out in the approved drawings and specifications. Throughout construction there will be numerous inspections and testing requirements for specific work tasks. The inspection and testing requirements will ensure compliance with the specifications, as well as completion of the work tasks to the highest level of quality. Inspections and testing will provide a qualitative means of monitoring the quality and progress of work performed.

In addition to the Q/A plan there will also be continued monitoring of the leachate levels within the landfill cell. If the leachate levels exceed a pre-determined elevation above the base of the landfill contingency measures as identified above will be implemented.

10.3.3 MANAGEMENT OF SOCIAL ISSUES AND HUMAN RESOURCES

This sub-section discusses management of the social issues and human resources during Site operations.

10.3.3.1 STAFFING

Employee Training

Prior to commencing any landfilling activities, an employee training program will be conducted for employees that are actively involved with any of the day to day landfill operations.

The training session will stress the importance that each attendee understand the following important information:

- basic principles of personal protection and safety;
- how to perform their assigned job tasks in accordance with the manufacturers or other specified requirements and in a safe and environmentally responsible manner;
- how to conduct activities in accordance with all applicable local and Guyanese waste management regulations; and
- how to respond in an appropriate manner to any landfill related emergency which may arise.

Only trained and properly qualified persons familiar with all safety procedures will work on equipment, electrical systems, fuel systems, compressed gas systems, pressure piping, chemical feed, or other associated landfill systems.

Background information pertinent to the Site will be provided and the various components of the program will be presented followed by an opportunity to ask questions to ensure that each attendee understands the program. Site personnel who

have not successfully completed this training program will not be permitted to work in potentially hazardous areas of the Site. Site specific procedures for items such as confined space entry protocols will be developed and incorporated into the staff training programs.

The contractor and operator will maintain records of all mitigation measures implemented in all phases of the project. Record for each phase shall include the following:

- media impacted;
- applicable regulations and standards; and
- mitigation measures.

Records and Documentation

Records will be filed with the EPA and MSWMD quarterly and a copy of each record will be maintained on site for review by EPA quality assurance personnel. All records and project documentation will be made available to the public upon request. The public will also be informed of their rights to request additional information through the public outreach campaign. The Operator would be mandated to develop reporting protocols for industrial and commercial facilities to ensure proper disposal of all waste generated. The MSWMD and EPA would also adopt these protocols to develop information on generators who may have contravened the waste disposal regulations and on major pollution sources and waste generators.

The procedure for public reporting of non-compliance incidents will be made available to the public as part of the awareness campaign. The campaign will also identify typical non-compliance incidents such as unauthorized traffic through housing areas, suspicious discharges, dumping or poor environmental conditions around major generators of waste. The procedure will also identify the agency with enforcement powers to which the non-compliance incidents should be reported. The EPA shall be the primary agency for receipt of non-compliance complaints. The MSWMD and Operator shall also be mandated to receive non-compliance incidents for action when within their jurisdiction.

10.3.3.2 HEALTH AND SAFETY

Proper safety procedures and equipment appropriate to the task at hand would be provided. Several safety features are incorporated in the landfill design and in the mechanical and electrical/control equipment to assure safe operation of the Site. To minimize the hazards involved in the daily operation of the Site both management and operators will be continuously vigilant in following safe working procedures. All employees will exercise caution in all activities in and around the Site and each employee would be responsible to protect others working at the Site. Potential problems at the Site would be identified and corrected before a safety related incident occurs. If an accident or injury does occur, the equipment established procedures or implementation of procedures would be carefully examined and any deficiencies in equipment, working procedures, and operator capability or other cause would be corrected immediately. The procedures will be reviewed and updated regularly as changing equipment and practices warrant.

The Health and Safety Program will be applicable to all personnel who will be working at the Site, including subcontractors and visitors. Subcontractors conducting project activities at the Site will be responsible for the health and safety of their own personnel.

Several safety features have been incorporated into the design of the Site to prevent injury and reduce potential hazards to employees. General safety and personal hygiene rules for the Site would include:

- Eating or drinking at the Site being limited to administration building and an area designated for the waste pickers;
- Smoking on or near the waste footprint, LFG collection piping, or LFG management facility, when installed, would be prohibited and smoking would only be allowed in designated areas;
- The "buddy system", i.e., working in pairs, will be used for all activities at the Site other than routine monitoring and light maintenance activities;
- Site security personnel would retain records of entry and exit of all Site personnel, subcontractors, and visitors;
- Individuals getting wet to the skin with effluent from the leachate treatment facility, leachate from the landfill, any waste matter or chemicals from the leachate operations will wash the affected area immediately. If clothes in contact with skin are wet, then these will be changed;

- Hands will be washed with soap and water before eating, drinking, smoking, and before using lavatory facilities;
- Waste produced on Site will be properly stored until such time that it is disposed of in accordance with appropriate regulations;
- All spills will be immediately cleaned up to prevent slipping and cross-contamination of Site areas;
- All appropriate personal protective equipment (PPE) including splash shields on hard hats, chemical-resistant aprons, and gloves will be worn when there is a potential for contact with hazardous substances;
- The administration building will be kept clean at all times; and
- All first-aid, safety, and emergency response equipment will be inspected periodically including the stationary and portable eyewash units, and portable fire extinguishers. All eyewash units will be flushed monthly with fresh water, and a record maintained of this occurrence.

Different levels personnel protective equipment (PPE) will be provided depending upon the nature of the work task to be performed at the Site. All activities performed at the Site involving contact with potentially impacted materials will be considered operations requiring personal protective equipment. The basic PPE requirements for all personnel at the Site will include:

- Full length pants;
- Safety footwear;
- Safety glasses with side shields as needed;
- Work gloves for any waste pickers or workers in contact with waste and recyclable materials;
- Hearing protection in designated areas; and
- Hard hat as needed. The use of hard hats shall include all work areas in proximity to operating construction equipment for cell development activities, waste filling activities or other similar works.

Upgrades to the PPE required for activities such as the laboratory testing of leachate samples shall be specified for these individual tasks.

In the event that there is a specific odour concern, workers will be requested to remove themselves from the affected area and obtain directions from supervisory personnel

before continuing to work in this area. Should dust become an issue in drier months, dust masks will be employed as a temporary control measure for the comfort of on-Site operating personnel and waste pickers. Operators of landfill equipment will be provided with hearing protection consisting of ear plugs or cap-mounted ear muffs. Any other Site personnel working in the immediate vicinity of the landfill equipment would also wear the same hearing protection.

Site personnel will check weather forecasts for the next day and week of work to provide advance notification of any severe weather conditions. Severe weather conditions likely to be experienced at the Site may cause unsafe conditions and in some situations work may have to be temporarily suspended. In the event of inclement weather the following measures will be implemented if necessary:

- Restriction of Site activity;
- Battening down light equipment or building materials;
- Partially enclosing localized work areas;
- Selection of preferred filling locations that are better protected; and
- Reduction or stoppage of some or all work activities.

10.3.4 MANAGEMENT OF ENVIRONMENTAL CONTROLS

This sub-section discusses management of environment controls during Site operations. In general contingency measures to be conducted to facilitate the implementation of response action would involve the following steps:

- Verification - Verify that trigger criteria have been exceeded through appropriate sampling and/or further evaluation. Consult with the MSWMD upon verification that trigger conditions have occurred.
- Assessment - Evaluate the likely source of the problem, including completion of the potential impacts and evaluate trends. If further actions are required, proceed to next step.
- Evaluation - Review any pre-determined contingency measures as well as any other potential solutions. Carry out any further investigative/design tasks necessary to evaluate alternative solutions and to develop the selected contingency measure. Proceed to next step.

- Implementation - Notify the MSWMD of the need to implement the contingency plan. Prepare detailed plans, specifications, and descriptions for the implementation, operation, and maintenance of the plan. Review with the MSWMD and receive approval. Implement the contingency plan. While going through the above process, if it is determined that no further action is warranted, the routine monitoring program will be re-implemented and re-evaluation of the triggering parameters and levels will be undertaken.

The specific implementation program developed and put into place would be dependent upon the situation that is to be addressed. Contingency plans are provided for individual environmental control systems within the appropriate sub-section.

10.3.4.1 WASTE CONTAINMENT CELL(S)

Unacceptable Waste

Site personnel actively involved with day to day landfill operations will be trained to identify waste loads which are unacceptable for landfilling.

Signage would be posted at the main gate with the following indicated:

- operating authority, telephone number, and address;
- contact information including telephone number;
- waste types acceptable for disposal at the Site; and
- hours of operation.

A single scale with traffic signals will be located at the Site entrance so that waste material entering the Site can be weighed and recorded. Provisions will be made for an optional second scale as warranted by waste disposal traffic and quantities. A daily record of weighing operations would be maintained by the scale operator. The information contained in this record would include the date, quantity of waste in tonnes, and type of waste received.

If a load is refused due to an unacceptable waste profile, efforts will be made to obtain the following information:

- the source of the load;
- name of driver;
- licence number of vehicle; and
- company name on truck.

This information, including date and reason for refusal, will be maintained on Site for record keeping purposes. A list of prohibited materials will be posted on signs at the Site entrance. The weigh scale operation will permit tracking of licence numbers of offending vehicles and companies to permit follow up response measures to be taken in the event that non compliance by some parties becomes a chronic issue. It is expected that over time, the list of restricted materials would be modified. These types of modifications will be based on public consultation and notification as well as a phase in period to ensure that all users of the Site become aware of any changes to policy and the Site specific requirements.

Waste Placement

Waste will be placed utilizing the area method, that is, the waste will be filled and compacted over the prepared base, in layers, and daily cover will be applied following the waste segregation and recycling activities carried out by the Site's licenced waste pickers.

Waste hauling trucks will unload at the designated drop off area within the landfill footprint for waste diversion activities including access for waste pickers. Waste pickers will be given access to a number of restricted areas of the Site and will be given a specified time allocation to have access to the waste. An area close to the tipping face will be designated for waste pickers. Waste placement will be staged such that after the allocated time period for recycling/segregation activities has expired, all waste pickers will be required to vacate the specific area and the waste will be pushed into the disposal cell and compacted. Waste pickers will not be granted access to the active tipping face areas due to safety and operational concerns.

The waste pickers will be allowed to move recoverable materials to the assigned staging area for subsequent sorting and cleanup. Any residual wastes from the sorting operation will be placed in another designated area to be moved back into the filling area on a daily basis. Residual wastes will not be retained in the sorting area for more than 24 hours. Waste pickers that do not adhere to the above procedures will lose their Site access privileges.

Waste will be compacted in lifts not exceeding 2.0 m thick using multiple passes with the landfill compactor, depending on the equipment available and the material being compacted. Daily cover consisting of native soils, wood chips, and suitable imported material designated as ADC will be placed in accessible portions of the working face prior to the end of each operating day. The type, amount, and area that the daily cover has been applied to will be included in the Site operator's daily report.

As previously noted, a flow diagram which depicts the route waste takes from when it enters the Site to final placement and compaction is provided in Appendix D.

Litter

Preventative litter control measures will be taken to minimize the blowing of litter from the active area of a landfill. The following measures would be employed at the Site during site operations to achieve this goal:

- Daily cover will be applied to waste that will be exposed after it has been removed from the waste picker area and placed into the tipping face, thereby confining light weight material;
- Waste picker/recycling areas will have perimeter fencing and wind breaks established to mitigate against blowing litter;
- All vehicular traffic transporting waste to and around the Site will be tarped, if required, to prevent litter from blowing out of the vehicle;
- The working face location will be selected based on the direction and intensity of the wind to provide maximum shelter for the active area. The aerial extent of the working face will be kept to a minimum on windy days;
- Temporary, moveable, litter control fencing, approximately 3.0 m in height, will be utilized at the active disposal area;
- Disposal operations will be reduced or stopped and relocated to alternate disposal areas if prevailing weather conditions cause off Site litter impacts; and
- A litter control program that includes site perimeter maintenance and off Site litter control will be implemented, for monitoring and cleanup of litter along the primary access route.

Fire

Site access will be controlled to prevent scavenging, and recycling will be carried out only by the Site's licenced waste pickers. Open burning of waste will be prohibited at all times during operation of the Site. No smoking or open flames of any type would be

permitted within the landfill cell areas or near the LFG collection and management facility once installed and operational. Designated areas for smoking and for any open flames will be established. A "hot work" permit process would be established for any maintenance or repair activity that requires the use of an open flame such as for a torch or welding equipment.

Should a surface or underground fire occur, it will be contained and extinguished as soon as possible using on Site equipment. No excavation equipment will be used to try to open up any area where there is a suspected fire. Landfill fires will be smothered and forced to extinguish themselves by a lack of the oxygen necessary to sustain the combustion.

LFG will be generated and emitted from the landfill Site. In the event of a fire at the landfill, this Site has an ideal water supply base available at all locations on the property for use to extinguish a fire. There are canals on three sides of the Site and there will be three stormwater sedimentation and control ponds, all of which will be sources of water for fire suppression.

Fire fighting will be augmented by addition of cover soils adjacent to the area of a suspected fire if it is deemed necessary. If there is an active LFG collection system operating and there is a suspected or known fire, LFG collection from any vertical wells or horizontal trenches in the vicinity of the suspected fire will be temporarily shut down. This will remove a potential oxygen supply source from the area of the fire and assist in allowing the gas generation in the landfill itself to assist in smothering the fire.

Any fire noted at the Site will be reported to the Site supervisor and MSWMD. There would be a ban on any open flame, spark, smoking or maintenance activities on top of the waste disposal areas without specific and extensive precautions in place. The waste picker rules and qualifications requirements will be quite stringent and will focus heavily on Site safety, with the open flame issue being one of the most critical issues.

Final Cover

Exposed and open waste on the crest of the landfill may potentially negatively impact the aesthetics of the area. Final cover will be applied to waste after attainment of final waste levels. The cover system will be designed to provide long-term performance with minimal maintenance, to minimize infiltration of precipitation into the waste and to promote good surface drainage and resist erosion. It will also control landfill gas migration and/or enhance recovery and separate waste from vectors. A healthy vegetative layer will be placed on top the final cover to provide erosion protection. Plant

species that are not deeply rooted will be planted on the final cover. Grass on the cover layer will have the ability to thrive in low-nutrient soils with minimum nutrient addition and will have the ability to survive and function with little or no maintenance. The use of vetiver grass would be considered for the vegetative species.

A visual impact assessment has determined that the extensive setback provisions associated with the new location of the landfill are now such that visual impacts are not a concern for actual landfilling operations. Palm trees will be planted along the western limit of the property. The maximum leaf density of these trees is at tree top level and will provide optimal screening of the upper half of the landfill.

10.3.4.2 LEACHATE COLLECTION AND TREATMENT

As part of the design of the leachate treatment system, precautions have been taken to prevent failure due to flooding. The storage ponds and tanks for the system have been designed with excess capacity to accommodate the peak 10-year 24-hour rainfall event.

If in the event that the leachate treatment facility exceeds its capacity, leachate will be pumped back into the aerobic equalization lagoon, which has a capacity of 10,000 m³. Additionally, leachate can be retained within the waste fill area itself for a period of time to allow the overload condition to be rectified. The hydraulic loading to the leachate treatment facility is the most sensitive in the period immediately following the opening of an additional section of the cell base. In non power-related situations, the trigger level for leachate quantity will be a flow within 10 percent of the maximum leachate treatment facility flow. In such cases, the following contingencies may apply:

- Recirculation of effluent to the aerobic equalization lagoon;
- Investigation of off-Site disposal of raw leachate; and
- Investigation of expansion of leachate treatment facility.

Potential operational issues that might compromise the leachate collection and treatment system may include the following:

- Power failure;
- Pump failure; and
- Overload or improper operation of the leachate treatment facility.

Inherent contingencies have been built into the design of the leachate treatment facility in order to address the situation of a power failure. Generator connection points have been designed into the system for prolonged power outages that could shut down the pumps and cause overflow of the system. Short term power outages (i.e., those expected to last for no more than 24 hours) are acceptable due to the storage capacity of the landfill and leachate treatment facility. Pump failure will be prevented by monitoring programs described in the Site Operations Manual. The design incorporates redundant pumping capacity and also requires that backup pumps be kept available at all times.

Contingency

The purpose of the leachate treatment system contingency plan is to illustrate the trigger levels and contingency measures to be implemented should it be determined that treated effluent is not meeting the required discharge criteria.

Trigger levels of key compounds listed in the Design and Operations Report will be set at 75 percent of the maximum allowable concentration in accordance with Guyanese water criteria as developed for the Site. If trigger levels of key compounds in the leachate treatment facility effluent continue to be exceeded, the following contingencies will apply:

- Enhanced recirculation of leachate within the leachate treatment facility; and
- Expansion of leachate treatment facility.

10.3.4.3 LANDFILL GAS COLLECTION AND TREATMENT

A full LFG management system has been designed for the Site. The active LFG control system will provide supplementary benefits for odour control since it will be interconnected with the LCS for the Site. The main LFG header will be installed initially at the Site until such time as the trigger level discussed in this section is attained. The primary trigger for the active LFG controls would be quality of life odour related impacts. One trigger for installation of the active LFG control system would be a nuisance odour to the users of the Site. The trigger level for the LFG contingency will be related to odour concerns and excessive complaints received from off-Site receptors. Excessive complaint is defined as more than two validated odour complaints per month from off-Site receptors.

In the event that the trigger noted above is exceeded and all other operational aspects of the Site are in proper order, the installation of the LFG management system would be initiated, installed, and commissioned for all of those areas of the Site that are at or near their final grade elevation. It is expected that this response will immediately remove the odour concerns and complaints as an issue. If there is a persistent odour issue, the response is to initiate collection of additional LFG from the active disposal areas of the Site as they are being constructed.

It should be noted that there are other sources of potential odour associated with both the raw waste that is being disposed of in the Site and the associated waste picker operations. It is assumed that these operations are being well maintained and that daily cover is being effectively used at the tipping face. The first response measure is verification that these areas are operating in compliance with the established programs and procedures for the Site. If not, these operational issues would be remedied before initiating the active LFG management system commissioning or expansion.

10.4 POST CLOSURE

For more complete details on the post closure maintenance requirements for the Site the reader is referred to the document entitled " Site Operations Manual, Sanitary Landfill in Haags Bosch", which was prepared by Trow International Ltd., in association with Conestoga-Rovers and Associate and E A Consultants and prepared for the Ministry of Local Government and Local Development and submitted under a separate cover in March 2005.

Maintenance activities would be undertaken to ensure that all of the required infrastructure and systems are able to satisfy the compliance and performance requirements for the Site. The level of maintenance required would be defined in the operating manuals and other documentation that will support the various systems that will be constructed and commissioned at the Site. These systems will be operated according to specifications of the manufacturer and such additional specifications as are provided for the operations of the overall systems.

Proper tools would be made available and be maintained in good, clean condition. The majority of the necessary tools for maintenance and calibration of equipment at the leachate treatment facility, LFG management facility, and any other equipment needed at the Site would be provided along with tool bench and tool storage facilities. Laboratory equipment, field instruments and tools removed for use would be returned

to the proper storage place. In the case where more than one person has access to tools a checkout system would be used so that tools are not lost and are available when needed.

Specialty and delicate tools and instruments will be stored in a secure location with restricted access so that they will not be inadvertently damaged by poor storage. Micrometres, dial gauges, calipers, taps and dies, multi metres, and feeler gauges are some examples of items which require care in storage

10.4.1 MANAGEMENT OF PHYSICAL ENVIRONMENT

After Site closure, monthly inspections would be carried out by landfill personnel of the various Site features including the landfill cover system, channels, ditches, culverts, access roads, and perimeter Site fence. The inspections of will consist of:

- Inspection of landfill cover for signs of erosion and to ensure the cover is intact;
- Inspection of vegetative cover and identify areas requiring attention;
- Inspection of perimeter fence and gates to ensure they are intact;
- Inspection of landfill cover for areas of erosion and surface water ponding;
- Inspection of landfill cover for evidence of exposed waste or leachate seeps;
- Inspection of landfill cover for evidence of animal burrows;
- Inspection of on site access roads to ensure they are driveable; and
- Inspection of swales for sediment accumulation and erosion.

If a seep is found, Site personnel will evaluate size, duration, flow, and impact to determine the appropriate response. Additional clay cover would be applied and compacted in the area of the breakout or seep. If the area is large or initial remedial efforts are unsuccessful, the excavation will be filled with granular material to improve drainage into the landfill and an improved hydraulic connection to the leachate collection drain blanket and piping will be installed as a french drain or toe drain. Any disturbed cover areas will be repaired and compacted with clay soil. Leachate breakouts or seeps will also be evaluated in the context of Site operations as a performance indicator. All seep locations and repair methodology will be recorded.

10.4.2 MANAGEMENT OF BIOLOGICAL ENVIRONMENT

Management of the biological environment in the post closure phase is consistent with the Site operations stage.

10.4.3 MANAGEMENT OF SOCIAL ISSUES AND HUMAN RESOURCES

Management of the social issues and human resources in the post closure phase is consistent with the Site operations stage.

10.4.4 MANAGEMENT OF ENVIRONMENTAL CONTROLS

Management of environmental controls in the post closure phase is consistent with the Site operations stage.

10.5 SUMMARY

An environmental management plan (EMP) has been created to mitigate any potential environmental impact and associated risk. In the unlikely event that the mitigative measures established do not function as intended contingency plans have also been prepared to address off-site impacts related to the landfill. Extensive monitoring programs have been established to confirm that the control systems constructed are operating as intending and preventing environmental impact to the local human and wildlife population. In addition quality control and assurance programs have been prepared and will be followed during the construction program to confirm that the site is constructed in accordance with the technical specifications and detail design drawings.

Programs have been established and will be implemented throughout the operating lifespan of the site to keep local residents and environmental groups/agencies appraised of any potential and/or real impacts related to the construction, operation and maintenance of the site. The design team retained to complete the design and oversee construction and operation of the Site clearly understand the importance of being a good neighbor and are committed to keeping opposition to the site at a minimum to the best of our ability. Staff training and worker health and safety is of paramount importance in

the successful construction and operation of the Site and have also been clearly addressed through all portions of the project as documented.

The following table presents a summary of environmental impacts and where mitigative and/or contingency measures are assigned.

<i>Area of Study</i>	<i>Design</i>	<i>Construction</i>	<i>Operation</i>	<i>Post Closure</i>
<u>Physical Environmental Impacts</u>	Mitigation	Mitigation	Mitigation	Mitigation
Site Conditions	No Impact	QA/QC	Site Ops Manual	D & O Report
Animal Habitat and/or Population	No Impact	QA/QC	Site Ops Manual	D & O Report
Plant Species and /or Vegetation	No Impact	QA/QC	Site Ops Manual	D & O Report
Surface Waterways	No Impact	QA/QC	Site Ops Manual	D & O Report
Noise and Odour	No Impact	QA/QC	Site Ops Manual	D & O Report
<u>Biological Environmental Impacts</u>				
Air Quality	No Impact	QA/QC	Site Ops Manual	D & O Report
Surface Water Quality	No Impact	QA/QC	Site Ops Manual	D & O Report
Groundwater Quality	No Impact	No Impact	Site Ops Manual	D & O Report
Native Soil Quality	No Impact	QA/QC	Site Ops Manual	D & O Report
Human Health	No Impact	HASP	HASP	HASP
<u>Social and Cultural</u>				
Opposition	Notification	Notification	Notification	Notification
Staffing	No Impact	QA/QC	Site Ops Manual	D & O Report
Health and Safety	No Impact	HASP	HASP	HASP
Public Involvement and Notification	Notification	Notification	Notification	Notification
Archeological and Heritage Issues	No Impact	No Impact	No Impact	No Impact
<u>Environmental Control Systems</u>				
Waste Containment Cell(s)	No Impact	QA/QC	Site Ops Manual	D & O Report
Leachate Collection and Treatment	No Impact	QA/QC	Site Ops Manual	D & O Report
Landfill Gas Collection and Treatment	No Impact	QA/QC	Site Ops Manual	D & O Report

No Impact - The action has no negative environmental impact. Where the action had no impact and/or associated risk no mitigation and/or contingency measures are developed.

Notification – Initial public input has been considered and will continue to be addressed throughout the operating life span of the project. The public will be kept aware and notified of any potential environmental impact and/or associated risk resulting from the construction and/or operation of the Site throughout the operating lifespan of the project.

QA/QC – Quality Assurance. All construction works will be completed in accordance with technical specification and detail design drawings prepared and sealed on behalf of the owner by a qualified engineering company. During construction, contract administration and inspection will be carried out by a qualified engineering company that clearly understands the technical specifications and drawings as well as the overall objective of the project. Quality Control – In addition to engineering consultant that provides contract administration and inspection services there will also be third party inspection and testing carried out by an independent consulting firm.

HASP – Health and Safety Plan. In order to protect site workers from injury and/or bodily harm a site specific HASP will be in effect throughout the operating lifespan of the project. All site workers will be required to complete training on the environmental control system they will be responsible for in order to understand the objective and related risks to that specific piece of equipment.

Site Ops Manual – Site Operations Manual. A Site operations manual has been prepared for the Owner to provide detailed operating procedures for the solid waste management facility. The procedures identified in the manual are to be followed by the selected contractor who enters into an agreement with the Owner to to operate the Site in accordance with terms and conditions set for in a contract. The contractor will be responsible for operating and maintaining the Site in accordance with the terms and conditions of the contract.

D & O Report – Design and Operations Report. A D & O Manual has been prepared for the Owner. A portion of the manual specifically discusses post closure monitoring and aftercare of the Site. Following closure of the Site the Owner and/or a hired contractor will be expected to maintain the Site in accordance with the guidelines outlined in the D & O.

CONCLUSION AND RECOMMENDATION

A systematic review of potential physical, biological, cultural and site specific impacts has been undertaken as part of this EIA study. Each potential impact, regardless of how

remote, has been identified and systematically categorized. Each potential impact has been addressed in the Environmental Management Plan as requiring mitigative and contingency measure to minimize environmental risk to the fullest extent possible and to have a contingency plan in order in the unlikely event that the mitigative measures fail.

It is concluded that all potential impacts have been identified and an effective and sound environmental management plan has been established to protect the human and animal population. It is recommended that EPA/IDB accept the EMP included as part of the EIA in that it will provide the highest level of protection to the environment that can be attained through effective operation of the proposed sanitary landfill site.

11.0 RESETTLEMENT PLAN FOR WASTE PICKERS

Surveys of recycling activities over the period of December 2003-June 2004 determined that there are 121 individuals working as informal recyclers at the Mandela site. Recycling is undertaken by either a single individual or in some instances, groups of individuals working in partnerships to recover bottles, metals, wood, cardboard and other items of value. Recovered materials are stored and sold near the entrance to the landfill. The level of discipline is low and storage and selling are disorganized. These result in several incidences of thefts and fights.

Several individuals would be displaced by cessation of landfilling operations at the Mandela Site. These individuals have developed livelihoods and some totally support their families based on recovery and resale of recyclables from waste disposed at this site. Closure of the site will deprive several individuals of their livelihood and reduce their ability to continue to support their families. This resettlement plan has been developed to mitigate impacts of the dislocation of waste pickers at the Mandela Site. The objective of this plan is the development of a framework for relocating these informal recyclers to the new site at Haags Bosch which at a minimum ensures maintenance of their current standard of living. Recycling operations at Haags Bosch will be regulated and controlled to ensure that it does not compromise the objectives of the project.

This resettlement plan has been designed to facilitate the relocation of the recyclers to Haags Bosch and to provide support for these individuals during the transition phase to the new site to ensure a continuation of income generation. This plan also focuses on ways of improving recycling capacity to increase overall productivity and on ways of reducing disruptive behavior.

11.1 BASELINE DEFINITION

A study of informal recyclers was conducted in December 2003 (Walcott, 2003). This study was complemented by a number of visits to the Mandela Site to gather data and to verify data previously compiled. These visits were made over the period June 16, 2004 to June 27, 2004. June 24, 2004 was established as the cut off date for persons to be included on the list of recyclers. During visits to the site, a total of 46 individuals were contacted either formally or informally. The informal nature of the discussion allowed specific issues to be raised and allowed participants to engage in dialogue about the proposed sanitary landfill.

Data collection techniques utilized to verify data initially collected and to gather additional data included:

- Observations during 4 site visits over a two weeks period to develop familiarity with the conditions and behavior of the recyclers and to validate recyclers responses detailed in the December 2003 study;
- Informal interviews with randomly selected recyclers to obtain information independent of group influence;
- Administration of a written questionnaire to randomly selected recyclers. Questions replicated those used in the December 2003 study, however some questions were rephrased and some new questions were added;
- Two focus group discussions were held with participants who indicated the greatest interest. These discussions provided a forum for information gathering in an environment with which these participants were more comfortable since it gave them opportunities to engage in dialogue. Several key individuals knowledgeable about the issues and willing to share information were also consulted as part of this exercise. Consultations through key informant interviews were held with personnel from the MSWMD, the Ministry of Labour, Human Services and Social Security (MoLHSSS) and the Kuru Kuru Cooperative College (KKCC); and
- A head count was performed to determine the number of recyclers who operate at the Mandela Site. This head count was cross referenced to the list in the December 2003 study, persons who participated in the questionnaire survey and those who attended group discussions during this exercise. The head count confirmed that 121 persons operate as informal recyclers. The group is comprised of 98 males (81%) and 23 females (19%). Consultations with MSWMD, however, confirmed 80 persons as working on site during the period June 16, 2003 to June 27, 2003. Approximately 82.5% (66) are males and 14 or 17.5% female. The ethnic composition of the informal recyclers is 75% (91) Afro-Guyanese, 9% (11) Indo-Guyanese persons, 5% (6) Amerindians and 11% (13) persons of mixed Race. Fourteen of these individuals sleep in the area around the entrance to the site.

11.2 CONSULTATION FINDINGS

Recyclers expressed a willingness to move from the Mandela site to the new landfill at Haags Bosch and welcomed the idea of organizing themselves. However the majority of individuals are against working in groups of not more than 24 persons since it is claimed

that a rotated system would reduce income levels and alternate employment was not available. Further transport costs to Haags Bosch will exceed their present costs and transportation should be provided to move them to and from the new site.

Some recyclers claim to have families, some claim to have no permanent residence and to sleep on the streets and others claim to have no permanent residence and to sleep at the landfill site. In all instances individuals, however provided home addresses away from the streets and the Mandela Site. Several recyclers were deported back to Guyana and others are drug addicts. These persons were generally not willing to identify themselves. It is likely that these individuals either live on the streets or at the landfill site because they had no family members in Guyana or were abandoned by relatives.

All recyclers had completed primary education with 77% of them having some form of post primary education. Six percent range in age from 16-20 years, eleven percent range in age from 21-30 years, fifty seven percent between 31-40 and the remainder are over 40 years old. Seventy seven percent worked at the site in excess of 5 years.

Most recyclers indicate that this is a profitable venture but refused to provide income data. Working at the Mandela Site provides satisfaction since they are self-employed and have cash every day. Because of lack of skills for the formal sector and low wages for manual labour, waste picking is preferred despite social stigma attached to their occupation. Recyclers indicated a willingness to pay a licensing fee for working at the landfill. This fee ranged from Guy \$ 500 to Guy \$ 2000 per month.

Some waste pickers supplement their income through other economic activities. Approximately 51 percent work every day of the week, 29 percent work 5-6 days per week and 20% work 2-4 days per week. Nine percent collect items for use, while the remainder sells theirs. Fifty four percent earn income from recycling alone and 35% have tried other economic activities. Approximately 85% of recyclers have families with average size of 7 persons and 83% are the sole income earner of the family. All claim not to earn enough to save. Three persons earn income over G\$500,000 per year, 10 individuals earn between G\$499,000-G\$400,000 and 17 earn between G\$399,000-G\$200,000. During focus group discussions, participants indicated that income levels were lower than reported by the December 2003 report since the information reported was not actually reported to the interviewer conducting that study but were based on forms being filled in the absence of any consultations with them.

The income levels reported are probably indicative of the informal recyclers desire not to pay fees to the MSWMD for operating at the site or to pay taxes on income. The

recyclers are unaccustomed to paying taxes and fees and this is construed as a reduction in their income.

Recyclers requested that a facility be provided for storage and sale to reduce incidences of thefts and that identification badges be provided to identify legitimate recyclers. It was also requested that first aid kits and training in first aid be provided. Typically copper wire is recovered by burning insulation away from the wire using an open flame. Open flames will not be permitted at Haags Bosch and recyclers requested that a facility be provided for controlled burning to recover copper wire.

11.3 FORMATION OF COOPERATIVE

Waste pickers working at the Mandela Site up to the cutoff date of June 24, 2004 will become members of a cooperative society which will be relocated to and authorized to continue recycling operation at the Haags Bosch Sanitary landfill. Members of this cooperative will be the sole individuals authorized to work at the Haags Bosch Site as waste pickers. The cooperative shall be established in accordance with The Cooperative Societies Act Cap 88:01. This act regulates the formation and operations of Cooperative Societies and provides for registration of cooperative societies, which have as its objectives the promotion of the economic interests of its members in accordance with the cooperative principles by the Commissioner of Cooperative Development. To confirm to the requirement of the Act the group shall be formed in the presence of an officer designated by the Commissioner to assess the cooperative society suitability for registration.

The cooperative society will consist of the 121 persons determined to be operating at the Mandela Site up to June 24, 2004. Daily operations at the new site will, however be undertaken by four subgroups of the cooperative, with any subgroup being allowed to provide a maximum of 24 persons on any day. The allowance for a total of 96 persons per day exceeds the largest number known to have ever been present at the Mandela Site on any given day and would adequately ensure access for waste recyclers interested in working each day at the new facility. Subgroups will work at the Haags Bosch landfill on a rotated basis. Details related to membership of the four subgroups will be established based on the regulations and by-laws of the cooperative.

Eighty percent of the respondents indicate that they will continue to work as recyclers at the Haags Bosch site while the remaining 20% have indicated that they will no longer be interested in working as recyclers after the closure of the Mandela site. Subgroups will

work at the facility on a rotated basis. The payment of fees by individual recyclers is likely to be very sensitive as currently no fees are charged and the institution of fees for operating at the Haags Bosch may not be readily acceptable to potential members. Licensing fees will be gradually introduced based on a determination of the willingness of members to pay from the assessment of income generated during the initial pilot phase of operations at the Mandela Site. The firm/NGO hired to support the recyclers during the transition period will ensure the implementation of proposed activities at the Mandela site so that the operation of recycling can be evaluated before the move to the Haags Bosch site and implementation at that site. This will allow for modification of operational measures to be implemented at the Haags Bosch site thereby minimizing the possibility of excessive disruptions.

The basis for inclusion in a specific subgroup will be decided based on the rules of the society. The single cooperative will ensure that management capability which resides with waste pickers is optimized for management of the society and will decrease the likelihood of fragmentation into weak and strongly managed individual cooperatives operating at the Haags Bosch site. A single cooperative will also provide greater bargaining capability for members in their dealings with buyers.

The cooperative will be functional by February of 2005 to allow for organization of the subgroups and to enable members to develop experience working in a cooperative venture prior to relocation to Haags Bosch. Membership shall be restricted to individuals listed as recyclers on the cutoff date. An evaluation shall be conducted of the cooperative operations before recyclers move to the new site. The evaluation shall develop remedial actions to address problems encountered in the early stage of the cooperative operation.

Membership in a singular subgroup will represent lack of daily access to the site by all waste pickers as currently obtains at the Mandela Site. This was construed by the waste pickers during the consultation exercise to represent loss of income. As a group, recyclers recommended that persons who have been working at the site for more than 8 years, be afforded access to work everyday or for at least four days per week. The number of individuals working at the site for more than 8 years exceeds 50 and this request would not satisfy capacity constraints mandated by the MSWMD for effective functioning of the site operations. Lack of access may further exacerbate problems related to fighting and bullying which exist at the Mandela Site. This concern was therefore addressed by examining two options for providing access to the site. These options were:

- *Option 1:* Subgroups work on an hourly basis. This can take the form of two and one-half hour/subgroup/day; and
- *Option 2:* Subgroups work on a daily basis. This will take the form of day/subgroup/four days.

Option 1 presents the risk of individuals congregating at the entrance to the Haags Bosch site to await their work period. Residents of surrounding communities have raised concerns about the presence of questionable characters in their communities related to operations at the site. This may represent a manifestation of these concerns and may result in tensions being developed between the residents and the landfill Operator. Option 2 presents the risk of individuals not being able to work every working day.

During the transition period, the two options identified above will be explained to the recyclers and agreement will be sought on their implementation. An evaluation will be conducted to assess the suitability of each option. A determination of which option is more suitable for operation at the new site will be made in consultation with the recyclers and additional options may be developed. This approach will address perceived concerns related to reduction of income by allowing recyclers to choose which option best suits them without compromising the Haags Bosch Sanitary Landfill operations and their welfare. A number of factors will be taken into consideration during the evaluation and these include:

- the rate of recovery of various recyclable materials;
- the number of days recyclers work at the site and; and
- the price of the items recovered.

Several problems will arise during the initial phases of the cooperative operations. These are likely to include:

- Difficulties in understanding complex procedures of a cooperative;
- Difficulties in accepting the financial arrangements under the Act;
- Absence of coordination and proper supervision;
- Problems with sale of recovered materials and
- Impacts of cost variability of materials on earning capacity.

A training program will be developed and will be supported by proper supervision and coaching to mitigate these problems.

Public awareness sessions will be conducted during the transition phase to inform recyclers about the various processes that will support their relocation and operation to the Haags Bosch site. This will help minimize the occurrences of conflicts. Potential conflicts likely to develop during project implementation may include:

- Lack of adherence to the rules of the society by members;
- Problems with the site Operator and MSWMD due to indiscipline of recyclers; and
- Internal problems with the society and members due to dissatisfaction with the management of the society.

Resolution of any conflicts will be addressed by the MSWMD, the cooperative society management, a firm retained to manage the transition phase and the Institutional Strengthening Consultant during the initial two year operational phase. Mechanisms developed for conflict resolution during the transition and initial operation phases shall act as a guide for future conflict resolution. If the resolution arrived at is unacceptable to all parties, any party may request that an arbitrator to appointed to determine a solution which will bind all parties. The Chief Cooperative operator supervises the activities of all cooperatives in Guyana. He or someone knowledgeable in the operations of cooperatives and acceptable to all parties, will serve as the arbitrator.

By-laws of the society will be developed by its members under the guidance of the MSWMD and the Cooperative Department with legal support being provided as needed. The by-laws will address issues such as eligibility for membership, behavior of cooperative members, sanctions to be imposed for violations of the site operation guidelines and cooperative rules, responsibility for sales and payment for recyclables, licensing fees for operating at the site and operational parameters for the cooperative itself. These by-laws will establish the framework for conflict resolution between members of the cooperative, between the cooperative and MSWMD and between the cooperative and the Site Operator and identify sanctions. The Cooperative act provides for the intervention of the Chief Cooperative Office in resolution of disputes between members and the society.

Several activities related to the relocation of the recyclers commence before actual project implementation and funds will be required to support the relocation program during this time. Activities expected to commence during this time include retaining a

firm to guide the program, provision of legal services to the cooperative for development of by-laws and training and confidence building for cooperative members. The GOG and the MSWMD may be required to provide financing for some elements of the transition phase.

The staging of members at the Mandela Site for transportation to Haags Bosch may incur a recurring cost for maintenance of the building at Mandela and for transport charges to and from Haags Bosch. These elements of the relocation implementation will be finalized during actual implementation. It is expected that members of the cooperative may have to absorb some charges for these recurring costs. Alternately, by-laws of the cooperative can be developed for members to invest sweat equity in maintaining the building at Mandela and for transportation charges to be subsidized by membership fees only to the extent that they exceed charges currently incurred for transport to the Mandela Site.

Table 32: Summary of Training Needs for Recyclers

<i>Area</i>	<i>Suggested Course</i>	<i>Target</i>	<i>Course Duration</i>	<i>Timing</i>	<i>Facilitators</i>	<i>Cost (US\$)</i>
Establishment of cooperative group	Talk on requirements of the Act for the establishment of cooperative society and development of rules and by-laws of cooperatives	Recyclers Firm staff MSWMD staff	1 day	Feb 05	MLHS&SS	No cost
Cooperative administration	Principles in cooperative philosophy Cooperative management and administration Business activities of cooperative, marketing strategy, record keeping, contract negotiations, team building, office management skills, data base management, preparation for audit, etc.	Recyclers general membership Steering committee members and key leaders Firm staff	39 4 hrs sessions	Feb 05 – Dec 05	KKCC	13,096
Health and safety	First aid and emergency procedures Occupational health and safety	Recyclers Firm staff	As necessary	ongoing	Red Cross MLHS&SS	No cost
Monitoring and supervision	Management of recycling activities Monitoring of output Development of communication strategy for promoting health and safety among recyclers Supervision to ensure discipline	Steering and discipline committee members and other key leaders Firm staff	2 days	1 st Q 05	Independent consultant PAHO	1,500
Study tour	Study tour should be organized for hands on learning of operating a waste recycling	At least 2 members of the committee of management nominated by their	3 days	3 rd Q 06		6,000

	cooperative. A visit should be made to a similar size landfill in one of the Latin American countries from where the model was adopted	colleagues and 1 person from the firm				
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11.4 TRAINING PROGRAM

Before commencement of operations, members will be trained in the principles of cooperative endeavor and management and on how to conduct the business of a cooperative society. Training would be an ongoing activity during the transition/preparation phase of the relocation. A system will be developed and agreed to by the recyclers that will allow them to attend cooperative training programs. Specific attention will be paid to training individuals identified as prospective leaders of the cooperative.

Training in the principles of cooperatives and the management and administration of the society will be provided by the KKCC, which would be contracted to undertake this aspect of off-site training. This training program which is divided into three levels will be conducted over a period of 39 weeks and comprises 39 four-hour sessions on Sundays. The first level training program will be provided to the general membership of the cooperative and will cover topics related to the principles of cooperatives. Attendance at all training sessions shall be a prerequisite for acceptance into the cooperative. The second and third level training programs will target members of the group with leadership potential. The upper level programs will cover in a very detailed and interactive manner the management, administrative and operational aspects of cooperative. The training package will include one year of follow up activities comprised of a six month coaching period and two evaluation exercises over the remaining 6 months to support further training, if necessary.

Establishment of a cooperative with an organized structure would require specific support to ensure its functional effectiveness. A program of confidence building must also be implemented before the cooperative begins to function at the Haags Bosch Site. A two phased approach has therefore been adopted to make the cooperative an effective and functional entity. The first phase will begin in February 2005 and will entail the identification of a consulting firm/NGO to oversee the formation, training and development of the operational structure of the cooperative to be implemented after it begins operation at Haags Bosch. The second phase will consist of the Institutional Strengthening and Capacity Building Consultant coordinating operations of the

cooperative and working with the cooperative to modify its rules and structure based on operational features of the Haags Bosch Site. Both phases will be supervised by the MSWMD. This will result in approximately two and one-half years of institutional support for the cooperative. The members of the cooperative shall assume sole responsibility for its management after this period.

The consulting firm/NGO retained by the MSWMD to undertake the first phase of the resettlement shall have demonstrated experience in solid waste management and capabilities to provide management and administrative guidance. The consulting firm/NGO will monitor recycling operations at the Mandela site and promote public awareness issues related to recycling with potential members of the cooperative society. Staff members of the consulting firm/NGO will attend all training activities since they will serve as on-site trainers to members of the cooperative before it becomes functional at the Haags Bosch Site. This consulting firm/NGO will provide support during the period leading up to June 2005 and will coordinate training for members of the cooperative. Table 32 presents a summary of the initial training needs, the agency, which will conduct the training, the target group and costs. After June 2005 the Institutional Strengthening and Capacity Building Consultant will oversee the operations of the cooperative.

Resources and Facilities

Facilities to improve the conditions under which recyclers operate will be provided at the sanitary landfill. Facilities to be provided will consist of the following:

- A covered and paved area for cleaning and storing materials recovered from waste;
- A sanitary block and dressing rooms;
- One fifteen seats vehicle;
- One Scale graduated to 200 kg; and
- An area for food vendors.

In addition to the physical resources provided members of the cooperative will be provided with the following personal resources:

- First Aid facilities and Training in First Aid and Basic Emergency Procedures;
- Protective clothing and footwear; and
- Identification cards.

The first set of these personnel facilities will be provided to members free of cost. However, it is expected that the licensing fees will be adequate to cover the costs for providing these personnel facilities to members of the cooperative. Availability and use of the personnel equipment shall be a basis for access to the site. Replacement items shall be purchased by members through the cooperative cost recovery mechanism. The payment of fees by individual recyclers is likely to be very sensitive as currently no fees are charged and the institution of fees for operating at Haags Bosch may not be readily acceptable to potential members. Licensing fees will be gradually introduced based on a determination of the willingness of members to pay from the assessment of income generated during the initial phase of operations at the Mandela Site.

During consultations recyclers indicated a desire to be provided with resources for burning away insulation from copper wire. The firm will assess the need for such a resource during the initial phase of the resettlement program at the Mandela Site and will agree with the cooperative on a least cost option to satisfy this need which will accord with the Operation Plan at the Haags Bosch site.

The cost recovery mechanism will aim to provide a fair and sustainable system that ensures that the recyclers are not overly burdened. The model for cost recovery will be practical and transparent and will be gradually introduced. Cost recovery will be implemented in a phased manner for services provided by the cooperative to members.

11.5 IMPLEMENTATION AND SCHEDULE

The MSWMD in collaboration with the consulting firm/NGO retained to oversee the first phase of the relocation of recyclers to Haags Bosch will inform the recyclers of the plans for the new landfill and indicate to them that a cooperative shall be the only entity allowed to operate at the Haags Bosch Sanitary landfill. The cooperative department of the MLHS&SS will be invited to brief recyclers on the formation of a cooperative and the regulations governing their formation and operation. Legal support will be provided to the recyclers for developing the rules and by-laws of the society. Training in the operations of a cooperative should commence by February 2005. Representatives of the consulting firm/NGO will be involved in all activities to provide guidance to the cooperative in its initial stage of operation.

The consulting firm/NGO will be immediately tasked to register all recyclers working on the new site by name, address, type and amount of materials recovered, name of

person or organization materials are sold to, and the range of selling prices. This data will be used to develop a system of cost recovery based on fees payable for provision of the resources and facilities to be provided to waste pickers.

The formation and operation of the cooperative may prove to be difficult as inferred from the level of interest demonstrated by attendance at formal gatherings during this exercise and may result in a cooperative dominated by a few members. This will be countered by awareness and training programs to generate greater interest. In addition, the MSWMD would continuously inform the recyclers of developments related to reforms to recycling operations through the group's steering committee/committee of management.

The first official meeting of the cooperative will be held in March 2005 and at that initial meeting, a steering committee shall be elected. Meetings shall be held on a weekly basis and records kept conforming to the regulations of the Cooperative Act. A cooperative officer from the MLHS&SS shall attend all meetings for the first two months of the cooperative operation and shall attend one meeting each month after. The steering committee shall be responsible for the management of the group. The immediate responsibility of this committee will be to verify the rules and by-laws of the group developed during the pre-formation stage. After operations for six months, a permanent executive shall be elected at a meeting supervised by the Cooperative Officer. Meeting shall be held once per month and the cooperative officer shall be present at a meeting once per quarter. The cooperative shall become fully operational in June 2006. However its principles and practices shall become effective in January 2006 to allow for identification and correction of problem areas.

Recycling operations at the site shall be governed by strict rules and regulations developed by the MSWMD and the Operator in consultation with the recyclers steering committee. These regulations would govern how recyclers operate at the Haags Bosch landfill, their conduct, enforcement of rules and penalties for breaking rules. The MSWMD will assist with negotiating arrangements for access by waste recyclers to the active area. Members shall conform to these arrangements and conformance shall be a basis for the continuing presence of individual members at the site. These arrangements shall be negotiated in April 2006 prior to commencement of operations at Haags Bosch.

Rules of the cooperative shall include prohibition against selling by individual members. The cooperative shall be the only entity authorized to negotiate and sell recycled materials individually to buyers. All selling shall take place at the area provided for storage. This arrangement is intended to maximize benefits to members by

development of a formal price structure. Members shall deposit their daily output with the cooperative and this would be recorded and a receipt provided. During the project transition phase, the firm shall compile a list of buyers of recyclables and the buyers will be sensitized to the new sales regime to be implemented at Haags Bosch. Statutory selling periods will be developed and communicated to buyers. These arrangements will be determined by the recyclers, MSWMD and the Operator. The by-laws will mandate adherence to schedules to prevent unregulated access to the site by buyers.

Members will be paid after items are sold, by the cooperative, on the basis of their output and all members will pay a fee for providing this service. It is expected that payment for output shall be made at the end of each day, however in those instances where buyers do not purchase materials on the same day as the materials are recovered, payment will be made within 24 hours of the material being sold. Fees shall be established based on agreement by the membership and shall be adequate to cover yearly operational cost of facilities to support their activities. The Institutional Strengthening and Capacity Building Consultant will provide support in maintaining records of output, and revenues and with monitoring financial aspects of the operation. All financial records should be managed by the financial committee drawn from members. In keeping with the Act a yearly audit shall be conducted of the cooperative.

The Institutional Strengthening and Capacity Building Consultant will support the cooperative in enforcing rules of the society and the rules that govern recycling operations at the site. Recyclers will be mandated by rules to work in a disciplined and safe manner. Rules shall forbid the recovery of materials from trucks before they reach the tipping face or while trucks are in the process of tipping. In addition, members shall be forbidden from working within 50 m of waste compacting and placing equipment.

The MSWMD will deploy marshals to oversee the recycling operations. Incidences of thefts and bullying will be referred to these marshals for resolution. Marshals would record instances of indiscipline and theft and perpetrators would be immediately sanctioned to prevent reoccurrences. The rules of the cooperative will mandate sanctions for incidences of indiscipline and theft. These rules shall include the expulsion of members who continually break the rules.

The implementation schedule is shown on Table 33.

11.6 TRANSITION PHASE

Before operation commences at Haags Bosch a coordinating committee comprised of the consulting firm/NGO, MSWMD, the Institutional Strengthening Consultant and the executive of the cooperative will meet and establish the modalities for moving to and operating at Haags Bosch. The consulting firm shall compile a summary of all individuals eligible for membership of the cooperative based on their attendance at training sessions and other criteria established for membership including their adherence to the disciplinary standards established for the cooperative operations.

A summary of outstanding issues related to implementation of the operational structure of the cooperative will also be identified. These issues will at the minimum include payment for maintenance and operation of the vehicle used to transport recyclers to Haags Bosch and agreement on the licensing fees to be paid for operating at the site. Data compiled by the consulting firm/NGO during the operation phase at the Mandela Site will be used as the basis for determination of the licensing fees. The executive committee of the cooperative will also be informed of the rotated work schedule proposed for operations at Haags Bosch and of the need for members to assemble at the Mandela Site for transportation to the site on a daily basis.

After consultations with its members, the executive of the cooperative and MSWMD shall compile a list of members of the cooperative eligible to operate at the new landfill. The executive of the cooperative shall also determine, based on consultation with its membership, the names of persons in each sub-group and will establish departure and pickup times for the Mandela and Haags Bosch locations respectively. This schedule will apply to the operations and will only be modified based on acceptance of proposed changes by the MSWMD.

If a recycler opts to exercise the option of not moving to Haags Bosch, the revenue garnered by that recycler based on operations at the Mandela Site will be compared to that obtained from the Haags Bosch site to develop a basis for an equitable compensation package for that recycler. The cumulative returns to the recycler over the transition phase at the Mandela Site would also be considered.

Table 33: Proposed Implementation Schedule

Activities	2005												2006												2007												
	J	F	M	A	M	J	J	A	S	C	N	D	J	F	M	A	M	J	J	A	S	C	N	D	J	F	M	A	M	J	J	A	S	O	N	D	
Identification of firm, development of terms of reference, finalization of arrangement (MSWMD)	■	■																																			
Setting up of groups and organizing meetings/awareness sessions, development of rules and regulations (Firm)		■	■	■																																	
Initiate the process for registration of cooperative - invite cooperative officer to explain the Act and the requirements for registration (Firm)			■	■																																	
Promote and support the holding of regular meetings to discuss business of the group, preparation of minutes and facilitate action (Firm)			■	■	■	■																															
Training of recyclers to undertake the business of cooperative (Firm & MSWMD)				■	■	■																															
Commencement of process for registration of cooperative, review of rules developed by group, prepare by-laws that will govern cooperative (Firm, MSWMD, Institutional Strengthening Consultant)				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Evaluation of groups activities at Mandela site (Institutional Strengthening Consultant)															■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Training in emergency procedures (Firm & Institutional Strengthening Consultant)																■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	

During the development of by-laws for the cooperative. The MSWMD and the firm will consult with the recyclers to establish a compensation package for recyclers who choose on a strictly voluntary basis not to move to Haags Bosch. The compensation package will consider the duration of time the individual has worked at the Mandela Site and the returns to that person recorded during the transition phase. The compensation package will, however, not exceed the sum calculated based on a formula which incorporates both the duration the individual operated at the site and his monthly returns from the operation and which is similar to the redundancy package provided by the labour laws of Guyana.

The by-laws would establish conditions for former members opting to rejoin the cooperative. Members opting to rejoin must submit new applications for membership within 60 days of choosing to discontinue membership. However, no consideration will be given to members who have already accepted the compensation package awarded for opting out of the cooperative. The by-laws would also contain the procedure to be followed by those members who choose to withdraw from the cooperative. Requests for transfer of membership will only be entertained in instances where it can be demonstrated that the person to whom membership is transferred has worked at the Mandela Site sometime in the past and where the member who chooses to transfer such membership renounces all claims to the compensation package for eligible members.

11.7 MONITORING

The operations of the cooperative will be monitored to ensure its effective functioning and to ensure that recyclers resettled at the Haags Bosch site work to attain the project objectives. The implementation schedule outlined in Table 59 shall be monitored to ensure adherence to the schedule for resettlement of recyclers. This is a critical component of the resettlement since recyclers will only be allowed to operate at Haags Bosch in an organized manner approved by MSWMD and the Operator. The Institutional Strengthening and Capacity Building Consultant will be responsible for monitoring the operations of the cooperative and for reporting on its progress to the MSWMD. The management committee of the cooperative will assume this role after June 2008.

During phase one of the formation of the cooperative and while operations continue at the Mandela Site, the cooperative will be monitored by the MLHS&SS cooperative department. Meetings will be kept in accordance with by-laws and minutes of these meetings shall serve as verifiable indicators of conformance. The firm retained by the MSWMD will monitor all meetings of the cooperative.

Since recycling has never taken place in an organized manner it is likely that there will be some conflict at the beginning of operations. A record will be maintained of all conflicts and their resolution. The cooperative will also monitor and maintain records of thefts and bullying and sanctions to troublemakers at the site.

The cooperative will monitor the recycling operations and maintain comprehensive records of items recovered for sale and by which member. This information shall be recorded on a daily basis and shall include:

- Type of materials recovered and by whom;
- Quantity recovered of the each type of materials;
- Daily selling price of various materials; and
- Payments to members.

The marshal retained by MSWMD will supervise these aspects of resettlement monitoring.

11.8 COSTS

The costs for the Resettlement Plan are presented in summary in Table 34. These represent sums not provided for by project estimates. Some facilities such as the sanitary block and changing areas are included as elements of the project and no allowances are made for these estimates in the resettlement costs.

Table 34: Summary of Budget for Resettlement Plan

<i>Budget Items</i>	<i>Time Frame</i>	<i>Cost (US\$)</i>
Training and Evaluation	February 2005 – July 2005	15,196
Dining area and selling area	January 2006 – June 2006	-
Purchasing one Fifteen seat Vehicle	June 2006	11,000
Maintenance of Waiting Area at Mandela Site	June 2006 -	2,000
Identification badges	June 2006	1,200
Payment to Firm to Support Cooperative	February 2005 – July 2005	36,548
Total		65,944

12.0 INSTITUTIONAL FRAMEWORK FOR PROJECT EXECUTION AND SUPERVISION

Project execution will be undertaken in four phases; design, construction, operation and post-closure. A special department; the Municipal Solid Waste Management Department (MSWMD) has been created to supervise all aspects of the project (ERM, 2003). This department replaces the former Cleansing Department and it has greater autonomy than was vested in that department. Regulatory oversight of the operations of the department will be provided by the Environmental Protection Agency (EPA). Administrative oversight will be provided by The Mayor and City Council of Georgetown.

12.1 MSWMD STRUCTURE

The structure of the MSWMD is shown on the figure following this sub-section. This department functions at the same level as the Public Health Department with provisions for separate accounting for municipal solid waste management, to separate different waste management functions and to clarify the roles and responsibilities of the stakeholders involved and to increase overall authority and autonomy in the provision of municipal solid waste services. The department is headed by a director who answers directly to the Mayor and City Council of Georgetown (MCC). Specific tasks of the MCC related to project execution includes reviewing monthly report prepared by the MSWMD, approval of MSWMD strategy and budget and approval and training of MSWMD managerial staff.

An Advisory Board (AB) liaises between MCC and the GOG. The Advisory Board provides a basis for open discussion and agreement between stakeholders in relation to the Georgetown Solid Waste Management Program. Major decisions and actions by MSWMD related to the program are approved by the Board. Standard decisions related to waste management for which approval is needed, such as basic recruitment, are approved only by MCC. Major issues such as the annual MSWMD budget are approved by the MCC, however the AB is provided an opportunity to comment and influence the planning of the budget.

The AB is comprised of representatives of MoLGRD, GM, NDCs, MoF and residents of Georgetown and Eccles and the Georgetown Chamber of Commerce. The AB works to resolve potential disputes and address wider issues such as cooperation between NDCs and GM and the legal implications related to successful program implementation. The advisory board supervises the contact between MSWMD and the private operator and acts as a mediator or appoints one where conflict in this relationship arise, especially with respect to tariffs. The AB initially meets once monthly. The frequency of meetings may be modified after the first two years of operation.

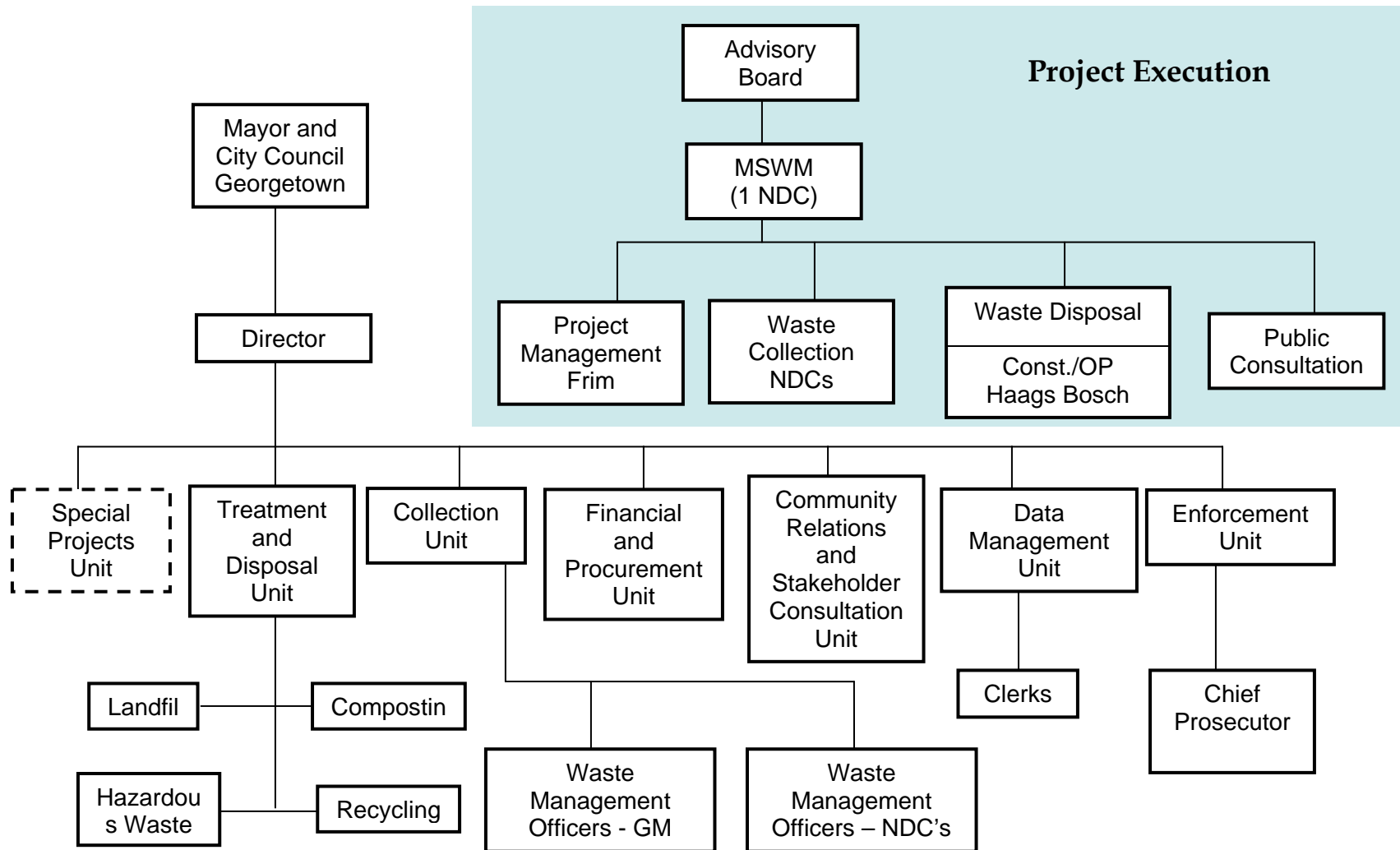
During sanitary landfill operation, concerns and/or complaints from members of the public will be received through the Community Relations and Stakeholder Consultation Unit and also through reports to the Operator. The MSWMD will report all complaints to the AB and indicate the procedures implemented to address the complaints. The AB will indicate whether the issue has been satisfactorily dealt with and shall refer the matter back to the MSWMD if further action is deemed necessary.

MSWMD will support the NDC Administrations in improving solid waste management by providing advice and support. The MSWMD will maintain regular communication with NDCs related to monitoring of waste flows from NDCs to the Haags Bosch landfill, to obtain data on waste generation for planning purposes and to facilitate sharing information on effective waste management practices and public awareness and education.

Several units are not yet fully staffed and others are still at the concept stage. The Institutional Strengthening and Capacity Building component of the project will strengthen the MSWMD through structured training, on-the-job training and capacity building, human resource development, support during recruitment, setting up financial systems and information databases, developing reporting structures, developing operational procedures and other ad-hoc day-to-day support. This will involve closely working with the Senior Management Team of the MSWMD throughout the project and will build on institutional strengthening work that has already been carried out by international consultants with the MSWMD.

Ideally all units will be fully staffed and will be operational before the commencement of construction works at the site in June 2005. In the event difficulties are experienced in identifying suitable staff, The Treatment and Disposal, Special Projects, Enforcement and Community Relations and Stakeholder Consultation units will be operational by that date. This will ensure that the Capacity Building and Institutional Strengthening Consultant has counterpart personnel in place at commencement of construction works. The other units will be operational by August 2005 to provide a long enough time frame for training to ensure the development of adequate capacity prior to the MSWMD assuming full responsibility for supervision of the operations.

Organizational Structure of the Municipal Solid Waste Management Department



12.2 SPECIAL PROJECT UNIT

This unit will undertake specific waste management projects. Initially the unit will undertake several studies which have tentatively been identified for implementation as part of the landfill operations. This unit will undertake the following elements of the Environmental Management and Monitoring Plans:

- Supervise remedial works for closure of open dumps in GM and NDCs;
- Work with Consultants preparing commercial waste inventories for the NDCs; and
- Supervise and work with Consultants performing hazardous and healthcare waste study.

This unit is not yet operational and has no staff. It is intended to provide it with capabilities to conduct pilot studies for recycling and composting. A manager for this unit has been tentatively identified as a retired Chief Environmental Health Officer with GM. However, he is still to assume duties. The Unit will consist of five persons in addition to the manager. These individuals are to be taken from the former Cleansing Department and have been provided with general training in composting and waste recycling.

12.3 TREATMENT AND DISPOSAL UNIT

The treatment and disposal unit is responsible for management of the landfill. This unit will liaise closely with the Financial and Procurement Unit and with the data management unit to ensure effective records are maintained of waste fill quantities. This unit will plan all future waste disposal operations and will work along with the Design Consultant to ensure the concept of the new landfill satisfies the MSWMD requirements and concerns. This unit will manage and monitor both the construction and operational phases of work at the Haags Bosch landfill. Specific aspects of operational oversight will include collection of data on waste volumes delivered to the landfill for linking with the Data Management Unit. This unit will also manage composting and recycling operations which result from pilot studies conducted by the Special Project Unit.

This unit will be responsible for overseeing implementation of major elements of both the Environmental Management and Monitoring Plans. Specific aspects of these plans which will fall under the mandate of the Treatment and Disposal Unit include the following:

- air quality mitigation;
- surface water mitigation and monitoring;
- groundwater monitoring;
- application of daily and final covers;
- liquid waste management;
- noise and dust mitigation and monitoring;
- traffic and access mitigation and monitoring; and
- landfill leachate monitoring.

This unit will interact with the EPA and will provide responses to stakeholders on issues concerning the operations of the facility through interface with the Community Relations and Stakeholder Consultation Unit. Data acquired from operations monitoring will be provided to the Data Management Unit. After completion of the study and acquisition of equipment for hazardous and healthcare waste, The Treatment and Disposal Unit will be responsible for long term implementation of the findings of the study and for management of the hazardous and healthcare waste facility.

This unit is now operational and is managed by the individual currently responsible for management of the Mandela Site. This individual has in excess of forty years experience with GM waste management practices. He is supported by a staff of eight individuals. The manager and his subordinate staff are all qualified to the high school diploma level. Several of these individuals have benefited from PAHO/WHO administered courses on waste management and public health.

Technical capability will be provided to this unit by the Capacity Building and Institutional Strengthening Consultant. The Deputy Director of the MSWMD is a qualified engineer. He will be trained during the initial two years of the project. That training will qualify him to provide long term capability to the project.

12.4 COLLECTIONS UNIT

The collections unit will manage Georgetown waste collection contractors and coordinate the collection of special wastes. This unit will implement minor elements of the Environmental Management and Monitoring Plans. Elements of these plans implemented by this unit are the assessment of large and small community bins allocation for Georgetown and NDCs. This unit will assess incidences of improper

waste disposal in GM and provide feedback to both the Enforcement and Community Relations and Stakeholder Consultation Units for action.

This unit is operational and is managed by an individual currently responsible for waste collection in Georgetown. The unit staff consists of 24 foremen/drivers, 12 street orderlies and 17 Waste Management Officers. The WMOs will undertake waste management planning, monitor waste collection operations and community relations activities. WMOs will also provide information to the Data Management Unit.

12.5 FINANCIAL AND PROCUREMENT UNIT

The Financial and Procurement Unit will be responsible for the transparent and accountable management of finances including payment to suppliers and MSWMD staff and for recording all revenues provided to MSWMD including payments for special waste collection, tipping fees, payment from PT by GM and subventions from MoLGRD. This unit will undertake all tasks related to procurement of services and equipment required by MSWMD. The unit will prepare contracts for waste collection and operation of the Haags Bosch Sanitary Landfill and will prepare monthly financial reports for the Director and AB. This unit, which is not yet operational, will implement cost recovery proposals for operations of the Haags Bosch Sanitary Landfill and will work with the Collections Unit to establish tariffs for waste disposal at the Haags Bosch Site to ensure implementation of effective cost recovery. Both the accountant and Administrator/Procurement manager for this unit have been identified and commenced work in September 2004. Effective operations of this unit will facilitate effective cost recovery related to implementation of the Programme.

12.6 COMMUNITY RELATIONS AND STAKEHOLDER CONSULTATION

This unit will manage the stakeholder consultation process during project implementation and will ensure continuous communication with key stakeholders to gain their confidence on issues critical to project success. This unit will develop and manage public awareness and education campaigns to inform perceptions about waste management and landfill operations and will manage the Public Involvement/Community Outreach component of the Environmental Management Plan. This unit, which is not yet operational, will interact with the Treatment and Disposal Unit to provide official responses to issues raised by stakeholders. It will interface with the Collections Unit to ensure that its public awareness and education

campaigns are producing the desired results in GM and in NDCs and will modify the campaigns based on feedback from these units. This unit will have direct contact with the Advisory Board to provide responses on issues raised by project stakeholders and residents of communities in proximity to the landfill which are related to its operation. The unit will confer with the AB to ensure responses to operation issues are satisfactory to both project stakeholders and to residents in the vicinity of the landfill.

The manager for this unit was hired effective September 01, 2004 and is currently attached to the Public Relations firm undertaking the public education/awareness program for the Mandela Site upgrades.

12.7 DATA MANAGEMENT UNIT

The data management unit will expand and improve the range of data collected by the MSWMD to ensure that day to day operations and management are informed by proper data. The unit will be responsible for maintaining data on residential waste collection, on commercial and industrial waste generators, waste quantities and types delivered to the landfill and waste collection companies performance provided by the Treatment and Disposal and Collection Units. This unit will maintain a database of all environmental monitoring and compliance data and will maintain a register of public complaints and responses to each complaint. This Unit will work with the Financial and Procurement Unit to ensure all variables related to cost recovery and waste management charges are considered in the assessments of cost effectiveness of waste collection and operations. This unit is operational and is currently staffed by a manager and two data entry clerks.

12.8 ENFORCEMENT UNIT

The enforcement unit will monitor the performance of waste collection companies, commercial and industrial waste generators and waste disposal operations. This unit will work closely with the Collections Unit to enforce actions against illegal dumping/littering in GM and NDCs. This unit will manage the monitoring of offsite impacts of facility operations such as impacts on groundwater quality and migration of landfill gases undertaken by the landfill Operator. This unit will also establish targets and monitor the performance of integrated waste management systems, such as recycling and composting. Reported and unreported incidences of non-compliance with sound environmental practices will be investigated by this unit and the unit will be responsible for the implementation of sanctions for the infringement of environmental standards mandated in contracts for both the site Operator and waste haulers. Reports

generated by this unit will be provided to the Director of the MSWMD. These reports will also be submitted to the AB to provide information on progress towards optimizing waste management systems in Georgetown and the NDCs.

A manager and assistant were hired into this unit effective September 01, 2004. This department has already undertaken action to prosecute several individuals for littering in Georgetown.

The Environmental Management Division of the EPA, with a staff of several individuals will directly enforce EPA mandates related to this project. The EPA will be responsible for ensuring conformance to the terms and conditions of the permit issued for design, construction, operation and closure of the sanitary landfill. The EPA will review all monitoring data for environmental compliance and will establish guideline values for site emissions to ensure the facility has minimal impacts on the environment. The EPA may also mandate changes to the environmental mitigation and monitoring plans based on the results of the monitoring program.

12.9 INSTITUTIONAL RESOURCES

The MSWMD will be provided with resources to ensure effective implementation of the Environmental Management and Monitoring Plans. The collections unit will be provided with specialized waste collection vehicles for collection of health care and hazardous waste. Healthcare wastes is presently segregated from other wastes and burned at the incinerator. The recovery of this waste will therefore not prove to be problematic. However, hazardous wastes is currently commingled with other wastes and disposed at the Mandela dump. Disposal of hazardous and healthcare waste under the project will therefore require the separation of hazardous waste at its source. Georgetown has initiated a program to identify hazardous waste generators and these generators will be targeted to segregate hazardous wastes from other waste before pick up. Hazardous and healthcare wastes will be delivered to the facility specially constructed for the disposal of this waste. This facility will be completed before landfilling commences at the Haags Bosch Sanitary Landfill. The MSWMD has developed a fee structure for waste generators in GM and this fee structure would be applied to the disposal of hazardous and healthcare waste.

Waste Management Officers will be provided with motorcycles. The motor cycles will ensure adequate coverage of areas falling under the jurisdiction of each WMO. The department will be provided with specialized equipment to recover groundwater and surface water samples, to monitor ambient air quality and to monitor for the presence of

landfill gases. The equipment provided to this department shall be in addition to those mandated to be provided by the Operator as part of his contractual obligations. Members of the Treatment and Disposal Unit will be trained by the Capacity Building and Institutional Strengthening Consultant to operate each piece of equipment. Data acquired by the MSWMD will be used to check the validity of results provided by the Operator and to complement the environmental monitoring data base for the project. This data will also be available for public access.

The MSWMD offices will be refurbished and will be equipped with computers. A suitable database management package will be provided to the department. The package shall have the capability to fully update itself based on the change in any variable related to assessment of waste collection and disposal charges.

12.10 INSTITUTIONAL ANALYSES

Supervision of several elements of the Environmental and Monitoring Plans will require a significant degree of technical expertise. The Institutional Strengthening and Capacity Building Component will bring this expertise to the project in the medium term and will provide training for members of the MSWMD. The extent of the training is, however, limited by the lack of advanced education of the individuals to be trained. The structure of the MSWMD does not incorporate any engineering skills. It is planned that the resources of the PIU for the Mandela Site upgrade are transferred to this unit. The current resources available to that PIU consist of a single engineer. There are several engineering issues related to effective management of the sanitary landfill, the primary ones being waste water treatment and material handling. The skills present in the MSWMD are inadequate to effectively deal with waste water management issues. The Institutional Strengthening and Capacity Building Consultant will be mandated to focus on developing the waste water engineering capability of the MSWMD to address this deficiency.

Several of the tasks to be undertaken by the Special Project Unit require specialist knowledge. These include assessment of landfill gas utilization, closure systems for open dumps and supervision of the study to examine disposal options for hazardous and health care wastes. The department has the management capability to supervise the operations but its technical abilities to examine and comment on the validity of the findings are limited. The EPA also lacks technical capability to support the MSWMD. Specialized aspects of the project will be supervised by the Institutional Strengthening and Capacity Building Consultant in the short term. The EPA and MSWMD will both be trained by the Institutional Strengthening and Capacity Building Consultant to develop

this specialized expertise for long-term management and monitoring of the sanitary landfill.

The budgets of most NDCs are inadequate to cover payment for waste tipping charges and special measures such as increases in property taxes and waste management fees will have to be enforced to generate revenues. Payment of WMOs may be an added burden to some NDCs, however, sums generated from enforcement of anti-littering laws may be used to pay WMOs in the short term. The MoLGRD has recorded its willingness to modify its subvention regime to allow subventions to be used for waste management services and this may compensate for shortfalls payments for waste management services by NDCs.

In the initial stages of the project WMOs may experience some difficulty with enforcement of anti-littering laws. This is reflected currently by no enforcement by Environmental Health Officers assigned to NDCs. A training program should be mounted to educate WMOs about aspects of the anti-littering legislation to ensure long term effectiveness of their roles.

Several NDCs, namely Nismes/La Grange, Malgre Tout/Meer Zorgen and Grove/Haslington, covered by this project are immediately next to NDCs not involved in this project. Residents of the NDCs which adjoin Nismes/La Grange, Malgre Tout/Meer Zorgen and Grove/Haslington may illegally dispose of waste in Nismes/La Grange, Malgre Tout/Meer Zorgen and Grove/Haslington. This can be countered by effective enforcement of anti-littering laws and by extending the public awareness and education campaign to also target residents of NDCs which adjoin Nismes/La Grange, Malgre Tout/Meer Zorgen and Grove/Haslington.

The capability of all departments of the MSWMD and of the EPA will be enhanced by counterpart training provided by the Capacity Building and Institutional Strengthening Consultant. This training will extend through the construction phase of the sanitary landfill. All MSWMD and EPA personnel expected to be involved in project execution will be trained to a level of competence to ensure effective project implementation. These individuals will be tasked by their individual departments to provide training to other members of each department to ensure a reservoir of trained individuals for long-term project management.

The only revenue sources for NDCs are property taxes and a subvention of \$3,000,000.00 per year from GOG. Property tax (PT) collection rates are generally low and range from approximately 35% to 70%. Use of the sanitary landfill must be accompanied by a mechanism for cost recovery. Some NDCs have initiated efforts to charge a waste

management fee but have faced opposition from residents. This cost recovery mechanism must precede any improvement in waste management. Public awareness programs would be implemented in the NDCs to sensitize people both to waste disposal and to the plan for waste management.

Illegal dumping occurs in each NDC in spite of collection services. Most illegal dumping is by commercial establishments in the NDC. Illegal dumping in the NDC can be curtailed by fines. The present fines do not reflect the true cost of enforcement. Legislation should be updated to increase fines and to have the fines paid to the NDC. These monies should be dedicated to waste management. The legislation should permit the hiring of Rural Constables (RC) to enforce anti littering laws. These RC should be hired and fired by the NDC. The Legislation should also provide more autonomy to the NDC in waste management matters.

The EPA is expected to provide regulatory oversight for enforcement of both the Environmental and Monitoring Plans. This department is staffed with technically competent individuals. The solid waste and landfill operation experience of these individuals is, however, constrained by lack of exposure to similar operations. Provisions should be made for training of EPA staff also during the Institutional Strengthening and Capacity Building component of this project.

13.0 MONITORING PLAN FOR OPERATIONAL COMPLIANCE

The monitoring program will provide data which would serve as the basis to determine the environmental performance of the systems. The facility will be monitored to confirm its adherence to sound environmental management practices and contractually established operational standards. Monitoring will be conducted during the construction, operation, closure and post closure phases of the project. The monitoring program is designed to ensure that the trends for specific parameters are tracked. It will also provide information on compliance with legislation, guidelines and contractual requirements for the construction, operation, closure and post-closure maintenance of the facility.

Stakeholders in communities in the environs of the facility will be mobilized to support the site monitoring programs. A hotline will be established to report illegal dumping, suspect releases, unusual health conditions or environmental conditions around the operations of major polluters who do not conform to performance requirements. Information on landfill and waste management operations and polluters and waste generators will be maintained at the landfill site and disseminated through public channels and local authorities to enable access by stakeholders to identify problems and sources quickly. The hotline would also be linked to the EPA and other appropriate authorities to effect emergency response, remediation and investigation when needed.

The monitoring plan addresses leachate generated by the landfill, groundwater and surface water quality, off site migration of landfill gases, and concerns raised by communities impacted by the project. In each instance the Monitoring Plan includes the parameter(s) to be monitored, the frequency of monitoring and responsibilities and costs for execution. The results of all monitoring programs will be maintained on site and will be available for accessing by members of the public at the site and at the EPA. The Community Relations and Stakeholder Consultation Unit will also provide yearly summaries of all results of monitoring to the public by both press and radio announcements. All data generated by the monitoring program will be sent to the EPA, MSWMD and to the Inter-American Development Bank.

A small on-site laboratory will be provided to check key parameters for the leachate treatment system and for surface water discharge. The costs for installation of all the monitoring networks are included as part of the operation costs of the sanitary landfill. The yearly monitoring costs are included as a part of the tipping fees to be paid to the Operator. The obligations for payments of tipping fees inclusive of the annual environmental monitoring costs will be assumed by the MSWMD as a part of its obligations.

13.1 WASTE/SOIL VOLUME MONITORING

The Site Operations Manual will provide clear direction on how waste will need to be placed, compacted and covered in order to achieve the necessary waste densities. The only way to accurately calculate waste compaction density is by comparing the volumetric airspace utilized during a given year of operation against the total weight of waste landfilled. A date will be established one year following the start of operations. On that date and for each year following an annual total station survey will be conducted and a topographic drawing will be created. From that topographic drawing a total landfill volume utilized to that date will be calculated. Each year, the equivalent waste density for the site will be calculated. This is simply the amount of waste that has been placed into the total volume of the site that has been used.

Additionally, for each year of operations the total volume of airspace utilized within the landfill will be compared by subtracting the volume utilized from the total at the end of the previous year. This number should demonstrate a density significantly higher than the target density. One of the most important regular daily indicators is the length of time that the compactor is used in the active filling area and the number of passes being made to compact the waste. It is readily apparent from visual observation whether or not adequate compactive effort and time are being expended.

In addition to calculating the volume of waste placed, the volume of on-site soil used annually for cover operations also needs to be calculated, primarily as a confirmation of good operating practice and to make sure that this resource is being used effectively. This calculation can also be used to identify the percentage of soil in the waste matrix so that it can be removed from the equation as a crosscheck on the volumes used and the equivalent waste density.

All waste disposed at the Site will be weighed at the entrance scales. The annual timeframe for weighing the waste needs to be consistent with the volume calculations. Once the overall volume has been calculated and the soil volume subtracted from this value it is simply a case of dividing the total weight of waste disposed by the volume that the waste occupies over the selected timeframe. It is also important to weigh material recycled from the landfill before it leaves the site and account for this volume in the calculation.

The attached example has been prepared to assist the reader in understanding waste/soil volume density monitoring and density calculation.

Volume of Waste – Year 1 End	100,000 m ³
Volume of Waste – Year 2 End	200,000 m ³
Difference	100,000 m ³

Volume of Soil – Year 1 End	250,000 m ³
Volume of Soil – Year 2 End	230,000 m ³
Volume of Soil Used	20,000 m ³

Therefore in Year 2 operations 100,000 m³ of landfill airspace was utilized of which 20,000 m³ is occupied by soil material. Therefore, 80,000 m³ is occupied by waste.

Total Scale Weight	60,000 tonnes
Weight of Recyclables Removed from Calculation	10,000 tonnes
Difference	50,000 tonnes

Therefore 50,000 tonnes of waste was deposited in Year Two operations occupying 80,000 m³ of volume. Therefore the waste density calculation is as follows:

$$50,000 \text{ tonnes} / 80,000 \text{ m}^3 = 0.625 \text{ tonnes/m}^3$$

13.2 GROUNDWATER MONITORING

The groundwater monitoring program is simplified due to the natural hydraulic trap conditions at the Site. The proposed groundwater quality and quantity monitoring program has been established to verify the Site performance.

Six on-Site shallow groundwater wells will be installed and be maintained adjacent to the limit of waste in each landfill stage at the locations shown Figure 13.1. Monthly water level measurements will be recorded in all on-Site groundwater monitoring wells to ensure the performance of the hydraulic trap. Groundwater samples will be recovered annually and analyzed for the following list of parameters:

- Biochemical Oxygen Demand (BOD);
- Chemical Oxygen Demand (COD);
- PH;
- Total Ammonia Nitrogen;
- Total Dissolved Solids (TDS);

- Total Suspended Solids (TSS);
- Volatile Suspended Solids (VSS);
- Total Kjeldahl Nitrogen (TKN);
- Total Phosphorus;
- Alkalinity;
- Hardness (Ca and Mg);
- Chloride;
- Fluoride;
- Phosphate;
- Sulfates;
- Nitrite; and
- Nitrate.

During the first year of operations, groundwater samples will be recovered quarterly from all wells and will be tested for the list of parameters above in order to develop a more complete database for the Site. Groundwater samples recovered quarterly thereafter from all wells will be tested to determine the presence and concentration of the reduced list of parameters listed below.

- Biochemical Oxygen Demand (BOD);
- Chemical Oxygen Demand (COD);
- PH;
- Total Ammonia Nitrogen;
- Total Suspended Solids;
- Total Kjeldahl Nitrogen (TKN);
- Total Phosphorus; and
- Alkalinity.

The groundwater monitoring program will be reviewed periodically as the database for the Site is further developed. Suggested revisions to the monitoring program will be noted in recommendations in the annual monitoring and operations report for review by the EPA and other relevant authorities before implementing changes to the program.

The Operator will be responsible for measuring groundwater depth and for recovering groundwater samples from each well working under the supervision of the MSWMD.

Samples will be submitted to an independent laboratory for testing. Results of all tests will be provided to MSWMD, the EPA and to the Inter-American Development Bank. A summary of all test results shall also be maintained onsite for inspection by the EPA.

13.3 LEACHATE HEAD MONITORING

The leachate hydraulic monitoring together with the groundwater level monitoring are critical aspects of the overall monitoring program. The groundwater level data and the leachate level monitoring data would be coupled to document that the inward gradient into the landfill cells is maintained.

The leachate management system monitoring program will include the installation and maintenance of six leachate monitoring wells at the toe of slope around the perimeter of the landfill. Monthly water level measurements will be recorded in all leachate monitoring wells to ensure the performance of the hydraulic trap. Daily water level measurements would be recorded at each of the leachate pump stations (PS 1 to 4) along with daily measurement of leachate pumping volumes. The quantity of leachate influent and effluent to the Leachate Treatment Process shall also be monitored on a daily basis. Leachate pumps will be monitored on a regular basis by the Site operator, as part of regular maintenance activities. Any pumping system malfunctions will be recorded as well as the remedy to the operations problem.

The proposed leachate management system monitoring program would be reviewed periodically as the database for the Site is further developed. Any suggested revisions to the monitoring program would be noted as a recommendation in the annual monitoring and operations report for review by the relevant governing authorities before implementing any changes to the program.

The Operator will be responsible for measuring leachate heads and measuring levels at the leachate pump stations in addition to maintaining the pumping records working under the supervision of the MSWMD. Results will be provided to MSWMD, the EPA and to the Inter-American Development Bank. A summary of all results shall also be maintained onsite for inspection by the EPA.

13.4 SURFACE WATER MONITORING

The surface water quality and quantity monitoring program will apply to effluent from the on-site stormwater sedimentation and control ponds, which discharge to the

adjacent north and south drainage canals. The objective of this aspect of the monitoring program is to ensure that all discharges to the local environment have been fully treated. The monitoring program will be staged according to construction of the individual stormwater sedimentation and control ponds.

The surface water monitoring network will include four monitoring points in the north and south drainage canals at points upstream and downstream of the site as indicated on Figure 13.1. Monthly flow measurements will be made at all canal surface water monitoring locations. Daily flow quantities of surface water will also be monitored at each stormwater pump station.

Surface water samples would be recovered annually analyses at all canal monitoring locations and from stormwater pump stations (PS 5 to 7). These surface water samples will be recovered and analyzed for the following list of parametres on an annual basis.

- Biochemical Oxygen Demand (BOD);
- Chemical Oxygen Demand (COD);
- PH;
- Total Ammonia Nitrogen;
- Total Dissolved Solids (TDS);
- Total Suspended Solids (TSS);
- Volatile Suspended Solids (VSS);
- Total Kjeldahl Nitrogen (TKN);
- Total Phosphorus;
- Alkalinity;
- Hardness (Ca and Mg);
- Chloride;
- Fluoride;
- Phosphate;
- Sulfate;
- Nitrite; and
- Nitrate.

During the first year of operations, surface water samples will be recovered quarterly from all canal monitoring points and from stormwater pump stations and tested for the

parameters above to develop a more complete database for the Site. Surface water samples recovered quarterly thereafter will be tested to determine the presence and concentration of the reduced list of parameters listed below.

- Biochemical Oxygen Demand (BOD);
- Chemical Oxygen Demand (COD);
- PH;
- Total Ammonia Nitrogen;
- Total Suspended Solids;
- Total Kjeldahl Nitrogen (TKN);
- Total Phosphorus; and
- Alkalinity.

A semi-annual inspection will be conducted of all ditches for evidence of excessive erosion.

The stormwater management pumps will be monitored on a regular basis by the Site operator, as part of regular maintenance activities. Any pumping system malfunctions will be recorded as well as the remedy to the operations problem. The surface water monitoring program will be reviewed periodically as the data base for the Site is further developed. Any revisions to the monitoring program will be noted as a recommendation in the annual monitoring and operations report for review by the relevant governing authorities before implementing any changes to the program.

The Operator will be responsible for measuring surface water flow volumes, for recovering surface water samples for analyses and for inspection of on site ditches, working under the supervision of the MSWMD. Surface water samples will be submitted to an independent laboratory for testing. Results of all tests will be provided to MSWMD, the EPA and to the Inter-American Development Bank. A summary of all test results shall also be maintained onsite for inspection by the EPA.

13.5 LEACHATE TREATMENT SYSTEM MONITORING

The Leachate Treatment System (LTS) monitoring program is intended to ensure the performance of the LTS equipment and processes. The leachate compliance monitoring program will include measurements of leachate flows monitored by the use of run time metres and monitoring of pumping system records from both the leachate pump

stations and the pumps for the leachate treatment facility. In addition raw leachate quality samples from the leachate pump stations, influent leachate to the LTS and treated effluent samples from the LTS will be recovered for analyses.

Raw leachate samples will be recovered from both the leachate pump stations and from the influent to the LTS. Treated leachate samples will be recovered from the effluent from the LTS. These samples will be recovered annually and analyzed for the following parameters:

- Biochemical Oxygen Demand (BOD);
- Chemical Oxygen Demand (COD);
- PH;
- Total Ammonia Nitrogen;
- Total Dissolved Solids (TDS);
- Total Suspended Solids (TSS);
- Volatile Suspended Solids (VSS);
- Total Kjeldahl Nitrogen (TKN);
- Total Phosphorus;
- Alkalinity;
- Hardness (Ca and Mg);
- Chloride;
- Fluoride;
- Phosphate;
- Sulfate;
- Nitrite; and
- Nitrate.

During the first year of operations, leachate samples will be recovered quarterly from the leachate pump stations, LTS influent and LTS effluent and tested for the parameters above to develop a more complete database for the Site. Leachate samples recovered from the leachate pump stations, LTS influent and LTS effluent quarterly thereafter will be tested to determine the presence and concentration of the reduced list of parameters listed below.

- Biochemical Oxygen Demand (BOD);
- Chemical Oxygen Demand (COD);

- PH;
- Total Ammonia Nitrogen;
- Total Suspended Solids;
- Total Kjeldahl Nitrogen (TKN);
- Total Phosphorus; and
- Alkalinity.

The leachate treatment monitoring program will be reviewed periodically as the database for the site is developed. Any revisions to the monitoring program will be noted as a recommendation in the annual monitoring and operations report for review by the relevant governing authorities before implementing any changes to the program.

There will be much more extensive field monitoring of leachate quality by the operator to regulate and control the treatment processes and the operation of the leachate treatment facility. This extensive field monitoring program will be included as part of the operations and maintenance manual which is to be developed for the leachate treatment facility following its commissioning.

The Operator will be responsible for recording influent and effluent flow volumes and for recovering leachate and effluent samples working under the supervision of the MSWMD. Samples will be submitted to an independent laboratory for testing. Results of all tests will be provided to MSWMD, the EPA and to the Inter-American Development Bank. A summary of all test results shall also be maintained onsite for inspection by the EPA.

13.6 LANDFILL GAS MONITORING

The only area where the monitoring of landfill gas (LFG) migration through the soils is warranted is in the built up area of the administration building and other service facilities. The landfill gas monitoring program will include the installation and maintenance of two on-Site LFG probes in the vicinity of the administration buildings and leachate treatment facility as shown on Figure 13.1 and quarterly monitoring of the major constituents of LFG. A portable field measurement instrument will be used to provide all of the required data that will also be useful in monitoring gas levels in the various leachate pumping stations and other in-ground installations. Landfill gas will be monitored for the following:

- Methane;
- Carbon Dioxide;
- Oxygen;
- Temperature; and
- Pressure.

Measurements and sampling will be performed by the Operator and shall be overseen by MSWMD. A record shall be maintained onsite of all LFG concentration measurements.

A record will be maintained of the incidences and relative frequency of any odour complaints. The Operator will record the following data for each odour complaint received at the site:

- Description, time, and date of the incident;
- Current status of all Site operations that may have triggered the event;
- Wind direction at the time of the incident; and
- Description of the measures taken to address the cause of the incident and to prevent a similar occurrence in the future.

This proposed LFG monitoring program will be reviewed periodically as the data base for the site is developed. Any suggested revisions to the monitoring program will be noted as a recommendation in the annual monitoring and operations report for review by the relevant governing authorities before implementing any changes to the program.

The Operator will be responsible for monitoring LFG working under the supervision of the MSWMD. Results of all measurements will be provided to MSWMD, the EPA and to the Inter-American Development Bank. A summary of all test results shall also be maintained onsite for inspection by the EPA.

13.7 LEACHATE POND MONITORING

Water levels observations in the leachate pond will be recorded daily and will be noted in the daily inspection report. After site closure, two of the ponds will be modified to remove the pumped controls. The pond which receives the leachate effluent after site closure will be subject to a period of extended monitoring. It will initially be monitored

for a period of 5 year and subsequent monitoring will be based on a review of the results. This exercise will incur no cost during the operation phase of the project.

13.8 INSPECTION AND RECORD KEEPING

Regular Site inspections will be conducted by Site personnel to verify that nuisance factors associated with housekeeping procedures such as dust, litter, and odour, are under control, to prevent routine operation nuisances from developing into more serious environmental problems. These inspections will be conducted on a monthly basis. Site personnel will maintain a checklist of housekeeping items that are implemented on a regular basis. Records of observations made during the Site inspections and all regular housekeeping activities carried out will also be maintained. In addition, the scale attendant will ensure that all material entering the Site is recorded as to the type, source, and quantity/weight of each load.

13.9 MONITORING OF COOPERATIVE OPERATIONS

The operations of the cooperative shall be monitored to ensure its effective functioning and to ensure that the recyclers resettled at the Haags Bosch site work to attain the project objectives. The implementation schedule of Table 59 shall be monitored to ensure adherence to the schedule for resettlement of recyclers. Initial monitoring of the activities of the cooperative shall be undertaken by the MLHS&SS cooperative department. Meetings shall be kept in accordance with by-laws and minutes of these meetings shall serve as verifiable indicators of conformance. The Consulting Firm will monitor all meetings of the cooperative up to June 2005. The Institutional Strengthening and Capacity Building Consultant shall assume this responsibility after this date.

Since recycling has never taken place in an organized manner it is likely that there will be some conflict at the beginning of operations. A record will be maintained of all conflicts and their resolution. The cooperative shall also monitor and maintain records of thefts and bullying and sanctions to trouble makers at the site.

The cooperative shall monitor the recycling operations and maintain comprehensive records of items recovered for sale and by which member. This information shall be recorded on a daily basis and shall include:

- Type of materials recovered and by whom;
- Quantity recovered of each type of materials;

- Daily selling price of various materials; and
- Payments to members.

13.10 ENVIRONMENTAL COMPETENCE AND PLANNING

The Operator will undertake all aspects of the monitoring plan under the supervision of the MSWMD project implementation team. The Operator will develop a plan for implementation of the monitoring program detailed above. Resources required for each aspect of the monitoring plan will be sourced prior to the commencement of operations at the site. In several instances, national standards for water quality have not been yet been promulgated and the EPA has accepted the application of WHO and USEPA standards to this project for aerial emissions and water quality respectively. The Operator will liaise with the EPA to determine the effective date of national standards which are promulgated for aerial emissions and water quality. The monitoring program will be modified to ensure compliance with newly promulgated national standards only in those instances where the new standards are more stringent than those initially adopted for the project.

13.11 REPORTING

An operations report for the Site will be prepared on an annual basis to ensure compliance with all Site operations and maintenance procedures. The following would be covered by the annual report:

- results and interpretive analysis of all leachate, groundwater, surface water, and LFG monitoring programs, particularly:
 - assessment of leachate/groundwater elevation data with respect to trigger elevations;
 - assessment of the need to amend the monitoring program;
 - assessment of the operation and performance of all engineered facilities, the need to amend the design or operation of the Site, and the adequacy of and need to implement the contingency plans;
 - site plans showing the existing contours of the Site, areas of landfilling operations during the reporting period, areas of intended operation during the next reporting period, areas of excavations during the reporting period, the progress of final cover and intermediate cover application, previously existing Site facilities, facilities installed during the reporting period, and Site

preparations and facilities planned for installation during the next reporting period;

- calculations of volume of waste, daily and intermediate cover, and final cover deposited or placed at the Site during the reporting period and a calculation of the total volume of Site capacity used during the reporting period;
- calculation of the remaining capacity of the Site and an estimate of the remaining Site life;
- Summary of the quantity of any leachate removed, and/or treated and discharged from the Site during each operating week;
- summary of the weekly, maximum daily and total annual tonnage of waste received at the Site;
- summary of any public complaints received by the owner and the responses made; and
- discussion of any operational problems encountered at the Site and corrective actions taken.

14.0 PUBLIC PARTICIPATION

Public participation has been effected throughout the Haags Bosch EIA process to date in general conformance with GOG and IDB requirements. Opportunities for further public participation are in place as part of the follow-up programme. This process included both affected and interested parties. Participation techniques included assemblies, surveys, interviews, meetings consultation forums, and information dissemination techniques such as pamphlet, panels, leaflets and media communications. Specific action and activities are described below and the concerns of stakeholders and responses of consultants are summarized in matrix form in the attached table at the end of this section. The complete transcript of public session is appended.

The objectives for the public participation program are to:

- Ensure all interested parties are informed of all relevant project information;
- Ensure public awareness and understanding of the studies allowing for meaningful input from affected parties and the community at large;
- Develop a positive community relationship so that concerns raised are aired and addressed through the study process; and
- Ensure that current and historical experience with landfilling is used to enhance design and operations of the new facility, including mitigation plans.

Primary stakeholders for this project include groups and individuals directly affected by the project. Primary stakeholders include individuals likely to be directly affected due to their proximity to the proposed site. Secondary stakeholders are the public and/or private sector organizations who may have a role and responsibility in the implementation and/or monitoring of the project. In addition to residents in close proximity to the site, other primary stakeholders include MoLGRD and GM and those NDCs which would be disposing of waste at the facility. Primary stakeholders include the waste pickers working at the Mandela Site.

Secondary stakeholders are regulatory bodies consisting of the Environmental Protection Agency (EPA) and the Ministry of Health (MoH) and households and commercial and industrial generators in both GM and NDCs who would be impacted by possible fees for waste management imposed by GM and NDCs.

Consultations were held with all primary stakeholders. Consultations with residents of communities in proximity to the facility were facilitated by two meetings hosted by the Environmental Assessment Board (EAB) on January 19 and February 08, 2004. A

description of the project and its expected impacts were outlined at the meeting of January 19. Residents were subsequently invited to identify issues and concerns for inclusion into the impact assessment and management measures for the facility. As a group, residents of the area expressed vehement opposition to the siting of the facility at the initially proposed location.

Primary reasons cited were the close proximity of the western end of the proposed facility to a new housing development, the presence of unwanted and questionable characters at the facility, open fires at the site and decreases in property values. Additional concerns included the management of hazardous waste at the site, the impact of operations at the site on the cricket stadium proposed to be sited at Nandy Park, the location of the access road to service the facility and the impact of the facility on groundwater since a well located in Eccles provides water to 40 % of the residents of the East Bank of Demerara.

Additional consultations were conducted with residents of the communities in proximity to and downwind of the proposed facility. Questionnaires were administered to residents of these communities during this exercise. A simple random sample generator was used to identify homes in each community for administration of the questionnaire. This method was modified in Republic and Nandy Parks to homes willing to participate in the survey since response was generally poor.

Findings inferred from administration of the questionnaires did not differ significantly from the views expressed at public meetings. Perception of the project is fueled by knowledge of operations at the Mandela Site. There was total resistance to the facility being sited at its initial location with the primary concerns being loss of peace and tranquility generally associated with the area and lowered property values.

As a result of the opposition expressed to the landfill being sited at Eccles, Project Stakeholders met on several occasions to factor the opposition of residents into a determination of the most appropriate location for the facility. Stakeholders represented at these meetings included GuySuCo, MoLGRD, MoF, IDB, MSWMD and Georgetown City Council. The GOG plans for roadways to link Cheddi Jagan International Airport with Mandela Avenue and the East Coast Highway to this newly proposed road and with the existing Demerara Harbor Bridge would result in the former roadway passing through the 120 ha area proposed for the landfill.

Stakeholders had previously undertaken to move the landfill to the extreme eastern area of the 120 ha. The proposed road would however have passed through this area. A decision was consequently taken on June 9, 2004 to move the entire landfill site

approximately 2.0 km east of the Eccles New Housing Scheme. This new location at Haags Bosch provides a 12 ha buffer zone between the landfill and the road proposed to link Mandela Avenue with Cheddi Jagan International Airport.

The decision to relocate the site to Haags Bosch led to questions being raised about development on the western side of the landfill at its new location. This has resulted in the Government of Guyana decision to zone that area immediately west of the landfill and east of the proposed road for commercial/industrial activities only. However, the commercial/industrial enterprises located in this area will be buffered from the landfill by the water management and operational facilities and by the vegetated zone on the western side of the landfill. Implementation of an energy generation project at the landfill may be used as an incentive for commercial/industrial enterprises to operate in the area. Questions about the operations impact on the commercial/industrial facilities were responded to by noting that there are provisions to modify the mitigation plan based on long term monitoring of the site.

During public consultations concerns were also expressed about the long-term financial viability of the project after IDB funds are no longer available. The MoLGRD gave an undertaking that short falls in charges for environmentally sound operation and management of the landfill will be made up by allocations from the GOG. In addition, the penalty structure of both Chapters 28.01 and 28.02 will be modified to produce significant increases in fines for littering. These fines will also be retained by GM and NDCs to pay for management of solid waste.

The MoLGRD retained a public relations firm to undertake a program of public education related to the environmentally sound management of landfill sites. The firm has conducted a detailed community attitude survey of residents of communities in the environs of the proposed site. The survey has indicated that a large percentage of the residents concerns were based on their knowledge of open dump operations in Guyana and on the lack of institutional capacity to effectively implement an environmentally sound landfill operation. The relocation of the site to facilitate the opposition of residents has also been greeted with a positive response by a significant percent of the residents.

The EPA was consulted to determine the regulatory framework for performing the EIA and to determine environmental standards for design, construction, operation and closure of the facility. Additional consultations were conducted with representatives of the Ministry of Local Government and Regional Development, Georgetown and Neighborhood Democratic Councils. Representatives of Georgetown consulted included the Director of the MSWMD; Mr. Rufus Lewis and The Deputy Mayor, Mr. Robert Williams. Several meetings were held with the Permanent Secretary, MoLGRD.

Meetings were also held with representative(s) of each NDC identified to be served by the facility. NDCs were most often represented by their Chairman and Overseer. In a few minor instances either of these two individuals was present at the meeting. Additional issues related to siting, construction and operation of the facility raised at meetings and consultations undertaken by ERM were also noted. A summary of the minutes of all consultations is presented as Appendix I to this report.

Two pilot projects are currently in progress and are being undertaken by the Mon Repos and BV/Triumph NDCs. The intention of the pilot projects is to determine the waste generation rate in these NDCs and to establish a transfer station to service both NDCs to facilitate final disposal at the Mandela Site. The MSWMD Director confirmed that approximately sixty million Guyana dollars are generated by the waste pickers operations. The Director of MSWMD indicated that the maximum number of waste pickers that can function effectively at the Haags Bosch Site is 24. Approximately 48 percent of the waste currently disposed at Mandela Site is organic material that can be composted. The municipality has successfully undertaken a pilot study for composting in the incinerator compound.

Discussions with the Deputy Mayor identified several reasons for the waste disposal problems in GM. The city is inundated with plastics and Styrofoam. These materials were not considered during the development of waste management practices for the city and no source separation occurs. In addition, there is pronounced importation of second hand and reconditioned goods by the commercial sector. These goods which have a relatively short life span add to the waste generated in the city. Industrial activity has also increased in the city. This increase has not been accompanied by a change in the waste management culture in the city. Squatting has added another dimension to the waste disposal problem. Squatters tend to concentrate on the embankments adjacent to the city drainage facilities. Waste is thrown into the canals in squatting areas. Efforts to clear the drainage ditches are impeded by both the squatters and by the presence of waste.

One aspect of the project is the improved and more regular collection of waste in the city. This will entail additional costs. MCC has some concerns about its ability to pay the waste collectors and operator in a timely manner since property tax payments are not made in a timely manner. One of the largest delinquent payers is GOG. GM has sought to have this addressed in an MOU between the parties. Hazardous waste is not proposed to be dealt with under the program. GM is not satisfied with options for the disposal of waste from fuel stations, GPL and sludge from the water treatment plant in the city. The plan for Haags Bosch proposes to reject unacceptable waste. This may lead

to illegal dumping in the city since there are no alternate facilities for disposal of unacceptable wastes.

There have been several reports in the press concerning health problems related to operations at Mandela Site. However, the Mandela Site can be extended if alternate disposal options such as cremation are utilized for the disposal of corpses. Litter pickers are an asset to GM since they provide additional facility life and associated costs savings. GM would like to see a continuation of waste picking activities. GM regards the pickers as employees of independent contractors. While waste picking is beneficial to the city a large percentage of the pickers are drug addicts who are only paid minimal sums by the independent contractors. GM would like to see an expanded role for composting efforts. This was tried and proven by GM and the compost was used as fertilizers for the GM gardens.

The Permanent Secretary, MoLGRD indicated that a decision on the site for the proposed facility at Eccles will be made on May 14, 2004. The delay in determining the exact location of the site has modified the completion dates for the design and EIA. The executing agency and MoLGRD are working to resolve the new project schedule.

The Regional Democratic Council of Region 4 is composed of GM and 15 NDCs. All NDCs implement delegated responsibilities from the Minister of Local Government in relation to their governance. GM is, however, directly answerable to the Minister. The NDCs are answerable to the Region for any expenditure greater than \$ G 180,000.00, for the passage of their budgets which covers all waste management costs, for the expenditure of subventions provided by the Ministry to each NDC and for the employment of certain categories of staff. Of the fifteen NDCs in Region 4, thirteen from Haslington on the East Coast Demerara to Soesdyke on the East Bank Demerara have signaled their intent to use the Haags Bosch facility. Two NDCs in Regions 3 on the West Bank Demerara have also signaled their intent to use the proposed facility. Consultations are in progress between the EA, MoLGRD and ERM to establish the modalities for NDCs access to the facility.

NDCs will be permitted to charge for waste management based on approval from MoLGRD. The possibility exists that GOG will guarantee significant financial contributions to ensure the effective operation of the Haags Bosch Sanitary Landfill and to cover payments to the operator.

Consultations with NDCs indicated several common concerns and issues. The only revenue sources for NDCs are property taxes and a subvention of \$3,000,000.00 per year from GOG. Property tax (PT) collection rates are generally low and range from

approximately 35 % to 70%. There is no common basis for property valuations in NDCs and some valuations date back to 1974. Consequently PT rates are very low and are not reflective of the level of services that must be provided to communities in each NDC. Several properties have been upgraded but the rates do not reflect the upgraded values and houses built on empty lots. Revaluation is sorely needed since the rates are as low as G \$80/year with the maximum not exceeding G \$5000/year.

Approximately 40 % of the NDCs included on the program do not provide any waste collection services to its residents. In the remaining NDCs waste is collected with a tractor and trailer, the sole exception being the Plaisance/Industry NDC which collects waste using a horse drawn cart. The NDCs which collect waste all dispose of that waste at open dumps within their boundaries. The sole exception is Eccles/Ramsburg which has a contracted waste hauler deliver its waste to the Mandela Site. Waste collection rates range from 2.5 to 4 tonnes/day. These rates are lowered by significant burning and burial of waste in NDCs. Some NDCs monitor the waste disposal site and excavates pits into which waste is placed. A soil cover is applied at periodic intervals to these pits.

Use of the Haags Bosch Sanitary Landfill must be accompanied by a mechanism for cost recovery. Some NDCs have initiated efforts to charge a waste management fee but have faced opposition from residents. This cost recovery mechanism must precede any improvement in waste management. It is felt that a public awareness program should be implemented in the NDCs to sensitize people both to waste disposal and to the plan for waste management.

NDCs are agreeable to cooperating for siting of transfer stations. Waste pickers would be welcomed at the transfer station provided it is effectively managed. However, waste pickers should be licensed and should pay a fee to the NDC.

Illegal dumping occurs in each NDC in spite of collection services. Most illegal dumping is by commercial establishments in the NDC. Drainage problems occur due to disposal of waste and plastics in drainage canals. The canals must be cleared every month to ensure effective drainage. Illegal dumping in the NDC can be curtailed by fines. The present fines do not reflect the true cost of enforcement. Legislation should be updated to increase fines and to have the fines paid to the NDC. These monies should be dedicated to waste management. The legislation should permit the hiring of Rural Constables (RC) to enforce law. These RC should be hired and fired by the NDC. The Legislation should also provide more autonomy to the NDC in waste management matters.

Some of the key issues/concerns articulated during the public participation process by stakeholder and the corresponding consultant's responses are summarized in the following table. Complete interaction transcripts are appended.

Summary of Key Public Concerns and Consultant's Responses – Public Participation Process

<i>Concerns</i>	<i>Consultant's Response</i>
Proximity to housing	Technically Landfill can be designated to mitigate potential impact. Examples of Keele Valley in Toronto and other similar landfill proximity condition in developing countries cited. Other points of note: Buffers and screens included Increase separation of about 2m by proposed site relocation further East.
Unwanted/questionable characters	The landfill site would be fenced and security installed. Waste pickers would be licensed and controlled.
Open fires at Landfill	A strict program of fire prevention and elimination would be included in the design and operation protocols. Procedures would include prohibition of open fires, designated smoking areas, procedures to contain and eliminate any fires etc.
Decrease in property values	The landfill would be operated in an environmentally sound manner. Buffers and screens would be in place. The final relocation further to the East would be favourable.
Loss of Peace and Tranquility	Sound operation and management should not significantly impact this item. The plans and commitment are in place for such management.
Management of Hazardous Waste	At this time the management of hazardous waste is not proposed for the Haags Bosch site. A plan to study the requirement for hazardous waste control is being developed. All attendant hearings and related EIA requires to be executed as part of the overall waste management strategy for Guyana.
Impact on the Cricket Stadium	No significant impact is indicated for a well designed and operated landfill facility as planned and sited. Example of sport stadium in St. Lucia, where the landfill successfully operates with 100m of stadium was presented. St. Vincent also presented as example.
Location of Access	Access through the East-West road at Eccles from the existing East bank road will not significantly affect traffic. Flow plans are to use the Southern by-pass as access as soon as it is constructed.

<i>Concerns</i>	<i>Consultant's Response</i>
Impact on Groundwater	Wells in the area are screened in aquifers more than 150m below grade. The landfill proposed has been modeled for all potential operating conditions and no significant impact determined given the favourable geologic/hydrogeologic setting and landfill design approach. Monitoring plans within contingencies are in place. Action plans with a regulatory framework are part of overall strategy.
Long term financial viability when no IDB funds available	Funds from the IDB loans are earmarked for the upgrading of institutional capacity to service environmentally sound and sustainable landfill activities.

15.0 RECOMMENDATIONS

In order to minimize uncertainty and community concerns resulting from the lack of information it is very important to keep the public informed regarding landfill operations, the effectiveness of impact mitigation measures and other waste management planning matters. Continuation of the community participation program through the life of the landfill is recommended. This can be affected through public information offices, special meetings to address issues of public concerns and planning matters. It is recommended that a waste management newsletter be created and distributed at least twice a year.

15.1 SUMMARY OF KEY RECOMMENDATIONS

There is a need to change the current system of waste disposal in Georgetown and Environs to protect the environment, the people and animals that live there. A sanitary landfill site at Haags Bosch presents an environmentally sound, sustainable and cost effective component of an integrated waste management plan for Georgetown. The following summarizes some key recommendations arising from the EIA process related to this project.

- Proceed with the Haags Bosch State-of-the-Art landfill. A site operations Manual is appended and conveys all key activities including Health and Safety Issues;
- Consider combining disposal construction and operation to create a more viable project for potential international bidders with appropriate experience and expertise;
- Minimum guarantees ("put or pay" options) may be required to cover fixed basic costs for private operators;
- BOT approach would optimize economic outlays and provide optimum sequencing and reduced potential impacts;
- Funds should be guaranteed or escrowed to permit safe and effective closure operations at key life cycle points;
- Strict adherence to EMP and related QA/QC issues is required;
- Continuation of the community participation program is recommended throughout the life of the landfill. This should include public liaison committee, public information office, meetings and publications. A semi-annual newsletter covering waste management issues is recommended. The public complaint mechanism must be maintained. Community awareness of waste management issues strengthened;
- Training and institutional strengthening is of paramount importance;

- Other key elements of an integrated waste management approach should be actively pursued; and
- It is recommended that the Government of Guyana formally commit to the support of any necessary financial guarantees and legislation to ensure project viability and environmental compliance over the full life cycle including post closure periods.

Summary of Impact Assessment on Valued Ecosystem Components

<i>Area of Study</i>	<i>Design</i>	<i>Construction</i>	<i>Operation</i>	<i>Post Closure</i>
Physical Environmental Impacts	Action	Action	Action	Action
Site Conditions	No Impact	Impact	Impact	Impact
Animal Habitat and/or Population	No Impact	Impact	Impact	Impact
Plant Species and /or Vegetation	No Impact	Impact	No Impact	Impact
Surface Waterways	No Impact	Impact	EMP	Impact
Noise and Odour	No Impact	EMP	EMP	EMP
Biological Environmental Impacts				
Air Quality	No Impact	EMP	EMP	EMP
Surface Water Quality	No Impact	EMP	EMP	EMP
Groundwater Quality	No Impact	No Impact	EMP	EMP
Native Soil Quality	No Impact	EMP	EMP	EMP
Human Health	No Impact	EMP	EMP	EMP
Social and Cultural				
Opposition	Impact	EMP	EMP	EMP
Staffing	No Impact	EMP	EMP	EMP
Health and Safety	No Impact	EMP	EMP	EMP
Public Involvement and Notification	Impact	EMP	EMP	EMP
Archeological and Heritage Issues	No Impact	No Impact	No Impact	No Impact
Environmental Control Systems				
Waste Containment Cell(s)	No Impact	EMP	EMP	EMP
Leachate Collection and Treatment	No Impact	EMP	EMP	EMP
Landfill Gas Collection and Treatment	No Impact	EMP	EMP	EMP

No Impact. The action has no negative environmental impact. Where the action had no impact and/or associated risk no mitigation and/or contingency measures are developed.

Impact. The action has an environmental impact but no associated risk. The environment is permanently changed as a result the action. Through the lifespan of the Site environmental conditions will be monitored and corrected in response to potential negative impacts.

EMP - Environmental Management Plan. There is a potential for the action to negatively impact the environment and there is an associated risk. The EMP has been prepared to mitigate environmental impact and risk throughout the operating lifespan of the Site. If an environmental impact occurs as a result of the action, even though mitigation measures have been developed and followed a contingency plan is prepared and executed to prevent damage to adjacent environment and residents.

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Appendix F

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Appendix G

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Appendix H

To Be Provided

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Consultation Minutes

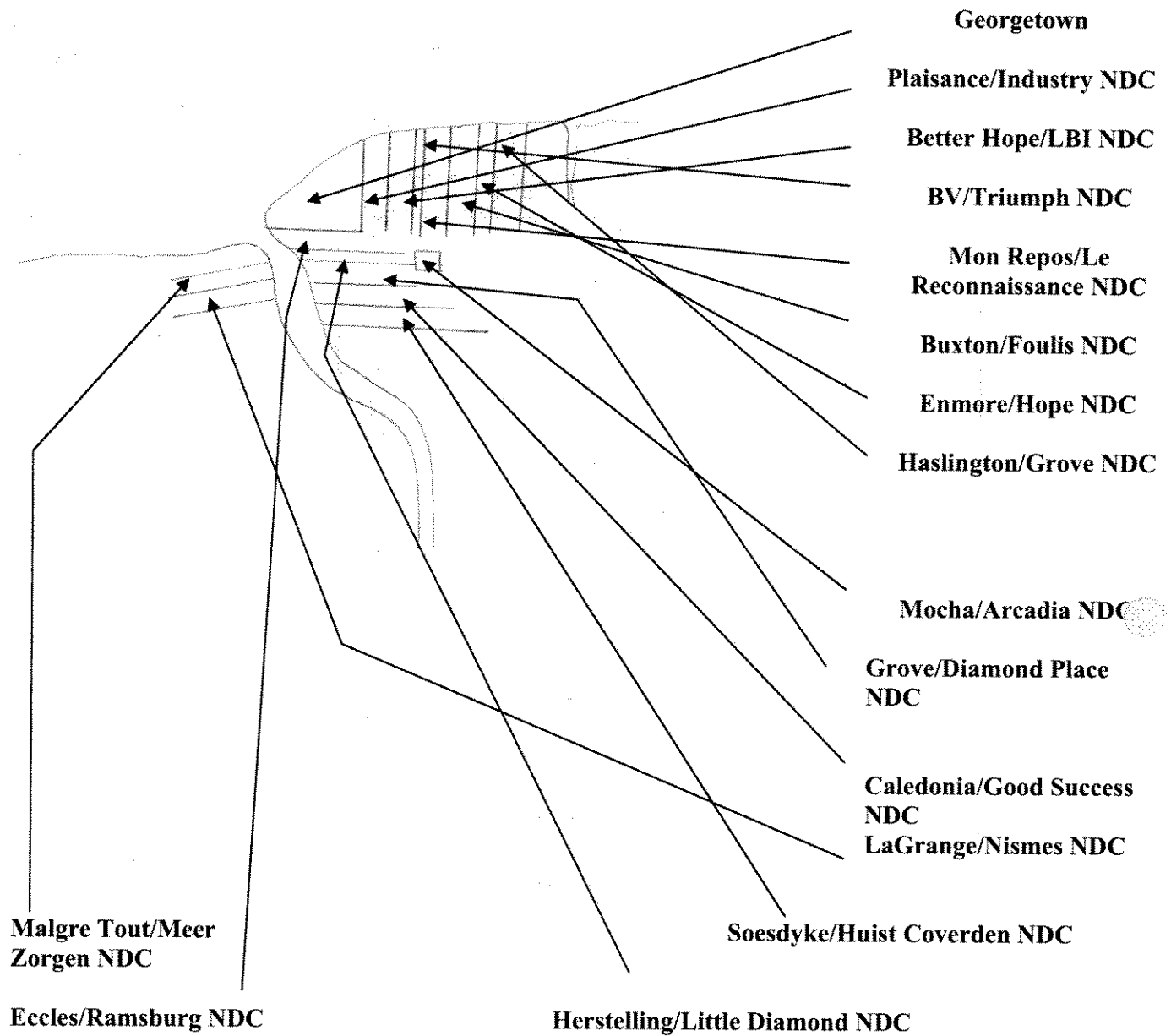
Appendix J

Site Operations Manual

APPENDIX A

TABLES, FIGURES, AND DRAWING SET

Figure 1: Location of NDCs and Georgetown



**REPUBLIC
PARK**

**Proposed
Cricket Stadium**

NANDY PARK

DEMERARA RIVER

**ECCLES NEW HOUSING
SCHEME**

AGRICOLA

**ECCLES INDUSTRIAL
ESTATE**

ECCLES LANDFILL SITE



Figure 2: Proximity of Sanitary Landfill Surrounding Communities

Figure 3: Location of Wards of GM Relative Mandela Site

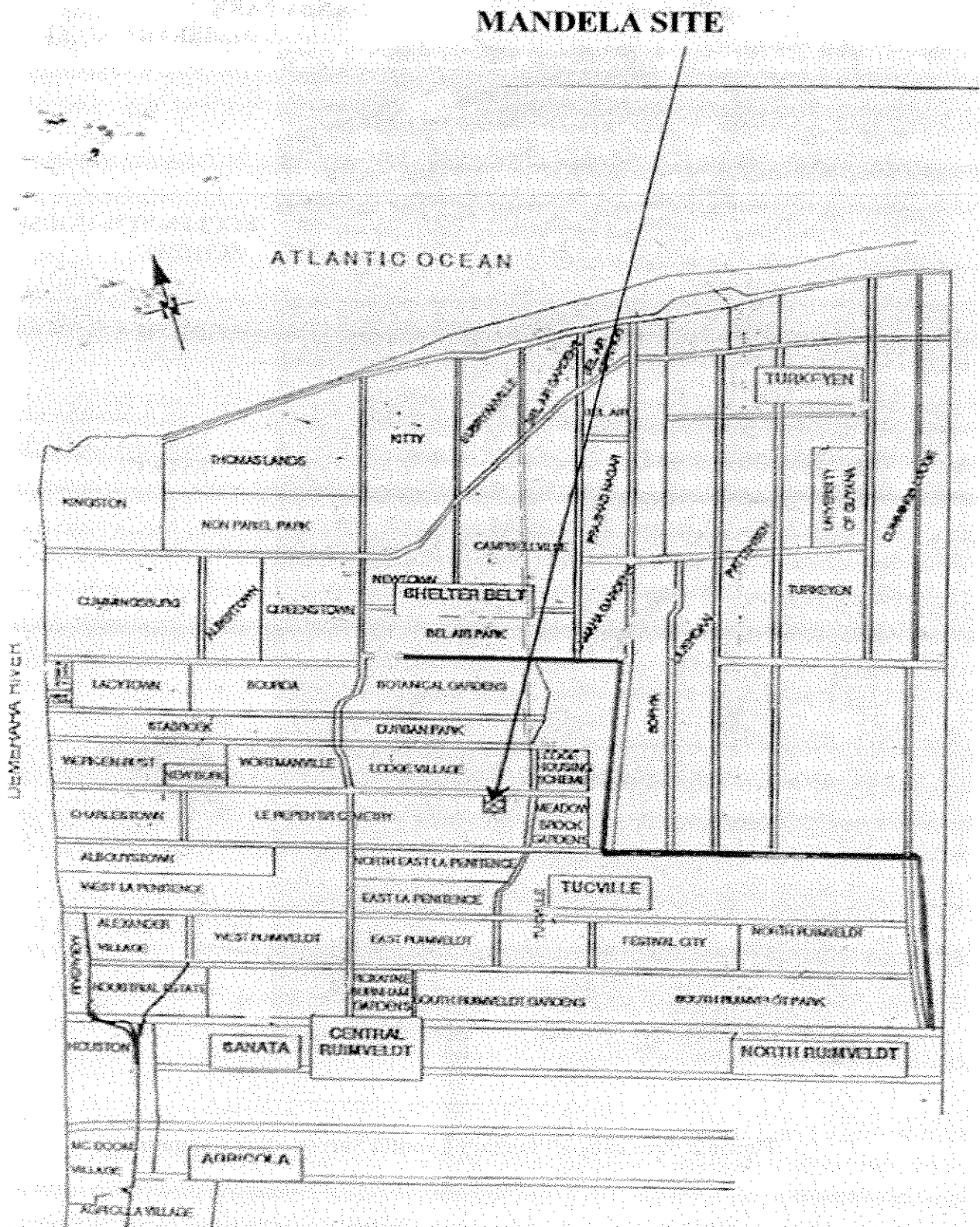
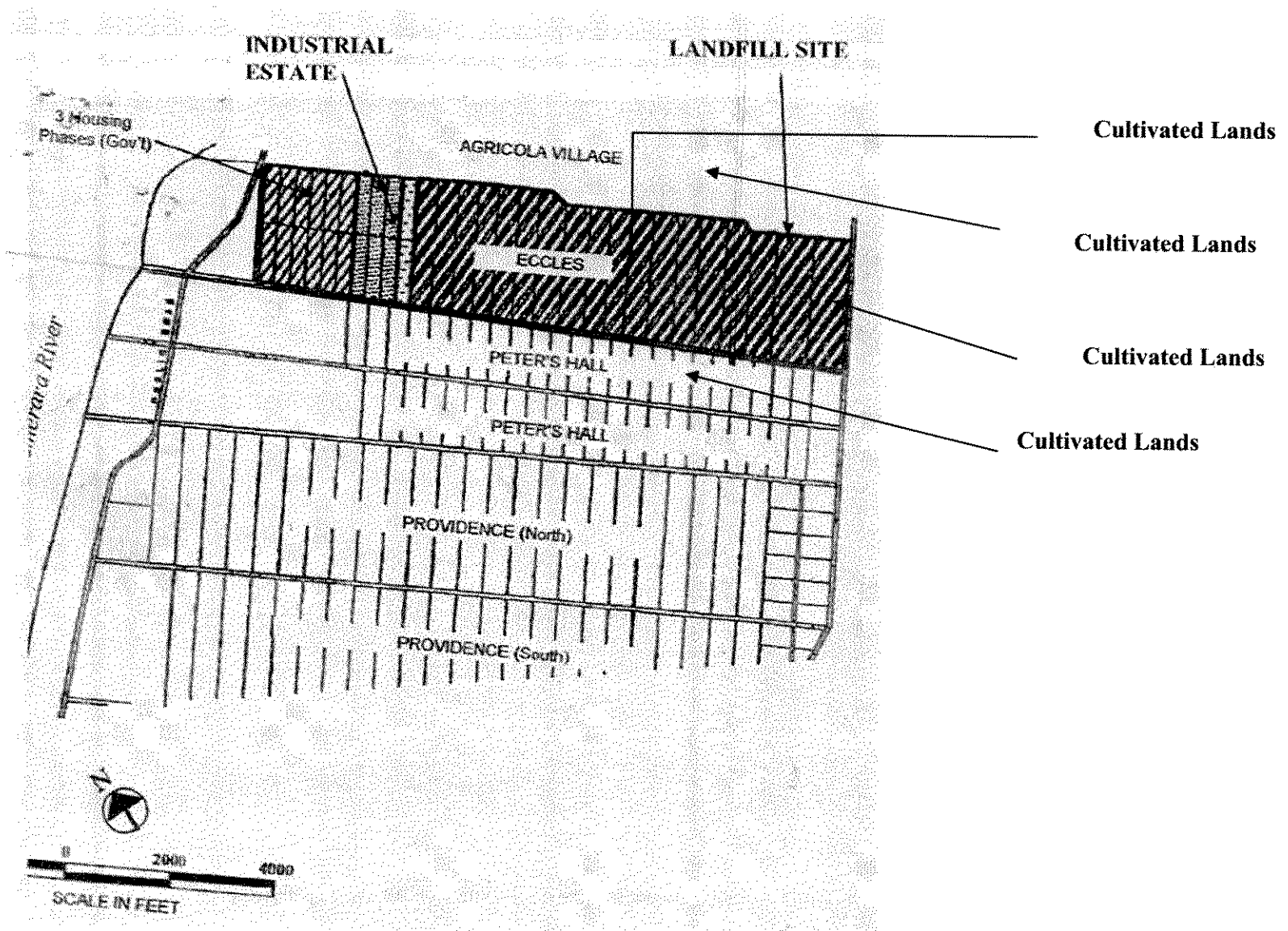
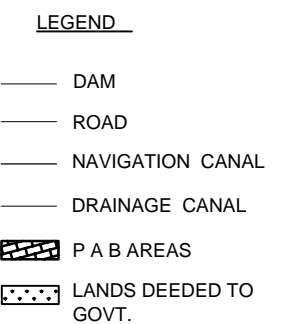


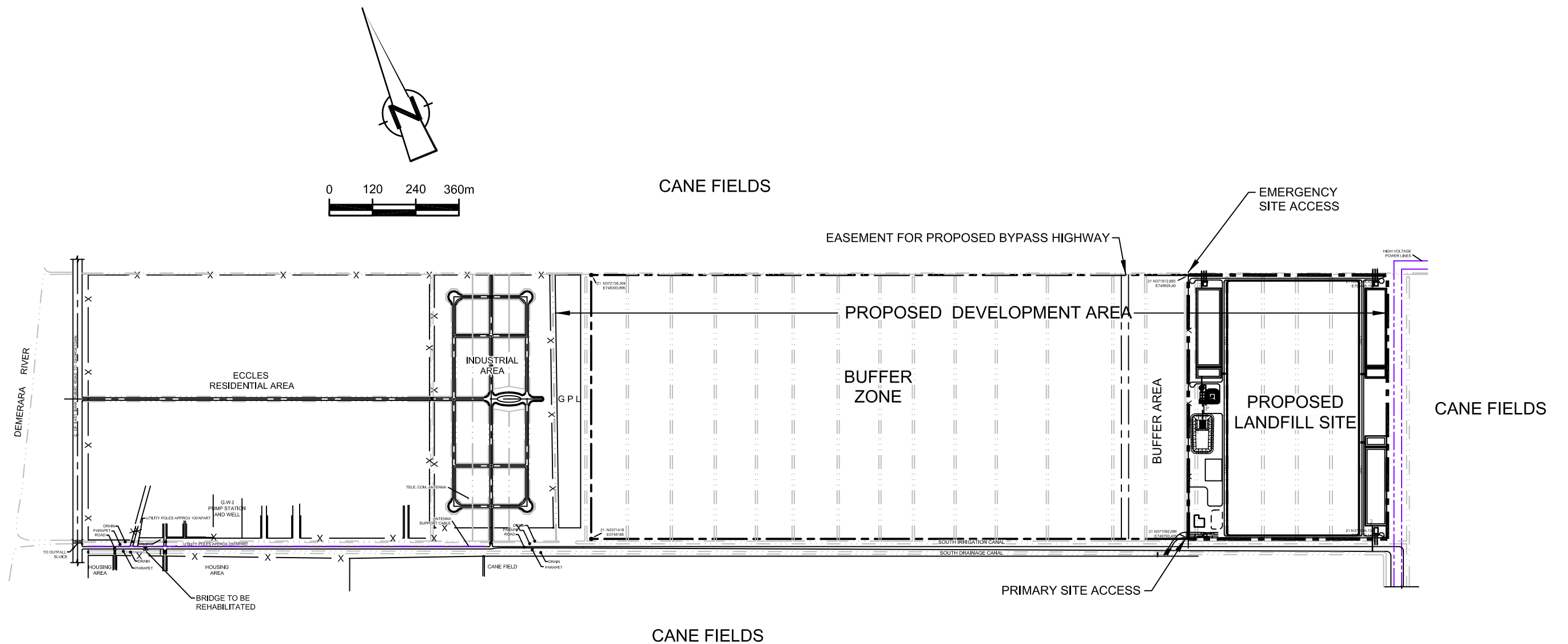
Figure 5: Location of Well at Eccles Relative to Sanitary Landfill Site





REGIONAL SITE LOCATION
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAGS BOSCH, GUYANA
Ministry of Local Government and Regional Development





LEGEND	
---	PROPERTY BOUNDARY
---	SITE BOUNDARY
---	CANAL
X	FENCE
■	BRIDGE
GPL	GUYANA POWER AND LIGHT
GWI	GUYANA WATER INC.

SOURCE:
SITE PLAN FROM TROW ASSOCIATES INC.
JUNE 2004

NOTES:
1) ALL MEASUREMENTS IN METRES
UNLESS OTHERWISE INDICATED
2) NORTH AND SOUTH DRAINAGE
CANALS DRAIN WEST TO THE
DEMERARA RIVER.

figure 1.2
SITE LOCATION PLAN
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH, GUYANA
Ministry of Local Government and Regional Development



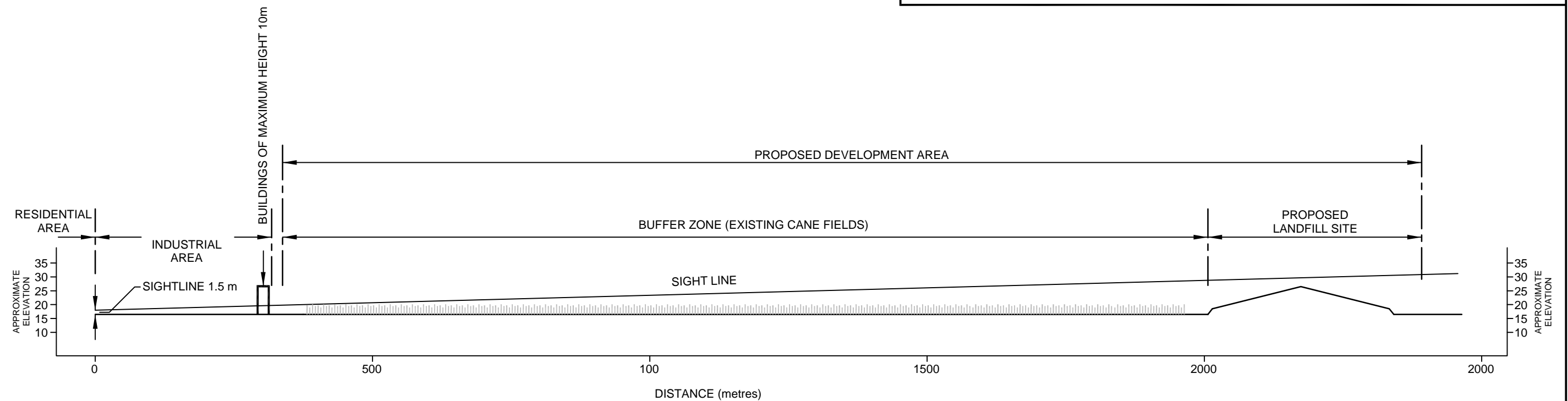
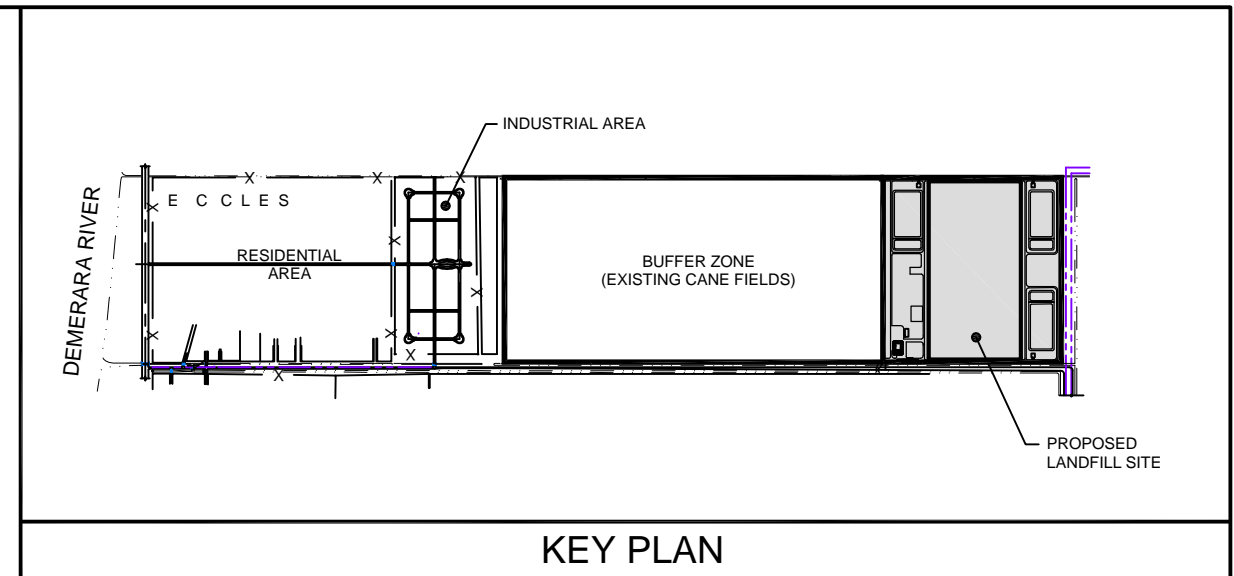
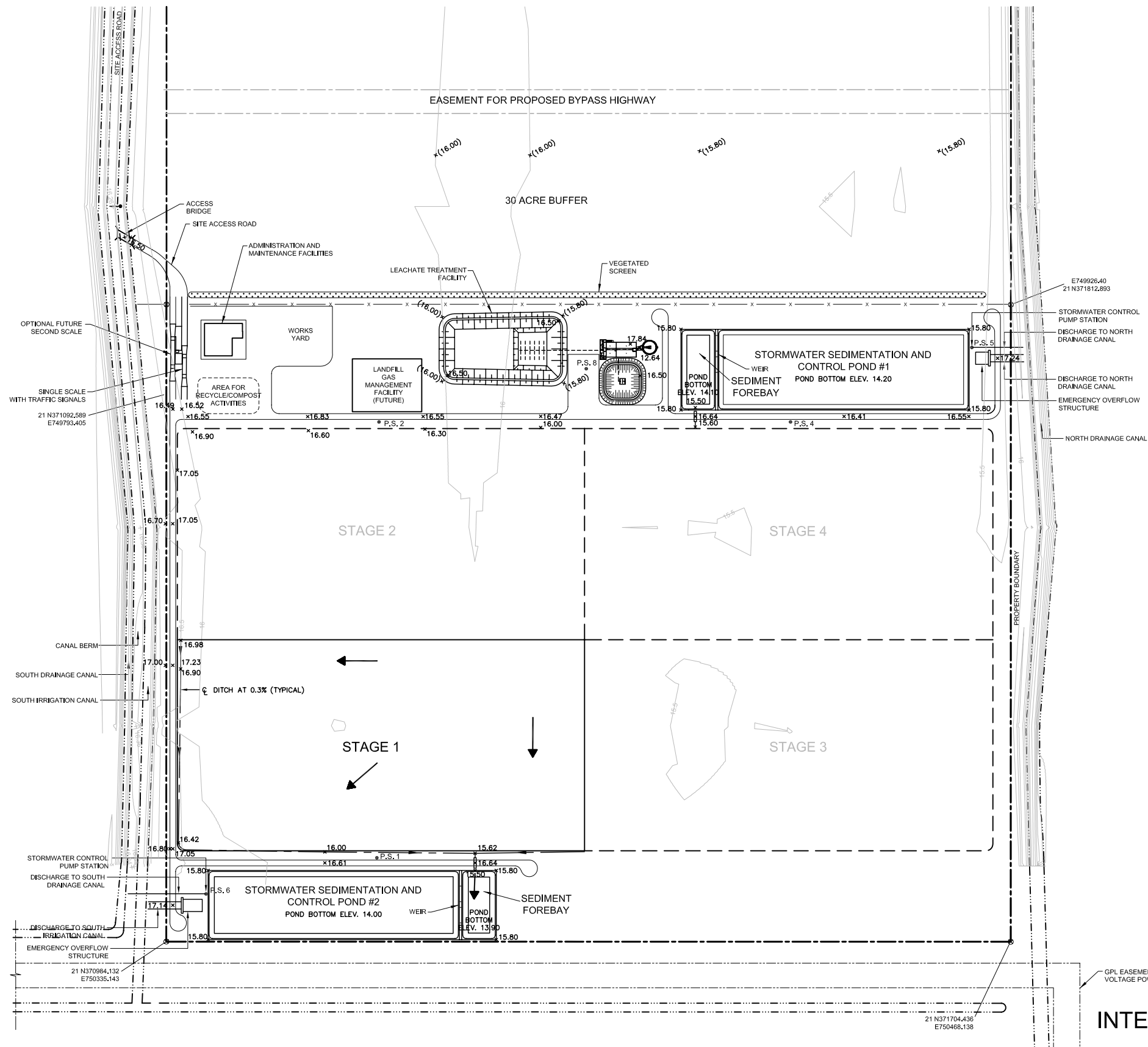
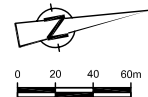


figure 4.1
 VISUAL SITE LINE
 DESIGN AND OPERATIONS REPORT
 NEW SANITARY LANDFILL IN HAAGS BOSCH, GUYANA
Ministry of Local Government and Regional Development





LEGEND

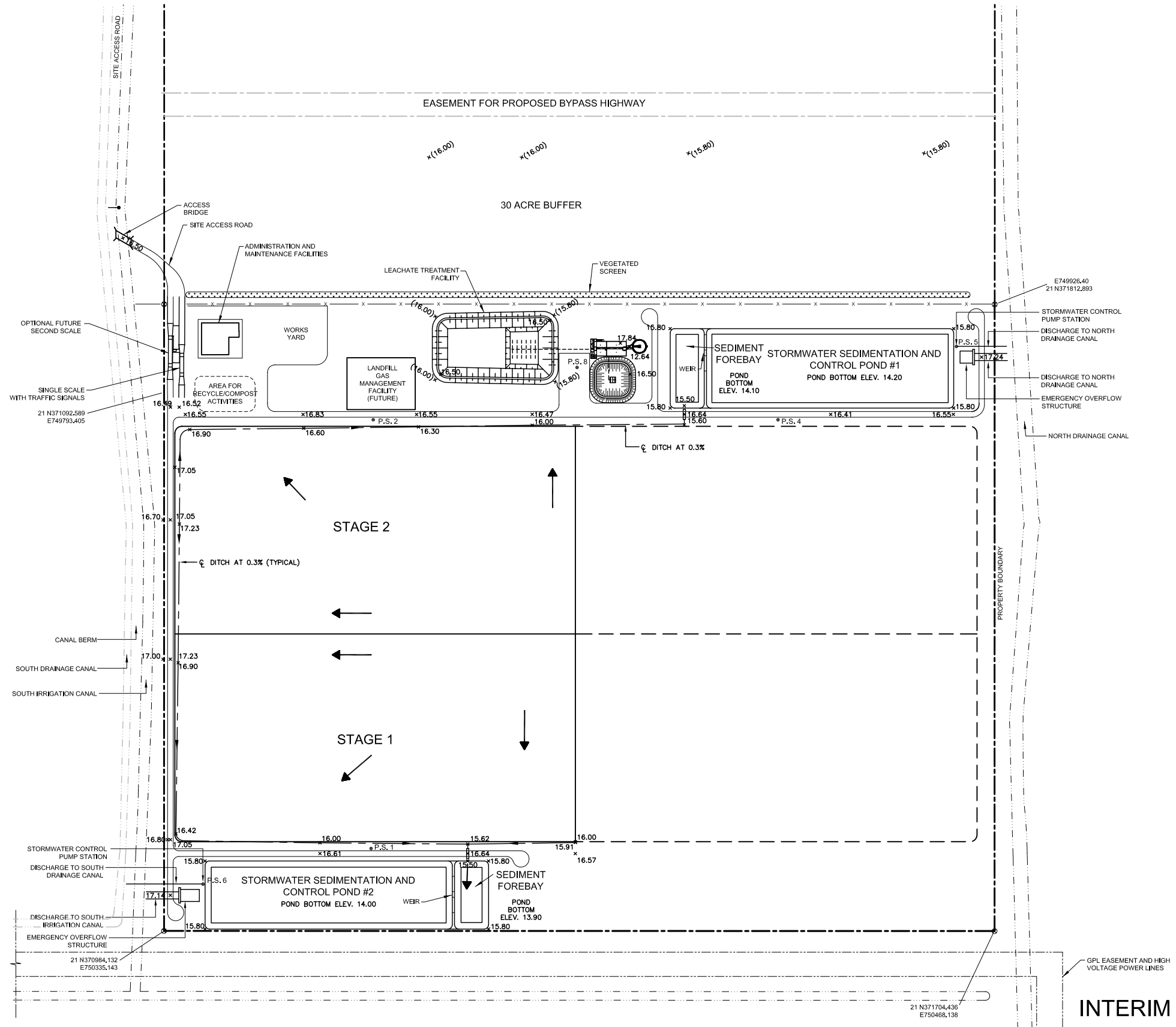
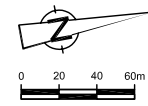
- OVERLAND FLOW
- *(15.80) EXISTING GRADE TO REMAIN
- x 16.60 PROPOSED GRADE

figure 6.1

INTERIM SITE DRAINAGE PATTERN STAGE 1

NEW SANITARY LANDFILL IN HAAGS BOSCH, GUYANA
Ministry of Local Government and Regional Development

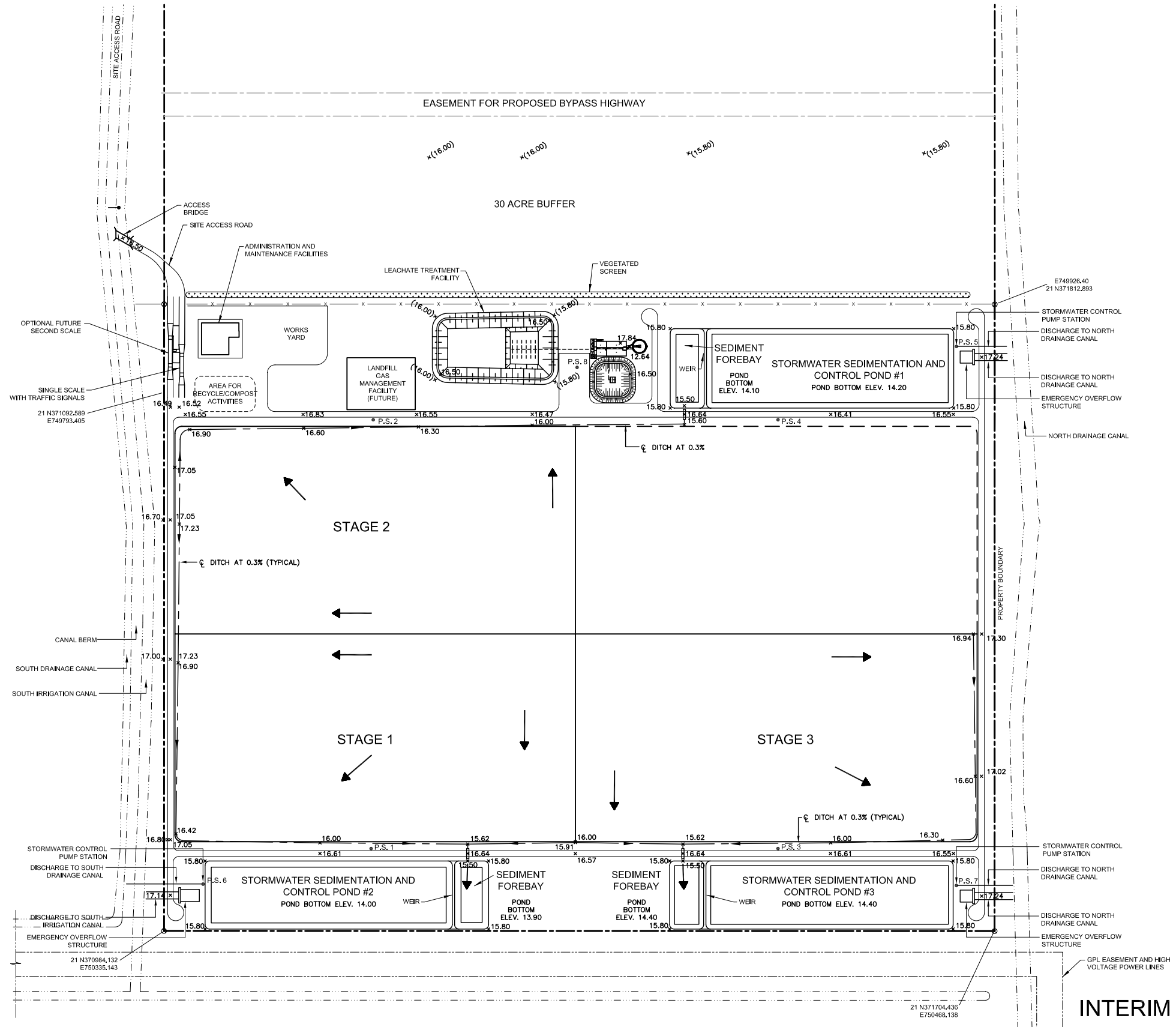
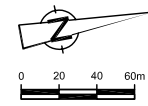




- LEGEND**
- OVERLAND FLOW
 - x(15.80) EXISTING GRADE TO REMAIN
 - x 16.60 PROPOSED GRADE

figure 6.2
**INTERIM SITE DRAINAGE PATTERN
STAGE 2**
NEW SANITARY LANDFILL IN HAAGS BOSCH, GUYANA
Ministry of Local Government and Regional Development





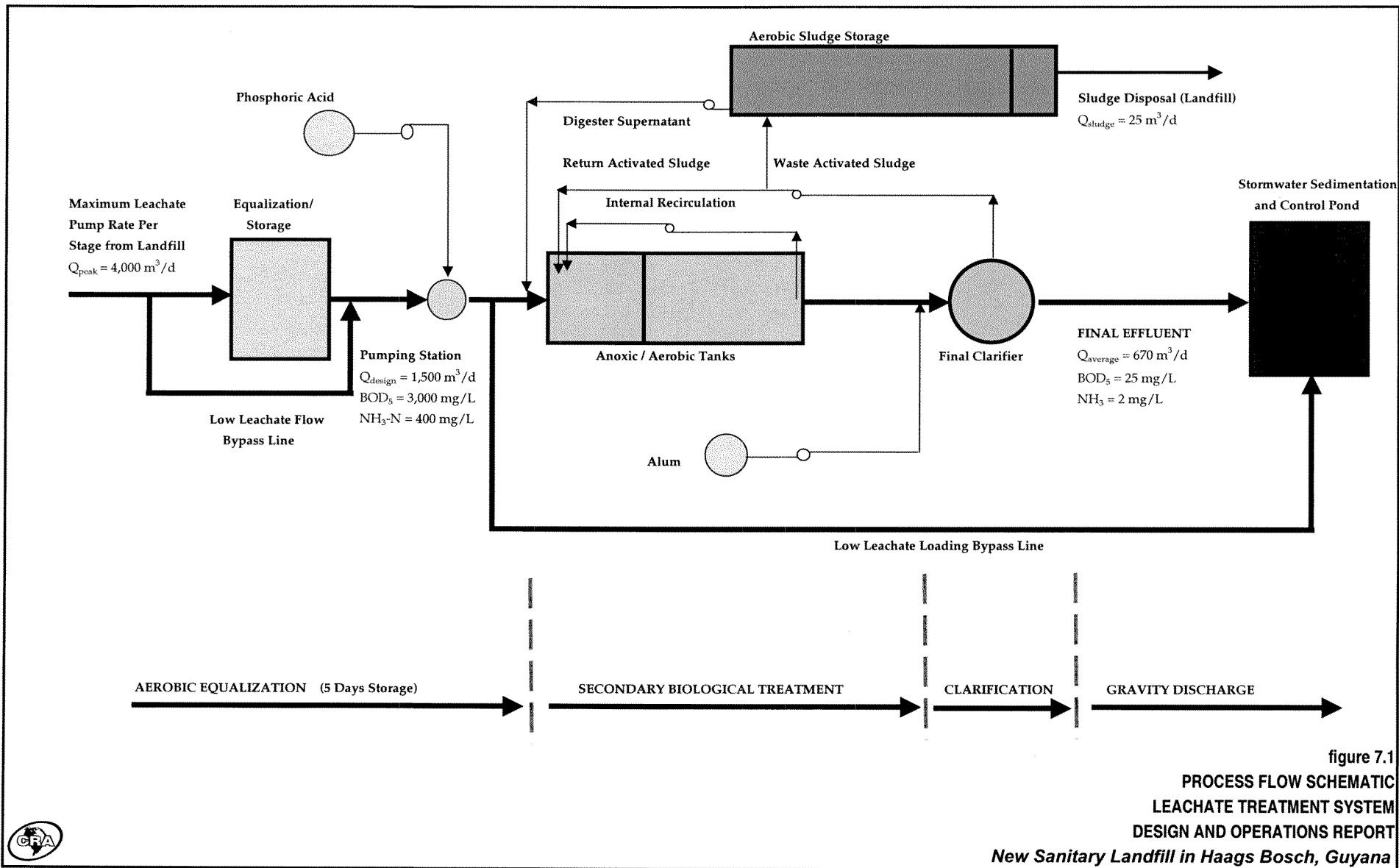
- LEGEND**
- OVERLAND FLOW
 - x(15.80) EXISTING GRADE TO REMAIN
 - x 16.60 PROPOSED GRADE

figure 6.3

**INTERIM SITE DRAINAGE PATTERN
STAGE 3**

NEW SANITARY LANDFILL IN HAAGS BOSCH, GUYANA
Ministry of Local Government and Regional Development





CONSTRUCTION OF SANITARY LANDFILL IN HAAGS BOSCH

GUYANA

MINISTRY OF LOCAL GOVERNMENT AND REGIONAL DEVELOPMENT



DRAWING INDEX				DRAWING INDEX			
DWG No	REV. No	DATE	TITLE	DWG No	REV. No	DATE	TITLE
GENERAL							
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CIVIL				STRUCTURAL			
C-01	0	JANUARY 2005	EXISTING CONDITIONS (OVERALL SITE AREA)	S-01	0	JANUARY 2005	ANOXIC AND AERATION TANK PLAN
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C-04	0	JANUARY 2005	SITE DEVELOPMENT SEQUENCE (1 OF 3)	S-04	0	JANUARY 2005	LEACHATE TREATMENT FACILITY SECTIONS AND DETAILS (1 OF 2)
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C-27	0	JANUARY 2005	LEACHATE TREATMENT FACILITY SITE PLAN	E-09	0	JANUARY 2005	ELECTRICAL CONTROL SCHEMATICS (3 OF 5)
C-28	0	JANUARY 2005	LEACHATE TREATMENT FACILITY LAGOON LINING SYSTEM	E-10	0	JANUARY 2005	ELECTRICAL CONTROL SCHEMATICS (4 OF 5)
C-29	0	JANUARY 2005	LEACHATE TREATMENT FACILITY LAGOON LINING SYSTEM DETAILS	E-11	0	JANUARY 2005	ELECTRICAL CONTROL SCHEMATICS (5 OF 5)
C-30	0	JANUARY 2005	LANDFILL GAS MANAGEMENT SYSTEM	E-12	0	JANUARY 2005	ELECTRICAL UTILITY SERVICE PLAN
C-31	0	JANUARY 2005	LANDFILL GAS TRENCH CONNECTION PLAN AND PROFILE	PROCESS			
C-32	0	JANUARY 2005	LANDFILL GAS COLLECTION SYSTEM DETAILS (FUTURE)	P-01	0	JANUARY 2005	PROCESS FLOW DIAGRAM AND AND HYDRAULIC GRADIENT DIAGRAM
C-33	0	JANUARY 2005	PROPOSED SCALEHOUSE AND ACCESS ROADWAY	INSTRUMENTATION AND CONTROL			
C-34	0	JANUARY 2005	SCALEHOUSE SECTIONS AND DETAILS	IC-01	0	JANUARY 2005	PROCESS AND INSTRUMENTATION DIAGRAM SHEET 1 OF 2
C-35	0	JANUARY 2005	SITE UTILITIES	IC-02	0	JANUARY 2005	PROCESS AND INSTRUMENTATION DIAGRAM SHEET 2 OF 2
C-36	0	JANUARY 2005	BURIED SITE UTILITIES (PROPOSED LANDFILL AREA)				
C-37	0	JANUARY 2005	MISCELLANEOUS CIVIL DETAILS				



CONESTOGA-ROVERS & ASSOCIATES



TABLE 2.1

**SITE DESIGN CRITERIA
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA**

<i>Item</i>	<i>Criteria</i>
• Area of Site	• 162 hectares
• Waste Footprint Area	• 259,000 m ²
• Landfill Volume	• 2,338,000 m ³
• Buffer Zone	• 121 hectares
• Base Design	• Site specific design with native clay base liner
• Minimum Elevation of Landfill Base Contours	• 11.9 m GD
• Maximum Elevation of Landfill Final Contours	• 26.5 m GD
• Maximum Sideslope (Horizontal:Vertical)	<ul style="list-style-type: none"> • Landfill base 3:1 (33%) • Landfill final contours 4:1 (25%)
• Minimum Top Slope (Horizontal:Vertical)	• Landfill final contours 20:1 (5%)
• Final Cover Depth of approx. 0.8 m	<ul style="list-style-type: none"> • 100 mm vegetated topsoil • 700 mm native clay
• Leachate Management	• Blanket underdrain collection system with on-Site treatment and discharge to Demerara River
• Surface Water Management	<ul style="list-style-type: none"> • Perimeter ditches for conveyance of runoff from 10-year 24-hour peak rainfall event • Total active stormwater management pond volume of approximately 67,000 m³ for storage of 10-year 24-hour peak rainfall event

TABLE 2.2
WASTE COMPOSITION⁽¹⁾
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA

<i>Waste Stream</i>	<i>Truck Load Percentage</i>	<i>Estimated Total Tonnage During Study Period</i>
Low and Middle-Income Residential Waste	64	56
High-Income Residential Waste	8	10
Middle-Income Residential and Commercial Waste	3	4
Commercial Waste	7	9
Market Waste	18	21

<i>Waste Type</i>	<i>Percentage</i>
Food Waste	41
Paper Waste	24
Glass and Metals	3.4
Plastics	10.1
Construction and Demolition Waste	1.8

Source:

- (1) Waste composition data provided by Brown, Vence and Associates in their report entitled, "Pre-Investment Study for Georgetown Solid Waste Management Program: Waste Characterization and Facility Siting.", May 2000.

TABLE 2.3

**ESTIMATED WASTE TONNAGES
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA**

<i>Year</i>	<i>Approximate Annual Waste Tonnage Placed⁽²⁾</i>
2005 ⁽¹⁾	30,000
2006	60,600
2007	61,210
2008	61,820
2009	62,440
2010	63,060
2011	63,690
2012	64,330
2013	64,970
2014	65,620
2015	66,280
2016	66,940
2017	67,610
2018	68,290
2019	68,970
2020	69,660
2021	70,360
2022	71,060
2023	71,770
2024	72,490
2025	73,210
2026	73,940
2027	74,680
2028	75,430
2029	76,180
2030	76,940
<hr/>	
Total Tonnage	1,741,550
Average Tonnage per Year	66,980
Estimated Site Life	26 years

Notes:

- (1) 2005 waste tonnage placed based on a initial waste placement of 60,000 tonnes split between new sanitary landfill in Haags Bosch and Mandela Avenue dumpsite.
- (2) Waste tonnage placed in subsequent years based on assumed 1 percent annual increase, and average waste density of 0.750 tonnes/m³.

TABLE 4.1

**ESTIMATED LANDFILL VOLUMES
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA**

<i>Landfill Stage</i>	<i>Area of Stage (m²)</i>	<i>Volume of Stage⁽¹⁾ (m³)</i>	<i>Volume of Leachate Collection System⁽²⁾ (m³)</i>	<i>Volume of Final Cover⁽³⁾ (m³)</i>	<i>Volume of Refuse and Daily Cover⁽⁴⁾ (m³)</i>	<i>Volume of Daily Cover (m³)</i>
Stage 1	64,750	639,500	55,000	51,800	584,500	83,500
Stage 2	64,750	639,500	55,000	51,800	584,500	83,500
Stage 3	64,750	639,500	55,000	51,800	584,500	83,500
Stage 4	64,750	639,500	55,000	51,800	584,500	83,500
Total Site ⁽⁵⁾	259,000	2,558,000	220,000	207,200	2,338,000	334,000

Notes:

- (1) Volume of stage is measured from native clay base to top of final cover.
- (2) Estimated leachate collection system thickness of 0.85 m.
- (3) Estimated final cover thickness of 0.8 m.
- (4) Ratio of waste-to-daily cover placement estimated to be 6:1.
- (5) Volume estimate in AutoCAD based on pre-settlement, post-closure landfill height of 12 m.

TABLE 4.2

**MATERIAL BALANCE
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA**

<i>Description</i>	<i>Material</i>	<i>Thickness (m)</i>	<i>Stage 1 (m³)</i>	<i>Stage 2 (m³)</i>	<i>Stage 3 (m³)</i>	<i>Stage 4 (m³)</i>	<i>Other (m³)</i>	<i>Total Site ⁽²⁾</i>	
								<i>(m³)</i>	<i>(m²)</i>
MATERIAL REQUIREMENTS:									
Daily Cover Soil ⁽¹⁾	Native Clay or ADC	-	83,500	83,500	83,500	83,500	-	334,000	-
Final Cover - Vegetative Layer	Native Clay or topsoil	0.100	6,500	6,500	6,500	6,500	-	26,000	-
Final Cover - Clay Cap	Native Clay	0.700	45,475	45,475	45,475	45,475	-	181,900	-
Grading for Row of Trees	Native Clay	-	-	-	-	-	-	4,000	-
Leachate Collection System - Support Layer	Sand	0.150	9,925	9,925	9,925	9,925	-	39,700	-
Leachate Collection System - Drainage Layer	25 to 50 mm Clear Stone	0.300	4,775	4,775	4,775	4,775	-	19,100	-
Leachate Collection System - Ballast Layer	Sand	0.300	19,875	19,875	19,875	19,875	-	79,500	-
Paved Highway - Base material	Sand	0.300	-	-	-	-	4,800	4,800	15,850
Paved Highway - Top grading	Asphalt	0.150	-	-	-	-	2,400	2,400	15,850
Paved Site Access Roads - Base material	Sand	0.300	-	-	-	-	500	500	1,630
Paved Site Access Roads - Top grading	Asphalt	0.150	-	-	-	-	300	300	1,630
Unpaved Site Access Roads - Base material	Native Clay	0.300	-	-	-	-	8,900	8,900	29,500
Unpaved Site Access Roads - Top grading	Sand	0.300	-	-	-	-	8,900	8,900	29,500
Total Soil	Native Clay	-	135,475	135,475	135,475	135,475	8,900	554,800	-
Total Aggregate	25 to 50 mm Clear Stone	-	4,775	4,775	4,775	4,775	0	19,100	-
Total Sand	Sand	-	29,800	29,800	29,800	29,800	14,200	133,400	-
Total Asphalt	Asphalt	-	-	-	-	-	2,700	2,700	17,480

MATERIAL AVAILABLE:

Marine Clay Soil	Native Clay	255,300	255,300	255,300	255,300	54,700	1,075,900
Workable Soil ⁽³⁾	Native Clay	191,500	191,500	191,500	191,500	41,000	807,000
Total Soil Available	Native Clay	191,500	191,500	191,500	191,500	41,000	807,000

TABLE 4.2

**MATERIAL BALANCE
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA**

<i>Description</i>	<i>Material</i>	<i>Thickness (m)</i>	<i>Stage 1 (m³)</i>	<i>Stage 2 (m³)</i>	<i>Stage 3 (m³)</i>	<i>Stage 4 (m³)</i>	<i>Other (m³)</i>	<i>Total Site ⁽²⁾</i>	
								<i>(m³)</i>	<i>(m²)</i>
MATERIAL BALANCE:									
Total Soil	Native Clay		56,025	56,025	56,025	56,025	32,100	256,200	
Total Aggregate	25 to 50 mm Clear Stone		-4,775	-4,775	-4,775	-4,775	0	-19,100	
Total Sand	Sand		-29,800	-29,800	-29,800	-29,800	-14,200	-133,400	

Notes:

- (1) Ratio of waste to daily cover placement estimated to be 6:1.
- (2) Total Site includes sum of material from Stages 1 to 4, plus additional material from Initial Construction of leachate treatment facility and stormwater ponds.
- (3) Workable soil estimated to be 75 percent of total clay excavated.

Total Footprint Area = 259,000 m².

Final Cover Surface Area = 259,900 m².

Base Surface Area = 264,900 m².

TABLE 5.1

**LEACHATE CHARACTERISTICS FOR LEACHATE TREATMENT
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA**

Peak Daily Leachate Production ⁽¹⁾⁻⁽³⁾	9,635	m ³ /d
Average Annual Leachate Production ⁽¹⁾⁻⁽³⁾	670	m ³ /d
Peak Post-Closure Leachate Production ⁽³⁾	215	m ³ /d
Maximum Leachate Pump Rate from Landfill ⁽⁴⁾	4,000	m ³ /d
Maximum Design Flow for Leachate Treatment	1,500	m ³ /d

Raw Leachate Characteristics:

<i>Parameter</i>	<i>Maximum Leachate Design Characteristics</i>		<i>Design Effluent Discharge Criteria</i>
	<i>(mg/L)</i>	<i>(kg/d)</i>	<i>(mg/L)</i>
Biological Oxygen Demand (BOD ₅)	3,000	675	25
Total Ammonia Nitrogen (NH ₃ -N)	400	90	2
Total Phosphorus	-	-	1
Sludge Generation:	25	m ³ /d	

Notes:

- (1) Based on statistical analysis of 10-year 24-hour peak rainfall data provided for from Guyana Hydromet Services for Georgetown Botanic Gardens from 1983 to 2003.
- (2) Assumes one active stage and three stages with interim/final cover.
- (3) Assumed infiltration rate of 300 mm/year for areas with interim/final cover.
- (4) Assigned on per Stage basis.

TABLE 6.1

RAINFALL EVENTS
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA

Peak 24-Hour Rainfall Event⁽¹⁾:

<i>Recurring Period (years)</i>	<i>Peak 24-Hour Rainfall Event (mm)</i>
2	103
5	129
10	146
25	168
50	184
100	200

21-Year Rainfall Statistics⁽²⁾:

	<i>5-Day Event (mm)</i>	<i>10-Day Event (mm)</i>	<i>Monthly (mm)</i>	<i>Yearly (mm)</i>
Maximum	228.8	331.5	589.1	2,889
Minimum	0	0	2.1	1,592
Average	28.4	56.8	176.8	2,099

Rainfall Intensity⁽³⁾:

<i>Duration (min)</i>	<i>Accumulation (mm)</i>	<i>Intensity (mm/hr)</i>
5	8.5	102.0
10	16.4	98.4
15	24.5	98.0
30	26.6	53.2
60	28.9	28.9
120	38.0	19.0

Notes:

- (1) Statistical analysis provided by Atmospheric Environment Service, Hydrometeorology Division, Canadian Climate Centre.
- (2) Based on statistical analysis of data for Georgetown Botanic Gardens from Guyana Hydromet Services from 1983 to 2003.
- (3) Data provided by Guyana Hydromet Services for June 1996.

TABLE 6.2

RESULTS OF SWMHYMO SIMULATIONS

DESIGN AND OPERATIONS REPORT

NEW SANITARY LANDFILL IN HAAGS BOSCH

GUYANA

<i>Pond No.</i>	<i>Storm Event</i>	<i>Peak Inflow Into Pond</i> <i>(m³/s)</i>	<i>Volume of Runoff</i>	
			<i>(mm)</i>	<i>(m³)</i>
1	25 mm 6 hour	0.152	9.87	1,342
	5 year 24 hour	0.725	100.9	13,713
	10 year 24 hour	0.841	117.29	15,940
2	25 mm 6 hour	0.152	9.83	1,329
	5 year 24 hour	0.726	100.8	13,622
	10 year 24 hour	0.842	117.19	15,836
3	25 mm 6 hour	0.098	10.43	1,074
	5 year 24 hour	0.484	102.45	10,543
	10 year 24 hour	0.561	118.9	12,235

TABLE 6.3

PERMANENT POOL VOLUME
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA

<i>Pond No.</i>	<i>Permanent Pool Volume</i>	<i>Permanent Pool Area Configuration</i>		<i>Forebay and Dispersion Lengths</i>	
	<i>Permanent Pool Volume Provided (m³)</i>	<i>Length (m)</i>	<i>Depth (m)</i>	<i>Forebay Length (m)</i>	<i>Dispersion Length (m)</i>
1	2,160	68.2	1.4	68.2	68.2
2	2,020	58.2	1.6	58.2	58.2
3	1,500	58.2	1.1	58.2	58.2

TABLE 6.4

POND DIMENSIONS AND ACTIVE STORAGE VOLUME
 DESIGN AND OPERATIONS REPORT
 NEW SANITARY LANDFILL IN HAAGS BOSCH
 GUYANA

<i>Pond No.</i>	<i>Length (m)</i>	<i>Width (m)</i>	<i>Depth (m)</i>	<i>Active Storage Volume (m³)</i>
1	216.2	68.2	1.3	25,020
2	216.2	58.2	1.5	23,440
3	216.2	58.2	1.1	18,710

TABLE 10.1
CONSTRUCTION QUALITY ASSURANCE INSPECTIONS
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA

<i>Work Task to be Inspected</i>	<i>Items to be Checked During Inspection</i>	<i>Type of Inspection</i>	<i>Frequency of Inspection</i>	<i>Submittals/Paperwork</i>
A. SITE PREPARATION				
Site Construction Operations	<ul style="list-style-type: none"> • unauthorized site access prevented • fencing in place to delineate work areas • dust control measures in place • access roads designated and signed 		<ul style="list-style-type: none"> • daily as required • daily as required • daily as required • daily as required 	<ul style="list-style-type: none"> • none • none • none • none
Rough Grading	<ul style="list-style-type: none"> • horizontal and vertical control • surface features have been protected • topsoil has been removed • obstructions removed (rocks, shrubs, trees) • adequate drainage has been provided 	<ul style="list-style-type: none"> • survey • visual • visual • visual • survey 	<ul style="list-style-type: none"> • daily as required • daily as required • daily as required • daily as required • daily as required 	<ul style="list-style-type: none"> • none • none • none • none • survey information
Stockpiles	<ul style="list-style-type: none"> • height not to exceed 4.5 m • slope not steeper than 2 horizontal to 1 vertical • protection from rain (tarpaulin or sheeting) 	<ul style="list-style-type: none"> • visual • visual • visual 	<ul style="list-style-type: none"> • as required • as required • as required 	<ul style="list-style-type: none"> • none • none • none
B. FOUNDATION				
	<ul style="list-style-type: none"> • native material meets specifications • base compaction is adequate 	<ul style="list-style-type: none"> • geotechnical testing • geotechnical testing 	<ul style="list-style-type: none"> • as required • as required 	<ul style="list-style-type: none"> • log notation • log notation
C. BACKFILL AND COMPACTION				
	<ul style="list-style-type: none"> • fill areas are to grades and elevations on drawings • layers do not exceed specified depths • grade changes are gradual • specified compaction density achieved 	<ul style="list-style-type: none"> • survey • measure • visual • measure 	<ul style="list-style-type: none"> • prior to, during, and after backfill and compaction • during and after backfill and compaction • during and after backfill and compaction • after backfill and compaction 	<ul style="list-style-type: none"> • survey information • none • none • compaction results

TABLE 10.1

**CONSTRUCTION QUALITY ASSURANCE INSPECTIONS
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA**

<i>Work Task to be Inspected</i>	<i>Items to be Checked During Inspection</i>	<i>Type of Inspection</i>	<i>Frequency of Inspection</i>	<i>Submittals/Paperwork</i>
D. EXCAVATION				
	<ul style="list-style-type: none"> horizontal and vertical control 	<ul style="list-style-type: none"> survey 	<ul style="list-style-type: none"> prior to, during, and after excavation 	<ul style="list-style-type: none"> survey information
	<ul style="list-style-type: none"> excavation to grades and elevations on drawings 	<ul style="list-style-type: none"> survey 	<ul style="list-style-type: none"> prior to, during, and after excavation 	<ul style="list-style-type: none"> survey information
	<ul style="list-style-type: none"> debris and obstructions removed 	<ul style="list-style-type: none"> visual 	<ul style="list-style-type: none"> prior to excavation 	<ul style="list-style-type: none"> none
	<ul style="list-style-type: none"> trench depths and widths are within specified tolerances 	<ul style="list-style-type: none"> measure 	<ul style="list-style-type: none"> prior to, during, and after excavation 	<ul style="list-style-type: none"> log notation
	<ul style="list-style-type: none"> excavated materials are disposed of 	<ul style="list-style-type: none"> visual 	<ul style="list-style-type: none"> after excavation 	<ul style="list-style-type: none"> none
E. BURIED UTILITIES				
	<ul style="list-style-type: none"> all pipes, fittings, and joints meet specified standards 	<ul style="list-style-type: none"> inspect documentation 	<ul style="list-style-type: none"> upon delivery 	<ul style="list-style-type: none"> supplier's certificates
	<ul style="list-style-type: none"> products are delivered with appropriate labeling 	<ul style="list-style-type: none"> visual 	<ul style="list-style-type: none"> upon delivery 	<ul style="list-style-type: none"> none
	<ul style="list-style-type: none"> trenching is performed to correct dimensions 	<ul style="list-style-type: none"> measure 	<ul style="list-style-type: none"> during installation 	<ul style="list-style-type: none"> reviewed plan
	<ul style="list-style-type: none"> horizontal and vertical control 	<ul style="list-style-type: none"> survey (maximum variation from true slope of 1 cm in 3 m) 	<ul style="list-style-type: none"> during and after installation 	<ul style="list-style-type: none"> survey information
	<ul style="list-style-type: none"> pipe installation follows proper alignment 	<ul style="list-style-type: none"> visual 	<ul style="list-style-type: none"> during and after installation 	<ul style="list-style-type: none"> log notation
	<ul style="list-style-type: none"> backfill material is adequate 	<ul style="list-style-type: none"> visual 	<ul style="list-style-type: none"> during installation 	<ul style="list-style-type: none"> material tests
	<ul style="list-style-type: none"> warning tape has been installed 	<ul style="list-style-type: none"> visual (300 mm below surface) 	<ul style="list-style-type: none"> during installation 	<ul style="list-style-type: none"> none
	<ul style="list-style-type: none"> hydrostatic and leak testing is adequate 	<ul style="list-style-type: none"> inspect test results 	<ul style="list-style-type: none"> after installation 	<ul style="list-style-type: none"> testing reports
	<ul style="list-style-type: none"> water supply piping meets specifications 	<ul style="list-style-type: none"> inspect documentation 	<ul style="list-style-type: none"> upon delivery 	<ul style="list-style-type: none"> supplier's certificates
	<ul style="list-style-type: none"> water supply piping meets specifications 	<ul style="list-style-type: none"> inspect documentation 	<ul style="list-style-type: none"> upon delivery 	<ul style="list-style-type: none"> supplier's certificates
	<ul style="list-style-type: none"> water supply piping meets standards for installation 	<ul style="list-style-type: none"> visual 	<ul style="list-style-type: none"> after installation 	<ul style="list-style-type: none"> log notation
F. PUMP STATIONS				
	<ul style="list-style-type: none"> all equipment meets specified standards 	<ul style="list-style-type: none"> inspect documentation 	<ul style="list-style-type: none"> upon delivery 	<ul style="list-style-type: none"> supplier's certificates
	<ul style="list-style-type: none"> electrical components conform to code 	<ul style="list-style-type: none"> inspect documentation 	<ul style="list-style-type: none"> upon delivery 	<ul style="list-style-type: none"> supplier's certificates
	<ul style="list-style-type: none"> manufacturer and installer's qualifications 	<ul style="list-style-type: none"> inspect documentation 	<ul style="list-style-type: none"> upon delivery 	<ul style="list-style-type: none"> supplier's certificates
	<ul style="list-style-type: none"> components delivered damage-free 	<ul style="list-style-type: none"> visual 	<ul style="list-style-type: none"> upon delivery 	<ul style="list-style-type: none"> none
	<ul style="list-style-type: none"> piping is installed to correct grades 	<ul style="list-style-type: none"> survey (maximum variation from plumb of 1 degree) 	<ul style="list-style-type: none"> during and after installation 	<ul style="list-style-type: none"> log notation
	<ul style="list-style-type: none"> backfill material is adequate 	<ul style="list-style-type: none"> visual 	<ul style="list-style-type: none"> during installation 	<ul style="list-style-type: none"> material tests

TABLE 10.1
CONSTRUCTION QUALITY ASSURANCE INSPECTIONS
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA

<i>Work Task to be Inspected</i>	<i>Items to be Checked During Inspection</i>	<i>Type of Inspection</i>	<i>Frequency of Inspection</i>	<i>Submittals/Paperwork</i>
G. FENCING	<ul style="list-style-type: none"> • products meet specified standards • manufacturer's qualifications • smooth gradient is obtained between posts • location of fencing conforms to drawings • fencing is within property lines 	<ul style="list-style-type: none"> • inspect documentation • inspect documentation • visual • survey • visual 	<ul style="list-style-type: none"> • upon delivery • upon delivery • during installation • during and after installation • during installation 	<ul style="list-style-type: none"> • supplier's certificates • supplier's certificates • none • none • none
H. LANDSCAPING	<ul style="list-style-type: none"> • supplier's qualifications • topsoil meets required specifications • horizontal and vertical control • proper grades are maintained • topsoil placed with appropriate moisture • fertilizer meets specifications • grass seed meets specifications • mulch meets specifications • noxious weeds are not present • plant material is disease-free • climactic conditions are suitable • final acceptance criteria met 	<ul style="list-style-type: none"> • check documentation • check documentation • survey • survey • visual • check documentation • check documentation • check documentation • visual • visual • visual • visual (80% of plant material in healthy, vigorous growing condition) 	<ul style="list-style-type: none"> • upon delivery • upon delivery • after topsoiling • during and after topsoiling • during topsoiling • upon delivery • upon delivery • upon delivery • after seeding • during and after planting • during planting • after planting 	<ul style="list-style-type: none"> • supplier's certificates • supplier's certificates • survey information • survey information • none • supplier's certificates • supplier's certificates • supplier's certificates • none • none • none • none
I. CAST-IN-PLACE CONCRETE	<ul style="list-style-type: none"> • concrete material meets specifications • concrete mix verified • forms built in accordance with specifications • concrete placed in accordance with specifications • reinforcement placed in accordance with specifications • surfaces finished • fastenings, wedges, ties and items are secure 	<ul style="list-style-type: none"> • check documentation • test • visual • test, visual • visual • visual • visual 	<ul style="list-style-type: none"> • upon delivery • prior to concrete placing • continuous during concrete placing • continuous during concrete placing • continuous during concrete placing • after concrete placing • continuous during concrete placing 	<ul style="list-style-type: none"> • supplier's certificate • none • none • none • none • none • none

TABLE 10.1
CONSTRUCTION QUALITY ASSURANCE INSPECTIONS
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA

<i>Work Task to be Inspected</i>	<i>Items to be Checked During Inspection</i>	<i>Type of Inspection</i>	<i>Frequency of Inspection</i>	<i>Submittals/Paperwork</i>
J. MATERIALS				
Flexible Membrane Liner (FML)	• Raw Materials			
	a) certificate of analysis from materials vendor	• inspect documentation	• upon delivery	• supplier's certificate
	b) documentation of the FML's prior successful use for this application	• inspect documentation	• upon delivery	• supplier's certificate
	• Manufacturing			
	a) manufacturer's verification that FML meets specs for type	• check supplier's specifications	• upon delivery	• supplier's certificate
	b) statement of basis for property values	• check supplier's specifications	• upon delivery	• supplier's certificate
	c) manufacturer's qualifications and references	• inspect documentation	• upon delivery	• supplier's certificate
	• Transportation			
	a) FML is shipped to prevent damage by other cargo	• visual	• upon delivery	• none
	b) FML rolls or blankets are properly labelled	• visual	• upon delivery	• none
	• Installation			
	a) installer's qualification letter	• inspect documentation	• upon delivery	• installer's certificate
	b) weather is adequate	• visual	• during installation	• none
	c) ground and subgrade conditions are adequate	• visual	• prior and during installation	• none
	d) panels are marked and unfolded properly	• visual	• prior and during installation	• none
	e) rolls are installed to prevent corrugations	• visual	• during installation	• none
	f) panel overlaps for seaming are suitable	• measure (100 mm for extrusion welds and 127 mm for hot wedge welds)	• during and after installation	• none
	g) all seams are labelled appropriately	• visual	• during and after installation	• none
	h) seaming area is dry and clean	• visual	• during installation	• none
	i) a hard substrate is used for soft soil	• visual	• prior and during installation	• none

TABLE 10.1
CONSTRUCTION QUALITY ASSURANCE INSPECTIONS
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA

<i>Work Task to be Inspected</i>	<i>Items to be Checked During Inspection</i>	<i>Type of Inspection</i>	<i>Frequency of Inspection</i>	<i>Submittals/Paperwork</i>
	j) inspect seams and non-seams for defects	• visual	• during and after installation	• none
Drainage Geocomposite	<ul style="list-style-type: none"> • Manufacturing <ul style="list-style-type: none"> a) manufacturer's certificate b) raw material/manufactured goods certificate c) manufacturer's qualifications d) geocomposite meets specifications • Transportation <ul style="list-style-type: none"> a) geocomposite is shipped to prevent damage by other cargo (check sunlight and heat) b) geocomposite rolls or blankets are properly labelled • Installation <ul style="list-style-type: none"> a) installer/seamer's qualifications b) inspection for defects upon delivery c) weather is adequate d) geocomposite is free of folds or wrinkles e) specified overlaps are maintained f) geocomposite is free of debris during seaming 	<ul style="list-style-type: none"> • inspect documentation • inspect documentation • inspect documentation • inspect documentation • visual • visual • inspect documentation • visual • visual • measure • visual 	<ul style="list-style-type: none"> • upon delivery • upon delivery • upon delivery • upon delivery • upon delivery • upon delivery • during installation • during installation • during installation • during installation 	<ul style="list-style-type: none"> • supplier's certificate • supplier's certificate • supplier's certificate • supplier's certificate • none • none • installer's certificate • none • none • none • none • none
Geotextile	<ul style="list-style-type: none"> • Manufacturing <ul style="list-style-type: none"> a) manufacturer's certificates b) manufacturer's qualifications 	<ul style="list-style-type: none"> • inspect documentation • inspect documentation 	<ul style="list-style-type: none"> • upon delivery • upon delivery 	<ul style="list-style-type: none"> • supplier's certificate • supplier's certificate

TABLE 10.1
CONSTRUCTION QUALITY ASSURANCE INSPECTIONS
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA

<i>Work Task to be Inspected</i>	<i>Items to be Checked During Inspection</i>	<i>Type of Inspection</i>	<i>Frequency of Inspection</i>	<i>Submittals/Paperwork</i>
Geogrid	<ul style="list-style-type: none"> • Handling <ul style="list-style-type: none"> a) geotextile rolls are appropriately labelled b) geotextile rolls are protected from moisture, dust, light, and heat • Installation <ul style="list-style-type: none"> a) installer's qualifications b) inspection for defects upon delivery c) supporting surface is free of irregularities d) overlaps conform with specifications e) no stones are entrapped in geotextile f) geotextile is not exposed to sun for more than 14 days 	<ul style="list-style-type: none"> • visual • visual • inspect documentation • visual • visual • measure • visual • visual 	<ul style="list-style-type: none"> • upon delivery • upon delivery • upon delivery • upon delivery • during installation • during and after installation • during installation • during and after installation 	<ul style="list-style-type: none"> • none • none • installer's certificate • none • none • none • none • none
	<ul style="list-style-type: none"> • Manufacturing <ul style="list-style-type: none"> a) manufacturer's certificates • Transportation <ul style="list-style-type: none"> a) geogrid is shipped to prevent damage by other cargo b) geocomposite rolls or blankets are properly labelled • Installation <ul style="list-style-type: none"> a) inspection for defects upon delivery b) supporting surface is free of irregularities c) weather is adequate d) overlaps conform with specifications e) geocomposite is free of folds or wrinkles 	<ul style="list-style-type: none"> • inspect documentation • visual • visual • visual • measure • visual 	<ul style="list-style-type: none"> • upon delivery • upon delivery • upon delivery • upon delivery • during installation • during and after installation • during and after installation 	<ul style="list-style-type: none"> • supplier's certificate • none • none • none • none • none • none

TABLE 10.1
CONSTRUCTION QUALITY ASSURANCE INSPECTIONS
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA

<i>Work Task to be Inspected</i>	<i>Items to be Checked During Inspection</i>	<i>Type of Inspection</i>	<i>Frequency of Inspection</i>	<i>Submittals/Paperwork</i>
K. MECHANICAL COMPONENTS (pumps, injectors, mixers, gauges, switches, aeration system, clarifier, blowers, etc.)	<ul style="list-style-type: none"> • components meet specified standards • assembly and installation are according to specifications 	<ul style="list-style-type: none"> • inspect documentation • visual/check specifications 	<ul style="list-style-type: none"> • upon delivery • during assembly and installation 	<ul style="list-style-type: none"> • supplier's certificate • none
L. INSTRUMENTS (sensors, transmitters and meters)	<ul style="list-style-type: none"> • instruments meet specified standards • assembly and installation are according to specifications 	<ul style="list-style-type: none"> • inspect documentation • visual/check specifications 	<ul style="list-style-type: none"> • upon delivery • during assembly and installation 	<ul style="list-style-type: none"> • supplier's certificate • none
M. ELECTRICAL COMPONENTS (panelboards, wire, meters, controls, etc.)	<ul style="list-style-type: none"> • electrical components meet specifications • electrical components assembled and installed according to specifications 	<ul style="list-style-type: none"> • inspect documentation • visual/check specifications 	<ul style="list-style-type: none"> • upon delivery • during assembly and installation 	<ul style="list-style-type: none"> • supplier's certificate • none
N. PRE-ENGINEERING BUILDING	<ul style="list-style-type: none"> • designer, manufacturer, and installer qualifications • mortar, grout, masonry units, and concrete are to specified standards 	<ul style="list-style-type: none"> • inspect documentation • visual 	<ul style="list-style-type: none"> • upon delivery • during installation 	<ul style="list-style-type: none"> • supplier's certificate • none
O. SURFACE WATER DRAINAGE				
Ditches	<ul style="list-style-type: none"> • constructed to pre-determined grades • erosion control meets specifications 	<ul style="list-style-type: none"> • survey • visual 	<ul style="list-style-type: none"> • during and after construction • during construction 	<ul style="list-style-type: none"> • survey information • none
P. SEPTIC SYSTEM (septic tank, holding tank, oil/water separator)	<ul style="list-style-type: none"> • products conform to specifications • installation according to specifications 	<ul style="list-style-type: none"> • inspect documentation • visual 	<ul style="list-style-type: none"> • upon delivery • during installation 	<ul style="list-style-type: none"> • supplier's certificate • log notation

TABLE 10.1
CONSTRUCTION QUALITY ASSURANCE INSPECTIONS
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA

<i>Work Task to be Inspected</i>	<i>Items to be Checked During Inspection</i>	<i>Type of Inspection</i>	<i>Frequency of Inspection</i>	<i>Submittals/Paperwork</i>
Q. WEIGH SCALE	<ul style="list-style-type: none"> weigh scale and scale house conform to specifications installation and calibration of scales according to specifications 	<ul style="list-style-type: none"> inspect documentation visual 	<ul style="list-style-type: none"> upon delivery during installation 	<ul style="list-style-type: none"> supplier's certificate log notation
R. ELECTRICITY SUPPLY	<ul style="list-style-type: none"> installation of supply network meets specifications 	<ul style="list-style-type: none"> visual 	<ul style="list-style-type: none"> during installation 	<ul style="list-style-type: none"> log notation
S. ROADS (access road and on-Site roads)	<ul style="list-style-type: none"> materials meet specifications installation according to specifications 	<ul style="list-style-type: none"> inspect documentation visual/survey 	<ul style="list-style-type: none"> upon delivery during installation 	<ul style="list-style-type: none"> supplier's certificate log notation
T. ACCESS BRIDGE	<ul style="list-style-type: none"> materials meet specifications installation according to specifications 	<ul style="list-style-type: none"> inspect documentation visual 	<ul style="list-style-type: none"> upon delivery during installation 	<ul style="list-style-type: none"> supplier's certificate log notation
U. MISCELLANEOUS				
Culverts	<ul style="list-style-type: none"> material meets specifications manufacturer's qualifications installation follows proper alignment bedding and backfill meets specifications 	<ul style="list-style-type: none"> inspect documentation inspect documentation survey and visual visual 	<ul style="list-style-type: none"> upon delivery upon delivery during installation during installation 	<ul style="list-style-type: none"> supplier's certificate supplier's certificate survey information material tests
Administration Building Equipment	<ul style="list-style-type: none"> all equipment meets specified standards 	<ul style="list-style-type: none"> inspect documentation 	<ul style="list-style-type: none"> upon delivery 	<ul style="list-style-type: none"> supplier's certificate

TABLE 10.2
CONSTRUCTION QUALITY CONTROL TESTING PROCEDURES
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA

<i>Work Task or Product</i>	<i>Type of Test</i>	<i>Reference Standard</i>	<i>Frequency of Test</i>	<i>Criteria</i>
A. FILL	<ul style="list-style-type: none"> • Maximum Dry Density • Bulk Density • Particle Size Analysis • Moisture Content 	<ul style="list-style-type: none"> • ASTM D698 • ASTM D1556, ASTM D2167, or ASTM D2922 • ASTM D422 or ASTM D1140 • ASTM D3017 	<ul style="list-style-type: none"> • 1 test per 5000 m³ • 1 test per 5000 m³ • 1 test per 5000 m³ • 1 test per 5000 m³ 	<ul style="list-style-type: none"> • per requirements • per requirements • per requirements • per requirements
B. BURIED UTILITIES				
1. Forcemain and Gravity Main	• Hydrostatic and Leak Testing	• test at 1.25 times maximum rated pressure	• after installation	• reject joints demonstrating leakage; repeat until pressure drop is within specified allowance
2. Access Manhole	• Leak Testing	• plug/seal and fill with water	• after installation	• leakage not exceeding 0.1% of volume of unit per hour
C. PUMPING STATION	<ul style="list-style-type: none"> • Pressure Testing • Leakage Testing 	<ul style="list-style-type: none"> • test at 1.5 times normal operating pressure (1 hour) • plug/seal and fill with water 	<ul style="list-style-type: none"> • after installation • after installation 	<ul style="list-style-type: none"> • pressure shall not decrease or fluctuate • leakage not exceeding 0.1% of volume of unit per hour
D. CHAIN LINK FENCE	• Repair of Damaged Surfaces	• ASTM A780	• after installation	• per requirements
E. TOPSOIL	<ul style="list-style-type: none"> • Organic Content • pH • Potassium, Phosphorous, Calcium, Magnesium 	<ul style="list-style-type: none"> • ASTM D2974 • ASTM D4972 • in accordance with Ministry of Agriculture regulations 	<ul style="list-style-type: none"> • 1 test per 1 hectare of topsoil • 1 test per 1 hectare of topsoil • 1 test per 1 hectare of topsoil 	<ul style="list-style-type: none"> • minimum 4% for clay loams and 2% for sandy loams to maximum of 20% by volume • accept pH 6-7.5 • per requirements
F. CAST-IN-PLACE CONCRETE	<ul style="list-style-type: none"> • Sample Procurement • Sample Molding • Sample Compressive Strength • Slump Test • Air Content 	<ul style="list-style-type: none"> • ASTM C172 • ASTM C31 • ASTM C39 • ASTM C143/C143M • ASTM C231 or ASTM C173 	<ul style="list-style-type: none"> • 1 test for every 10 m³ • 1 test for every 10 m³ • 1 test for every 10 m³ • 1 test for every 10 m³ • 1 test for every 10 m³ 	<ul style="list-style-type: none"> • N/A • N/A • accept 35 MPa • accept 75 mm +/- 25 mm • accept 6.5% +/- 0.5%

TABLE 10.2
CONSTRUCTION QUALITY CONTROL TESTING PROCEDURES
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA

<i>Work Task or Product</i>	<i>Type of Test</i>	<i>Reference Standard</i>	<i>Frequency of Test</i>	<i>Criteria</i>
G. METAL FABRICATION TESTING	• Bolt Tightening	• AISC	• after installation	• per requirements
	• Nondestructive Weld Testing	• AWS	• after installation	• per requirements
H. WATER AND CHEMICAL PIPING	• Hydrostatic Testing	• ASME 31.1	• after installation	• hold design pressure for minimum 8 hours
I. VALVES	• Hydrostatic Testing	• ASME 31.1	• after installation	• hold design pressure for minimum 8 hours
J. ENCLOSED SWITCHES	• Electrical Testing	• NEMA KS 1	• after installation	• per requirements
K. MOTOR CONTROL CENTER	• Electrical Testing	• NEMA ICS 2	• after installation	• per requirements
L. FLEXIBLE MEMBRANE LINER INSTALLATION AND REPAIR	• Test Seams	• ASTM D4437	• at least twice a day	<ul style="list-style-type: none"> • when tested in shear, minimum test seam strength of 90% of tensile strength at yield of unseamed liner • when tested in peel, minimum test seam strength of 60% of tensile strength at yield of unseamed liner
	• Non-Destructive Seam Testing (Pressure Testing)	• GRI Test Method GM6	• 1 sample per 150 m of field seam	• as specified in GRI Test Method GM6
	• Destructive Seam Testing	• ASTM D4437	• 1 sample per 150 m of field seam	• when tested in shear, minimum field seam strength of 90% of tensile strength at yield of unseamed liner

TABLE 10.2
CONSTRUCTION QUALITY CONTROL TESTING PROCEDURES
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA

<i>Work Task or Product</i>	<i>Type of Test</i>	<i>Reference Standard</i>	<i>Frequency of Test</i>	<i>Criteria</i>
M. AGGREGATE				
1. Coarse Aggregate	• Sieve Aggregate Analysis	• ASTM C136	1 per 2,000 m ³ of material required	
	• Sieve Aggregate Fines Analysis	• ASTM C117	1 per 2,000 m ³ of material required	
	• clear stone			accept 6-16 mm size
	• pea gravel			accept nominal size 11 mm sieve to 5 mm sieve
• drain aggregate				accept 19 mm diameter: 100% passing 25 mm sieve, 90% retained on No. 4 sieve, less than 5% passing No. 40 sieve
• riprap				accept material with: 100% of total weight smaller than 150 mm, 85% smaller than 127 mm, 50% smaller than 100 mm, and 15% smaller than 30 mm
2. Material (fine aggregate)	• Maximum Dry Density	• ASTM D698	• 1 per 2,000 m ³ of material required	• per requirements
	• Particle Size Analysis	• ASTM D422	• 1 per 2,000 m ³ of material required	• accept material with: 100% passing 5 mm sieve, 0-5% passing 0.6 mm sieve, and 0% passing 0.080 mm sieve
	• Recompacted Permeability	• ASTM D2434	• 1 per 2,000 m ³ of material required	• per requirements

TABLE 13.1

**PROPOSED COMPLIANCE MONITORING FREQUENCY
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA**

<i>Monitoring Locations</i>	<i>Daily</i>	<i>Monthly</i>	<i>Quarterly</i>	<i>Annually</i>
<i>Groundwater Monitoring Wells (6 wells)</i>				
• Groundwater Quality Monitoring ⁽¹⁾⁽²⁾			√	√
• Groundwater Hydraulic Monitoring		√		
<i>Leachate Monitoring Wells (6 wells)</i>				
• Leachate Hydraulic Monitoring		√		
<i>Leachate Pump Stations (4 stations)</i>				
• Leachate Quality ⁽¹⁾⁽²⁾			√	√
• Leachate Hydraulic Monitoring	√			
• Leachate Quantity	√			
<i>Leachate Treatment Process Effluent</i>				
• Influent Quality ⁽¹⁾⁽²⁾			√	√
• Influent Quantity	√			
• Effluent Quality ⁽¹⁾⁽²⁾			√	√
• Effluent Quantity	√			
<i>Surface Water Monitoring (4 locations)</i>				
• Surface Water Quality ⁽¹⁾⁽²⁾			√	√
• Surface Water Quantity		√		
<i>Stormwater Pump Stations (3 stations)</i>				
• Surface Water Quality ⁽¹⁾⁽²⁾			√	√
• Surface Water Quantity	√			
<i>Landfill Gas Probes (3 probes)</i>				
• Gas Quality			√	

Notes:

- (1) Reduced parameter list for quarterly groundwater, surfacewater, and leachate analyses as indicated on Table 13.2. Full list of parameters for annual monitoring event.
- (2) Full list of parameters for quarterly groundwater, surfacewater, and leachate analyses during first year of Site operation only.

TABLE 13.2

**PROPOSED COMPLIANCE MONITORING PARAMETERS
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA**

<i>Surface Water Sampling</i>	<i>Groundwater Sampling</i>	<i>Leachate Sampling</i>	<i>Landfill Gas Sampling</i>
BOD *	BOD *	BOD *	Methane
COD *	COD *	COD *	Carbon Dioxide
pH ⁽³⁾ *	pH ⁽³⁾ *	pH ⁽³⁾ *	Oxygen
NH ₃ -N *	NH ₃ -N *	NH ₃ -N *	Temperature
TDS	TDS	TDS	Pressure
TSS *	TSS *	TSS *	
VSS	VSS	VSS	
TKN *	TKN *	TKN *	
Total Phosphorous *	Total Phosphorous *	Total Phosphorous *	
Alkalinity *	Alkalinity *	Alkalinity *	
Hardness (Ca and Mg)	Hardness (Ca and Mg)	Hardness (Ca and Mg)	
Chloride	Chloride	Chloride	
Fluoride	Fluoride	Fluoride	
Phosphate	Phosphate	Phosphate	
Sulphate	Sulphate	Sulphate	
Nitrate	Nitrate	Nitrate	
Nitrite	Nitrite	Nitrite	

Notes:

* Indicates parameter on reduced list.

- (1) Reduced parameter list for quarterly groundwater, surfacewater, and leachate analyses.
Full list of parameters for annual monitoring event.
- (2) Full list of parameters for quarterly groundwater, surface water, and leachate analyses during first year of Site operation only.
- (3) Includes both field and lab analysis.

COD Chemical Oxygen Demand.

BOD Biological Oxygen Demand.

NH₃-N Total Ammonia Nitrogen.

TDS Total Dissolved Solids.

TSS Total Suspended Solids.

VSS Volatile Suspended Solids.

TKN Total Kjeldahl Nitrogen.

APPENDIX B

LEACHATE TREATMENT PROCESS

1.0 LEACHATE TREATMENT SYSTEM

Landfill leachate is the inorganic and organic containing liquid mixture produced when water percolates through and contacts solid waste. Leachate generated from the active waste fill areas and the stormwater that accumulates in the active disposal cells during the preparation of each stage base will be collected in the LCS at the base of the landfill. This liquid will be collected at each of four leachate pumping stations corresponding to the low points of each stage, and conveyed via a common forcemain to the leachate treatment system. Collected liquid is routed either through the leachate treatment system or directly to the stormwater sedimentation and control pond depending upon whether the stage is actively accepting any waste and if the liquid has contacted any of this waste. Any liquid that has contacted waste will be routed through leachate treatment system.

The full leachate management system is comprised of the following elements:

- leachate collection system;
- aerobic equalization;
- secondary biological treatment;
- clarification;
- sludge storage; and
- stormwater sedimentation and control pond.

Secondary biological treatment, clarification, and sludge storage are processes conducted at the leachate treatment facility. Each of the following subsections provides information regarding the safe operation of the leachate management system.

1.1 LEACHATE TREATMENT SYSTEM OVERVIEW

The purpose of this section is to provide a general overview of the pathway and treatment systems that the collected leachate would endure prior to final discharge. A process schematic for the leachate treatment system is provided on Figure 5.1.

All waters to be treated would be collected in the aerobic equalization lagoon, by pumping stations located at the low point of each landfill. The location of these pump stations are indicated on Drawing C-11, provided in Appendix A. These stations are operated in an automatic mode with level indicators so as to minimize the amount of

time the operator is required to be off-Site. The pumps will switch ON/OFF by themselves.

The first treatment step in the system is the aerobic lagoon. Both high strength and dilute influent streams can be mixed and temporarily stored in the aerobic equalization lagoon. The lagoon also acts as a flow stabilization step within the process. The lagoon also acts as additional storage capacity for the leachate treatment facility under heavy rainfall conditions to ensure that the design capacity of the facility is not exceeded. Under normal operating conditions, the collected high strength leachate may be discharged directly to the leachate treatment facility (i.e., bypassing of the aerobic lagoon). The lagoon is equipped with aeration equipment to control and mitigate any odour issues. It has a capacity of 20,000 m³, and with a working water depth of 2.43 m. From the aerobic lagoon, the water is pumped directly into the splitter box of the secondary biological treatment step.

The secondary biological treatment step is comprised of an anoxic/oxic biological treatment system. It is designed to biologically remove contaminants, both nitrogenous and carbonaceous in nature, down to meet the designed effluent discharge criteria. Two equal sized anoxic/oxic trains will be utilized at the leachate treatment facility in order to accommodate the varying treatment flows experienced through the year.

The raw water would enter the anoxic tank first, where it would undergo biological denitrification. It is in this tank that the nitrogen, in the form of nitrates, is reduced to molecular nitrogen and emitted to the atmosphere. Furthermore, the anoxic system allows for rapid removal of the carbonaceous material during the denitrification process. To assist in this biological process, the raw water influent provides a source of organic carbon, and as needed, may be supplemented at the site by the addition of sugar cane or molasses. Phosphorus would need to be added as a nutrient required to sustain the biological process and would be done at the site. The anoxic tank is well mixed by an mechanical stirrer but is not aerated.

From the anoxic tank, the water overflows into the oxic tank. The oxic tank is well mixed and aerated to provide oxygen to the bacteria present in the system. It is in this tank that the nitrogen, in the form of ammonia, is oxidized to nitrates. With having the majority of the carbonaceous materials removed during anoxic treatment, this allows for the optimum nitrification conditions to occur during oxic treatment. The water from the oxic tank is recirculated back to the anoxic tank at a very high flow (e.g., four times influent flow rate) to ensure adequate time for denitrification to occur. The water is also overflowed to a clarifier.

As needed, excess phosphorus is to be removed from this system by the use of supplemental chemical feed. Alum or ferric chloride would be dosed to the system to assist in solids separation during clarification as well as a means of chemically reacting with the excess phosphorus to ensure compliance with the discharge effluent criteria.

The clarifier acts as a solids removal step. It is here that settling of the solids in the oxic tank effluent occurs, to minimize the amount of suspended solids being discharged in the final effluent. The thickened solids from the clarifier would be collected and either returned to the splitter box of the anoxic tank. Overflow from the clarifier would be directed to the stormwater sedimentation and control pond for final polishing prior to discharge to the drain canal.

Sludges collected from the leachate treatment facility would be disposed of in the active landfill area. The sludges would undergo aerobic sludge digestion prior to landfill disposal. These would be transported by a pump truck to the landfill.

1.2 START UP OF THE LEACHATE TREATMENT SYSTEM

The purpose of this section is to provide guidance and direction for the safe operation of the leachate treatment system. This section deals with the treatment of the influent wastewater, which is presumed to be mainly due to stormwater from the open stages. This section of the operations and maintenance manual is intended for the first 12-18 months of the leachate treatment facility operation.

The leachate/stormwater pumping stations may need to be activated to direct water from the LCS to the aerobic equalization tank. The pumps are to be manually activated to transfer the accumulated water to the aerobic equalization lagoon. This operation is only to be used provided that there was a visual confirmation that there is water accumulating in the pump station. This operation would continue as a manual function until there is a sufficient enough influent flow to allow the system to be operated in an automatic mode.

Leachate collection system pump station operation:

1. Visually confirm that there is water accumulating in the pump station.
2. Turn on the pump by depressing the ON switch for the pump.

3. Continue pumping water until there is no more water movement out of the pump.
4. Depress the OFF button for the pump.

Water is allowed to accumulate in the equalization lagoon. When the liquid level in the equalization lagoon is at a 2 m height (approximately 3/4 full), then daily sampling of the lagoon water is to commence. The daily sampling would consist of chemical oxygen demand (COD) and ammonia (NH₃-N) using grab samples and the HACH analysis instrument. All analyses are to be performed in accordance with the HACH manufacturer instructions. In the event that there is a noticeable odour emanating from the aerobic equalization lagoon, then this is an indication that there is sufficient strength water to support anaerobic biodegradation of the contaminants, and as such the lagoon's aeration system is to be activated. This will halt the generation of the anaerobic bacteria and reduce the odours emanating from the lagoon. The following instructions are provided below to guide the operation of the equalization lagoon aeration system.

Operation of the Aerobic Equalization Lagoon:

1. Sample the equalization lagoon water.
2. If an odour is noticeable, activate the equalization lagoon aeration system. Analyze water samples for COD and NH₃-N using the HACH instrument and following the supplier's instructions.
3. If no odour is present, analyze the water using the HACH instrument and instructions for COD and NH₃-N.
4. If the measured lagoon water is COD >100 mg/L and/or the NH₃-N >5 mg/L, then the equalization lagoon aeration system is to be activated. If there is an ongoing influent flow to the equalization lagoon at this time, then the lagoon water is to be pumped forward to the secondary biological treatment system.
5. If the measured lagoon water has a COD <100 mg/L and NH₃-N <5 mg/L, then the lagoon water may be pumped forward to the primary stormwater sedimentation and control pond via the bypass sewer.
6. If the level in the lagoon exceeds 2 metres of liquid depth (i.e., greater than 3/4 full), then the aerobic lagoon transfer pumps are to be activated to maintain the liquid level between 1.5 and 2 metres liquid depth. If the sample analysis indicated a clean water in the lagoon (i.e., COD <100 mg/L and NH₃-N <5 mg/L), then the aerobic lagoon water may be transferred forward to the primary stormwater sedimentation and control pond via the bypass sewer. If the sample

analysis indicated that the aerobic lagoon water was impaired (i.e., COD>100 mg/L or NH₃-N>5 mg/L), then the lagoon water is to be treated in the leachate treatment facility.

Operation of the Aerobic Lagoon Blowers:

In the event that there is an odour emanating from the aerobic lagoon and/or there is a sufficient amount of COD or ammonia in the lagoon water (i.e., COD>100 mg/L NH₃-N>5 mg/L), the aeration system is to be activated, according to the following procedure:

1. Ensure the air intake to the blower to be activated is clear of debris. As needed, clear the air intake prior to starting up the blower.
2. Follow the manufacturer's operations manual for safe start up of the Blowers.

If the daily sampling results from the aerobic lagoon indicate that there is very little contamination present, then the aeration system can be halted. This is determined by the HACH sample analysis with COD<100 mg/L and NH₃-N<5 mg/L, and that there is no noticeable odour emanating from the lagoon after the aeration equipment has been halted.

Operation of the Leachate Treatment Facility

In the event that the lagoon water tested results in COD>200 mg/L and/or NH₃-N>10 mg/L, it will be necessary to treat this water in the biological treatment facility. At this time, water from the aerobic equalization lagoon would not be discharging directly to the stormwater sedimentation and control pond. It is strongly recommended that the start up of the biological treatment facility occur under the guidance of an experienced professional familiar with such undertakings.

1. Drain the anoxic tank to allow for room to inoculate the anoxic/oxic tanks with active biological sludges. This is to be done by having approximately three truckloads of returned activated sludges from neighbouring municipal wastewater treatment works discharged directly into the anoxic tank. Ensure that there is no overflow from the clarifier by topping up the system with the aerobic lagoon water until the clarifier is 0.5 m from the weir. It is recommended that the sludges being obtained have been demonstrated to be strongly

nitrifying. Confirm this with the municipal plant supplying the activated sludges.

2. Activate the blower system by starting up Blowers #2 and #3, by following the instructions in the manufacturer's operations manual. Adjust the blowers speed to maintain the dissolved oxygen in the oxic tank to between 1.5 and 2.0 mg/L.
3. Start up the anoxic mixer. Follow the manufacturer's instructions for the operation and start up of the mixer.
4. Measure the influent water for soluble phosphorus. Take a grab sample from the aerobic lagoon and measure its phosphorus content using the HACH and following the supplier's instructions. If the measured soluble phosphorus is <0.5 mg/L, then supplemental phosphorus will be to be added by the phosphate tank. Follow the manufacturer's operations manual for operating the phosphate pump.
5. Start up the supplemental carbon nutrient system. Additional organic carbon will be necessary to quickly acclimatize the sludges to the leachates. Follow the manufacturer's instructions for the safe operation of this equipment. Add supplemental carbon to the anoxic tank so as to maintain a COD:N:P ratio of 100:5:1.
6. Activate the sludge return pumps and the internal recirculation pumps. Do not waste any sludges during this time. Measure the clarifier effluent for COD, NH₃-N, and soluble phosphorus. As needed, adjust the chemical dosing pump to assist in removing any excessive phosphorus.
7. Allow the system to stabilize for 24 hours. Monitor for COD, NH₃-N, and soluble phosphorus in both the anoxic and oxic tanks. If all the monitored parameters are in line and it is apparent that the biology has taken hold in the system, then leachates can slowly be introduced. Depending upon the influent leachate COD, the supplemental carbon dosing will need to be adjusted accordingly to maintain the COD:N:P ratio of 100:5:1.
8. Slowly pump the aerobic lagoon water directly into the anoxic tank. The influent pumping rate for the aerobic lagoon should be adjust so as to maintain a 2 metre liquid level in the aerobic lagoon.

As needed, daily monitoring of the system is to take place. As needed, adjust the supplemental carbon dosing rate to the point that more leachates can be treated by the system.

1.3 OPERATION OF THE LEACHATE TREATMENT FACILITY

This section is provided to give directions for the safe operation of the leachate treatment system. It is intended that the leachate treatment facility would now be needed to treat the high strength leachates from the landfill sites. It is assumed that the anoxic and oxic treatment systems have been commissioned and inoculated with viable bacteria to allow for proper treatment of the high strength sludges.

Sample in incoming raw water to the leachate treatment facility. If the leachate strength is low, as determined by the sample analysis results from the HACH instrument of $\text{COD} < 100 \text{ mg/L}$ and $\text{NH}_3\text{-N} < 5 \text{ mg/L}$, then this water may bypass the aerobic equalization lagoon and pumped directly to the stormwater sedimentation and control pond.

If the sample analysis results in having a $\text{COD} > 100 \text{ mg/L}$ or $\text{NH}_3\text{-N} > 5 \text{ mg/L}$, then the raw water is to be sent to the leachate treatment facility.

Maintain the lagoon at a 2 m depth and have all additional influent water being pumped to the leachate treatment facility. If there is a noticeable odour emanating from the aerobic equalization lagoon during this time, the aeration system is to be activated. Please refer to Section 5.1.2 for the operation of the aeration system for the aerobic lagoon.

Sample the water entering the biological treatment facility and analysis using the HACH instrument and following the supplier's instructions for soluble phosphorus. If the soluble phosphorus in this sample is less than 0.5 mg/L , then additional phosphorus is required to maintain optimum biological treatment of the leachates. Start up the phosphorus addition system and adjust the feed rate of the pump to achieve the desired soluble phosphorus concentration in the influent wastewater. This is to be done in accordance with the supplied phosphorus guidance sheet.

In the event that the soluble phosphorus is greater than 8 mg/L , then additional chemicals are required to maintain the effluent within the discharge criteria. Start the alum/ferric chloride addition system and adjust the feed rate to remove the excess soluble phosphorus.

As the system starts to generate additional solids, commence slowly sludge wasting to maintain the mixed liquor suspended solids in the oxic tank in the range of $2,000 \text{ mg/L}$.

1.4 OPERATOR ROUTINE CHECKS

As part of the operators regular duties, the operator will be responsible for performing daily, weekly, and monthly checks on the equipment and operations of the leachate treatment facility. These checks are to be recorded on log sheets to allow for the tracking of the performance of the leachate treatment facility, ensuring adherence to the supplier's recommended maintenance schedules, and to assist with any troubleshooting of operational difficulties which may arise during the course of the facility's operation. As needed, the operator will complete the log sheet and submit it to his immediate supervisor for tracking and record keeping.

A sample log sheet to be completed daily by the operator has been provided in Appendix B.

Some of the routine monitoring tasks that are to be performed by the operator are listed below.

1.4.1 DAILY MONITORING

Blowers:

- All blowers intakes are free and clear of any obstructions. Remove all obstructions to ensure proper operation of the blower equipment.
- No noticeable oil leaks in the vicinity of blower equipment. Clean up any noticeable oil leaks and determine the source of the leak. As needed, tag and lock out the affected equipment and enact maintenance procedures to bring equipment back online.

Aerobic Lagoon system:

- Discharge pump intakes are free and clear of any obstructions. Remove all obstructions to ensure proper operation of the lagoon pumps equipment.

Biological Treatment Facility:

- Clarifier overflow weir is free and clear of debris, remove all obstructions to ensure proper operation of the clarifier.

- Remove and visually inspect all instrumentation probes such as DO, pH, and ORP. Clean probes to ensure good contacting surface.
- Grab samples from the aerobic lagoon, anoxic, oxic, and clarifier effluents for chemical analysis.
- Record the amount of sludge wasting.
- Adjust supplemental chemical, phosphorus, and carbon dosing feed rates as needed.

1.4.2 WEEKLY MONITORING

Biological Treatment Facility:

- Calibrate pH meters in accordance with the supplier's instructions.
- Perform sludge settleability tests upon anoxic and oxic sludges, record results.
- Perform oxygen uptake tests upon oxic sludge, record results.
- Record all chemical storage tank levels as needed, place a request for restocking of chemical if needed.
- Dispose of sludges to the landfill after undergoing aerobic digestion. Record the amount of sludges transferred to the landfill.

1.4.3 MONTHLY MONITORING

- Perform oil changes on all motorized equipment on a monthly basis. As needed, record oil levels and top up if necessary. Record and report any excessive oil consumption to immediate supervisor.
- Measure the depth of solids in the aerobic lagoon. Record the result.
- Calibrate the DO and ORP meters in accordance with the supplier's instructions.

APPENDIX C

LANDFILL GAS MANAGEMENT

LANDFILL GAS COLLECTION SYSTEM

An active LFG control system has been developed and shall implemented upon reaching specified triggering levels or conditions that would initiate the installation and operation of the LFG collection and flaring system.

The LFG management system will be composed of a number of elements. The four key elements are as follows:

- LFG collection field consisting of horizontal trenches;
- main header pipe network and laterals to convey the collected LFG to the LFG management facility;
- condensate management system; and
- LFG management facility consisting of centrifugal blower and flare.

The first phase of the LFG management system construction would be limited to the installation of the main header during infrastructure development in the first year of the Contract. The LFG horizontal trenches shall be installed in the second last lift of waste prior to progressive capping of the Site.

The LFG management facility would be constructed to coincide with the completion of the first phase of the progressive closure, permitting the installed LFG collection trenches to be commissioned as they are installed and LFG collection operations to commence. It is assumed, for the purpose of this report, that the first phase of progressive closure would be completed approximately 10 years after commencement of site development activities.

The pipe network is envisioned to include two components to be installed in the initial construction phase of the proposed Site:

- main header; and
- lateral header "T" connections.

The main header will be constructed of 300 mm (12-inch) diameter SDR 26 HDPE pipe. The 150 mm HDPE "T" couplers will be fused at 40 m intervals along the main header, extended to the surface at a minimum slope of 2 percent and blind flanged at surface to facilitate the connection of the LFG extraction trenches during progressive closure of the Site.

The main header shall sloped towards two low points along the header alignment at a minimum slope of 1 percent. These two low points should coincide with the locations of the leachate pump stations.

The primary components of the LFG management facility include the following:

- condensate knock-out pot (KOP);
- piping and valves;
- LFG instrumentation (quantity and quality);
- LFG extraction blower; and
- Enclosed flare.

Due to the temperate climate of the region, a simple roofed enclosure structure will be required to shelter the control plant instrumentation and blower systems and to provide security for the equipment and control panels.

The blower should have a design capacity of 2,000 m³/hour and be equipped with an explosion-proof electric motor and spark-proof fan assembly.

The installation of the flare is recommended for the purpose of combusting the LFG in a cost-effective manner.

NOTE:

At the time of this writing, complete details for the operation and maintenance of the LFG collection and flaring are not available since the system has not been designed and commissioned. As previously discussed, it is anticipated that the LFG collection and flaring system will be required after approximately 10 years of operating Site life. When the LFG collection and flaring system has been constructed and commissioned a final operation and maintenance guideline will be prepared and submitted for review and evaluation by the Owner.

APPENDIX D

FLOW OF WASTE

1.0 WASTE MANAGEMENT

The tipping face is the active part of the Site, where waste is placed and compacted on a daily basis. The location of the tipping face within the Site changes as more waste is added. As waste accumulates in the Site, the tipping face also proceeds higher in elevation along with the increase in the height of the deposited waste. The size of the tipping face will be adjusted according to the number of vehicles likely to be at the tipping face at any time.

The operations at the tipping face consist of the following primary tasks:

- preparation of the tipping face and the site road;
- relocation of direction signs;
- notification to the site personnel and weighbridge staff as soon as the area is ready to accept waste deposition vehicles;
- directing the vehicles at the tipping face;
- spread waste maintaining required slope;
- compact waste to required density;
- apply daily cover at the end of the day;
- arrange for the following day's tipping location; and
- shut down landfill site and equipment.

1.1 PLACEMENT OF WASTE

Waste will be placed by utilizing the area method, that is, the waste will be filled and compacted over the prepared base, in layers, and daily cover will be applied following the waste segregation and recycling activities carried out by the Site's licenced waste pickers.

Waste hauling trucks will unload at the designated drop-off area within the landfill footprint for waste diversion activities including access for waste pickers. Waste pickers will be given access to a number of restricted areas of the Site and will be given a specified time allocation to have access to the waste. An area close to the tipping face will be designated for waste pickers. The waste placement must be staged such that after the allocated time period for recycling/segregation activities has expired, that all waste pickers will be required to vacate the specific area and the waste will be pushed

into the disposal cell and compacted. Waste pickers will not be granted access to the active tipping face areas due to safety and operational concerns.

The waste pickers will be allowed to move recoverable materials to the assigned staging area for subsequent sorting and cleanup. Any residual wastes from the sorting operation will be placed in a separate designated area to be returned to the filling area on a daily basis. Residual wastes will not be retained in the sorting area for more than 24 hours. Waste pickers that do not adhere to the above procedures may lose their Site access privileges.

For the placement of the initial layer (lift) of waste at the Site, the following procedures and considerations are to be followed:

- a site road shall constructed to the pre-determined access point for waste placement, from the ramp running from the site service road to the landfill base, for the placement of the initial lift of waste above the leachate collection system. The initial site road will be part of the construction works contract. However, the maintenance and extension during the operation period will be an obligation of the Contractor;
- a turnaround area and tipping platform designed to accommodate a minimum of three trucks also has to be built of materials suitable for the season, which will support dumping and turning by the waste ferrying vehicles. The initial construction work will be part of the construction works contract. However, the maintenance and extension during the operation period will be an obligation of the Contractor; and
- the minimum thickness of the initial lift shall 0.6 m layer of selected waste at the base and at least an additional 1.5 m of waste above that.

As indicated in the earlier sections of this document, the selected waste will consist of residential waste or other suitable wastes without sharp metallic objects or material likely to damage the leachate collection system. Typically, general residential wastes do not contain large and/or sharp objects that could damage the leachate collection system.

Drivers shall keep a minimum of 2 m from the edge of the initial lift and use caution whilst working in that area. Aggressive handling of the waste could cause the filter fabric or drainage layer to shift thereby reducing the effectiveness of the leachate collection system.

Waste hauling vehicles shall kept away from the edge of the initial lift to prevent them from getting into the selected waste and damaging the leachate collection layer.

A light or medium sized bulldozer or excavator shall used to push and level the waste for the initial lift. Equipment operators should take extreme care in levelling the waste, as no compaction shall applied other than during spreading. The operator should not attempt to drive over the leading edge of the lift. At no time should the thickness of the waste on which the equipment is operating for the initial lift be less than 1 m above the upper element of the leachate collection system. The landfill compactor must not be used to compact the initial lift.

The initial lift of residential waste will act as filter for the leachate collection system. Accordingly, heavy compaction of this initial lift is to be avoided so as not to reduce the ability of the initial layer to protect the leachate collection system, and also not to reduce the flow of leachate to the collection system.

The Contractor will build an all weather site road over the waste as filling progresses. This road will serve as access to the tipping face and maintained to give rear-wheel drive vehicles access in all weather conditions.

Waste will be compacted in lifts not exceeding 2.0 m thick using multiple passes with the landfill compactor (typically two to five passes), depending on the equipment available and the material being compacted. Daily cover consisting of native soils, wood chips, and suitable imported material designated as ADC will be placed in accessible portions of the working face prior to the end of each operating day. The type, amount, and area that the daily cover has been applied to will be included in the Site operator's daily report.

The estimated average daily volume of waste/daily cover landfilled will be approximately 200 to 250 tonnes per day based on the average annual disposal rate of approximately 67,000 tonnes per year.

Typically daily cover for active areas of the Site shall approximately 100 to 150 mm in thickness to ensure reasonable cover of the waste. The daily cover shall placed by a bulldozer and not by a waste compactor. A waste compactor will render the daily cover materials ineffective for litter and vector control unless it was placed in a much thicker lift of material that is not recommended and which would place greater stress on soil resources.

1.2 WASTE COMPACTION

The Contractor must increase the in-situ density of the solid waste delivered at the site, through compaction, to meet the maximum density of 700 kg/m³ for the designed life span of the site. Compacting the waste is intended to maximize the waste density to best utilise available void space, which in addition, also offers significant other benefits, including:

- minimising the daily cover requirements;
- reducing the chance of differential settlement;
- minimising leachate production;
- enhancing the structural stability of the landfill;
- reducing the potential for fire;
- reducing problems of infestation by vermin, flies, pests and birds; and
- minimising odour problems.

The Contractor shall take into consideration the following points while spreading and compacting the waste:

- attempt to push only the amount of waste that the equipment can move without excessive wheel slippage, as it will damage the previously compacted layer;
- progressively raise the blade of compactor/ bulldozer as it travels up a slope of waste. The operator should maintain an average waste thickness of 0.5 m;
- distribution and co-disposal of different types of waste on the tipping face is considered as a means to improve compaction;
- waste placement, spreading and compaction is best achieved by pushing waste up slope not be steeper than 1:5 (H:V);
- after the equipment operator has pushed and spread a layer of waste over the entire slope area the waste will be compacted a minimum of three passes to achieve the minimum waste deposited density of 700 kg/m³;
- when dealing with low-density waste that rebounds after compaction such as brush, leaves, tree trimmings, agricultural wastes, and low-density plastics, special measures are to be taken to ensure that they are compacted sufficiently;
- maintain a smooth tipping face slope and horizontal surface to ensure need of only minimal daily cover soil and to promote surface water drainage;

- whenever possible, wet waste and dry waste from different vehicles are to be mixed; and
- during periods of above normal precipitation, the Contractor should reduce the tipping area and increase the slope [no steeper than 1:5 (H:V)] to reduce the infiltration of water and thereby, reduce the generation of leachate.

1.3 COVER OPERATIONS

Use of clay materials for daily cover on the tipping face and on the working lift platforms is not the ideal material because it can tend to produce localized perched areas in the landfill which promote lateral flows to the sideslopes of the landfill, resulting in potential leachate seeps. To promote good hydraulic connection throughout the waste in the landfill, the use of alternative daily cover (ADC) materials shall encouraged, when these materials can be made available. ADC materials can include the following:

- construction and demolition debris;
- woodchips and other vegetative matter;
- solid, non-hazardous wastes such as contaminated soils or other industrial or commercial wastes suitable as daily cover; and
- other cost-effective ADC technologies such as tarp systems and binder sprays.

The use of alternative daily and interim cover would have some inherent benefits for the landfill performance and would reduce any potential future costs of importing materials. ADC material selected for use at the Site will depend upon availability of local materials. The waste-to-daily cover ratio is expected to be in the range of 6:1. Thus, the volume of daily cover material required to complete the Site is approximately 335,000 m³.

Interim cover is a term used to apply to an area that is not yet completed but is expected to be inactive for waste filling for 6 months or more. In these areas, which are typically the working platforms above the major lift lines, a thicker layer of interim cover is placed on the waste in the range of 300 mm in thickness. Note that interim cover materials shall be removed prior to placing the next lift of waste to try to ensure a good hydraulic connection through the waste, and minimize the potential for leachate seepage. After surplus cover is removed, the waste compactor should traverse the area before the next lift of waste is placed to co-mingle the remaining cover and waste to mitigate against localized perched leachate conditions within the Site.

1.4 UNACCEPTABLE WASTE

Site personnel actively involved with day-to-day landfill operations will be trained to identify waste loads that may be unacceptable for landfilling at the Site. If a load is refused due to an unacceptable waste profile, efforts will be made to obtain the following information:

- the source of the load;
- name of driver;
- licence number of vehicle; and
- company name on truck.

This information, including date and reason for refusal, will be maintained on Site for record-keeping purposes.

There will be a list of prohibited materials posted on signs at the Site entrance. The nature of the weigh scale operation will permit tracking of licence numbers of offending vehicles and companies to permit follow-up response measures to be taken in the event that the non-compliance by some parties becomes a chronic issue. It is also expected that over time, the list of restricted materials may be modified by the waste management authorities. These types of changes will require public consultation and notification as well as a phase in period to ensure that all users of the Site become aware of any changes to policy and the Site-specific requirements.

Appendix B

Leachate Treatment System
Leachate Treatment System Overview
Start up of the Leachate Treatment System
Operation of the Leachate Treatment Facility
Operator Routine Checks
Daily Monitoring
Weekly Monitoring
Monthly Monitoring

Appendix C

Landfill Gas Collection System

Appendix D

Waste Management
Placement of Waste
Waste Compaction
Cover Operations
Unacceptable Waste

Appendix E

Preparation of Environmental and Social Impact Report and Public Consultation
Environmental and Social Impact Management Report

Appendix F

Response to Questionnaires

Appendix G

Landfill Gas Emissions Analysis

Appendix H

To Be Provided

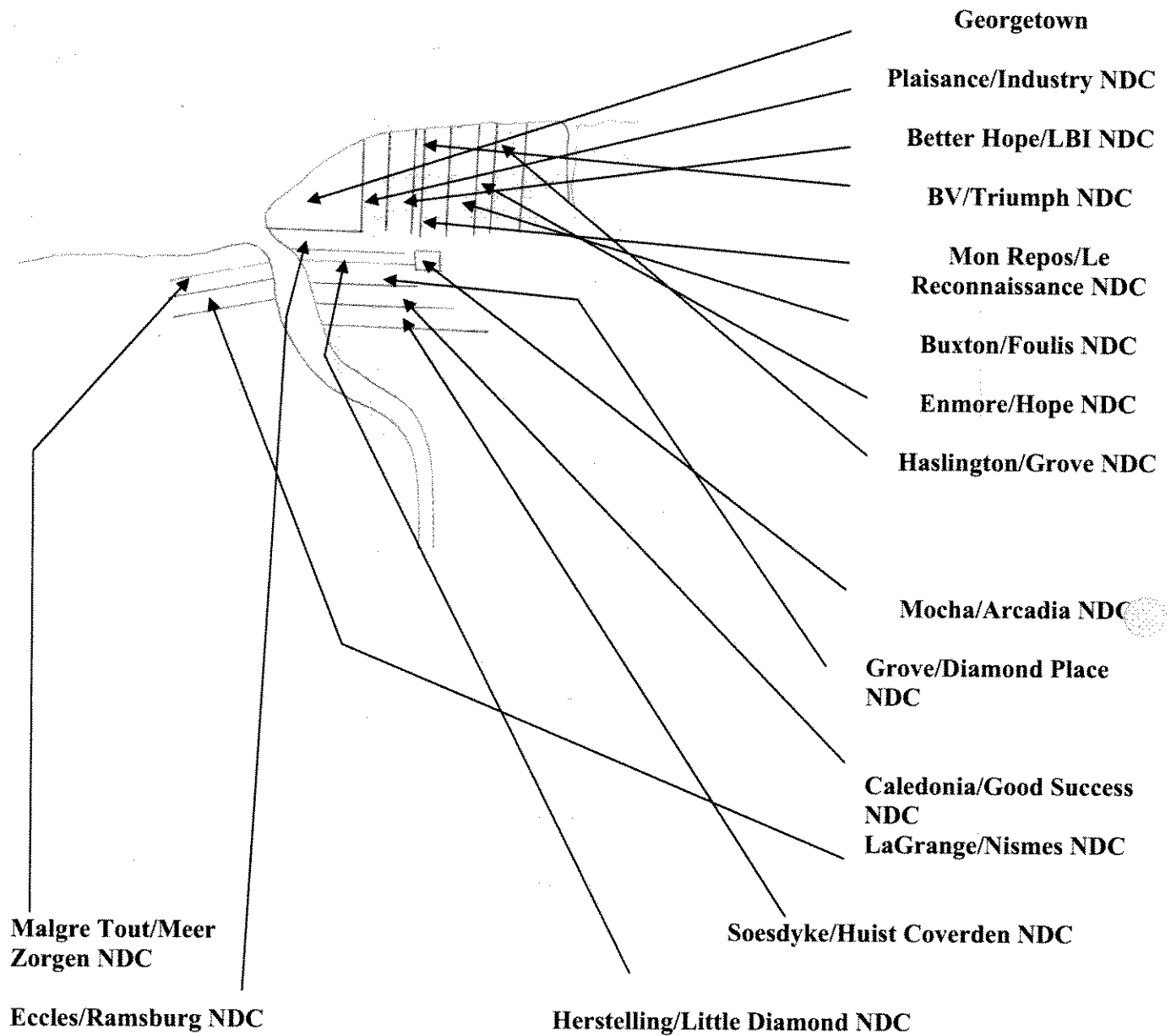
Appendix I

Consultation Minutes

APPENDIX A

TABLES, FIGURES, AND DRAWING SET

Figure 1: Location of NDCs and Georgetown



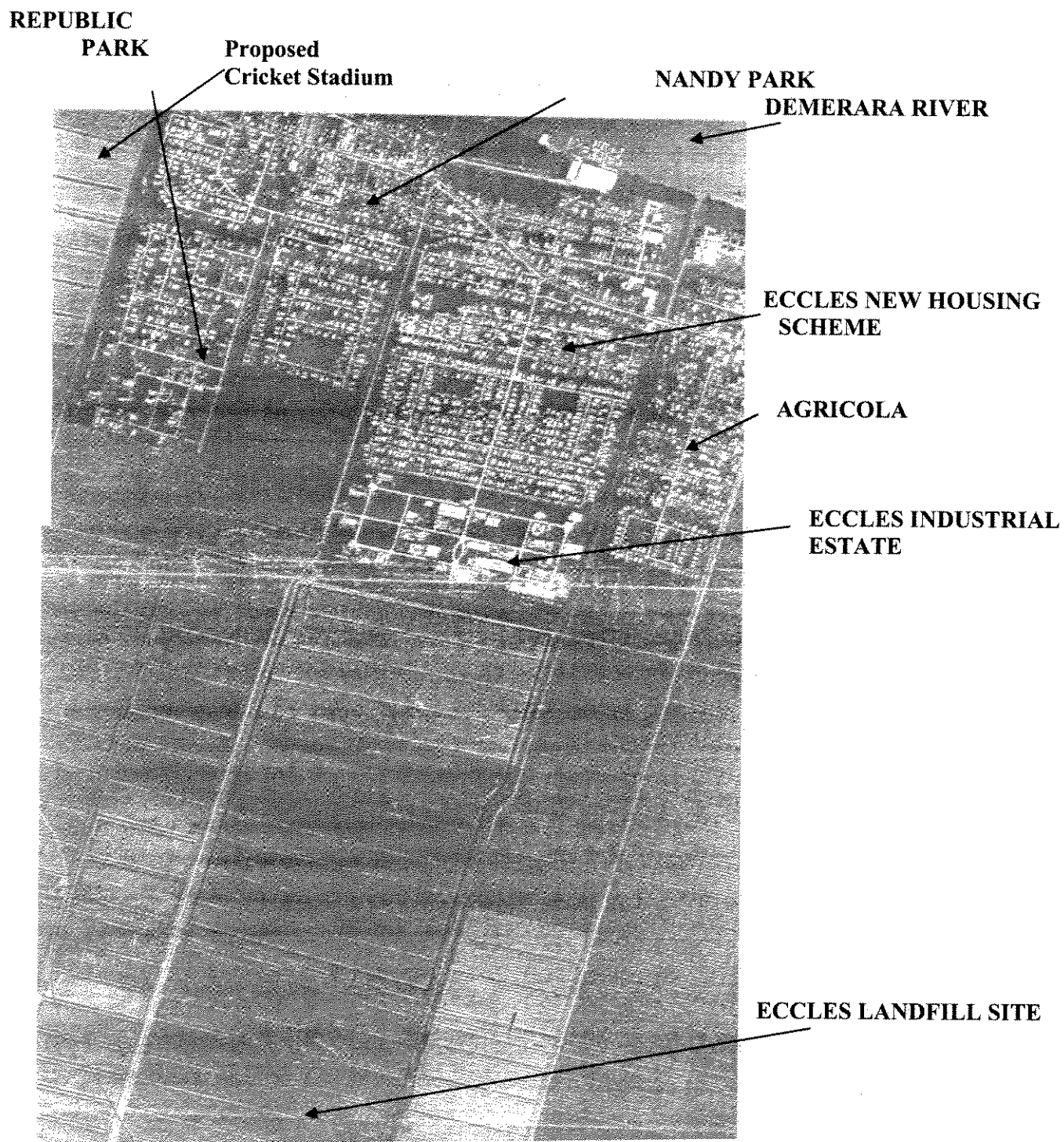
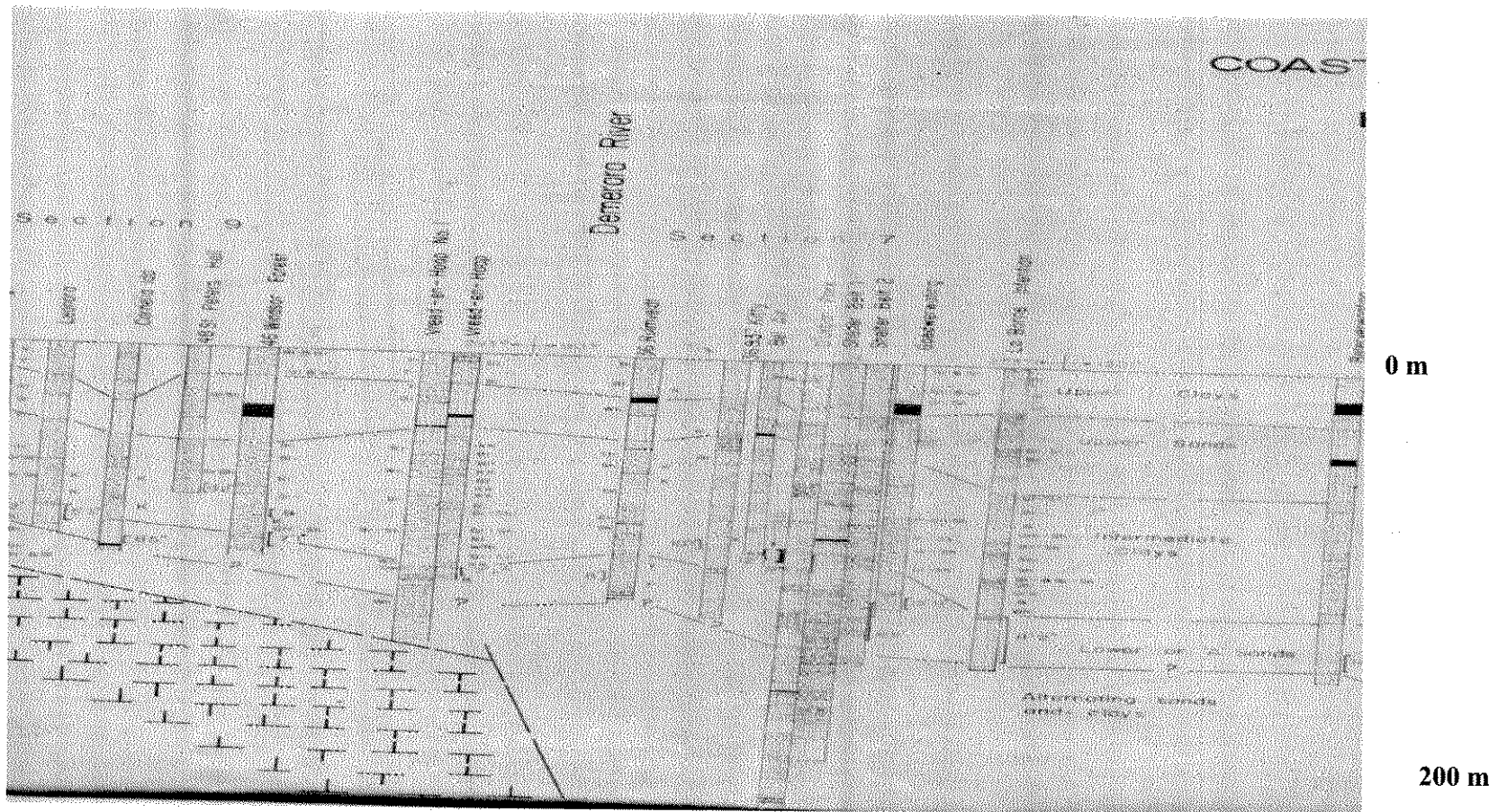


Figure 2: Proximity of Sanitary Landfill Surrounding Communities



Figure 4: Section Through Coastal Artesian Aquifer showing Peters Hall Well



The map illustrates the study area with the following labeled locations and features:

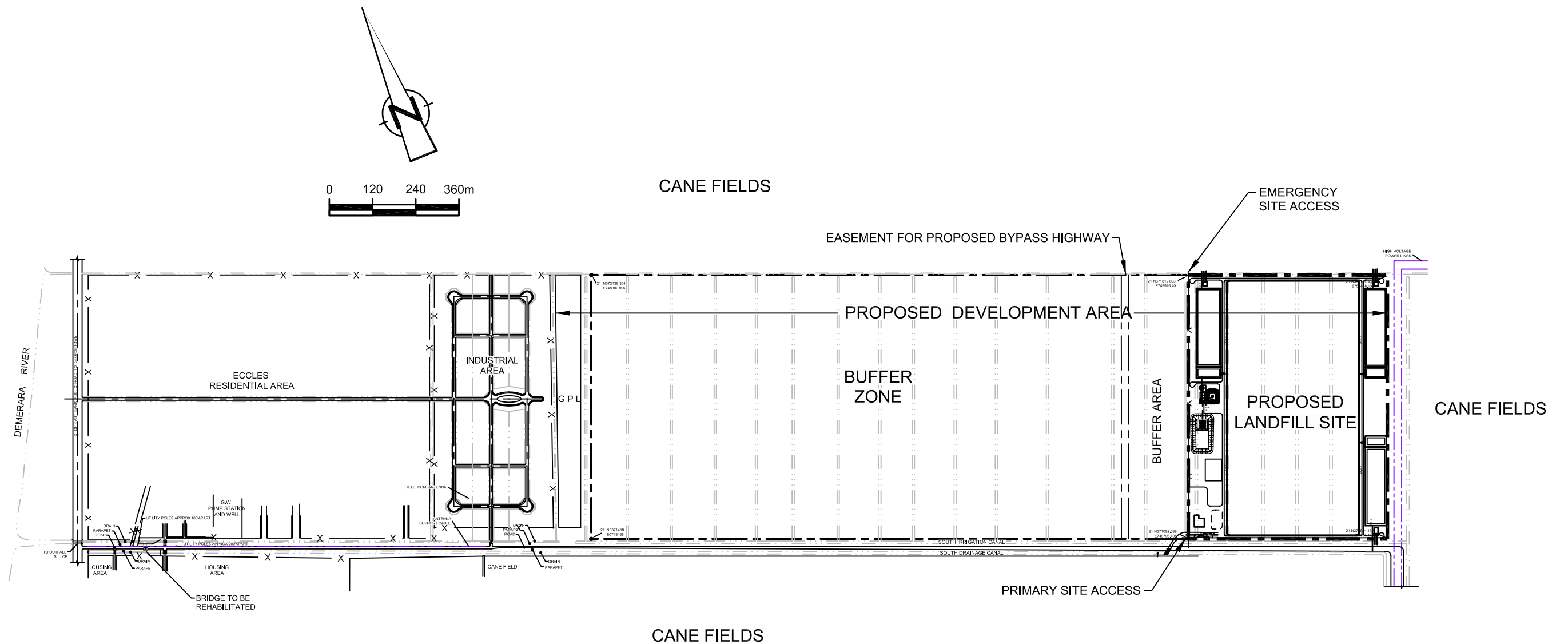
- INDUSTRIAL ESTATE**: Located in the upper left, indicated by a hatched area.
- LANDFILL SITE**: Located in the upper right, indicated by a hatched area.
- AGRICOLA VILLAGE**: Located in the upper center, indicated by a hatched area.
- ECCLES**: Located in the upper center, indicated by a hatched area.
- PETER'S HALL**: Two locations, indicated by vertical lines.
- PROVIDENCE (North)**: Located in the lower center, indicated by vertical lines.
- PROVIDENCE (South)**: Located in the lower center, indicated by vertical lines.
- 3 Housing Phases (Govt)**: Located in the upper left, indicated by a hatched area.
- Cultivated Lands**: Four locations, indicated by vertical lines.
- Barra River**: Located on the left side, indicated by a wavy line.

A scale bar at the bottom left indicates distances in feet (0, 2000, 4000). A north arrow is also present.

Cultivated Lands

Cultivated Lands

Cultivated Lands



LEGEND	
---	PROPERTY BOUNDARY
---	SITE BOUNDARY
---	CANAL
X	FENCE
■	BRIDGE
GPL	GUYANA POWER AND LIGHT
GW1	GUYANA WATER INC.

SOURCE:
SITE PLAN FROM TROW ASSOCIATES INC.
JUNE 2004

NOTES:
1) ALL MEASUREMENTS IN METRES
UNLESS OTHERWISE INDICATED
2) NORTH AND SOUTH DRAINAGE
CANALS DRAIN WEST TO THE
DEMERARA RIVER.

figure 1.2
SITE LOCATION PLAN
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH, GUYANA
Ministry of Local Government and Regional Development



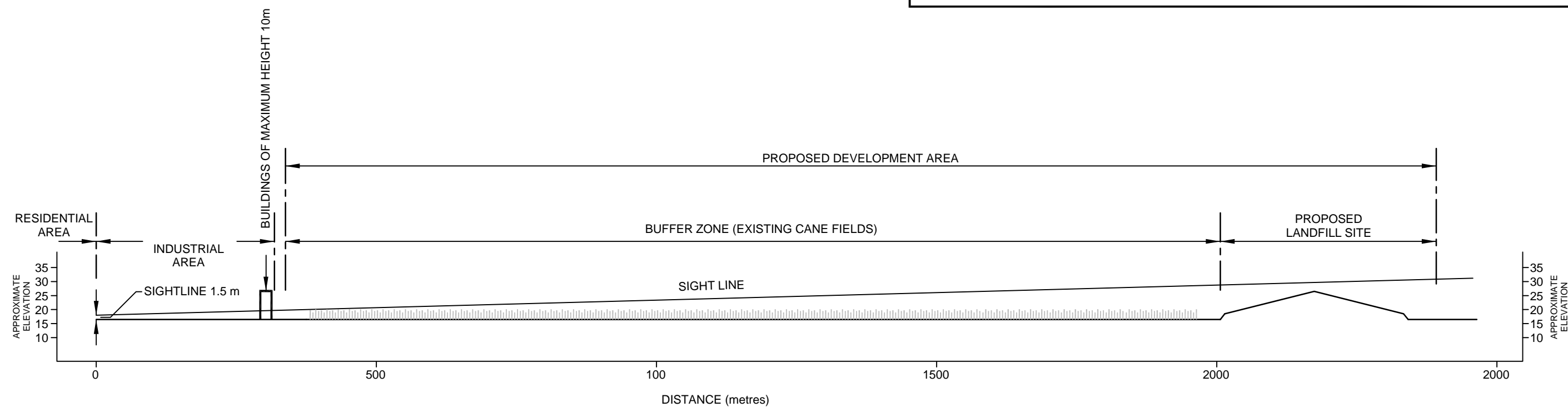
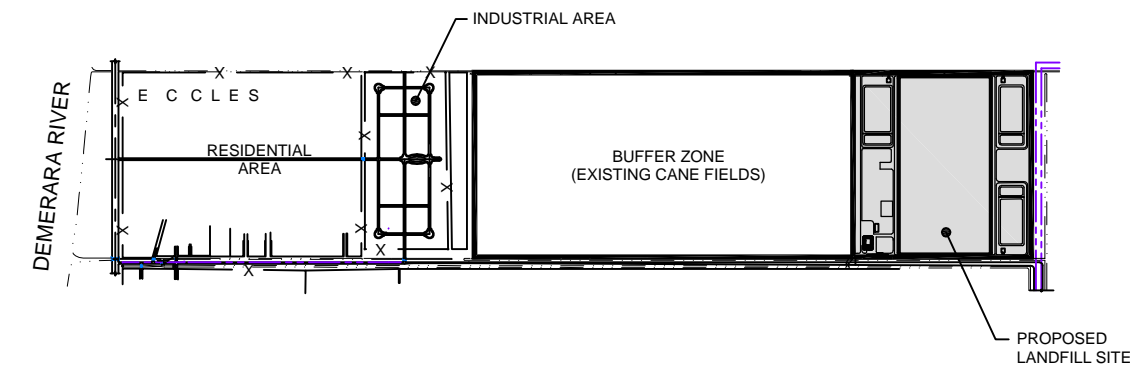
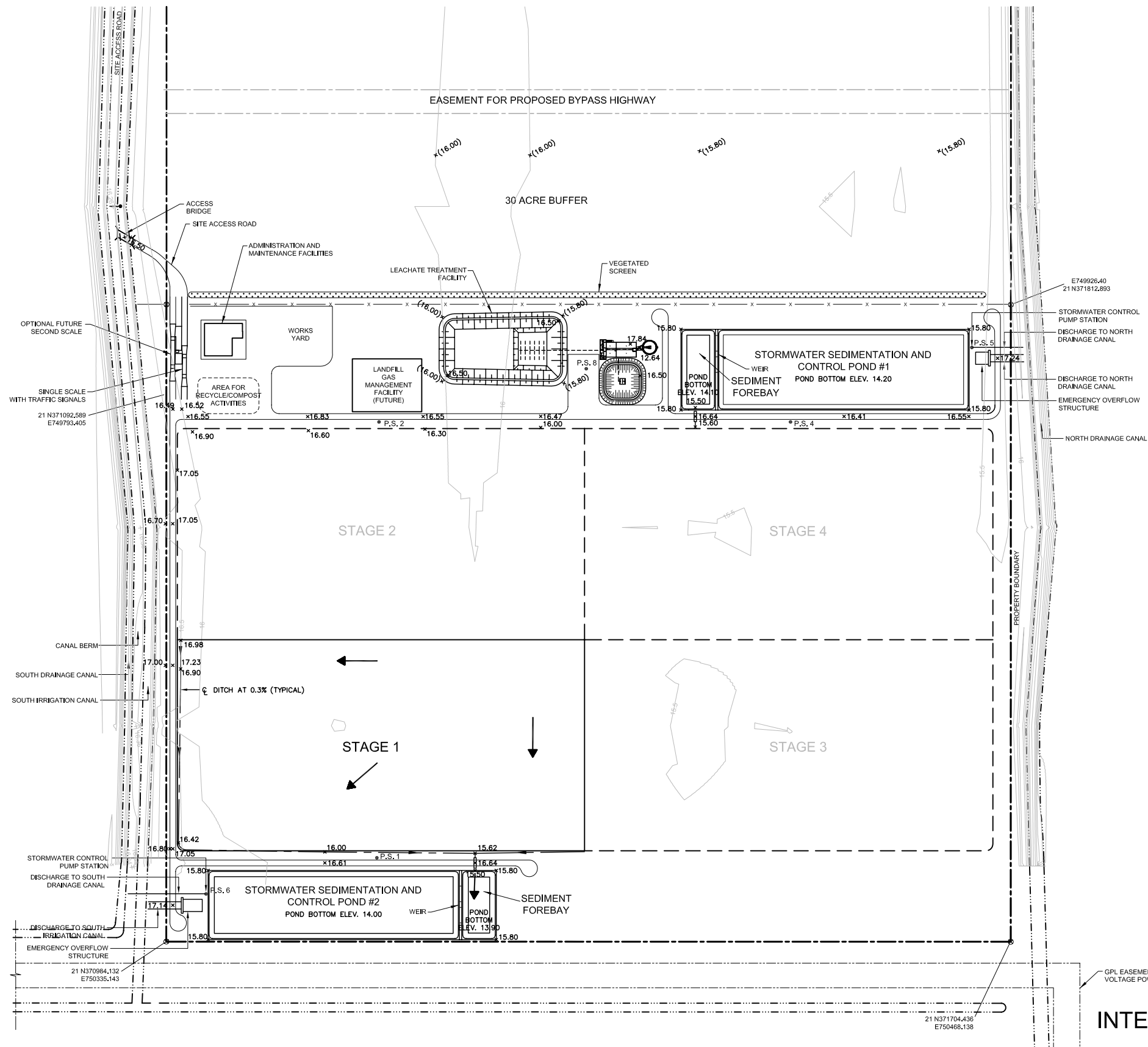
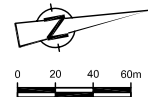


figure 4.1

VISUAL SITE LINE
 DESIGN AND OPERATIONS REPORT
 NEW SANITARY LANDFILL IN HAAGS BOSCH, GUYANA
Ministry of Local Government and Regional Development





LEGEND

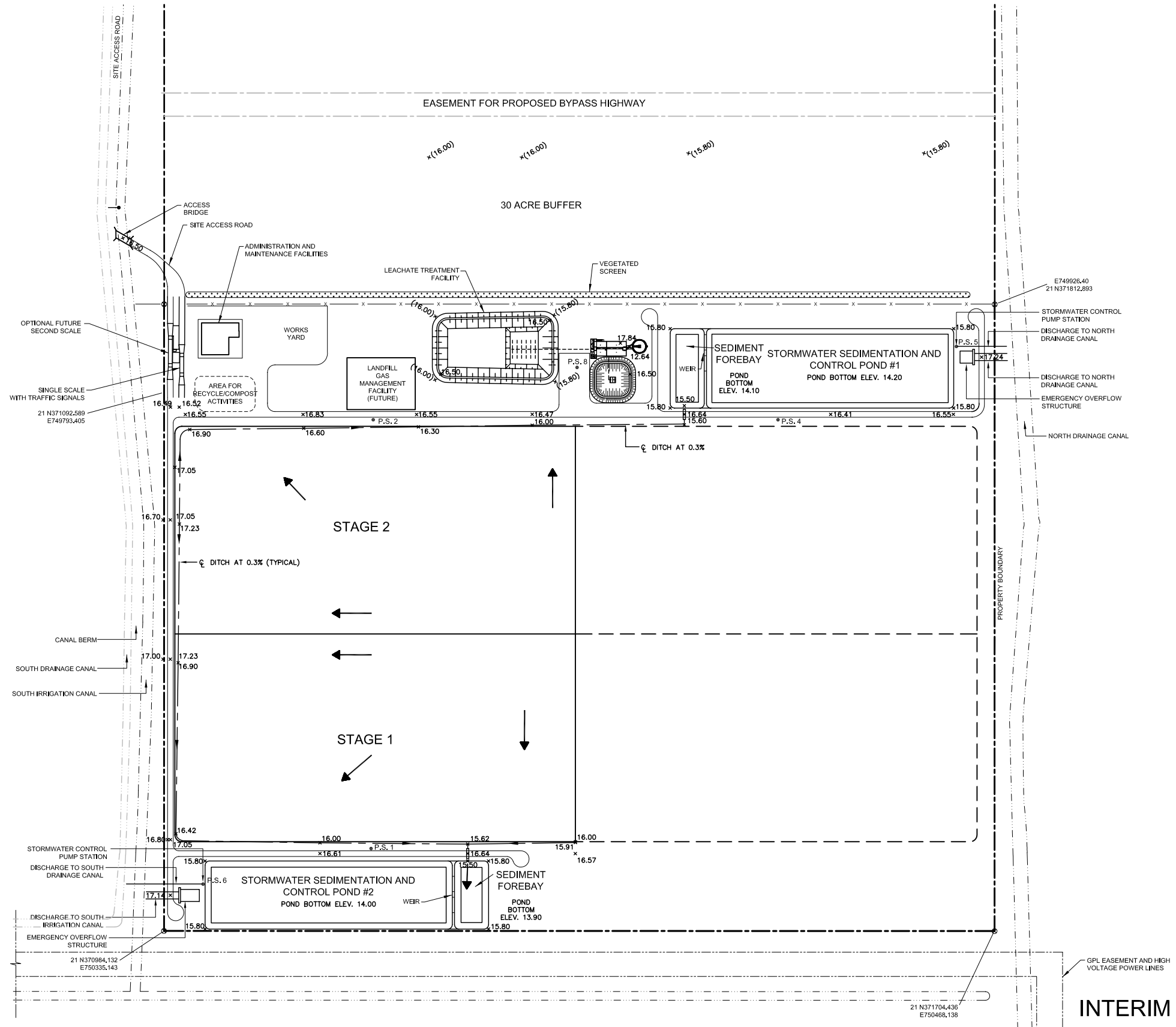
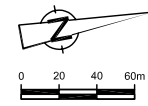
- OVERLAND FLOW
- * (15.80) EXISTING GRADE TO REMAIN
- x 16.60 PROPOSED GRADE

figure 6.1

**INTERIM SITE DRAINAGE PATTERN
STAGE 1**

NEW SANITARY LANDFILL IN HAAGS BOSCH, GUYANA
Ministry of Local Government and Regional Development

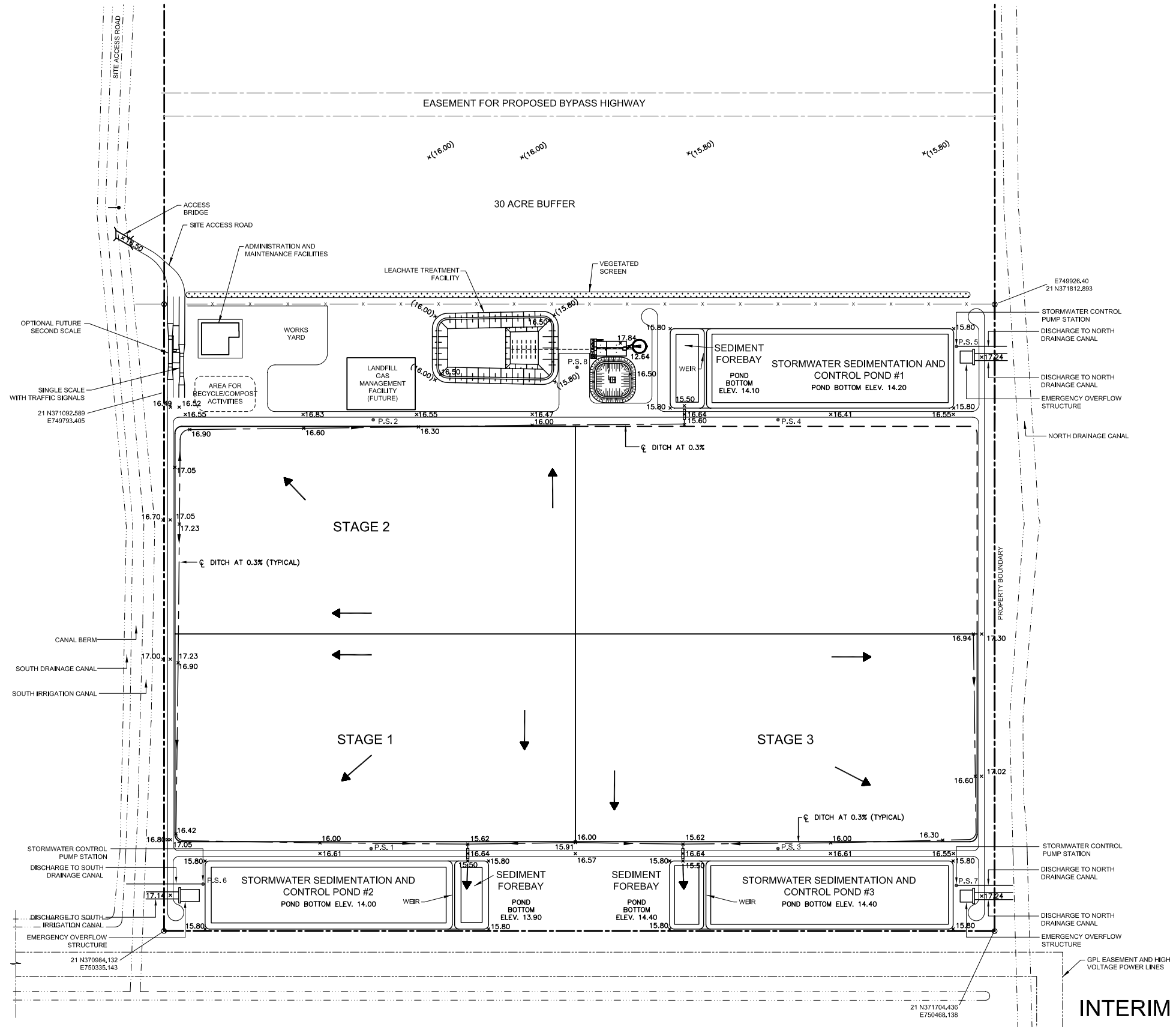
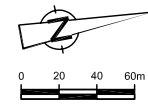




- LEGEND**
- OVERLAND FLOW
 - x(15.80) EXISTING GRADE TO REMAIN
 - x 16.60 PROPOSED GRADE

figure 6.2
**INTERIM SITE DRAINAGE PATTERN
STAGE 2**
NEW SANITARY LANDFILL IN HAAGS BOSCH, GUYANA
Ministry of Local Government and Regional Development





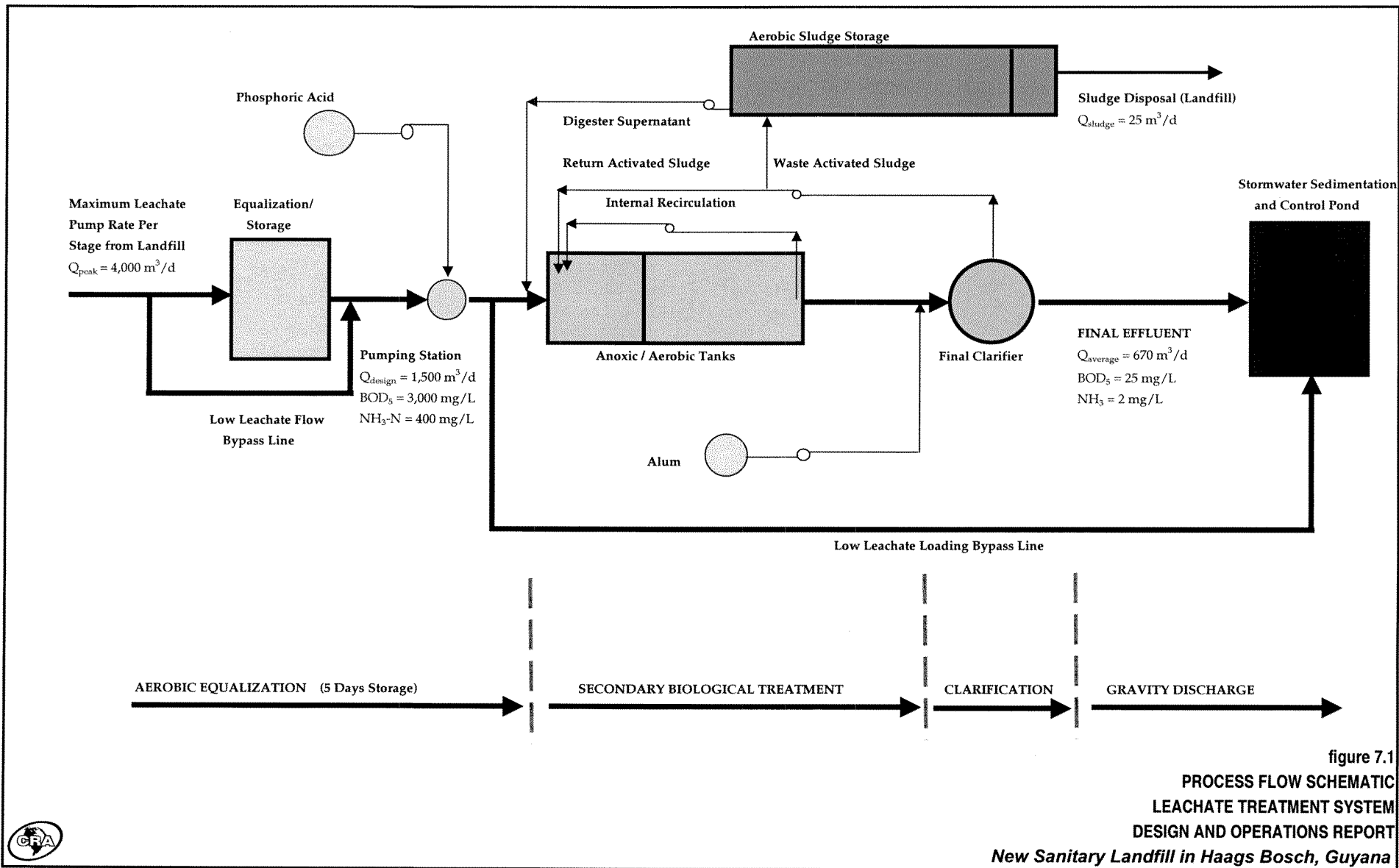
- LEGEND**
- OVERLAND FLOW
 - x(15.80) EXISTING GRADE TO REMAIN
 - x 16.60 PROPOSED GRADE

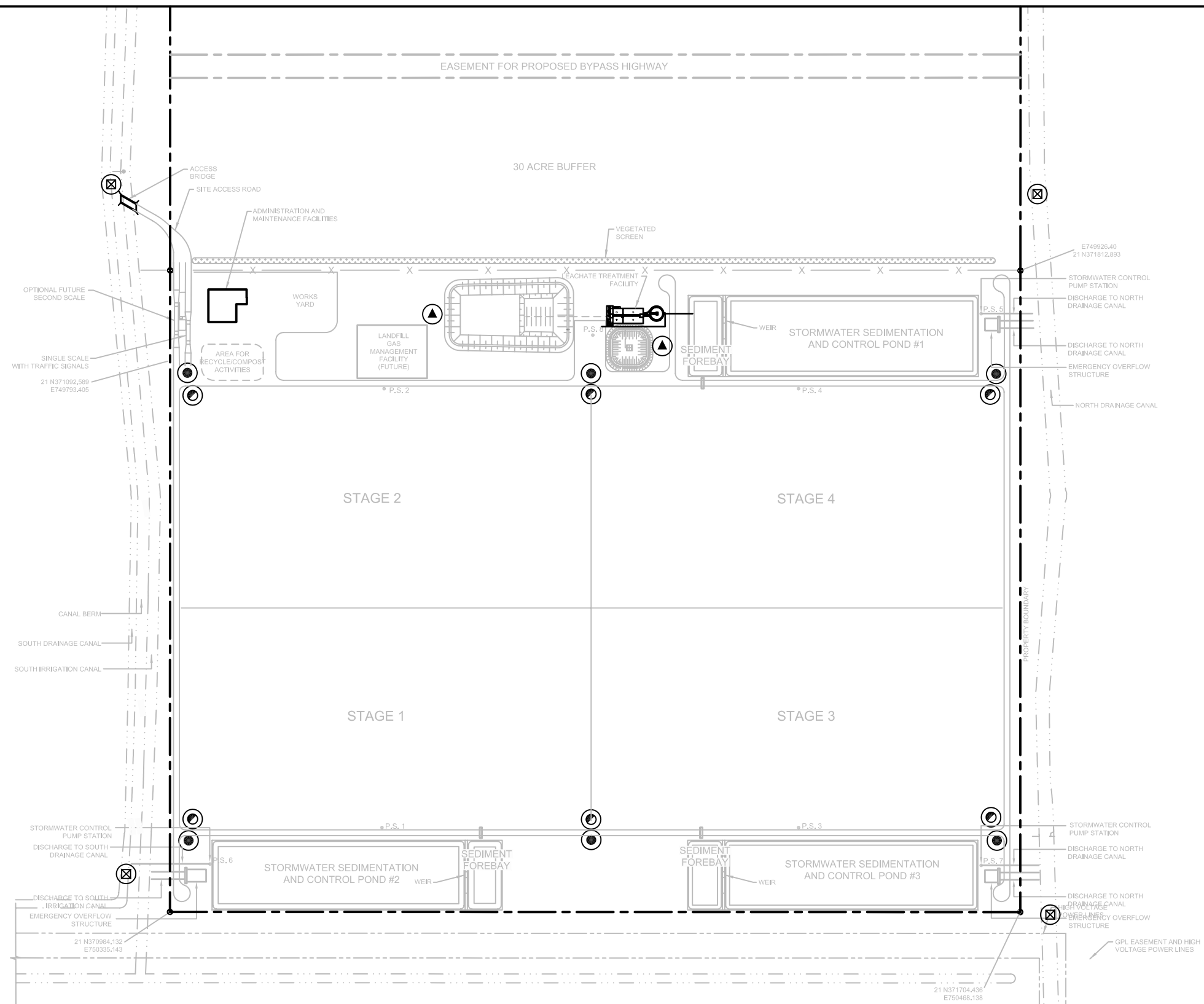
figure 6.3

**INTERIM SITE DRAINAGE PATTERN
STAGE 3**

NEW SANITARY LANDFILL IN HAAGS BOSCH, GUYANA
Ministry of Local Government and Regional Development







CONSTRUCTION OF SANITARY LANDFILL IN HAAGS BOSCH

GUYANA

MINISTRY OF LOCAL GOVERNMENT AND REGIONAL DEVELOPMENT



DRAWING INDEX				DRAWING INDEX			
DWG No	REV. No	DATE	TITLE	DWG No	REV. No	DATE	TITLE
GENERAL							
G-01	0	JANUARY 2005	COVER PAGE	C-38	0	JANUARY 2005	BRIDGE DETAILS
G-02	0	JANUARY 2005	ABBREVIATIONS AND DETAIL DESIGNATIONS	C-39	0	JANUARY 2005	ADMINISTRATION BUILDING
G-03	0	JANUARY 2005	MECHANICAL LEGEND	C-40	0	JANUARY 2005	BUILDING ELEVATIONS AND SECTIONS
G-04	0	JANUARY 2005	ELECTRICAL LEGEND	C-41	0	JANUARY 2005	FOUNDATION PLANS AND DETAILS
G-05	0	JANUARY 2005	INSTRUMENTATION AND CONTROL LEGEND	C-42	0	JANUARY 2005	SUN SHELTER
CIVIL				STRUCTURAL			
C-01	0	JANUARY 2005	EXISTING CONDITIONS (OVERALL SITE AREA)	S-01	0	JANUARY 2005	ANOXIC AND AERATION TANK PLAN
C-02	0	JANUARY 2005	EXISTING CONDITIONS (PROPOSED LANDFILL AREA))	S-02	0	JANUARY 2005	CLARIFIER PLAN AND SECTIONS
C-03	0	JANUARY 2005	SITE PLAN (PROPOSED LANDFILL AREA)	S-03	0	JANUARY 2005	ANOXIC AND AERATION TANK SECTIONS
C-04	0	JANUARY 2005	SITE DEVELOPMENT SEQUENCE (1 OF 3)	S-04	0	JANUARY 2005	LEACHATE TREATMENT FACILITY SECTIONS AND DETAILS (1 OF 2)
C-05	0	JANUARY 2005	SITE DEVELOPMENT SEQUENCE (2 OF 3)	S-05	0	JANUARY 2005	LEACHATE TREATMENT FACILITY SECTIONS AND DETAILS (2 OF 2)
C-06	0	JANUARY 2005	SITE DEVELOPMENT SEQUENCE (3 OF 3)	S-06	0	JANUARY 2005	STANDARD DETAILS (1 OF 3)
C-07	0	JANUARY 2005	BASE CONTOUR PLAN	S-07	0	JANUARY 2005	STANDARD DETAILS (2 OF 3)
C-08	0	JANUARY 2005	FINAL CONTOUR PLAN	S-08	0	JANUARY 2005	STANDARD DETAILS (3 OF 3)
C-09	0	JANUARY 2005	LANDFILL AREA SECTION A AND B	MECHANICAL			
C-10	0	JANUARY 2005	LANDFILL AREA SECTION C AND D	M-01	0	JANUARY 2005	ANOXIC AND AERATION TANK PLAN
C-11	0	JANUARY 2005	LEACHATE COLLECTION SYSTEM	M-02	0	JANUARY 2005	CLARIFIER PLAN
C-12	0	JANUARY 2005	BASE LINER AND FINAL COVER DETAILS	M-03	0	JANUARY 2005	ANOXIC AND AERATION TANK SECTIONS AND DETAILS
C-13	0	JANUARY 2005	LEACHATE COLLECTION SYSTEM DETAILS	M-04	0	JANUARY 2005	ANOXIC AND AERATION TANK PLAN
C-14	0	JANUARY 2005	LANDFILL TOE DETAILS	M-05	0	JANUARY 2005	LEACHATE PUMPING STATIONS
C-15	0	JANUARY 2005	PROPOSED ACCESS ROAD	M-06	0	JANUARY 2005	LAGOON AERATION SYSTEMS AND PUMPING STATION 8
C-16	0	JANUARY 2005	STORMWATER SUBCATCHMENT AREA, PRE-DEVELOPMENT CONDITION	M-07	0	JANUARY 2005	STANDARD DETAILS
C-17	0	JANUARY 2005	STORMWATER SUBCATCHMENT AREA, POST-DEVELOPMENT CONDITION	M-08	0	JANUARY 2005	STORMWATER PUMPING STATION
C-18	0	JANUARY 2005	SITE GRADING AND DRAINAGE	ELECTRICAL			
C-19	0	JANUARY 2005	STORMWATER CONTROL POND NO.1 LAYOUT	E-01	0	JANUARY 2005	ELECTRICAL SITE PLAN
C-20	0	JANUARY 2005	STORMWATER CONTROL POND NO.1 ELEVATIONS	E-02	0	JANUARY 2005	POWER DISTRIBUTION SINGLE LINE DIAGRAM
C-21	0	JANUARY 2005	STORMWATER CONTROL POND NO.2 LAYOUT	E-03	0	JANUARY 2005	ELECTRICAL MCC DIAGRAM
C-22	0	JANUARY 2005	STORMWATER CONTROL POND NO.2 ELEVATIONS	E-04	0	JANUARY 2005	INSTRUMENTATION LAYOUT
C-23	0	JANUARY 2005	STORMWATER CONTROL POND NO.3 LAYOUT	E-05	0	JANUARY 2005	ELECTRICAL GROUNDING AND LIGHTING LAYOUT
C-24	0	JANUARY 2005	STORMWATER CONTROL POND NO.3 ELEVATIONS	E-06	0	JANUARY 2005	ELECTRICAL ROOM LIGHTING LAYOUT
C-25	0	JANUARY 2005	PERIMETER DITCH CROSS-SECTIONS	E-07	0	JANUARY 2005	ELECTRICAL CONTROL SCHEMATICS (1 OF 5)
C-26	0	JANUARY 2005	DISCHARGE STRUCTURE DETAILS	E-08	0	JANUARY 2005	ELECTRICAL CONTROL SCHEMATICS (2 OF 5)
C-27	0	JANUARY 2005	LEACHATE TREATMENT FACILITY SITE PLAN	E-09	0	JANUARY 2005	ELECTRICAL CONTROL SCHEMATICS (3 OF 5)
C-28	0	JANUARY 2005	LEACHATE TREATMENT FACILITY LAGOON LINING SYSTEM	E-10	0	JANUARY 2005	ELECTRICAL CONTROL SCHEMATICS (4 OF 5)
C-29	0	JANUARY 2005	LEACHATE TREATMENT FACILITY LAGOON LINING SYSTEM DETAILS	E-11	0	JANUARY 2005	ELECTRICAL CONTROL SCHEMATICS (5 OF 5)
C-30	0	JANUARY 2005	LANDFILL GAS MANAGEMENT SYSTEM	E-12	0	JANUARY 2005	ELECTRICAL UTILITY SERVICE PLAN
C-31	0	JANUARY 2005	LANDFILL GAS TRENCH CONNECTION PLAN AND PROFILE	PROCESS			
C-32	0	JANUARY 2005	LANDFILL GAS COLLECTION SYSTEM DETAILS (FUTURE)	P-01	0	JANUARY 2005	PROCESS FLOW DIAGRAM AND AND HYDRAULIC GRADIENT DIAGRAM
C-33	0	JANUARY 2005	PROPOSED SCALEHOUSE AND ACCESS ROADWAY	INSTRUMENTATION AND CONTROL			
C-34	0	JANUARY 2005	SCALEHOUSE SECTIONS AND DETAILS	IC-01	0	JANUARY 2005	PROCESS AND INSTRUMENTATION DIAGRAM SHEET 1 OF 2
C-35	0	JANUARY 2005	SITE UTILITIES	IC-02	0	JANUARY 2005	PROCESS AND INSTRUMENTATION DIAGRAM SHEET 2 OF 2
C-36	0	JANUARY 2005	BURIED SITE UTILITIES (PROPOSED LANDFILL AREA)				
C-37	0	JANUARY 2005	MISCELLANEOUS CIVIL DETAILS				



CONESTOGA-ROVERS & ASSOCIATES



TABLE 2.1

**SITE DESIGN CRITERIA
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA**

<i>Item</i>	<i>Criteria</i>
• Area of Site	• 162 hectares
• Waste Footprint Area	• 259,000 m ²
• Landfill Volume	• 2,338,000 m ³
• Buffer Zone	• 121 hectares
• Base Design	• Site specific design with native clay base liner
• Minimum Elevation of Landfill Base Contours	• 11.9 m GD
• Maximum Elevation of Landfill Final Contours	• 26.5 m GD
• Maximum Sideslope (Horizontal:Vertical)	• Landfill base 3:1 (33%) • Landfill final contours 4:1 (25%)
• Minimum Top Slope (Horizontal:Vertical)	• Landfill final contours 20:1 (5%)
• Final Cover Depth of approx. 0.8 m	• 100 mm vegetated topsoil • 700 mm native clay
• Leachate Management	• Blanket underdrain collection system with on-Site treatment and discharge to Demerara River
• Surface Water Management	• Perimeter ditches for conveyance of runoff from 10-year 24-hour peak rainfall event • Total active stormwater management pond volume of approximately 67,000 m ³ for storage of 10-year 24-hour peak rainfall event

TABLE 2.2
WASTE COMPOSITION⁽¹⁾
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA

<i>Waste Stream</i>	<i>Truck Load Percentage</i>	<i>Estimated Total Tonnage During Study Period</i>
Low and Middle-Income Residential Waste	64	56
High-Income Residential Waste	8	10
Middle-Income Residential and Commercial Waste	3	4
Commercial Waste	7	9
Market Waste	18	21

<i>Waste Type</i>	<i>Percentage</i>
Food Waste	41
Paper Waste	24
Glass and Metals	3.4
Plastics	10.1
Construction and Demolition Waste	1.8

Source:

- (1) Waste composition data provided by Brown, Vence and Associates in their report entitled, "Pre-Investment Study for Georgetown Solid Waste Management Program: Waste Characterization and Facility Siting.", May 2000.

TABLE 2.3

**ESTIMATED WASTE TONNAGES
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA**

<i>Year</i>	<i>Approximate Annual Waste Tonnage Placed⁽²⁾</i>
2005 ⁽¹⁾	30,000
2006	60,600
2007	61,210
2008	61,820
2009	62,440
2010	63,060
2011	63,690
2012	64,330
2013	64,970
2014	65,620
2015	66,280
2016	66,940
2017	67,610
2018	68,290
2019	68,970
2020	69,660
2021	70,360
2022	71,060
2023	71,770
2024	72,490
2025	73,210
2026	73,940
2027	74,680
2028	75,430
2029	76,180
2030	76,940
<hr/>	
Total Tonnage	1,741,550
Average Tonnage per Year	66,980
Estimated Site Life	26 years

Notes:

- (1) 2005 waste tonnage placed based on a initial waste placement of 60,000 tonnes split between new sanitary landfill in Haags Bosch and Mandela Avenue dumpsite.
- (2) Waste tonnage placed in subsequent years based on assumed 1 percent annual increase, and average waste density of 0.750 tonnes/m³.

TABLE 4.1

**ESTIMATED LANDFILL VOLUMES
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA**

<i>Landfill Stage</i>	<i>Area of Stage (m²)</i>	<i>Volume of Stage⁽¹⁾ (m³)</i>	<i>Volume of Leachate Collection System⁽²⁾ (m³)</i>	<i>Volume of Final Cover⁽³⁾ (m³)</i>	<i>Volume of Refuse and Daily Cover⁽⁴⁾ (m³)</i>	<i>Volume of Daily Cover (m³)</i>
Stage 1	64,750	639,500	55,000	51,800	584,500	83,500
Stage 2	64,750	639,500	55,000	51,800	584,500	83,500
Stage 3	64,750	639,500	55,000	51,800	584,500	83,500
Stage 4	64,750	639,500	55,000	51,800	584,500	83,500
Total Site ⁽⁵⁾	259,000	2,558,000	220,000	207,200	2,338,000	334,000

Notes:

- (1) Volume of stage is measured from native clay base to top of final cover.
- (2) Estimated leachate collection system thickness of 0.85 m.
- (3) Estimated final cover thickness of 0.8 m.
- (4) Ratio of waste-to-daily cover placement estimated to be 6:1.
- (5) Volume estimate in AutoCAD based on pre-settlement, post-closure landfill height of 12 m.

TABLE 4.2

**MATERIAL BALANCE
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA**

<i>Description</i>	<i>Material</i>	<i>Thickness (m)</i>	<i>Stage 1 (m³)</i>	<i>Stage 2 (m³)</i>	<i>Stage 3 (m³)</i>	<i>Stage 4 (m³)</i>	<i>Other (m³)</i>	<i>Total Site ⁽²⁾</i>	
								<i>(m³)</i>	<i>(m²)</i>
MATERIAL REQUIREMENTS:									
Daily Cover Soil ⁽¹⁾	Native Clay or ADC	-	83,500	83,500	83,500	83,500	-	334,000	-
Final Cover - Vegetative Layer	Native Clay or topsoil	0.100	6,500	6,500	6,500	6,500	-	26,000	-
Final Cover - Clay Cap	Native Clay	0.700	45,475	45,475	45,475	45,475	-	181,900	-
Grading for Row of Trees	Native Clay	-	-	-	-	-	-	4,000	-
Leachate Collection System - Support Layer	Sand	0.150	9,925	9,925	9,925	9,925	-	39,700	-
Leachate Collection System - Drainage Layer	25 to 50 mm Clear Stone	0.300	4,775	4,775	4,775	4,775	-	19,100	-
Leachate Collection System - Ballast Layer	Sand	0.300	19,875	19,875	19,875	19,875	-	79,500	-
Paved Highway - Base material	Sand	0.300	-	-	-	-	4,800	4,800	15,850
Paved Highway - Top grading	Asphalt	0.150	-	-	-	-	2,400	2,400	15,850
Paved Site Access Roads - Base material	Sand	0.300	-	-	-	-	500	500	1,630
Paved Site Access Roads - Top grading	Asphalt	0.150	-	-	-	-	300	300	1,630
Unpaved Site Access Roads - Base material	Native Clay	0.300	-	-	-	-	8,900	8,900	29,500
Unpaved Site Access Roads - Top grading	Sand	0.300	-	-	-	-	8,900	8,900	29,500
Total Soil	Native Clay	-	135,475	135,475	135,475	135,475	8,900	554,800	-
Total Aggregate	25 to 50 mm Clear Stone	-	4,775	4,775	4,775	4,775	0	19,100	-
Total Sand	Sand	-	29,800	29,800	29,800	29,800	14,200	133,400	-
Total Asphalt	Asphalt	-	-	-	-	-	2,700	2,700	17,480

MATERIAL AVAILABLE:

Marine Clay Soil	Native Clay	255,300	255,300	255,300	255,300	54,700	1,075,900
Workable Soil ⁽³⁾	Native Clay	191,500	191,500	191,500	191,500	41,000	807,000
Total Soil Available	Native Clay	191,500	191,500	191,500	191,500	41,000	807,000

TABLE 4.2

**MATERIAL BALANCE
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA**

<i>Description</i>	<i>Material</i>	<i>Thickness (m)</i>	<i>Stage 1 (m³)</i>	<i>Stage 2 (m³)</i>	<i>Stage 3 (m³)</i>	<i>Stage 4 (m³)</i>	<i>Other (m³)</i>	<i>Total Site ⁽²⁾</i>	
								<i>(m³)</i>	<i>(m²)</i>
MATERIAL BALANCE:									
Total Soil	Native Clay		56,025	56,025	56,025	56,025	32,100	256,200	
Total Aggregate	25 to 50 mm Clear Stone		-4,775	-4,775	-4,775	-4,775	0	-19,100	
Total Sand	Sand		-29,800	-29,800	-29,800	-29,800	-14,200	-133,400	

Notes:

- (1) Ratio of waste to daily cover placement estimated to be 6:1.
- (2) Total Site includes sum of material from Stages 1 to 4, plus additional material from Initial Construction of leachate treatment facility and stormwater ponds.
- (3) Workable soil estimated to be 75 percent of total clay excavated.

Total Footprint Area = 259,000 m².

Final Cover Surface Area = 259,900 m².

Base Surface Area = 264,900 m².

TABLE 5.1

**LEACHATE CHARACTERISTICS FOR LEACHATE TREATMENT
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA**

Peak Daily Leachate Production ⁽¹⁾⁻⁽³⁾	9,635	m ³ /d
Average Annual Leachate Production ⁽¹⁾⁻⁽³⁾	670	m ³ /d
Peak Post-Closure Leachate Production ⁽³⁾	215	m ³ /d
Maximum Leachate Pump Rate from Landfill ⁽⁴⁾	4,000	m ³ /d
Maximum Design Flow for Leachate Treatment	1,500	m ³ /d

Raw Leachate Characteristics:

<i>Parameter</i>	<i>Maximum Leachate Design Characteristics</i>		<i>Design Effluent Discharge Criteria</i>
	<i>(mg/L)</i>	<i>(kg/d)</i>	<i>(mg/L)</i>
Biological Oxygen Demand (BOD ₅)	3,000	675	25
Total Ammonia Nitrogen (NH ₃ -N)	400	90	2
Total Phosphorus	-	-	1
Sludge Generation:	25	m ³ /d	

Notes:

- (1) Based on statistical analysis of 10-year 24-hour peak rainfall data provided for from Guyana Hydromet Services for Georgetown Botanic Gardens from 1983 to 2003.
- (2) Assumes one active stage and three stages with interim/final cover.
- (3) Assumed infiltration rate of 300 mm/year for areas with interim/final cover.
- (4) Assigned on per Stage basis.

TABLE 6.1

RAINFALL EVENTS
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA

Peak 24-Hour Rainfall Event⁽¹⁾:

<i>Recurring Period (years)</i>	<i>Peak 24-Hour Rainfall Event (mm)</i>
2	103
5	129
10	146
25	168
50	184
100	200

21-Year Rainfall Statistics⁽²⁾:

	<i>5-Day Event (mm)</i>	<i>10-Day Event (mm)</i>	<i>Monthly (mm)</i>	<i>Yearly (mm)</i>
Maximum	228.8	331.5	589.1	2,889
Minimum	0	0	2.1	1,592
Average	28.4	56.8	176.8	2,099

Rainfall Intensity⁽³⁾:

<i>Duration (min)</i>	<i>Accumulation (mm)</i>	<i>Intensity (mm/hr)</i>
5	8.5	102.0
10	16.4	98.4
15	24.5	98.0
30	26.6	53.2
60	28.9	28.9
120	38.0	19.0

Notes:

- (1) Statistical analysis provided by Atmospheric Environment Service, Hydrometeorology Division, Canadian Climate Centre.
- (2) Based on statistical analysis of data for Georgetown Botanic Gardens from Guyana Hydromet Services from 1983 to 2003.
- (3) Data provided by Guyana Hydromet Services for June 1996.

TABLE 6.2

RESULTS OF SWMHYMO SIMULATIONS

DESIGN AND OPERATIONS REPORT

NEW SANITARY LANDFILL IN HAAGS BOSCH

GUYANA

<i>Pond No.</i>	<i>Storm Event</i>	<i>Peak Inflow Into Pond</i> <i>(m³/s)</i>	<i>Volume of Runoff</i>	
			<i>(mm)</i>	<i>(m³)</i>
1	25 mm 6 hour	0.152	9.87	1,342
	5 year 24 hour	0.725	100.9	13,713
	10 year 24 hour	0.841	117.29	15,940
2	25 mm 6 hour	0.152	9.83	1,329
	5 year 24 hour	0.726	100.8	13,622
	10 year 24 hour	0.842	117.19	15,836
3	25 mm 6 hour	0.098	10.43	1,074
	5 year 24 hour	0.484	102.45	10,543
	10 year 24 hour	0.561	118.9	12,235

TABLE 6.3

PERMANENT POOL VOLUME
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA

<i>Pond No.</i>	<i>Permanent Pool Volume</i>	<i>Permanent Pool Area Configuration</i>		<i>Forebay and Dispersion Lengths</i>	
	<i>Permanent Pool Volume Provided (m³)</i>	<i>Length (m)</i>	<i>Depth (m)</i>	<i>Forebay Length (m)</i>	<i>Dispersion Length (m)</i>
1	2,160	68.2	1.4	68.2	68.2
2	2,020	58.2	1.6	58.2	58.2
3	1,500	58.2	1.1	58.2	58.2

TABLE 6.4

POND DIMENSIONS AND ACTIVE STORAGE VOLUME
 DESIGN AND OPERATIONS REPORT
 NEW SANITARY LANDFILL IN HAAGS BOSCH
 GUYANA

<i>Pond No.</i>	<i>Length (m)</i>	<i>Width (m)</i>	<i>Depth (m)</i>	<i>Active Storage Volume (m³)</i>
1	216.2	68.2	1.3	25,020
2	216.2	58.2	1.5	23,440
3	216.2	58.2	1.1	18,710

TABLE 10.1
CONSTRUCTION QUALITY ASSURANCE INSPECTIONS
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA

<i>Work Task to be Inspected</i>	<i>Items to be Checked During Inspection</i>	<i>Type of Inspection</i>	<i>Frequency of Inspection</i>	<i>Submittals/Paperwork</i>
A. SITE PREPARATION				
Site Construction Operations	<ul style="list-style-type: none"> • unauthorized site access prevented • fencing in place to delineate work areas • dust control measures in place • access roads designated and signed 		<ul style="list-style-type: none"> • daily as required • daily as required • daily as required • daily as required 	<ul style="list-style-type: none"> • none • none • none • none
Rough Grading	<ul style="list-style-type: none"> • horizontal and vertical control • surface features have been protected • topsoil has been removed • obstructions removed (rocks, shrubs, trees) • adequate drainage has been provided 	<ul style="list-style-type: none"> • survey • visual • visual • visual • survey 	<ul style="list-style-type: none"> • daily as required • daily as required • daily as required • daily as required • daily as required 	<ul style="list-style-type: none"> • none • none • none • none • survey information
Stockpiles	<ul style="list-style-type: none"> • height not to exceed 4.5 m • slope not steeper than 2 horizontal to 1 vertical • protection from rain (tarpaulin or sheeting) 	<ul style="list-style-type: none"> • visual • visual • visual 	<ul style="list-style-type: none"> • as required • as required • as required 	<ul style="list-style-type: none"> • none • none • none
B. FOUNDATION				
	<ul style="list-style-type: none"> • native material meets specifications • base compaction is adequate 	<ul style="list-style-type: none"> • geotechnical testing • geotechnical testing 	<ul style="list-style-type: none"> • as required • as required 	<ul style="list-style-type: none"> • log notation • log notation
C. BACKFILL AND COMPACTION				
	<ul style="list-style-type: none"> • fill areas are to grades and elevations on drawings • layers do not exceed specified depths • grade changes are gradual • specified compaction density achieved 	<ul style="list-style-type: none"> • survey • measure • visual • measure 	<ul style="list-style-type: none"> • prior to, during, and after backfill and compaction • during and after backfill and compaction • during and after backfill and compaction • after backfill and compaction 	<ul style="list-style-type: none"> • survey information • none • none • compaction results

TABLE 10.1

**CONSTRUCTION QUALITY ASSURANCE INSPECTIONS
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA**

<i>Work Task to be Inspected</i>	<i>Items to be Checked During Inspection</i>	<i>Type of Inspection</i>	<i>Frequency of Inspection</i>	<i>Submittals/Paperwork</i>
D. EXCAVATION				
	<ul style="list-style-type: none"> horizontal and vertical control 	<ul style="list-style-type: none"> survey 	<ul style="list-style-type: none"> prior to, during, and after excavation 	<ul style="list-style-type: none"> survey information
	<ul style="list-style-type: none"> excavation to grades and elevations on drawings 	<ul style="list-style-type: none"> survey 	<ul style="list-style-type: none"> prior to, during, and after excavation 	<ul style="list-style-type: none"> survey information
	<ul style="list-style-type: none"> debris and obstructions removed 	<ul style="list-style-type: none"> visual 	<ul style="list-style-type: none"> prior to excavation 	<ul style="list-style-type: none"> none
	<ul style="list-style-type: none"> trench depths and widths are within specified tolerances 	<ul style="list-style-type: none"> measure 	<ul style="list-style-type: none"> prior to, during, and after excavation 	<ul style="list-style-type: none"> log notation
	<ul style="list-style-type: none"> excavated materials are disposed of 	<ul style="list-style-type: none"> visual 	<ul style="list-style-type: none"> after excavation 	<ul style="list-style-type: none"> none
E. BURIED UTILITIES				
	<ul style="list-style-type: none"> all pipes, fittings, and joints meet specified standards 	<ul style="list-style-type: none"> inspect documentation 	<ul style="list-style-type: none"> upon delivery 	<ul style="list-style-type: none"> supplier's certificates
	<ul style="list-style-type: none"> products are delivered with appropriate labeling 	<ul style="list-style-type: none"> visual 	<ul style="list-style-type: none"> upon delivery 	<ul style="list-style-type: none"> none
	<ul style="list-style-type: none"> trenching is performed to correct dimensions 	<ul style="list-style-type: none"> measure 	<ul style="list-style-type: none"> during installation 	<ul style="list-style-type: none"> reviewed plan
	<ul style="list-style-type: none"> horizontal and vertical control 	<ul style="list-style-type: none"> survey (maximum variation from true slope of 1 cm in 3 m) 	<ul style="list-style-type: none"> during and after installation 	<ul style="list-style-type: none"> survey information
	<ul style="list-style-type: none"> pipe installation follows proper alignment 	<ul style="list-style-type: none"> visual 	<ul style="list-style-type: none"> during and after installation 	<ul style="list-style-type: none"> log notation
	<ul style="list-style-type: none"> backfill material is adequate 	<ul style="list-style-type: none"> visual 	<ul style="list-style-type: none"> during installation 	<ul style="list-style-type: none"> material tests
	<ul style="list-style-type: none"> warning tape has been installed 	<ul style="list-style-type: none"> visual (300 mm below surface) 	<ul style="list-style-type: none"> during installation 	<ul style="list-style-type: none"> none
	<ul style="list-style-type: none"> hydrostatic and leak testing is adequate 	<ul style="list-style-type: none"> inspect test results 	<ul style="list-style-type: none"> after installation 	<ul style="list-style-type: none"> testing reports
	<ul style="list-style-type: none"> water supply piping meets specifications 	<ul style="list-style-type: none"> inspect documentation 	<ul style="list-style-type: none"> upon delivery 	<ul style="list-style-type: none"> supplier's certificates
	<ul style="list-style-type: none"> water supply piping meets specifications 	<ul style="list-style-type: none"> inspect documentation 	<ul style="list-style-type: none"> upon delivery 	<ul style="list-style-type: none"> supplier's certificates
	<ul style="list-style-type: none"> water supply piping meets standards for installation 	<ul style="list-style-type: none"> visual 	<ul style="list-style-type: none"> after installation 	<ul style="list-style-type: none"> log notation
F. PUMP STATIONS				
	<ul style="list-style-type: none"> all equipment meets specified standards 	<ul style="list-style-type: none"> inspect documentation 	<ul style="list-style-type: none"> upon delivery 	<ul style="list-style-type: none"> supplier's certificates
	<ul style="list-style-type: none"> electrical components conform to code 	<ul style="list-style-type: none"> inspect documentation 	<ul style="list-style-type: none"> upon delivery 	<ul style="list-style-type: none"> supplier's certificates
	<ul style="list-style-type: none"> manufacturer and installer's qualifications 	<ul style="list-style-type: none"> inspect documentation 	<ul style="list-style-type: none"> upon delivery 	<ul style="list-style-type: none"> supplier's certificates
	<ul style="list-style-type: none"> components delivered damage-free 	<ul style="list-style-type: none"> visual 	<ul style="list-style-type: none"> upon delivery 	<ul style="list-style-type: none"> none
	<ul style="list-style-type: none"> piping is installed to correct grades 	<ul style="list-style-type: none"> survey (maximum variation from plumb of 1 degree) 	<ul style="list-style-type: none"> during and after installation 	<ul style="list-style-type: none"> log notation
	<ul style="list-style-type: none"> backfill material is adequate 	<ul style="list-style-type: none"> visual 	<ul style="list-style-type: none"> during installation 	<ul style="list-style-type: none"> material tests

TABLE 10.1
CONSTRUCTION QUALITY ASSURANCE INSPECTIONS
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<i>Work Task to be Inspected</i>	<i>Items to be Checked During Inspection</i>	<i>Type of Inspection</i>	<i>Frequency of Inspection</i>	<i>Submittals/Paperwork</i>
G. FENCING	<ul style="list-style-type: none"> • products meet specified standards • manufacturer's qualifications • smooth gradient is obtained between posts • location of fencing conforms to drawings • fencing is within property lines 	<ul style="list-style-type: none"> • inspect documentation • inspect documentation • visual • survey • visual 	<ul style="list-style-type: none"> • upon delivery • upon delivery • during installation • during and after installation • during installation 	<ul style="list-style-type: none"> • supplier's certificates • supplier's certificates • none • none • none
H. LANDSCAPING	<ul style="list-style-type: none"> • supplier's qualifications • topsoil meets required specifications • horizontal and vertical control • proper grades are maintained • topsoil placed with appropriate moisture • fertilizer meets specifications • grass seed meets specifications • mulch meets specifications • noxious weeds are not present • plant material is disease-free • climactic conditions are suitable • final acceptance criteria met 	<ul style="list-style-type: none"> • check documentation • check documentation • survey • survey • visual • check documentation • check documentation • check documentation • visual • visual • visual • visual (80% of plant material in healthy, vigorous growing condition) 	<ul style="list-style-type: none"> • upon delivery • upon delivery • after topsoiling • during and after topsoiling • during topsoiling • upon delivery • upon delivery • upon delivery • after seeding • during and after planting • during planting • after planting 	<ul style="list-style-type: none"> • supplier's certificates • supplier's certificates • survey information • survey information • none • supplier's certificates • supplier's certificates • supplier's certificates • none • none • none • none
I. CAST-IN-PLACE CONCRETE	<ul style="list-style-type: none"> • concrete material meets specifications • concrete mix verified • forms built in accordance with specifications • concrete placed in accordance with specifications • reinforcement placed in accordance with specifications • surfaces finished • fastenings, wedges, ties and items are secure 	<ul style="list-style-type: none"> • check documentation • test • visual • test, visual • visual • visual • visual 	<ul style="list-style-type: none"> • upon delivery • prior to concrete placing • continuous during concrete placing • continuous during concrete placing • continuous during concrete placing • after concrete placing • continuous during concrete placing 	<ul style="list-style-type: none"> • supplier's certificate • none • none • none • none • none • none

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J. MATERIALS				
Flexible Membrane Liner (FML)	• Raw Materials			
	a) certificate of analysis from materials vendor	• inspect documentation	• upon delivery	• supplier's certificate
	b) documentation of the FML's prior successful use for this application	• inspect documentation	• upon delivery	• supplier's certificate
	• Manufacturing			
	a) manufacturer's verification that FML meets specs for type	• check supplier's specifications	• upon delivery	• supplier's certificate
	b) statement of basis for property values	• check supplier's specifications	• upon delivery	• supplier's certificate
	c) manufacturer's qualifications and references	• inspect documentation	• upon delivery	• supplier's certificate
	• Transportation			
	a) FML is shipped to prevent damage by other cargo	• visual	• upon delivery	• none
	b) FML rolls or blankets are properly labelled	• visual	• upon delivery	• none
	• Installation			
	a) installer's qualification letter	• inspect documentation	• upon delivery	• installer's certificate
	b) weather is adequate	• visual	• during installation	• none
	c) ground and subgrade conditions are adequate	• visual	• prior and during installation	• none
	d) panels are marked and unfolded properly	• visual	• prior and during installation	• none
	e) rolls are installed to prevent corrugations	• visual	• during installation	• none
	f) panel overlaps for seaming are suitable	• measure (100 mm for extrusion welds and 127 mm for hot wedge welds)	• during and after installation	• none
	g) all seams are labelled appropriately	• visual	• during and after installation	• none
	h) seaming area is dry and clean	• visual	• during installation	• none
	i) a hard substrate is used for soft soil	• visual	• prior and during installation	• none

TABLE 10.1
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<i>Work Task to be Inspected</i>	<i>Items to be Checked During Inspection</i>	<i>Type of Inspection</i>	<i>Frequency of Inspection</i>	<i>Submittals/Paperwork</i>
	j) inspect seams and non-seams for defects	• visual	• during and after installation	• none
Drainage Geocomposite	<ul style="list-style-type: none"> • Manufacturing <ul style="list-style-type: none"> a) manufacturer's certificate b) raw material/manufactured goods certificate c) manufacturer's qualifications d) geocomposite meets specifications • Transportation <ul style="list-style-type: none"> a) geocomposite is shipped to prevent damage by other cargo (check sunlight and heat) b) geocomposite rolls or blankets are properly labelled • Installation <ul style="list-style-type: none"> a) installer/seamer's qualifications b) inspection for defects upon delivery c) weather is adequate d) geocomposite is free of folds or wrinkles e) specified overlaps are maintained f) geocomposite is free of debris during seaming 	<ul style="list-style-type: none"> • inspect documentation • inspect documentation • inspect documentation • inspect documentation • visual • visual • inspect documentation • visual • visual • measure • visual 	<ul style="list-style-type: none"> • upon delivery • upon delivery • upon delivery • upon delivery • upon delivery • upon delivery • during installation • during installation • during installation • during installation 	<ul style="list-style-type: none"> • supplier's certificate • supplier's certificate • supplier's certificate • supplier's certificate • none • none • installer's certificate • none • none • none • none • none
Geotextile	<ul style="list-style-type: none"> • Manufacturing <ul style="list-style-type: none"> a) manufacturer's certificates b) manufacturer's qualifications 	<ul style="list-style-type: none"> • inspect documentation • inspect documentation 	<ul style="list-style-type: none"> • upon delivery • upon delivery 	<ul style="list-style-type: none"> • supplier's certificate • supplier's certificate

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<i>Work Task to be Inspected</i>	<i>Items to be Checked During Inspection</i>	<i>Type of Inspection</i>	<i>Frequency of Inspection</i>	<i>Submittals/Paperwork</i>
Geogrid	<ul style="list-style-type: none"> • Handling <ul style="list-style-type: none"> a) geotextile rolls are appropriately labelled b) geotextile rolls are protected from moisture, dust, light, and heat • Installation <ul style="list-style-type: none"> a) installer's qualifications b) inspection for defects upon delivery c) supporting surface is free of irregularities d) overlaps conform with specifications e) no stones are entrapped in geotextile f) geotextile is not exposed to sun for more than 14 days 	<ul style="list-style-type: none"> • visual • visual • inspect documentation • visual • visual • measure • visual • visual 	<ul style="list-style-type: none"> • upon delivery • upon delivery • upon delivery • during installation • during and after installation • during installation • during and after installation 	<ul style="list-style-type: none"> • none • none • installer's certificate • none • none • none • none • none
	<ul style="list-style-type: none"> • Manufacturing <ul style="list-style-type: none"> a) manufacturer's certificates • Transportation <ul style="list-style-type: none"> a) geogrid is shipped to prevent damage by other cargo b) geocomposite rolls or blankets are properly labelled • Installation <ul style="list-style-type: none"> a) inspection for defects upon delivery b) supporting surface is free of irregularities c) weather is adequate d) overlaps conform with specifications e) geocomposite is free of folds or wrinkles 	<ul style="list-style-type: none"> • inspect documentation • visual • visual • visual • measure • visual 	<ul style="list-style-type: none"> • upon delivery • upon delivery • upon delivery • during installation • during installation • during and after installation • during and after installation 	<ul style="list-style-type: none"> • supplier's certificate • none • none • none • none • none • none

TABLE 10.1
CONSTRUCTION QUALITY ASSURANCE INSPECTIONS
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NEW SANITARY LANDFILL IN HAAGS BOSCH
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<i>Work Task to be Inspected</i>	<i>Items to be Checked During Inspection</i>	<i>Type of Inspection</i>	<i>Frequency of Inspection</i>	<i>Submittals/Paperwork</i>
K. MECHANICAL COMPONENTS (pumps, injectors, mixers, gauges, switches, aeration system, clarifier, blowers, etc.)	<ul style="list-style-type: none"> • components meet specified standards • assembly and installation are according to specifications 	<ul style="list-style-type: none"> • inspect documentation • visual/check specifications 	<ul style="list-style-type: none"> • upon delivery • during assembly and installation 	<ul style="list-style-type: none"> • supplier's certificate • none
L. INSTRUMENTS (sensors, transmitters and meters)	<ul style="list-style-type: none"> • instruments meet specified standards • assembly and installation are according to specifications 	<ul style="list-style-type: none"> • inspect documentation • visual/check specifications 	<ul style="list-style-type: none"> • upon delivery • during assembly and installation 	<ul style="list-style-type: none"> • supplier's certificate • none
M. ELECTRICAL COMPONENTS (panelboards, wire, meters, controls, etc.)	<ul style="list-style-type: none"> • electrical components meet specifications • electrical components assembled and installed according to specifications 	<ul style="list-style-type: none"> • inspect documentation • visual/check specifications 	<ul style="list-style-type: none"> • upon delivery • during assembly and installation 	<ul style="list-style-type: none"> • supplier's certificate • none
N. PRE-ENGINEERING BUILDING	<ul style="list-style-type: none"> • designer, manufacturer, and installer qualifications • mortar, grout, masonry units, and concrete are to specified standards 	<ul style="list-style-type: none"> • inspect documentation • visual 	<ul style="list-style-type: none"> • upon delivery • during installation 	<ul style="list-style-type: none"> • supplier's certificate • none
O. SURFACE WATER DRAINAGE				
Ditches	<ul style="list-style-type: none"> • constructed to pre-determined grades • erosion control meets specifications 	<ul style="list-style-type: none"> • survey • visual 	<ul style="list-style-type: none"> • during and after construction • during construction 	<ul style="list-style-type: none"> • survey information • none
P. SEPTIC SYSTEM (septic tank, holding tank, oil/water separator)	<ul style="list-style-type: none"> • products conform to specifications • installation according to specifications 	<ul style="list-style-type: none"> • inspect documentation • visual 	<ul style="list-style-type: none"> • upon delivery • during installation 	<ul style="list-style-type: none"> • supplier's certificate • log notation

TABLE 10.1
CONSTRUCTION QUALITY ASSURANCE INSPECTIONS
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NEW SANITARY LANDFILL IN HAAGS BOSCH
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<i>Work Task to be Inspected</i>	<i>Items to be Checked During Inspection</i>	<i>Type of Inspection</i>	<i>Frequency of Inspection</i>	<i>Submittals/Paperwork</i>
Q. WEIGH SCALE	<ul style="list-style-type: none"> weigh scale and scale house conform to specifications installation and calibration of scales according to specifications 	<ul style="list-style-type: none"> inspect documentation visual 	<ul style="list-style-type: none"> upon delivery during installation 	<ul style="list-style-type: none"> supplier's certificate log notation
R. ELECTRICITY SUPPLY	<ul style="list-style-type: none"> installation of supply network meets specifications 	<ul style="list-style-type: none"> visual 	<ul style="list-style-type: none"> during installation 	<ul style="list-style-type: none"> log notation
S. ROADS (access road and on-Site roads)	<ul style="list-style-type: none"> materials meet specifications installation according to specifications 	<ul style="list-style-type: none"> inspect documentation visual/survey 	<ul style="list-style-type: none"> upon delivery during installation 	<ul style="list-style-type: none"> supplier's certificate log notation
T. ACCESS BRIDGE	<ul style="list-style-type: none"> materials meet specifications installation according to specifications 	<ul style="list-style-type: none"> inspect documentation visual 	<ul style="list-style-type: none"> upon delivery during installation 	<ul style="list-style-type: none"> supplier's certificate log notation
U. MISCELLANEOUS				
Culverts	<ul style="list-style-type: none"> material meets specifications manufacturer's qualifications installation follows proper alignment bedding and backfill meets specifications 	<ul style="list-style-type: none"> inspect documentation inspect documentation survey and visual visual 	<ul style="list-style-type: none"> upon delivery upon delivery during installation during installation 	<ul style="list-style-type: none"> supplier's certificate supplier's certificate survey information material tests
Administration Building Equipment	<ul style="list-style-type: none"> all equipment meets specified standards 	<ul style="list-style-type: none"> inspect documentation 	<ul style="list-style-type: none"> upon delivery 	<ul style="list-style-type: none"> supplier's certificate

TABLE 10.2
CONSTRUCTION QUALITY CONTROL TESTING PROCEDURES
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA

<i>Work Task or Product</i>	<i>Type of Test</i>	<i>Reference Standard</i>	<i>Frequency of Test</i>	<i>Criteria</i>
A. FILL	<ul style="list-style-type: none"> • Maximum Dry Density • Bulk Density • Particle Size Analysis • Moisture Content 	<ul style="list-style-type: none"> • ASTM D698 • ASTM D1556, ASTM D2167, or ASTM D2922 • ASTM D422 or ASTM D1140 • ASTM D3017 	<ul style="list-style-type: none"> • 1 test per 5000 m³ • 1 test per 5000 m³ • 1 test per 5000 m³ • 1 test per 5000 m³ 	<ul style="list-style-type: none"> • per requirements • per requirements • per requirements • per requirements
B. BURIED UTILITIES				
1. Forcemain and Gravity Main	• Hydrostatic and Leak Testing	• test at 1.25 times maximum rated pressure	• after installation	• reject joints demonstrating leakage; repeat until pressure drop is within specified allowance
2. Access Manhole	• Leak Testing	• plug/seal and fill with water	• after installation	• leakage not exceeding 0.1% of volume of unit per hour
C. PUMPING STATION	<ul style="list-style-type: none"> • Pressure Testing • Leakage Testing 	<ul style="list-style-type: none"> • test at 1.5 times normal operating pressure (1 hour) • plug/seal and fill with water 	<ul style="list-style-type: none"> • after installation • after installation 	<ul style="list-style-type: none"> • pressure shall not decrease or fluctuate • leakage not exceeding 0.1% of volume of unit per hour
D. CHAIN LINK FENCE	• Repair of Damaged Surfaces	• ASTM A780	• after installation	• per requirements
E. TOPSOIL	<ul style="list-style-type: none"> • Organic Content • pH • Potassium, Phosphorous, Calcium, Magnesium 	<ul style="list-style-type: none"> • ASTM D2974 • ASTM D4972 • in accordance with Ministry of Agriculture regulations 	<ul style="list-style-type: none"> • 1 test per 1 hectare of topsoil • 1 test per 1 hectare of topsoil • 1 test per 1 hectare of topsoil 	<ul style="list-style-type: none"> • minimum 4% for clay loams and 2% for sandy loams to maximum of 20% by volume • accept pH 6-7.5 • per requirements
F. CAST-IN-PLACE CONCRETE	<ul style="list-style-type: none"> • Sample Procurement • Sample Molding • Sample Compressive Strength • Slump Test • Air Content 	<ul style="list-style-type: none"> • ASTM C172 • ASTM C31 • ASTM C39 • ASTM C143/C143M • ASTM C231 or ASTM C173 	<ul style="list-style-type: none"> • 1 test for every 10 m³ • 1 test for every 10 m³ • 1 test for every 10 m³ • 1 test for every 10 m³ • 1 test for every 10 m³ 	<ul style="list-style-type: none"> • N/A • N/A • accept 35 MPa • accept 75 mm +/- 25 mm • accept 6.5% +/- 0.5%

TABLE 10.2
CONSTRUCTION QUALITY CONTROL TESTING PROCEDURES
DESIGN AND OPERATIONS REPORT
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GUYANA

<i>Work Task or Product</i>	<i>Type of Test</i>	<i>Reference Standard</i>	<i>Frequency of Test</i>	<i>Criteria</i>
G. METAL FABRICATION TESTING	• Bolt Tightening	• AISC	• after installation	• per requirements
	• Nondestructive Weld Testing	• AWS	• after installation	• per requirements
H. WATER AND CHEMICAL PIPING	• Hydrostatic Testing	• ASME 31.1	• after installation	• hold design pressure for minimum 8 hours
I. VALVES	• Hydrostatic Testing	• ASME 31.1	• after installation	• hold design pressure for minimum 8 hours
J. ENCLOSED SWITCHES	• Electrical Testing	• NEMA KS 1	• after installation	• per requirements
K. MOTOR CONTROL CENTER	• Electrical Testing	• NEMA ICS 2	• after installation	• per requirements
L. FLEXIBLE MEMBRANE LINER INSTALLATION AND REPAIR	• Test Seams	• ASTM D4437	• at least twice a day	<ul style="list-style-type: none"> • when tested in shear, minimum test seam strength of 90% of tensile strength at yield of unseamed liner • when tested in peel, minimum test seam strength of 60% of tensile strength at yield of unseamed liner
	• Non-Destructive Seam Testing (Pressure Testing)	• GRI Test Method GM6	• 1 sample per 150 m of field seam	• as specified in GRI Test Method GM6
	• Destructive Seam Testing	• ASTM D4437	• 1 sample per 150 m of field seam	• when tested in shear, minimum field seam strength of 90% of tensile strength at yield of unseamed liner

TABLE 10.2
CONSTRUCTION QUALITY CONTROL TESTING PROCEDURES
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<i>Work Task or Product</i>	<i>Type of Test</i>	<i>Reference Standard</i>	<i>Frequency of Test</i>	<i>Criteria</i>
M. AGGREGATE				
1. Coarse Aggregate	• Sieve Aggregate Analysis	• ASTM C136	1 per 2,000 m ³ of material required	
	• Sieve Aggregate Fines Analysis	• ASTM C117	1 per 2,000 m ³ of material required	
	• clear stone			accept 6-16 mm size
	• pea gravel			accept nominal size 11 mm sieve to 5 mm sieve
• drain aggregate				accept 19 mm diameter: 100% passing 25 mm sieve, 90% retained on No. 4 sieve, less than 5% passing No. 40 sieve
• riprap				accept material with: 100% of total weight smaller than 150 mm, 85% smaller than 127 mm, 50% smaller than 100 mm, and 15% smaller than 30 mm
2. Material (fine aggregate)	• Maximum Dry Density	• ASTM D698	• 1 per 2,000 m ³ of material required	• per requirements
	• Particle Size Analysis	• ASTM D422	• 1 per 2,000 m ³ of material required	• accept material with: 100% passing 5 mm sieve, 0-5% passing 0.6 mm sieve, and 0% passing 0.080 mm sieve
	• Recompacted Permeability	• ASTM D2434	• 1 per 2,000 m ³ of material required	• per requirements

TABLE 13.1

**PROPOSED COMPLIANCE MONITORING FREQUENCY
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
GUYANA**

<i>Monitoring Locations</i>	<i>Daily</i>	<i>Monthly</i>	<i>Quarterly</i>	<i>Annually</i>
<i>Groundwater Monitoring Wells (6 wells)</i>				
• Groundwater Quality Monitoring ⁽¹⁾⁽²⁾			√	√
• Groundwater Hydraulic Monitoring		√		
<i>Leachate Monitoring Wells (6 wells)</i>				
• Leachate Hydraulic Monitoring		√		
<i>Leachate Pump Stations (4 stations)</i>				
• Leachate Quality ⁽¹⁾⁽²⁾			√	√
• Leachate Hydraulic Monitoring	√			
• Leachate Quantity	√			
<i>Leachate Treatment Process Effluent</i>				
• Influent Quality ⁽¹⁾⁽²⁾			√	√
• Influent Quantity	√			
• Effluent Quality ⁽¹⁾⁽²⁾			√	√
• Effluent Quantity	√			
<i>Surface Water Monitoring (4 locations)</i>				
• Surface Water Quality ⁽¹⁾⁽²⁾			√	√
• Surface Water Quantity		√		
<i>Stormwater Pump Stations (3 stations)</i>				
• Surface Water Quality ⁽¹⁾⁽²⁾			√	√
• Surface Water Quantity	√			
<i>Landfill Gas Probes (3 probes)</i>				
• Gas Quality			√	

Notes:

- (1) Reduced parameter list for quarterly groundwater, surfacewater, and leachate analyses as indicated on Table 13.2. Full list of parameters for annual monitoring event.
- (2) Full list of parameters for quarterly groundwater, surfacewater, and leachate analyses during first year of Site operation only.

TABLE 13.2

PROPOSED COMPLIANCE MONITORING PARAMETERS
DESIGN AND OPERATIONS REPORT
NEW SANITARY LANDFILL IN HAAGS BOSCH
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<i>Surface Water Sampling</i>	<i>Groundwater Sampling</i>	<i>Leachate Sampling</i>	<i>Landfill Gas Sampling</i>
BOD *	BOD *	BOD *	Methane
COD *	COD *	COD *	Carbon Dioxide
pH ⁽³⁾ *	pH ⁽³⁾ *	pH ⁽³⁾ *	Oxygen
NH ₃ -N *	NH ₃ -N *	NH ₃ -N *	Temperature
TDS	TDS	TDS	Pressure
TSS *	TSS *	TSS *	
VSS	VSS	VSS	
TKN *	TKN *	TKN *	
Total Phosphorous *	Total Phosphorous *	Total Phosphorous *	
Alkalinity *	Alkalinity *	Alkalinity *	
Hardness (Ca and Mg)	Hardness (Ca and Mg)	Hardness (Ca and Mg)	
Chloride	Chloride	Chloride	
Fluoride	Fluoride	Fluoride	
Phosphate	Phosphate	Phosphate	
Sulphate	Sulphate	Sulphate	
Nitrate	Nitrate	Nitrate	
Nitrite	Nitrite	Nitrite	

Notes:

* Indicates parameter on reduced list.

- (1) Reduced parameter list for quarterly groundwater, surfacewater, and leachate analyses.
Full list of parameters for annual monitoring event.
- (2) Full list of parameters for quarterly groundwater, surface water, and leachate analyses during first year of Site operation only.
- (3) Includes both field and lab analysis.

COD Chemical Oxygen Demand.

BOD Biological Oxygen Demand.

NH₃-N Total Ammonia Nitrogen.

TDS Total Dissolved Solids.

TSS Total Suspended Solids.

VSS Volatile Suspended Solids.

TKN Total Kjeldahl Nitrogen.

APPENDIX B

LEACHATE TREATMENT PROCESS

1.0 LEACHATE TREATMENT SYSTEM

Landfill leachate is the inorganic and organic containing liquid mixture produced when water percolates through and contacts solid waste. Leachate generated from the active waste fill areas and the stormwater that accumulates in the active disposal cells during the preparation of each stage base will be collected in the LCS at the base of the landfill. This liquid will be collected at each of four leachate pumping stations corresponding to the low points of each stage, and conveyed via a common forcemain to the leachate treatment system. Collected liquid is routed either through the leachate treatment system or directly to the stormwater sedimentation and control pond depending upon whether the stage is actively accepting any waste and if the liquid has contacted any of this waste. Any liquid that has contacted waste will be routed through leachate treatment system.

The full leachate management system is comprised of the following elements:

- leachate collection system;
- aerobic equalization;
- secondary biological treatment;
- clarification;
- sludge storage; and
- stormwater sedimentation and control pond.

Secondary biological treatment, clarification, and sludge storage are processes conducted at the leachate treatment facility. Each of the following subsections provides information regarding the safe operation of the leachate management system.

1.1 LEACHATE TREATMENT SYSTEM OVERVIEW

The purpose of this section is to provide a general overview of the pathway and treatment systems that the collected leachate would endure prior to final discharge. A process schematic for the leachate treatment system is provided on Figure 5.1.

All waters to be treated would be collected in the aerobic equalization lagoon, by pumping stations located at the low point of each landfill. The location of these pump stations are indicated on Drawing C-11, provided in Appendix A. These stations are operated in an automatic mode with level indicators so as to minimize the amount of

time the operator is required to be off-Site. The pumps will switch ON/OFF by themselves.

The first treatment step in the system is the aerobic lagoon. Both high strength and dilute influent streams can be mixed and temporarily stored in the aerobic equalization lagoon. The lagoon also acts as a flow stabilization step within the process. The lagoon also acts as additional storage capacity for the leachate treatment facility under heavy rainfall conditions to ensure that the design capacity of the facility is not exceeded. Under normal operating conditions, the collected high strength leachate may be discharged directly to the leachate treatment facility (i.e., bypassing of the aerobic lagoon). The lagoon is equipped with aeration equipment to control and mitigate any odour issues. It has a capacity of 20,000 m³, and with a working water depth of 2.43 m. From the aerobic lagoon, the water is pumped directly into the splitter box of the secondary biological treatment step.

The secondary biological treatment step is comprised of an anoxic/oxic biological treatment system. It is designed to biologically remove contaminants, both nitrogenous and carbonaceous in nature, down to meet the designed effluent discharge criteria. Two equal sized anoxic/oxic trains will be utilized at the leachate treatment facility in order to accommodate the varying treatment flows experienced through the year.

The raw water would enter the anoxic tank first, where it would undergo biological denitrification. It is in this tank that the nitrogen, in the form of nitrates, is reduced to molecular nitrogen and emitted to the atmosphere. Furthermore, the anoxic system allows for rapid removal of the carbonaceous material during the denitrification process. To assist in this biological process, the raw water influent provides a source of organic carbon, and as needed, may be supplemented at the site by the addition of sugar cane or molasses. Phosphorus would need to be added as a nutrient required to sustain the biological process and would be done at the site. The anoxic tank is well mixed by an mechanical stirrer but is not aerated.

From the anoxic tank, the water overflows into the oxic tank. The oxic tank is well mixed and aerated to provide oxygen to the bacteria present in the system. It is in this tank that the nitrogen, in the form of ammonia, is oxidized to nitrates. With having the majority of the carbonaceous materials removed during anoxic treatment, this allows for the optimum nitrification conditions to occur during oxic treatment. The water from the oxic tank is recirculated back to the anoxic tank at a very high flow (e.g., four times influent flow rate) to ensure adequate time for denitrification to occur. The water is also overflowed to a clarifier.

As needed, excess phosphorus is to be removed from this system by the use of supplemental chemical feed. Alum or ferric chloride would be dosed to the system to assist in solids separation during clarification as well as a means of chemically reacting with the excess phosphorus to ensure compliance with the discharge effluent criteria.

The clarifier acts as a solids removal step. It is here that settling of the solids in the oxic tank effluent occurs, to minimize the amount of suspended solids being discharged in the final effluent. The thickened solids from the clarifier would be collected and either returned to the splitter box of the anoxic tank. Overflow from the clarifier would be directed to the stormwater sedimentation and control pond for final polishing prior to discharge to the drain canal.

Sludges collected from the leachate treatment facility would be disposed of in the active landfill area. The sludges would undergo aerobic sludge digestion prior to landfill disposal. These would be transported by a pump truck to the landfill.

1.2 START UP OF THE LEACHATE TREATMENT SYSTEM

The purpose of this section is to provide guidance and direction for the safe operation of the leachate treatment system. This section deals with the treatment of the influent wastewater, which is presumed to be mainly due to stormwater from the open stages. This section of the operations and maintenance manual is intended for the first 12-18 months of the leachate treatment facility operation.

The leachate/stormwater pumping stations may need to be activated to direct water from the LCS to the aerobic equalization tank. The pumps are to be manually activated to transfer the accumulated water to the aerobic equalization lagoon. This operation is only to be used provided that there was a visual confirmation that there is water accumulating in the pump station. This operation would continue as a manual function until there is a sufficient enough influent flow to allow the system to be operated in an automatic mode.

Leachate collection system pump station operation:

1. Visually confirm that there is water accumulating in the pump station.
2. Turn on the pump by depressing the ON switch for the pump.

3. Continue pumping water until there is no more water movement out of the pump.
4. Depress the OFF button for the pump.

Water is allowed to accumulate in the equalization lagoon. When the liquid level in the equalization lagoon is at a 2 m height (approximately 3/4 full), then daily sampling of the lagoon water is to commence. The daily sampling would consist of chemical oxygen demand (COD) and ammonia (NH₃-N) using grab samples and the HACH analysis instrument. All analyses are to be performed in accordance with the HACH manufacturer instructions. In the event that there is a noticeable odour emanating from the aerobic equalization lagoon, then this is an indication that there is sufficient strength water to support anaerobic biodegradation of the contaminants, and as such the lagoon's aeration system is to be activated. This will halt the generation of the anaerobic bacteria and reduce the odours emanating from the lagoon. The following instructions are provided below to guide the operation of the equalization lagoon aeration system.

Operation of the Aerobic Equalization Lagoon:

1. Sample the equalization lagoon water.
2. If an odour is noticeable, activate the equalization lagoon aeration system. Analyze water samples for COD and NH₃-N using the HACH instrument and following the supplier's instructions.
3. If no odour is present, analyze the water using the HACH instrument and instructions for COD and NH₃-N.
4. If the measured lagoon water is COD >100 mg/L and/or the NH₃-N >5 mg/L, then the equalization lagoon aeration system is to be activated. If there is an ongoing influent flow to the equalization lagoon at this time, then the lagoon water is to be pumped forward to the secondary biological treatment system.
5. If the measured lagoon water has a COD <100 mg/L and NH₃-N <5 mg/L, then the lagoon water may be pumped forward to the primary stormwater sedimentation and control pond via the bypass sewer.
6. If the level in the lagoon exceeds 2 metres of liquid depth (i.e., greater than 3/4 full), then the aerobic lagoon transfer pumps are to be activated to maintain the liquid level between 1.5 and 2 metres liquid depth. If the sample analysis indicated a clean water in the lagoon (i.e., COD <100 mg/L and NH₃-N <5 mg/L), then the aerobic lagoon water may be transferred forward to the primary stormwater sedimentation and control pond via the bypass sewer. If the sample

analysis indicated that the aerobic lagoon water was impaired (i.e., COD>100 mg/L or NH₃-N>5 mg/L), then the lagoon water is to be treated in the leachate treatment facility.

Operation of the Aerobic Lagoon Blowers:

In the event that there is an odour emanating from the aerobic lagoon and/or there is a sufficient amount of COD or ammonia in the lagoon water (i.e., COD>100 mg/L NH₃-N>5 mg/L), the aeration system is to be activated, according to the following procedure:

1. Ensure the air intake to the blower to be activated is clear of debris. As needed, clear the air intake prior to starting up the blower.
2. Follow the manufacturer's operations manual for safe start up of the Blowers.

If the daily sampling results from the aerobic lagoon indicate that there is very little contamination present, then the aeration system can be halted. This is determined by the HACH sample analysis with COD<100 mg/L and NH₃-N<5 mg/L, and that there is no noticeable odour emanating from the lagoon after the aeration equipment has been halted.

Operation of the Leachate Treatment Facility

In the event that the lagoon water tested results in COD>200 mg/L and/or NH₃-N>10 mg/L, it will be necessary to treat this water in the biological treatment facility. At this time, water from the aerobic equalization lagoon would not be discharging directly to the stormwater sedimentation and control pond. It is strongly recommended that the start up of the biological treatment facility occur under the guidance of an experienced professional familiar with such undertakings.

1. Drain the anoxic tank to allow for room to inoculate the anoxic/oxic tanks with active biological sludges. This is to be done by having approximately three truckloads of returned activated sludges from neighbouring municipal wastewater treatment works discharged directly into the anoxic tank. Ensure that there is no overflow from the clarifier by topping up the system with the aerobic lagoon water until the clarifier is 0.5 m from the weir. It is recommended that the sludges being obtained have been demonstrated to be strongly

nitrifying. Confirm this with the municipal plant supplying the activated sludges.

2. Activate the blower system by starting up Blowers #2 and #3, by following the instructions in the manufacturer's operations manual. Adjust the blowers speed to maintain the dissolved oxygen in the oxic tank to between 1.5 and 2.0 mg/L.
3. Start up the anoxic mixer. Follow the manufacturer's instructions for the operation and start up of the mixer.
4. Measure the influent water for soluble phosphorus. Take a grab sample from the aerobic lagoon and measure its phosphorus content using the HACH and following the supplier's instructions. If the measured soluble phosphorus is <0.5 mg/L, then supplemental phosphorus will be to be added by the phosphate tank. Follow the manufacturer's operations manual for operating the phosphate pump.
5. Start up the supplemental carbon nutrient system. Additional organic carbon will be necessary to quickly acclimatize the sludges to the leachates. Follow the manufacturer's instructions for the safe operation of this equipment. Add supplemental carbon to the anoxic tank so as to maintain a COD:N:P ratio of 100:5:1.
6. Activate the sludge return pumps and the internal recirculation pumps. Do not waste any sludges during this time. Measure the clarifier effluent for COD, NH₃-N, and soluble phosphorus. As needed, adjust the chemical dosing pump to assist in removing any excessive phosphorus.
7. Allow the system to stabilize for 24 hours. Monitor for COD, NH₃-N, and soluble phosphorus in both the anoxic and oxic tanks. If all the monitored parameters are in line and it is apparent that the biology has taken hold in the system, then leachates can slowly be introduced. Depending upon the influent leachate COD, the supplemental carbon dosing will need to be adjusted accordingly to maintain the COD:N:P ratio of 100:5:1.
8. Slowly pump the aerobic lagoon water directly into the anoxic tank. The influent pumping rate for the aerobic lagoon should be adjust so as to maintain a 2 metre liquid level in the aerobic lagoon.

As needed, daily monitoring of the system is to take place. As needed, adjust the supplemental carbon dosing rate to the point that more leachates can be treated by the system.

1.3 OPERATION OF THE LEACHATE TREATMENT FACILITY

This section is provided to give directions for the safe operation of the leachate treatment system. It is intended that the leachate treatment facility would now be needed to treat the high strength leachates from the landfill sites. It is assumed that the anoxic and oxic treatment systems have been commissioned and inoculated with viable bacteria to allow for proper treatment of the high strength sludges.

Sample in incoming raw water to the leachate treatment facility. If the leachate strength is low, as determined by the sample analysis results from the HACH instrument of $\text{COD} < 100 \text{ mg/L}$ and $\text{NH}_3\text{-N} < 5 \text{ mg/L}$, then this water may bypass the aerobic equalization lagoon and pumped directly to the stormwater sedimentation and control pond.

If the sample analysis results in having a $\text{COD} > 100 \text{ mg/L}$ or $\text{NH}_3\text{-N} > 5 \text{ mg/L}$, then the raw water is to be sent to the leachate treatment facility.

Maintain the lagoon at a 2 m depth and have all additional influent water being pumped to the leachate treatment facility. If there is a noticeable odour emanating from the aerobic equalization lagoon during this time, the aeration system is to be activated. Please refer to Section 5.1.2 for the operation of the aeration system for the aerobic lagoon.

Sample the water entering the biological treatment facility and analysis using the HACH instrument and following the supplier's instructions for soluble phosphorus. If the soluble phosphorus in this sample is less than 0.5 mg/L , then additional phosphorus is required to maintain optimum biological treatment of the leachates. Start up the phosphorus addition system and adjust the feed rate of the pump to achieve the desired soluble phosphorus concentration in the influent wastewater. This is to be done in accordance with the supplied phosphorus guidance sheet.

In the event that the soluble phosphorus is greater than 8 mg/L , then additional chemicals are required to maintain the effluent within the discharge criteria. Start the alum/ferric chloride addition system and adjust the feed rate to remove the excess soluble phosphorus.

As the system starts to generate additional solids, commence slowly sludge wasting to maintain the mixed liquor suspended solids in the oxic tank in the range of $2,000 \text{ mg/L}$.

1.4 OPERATOR ROUTINE CHECKS

As part of the operators regular duties, the operator will be responsible for performing daily, weekly, and monthly checks on the equipment and operations of the leachate treatment facility. These checks are to be recorded on log sheets to allow for the tracking of the performance of the leachate treatment facility, ensuring adherence to the supplier's recommended maintenance schedules, and to assist with any troubleshooting of operational difficulties which may arise during the course of the facility's operation. As needed, the operator will complete the log sheet and submit it to his immediate supervisor for tracking and record keeping.

A sample log sheet to be completed daily by the operator has been provided in Appendix B.

Some of the routine monitoring tasks that are to be performed by the operator are listed below.

1.4.1 DAILY MONITORING

Blowers:

- All blowers intakes are free and clear of any obstructions. Remove all obstructions to ensure proper operation of the blower equipment.
- No noticeable oil leaks in the vicinity of blower equipment. Clean up any noticeable oil leaks and determine the source of the leak. As needed, tag and lock out the affected equipment and enact maintenance procedures to bring equipment back online.

Aerobic Lagoon system:

- Discharge pump intakes are free and clear of any obstructions. Remove all obstructions to ensure proper operation of the lagoon pumps equipment.

Biological Treatment Facility:

- Clarifier overflow weir is free and clear of debris, remove all obstructions to ensure proper operation of the clarifier.

- Remove and visually inspect all instrumentation probes such as DO, pH, and ORP. Clean probes to ensure good contacting surface.
- Grab samples from the aerobic lagoon, anoxic, oxic, and clarifier effluents for chemical analysis.
- Record the amount of sludge wasting.
- Adjust supplemental chemical, phosphorus, and carbon dosing feed rates as needed.

1.4.2 WEEKLY MONITORING

Biological Treatment Facility:

- Calibrate pH meters in accordance with the supplier's instructions.
- Perform sludge settleability tests upon anoxic and oxic sludges, record results.
- Perform oxygen uptake tests upon oxic sludge, record results.
- Record all chemical storage tank levels as needed, place a request for restocking of chemical if needed.
- Dispose of sludges to the landfill after undergoing aerobic digestion. Record the amount of sludges transferred to the landfill.

1.4.3 MONTHLY MONITORING

- Perform oil changes on all motorized equipment on a monthly basis. As needed, record oil levels and top up if necessary. Record and report any excessive oil consumption to immediate supervisor.
- Measure the depth of solids in the aerobic lagoon. Record the result.
- Calibrate the DO and ORP meters in accordance with the supplier's instructions.

APPENDIX C

LANDFILL GAS MANAGEMENT

LANDFILL GAS COLLECTION SYSTEM

An active LFG control system has been developed and shall implemented upon reaching specified triggering levels or conditions that would initiate the installation and operation of the LFG collection and flaring system.

The LFG management system will be composed of a number of elements. The four key elements are as follows:

- LFG collection field consisting of horizontal trenches;
- main header pipe network and laterals to convey the collected LFG to the LFG management facility;
- condensate management system; and
- LFG management facility consisting of centrifugal blower and flare.

The first phase of the LFG management system construction would be limited to the installation of the main header during infrastructure development in the first year of the Contract. The LFG horizontal trenches shall be installed in the second last lift of waste prior to progressive capping of the Site.

The LFG management facility would be constructed to coincide with the completion of the first phase of the progressive closure, permitting the installed LFG collection trenches to be commissioned as they are installed and LFG collection operations to commence. It is assumed, for the purpose of this report, that the first phase of progressive closure would be completed approximately 10 years after commencement of site development activities.

The pipe network is envisioned to include two components to be installed in the initial construction phase of the proposed Site:

- main header; and
- lateral header "T" connections.

The main header will be constructed of 300 mm (12-inch) diameter SDR 26 HDPE pipe. The 150 mm HDPE "T" couplers will be fused at 40 m intervals along the main header, extended to the surface at a minimum slope of 2 percent and blind flanged at surface to facilitate the connection of the LFG extraction trenches during progressive closure of the Site.

The main header shall sloped towards two low points along the header alignment at a minimum slope of 1 percent. These two low points should coincide with the locations of the leachate pump stations.

The primary components of the LFG management facility include the following:

- condensate knock-out pot (KOP);
- piping and valves;
- LFG instrumentation (quantity and quality);
- LFG extraction blower; and
- Enclosed flare.

Due to the temperate climate of the region, a simple roofed enclosure structure will be required to shelter the control plant instrumentation and blower systems and to provide security for the equipment and control panels.

The blower should have a design capacity of 2,000 m³/hour and be equipped with an explosion-proof electric motor and spark-proof fan assembly.

The installation of the flare is recommended for the purpose of combusting the LFG in a cost-effective manner.

NOTE:

At the time of this writing, complete details for the operation and maintenance of the LFG collection and flaring are not available since the system has not been designed and commissioned. As previously discussed, it is anticipated that the LFG collection and flaring system will be required after approximately 10 years of operating Site life. When the LFG collection and flaring system has been constructed and commissioned a final operation and maintenance guideline will be prepared and submitted for review and evaluation by the Owner.

APPENDIX D

FLOW OF WASTE

1.0 WASTE MANAGEMENT

The tipping face is the active part of the Site, where waste is placed and compacted on a daily basis. The location of the tipping face within the Site changes as more waste is added. As waste accumulates in the Site, the tipping face also proceeds higher in elevation along with the increase in the height of the deposited waste. The size of the tipping face will be adjusted according to the number of vehicles likely to be at the tipping face at any time.

The operations at the tipping face consist of the following primary tasks:

- preparation of the tipping face and the site road;
- relocation of direction signs;
- notification to the site personnel and weighbridge staff as soon as the area is ready to accept waste deposition vehicles;
- directing the vehicles at the tipping face;
- spread waste maintaining required slope;
- compact waste to required density;
- apply daily cover at the end of the day;
- arrange for the following day's tipping location; and
- shut down landfill site and equipment.

1.1 PLACEMENT OF WASTE

Waste will be placed by utilizing the area method, that is, the waste will be filled and compacted over the prepared base, in layers, and daily cover will be applied following the waste segregation and recycling activities carried out by the Site's licenced waste pickers.

Waste hauling trucks will unload at the designated drop-off area within the landfill footprint for waste diversion activities including access for waste pickers. Waste pickers will be given access to a number of restricted areas of the Site and will be given a specified time allocation to have access to the waste. An area close to the tipping face will be designated for waste pickers. The waste placement must be staged such that after the allocated time period for recycling/segregation activities has expired, that all waste pickers will be required to vacate the specific area and the waste will be pushed

into the disposal cell and compacted. Waste pickers will not be granted access to the active tipping face areas due to safety and operational concerns.

The waste pickers will be allowed to move recoverable materials to the assigned staging area for subsequent sorting and cleanup. Any residual wastes from the sorting operation will be placed in a separate designated area to be returned to the filling area on a daily basis. Residual wastes will not be retained in the sorting area for more than 24 hours. Waste pickers that do not adhere to the above procedures may lose their Site access privileges.

For the placement of the initial layer (lift) of waste at the Site, the following procedures and considerations are to be followed:

- a site road shall constructed to the pre-determined access point for waste placement, from the ramp running from the site service road to the landfill base, for the placement of the initial lift of waste above the leachate collection system. The initial site road will be part of the construction works contract. However, the maintenance and extension during the operation period will be an obligation of the Contractor;
- a turnaround area and tipping platform designed to accommodate a minimum of three trucks also has to be built of materials suitable for the season, which will support dumping and turning by the waste ferrying vehicles. The initial construction work will be part of the construction works contract. However, the maintenance and extension during the operation period will be an obligation of the Contractor; and
- the minimum thickness of the initial lift shall 0.6 m layer of selected waste at the base and at least an additional 1.5 m of waste above that.

As indicated in the earlier sections of this document, the selected waste will consist of residential waste or other suitable wastes without sharp metallic objects or material likely to damage the leachate collection system. Typically, general residential wastes do not contain large and/or sharp objects that could damage the leachate collection system.

Drivers shall keep a minimum of 2 m from the edge of the initial lift and use caution whilst working in that area. Aggressive handling of the waste could cause the filter fabric or drainage layer to shift thereby reducing the effectiveness of the leachate collection system.

Waste hauling vehicles shall kept away from the edge of the initial lift to prevent them from getting into the selected waste and damaging the leachate collection layer.

A light or medium sized bulldozer or excavator shall used to push and level the waste for the initial lift. Equipment operators should take extreme care in levelling the waste, as no compaction shall applied other than during spreading. The operator should not attempt to drive over the leading edge of the lift. At no time should the thickness of the waste on which the equipment is operating for the initial lift be less than 1 m above the upper element of the leachate collection system. The landfill compactor must not be used to compact the initial lift.

The initial lift of residential waste will act as filter for the leachate collection system. Accordingly, heavy compaction of this initial lift is to be avoided so as not to reduce the ability of the initial layer to protect the leachate collection system, and also not to reduce the flow of leachate to the collection system.

The Contractor will build an all weather site road over the waste as filling progresses. This road will serve as access to the tipping face and maintained to give rear-wheel drive vehicles access in all weather conditions.

Waste will be compacted in lifts not exceeding 2.0 m thick using multiple passes with the landfill compactor (typically two to five passes), depending on the equipment available and the material being compacted. Daily cover consisting of native soils, wood chips, and suitable imported material designated as ADC will be placed in accessible portions of the working face prior to the end of each operating day. The type, amount, and area that the daily cover has been applied to will be included in the Site operator's daily report.

The estimated average daily volume of waste/daily cover landfilled will be approximately 200 to 250 tonnes per day based on the average annual disposal rate of approximately 67,000 tonnes per year.

Typically daily cover for active areas of the Site shall approximately 100 to 150 mm in thickness to ensure reasonable cover of the waste. The daily cover shall placed by a bulldozer and not by a waste compactor. A waste compactor will render the daily cover materials ineffective for litter and vector control unless it was placed in a much thicker lift of material that is not recommended and which would place greater stress on soil resources.

1.2 WASTE COMPACTION

The Contractor must increase the in-situ density of the solid waste delivered at the site, through compaction, to meet the maximum density of 700 kg/m³ for the designed life span of the site. Compacting the waste is intended to maximize the waste density to best utilise available void space, which in addition, also offers significant other benefits, including:

- minimising the daily cover requirements;
- reducing the chance of differential settlement;
- minimising leachate production;
- enhancing the structural stability of the landfill;
- reducing the potential for fire;
- reducing problems of infestation by vermin, flies, pests and birds; and
- minimising odour problems.

The Contractor shall take into consideration the following points while spreading and compacting the waste:

- attempt to push only the amount of waste that the equipment can move without excessive wheel slippage, as it will damage the previously compacted layer;
- progressively raise the blade of compactor/ bulldozer as it travels up a slope of waste. The operator should maintain an average waste thickness of 0.5 m;
- distribution and co-disposal of different types of waste on the tipping face is considered as a means to improve compaction;
- waste placement, spreading and compaction is best achieved by pushing waste up slope not be steeper than 1:5 (H:V);
- after the equipment operator has pushed and spread a layer of waste over the entire slope area the waste will be compacted a minimum of three passes to achieve the minimum waste deposited density of 700 kg/m³;
- when dealing with low-density waste that rebounds after compaction such as brush, leaves, tree trimmings, agricultural wastes, and low-density plastics, special measures are to be taken to ensure that they are compacted sufficiently;
- maintain a smooth tipping face slope and horizontal surface to ensure need of only minimal daily cover soil and to promote surface water drainage;

- whenever possible, wet waste and dry waste from different vehicles are to be mixed; and
- during periods of above normal precipitation, the Contractor should reduce the tipping area and increase the slope [no steeper than 1:5 (H:V)] to reduce the infiltration of water and thereby, reduce the generation of leachate.

1.3 COVER OPERATIONS

Use of clay materials for daily cover on the tipping face and on the working lift platforms is not the ideal material because it can tend to produce localized perched areas in the landfill which promote lateral flows to the sideslopes of the landfill, resulting in potential leachate seeps. To promote good hydraulic connection throughout the waste in the landfill, the use of alternative daily cover (ADC) materials shall encouraged, when these materials can be made available. ADC materials can include the following:

- construction and demolition debris;
- woodchips and other vegetative matter;
- solid, non-hazardous wastes such as contaminated soils or other industrial or commercial wastes suitable as daily cover; and
- other cost-effective ADC technologies such as tarp systems and binder sprays.

The use of alternative daily and interim cover would have some inherent benefits for the landfill performance and would reduce any potential future costs of importing materials. ADC material selected for use at the Site will depend upon availability of local materials. The waste-to-daily cover ratio is expected to be in the range of 6:1. Thus, the volume of daily cover material required to complete the Site is approximately 335,000 m³.

Interim cover is a term used to apply to an area that is not yet completed but is expected to be inactive for waste filling for 6 months or more. In these areas, which are typically the working platforms above the major lift lines, a thicker layer of interim cover is placed on the waste in the range of 300 mm in thickness. Note that interim cover materials shall be removed prior to placing the next lift of waste to try to ensure a good hydraulic connection through the waste, and minimize the potential for leachate seepage. After surplus cover is removed, the waste compactor should traverse the area before the next lift of waste is placed to co-mingle the remaining cover and waste to mitigate against localized perched leachate conditions within the Site.

1.4 UNACCEPTABLE WASTE

Site personnel actively involved with day-to-day landfill operations will be trained to identify waste loads that may be unacceptable for landfilling at the Site. If a load is refused due to an unacceptable waste profile, efforts will be made to obtain the following information:

- the source of the load;
- name of driver;
- licence number of vehicle; and
- company name on truck.

This information, including date and reason for refusal, will be maintained on Site for record-keeping purposes.

There will be a list of prohibited materials posted on signs at the Site entrance. The nature of the weigh scale operation will permit tracking of licence numbers of offending vehicles and companies to permit follow-up response measures to be taken in the event that the non-compliance by some parties becomes a chronic issue. It is also expected that over time, the list of restricted materials may be modified by the waste management authorities. These types of changes will require public consultation and notification as well as a phase in period to ensure that all users of the Site become aware of any changes to policy and the Site-specific requirements.

APPENDIX E

TERMS OF REFERENCE

TERMS OF REFERENCE

Preparation of Environmental and Social Impact Report and Public Consultation Eccles Municipal Solid Waste Management Facility

The environmental and social impacts of the new facility at Eccles shall be assessed and summarized in a separate Environmental and Social Management Report (ESMR). This report shall be prepared in accordance with the IDB PR-204 procedures. The consultants will use the World Bank's "Environmental Assessment Sourcebook" 1999 available from www.worldbank.org, as reference.

The Consultant shall include results from the preliminary environmental assessment included in the Pre-Investment Study for Georgetown Solid Waste Management Program – Waste Characterization and Facility Siting. 4th May 2000. Report prepared by Brown, Vence & Associates.

The EIA shall include the following:

1. Compilation of environmental baseline data for all environmental media including land use in the vicinity of the Eccles site and of the Mandela Dump and any ongoing or planned activities in the area etc. New data shall be collected in instances where no secondary data is available
2. Location analysis (distance to residential, recreational or industrial areas or other relevant installations). This includes sampling of air, water, noise and mapping of flora and fauna. The results of a site investigation undertaken by the Design Consultant shall be incorporated into the environmental baseline;
3. Investigation of surface water conditions as well as meteorological conditions;
4. Study of socio-economic conditions in the project area;
5. Examination of peoples affected by the project and development of Resettlement or Compensatory Plan to conform to IDB Policy on Involuntary Resettlement, OP-710
6. Impact modeling and prediction;
7. Impact assessment for design, construction, operation and closure phases including socio-economic effects on GM, NDCs and neighboring communities;
8. Risk assessment of technical facility (e.g. leakage, contaminations), natural hazards (e.g. flooding) and road transport accidents;
9. Mitigation planning on feasibility level specifying environmental requirements and design measures including protection zones etc;
10. Outline of an Environmental Mitigation Plan, specifying measures to avoid/reduce harmful impacts during construction and operation. Mitigation measures shall be designed to the feasibility level and should indicate the timetable, costs and responsibility for implementation,
11. Design an environmental monitoring program indicating variables, frequency of sampling, duration, costs and responsibility for execution and supervision;
12. Develop cost estimates of environmental protection and mitigation measures; and
13. Specify Closure measures to the level of feasibility;
14. Detail the results of consultation with statutory stakeholders and the public and project affected people, including the development of project responses and whether concerns have been incorporated into the project design.
15. Identify project risks that can threaten the sustainability of the project and propose of remedial actions/measures to minimize potential project risks.

The Consultant shall assist the MSWMD during the Public Consultation that shall follow the completion of the Environmental and Social Impact Report. This assistance will include presentation of the report at a public workshop in the project area followed by presentation of responses to issues raised in the workshop.

The Consultant shall undertake to provide as follows:

- Assistance to the MSWMD in drafting applications for permits;
- Assistance to the MSWMD in answering queries from permitting authorities;
- Assistance to the MSWMD in obtaining permits.

Final responsibility for obtaining permits will remain with the MSWMD.

The Environmental and Social Impact Report should include the following items:

1. Executive Summary: A concise discussion of significant findings and recommended actions
 2. Project description: Concise description of the project's geographic, ecological, social, and temporal context, including any GoG investments that may be required by the project and including a description of the project components as detailed in the project Profile II;
 3. Baseline Data: Assessment of the dimensions of the study area and description of relevant physical, biological, and socioeconomic conditions, including any changes anticipated before the project commences. Current and proposed development activities within the project area (but not directly connected to the project) should also be taken into account;
 4. Legal, and Institutional Framework: A discussion of the legal, and institutional framework forming the basis for the EIA indicating flaws and proposing actions to strengthen actions. The EIA approval procedures and steps to be followed shall also be outlined.
 5. Environmental Impacts: Identification and assessment of the positive and negative impacts likely to result from the proposed project. Mitigation measures, and any residual negative impacts that cannot be mitigated, should be identified. Opportunities for environmental enhancement should be explored. The extent and quality of available data, key datagaps, and uncertainties associated with predictions should be identified/ estimated. Topics that do not require further attention should be specified; mitigation measures shall be designed to the feasibility level and shall include drawings if necessary, costs, timetables and responsibilities for implementation
 6. Analysis of Alternatives: A systematic comparison of the proposed investment design, site, technology, and operational alternatives in terms of their potential environmental impacts; capital and recurrent costs; suitability under local conditions; and institutional, training, and monitoring requirements.
 7. Quantification of the environmental and social costs and benefits for each alternative to the extent possible, and economic values should be attached where feasible. The basis for the selection of the alternative proposed for the project design must be stated considering the respective social and environmental costs;
 8. Mitigation Plan: Identification of feasible and cost- effective measures that may reduce potentially significant adverse environmental impacts to acceptable levels, and estimation of the potential environmental impacts; capital and recurrent costs; and institutional, training, and monitoring requirements of those measures. The plan should provide details on proposed work programs and schedules. Such details help ensure that the proposed environmental actions are in phase with engineering and other project activities throughout implementation. The plan should consider compensatory measures if mitigation measures are not feasible or cost-effective;
 9. Institutional Assessment: Assessment of the existence, role, and capability of the MSWMD to ensure project sustainability. Finding of the assessment shall include recommendations related to funding and/or expansion of this department and the training of staff, to the point that Environmental Mitigation and Monitoring Plans can be implemented;
 10. Environmental Monitoring Plan. Specification of the type of monitoring, who would do it, how much it would cost, and what other inputs (e.g., training) are necessary; and
- Appendices:
 - List of contributors to the Environmental Assessment, individuals and organizations;
 - References and written materials used in study preparation;
 - Record of Consultation Meetings etc. including lists of both invitees and attendees. The record of consultations for obtaining the informed views of the affected people and local NGOs should be included. The record should specify any means other than consultations that were used to obtain the views of affected groups and local NGOs.

Reporting: 7 copies of the EIA in English language (4 copies to the MSWMD, 2 copies to the IDB in Washington and one copy to the IDB in Guyana). The EIA shall be submitted in a draft version followed by a first final version based on

comments made by the IDB and the MSWMD. 250 copies of the Executive Summary shall be made for the public consultation. The results of the public workshop and the modifications of the EIA shall be incorporated in an addendum to the report.

TERMS OF REFERENCE

ENVIRONMENTAL AND SOCIAL IMPACT MANAGEMENT REPORT

A separate Environmental and Social Impact Management Report (ESMR) shall be prepared for submission to the IDB. This ESMR shall contain the following:

Project description: Concise description of the project's geographic, ecological, social, and temporal context, including any GoG investments that may be required by the project;

Environmental Impacts: A presentation of the key direct and indirect social/environmental impacts or risks of the proposed operation including if applicable, gender issues, impacts on indigenous and afrodescendants communities, on vulnerable groups an occupational safety and health concerns.

Mitigation Plan: The proposed social/environmental measures to avoid, minimize and mitigate the key direct an indirect impacts or risks associated with the project.

Institutional Assessment: Institutional responsibility to implement the mitigation measures with an explanation of the institutional capacity to successfully handle these responsibilities.

Costs: The schedule and budget allocated for the implementation and management of the social/environmental mitigation measures designed to the feasibility level.

Consultation: The consultation program undertaken for the operation

Monitoring: The framework for monitoring of social and environmental impacts throughout the execution of the project, including clearly defined indicators, monitoring schedules, responsibilities and costs.

APPENDIX F

RESPONSE TO QUESTIONNAIRES

Continental Park

The racial distribution showed that this is a predominantly Black community (45%) with a large Mixed population (40%) and a large percentage (65%) of the residents have flower gardens. It is an affluent residential community so there are no businesses and everyone owned the property.

Information

Everyone had heard about the project but the general view was that they did not want it in their backyard. Residents pointed to the need for information to understand the design of the proposed system and felt that it would be another hazardous site like the Mandela Avenue Dump Site. Residents posited that they chose the area for its tranquility and the clean air because they had no idea that such a project was intended for Eccles.

Management of Waste

There were two waste disposal systems operating in this community. One was the general service provided to the community every fortnight and the other was a privately contracted service, which allowed for the collection of waste once weekly. Garbage is commonly stored in garbage bags and left in Bins for the collectors.

Concerns & Effects

The greatest concern of the residents is the devaluation of property since they had invested millions of dollars for the land and the construction of their homes. They anticipate that the impacts will be negative on their life and on the community in general and a significant percentage (50%) felt that in the long term, it would lead to their migration to other areas, while another (45%) felt that it would lead to an upsurge in air and water borne diseases.

Perceptions of Project Location/Recommendations

Most of the residents (90%) are against the establishment of the project at that location and suggested that such a project should be established out of the city and sub-urban areas in the backdams far away from residences. They also recommended that modern waste management practices should be utilized and the government should contract experts to advise them on the issue.

Fig 1a.

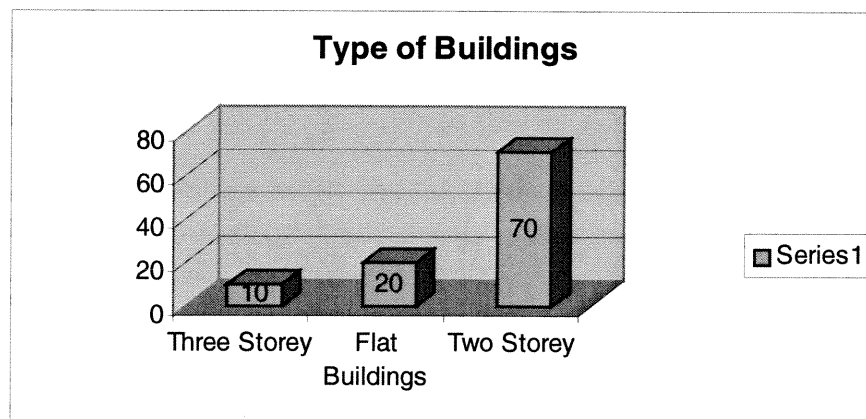


Fig 2a.

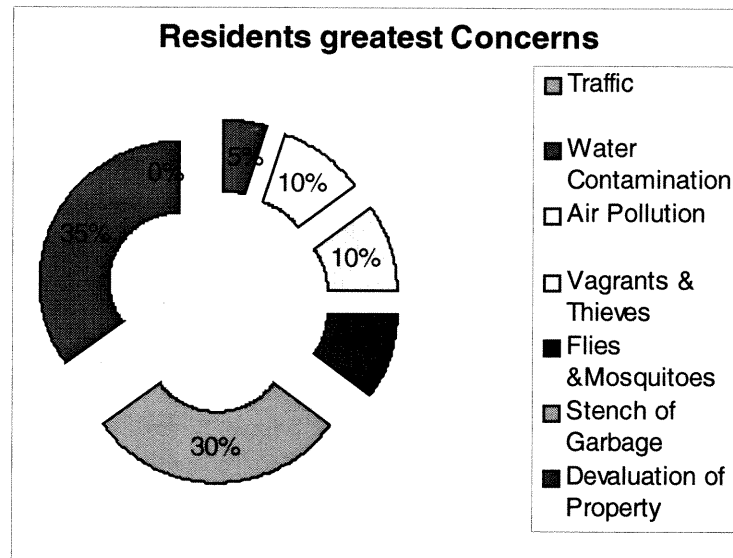
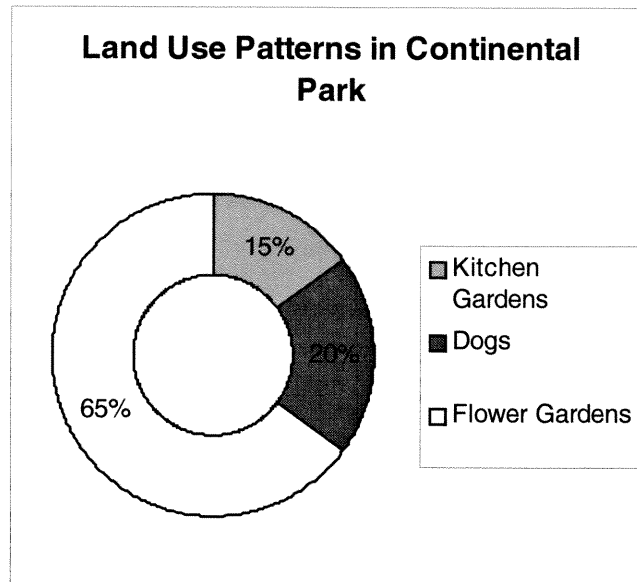


Fig 3a.

Fig 5a.

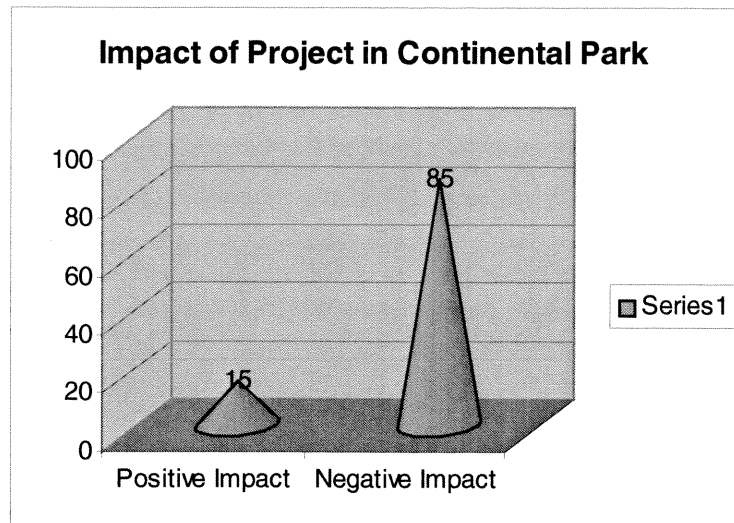


Fig 6a.

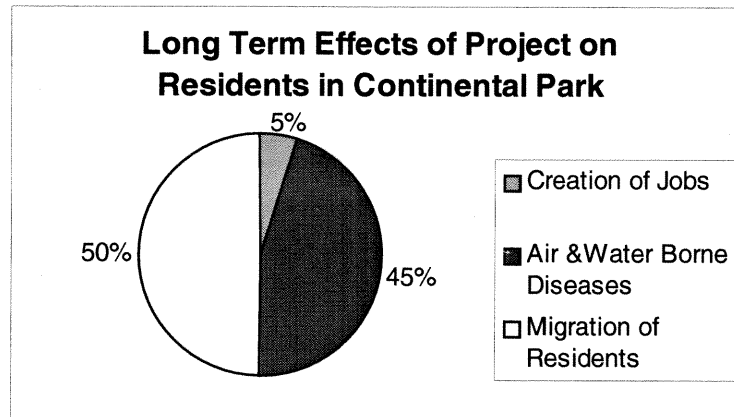


Fig 7a.

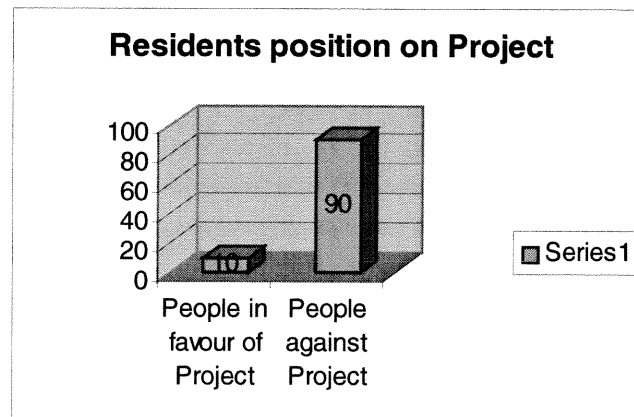


Fig 8a.

Bagotstown

The sample showed a predominantly African population (48%) and a significant number of persons of Mixed Race (26%).

This is a poor community so many of the persons use the resources available to them to make their livelihood. This includes poultry rearing (38.3%) and vending (sweets, cigarettes, drinks, bread, etc) 15%. Kitchen gardens are also used

(15%) to supplement their income. Land is scarce in the area and most of the space is occupied by shacks, houses and stalls.

Information

Most of the residents had heard about the Eccles Project and felt that the site would be storing the waste of the Eccles and Peter's Hall Area. Many of them did not know the actual location of the proposed site and felt that the project was political and the government had no concern for their community because they were Black and poor.

Management of Waste

Dumping and burning are commonly practiced in this community and there is evidence of several dump sites throughout the community. This is primarily because the streets are short and narrow and the garbage trucks are irregular, so they residents manage their waste individually by dumping and burning.

Concerns and Effects

The greatest concerns in this community are the increase of flies, mosquitoes and rodents (31.7%), the possibility of ground water contamination (21.5%) since standpipes are the main source of potable water and the anticipated stench (20%) of the garbage. The majority of the residents believe that it will have a negative effect on their lives and their community and they expressed concern for the health of their young children. The major long term effects they see resulting from this project are an increase in air and water borne diseases (66.7%) and migration from the community (30%).

Perceptions of Project Location/Recommendations

The general perception (95%) was that the location was inappropriate and that it would be bad for their businesses and they did not want any such project next to them. The recommended that alternative sites are Ogle and the Soesdyke Highway and suggested that the government consider establishing incinerators in those areas.

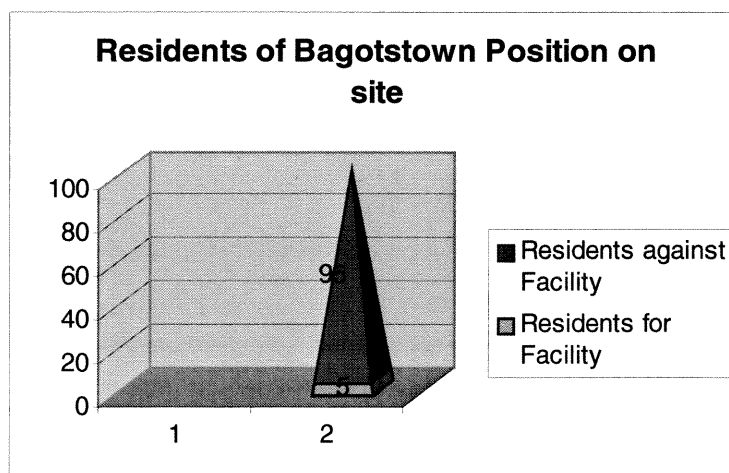


Fig 1b.

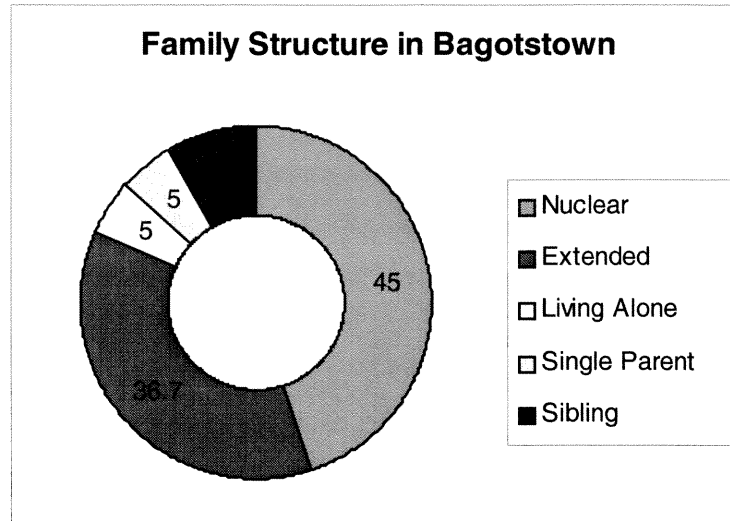


Fig 2b.

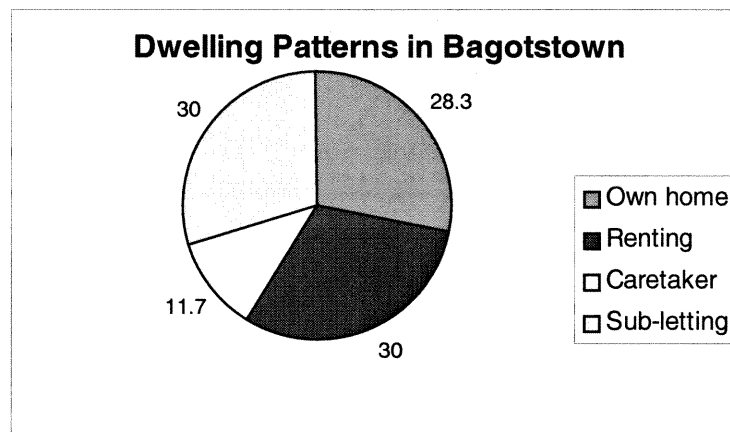


Fig 3b.

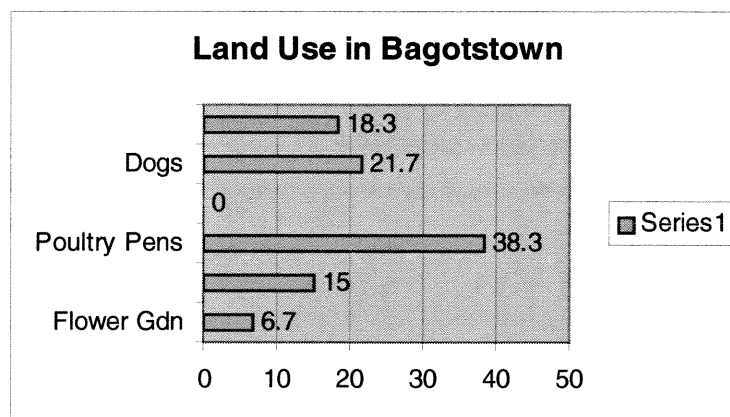


Fig 4b.

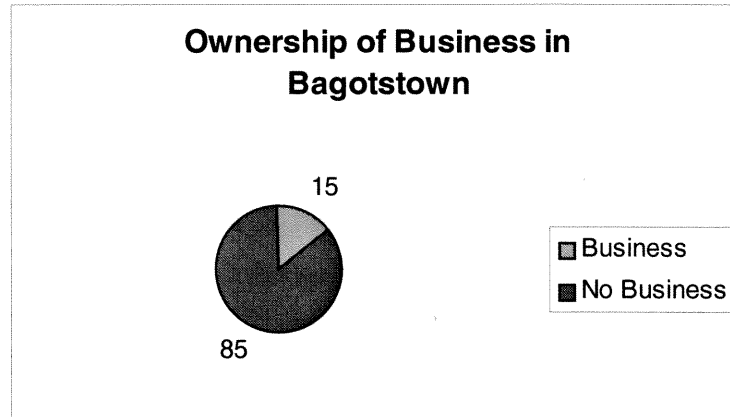


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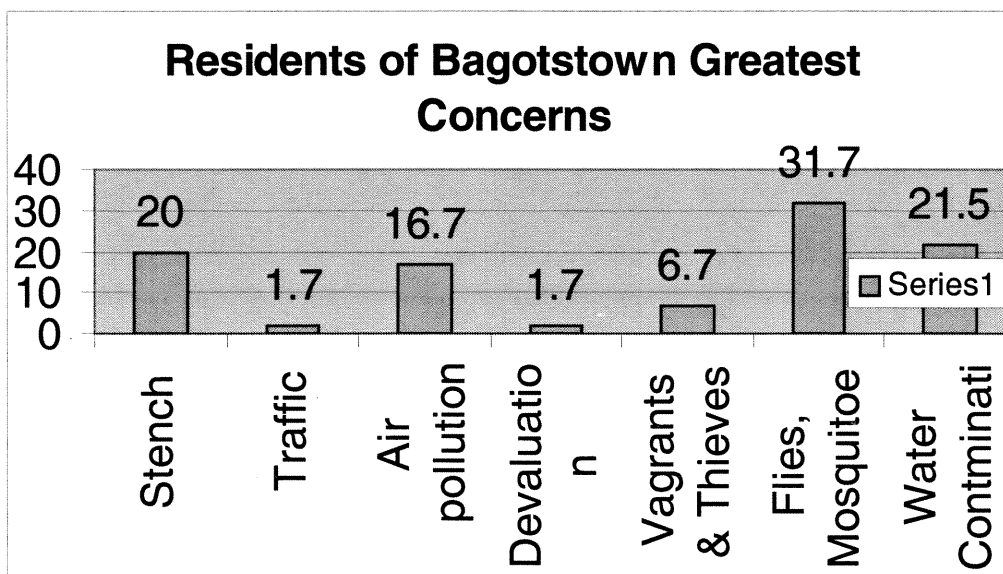


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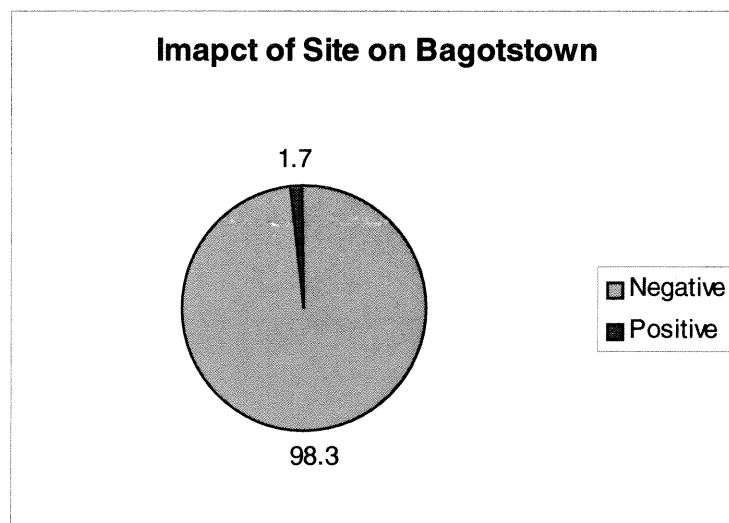


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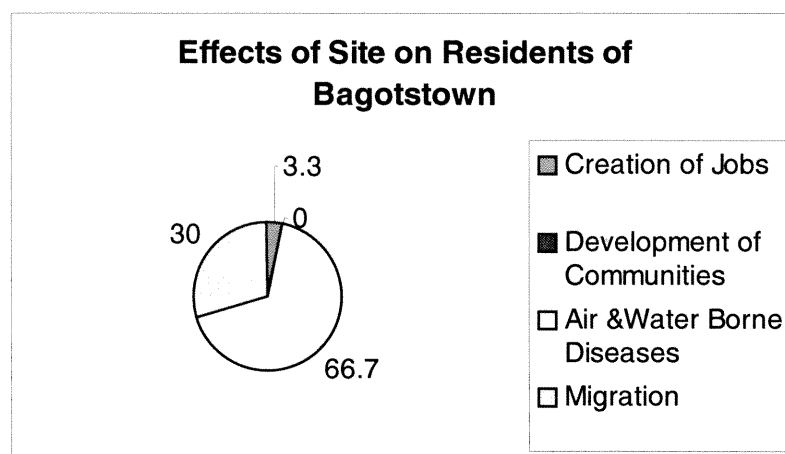


Fig 8b

Nandy Park

This is a predominantly Indian community with small percentages of persons from the other race groups. This is a middle class area which can be described as semi-residential owing to the number of businesses in the community. Many of those persons sampled practice subsistence farming and livestock rearing to support their families, while another set maintains flower gardens.

Information

Most of the residents were aware of the project, however some of them experienced conflict with their preferences and party loyalty, since the project was perceived as a government initiative. There was also the evidence of disagreement within households over what should be their official position on the issue, but there was the general perception that distance was an important factor and they were too far away to suffer the direct impacts of the project.

Management of Waste

This community is divided into two parts, one part located between Bagotstown and Republic Park and the other part located behind Republic Park just north of Providence. The latter part is the semi-residential area which houses the few businesses and stalls in the area while the other part while the other part is cleaner and can be described as an upper class area.

The residents in the semi-residential area practice dumping in several sections of the community, even though garbage is collected fortnightly. This may be as a result of the number of businesses in the area and the fact that there is an accumulation of weekly waste. In the other section, persons manage their waste by storing them in garbage bags and bins and burning and composting is practiced on a minimal scale.

Concerns and Effects

A significant percentage of the residents (42.4%) are primarily concerned with the stench of the garbage and the possibility of air pollution (16.4%) if such a waste management site is established. They predict that the long term effects will be an increase in air and water borne diseases and migration out of the community.

Perceptions of the Project Location/Recommendations

The majority of the residents (91.8%) opined that the project will have a negative impact on their community and their quality of life and they were against the location of the site. However some residents (8.2%) approved of the site at its present location on the grounds that it will create jobs and it will serve to develop the neighbouring communities. (See Charts Below)

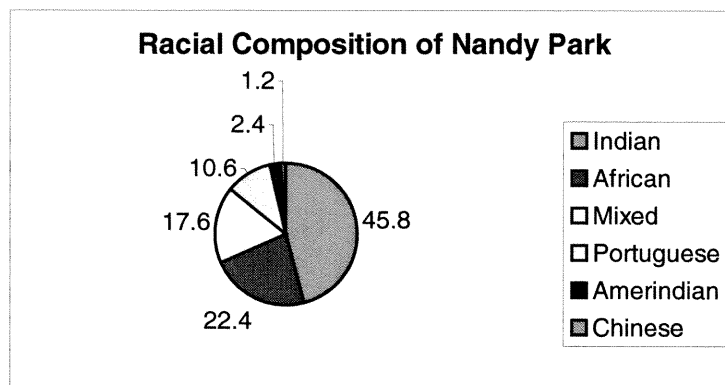


Fig 1c.

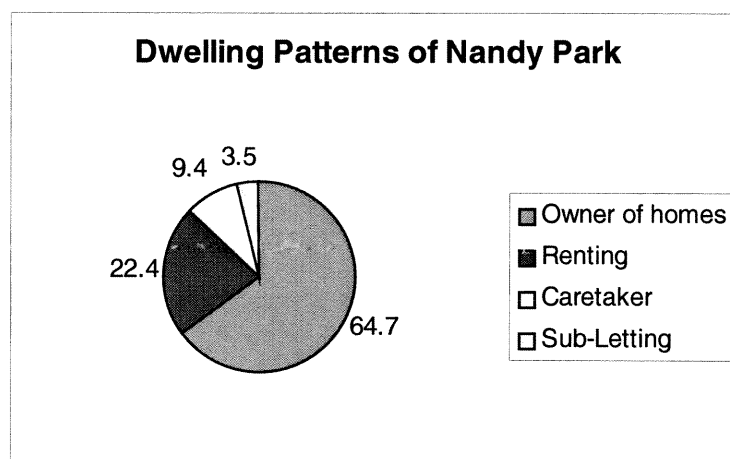


Fig 2c.

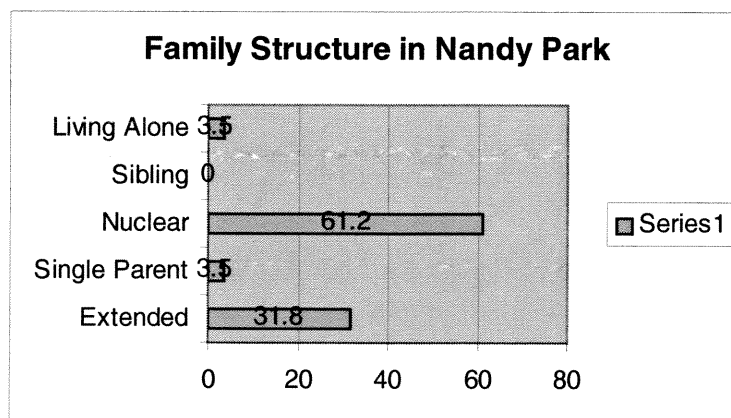


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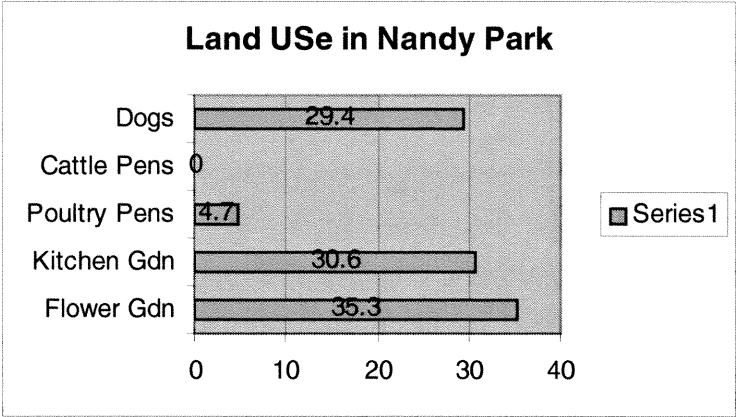


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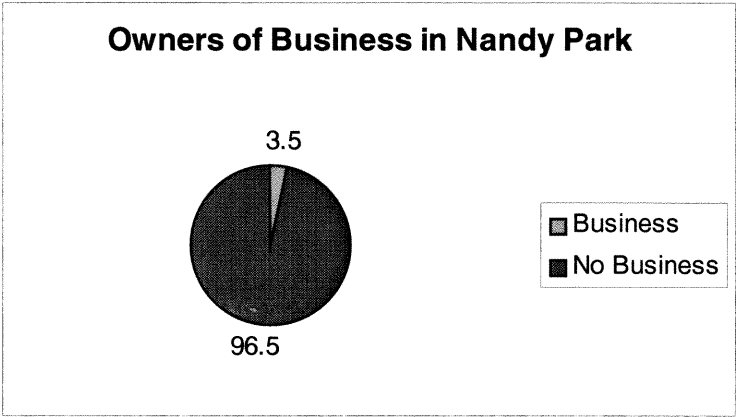


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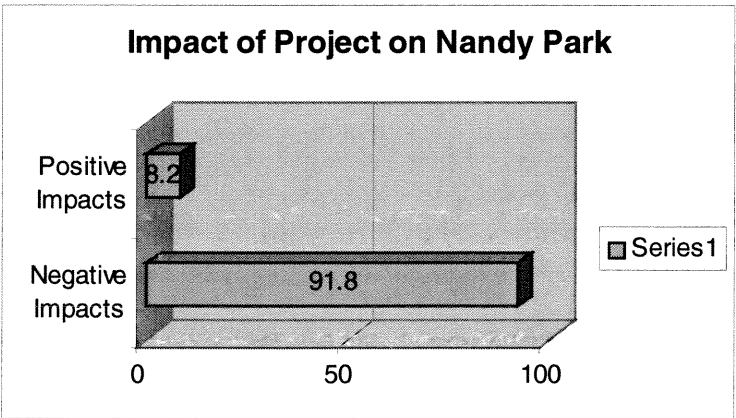


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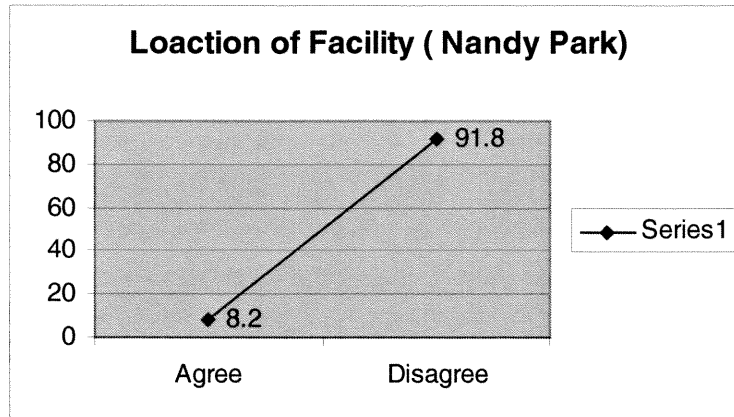


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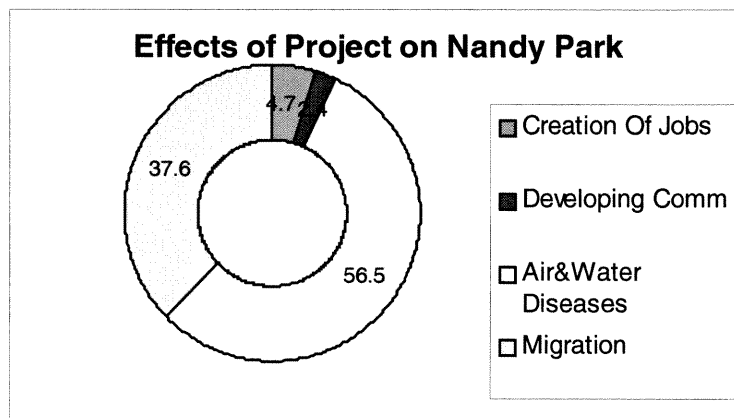


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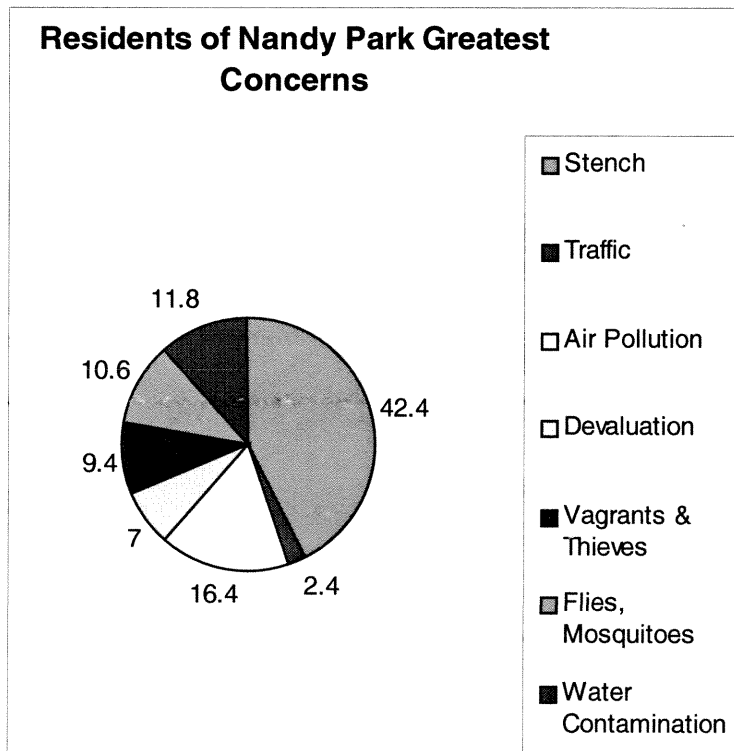


Fig 9c.

Eccles

This is a developing community which is predominantly Indian. The majority of people sampled owned their own homes (72%) and there are several business established in the area. While some (22%) refused to provide information pertaining to the ownership of cattle and livestock in the area, these animals (cows and pigs) are visible in the community and (4%) of the residents admitted to rearing poultry. Kitchen and flower gardens are also maintained in this community, especially in the middle income areas at the front of the scheme.

Information

All of the residents interviewed are aware of the project, but there is a paucity of information regarding the actual operation of the Waste Management Facility. There was the general view that the Project would promote the community and create jobs for the residents, however most of the residents disapprove of the project in their community.

Management of Waste

Garbage is collected every fortnight in this community, but some of the residents engage in dumping and burning whenever there is an accumulation of garbage. Generally however, garbage is stored in garbage bags and bins and placed at the front of the homes.

Concerns & Effects

The greatest concerns of the residents is the possibility of groundwater contamination, the increase of flies, rodents and mosquitoes and the stench of the garbage in the community.

Other concerns offered were the spillage of potentially harmful chemicals and hazardous waste during the transport of waste through their community and the long term impact on the young children.

Some residents (54%) predict that the long term effects will show an increase in water and air borne diseases and (36%) the migration of residents from the community.

Perception of the Project Location/Recommendations

The commonly held view was that the majority of the people (75%) rejected the idea of a dump site in their community and suggested that the site be relocated to the Linden Soesdyke Highway or some part of the East Coast where there are waste lands.

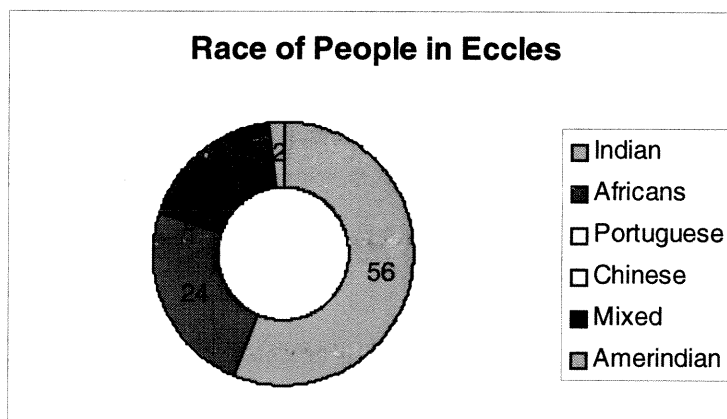


Fig 1d.

Information

Most of the residents seemed aware of the project but expressed disgust about the way in which the information is being disseminated. Some of them referred to the need for information on the different phase of the project and the design and

management of the project. They expressed concern that there needs to be further public consultation on the issue because the area is inappropriate for such a project.

Republic Park

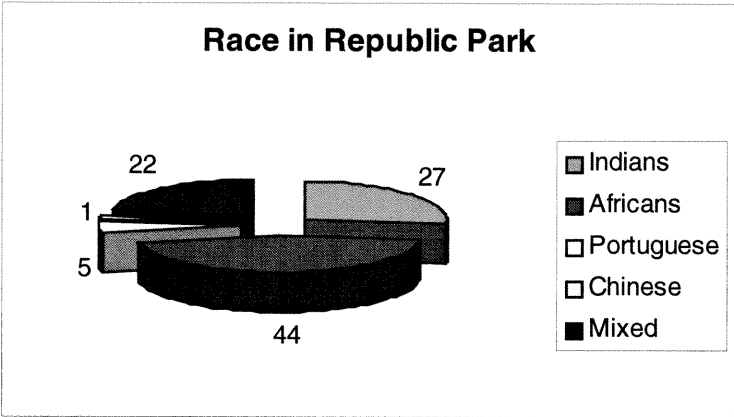


Fig 1e.

This community has a large percentage of Blacks(44%) with significant groups of Indians and persons of Mixed race. This is a residential upper class community so most of the land is used to display the aesthetics of the area. Most of the residents (95%) own their own homes, so flower gardens and kitchen gardens are commonly maintained by gardeners in this community.

Management of Waste

Garbage is commonly managed by storage in garbage bags and bins and this is collected every fortnight. Some residents also contract private Collectors (Cevon’s Waste Management) and refuse and other garden waste is collected directly.

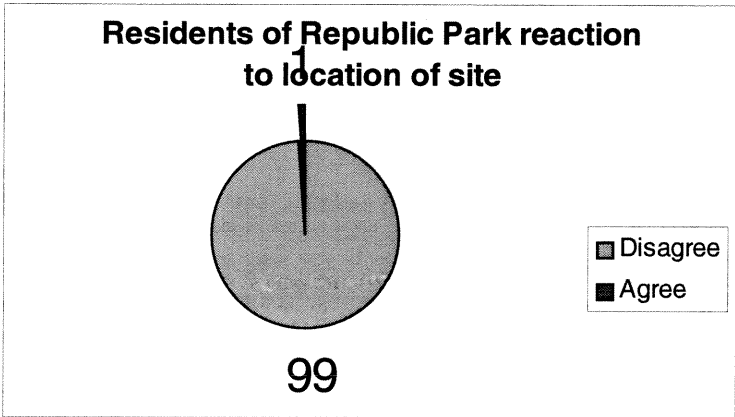


Fig 2e.

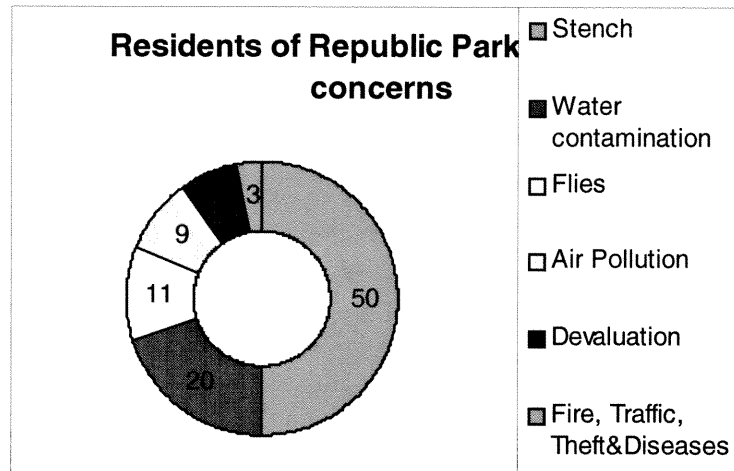


Fig 3e.

Concerns & Effects

Most of the residents expressed concern about the stench in the community, this that is expected to affect their general quality of life. Other concerns expressed include the treatment of hazardous waste, the control of possible emergency situations resulting from spillage or other scenarios and the management and maintenance of such a project. Residents expressed the view that the government lacks the expertise and the finance to adequately manage such a project and that would result in the site becoming a disaster zone.

They anticipate that the effects in the long term will range from the devaluation of their property and the migration of the residents from the community and pandemic outbreaks of diseases.

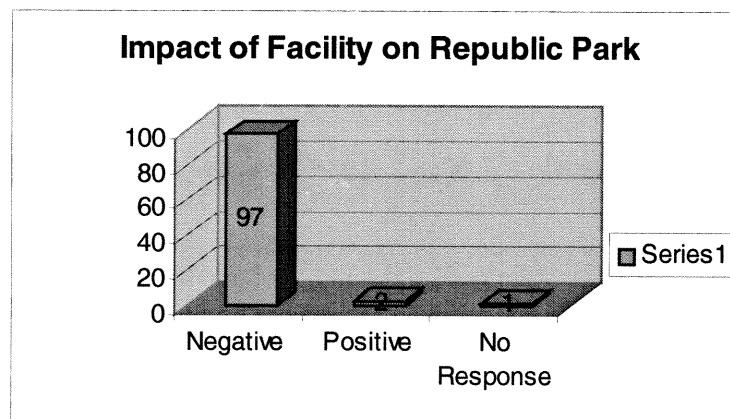


Fig 4e.

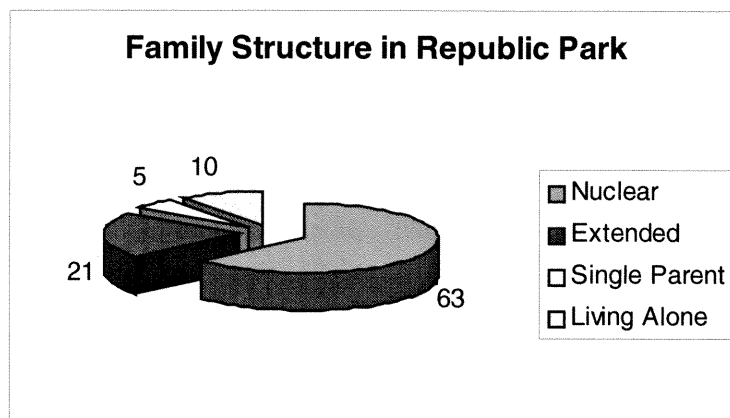


Fig 5.e

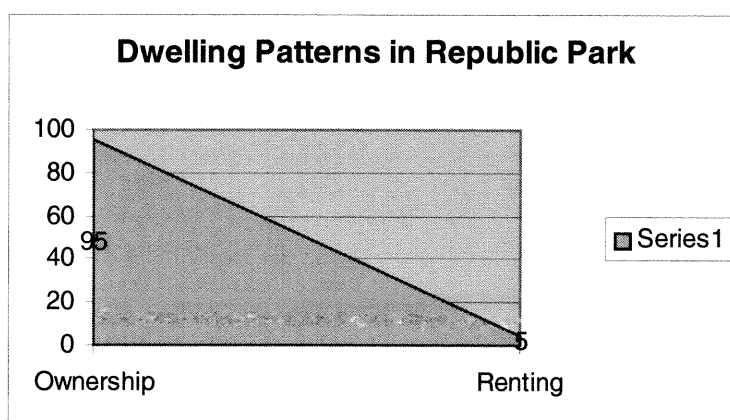


Fig 5e.

Perception of Project Location/Recommendations

The majority of the residents (99%) reject the proposed location for the project on the basis that the long term costs can be detrimental to the Government and people of Guyana. They recommend that the issue be revisited and efforts should be made to find an alternative site on the East Coast Wastelands or in the Linden to locate such a project.

APPENDIX G

LANDFILL GAS EMISSIONS ANALYSIS

Uncontrolled emissions of the various compounds present in landfill gas were estimated by determining the total landfill gas emissions. Generation of CH₄ was estimated using a theoretical first-order kinetic model of methane production developed by the USEPA. The Landfill Air Emissions Estimation model equation for CH₄ is:

$$Q_{CH_4} = L_o R(e^{-kc} - e^{-kt})$$

where:

Q_{CH_4} = Methane generation rate at time t, m³/yr

L_o = Methane generation potential, m³ CH₄/Mg refuse;

R = Average annual refuse acceptance rate during active life, Mg/yr;

e = Base log, unitless;

k = Methane generation rate constant, yr⁻¹

c = Time since landfill closure, yrs ($c = 0$ for active landfills); and

t = Time since the initial refuse placement, yrs.

The recommended default values of k equals 0.04/yr for areas receiving 25 inches or more of rain per year and L equals 100 m³/Mg were used to estimate the methane generated by the facility. At steady state, LFG consists of approximately 40 percent by volume CO₂, 55 percent CH₄, 5 percent N₂ and trace amounts of NMOCs. The estimate of CH₄ generation using the Landfill Air Emissions Estimation model was consequently also used to determine CO₂ and N₂ generation.

The NMOC emissions of the landfill gas were estimated by the equation:

$$Q_p = (1.82 Q_{CH_4} * C_p) / (1 \times 10^6)$$

where:

Q_p = Emission rate of pollutant P (i.e. NMOC), m³/yr;

Q_{CH_4} = CH generation rate, m³/yr

C_p = Concentration of P in landfill gas, ppmv and

1.82 = Multiplication factor (based on 55 percent of landfill gas being CH₄, and 45 percent is CO₂, N₂, and other constituents)

Uncontrolled mass emissions per year of total NMOC, CO₂, CH₄, and speciated organic and inorganic compounds were estimated using the relationship below.

$$UM_p = Q_p * [MW_p * 1 \text{ atm} / ((8.205 \times 10^{-5} \text{ m}^3 \cdot \text{atm} / \text{gmol} \cdot ^\circ\text{K}) (1000 \text{ g/kg}) (273 + T^\circ\text{K}))]$$

where:

UM_p = Uncontrolled mass emissions of pollutant P kg/yr

MW_p = Molecular weight of P, g/gmol

Q_p = NMOC emission rate of P, m³/yr; and

T = Temperature of landfill gas, °C

Uncontrolled default concentrations of speciated organics and a landfill gas temperature of 30 °C were used to generate estimates of uncontrolled emissions from the facility. 2-Propanol was used an indicator for NMOC emitted by the landfill. The generation rates of uncontrolled emission of CH₄, CO₂, N₂ and 2-Propanol over the 20 year design life of the facility are detailed in the table below.

Rate and Constituents of Uncontrolled Emissions from Landfill

Year	Q _{CH₄} (kg/hour)	Q _{CO₂} (kg/hour)	N ₂ (kg/hour)	2-Propanol (kg/hour)
1	23	45	4	0.008
2	44	88	7	0.015
3	65	130	10	0.022
4	85	169	13	0.029
5	104	207	16	0.036
6	123	245	19	0.042
7	140	279	22	0.048
8	157	313	25	0.054

9	174	346	28	0.059
10	189	377	30	0.065
11	204	407	32	0.070
12	219	436	35	0.075
12	232	463	37	0.079
14	246	491	39	0.084
15	259	516	41	0.088
16	271	541	43	0.093
17	283	565	45	0.097
18	294	587	47	0.101
19	305	609	48	0.104
20	316	1193	50	0.108

APPENDIX H

RENTAL PROPERTY EVALUATION

Mayor & City Council

Rate Summary (by Ward)

Ward Name	Property Count	Residential	Commercial	Exemption	Assessed Value
Kingston	349	13,885,459.00	36,149,836.00	1,514,400.00	48,703,595.00
North CummingsBurg	505	24,748,799.00	28,988,372.00	1,337,400.00	52,399,771.00
South CummingsBurg	609	23,668,822.00	31,874,158.00	3,792,600.00	52,129,880.00
Lacytown	512	19,498,249.00	30,957,911.00	1,289,400.00	50,370,960.00
Stabroek	302	16,361,035.00	32,601,275.00	194,450.00	48,962,310.00
Werk-en-Rust	297	10,224,450.00	13,252,060.00	0.00	23,476,510.00
Charlestown	688	18,957,850.00	16,489,255.00	279,700.00	35,415,605.00
Bourda	706	23,560,945.00	9,436,185.00	1,425,650.00	32,997,130.00
Alberttown	765	24,447,160.00	1,977,812.00	0.00	26,424,972.00
Thomas Lands	49	110,250.00	20,449,138.00	0.00	20,559,388.00
Bel Air Springs	58	4,339,900.00	36,400.00	0.00	4,376,300.00
Plantation Bel Air	220	8,871,700.00	115,350.00	0.00	8,987,050.00
Prashad Nagar	401	17,732,300.00	100,800.00	0.00	17,833,100.00
Lamaha Gardens	321	12,857,700.00	90,000.00	0.00	12,947,700.00
Bel Air Gardens	48	5,508,000.00	43,500.00	159,400.00	5,551,500.00
Blygezight Gardens / Campbellville "L - M"	566	17,946,125.00	2,137,000.00	0.00	20,083,125.00
Campbellville sections "E" - "N"	446	15,654,120.00	350,450.00	0.00	16,004,570.00
Subryanville	221	9,401,200.00	368,500.00	0.00	9,769,700.00
Kitty Village	797	22,328,780.00	1,785,800.00	72,000.00	24,114,580.00
Campbellville sections "A" - "I"	638	19,872,180.00	1,678,850.00	0.00	21,551,030.00
Kitty Railway Lands	662	14,904,400.00	712,750.00	0.00	15,617,150.00
Kitty / Newtown	699	16,488,528.00	954,722.00	0.00	17,443,250.00
Bel Air Park	371	20,036,500.00	6,491,100.00	0.00	26,527,600.00
D'Urban Backlands	38	2,784,100.00	4,053,850.00	0.00	6,837,950.00

Date: 06/17/2004

Mayor & City Council

Page 2

Rate Summary (by Ward)

Ward Name	Property Count	Residential	Commercial	Exemption	Assessed Value
25 - Lodge Village North	517	8,671,200.00	295,600.00	0.00	8,966,800.00
26 - Meadow Brook Gardens	351	8,646,250.00	148,950.00	0.00	8,795,200.00
27 - La Penitence Village	431	9,815,710.00	266,350.00	0.00	10,082,060.00
28 - La Penitence Housing Scheme	1194	15,337,360.00	297,400.00	0.00	15,634,760.00
29 - East La Penitence / Tucville	332	5,038,150.00	460,525.00	0.00	5,498,675.00
30 - Alexander Village	351	6,983,600.00	3,820,750.00	0.00	10,804,350.00
31 - West Ruimveldt Government Housing Scheme	755	8,573,390.00	1,480,350.00	179,350.00	10,053,740.00
32 - East Ruimveldt Housing Scheme	824	8,702,900.00	123,350.00	120,200.00	8,826,250.00
33 - North Ruimveldt / Tucville	380	6,480,925.00	2,700.00	0.00	6,483,625.00
34 - West Ruimveldt Industrial Site	52	11,328,850.00	22,446,900.00	0.00	33,775,750.00
35 - Shirley Field Ridley Housing Scheme	177	2,264,390.00	2,516,400.00	0.00	4,780,790.00
36 - South R/veldt Gdns./Roxanne Durham	445	8,240,800.00	653,850.00	0.00	8,894,650.00
37 - South Ruimveldt Gardens	451	10,325,490.00	265,950.00	0.00	10,591,440.00
38 - River View Ruimveldt	186	1,682,550.00	11,898,300.00	0.00	13,580,850.00
39 - Meadow Bank / Houston	480	7,975,200.00	9,381,850.00	0.00	17,357,050.00
40 - Rome	7	41,400.00	723,000.00	0.00	764,400.00
41 - Plantation Rome South Half	1	331,600.00	0.00	0.00	331,600.00
42 - Plantation Rome North Half	2	373,600.00	19,000.00	0.00	392,600.00
43 - Plantation Houston South Half	11	519,350.00	9,500.00	0.00	528,850.00
44 - Plantation Houston North Half	32	602,400.00	44,000.00	0.00	646,400.00
45 - North Ruimveldt / Festival City	1165	17,495,250.00	1,184,750.00	8,000.00	18,672,000.00
46 - La Penitence / Guyhoc	767	5,773,500.00	16,900.00	0.00	5,790,400.00
47 - Botanic Gardens	6	386,000.00	965,200.00	0.00	1,351,200.00

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Rate Summary (by Ward)

Ward Name	Property Count	Residential	Commercial	Exemption	Assessed Value
- Sophia Backlands	5	437,600.00	1,899,400.00	0.00	2,337,000.00
- Lilliendaal Backlands	3	3,300.00	102,400.00	0.00	105,700.00
- Newtown	39	1,149,600.00	7,666,800.00	4,200.00	8,816,400.00
- Robbstown / Lacytown	33	1,024,900.00	14,129,950.00	0.00	15,154,850.00
- Pattersen Backlands	1	0.00	145,200.00	0.00	145,200.00
- Turkeyen Backlands	15	119,500.00	242,600.00	0.00	362,100.00
- Cummings Lodge Backlands	1	0.00	224,600.00	0.00	224,600.00
- Sophia	58	500,650.00	1,033,400.00	168,600.00	1,534,050.00
- Lilliendaal	19	129,300.00	1,329,550.00	0.00	1,458,850.00
- Plantation Patterson	14	16,900.00	100,250.00	0.00	117,150.00
- Turkeyen	95	1,204,850.00	4,921,300.00	33,450.00	6,126,150.00
- Cummings Lodge	572	6,103,700.00	656,500.00	0.00	6,760,200.00
- Sophia & Lilliendaal Frontlands	180	3,171,600.00	544,050.00	0.00	3,715,650.00
- Pattersen & Turkeyen Frontlands	69	988,550.00	132,650.00	0.00	1,121,200.00
- Cummings Lodge Frontlands	330	3,677,350.00	448,200.00	0.00	4,125,550.00
- North Freeburg	270	7,521,050.00	3,323,050.00	41,000.00	10,803,100.00
- South Freeburg	86	2,741,900.00	170,300.00	0.00	2,912,200.00
- Newburg	366	9,357,600.00	815,600.00	0.00	10,173,200.00
- Wortmanville	915	21,734,847.00	2,141,810.00	0.00	23,876,657.00
-	2	0.00	0.00	0.00	0.00
- Albouystown	663	15,502,050.00	4,362,600.00	0.00	19,864,650.00
- Queenstown	634	33,348,030.00	3,824,756.00	189,300.00	37,172,786.00
- Fraserville	28	1,161,300.00	193,550.00	0.00	1,354,850.00
- Prince Edward's Town (West)	223	5,325,700.00	151,500.00	0.00	5,477,200.00
- Prince Edward's Town (East)	266	6,222,100.00	1,238,650.00	0.00	7,460,750.00

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Rate Summary (by Ward)

Ward Name	Property Count	Residential	Commercial	Exemption	Assessed Value
5A - Lodge Village South	620	11,099,600.00	212,200.00	0.00	11,311,800.00
5B - Lodge Housing Scheme	254	4,567,500.00	1,119,400.00	0.00	5,686,900.00
1A - West Ruimveldt Company Housing Scheme	235	1,684,350.00	662,400.00	0.00	2,346,750.00
0A - McDoom	183	4,094,250.00	1,309,550.00	0.00	5,403,800.00
0B - Agricola	571	9,231,777.00	946,300.00	0.00	10,178,077.00
5A - South Ruimveldt Park	1147	22,475,205.00	679,700.00	30,500.00	23,154,905.00
5B - Mekdeci	60	715,450.00	7,850.00	0.00	723,300.00
7A -	1	3,700.00	0.00	0.00	3,700.00
8A -	1	350.00	0.00	0.00	350.00
total:	27144	685,092,976.00	352,852,715.00	10,839,600.00	1,031,697,791.00

APPENDIX I

CONSULTATION MINUTES

Date: May 13, 2004
Agency: Municipal Solid Waste Management Department (MSWMD)
Representative: Rufus Lewis

The design has been completed for the Mandela Site and the pre-qualifiers list is presently being reviewed. The drawings are not with the MSWMD. The deputy director and accountant for the MSWMD are still to be hired. The Deputy Director will work within the MSWMD. However, there are no doubts about whether a PIU will be established since the issue of payment to PIU staff has not been resolved. The Advisory Board will decide if the PIU would be established.

The proposed Haaguebosch Sanitary Landfill will be operated seven days per week. Georgetown municipality will guarantee the delivery of 120 tonnes per day of waste to the site. However Georgetown presently generates approximately 200 tonnes of waste each day. A total of 220 ton/day of waste is currently landfilled at the Mandela site. The additional waste landfilled comes from NDCs surrounding Georgetown. MSWMD will monitor waste arriving at the Haaguebosch site and will make payments to the operator. Haulers of commercial waste will make payments to MSWMD for eventual payment of the operator. It is felt that there may be a shortfall in revenue generation if the NDCs are unlikely to generate the additional 100 tons/day. The present costs for waste disposal at Mandela are US \$2.65 per tonne. The proposed fee to be paid by the MSWMD to the Haaguebosch operator is US \$ 8.60 per tonne.

The following NDCs have signaled their intention to utilize the site aback of Eccles:

- Mon Repos
- BV/Triumph
- Eccles/Ramsburg
- Diamond/Grove

Two pilot projects are currently in progress and are being undertaken by the Mon Repos and BV/Triumph NDCs. The intention of the pilot projects is to determine the waste generation rate in these NDCs and to establish a transfer station to service both NDCs to facilitate final disposal at the Mandela Site. The pilot project will also involve an analysis of the cost recovery potential for these NDCs by performing a willingness to pay survey. Performance of the survey will be assisted by ERM and MSWMD.

The Director confirmed that approximately sixty million Guyana dollars are generated by the waste pickers operations. The Director of MSWMD indicated that the maximum number of waste pickers that can function effectively on site is 24. The MSWMD thinks that the number could be determined by excluding bullies and drug dealers from those proposed to be relocated to Eccles. Further the MSWMD disagrees with the number of waste pickers reported to be operating on site in the Walcott report and thinks that the numbers were skewed by the offer of food and drinks to persons during that survey.

The public health department has no record of illnesses in the vicinity of the Mandela Site related to its operation. There are some instances where expired foodstuff and food seized by the Food and Drug Administration are disposed at the Mandela Site. Mechanisms are, however, implemented to prevent the food from being removed by waste pickers.

Approximately 48 percent of the waste currently disposed at Mandela Site is organic material that can be composted. Composting of waste may, however, threaten the viability of the project. The municipality has successfully undertaken a pilot study for composting in the incinerator compound. Composting was done manually using a team of 30 persons over a period of 5 months. The MSWMD may be receptive to using some waste pickers for composting operations.

Date: May 13, 2004
Agency: Mayor and City Council - Georgetown
Representative: Robert Williams – Deputy Mayor

Georgetown covers an area of 22 km² and extends from Cummings Lodge to Agricola which immediately borders Eccles on the north. Lands are within the city limits immediately adjacent to the site proposed for the Haaguebosch landfill site. These lands are, however, privately owned.

There are several reasons for the waste disposal problems in GM. The city is inundated with plastics and Styrofoam. These materials were not considered during the development of waste management practices for the city and no source separation occurs. In addition, there is pronounced importation of second hand and reconditioned goods by the commercial sector. These goods which have a relatively short life span add to the waste generated in the city. Industrial activity has also increased in the city. This increase has not been accompanied by a change in the waste management culture in the city. Squatting has added another dimension to the waste disposal problem. Squatters tend to concentrate on the embankments adjacent to the city drainage facilities. Waste is thrown into the canals in squatting areas. The efforts to clear the drainage ditches are impeded by both the squatters and by the presence of waste.

The GM has agreed to the creation of the MSWMD and to the establishment of a separate account for the payment of solid waste management contractors to satisfy the criteria for disbursement of the loan for Haaguebosch in Eccles by the IDB. It is the understanding of the MCC that operation of the Haaguebosch site will facilitate the receipt of solid waste from GM and from NDCs between Soesdyke and BV/Triumph. GM will guarantee the delivery of 120 tonnes of waste per day and pay for the guaranteed quantity and any additional waste at the tipping rate agreed in the ERM study. Additional payments will be made by NDCs based on the quantity of waste taken to Haaguebosch.

An operator will be identified based on a competitive bidding process and MSWMD will manage the operator's contract. One aspect of the project is the improved and more regular collection of waste in the city. This will entail additional costs. MCC has some concerns about its ability to pay the waste collectors and operator in a timely manner since property tax payments are not made in a timely manner. One of the largest delinquent payers is GoG. GM has sought to have this addressed in an MOU between the parties. However, no payments have been made for 2004 in spite of the MOU. A further complication has arisen in that the MOU agreed to the establishment of a PIU in the MSWMD. This PIU is now in doubt over the issue of payment to its staff members.

Hazardous waste is not proposed to be dealt with under the program. MCC is not satisfied with options the disposal of waste from fuel stations, GPL and sludge from the water treatment plant in the city. The plan for Haaguebosch proposes to reject unacceptable waste. This may lead to illegal dumping in the city since there are no alternate facilities for disposal of unacceptable wastes.

There have been several reports in the press concerning health problems related to operations at Mandela Site. However, the Mandela Site can be extended if alternate disposal options such as cremation are utilized for the disposal of human corpses. In addition, burial can be decentralized from the Le Repentir cemetery to other cemeteries in the city such as those on Bourda and Sheriff Streets.

The litter pickers are an asset to GM since they provide additional facility life and associated costs savings. GM would like to see a continuation of waste picking activities. GM regards the pickers as employees of independent contractors. While waste picking is beneficial to the city a large percentage of the pickers are drug addicts who are only paid minimal sums by the independent contractors.

GM would like to see an expanded role for composting efforts. This was tried and proven by GM and the compost was used as fertilizers for the GM gardens. It also provided training and employment for residents of depressed wards in GM. Sixty to seventy percent of GM waste can be composted and Mandela Site can be used for this purpose after its closure.

Date: May 13, 2004
Agency: Ministry of Local Government and Regional Development
Representative: Philip Hamilton – Permanent Secretary

A decision on the site for the proposed facility at Eccles will be made on May 14, 2004. The delay in determining the exact location of the site has modified the completion dates for the design and EIA. The executing agency and MoLRD are working to resolve the new project schedule.

The Regional Democratic Council of Region 4 is composed of GM and 15 NDCs. All NDCs implement delegated responsibilities from the Minister of Local Government in relation to their governance. GM is, however, directly answerable to the Minister. The NDCs are answerable to the Region for any expenditure greater than \$ G 180,000.00, for the passage of their budgets which covers all waste management costs, for the expenditure of subventions provided by the Ministry to each NDC and for the employment of certain categories of staff. Of the fifteen NDCs in Region 4, twelve from Paradise on the East Coast Demerara to Soesdyke on the East Bank Demerara have signaled their intent to use the Eccles facility. Three NDCs in Regions 3 on the West Bank Demerara have also signaled their intent to use the proposed facility. Consultations are in progress between the EA, MoLGRD and ERM to establish the modalities for NDCs access to the facility.

The NDCs can implement a specific charge for waste management based on approval from MoLGRD. GoG has signaled its intention to approve any such request. The possibility exists that GoG will guarantee significant financial contributions to ensure the effective operation of the Eccles facility and to cover payments to the operator.

Waste picking problems are likely to develop at transfer stations in NDCs. NDCs can restrict access to transfer stations of individuals from both inside and outside the NDC. NDCs should be consulted on the most appropriate location for transfer stations.

Date: June 24, 2004
Agency: Haslington/Grove Neighborhood Democratic Council
Representative: Brandford Burke – Overseer

The NDC has a total area of 16 mi² (square miles) with approximately 6000 houses and a population of 20,000 persons. Revenue for NDC operations consists of subventions, property taxes and revenue from rental of an excavator and tractor and trailer. The last PT assessment was conducted in 1974, however, the NDC is seeking approval for a new assessment to be done in 2005. The PT collection rate is about 40 %. The low collection rate is due primarily to residents belief that monies were being mis-appropriated. This fact was confirmed by a recently concluded audit of the NDC's accounts.

The NDC does not provide a formal waste collection service to residents at present. It is proposed to commence waste collection services in January 2005. The NDC has a tractor and trailer which will be used for waste collection after this program commences. A schedule will be developed to ensure service is provided to all communities in the NDC. A fee will be attached to the property taxes to cover waste management. A preliminary assessment has established that residents are willing to pay G\$500/month for waste disposal. Waste will be disposed in an abandoned canal or in a pit excavated on NDC land.

A waste hauler presently offer waste collection services in the NDC and along the East Coast Demerara. A fee of G\$ 700/month is charged for a once per month pickup. It is estimated that approximately 3 tonnes of waste is picked up each month by this service provider. Residents in the NDC who do not use the waste hauling service generally burn their waste. However a large amount of waste is dumped in the area at street corners and in canals. No service is provided to cleanup these areas and waste stays in place at these points. Specific waste problems in the community are related to the operation of an oil mill in the NDC.

The NDC should be empowered to prosecute for littering offences since the EPA with whom current authority rests has no presence in the area. The NDC has rangers on its staff that are responsible for inspecting all works done by the NDC and to ensure the security of NDC's property. The role of the ranger should be expanded to include the enforcement of anti-littering laws and revenues generated by defaulters should go to the NDC's treasury and not to the EPA.

Date: May 19, 2004
Agency: Enmore/Hope Neighborhood Democratic Council
Representative: Parsuram Diyal – Overseer
Chairman

The NDC has a total area of 2.5 mi², 1100 houses and a small squatting area of 30 houses. The population of the area is approximately 7000 persons. The only revenue sources for the NDC are property taxes and a subvention of \$3,000,000.00 per year from GoG. While property taxes are valued at 0.45% of property values, the last valuation was conducted in 1975. At that time the total assessed value of all properties was \$2,500,000.00. Revaluation is sorely needed since the rates are as low as \$80/year with the maximum not exceeding \$2500/year. Several properties have been upgraded (approximately 24 building plans are approved/year) but the rates do not reflect the upgraded values and houses built on empty lots. The rate of PT collection ranges from 80 – 85 percent.

Waste is collected by tractor and trailer four days per week. Two laborers are employed to load waste onto trailer. Approximately 16 tonnes per month of waste is collected for disposal with 70% being organic waste, 10% being plastic waste and the remainder being commercial and construction and demolition debris. Laborers are provided with gloves, long boots, cutlasses, respirators and picks and shovels. Waste is disposed in an area adjacent to Enmore Sugar Factory and to the GWI wellhead. The waste is periodically burned when weather conditions permit. Illegal dumping occurs in the NDC in spite of collection services. Most illegal dumping is by commercial establishments in the NDC. A recent development has seen the dumping of used imported tyres on roads running through the NDC. Drainage problems occur due to disposal of waste and plastics in drainage canals. The canals must be cleared every month to ensure effective drainage.

Use of the Eccles facility must be accompanied by a mechanism for cost recovery. The NDCs initiated efforts to charge a fee of \$600/year for waste management but has faced significant opposition from influential people in the NDC. This cost recovery mechanism must precede any improvement in waste management. It is felt that a public awareness program should be implemented in the NDCs to sensitize people both to waste disposal and to the plan for waste management.

The concept of a single transfer station for several NDCs seems sound but there is limited space in this NDC for such a facility. The NDC would, however willingly explore options with adjacent NDCs for siting and utilization of a transfer station.

Date: May 24, 2004
Agency: Buxton/Foulis Neighborhood Democratic Council
Representative: Mr. Randolph Blair - Chairman

The NDC has a total area of approximately 16 square miles with 7000 houses. The population of the NDC is approximately 21000. An appraisal was last conducted in 2001. The range of property taxes is \$1000 – 5000 per year. The collection rate for property taxes is approximately 80%. The largest rate payer in the NDC is GuySuCo. Commercial enterprises in the NDC are mainly family owned shops and lumber yards. The Coldingen Industrial estate is located in the NDC, however no taxes are paid by industries in the estate to the NDC. This also applies to several new housing areas in the NDC since these areas have not been “handed over” to the NDC and there is no mechanism to collect property taxes from the Ministry of Housing for these areas. The NDC must collect waste in these areas since there is significant illegal dumping if waste is not collected.

The NDC collects waste five days per week using a tractor trailer. The trailer is manned by 2 laborers who are provided with gloves, long boots and rain coats. Each neighborhood is serviced at least one time per week. This waste generation rate is approximately 2 – 2.5 tonnes/day. This service is restricted to the regularized areas. Periodic service is provided to other areas. All waste is not collected since a large proportion of the waste is either burned or buried by residents. There is also a significant amount of illegal dumping by residents of the area. Waste is disposed in pits excavated adjacent to the foreshore and in a trench GuySuCo has identified for filling in one of the communities in the NDC. The NDC would be receptive to working with other NDC if the concept of a transfer station is in place for waste collection.

Date: May 19, 2004
Agency: Mon Repos/La Reconnaissance Neighborhood Democratic Council
Representative: Ms. S. Ammaraj - Overseer
Mr. Richard Bactawar - Chairman

The number of residences in this NDC is approximately 2200 with a population of 22000. The last valuation was conducted in 1975. PT are based on a classification of the size of the property. The rate collection is approximately 56% with most of the funds coming from the large rate payers such as GuySuCo and IEL.

The NDC shares a waste disposal site with BV/Triumph NDC. Two tractor trailers are used for house to house collections, with collection taking place once every two weeks. Approximately 4-5 tons/day of waste is collected. A backhoe is also available to the NDC to aid with waste management operations. A driver and two laborers are assigned to each backhoe. Laborers are provided with gloves, long boots, respirators, forks and baskets for retrieval of plastic bottles from drains. Some residents still burn garbage in spite of waste collection. Commercial generators are allowed to use the waste dump. However they are responsible for hauling their own waste or must pay a separate fee for collection and disposal. There is considerable illegal dumping on both roads and in the cemetery in the NDC. One person is employed on a fulltime basis to clean drains primarily because of plastic bottles.

This NDC is agreeable to cooperating with adjacent NDC for siting of a transfer station. Waste pickers would be welcomed at the transfer station provided it is effectively managed. However, waste pickers should be licensed and should pay a fee to the NDC.

The tipping fees being proposed for Eccles would be an additional cost to the NDC. The GoG would have to increase subventions to cover these fees or an increase in the property taxes will be required to cover tipping charges. The NDC has commenced a public awareness program utilizing posters and flyers to inform people of waste management plans.

Illegal dumping in the NDC can be curtailed by fines. The present fines do not reflect the true cost of enforcement. Legislation should be improved to increase fines and to have the fines paid to the NDC. These monies should be dedicated to waste management. The legislation should permit the hiring of Rural Constables (RC) to enforce law. These RC should be hired and fired by the NDC and can be recruited from members of the Community Policing Group. The Legislation should also provide more autonomy to the NDC in waste management matters.

Date: May 19, 2004
Agency: BV/Triumph Neighborhood Democratic Council
Representative: Ms. Yvonne Ramphal - Overseer
Mr. Bruce Adams - Chairman
Ms. K. Garnett – Environment Health Officer

The area of BV/Triumph NDC is approximately 12 mi². It has a total of 2000 houses and a population of approximately 20000. Property taxes in the NDC are set as a percentage of the assessed value of the properties. The last detailed property appraisal was conducted in 1997. No rate increase for the past 3 years. Rates range from \$350 to 11,000.00 per property for NDC and collection rate ranges from 60 – 70 %. The NDC receives a subvention of \$3,000,000.00 per year from GoG. However, projects funded by the subvention are primarily community oriented project and no funds are provided for waste management.

Waste is collected by a tractor and trailer. The NDC employs four laborers for waste pickup. Laborers are provided with gloves, long boots, respirators and raincoats. The frequency of pickup is once weekly. Approximately 2.5 tons/day of waste is collected. The collection equipment cannot access several locations. However, NDC employees are paid an additional fee for removing waste from such areas.

Residents pay a waste disposal levy of \$100/month or 1000/year for collection and disposal. Compliance is approximately 50 %. Some residents do not pay since they claim to burn and bury their waste. There are, however, several complaints from residents about the burning of waste. The NDC maintain a crew specifically for cleaning drains which are cleaned 12times/year. The frequency of cleaning can be reduced if less plastic and Styrofoam are disposed in drains. The GoG collects a fee for every plastic bottle brought into the country. Consideration should be given to providing some of this money to NDC.

Waste pickers would be welcome to work at transfer station. The transfer station should be configured to enable deposition of different types of wastes. The current waste levy will be used to provide bags to residents to facilitate source separation.

The NDCs is not aware that additional payments would be required for tipping at Eccles. This will require additional charges to residents. These charges can only be justified after a public awareness campaign to notify residents of the new option for disposal of waste. People may choose not to pay and continue illegal dumping. Therefore legislation should be strengthened and substantial fines should be levied for non-compliance. Legislation should also be strengthened for collection of property taxes since without this cutbacks may be needed in other services to pay tipping fees. The public awareness program and legislative improvement should precede waste disposal at Eccles. Funds should also be provided for hiring of Environmental Health Officer (EHO) by individual NDCs. At the very least and EHO and two assistants should be provided.

Date: May 19, 2004
Agency: Plaisance/Industry Neighborhood Democratic Council
Representative: Ms. McDerby - Overseer
Mr. Sandiford - Chairman
Mr. Ramlall – Responsible for Waste Management

The population of Plaisance/Industry is approximately 20,000 with there being approximately 3000 houses in the NDC. PT are established as a function of the rental value of properties. A valuation is currently in progress. This addresses only new building or buildings that have been renovated. The last valuation for the other buildings was completed in 1977. The rates assessed as PT are 21%, 24.5% and 28% of the rental values for residential, commercial and industrial properties.

Waste is collected once weekly from all areas within the NDC. A cart and horse has been contracted to remove waste. It is staffed by three laborers paid by the NDC and provided with minimal PPE (gloves and long boots). Access problems are encountered by the cart during the wet season and the frequency of pick up decreases. Approximately 6 tons/week of waste are collected. A large percentage of waste generated in the NDC is burned by its residents. All waste is disposed in the southern part of Ogle in a pit excavated onsite and on land owned by the Ogle Aerodrome. Several squatters live in the vicinity of the disposal area. The Aerodrome has served notice on the NDC to vacate the site but an alternative location is unavailable. The current NDC inherited this site from the former NDC.

There are major problems related to plastics and tyres dumped illegally in NDCs. One constable was threatened with a gun by a driver of a vehicle observed illegally dumping waste in the NDC. No enforcement action is undertaken by NDC since the costs for enforcement including legal fees are significantly less than penalties meted out to defaulters. The NDC has attempted to sensitize people to waste management problems by distributing pamphlets in homes in the NDC, but have seen no improvements. This has increased the frequency with which drains must be cleaned in community. It is estimated that cleaning would be required once in comparison to the present three times per year due to improper waste disposal.

Residents are not receptive to paying any additional charges for waste management. Some residents of the more affluent areas of the NDC are, however, willing to pay additional fees. Imposition of fees should be preceded by public awareness program. NDC is directed how to spend subvention of \$3,000,000/year. Money is needed for waste management plant, preferably a truck that can be used for other services and for hiring sanitary inspectors to be assigned to specific areas in the NDC. The legislation for littering and illegal dumping should be strengthened and updated to reflect costs associated with cleanup and prosecution.

The location of transfer stations should be well thought out to ensure it does not pose a threat to any community. There are no objections to waste pickers working at transfer stations.

Date: June 17, 2004
Agency: Eccles/Ramsburg Neighborhood Democratic Council
Representatives: Floyd France – Overseer
Ashoke Kumar - Chairman

The population of this NDC is approximately 20,000. Waste management fees are paid out of subvention and property taxes. The property collection rate is approximately 55 %. Major property tax revenues are collected from several large industrial establishments in this NDC. These include Noble House Seafood, Georgetown Seafood and Trading Company, Sterling Products, Demerara Oxygen Company, GuySuCo and several gas stations. The date of the last property valuation is not known. However a new valuation is proposed to be conducted before December 2004. Property tax rates are respectively 15%, 45, 60 and 100% of the assessed value for residential, commercial, industrial and vacant land and farmlands.

Waste is collected once every two weeks in each community within the NDC. On the average three compactor trucks of waste are picked up every second week and taken to the Mandela Site. The Eccles New Housing Scheme has not formally been handed over to the NDC and there is no mechanism for collecting property taxes from this community. The NDC has therefore instituted a waste collection charge of G\$ 500/month for waste collection in this community. There are approximately 400 houses in this scheme, however, the participation rate is only 20% (80 households). Garbage is only picked up from household who pay the waste charge. The remaining households in the area claim to bury and burn their waste. There are some areas of the new scheme which are inaccessible. The NDC's tractor accesses these areas and drops the waste off at a pickup point for removal by the contracted waste hauler.

There is no formal disposal agreement with GM to dispose of waste at the Mandela Site. Waste is taken there by waste haulers who are familiar with operations at the site and who can consequently bypass any source monitoring mechanism there.

There is a significant amount of dumping along the main roads that run through the NDC and a crew is maintained on a fulltime basis to address this problem. Waste management charges in this NDC are an accumulation of payments to the waste haulage contractor, charges for operating the tractor and trailer for waste collection and sum expended on litter pickup. This equates to a total of approximately US 16,500 per year. In addition, this NDC also expend sums on cleaning drains clogged by waste. A crew of 12 individuals works fulltime on the maintenance of drains and it is estimated that 20 % of the work is due to improper waste management. The total expended on drainage maintenance is approximately US \$20,500 per year.

People may be reluctant to pay additional fees for waste management. An education program coupled with public awareness campaign may help to convince people of the need to pay for waste management. The concept of transfer station may not apply to this NDC since the proposed facility is located within its boundaries.

Date: May 24, 2004
Agency: Herstelling/Little Diamond Neighborhood Democratic Council
Representative: Ms. Mohanedai Prashad - Overseer
Mr. Sahadeo Kandhi – Chairman, Works Committee

This NDC of approximately 2 mi² has about 1000 houses with a population of 5000 persons. Some of the major industries in the NDC include Guyana Pharmaceutical Company (GPC), SAPIL, Guyana Stockfeeds, The National Edible Oil Company and National Hardware. GuySuCo is the largest rate payer in the NDC. The last property appraisal was conducted two years ago and the PT rates as percentages of the assessed values are 0.375% for residential, 0.5% for commercial and 2.5% for industrial properties. PT collection rate is approximately 50%. The primary defaulters are the industries located in the NDC.

A tractor and trailer are used for waste collection. The trailer is manned by a driver and three laborers who are provided with cloaks and gloves. Four to five full loads are picked up each day. A large percentage of the waste is burned and buried by residents. There are complaints from residents about smoke and fumes during burning. Every area is serviced once/week with the exception of Herstelling which is serviced twice/week. Commercial generators and industries provide their own waste disposal services. Disposal is in pits excavated adjacent to canals in the community. Waste is periodically burned in the pits. The pits are monitored for flies etc and covered when full.

The canals in the community have to be cleaned at least trice/year due to illegal dumping. It was suggested that these canals may only need to be cleaned once/year if illegal dumping ceases. The EPA and NDC should cooperate to hire solid waste rangers to deal with illegal dumping. In addition, the laws should be upgraded to provide the NDC enforcement authority. A health awareness program should also be undertaken in the community to sensitize people to vector problems associated with illegal dumping. The NDC should keep monies from fines imposed for illegal dumping and these monies should be used for public awareness. The fines should be substantial to prevent repeat offences.

Cooperation with adjacent NDC on the transfer station is good concept since it will result in the use of less space. Operation of the transfer station will however escalate the waste management cost. The transfer station should be built to accommodate sorting of waste. The residents of the NDC are unlikely to welcome people from outside the community working as waste pickers since these are job opportunities that should be reserved for residents. The payment of a tipping fee will create additional employment and is consequently a good idea.

Date: June 2, 2004
Agency: Mocha/Arcadia Neighborhood Democratic Council
Representative: Mr. Gregory John – Chairman
Ms. Jacqueline Delph – Overseer
Mr. Leonard Mayers – Councilor

This NDC has a total area of 1.5 sq. mi, 600 houses and 2800 persons. Revenues are the GoG subvention and PT from residents. The last valuation was done prior to 2001. PT rates are 113 % and 25% of the accessed value for land and houses respectively. There are no commercial or industrial institutions in the NDC. Some residents are private cane farmers. Neither GuySuCo nor the private cane farmers pay PT to the NDC.

The NDC does not offer any waste management services to residents. Residents burn and/or bury their waste. There is some illegal dumping along parapets in the NDC. These are cleaned by residents as community projects. After removal the illegally dumped waste is burned. This is done on a quarterly basis. The waste dumped is primarily plastics, tins and other household waste. The volume of illegally dumped waste has increased greatly over the last two years.

The access road to the NDC is a GoG road. There is a large quantity of dumping on this road by non residents of the NDC and by some waste collection companies. Waste disposed along the access road includes septic tank waste, auto bodies and construction debris.

If the NDC is to utilize the new facility, it must be provided with cash to acquire plant and to hire personnel for waste management services. The NDC is not large enough to justify investment in plant and personnel that is only going to be used on a part time basis. In addition, a waste collection charge will have to be imposed on residents. Residents are likely to be willing to pay since everyone is concerned about effective waste disposal. A special local government court must be set up to force payment of PT. This court will also allow waste collection charges to be paid. However, a public awareness program should be effected to make people aware that these charges are also applicable to other NDCs. The legislation should also be updated and enforcement authority should be vested in the NDC. The NDC should also collect all fines for improper waste disposal.

Date: June 2, 2004
Agency: Golden Grove/Diamond Place
Representative: Mr. P. A Roberts – Acting Chairman
Mr. Balraj Budwah – Overseer
Ms. Marilyn Dalton – Councillor

This NDC with a total area of approximately 3 sq. mi. has a total of 2000 houses and a population of approximately 10000 persons. Approximately 500 of these houses are located in squatting areas. The NDC revenues are essentially the subvention from GoG and property taxes collected from residents and institutions in the NDC. The last property valuation was conducted 2003. PT rates range from 5% to 47% of accessed values for residential and commercial rate payer respectively. The largest rate payers in this NDC are Demerara Distilleries Limited (DDL) and GuySuCo. The subvention from central government is used primarily for maintenance of roads in the NDC.

Solid waste is collected daily with each area in the NDC being serviced once per week. The program was developed after a pilot program was conducted in the NDC to determine waste generation rates and the resources needed to manage that waste. As a result of that pilot study, a tractor and trailer was acquired and three laborers and a driver were hired on a fulltime basis for waste management. All waste management personnel are provided with personnel protective equipment which consists of raincoats, long boots, respirators and gloves. Approximately 2 – 2.5 tonnes of waste are collected each day. About 60 % of waste collected is food waste.

There is very little burning or burying in the NDC since residents are aware of the pickup schedule and put out their waste for collection. The roads are in fair enough condition to enable access to all locations even during poor weather conditions. Waste is deposited in an open excavation about 200 m from residences. However the site is shielded from residents by a tree line. A waste monitor is posted at the site. A second waste monitor travels through the NDC to identify illegal waste disposal operations and to effect corrective actions.

There is a small amount of illegal dumping by people driving through the NDC. Primarily plastic bottles are dumped and clog up the culverts in the area. These culverts are cleaned at least twice/year. Non of the environmental tax on plastic collected by the GoG is passed to the NDC.

The transfer station will entail double handling of waste and the associated additional cost is not necessary. Residents are unlikely to be willing to pay a separate waste levy to cover tipping fees. The NDC has its own transportation and should be allowed to transport waste to Eccles. Imposition of waste management fees will result in more burning and burying of waste in community. At present waste management costs are relatively high and include costs for maintenance of plant, personnel salaries including waste monitors. These costs amount to approximately \$2,000,000.00 per year. A public awareness program would be needed to convince residents of the additional charges for waste management.

The site at Eccles would provide no benefits to NDC. In addition, a new administration may be in place by 2007 and may opt to forego the project. Recyclers would be welcome provided that they are from the NDC.

Date: May 25, 2004
Agency: Craig/Caledonia Neighborhood Democratic Council
Representative: Mr. Wellesley Davis– Chairman

This NDC has a total area of approximately 5 mi² and has 1200 houses with a population of 7000 persons. It receives a subvention of 3,000,000.00 which is supplemented by property taxes. There are no industrial establishments in this NDC. Two formerly operating in the NDC; Colgate Palmolive and Ideal Industries have closed operations. The last property valuation was conducted in 1997 and the property collection rate is approximately 35 percent with the largest defaulters being large land and business owners. PT rates are 3 and 5 percent of assessed values for residential and commercial respectively. Most of NDCs revenues are spent on maintenance of drainage works.

There is no structured solid waste management. The NDC has no plant to collect waste. Residents either burn or bury their waste. A significant quantity of waste is disposed in drains and on roadway verges in the NDC. Illegal dumping in the NDC is aggravated by people passing through the area. The GoG has recently increased the frequency of cleaning of roadway verges and this has lessened the illegal dumping along roads. The NDC estimates that approximately 20 % of money spent on drainage maintenance is related to improper waste disposal. Volume estimates for waste generated by the NDC is not available due to lack of structured collection. The NDC is examining working with Craig/Caldonia NDC to enable use of their tractor and trailer during the project implementation. The volume of plastics generated in the NDC will exacerbate the waste problem and the NDC is interested in the program to ensure the plastics do not have a negative effects.

The NDC will have to impose fees to cover waste management charges. However imposition of these fees should be preceded by demonstrated improvements in waste collection and aesthetics in the community. This will aid to convince people that the fee should be paid. This should be aided by a public awareness program. The public awareness program should focus on health impacts to households of improved waste collection and should concentrate on schools in the NDC since children are charged with waste disposal. The public awareness program should run for one year before the program and should continue for some period afterwards.

Information on likely waste management fees should form part of the program and fees should be imposed six months after the program begins. A cost sharing mechanism should be developed so that the NDC can obtain some revenue related to management of collection operations. Illegal dumpers shall be prosecuted after program begins. A special court should be established to deal with NDC matters and penalties imposed by the court shall go into the treasuries of NDCs after operational charges have been deleted.

Date: June 11, 2004
Agency: Soesdyke/Huist Te Coverden
Representative: Mr. Leslie Glasgow– Chairman
Dianne Bissoon – Overseer

This NDC also receives a subvention of 3,000,000.00 which is supplemented by property taxes. The largest rate payers in this NDC are Barama Company Limited (BCL) and Gafoor and Sons. The collection rate ranges from 60 – 70 percent with the largest defaulters being large land and business owners. PT payments are not made on time because residents are unhappy with the services provided (roads & drains), some residents have however indicated a willingness to pay more than they do at present if better services are provided. The last property valuation was conducted in 1999 and PT are set as a percentage of assessed value; the rates are however relatively low.

There is no structured solid waste management in this NDC. BCL has indicated a willingness to donate 20 acres (8 ha) of land to the NDC for waste disposal. The EPA advice on landfilling requirements has resulted in the costs for development being prohibitive. Residents either burn or bury their waste. The NDC only collects waste illegal dumped. A tractor &

trailer is used for collection. That waste which is primarily plastic, paper and cardboard is burnt. Volume estimates for waste generated by the NDC is not available due to lack of structured collection.

Golden Grove/Diamond NDC has invited this NDC to share its dump. That dump abuts on several houses and the option was not exercised. The culture of burning and burying is well established in this NDC and consequently drains are free of waste. This is also attributable to the large percentage of property owners, who would not like to spoil their surroundings. Squatting is minimal in this NDC and very few tenants.

The NDC has a program of interaction with school and plans to donate bins to each school as part of their efforts to modify attitudes about waste management. Enforcement against illegal dumping is minimal since no facility is available for public use. The large businesses truck their waste to Mandela Site. In addition, the local government law Chapter 28:02 was last updated in 1957 and efforts to prosecute are dwarfed by the fine imposed on defaulters. The proposed solid waste act will impact on illegal dumping but a mechanism should be put in place to allow the NDCs to share fines imposed for illegal dumping. At present the plastic bottle levy does not go to NDCs who are saddled with the plastics problem.

The transfer station concept may be problematic since it will entail double handling of waste and it may not satisfy economies of scale related to the reliability of the waste management equipment presently used in Guyana. There are constant breakdowns and this can lead to waste piling up at the transfer stations. The decision to use transfer stations should be based on a cost analysis that compares the station to the direct cost of contracting a waste hauling truck. Waste pickers at the transfer station should pay a licensing fee.

This is a farming community and composting should be considered as a major option for waste since it can be used as fertilizer. A public awareness program should be conducted in the NDC, however the program should be specific to this community and should consider the housing pattern and economic activities in the NDC.

The distance to Eccles is a disincentive; however the cost of individual landfill site development is prohibitive. A waste management charge will have to be built into the PT and a separate accounting system must be established for waste management.

Date: June 15, 2004
Agency: Malgre Tout/Meer Zorgen Neighborhood Democratic Council
Representative: Mr. Hugh George - Chairman

This NDC receives a subvention of 3,000,000.00 which is supplemented by property taxes. The collection rate is approximately 50 percent with the largest defaulters being rice farmers. The Versailles Power Plant is one of the larger rate payers. The last property valuation was done prior to 1990. PT rates are 10% of the then assessed property values.

There is no structured solid waste management in this NDC. The NDC does not have any plant for waste collection. Residents either burn or bury their waste. Two new communities in the NDC; Roraima and Crystal Springs provide some mechanism for disposal of waste generated in those developments. The actual mechanism is not known. Waste, primarily plastic and styrofoam is disposed in drains in the NDC. The NDC recently contracted a company to bury waste disposed at an informal dump site in the NDC. This, was however a one off operation. Volume estimates for waste generated by the NDC is not available due to lack of structured collection.

There is a large squatting area of about 145 houses where no waste management occurs. Waste is disposed in drains in the area. The Drainage and Irrigation Board (DIB) maintains a single drain in the NDC. Maintenance of drains in the NDC is consequently presenting a strain on the budget since the greater part of the subvention is spent on cleaning drains of debris.

The NDC is agreeable to working with the adjoining NDC to facilitate operation of a waste transfer station, however, costs may prove prohibitive and should be allowed for. Separate charges for waste collection were tried in the past but were unsuccessful. The system was not open and accountable and residents took the position that they were already paying rates and taxes and that the new monies provided more room for corrupt practices. This attitude should be modified by a public awareness program conducted in the NDC. This program should take place before the program is implemented.

The local government law Chapter 28.02 should be updated to provide more muscle to NDC and a special court should be established to deal with NDC matters including payment of PT in the short term.

Date: June 15, 2004
Agency: La Grange/Nismes Neighborhood Democratic Council
Representative: Mr. Isaac Bhagwandin - Chairman
Ms. - Overseer

This NDC receives a subvention of 3,000,000.00 which is supplemented by property taxes. The collection rate is approximately 38 percent. The last property valuation was done prior to 1978. PT rates are 19% of the then assessed values for residential houses, 40% for residential land and 50% for farm lands.

There is no central solid waste collection system in this NDC. The NDC does not have any plant for waste collection. Residents either burn or bury their waste. There are infrequent complaints from some residents about burning. Approximately 10 -15 percent of waste generated in the NDC is illegally dumped. Illegally disposed waste is primarily plastic and styrofoam and is disposed alongside roads and in drains. Volume estimates for waste generated by the NDC is not available due to lack of structured collection. Approximately 20% of revenues collected by NDC is spent on drainage maintenance works. There are three industrial establishments in NDC; a furniture factory, a machine shop and a food processing plant. All dispose of their waste in the back of their property.

The Drainage and Irrigation Board (DIB) maintains drainage in agricultural section of the NDC. Maintenance of the others drainage infrastructure is by the NDC. This presents a strain on the budget since the greater part of the subvention is spent on cleaning drains of debris.

The NDC is agreeable to working with the adjoining NDC to facilitate operation of a waste transfer station, however, costs may prove prohibitive and should be allowed for. Separate charges for waste collection were tried by other NDCs but failed. There is need for a new valuation to incorporate upgrades to properties and to include new properties. This should generate enough revenues to pay for waste disposal. Separating PT from waste collection charge may prove contentious. In any case a public awareness program should be done to inform people of the need for additional payments related to waste disposal.

This NDC adjoins others that will not be involved in project. A system should be developed to discourage dumping by residents of adjoining NDCs. This may best be done by providing rangers to issue tickets and charges to defaulters.

The local government law Chapter 28.02 should be updated to increase fines for littering and the fines should be paid to the NDC to clean up illegally disposed waste.

Agency: Environmental Protection Agency
Representatives: Simone Osborne

EPA is the regulatory agency responsible for the environmental impact assessment process as outlined in the Environmental Protection Act 1996. The proposed Project requires an environmental authorization that can only be issued after submission and review of an environmental impact assessment. Both an Environmental Impact Statement and an Environmental Impact Assessment Report should be submitted to the agency for review and approval. The Environmental Protection Water Quality regulations 2000 would be one of the regulations that would have some impact on the proposed development. However, no quantitative standards are available as yet for solid waste operations. The EIA is required to identify all environmental and social impacts related to the operation of the facility. The EPA facilitates public comments on EIAs both before performance and after completion of EIAs. The EPA will provide a documented report of their concerns and suggestions and forward copies to Ground Structures Engineering Consultants Inc.

Agency: Ministry of Agriculture, Hydrometeorological Unit.
Representatives: Ms.Jafferalli, Hydrologist.
Ms.Farnum-Ramjoo, Climatologist.

This agency indicated that no data is available for any location in relatively close proximity to Eccles. Data is however available for Georgetown from a station located in the Botanic Gardens. This data is considered representative of the project location and a subset of the data was acquired.

Minutes of the Public Scoping for the Georgetown Solid Waste Management Programme (Eccles Landfill) held on Monday January 19, 2004 at the Eccles Primary School, Old Road Eccles at 5:00 pm

Present were:

At the Head Table

Hon. Clinton Collymore	Minister, MoLG & RD
Ms Denise Simmons	Member, EAB
Mr. Rufus Lewis	Director, MSWMD
Mr. Robert Williams	Deputy Mayor, Georgetown M & CC
Mr. Charles Ceres	Consultant, Ground Structures Eng.

Others present

Mr. Philip Hamilton	Permanent Secretary, MoLG & RD
Ms Eliza Florendo	Director, EMD – EPA
Ms Dhanrajie Madray	Director, Admin - EPA
Mr. Clifton Paul	SEO, EMD – EPA
Ms Leeya Khan	SEO, EIT - EPA
Ms Simone Osborne	EO, EMD – EPA
Ms Priyadarshni Rai	EO, EMD – EPA
Ms. Parbattie Khemraj	EA, NRMD - EPA
Mr. Gavin Agard	Intern, EMD - EPA

Attached hereto: Members of the Public (attendees)

Ms Denise Simmons of the Environmental Assessment Board commenced the meeting at 5:15 pm. Participants were asked to relocate from the Eccles Primary School auditorium to the schoolyard because of exceedingly loud noise emanating from the neighbouring property and a power outage to the Eccles area (which precluded the use of the public address system).

Ms Simmons welcomed persons to the Public Scoping exercise and outlined the objectives of the meeting. She advised that the meeting would give persons an opportunity to express their concerns about the Eccles Landfill project and that all concerns voiced will be addressed in the EIA study. Ms Simmons gave a synopsis of the EAB's role in the EIA process.

Mr. Clifton Paul of the EPA was then asked to explain "*the EIA process and the role of the Public*". However a resident (Mr. Geer) interjected and enquired whether or not the project has already reached the development stage and if the developer has been identified.

Mr. Robert Williams responded, indicating that the Government of Guyana has accessed a loan from the Inter-American Development Bank (IDB) to develop a waste disposal facility that will address solid waste issues in Georgetown and several localities in the its environs. Mr. Rufus Lewis added that in 1998, as a result of discussions with Municipalities and other local authorities, the Government of Guyana in an effort to manage solid waste and prevent the improper disposal of waste, initiated a process that identified six possible sites for waste disposal. Some of the areas identified were: Eccles, Diamond, old bauxite mines in Linden, OGML mines and reclaimed lands from the sea. Mr. Lewis further stated that the Eccles site was selected through a process of elimination.

Mr. Gaskin enquired whether or not approval has already been given for the development of the Eccles Landfill. The residents felt that the decision to develop the landfill in Eccles was already made. They became agitated and expressed their unwillingness to listen to the presentations by the EPA (and the Developer and Consultant). Ms Simmons attempted to restore order, indicating that residents will be given a chance to ask questions after the presentations. She emphasised the need for residents to listen to the presentations so that they can have a greater understanding of the issues that should be addressed in the EIA study. The Honourable Minister, Mr. Clinton Collymore appealed for civility and highlighted key items on the Agenda.

Mr. Paul of the EPA then assured the residents that the project has not been approved as yet and indicated that the proceedings at the public scoping were engineered to allow residents to voice their concerns about the Project. He further indicated that the concerns of the residents would be incorporated in the final Terms of Reference (TOR) for the EIA

study. The EIA will provide a plan for the avoidance and/or mitigation of environmental impacts that are associated with the development and operation of the waste disposal facility.

Ms Simmons then asked Mr. Rufus Lewis, Director of the Municipal Solid Waste Division, Georgetown Mayor & City Councillors to give an “*Overview of the Project*”. Mr. Lewis outlined key aspects of the project, indicating that the Government of Guyana endeavoured to find a way to improve solid waste management in Region 4 because of the indiscriminate dumping of solid waste in this region. He highlighted hydrological conditions and cost as the key reasons for the exclusion of the City of Georgetown from consideration for the development of the landfill facility. Mr. Lewis assured the public that a landfill, if properly engineered will not adversely affect groundwater quality. He outlined some of the measures that will be implemented to mitigate environmental impacts such as: daily cover of the working face of the landfill, gas monitoring and control systems, and a leachate management system.

Mr. Ceres, the Project Consultant was then asked to present the “*Environmental Impacts of the Project*”. As a preamble to his presentation and in an effort to clarify salient points about the EIA process, Mr. Ceres indicated that the EPA published a twenty eight (28) day public notice. He explained that the public notice indicated that an EIA is required for the project and invited members of the public to submit to the EPA any questions and/or concerns that they may have about the project within 28 days of the publication of the notice. Mr. Ceres further indicated that subsequent to the publication of the public notice the public scoping exercise (that is being held) allows persons to express concerns that will be considered in the TOR. He stated that the TOR is a public document and it will be finalised and made available for perusal by the public.

Mr. Ceres emphasised that an Integrated Solid Waste Facility is proposed for Eccles, stating that there will be composting, recycling and possibly incineration of waste streams from hospitals and abattoirs. He indicated that the facility will be located east of the Eccles Industrial Estate. Mr. Ceres further explained that groundwater contamination will not occur because of the geology of the area. He outlined some of the preventive/mitigatory mechanisms that will be implemented at the facility, such as: recompact clay liner, flexible membrane, leachate collection system, storm water control and explosive gas monitoring system. Mr. Ceres also stated that the facility may have a special cell for the disposal of hazardous waste.

Mr. Ceres assured the public that as a technocrat, he will ‘go where the data take him’ and will reject the site if it is determined that the area is not suitable for the development of such a facility. He examined the alternatives to the project and the regulatory framework within which the project will be implemented. Mr. Ceres indicated that the maintenance of a buffer zone at the perimeter of the project as well as issues of population distribution, proximity of businesses and education facility and cumulative impacts will be addressed in the EIA study.

Mr. Ceres candidly stated that the development of the facility may result in the following: the Eccles industrial area being constrained; an increase in employment in the area; a decrease in property value; and the aesthetics of the area being adversely affected since the view of residents will be obstructed by the 10 metre high landfill. He concluded by outlining some aspects of the project, such as the remedial measures, impacts that cannot be mitigated and monitoring programmes (air, surface and ground water) that will be addressed in the EIA.

Ms Simmons then invited members of the public to express their concerns about the development.

Questions/Concerns

Mr. Michael Grant – Will the presence of junkies/vagrants as a result of the development of the landfill be monitored?
A female resident – Will there be burning at the facility? Will the site be open? If so, how will this affect asthmatics?

A male resident – Will there be accidental burning due to the methane gas that will be produced?

A male resident – Where is the proposed landfill site in Eccles?

Mr. Ceres reiterated that questions are not answered at the public scoping exercise, but the questions/concerns voiced are incorporated in the TOR for the EIA study.

Mr. Neil Kumar (CDC and the Policing Group) – stated that he was not given proper information about the site and that the project area was not defined. He expressed concerns about the proximity of the facility to other projects and the

drainage system in the Eccles area. Mr. Kumar indicated that he is vehemently opposed to the development of the facility at the proposed location in Eccles.

Mr. Robert Williams responded to Mr. Kumar stating that 75 acres of the land that was initially earmarked for the development of the project were allocated to the Industrial site and the housing scheme.

Bert Carter – stated that it is unfair that questions are not being answered at this meeting. He asked the following questions: What is the spatial display of the facility from east of the public road? What is the depth of the polyethylene basin? What is the height of the landfill above the natural height (of the ground)? What is the envisaged generation of methane gas? What is the anticipated life of the facility?

Mr. Ceres – The height of the landfill is 10 metres above existing ground surface level. The life of the landfill is estimated to be 20 years.

Mr. Sagl – referred to the Kyoto Protocol and sited the Netherlands as a country that is below sea level and as a result of that, does not have landfills. He asked – ‘Can you say that the project will not affect the environment?’ and ‘Where will the leachate go?’

At this point, the residents loudly objected to the development of the landfill facility at the proposed location and efforts to restore order were futile. The meeting was adjourned at approximately 6:30 pm.

The recording of the minutes was severely limited by the loud chanting and chatter of the residents.

Minutes of the Public Scoping for the Georgetown Solid Waste Management Programme (Eccles Landfill) held on Sunday February 8, 2004 at the Peter's Hall Primary School at 3:00 pm

Present were:

At the Head Table

Ms Denise Simmons	Member, EAB
Mr. Maurice Veacock	Member, EAB

Others present

Mr. Philip Hamilton	Permanent Secretary, MoLG & RD
Ms Eliza Florendo	Director, EMD – EPA
Mr. Rufus Lewis	Director, MSWMD
Mr. Charles Ceres	Consultant, Ground Structures Eng.
Mr. Clifton Paul	SEO, EMD – EPA
Ms Preeya Rampersaud	SEO (a.g), EMD - EPA
Ms Simone Osborne	EO, EMD – EPA
Mr. Ronald Cumberbatch	EO, EMD – EPA
Mr. Suraj Nauth	EO, EMD - EPA
Attached hereto:	Members of the Public (attendees)

Ms Denise Simmons of the Environmental Assessment Board (EAB) commenced the meeting at 3:45 pm after apologising for the delayed start which was largely due to the late arrival of the public address system. Ms. Simmons outlined the purpose of the public scoping exercise. She requested that the process be respected and stated that questions should be asked during the time allotted on the Agenda for Comments/Questions.

Mr. R Gaskin indicated that he would like to make a preliminary objection. He referred to the EP Act 1996 and stated that the EAB is an appellate body to which appeals against the EIA process are made. He further stated that the EAB should not be chairing the public scoping exercise as this may constitute a conflict of interest. He demanded that the functions of the EAB be clearly defined before the public scoping proceeds.

Ms. Simmons with the assistance of Mr. Veacock outlined the functions of the EAB. The public was dissatisfied with the response and refused to proceed with the meeting. Mr. Terrence Simmons requested that the question posed by Mr. Gaskin be answered since there may be conflict of interest if the body (EAB) which conducts the public scoping also hears appeals.

Mr. C. Paul of the EPA attempted to make his presentation on 'the EIA Process' as well as clarify the functions of the EAB. He outlined the role of the EAB as stated in the EPA's *Roles and Procedures for Conducting and Reviewing EIAs, Volume I*. His efforts were interrupted by some members of the public. The residents also indicated that they had already heard the presentations at the previous meeting and did not want the presentations to be made again. Mr. Phillip Hamilton, Permanent Secretary, MoLG & RD attempted to restore order.

Mr. Paul Geer stated that he would like to know the outcome of the previous meeting. He indicated that he had raised a number of concerns at the previous meeting and wanted to know if they were addressed.

Mr. Gaskin then stated that the residents of Eccles do not want the project. He said that the residents made that position clear at the previous public scoping but the EAB is still trying to "sell the same propaganda". Some residents called on Mr. Ceres to apologise for a remark made by him at the previous public scoping.

As a result of further disruption of the meeting by the public, Ms Simmons enquired whether or not the public would like the Agenda to be suspended. With the public's agreement, Ms Simmons invited comments and questions on the project. She advised the public that their concerns would be incorporated in the TOR for the EIA study. Mr. Veacock assured the public that the views expressed would be documented (and if most persons are against the project this will be taken into consideration).

Comments/Questions

Ann Geer – What is the location of the landfill site? How many miles will it be away from residential areas?

Mr. Rufus Lewis – Referred to pg 34 of the 'Environmental Improvement of the Georgetown Interim Disposal Site – Selection Document' and stated that Guysuco under instruction from the Government of Guyana liberated 300 acres of land in Eccles for the development of the project. He further stated that a buffer zone of 100 acres of thick vegetation will be maintained from the western boundary of the landfill. Mr. Lewis also explained that even though the Eccles site was the most feasible of the sites considered, it may not be the chosen site if the EIA findings preclude it.

A male resident - indicated that Mr. Rufus Lewis had promised to provide a plan of the proposed area for the development of the landfill. He stated that drawings that show the exact location of the site should be made available to the public. Mr. Lewis assured him that plans are available.

Paul Geer and Ian Chang made references to the project summary and concluded that the project was a 'done deal'.

Dr. David Singh – outlined his understanding of the EIA process. He indicated that alternatives should be examined. He questioned whether the EIA process is going to ensure that residents are not affected and whether there are legal provisions that will ensure that the situation which exists at the Mandela Dumpsite does not recur. He stated that there should be clear delineation of a buffer zone so that residents will not be adversely affected by the project. Dr Singh further proposed that liability should be addressed and suggested that an environmental bond be established to remedy any adverse effects of the project on the environment and public health.

Ann Geer – Stated that along the Linden Soesdyke Highway there are many eroded areas where waste can be disposed.

Terrence Simmons – Referred to Mr. Rufus Lewis' statement that the buffer zone will be 100 acres and stated that the distance between the site and the housing/industrial areas would be about 4-5 miles. He noted that residents at the back of South Ruimveldt and other areas which are north/east of the proposed project site were not present at the meeting and wondered why they were excluded.

Ann Geer – What are the impacts on the stadium?

Terrence Simmons – Questioned the access route through Eccles Housing Scheme to the landfill and asked why another access road was not considered.

A resident – Requested that the distance of the project from housing areas be given in feet.

Mr. R. Lewis – Indicated that the distance is 300m east of the western boundary of the landfill.

Paul Geer – Enquired about the source of the information given by Mr. Lewis. Mr. Lewis indicated that the information was taken from the 'Environmental Improvement of the Georgetown Interim Disposal Site – Selection Document'.

A resident – Where is the dense vegetation for the buffer zone?

Ann Geer – Stated that the distance of the buffer zone is the size of ten (10) house lots.

A male resident - Stated that the buffer zone will be about 1000 ft.

R. Gaskin – Suggested that residents vote for or against the project. Paul Geer agreed, stating that the Chairperson may want to get a feel of the outcome of the meeting and suggested that residents vote by a show of hands.

Denise Simmons – Explained that a Social Impact Assessment (SIA) which will include public surveys will be done as part of the EIA study, stating that there is no need for residents to vote (by a show of hands) at this forum.

Paul Geer – Stated that there were approximately 125 persons at the meeting and voting will give an assessment of whether the residents are for or against the project.

Denise Simmons – Indicated that the results of the vote would not be reflected in the TOR.

A male resident - referred to the 'Government of Guyana – Waste Disposal Facility' document (which was circulated by Mr. Sahadeo Kandhai of the Little Diamond/ Herstelling NDC and was reportedly prepared by MoLG & RD) which

APPENDIX I

CONSULTATION MINUTES

Date: May 13, 2004
Agency: Municipal Solid Waste Management Department (MSWMD)
Representative: Rufus Lewis

The design has been completed for the Mandela Site and the pre-qualifiers list is presently being reviewed. The drawings are not with the MSWMD. The deputy director and accountant for the MSWMD are still to be hired. The Deputy Director will work within the MSWMD. However, there are no doubts about whether a PIU will be established since the issue of payment to PIU staff has not been resolved. The Advisory Board will decide if the PIU would be established.

The proposed Haaguebosch Sanitary Landfill will be operated seven days per week. Georgetown municipality will guarantee the delivery of 120 tonnes per day of waste to the site. However Georgetown presently generates approximately 200 tonnes of waste each day. A total of 220 ton/day of waste is currently landfilled at the Mandela site. The additional waste landfilled comes from NDCs surrounding Georgetown. MSWMD will monitor waste arriving at the Haaguebosch site and will make payments to the operator. Haulers of commercial waste will make payments to MSWMD for eventual payment of the operator. It is felt that there may be a shortfall in revenue generation if the NDCs are unlikely to generate the additional 100 tons/day. The present costs for waste disposal at Mandela are US \$2.65 per tonne. The proposed fee to be paid by the MSWMD to the Haaguebosch operator is US \$ 8.60 per tonne.

The following NDCs have signaled their intention to utilize the site aback of Eccles:

- Mon Repos
- BV/Triumph
- Eccles/Ramsburg
- Diamond/Grove

Two pilot projects are currently in progress and are being undertaken by the Mon Repos and BV/Triumph NDCs. The intention of the pilot projects is to determine the waste generation rate in these NDCs and to establish a transfer station to service both NDCs to facilitate final disposal at the Mandela Site. The pilot project will also involve an analysis of the cost recovery potential for these NDCs by performing a willingness to pay survey. Performance of the survey will be assisted by ERM and MSWMD.

The Director confirmed that approximately sixty million Guyana dollars are generated by the waste pickers operations. The Director of MSWMD indicated that the maximum number of waste pickers that can function effectively on site is 24. The MSWMD thinks that the number could be determined by excluding bullies and drug dealers from those proposed to be relocated to Eccles. Further the MSWMD disagrees with the number of waste pickers reported to be operating on site in the Walcott report and thinks that the numbers were skewed by the offer of food and drinks to persons during that survey.

The public health department has no record of illnesses in the vicinity of the Mandela Site related to its operation. There are some instances where expired foodstuff and food seized by the Food and Drug Administration are disposed at the Mandela Site. Mechanisms are, however, implemented to prevent the food from being removed by waste pickers.

Approximately 48 percent of the waste currently disposed at Mandela Site is organic material that can be composted. Composting of waste may, however, threaten the viability of the project. The municipality has successfully undertaken a pilot study for composting in the incinerator compound. Composting was done manually using a team of 30 persons over a period of 5 months. The MSWMD may be receptive to using some waste pickers for composting operations.

Date: May 13, 2004
Agency: Mayor and City Council - Georgetown
Representative: Robert Williams – Deputy Mayor

Georgetown covers an area of 22 km² and extends from Cummings Lodge to Agricola which immediately borders Eccles on the north. Lands are within the city limits immediately adjacent to the site proposed for the Haaguebosch landfill site. These lands are, however, privately owned.

There are several reasons for the waste disposal problems in GM. The city is inundated with plastics and Styrofoam. These materials were not considered during the development of waste management practices for the city and no source separation occurs. In addition, there is pronounced importation of second hand and reconditioned goods by the commercial sector. These goods which have a relatively short life span add to the waste generated in the city. Industrial activity has also increased in the city. This increase has not been accompanied by a change in the waste management culture in the city. Squatting has added another dimension to the waste disposal problem. Squatters tend to concentrate on the embankments adjacent to the city drainage facilities. Waste is thrown into the canals in squatting areas. The efforts to clear the drainage ditches are impeded by both the squatters and by the presence of waste.

The GM has agreed to the creation of the MSWMD and to the establishment of a separate account for the payment of solid waste management contractors to satisfy the criteria for disbursement of the loan for Haaguebosch in Eccles by the IDB. It is the understanding of the MCC that operation of the Haaguebosch site will facilitate the receipt of solid waste from GM and from NDCs between Soesdyke and BV/Triumph. GM will guarantee the delivery of 120 tonnes of waste per day and pay for the guaranteed quantity and any additional waste at the tipping rate agreed in the ERM study. Additional payments will be made by NDCs based on the quantity of waste taken to Haaguebosch.

An operator will be identified based on a competitive bidding process and MSWMD will manage the operator's contract. One aspect of the project is the improved and more regular collection of waste in the city. This will entail additional costs. MCC has some concerns about its ability to pay the waste collectors and operator in a timely manner since property tax payments are not made in a timely manner. One of the largest delinquent payers is GoG. GM has sought to have this addressed in an MOU between the parties. However, no payments have been made for 2004 in spite of the MOU. A further complication has arisen in that the MOU agreed to the establishment of a PIU in the MSWMD. This PIU is now in doubt over the issue of payment to its staff members.

Hazardous waste is not proposed to be dealt with under the program. MCC is not satisfied with options the disposal of waste from fuel stations, GPL and sludge from the water treatment plant in the city. The plan for Haaguebosch proposes to reject unacceptable waste. This may lead to illegal dumping in the city since there are no alternate facilities for disposal of unacceptable wastes.

There have been several reports in the press concerning health problems related to operations at Mandela Site. However, the Mandela Site can be extended if alternate disposal options such as cremation are utilized for the disposal of human corpses. In addition, burial can be decentralized from the Le Repentir cemetery to other cemeteries in the city such as those on Bourda and Sheriff Streets.

The litter pickers are an asset to GM since they provide additional facility life and associated costs savings. GM would like to see a continuation of waste picking activities. GM regards the pickers as employees of independent contractors. While waste picking is beneficial to the city a large percentage of the pickers are drug addicts who are only paid minimal sums by the independent contractors.

GM would like to see an expanded role for composting efforts. This was tried and proven by GM and the compost was used as fertilizers for the GM gardens. It also provided training and employment for residents of depressed wards in GM. Sixty to seventy percent of GM waste can be composted and Mandela Site can be used for this purpose after its closure.

Date: May 13, 2004
Agency: Ministry of Local Government and Regional Development
Representative: Philip Hamilton – Permanent Secretary

A decision on the site for the proposed facility at Eccles will be made on May 14, 2004. The delay in determining the exact location of the site has modified the completion dates for the design and EIA. The executing agency and MoLRD are working to resolve the new project schedule.

The Regional Democratic Council of Region 4 is composed of GM and 15 NDCs. All NDCs implement delegated responsibilities from the Minister of Local Government in relation to their governance. GM is, however, directly answerable to the Minister. The NDCs are answerable to the Region for any expenditure greater than \$ G 180,000.00, for the passage of their budgets which covers all waste management costs, for the expenditure of subventions provided by the Ministry to each NDC and for the employment of certain categories of staff. Of the fifteen NDCs in Region 4, twelve from Paradise on the East Coast Demerara to Soesdyke on the East Bank Demerara have signaled their intent to use the Eccles facility. Three NDCs in Regions 3 on the West Bank Demerara have also signaled their intent to use the proposed facility. Consultations are in progress between the EA, MoLGRD and ERM to establish the modalities for NDCs access to the facility.

The NDCs can implement a specific charge for waste management based on approval from MoLGRD. GoG has signaled its intention to approve any such request. The possibility exists that GoG will guarantee significant financial contributions to ensure the effective operation of the Eccles facility and to cover payments to the operator.

Waste picking problems are likely to develop at transfer stations in NDCs. NDCs can restrict access to transfer stations of individuals from both inside and outside the NDC. NDCs should be consulted on the most appropriate location for transfer stations.

Date: June 24, 2004
Agency: Haslington/Grove Neighborhood Democratic Council
Representative: Brandford Burke – Overseer

The NDC has a total area of 16 mi² (square miles) with approximately 6000 houses and a population of 20,000 persons. Revenue for NDC operations consists of subventions, property taxes and revenue from rental of an excavator and tractor and trailer. The last PT assessment was conducted in 1974, however, the NDC is seeking approval for a new assessment to be done in 2005. The PT collection rate is about 40 %. The low collection rate is due primarily to residents belief that monies were being mis-appropriated. This fact was confirmed by a recently concluded audit of the NDC's accounts.

The NDC does not provide a formal waste collection service to residents at present. It is proposed to commence waste collection services in January 2005. The NDC has a tractor and trailer which will be used for waste collection after this program commences. A schedule will be developed to ensure service is provided to all communities in the NDC. A fee will be attached to the property taxes to cover waste management. A preliminary assessment has established that residents are willing to pay G\$500/month for waste disposal. Waste will be disposed in an abandoned canal or in a pit excavated on NDC land.

A waste hauler presently offer waste collection services in the NDC and along the East Coast Demerara. A fee of G\$ 700/month is charged for a once per month pickup. It is estimated that approximately 3 tonnes of waste is picked up each month by this service provider. Residents in the NDC who do not use the waste hauling service generally burn their waste. However a large amount of waste is dumped in the area at street corners and in canals. No service is provided to cleanup these areas and waste stays in place at these points. Specific waste problems in the community are related to the operation of an oil mill in the NDC.

The NDC should be empowered to prosecute for littering offences since the EPA with whom current authority rests has no presence in the area. The NDC has rangers on its staff that are responsible for inspecting all works done by the NDC and to ensure the security of NDC's property. The role of the ranger should be expanded to include the enforcement of anti-littering laws and revenues generated by defaulters should go to the NDC's treasury and not to the EPA.

Date: May 19, 2004
Agency: Enmore/Hope Neighborhood Democratic Council
Representative: Parsuram Diyal – Overseer
Chairman

The NDC has a total area of 2.5 mi², 1100 houses and a small squatting area of 30 houses. The population of the area is approximately 7000 persons. The only revenue sources for the NDC are property taxes and a subvention of \$3,000,000.00 per year from GoG. While property taxes are valued at 0.45% of property values, the last valuation was conducted in 1975. At that time the total assessed value of all properties was \$2,500,000.00. Revaluation is sorely needed since the rates are as low as \$80/year with the maximum not exceeding \$2500/year. Several properties have been upgraded (approximately 24 building plans are approved/year) but the rates do not reflect the upgraded values and houses built on empty lots. The rate of PT collection ranges from 80 – 85 percent.

Waste is collected by tractor and trailer four days per week. Two laborers are employed to load waste onto trailer. Approximately 16 tonnes per month of waste is collected for disposal with 70% being organic waste, 10% being plastic waste and the remainder being commercial and construction and demolition debris. Laborers are provided with gloves, long boots, cutlasses, respirators and picks and shovels. Waste is disposed in an area adjacent to Enmore Sugar Factory and to the GWI wellhead. The waste is periodically burned when weather conditions permit. Illegal dumping occurs in the NDC in spite of collection services. Most illegal dumping is by commercial establishments in the NDC. A recent development has seen the dumping of used imported tyres on roads running through the NDC. Drainage problems occur due to disposal of waste and plastics in drainage canals. The canals must be cleared every month to ensure effective drainage.

Use of the Eccles facility must be accompanied by a mechanism for cost recovery. The NDCs initiated efforts to charge a fee of \$600/year for waste management but has faced significant opposition from influential people in the NDC. This cost recovery mechanism must precede any improvement in waste management. It is felt that a public awareness program should be implemented in the NDCs to sensitize people both to waste disposal and to the plan for waste management.

The concept of a single transfer station for several NDCs seems sound but there is limited space in this NDC for such a facility. The NDC would, however willingly explore options with adjacent NDCs for siting and utilization of a transfer station.

Date: May 24, 2004
Agency: Buxton/Foulis Neighborhood Democratic Council
Representative: Mr. Randolph Blair - Chairman

The NDC has a total area of approximately 16 square miles with 7000 houses. The population of the NDC is approximately 21000. An appraisal was last conducted in 2001. The range of property taxes is \$1000 – 5000 per year. The collection rate for property taxes is approximately 80%. The largest rate payer in the NDC is GuySuCo. Commercial enterprises in the NDC are mainly family owned shops and lumber yards. The Coldingen Industrial estate is located in the NDC, however no taxes are paid by industries in the estate to the NDC. This also applies to several new housing areas in the NDC since these areas have not been “handed over” to the NDC and there is no mechanism to collect property taxes from the Ministry of Housing for these areas. The NDC must collect waste in these areas since there is significant illegal dumping if waste is not collected.

The NDC collects waste five days per week using a tractor trailer. The trailer is manned by 2 laborers who are provided with gloves, long boots and rain coats. Each neighborhood is serviced at least one time per week. This waste generation rate is approximately 2 – 2.5 tonnes/day. This service is restricted to the regularized areas. Periodic service is provided to other areas. All waste is not collected since a large proportion of the waste is either burned or buried by residents. There is also a significant amount of illegal dumping by residents of the area. Waste is disposed in pits excavated adjacent to the foreshore and in a trench GuySuCo has identified for filling in one of the communities in the NDC. The NDC would be receptive to working with other NDC if the concept of a transfer station is in place for waste collection.

Date: May 19, 2004
Agency: Mon Repos/La Reconnaissance Neighborhood Democratic Council
Representative: Ms. S. Ammaraj - Overseer
Mr. Richard Bactawar - Chairman

The number of residences in this NDC is approximately 2200 with a population of 22000. The last valuation was conducted in 1975. PT are based on a classification of the size of the property. The rate collection is approximately 56% with most of the funds coming from the large rate payers such as GuySuCo and IEL.

The NDC shares a waste disposal site with BV/Triumph NDC. Two tractor trailers are used for house to house collections, with collection taking place once every two weeks. Approximately 4-5 tons/day of waste is collected. A backhoe is also available to the NDC to aid with waste management operations. A driver and two laborers are assigned to each backhoe. Laborers are provided with gloves, long boots, respirators, forks and baskets for retrieval of plastic bottles from drains. Some residents still burn garbage in spite of waste collection. Commercial generators are allowed to use the waste dump. However they are responsible for hauling their own waste or must pay a separate fee for collection and disposal. There is considerable illegal dumping on both roads and in the cemetery in the NDC. One person is employed on a fulltime basis to clean drains primarily because of plastic bottles.

This NDC is agreeable to cooperating with adjacent NDC for siting of a transfer station. Waste pickers would be welcomed at the transfer station provided it is effectively managed. However, waste pickers should be licensed and should pay a fee to the NDC.

The tipping fees being proposed for Eccles would be an additional cost to the NDC. The GoG would have to increase subventions to cover these fees or an increase in the property taxes will be required to cover tipping charges. The NDC has commenced a public awareness program utilizing posters and flyers to inform people of waste management plans.

Illegal dumping in the NDC can be curtailed by fines. The present fines do not reflect the true cost of enforcement. Legislation should be improved to increase fines and to have the fines paid to the NDC. These monies should be dedicated to waste management. The legislation should permit the hiring of Rural Constables (RC) to enforce law. These RC should be hired and fired by the NDC and can be recruited from members of the Community Policing Group. The Legislation should also provide more autonomy to the NDC in waste management matters.

Date: May 19, 2004
Agency: BV/Triumph Neighborhood Democratic Council
Representative: Ms. Yvonne Ramphal - Overseer
Mr. Bruce Adams - Chairman
Ms. K. Garnett – Environment Health Officer

The area of BV/Triumph NDC is approximately 12 mi². It has a total of 2000 houses and a population of approximately 20000. Property taxes in the NDC are set as a percentage of the assessed value of the properties. The last detailed property appraisal was conducted in 1997. No rate increase for the past 3 years. Rates range from \$350 to 11,000.00 per property for NDC and collection rate ranges from 60 – 70 %. The NDC receives a subvention of \$3,000,000.00 per year from GoG. However, projects funded by the subvention are primarily community oriented project and no funds are provided for waste management.

Waste is collected by a tractor and trailer. The NDC employs four laborers for waste pickup. Laborers are provided with gloves, long boots, respirators and raincoats. The frequency of pickup is once weekly. Approximately 2.5 tons/day of waste is collected. The collection equipment cannot access several locations. However, NDC employees are paid an additional fee for removing waste from such areas.

Residents pay a waste disposal levy of \$100/month or 1000/year for collection and disposal. Compliance is approximately 50 %. Some residents do not pay since they claim to burn and bury their waste. There are, however, several complaints from residents about the burning of waste. The NDC maintain a crew specifically for cleaning drains which are cleaned 12times/year. The frequency of cleaning can be reduced if less plastic and Styrofoam are disposed in drains. The GoG collects a fee for every plastic bottle brought into the country. Consideration should be given to providing some of this money to NDC.

Waste pickers would be welcome to work at transfer station. The transfer station should be configured to enable deposition of different types of wastes. The current waste levy will be used to provide bags to residents to facilitate source separation.

The NDCs is not aware that additional payments would be required for tipping at Eccles. This will require additional charges to residents. These charges can only be justified after a public awareness campaign to notify residents of the new option for disposal of waste. People may choose not to pay and continue illegal dumping. Therefore legislation should be strengthened and substantial fines should be levied for non-compliance. Legislation should also be strengthened for collection of property taxes since without this cutbacks may be needed in other services to pay tipping fees. The public awareness program and legislative improvement should precede waste disposal at Eccles. Funds should also be provided for hiring of Environmental Health Officer (EHO) by individual NDCs. At the very least and EHO and two assistants should be provided.

Date: May 19, 2004
Agency: Plaisance/Industry Neighborhood Democratic Council
Representative: Ms. McDerby - Overseer
Mr. Sandiford - Chairman
Mr. Ramlall – Responsible for Waste Management

The population of Plaisance/Industry is approximately 20,000 with there being approximately 3000 houses in the NDC. PT are established as a function of the rental value of properties. A valuation is currently in progress. This addresses only new building or buildings that have been renovated. The last valuation for the other buildings was completed in 1977. The rates assessed as PT are 21%, 24.5% and 28% of the rental values for residential, commercial and industrial properties.

Waste is collected once weekly from all areas within the NDC. A cart and horse has been contracted to remove waste. It is staffed by three laborers paid by the NDC and provided with minimal PPE (gloves and long boots). Access problems are encountered by the cart during the wet season and the frequency of pick up decreases. Approximately 6 tons/week of waste are collected. A large percentage of waste generated in the NDC is burned by its residents. All waste is disposed in the southern part of Ogle in a pit excavated onsite and on land owned by the Ogle Aerodrome. Several squatters live in the vicinity of the disposal area. The Aerodrome has served notice on the NDC to vacate the site but an alternative location is unavailable. The current NDC inherited this site from the former NDC.

There are major problems related to plastics and tyres dumped illegally in NDCs. One constable was threatened with a gun by a driver of a vehicle observed illegally dumping waste in the NDC. No enforcement action is undertaken by NDC since the costs for enforcement including legal fees are significantly less than penalties meted out to defaulters. The NDC has attempted to sensitize people to waste management problems by distributing pamphlets in homes in the NDC, but have seen no improvements. This has increased the frequency with which drains must be cleaned in community. It is estimated that cleaning would be required once in comparison to the present three times per year due to improper waste disposal.

Residents are not receptive to paying any additional charges for waste management. Some residents of the more affluent areas of the NDC are, however, willing to pay additional fees. Imposition of fees should be preceded by public awareness program. NDC is directed how to spend subvention of \$3,000,000/year. Money is needed for waste management plant, preferably a truck that can be used for other services and for hiring sanitary inspectors to be assigned to specific areas in the NDC. The legislation for littering and illegal dumping should be strengthened and updated to reflect costs associated with cleanup and prosecution.

The location of transfer stations should be well thought out to ensure it does not pose a threat to any community. There are no objections to waste pickers working at transfer stations.

Date: June 17, 2004
Agency: Eccles/Ramsburg Neighborhood Democratic Council
Representatives: Floyd France – Overseer
Ashoke Kumar - Chairman

The population of this NDC is approximately 20,000. Waste management fees are paid out of subvention and property taxes. The property collection rate is approximately 55 %. Major property tax revenues are collected from several large industrial establishments in this NDC. These include Noble House Seafood, Georgetown Seafood and Trading Company, Sterling Products, Demerara Oxygen Company, GuySuCo and several gas stations. The date of the last property valuation is not known. However a new valuation is proposed to be conducted before December 2004. Property tax rates are respectively 15%, 45, 60 and 100% of the assessed value for residential, commercial, industrial and vacant land and farmlands.

Waste is collected once every two weeks in each community within the NDC. On the average three compactor trucks of waste are picked up every second week and taken to the Mandela Site. The Eccles New Housing Scheme has not formally been handed over to the NDC and there is no mechanism for collecting property taxes from this community. The NDC has therefore instituted a waste collection charge of G\$ 500/month for waste collection in this community. There are approximately 400 houses in this scheme, however, the participation rate is only 20% (80 households). Garbage is only picked up from household who pay the waste charge. The remaining households in the area claim to bury and burn their waste. There are some areas of the new scheme which are inaccessible. The NDC's tractor accesses these areas and drops the waste off at a pickup point for removal by the contracted waste hauler.

There is no formal disposal agreement with GM to dispose of waste at the Mandela Site. Waste is taken there by waste haulers who are familiar with operations at the site and who can consequently bypass any source monitoring mechanism there.

There is a significant amount of dumping along the main roads that run through the NDC and a crew is maintained on a fulltime basis to address this problem. Waste management charges in this NDC are an accumulation of payments to the waste haulage contractor, charges for operating the tractor and trailer for waste collection and sum expended on litter pickup. This equates to a total of approximately US 16,500 per year. In addition, this NDC also expend sums on cleaning drains clogged by waste. A crew of 12 individuals works fulltime on the maintenance of drains and it is estimated that 20 % of the work is due to improper waste management. The total expended on drainage maintenance is approximately US \$20,500 per year.

People may be reluctant to pay additional fees for waste management. An education program coupled with public awareness campaign may help to convince people of the need to pay for waste management. The concept of transfer station may not apply to this NDC since the proposed facility is located within its boundaries.

Date: May 24, 2004
Agency: Herstelling/Little Diamond Neighborhood Democratic Council
Representative: Ms. Mohanedai Prashad - Overseer
Mr. Sahadeo Kandhi – Chairman, Works Committee

This NDC of approximately 2 mi² has about 1000 houses with a population of 5000 persons. Some of the major industries in the NDC include Guyana Pharmaceutical Company (GPC), SAPIL, Guyana Stockfeeds, The National Edible Oil Company and National Hardware. GuySuCo is the largest rate payer in the NDC. The last property appraisal was conducted two years ago and the PT rates as percentages of the assessed values are 0.375% for residential, 0.5% for commercial and 2.5% for industrial properties. PT collection rate is approximately 50%. The primary defaulters are the industries located in the NDC.

A tractor and trailer are used for waste collection. The trailer is manned by a driver and three laborers who are provided with cloaks and gloves. Four to five full loads are picked up each day. A large percentage of the waste is burned and buried by residents. There are complaints from residents about smoke and fumes during burning. Every area is serviced once/week with the exception of Herstelling which is serviced twice/week. Commercial generators and industries provide their own waste disposal services. Disposal is in pits excavated adjacent to canals in the community. Waste is periodically burned in the pits. The pits are monitored for flies etc and covered when full.

The canals in the community have to be cleaned at least trice/year due to illegal dumping. It was suggested that these canals may only need to be cleaned once/year if illegal dumping ceases. The EPA and NDC should cooperate to hire solid waste rangers to deal with illegal dumping. In addition, the laws should be upgraded to provide the NDC enforcement authority. A health awareness program should also be undertaken in the community to sensitize people to vector problems associated with illegal dumping. The NDC should keep monies from fines imposed for illegal dumping and these monies should be used for public awareness. The fines should be substantial to prevent repeat offences.

Cooperation with adjacent NDC on the transfer station is good concept since it will result in the use of less space. Operation of the transfer station will however escalate the waste management cost. The transfer station should be built to accommodate sorting of waste. The residents of the NDC are unlikely to welcome people from outside the community working as waste pickers since these are job opportunities that should be reserved for residents. The payment of a tipping fee will create additional employment and is consequently a good idea.

Date: June 2, 2004
Agency: Mocha/Arcadia Neighborhood Democratic Council
Representative: Mr. Gregory John – Chairman
Ms. Jacqueline Delph – Overseer
Mr. Leonard Mayers – Councilor

This NDC has a total area of 1.5 sq. mi, 600 houses and 2800 persons. Revenues are the GoG subvention and PT from residents. The last valuation was done prior to 2001. PT rates are 113 % and 25% of the accessed value for land and houses respectively. There are no commercial or industrial institutions in the NDC. Some residents are private cane farmers. Neither GuySuCo nor the private cane farmers pay PT to the NDC.

The NDC does not offer any waste management services to residents. Residents burn and/or bury their waste. There is some illegal dumping along parapets in the NDC. These are cleaned by residents as community projects. After removal the illegally dumped waste is burned. This is done on a quarterly basis. The waste dumped is primarily plastics, tins and other household waste. The volume of illegally dumped waste has increased greatly over the last two years.

The access road to the NDC is a GoG road. There is a large quantity of dumping on this road by non residents of the NDC and by some waste collection companies. Waste disposed along the access road includes septic tank waste, auto bodies and construction debris.

If the NDC is to utilize the new facility, it must be provided with cash to acquire plant and to hire personnel for waste management services. The NDC is not large enough to justify investment in plant and personnel that is only going to be used on a part time basis. In addition, a waste collection charge will have to be imposed on residents. Residents are likely to be willing to pay since everyone is concerned about effective waste disposal. A special local government court must be set up to force payment of PT. This court will also allow waste collection charges to be paid. However, a public awareness program should be effected to make people aware that these charges are also applicable to other NDCs. The legislation should also be updated and enforcement authority should be vested in the NDC. The NDC should also collect all fines for improper waste disposal.

Date: June 2, 2004
Agency: Golden Grove/Diamond Place
Representative: Mr. P. A Roberts – Acting Chairman
Mr. Balraj Budwah – Overseer
Ms. Marilyn Dalton – Councillor

This NDC with a total area of approximately 3 sq. mi. has a total of 2000 houses and a population of approximately 10000 persons. Approximately 500 of these houses are located in squatting areas. The NDC revenues are essentially the subvention from GoG and property taxes collected from residents and institutions in the NDC. The last property valuation was conducted 2003. PT rates range from 5% to 47% of accessed values for residential and commercial rate payer respectively. The largest rate payers in this NDC are Demerara Distilleries Limited (DDL) and GuySuCo. The subvention from central government is used primarily for maintenance of roads in the NDC.

Solid waste is collected daily with each area in the NDC being serviced once per week. The program was developed after a pilot program was conducted in the NDC to determine waste generation rates and the resources needed to manage that waste. As a result of that pilot study, a tractor and trailer was acquired and three laborers and a driver were hired on a fulltime basis for waste management. All waste management personnel are provided with personnel protective equipment which consists of raincoats, long boots, respirators and gloves. Approximately 2 – 2.5 tonnes of waste are collected each day. About 60 % of waste collected is food waste.

There is very little burning or burying in the NDC since residents are aware of the pickup schedule and put out their waste for collection. The roads are in fair enough condition to enable access to all locations even during poor weather conditions. Waste is deposited in an open excavation about 200 m from residences. However the site is shielded from residents by a tree line. A waste monitor is posted at the site. A second waste monitor travels through the NDC to identify illegal waste disposal operations and to effect corrective actions.

There is a small amount of illegal dumping by people driving through the NDC. Primarily plastic bottles are dumped and clog up the culverts in the area. These culverts are cleaned at least twice/year. Non of the environmental tax on plastic collected by the GoG is passed to the NDC.

The transfer station will entail double handling of waste and the associated additional cost is not necessary. Residents are unlikely to be willing to pay a separate waste levy to cover tipping fees. The NDC has its own transportation and should be allowed to transport waste to Eccles. Imposition of waste management fees will result in more burning and burying of waste in community. At present waste management costs are relatively high and include costs for maintenance of plant, personnel salaries including waste monitors. These costs amount to approximately \$2,000,000.00 per year. A public awareness program would be needed to convince residents of the additional charges for waste management.

The site at Eccles would provide no benefits to NDC. In addition, a new administration may be in place by 2007 and may opt to forego the project. Recyclers would be welcome provided that they are from the NDC.

Date: May 25, 2004
Agency: Craig/Caledonia Neighborhood Democratic Council
Representative: Mr. Wellesley Davis– Chairman

This NDC has a total area of approximately 5 mi² and has 1200 houses with a population of 7000 persons. It receives a subvention of 3,000,000.00 which is supplemented by property taxes. There are no industrial establishments in this NDC. Two formerly operating in the NDC; Colgate Palmolive and Ideal Industries have closed operations. The last property valuation was conducted in 1997 and the property collection rate is approximately 35 percent with the largest defaulters being large land and business owners. PT rates are 3 and 5 percent of assessed values for residential and commercial respectively. Most of NDCs revenues are spent on maintenance of drainage works.

There is no structured solid waste management. The NDC has no plant to collect waste. Residents either burn or bury their waste. A significant quantity of waste is disposed in drains and on roadway verges in the NDC. Illegal dumping in the NDC is aggravated by people passing through the area. The GoG has recently increased the frequency of cleaning of roadway verges and this has lessened the illegal dumping along roads. The NDC estimates that approximately 20 % of money spent on drainage maintenance is related to improper waste disposal. Volume estimates for waste generated by the NDC is not available due to lack of structured collection. The NDC is examining working with Craig/Caldonia NDC to enable use of their tractor and trailer during the project implementation. The volume of plastics generated in the NDC will exacerbate the waste problem and the NDC is interested in the program to ensure the plastics do not have a negative effects.

The NDC will have to impose fees to cover waste management charges. However imposition of these fees should be preceded by demonstrated improvements in waste collection and aesthetics in the community. This will aid to convince people that the fee should be paid. This should be aided by a public awareness program. The public awareness program should focus on health impacts to households of improved waste collection and should concentrate on schools in the NDC since children are charged with waste disposal. The public awareness program should run for one year before the program and should continue for some period afterwards.

Information on likely waste management fees should form part of the program and fees should be imposed six months after the program begins. A cost sharing mechanism should be developed so that the NDC can obtain some revenue related to management of collection operations. Illegal dumpers shall be prosecuted after program begins. A special court should be established to deal with NDC matters and penalties imposed by the court shall go into the treasuries of NDCs after operational charges have been deleted.

Date: June 11, 2004
Agency: Soesdyke/Huist Te Coverden
Representative: Mr. Leslie Glasgow– Chairman
Dianne Bissoon – Overseer

This NDC also receives a subvention of 3,000,000.00 which is supplemented by property taxes. The largest rate payers in this NDC are Barama Company Limited (BCL) and Gafoor and Sons. The collection rate ranges from 60 – 70 percent with the largest defaulters being large land and business owners. PT payments are not made on time because residents are unhappy with the services provided (roads & drains), some residents have however indicated a willingness to pay more than they do at present if better services are provided. The last property valuation was conducted in 1999 and PT are set as a percentage of assessed value; the rates are however relatively low.

There is no structured solid waste management in this NDC. BCL has indicated a willingness to donate 20 acres (8 ha) of land to the NDC for waste disposal. The EPA advice on landfilling requirements has resulted in the costs for development being prohibitive. Residents either burn or bury their waste. The NDC only collects waste illegal dumped. A tractor &

trailer is used for collection. That waste which is primarily plastic, paper and cardboard is burnt. Volume estimates for waste generated by the NDC is not available due to lack of structured collection.

Golden Grove/Diamond NDC has invited this NDC to share its dump. That dump abuts on several houses and the option was not exercised. The culture of burning and burying is well established in this NDC and consequently drains are free of waste. This is also attributable to the large percentage of property owners, who would not like to spoil their surroundings. Squatting is minimal in this NDC and very few tenants.

The NDC has a program of interaction with school and plans to donate bins to each school as part of their efforts to modify attitudes about waste management. Enforcement against illegal dumping is minimal since no facility is available for public use. The large businesses truck their waste to Mandela Site. In addition, the local government law Chapter 28:02 was last updated in 1957 and efforts to prosecute are dwarfed by the fine imposed on defaulters. The proposed solid waste act will impact on illegal dumping but a mechanism should be put in place to allow the NDCs to share fines imposed for illegal dumping. At present the plastic bottle levy does not go to NDCs who are saddled with the plastics problem.

The transfer station concept may be problematic since it will entail double handling of waste and it may not satisfy economies of scale related to the reliability of the waste management equipment presently used in Guyana. There are constant breakdowns and this can lead to waste piling up at the transfer stations. The decision to use transfer stations should be based on a cost analysis that compares the station to the direct cost of contracting a waste hauling truck. Waste pickers at the transfer station should pay a licensing fee.

This is a farming community and composting should be considered as a major option for waste since it can be used as fertilizer. A public awareness program should be conducted in the NDC, however the program should be specific to this community and should consider the housing pattern and economic activities in the NDC.

The distance to Eccles is a disincentive; however the cost of individual landfill site development is prohibitive. A waste management charge will have to be built into the PT and a separate accounting system must be established for waste management.

Date: June 15, 2004
Agency: Malgre Tout/Meer Zorgen Neighborhood Democratic Council
Representative: Mr. Hugh George - Chairman

This NDC receives a subvention of 3,000,000.00 which is supplemented by property taxes. The collection rate is approximately 50 percent with the largest defaulters being rice farmers. The Versailles Power Plant is one of the larger rate payers. The last property valuation was done prior to 1990. PT rates are 10% of the then assessed property values.

There is no structured solid waste management in this NDC. The NDC does not have any plant for waste collection. Residents either burn or bury their waste. Two new communities in the NDC; Roraima and Crystal Springs provide some mechanism for disposal of waste generated in those developments. The actual mechanism is not known. Waste, primarily plastic and styrofoam is disposed in drains in the NDC. The NDC recently contracted a company to bury waste disposed at an informal dump site in the NDC. This, was however a one off operation. Volume estimates for waste generated by the NDC is not available due to lack of structured collection.

There is a large squatting area of about 145 houses where no waste management occurs. Waste is disposed in drains in the area. The Drainage and Irrigation Board (DIB) maintains a single drain in the NDC. Maintenance of drains in the NDC is consequently presenting a strain on the budget since the greater part of the subvention is spent on cleaning drains of debris.

The NDC is agreeable to working with the adjoining NDC to facilitate operation of a waste transfer station, however, costs may prove prohibitive and should be allowed for. Separate charges for waste collection were tried in the past but were unsuccessful. The system was not open and accountable and residents took the position that they were already paying rates and taxes and that the new monies provided more room for corrupt practices. This attitude should be modified by a public awareness program conducted in the NDC. This program should take place before the program is implemented.

The local government law Chapter 28.02 should be updated to provide more muscle to NDC and a special court should be established to deal with NDC matters including payment of PT in the short term.

Date: June 15, 2004
Agency: La Grange/Nismes Neighborhood Democratic Council
Representative: Mr. Isaac Bhagwandin - Chairman
Ms. - Overseer

This NDC receives a subvention of 3,000,000.00 which is supplemented by property taxes. The collection rate is approximately 38 percent. The last property valuation was done prior to 1978. PT rates are 19% of the then assessed values for residential houses, 40% for residential land and 50% for farm lands.

There is no central solid waste collection system in this NDC. The NDC does not have any plant for waste collection. Residents either burn or bury their waste. There are infrequent complaints from some residents about burning. Approximately 10 -15 percent of waste generated in the NDC is illegally dumped. Illegally disposed waste is primarily plastic and styrofoam and is disposed alongside roads and in drains. Volume estimates for waste generated by the NDC is not available due to lack of structured collection. Approximately 20% of revenues collected by NDC is spent on drainage maintenance works. There are three industrial establishments in NDC; a furniture factory, a machine shop and a food processing plant. All dispose of their waste in the back of their property.

The Drainage and Irrigation Board (DIB) maintains drainage in agricultural section of the NDC. Maintenance of the others drainage infrastructure is by the NDC. This presents a strain on the budget since the greater part of the subvention is spent on cleaning drains of debris.

The NDC is agreeable to working with the adjoining NDC to facilitate operation of a waste transfer station, however, costs may prove prohibitive and should be allowed for. Separate charges for waste collection were tried by other NDCs but failed. There is need for a new valuation to incorporate upgrades to properties and to include new properties. This should generate enough revenues to pay for waste disposal. Separating PT from waste collection charge may prove contentious. In any case a public awareness program should be done to inform people of the need for additional payments related to waste disposal.

This NDC adjoins others that will not be involved in project. A system should be developed to discourage dumping by residents of adjoining NDCs. This may best be done by providing rangers to issue tickets and charges to defaulters.

The local government law Chapter 28.02 should be updated to increase fines for littering and the fines should be paid to the NDC to clean up illegally disposed waste.

Agency: Environmental Protection Agency
Representatives: Simone Osborne

EPA is the regulatory agency responsible for the environmental impact assessment process as outlined in the Environmental Protection Act 1996. The proposed Project requires an environmental authorization that can only be issued after submission and review of an environmental impact assessment. Both an Environmental Impact Statement and an Environmental Impact Assessment Report should be submitted to the agency for review and approval. The Environmental Protection Water Quality regulations 2000 would be one of the regulations that would have some impact on the proposed development. However, no quantitative standards are available as yet for solid waste operations. The EIA is required to identify all environmental and social impacts related to the operation of the facility. The EPA facilitates public comments on EIAs both before performance and after completion of EIAs. The EPA will provide a documented report of their concerns and suggestions and forward copies to Ground Structures Engineering Consultants Inc.

Agency: Ministry of Agriculture, Hydrometeorological Unit.
Representatives: Ms. Jafferalli, Hydrologist.
Ms. Farnum-Ramjoo, Climatologist.

This agency indicated that no data is available for any location in relatively close proximity to Eccles. Data is however available for Georgetown from a station located in the Botanic Gardens. This data is considered representative of the project location and a subset of the data was acquired.

Minutes of the Public Scoping for the Georgetown Solid Waste Management Programme (Eccles Landfill) held on Monday January 19, 2004 at the Eccles Primary School, Old Road Eccles at 5:00 pm

Present were:

At the Head Table

Hon. Clinton Collymore	Minister, MoLG & RD
Ms Denise Simmons	Member, EAB
Mr. Rufus Lewis	Director, MSWMD
Mr. Robert Williams	Deputy Mayor, Georgetown M & CC
Mr. Charles Ceres	Consultant, Ground Structures Eng.

Others present

Mr. Philip Hamilton	Permanent Secretary, MoLG & RD
Ms Eliza Florendo	Director, EMD – EPA
Ms Dhanrajie Madray	Director, Admin - EPA
Mr. Clifton Paul	SEO, EMD – EPA
Ms Leeya Khan	SEO, EIT - EPA
Ms Simone Osborne	EO, EMD – EPA
Ms Priyadarshni Rai	EO, EMD – EPA
Ms. Parbattie Khemraj	EA, NRMD - EPA
Mr. Gavin Agard	Intern, EMD - EPA

Attached hereto: Members of the Public (attendees)

Ms Denise Simmons of the Environmental Assessment Board commenced the meeting at 5:15 pm. Participants were asked to relocate from the Eccles Primary School auditorium to the schoolyard because of exceedingly loud noise emanating from the neighbouring property and a power outage to the Eccles area (which precluded the use of the public address system).

Ms Simmons welcomed persons to the Public Scoping exercise and outlined the objectives of the meeting. She advised that the meeting would give persons an opportunity to express their concerns about the Eccles Landfill project and that all concerns voiced will be addressed in the EIA study. Ms Simmons gave a synopsis of the EAB's role in the EIA process.

Mr. Clifton Paul of the EPA was then asked to explain "*the EIA process and the role of the Public*". However a resident (Mr. Geer) interjected and enquired whether or not the project has already reached the development stage and if the developer has been identified.

Mr. Robert Williams responded, indicating that the Government of Guyana has accessed a loan from the Inter-American Development Bank (IDB) to develop a waste disposal facility that will address solid waste issues in Georgetown and several localities in the its environs. Mr. Rufus Lewis added that in 1998, as a result of discussions with Municipalities and other local authorities, the Government of Guyana in an effort to manage solid waste and prevent the improper disposal of waste, initiated a process that identified six possible sites for waste disposal. Some of the areas identified were: Eccles, Diamond, old bauxite mines in Linden, OGML mines and reclaimed lands from the sea. Mr. Lewis further stated that the Eccles site was selected through a process of elimination.

Mr. Gaskin enquired whether or not approval has already been given for the development of the Eccles Landfill. The residents felt that the decision to develop the landfill in Eccles was already made. They became agitated and expressed their unwillingness to listen to the presentations by the EPA (and the Developer and Consultant). Ms Simmons attempted to restore order, indicating that residents will be given a chance to ask questions after the presentations. She emphasised the need for residents to listen to the presentations so that they can have a greater understanding of the issues that should be addressed in the EIA study. The Honourable Minister, Mr. Clinton Collymore appealed for civility and highlighted key items on the Agenda.

Mr. Paul of the EPA then assured the residents that the project has not been approved as yet and indicated that the proceedings at the public scoping were engineered to allow residents to voice their concerns about the Project. He further indicated that the concerns of the residents would be incorporated in the final Terms of Reference (TOR) for the EIA

study. The EIA will provide a plan for the avoidance and/or mitigation of environmental impacts that are associated with the development and operation of the waste disposal facility.

Ms Simmons then asked Mr. Rufus Lewis, Director of the Municipal Solid Waste Division, Georgetown Mayor & City Councillors to give an “*Overview of the Project*”. Mr. Lewis outlined key aspects of the project, indicating that the Government of Guyana endeavoured to find a way to improve solid waste management in Region 4 because of the indiscriminate dumping of solid waste in this region. He highlighted hydrological conditions and cost as the key reasons for the exclusion of the City of Georgetown from consideration for the development of the landfill facility. Mr. Lewis assured the public that a landfill, if properly engineered will not adversely affect groundwater quality. He outlined some of the measures that will be implemented to mitigate environmental impacts such as: daily cover of the working face of the landfill, gas monitoring and control systems, and a leachate management system.

Mr. Ceres, the Project Consultant was then asked to present the “*Environmental Impacts of the Project*”. As a preamble to his presentation and in an effort to clarify salient points about the EIA process, Mr. Ceres indicated that the EPA published a twenty eight (28) day public notice. He explained that the public notice indicated that an EIA is required for the project and invited members of the public to submit to the EPA any questions and/or concerns that they may have about the project within 28 days of the publication of the notice. Mr. Ceres further indicated that subsequent to the publication of the public notice the public scoping exercise (that is being held) allows persons to express concerns that will be considered in the TOR. He stated that the TOR is a public document and it will be finalised and made available for perusal by the public.

Mr. Ceres emphasised that an Integrated Solid Waste Facility is proposed for Eccles, stating that there will be composting, recycling and possibly incineration of waste streams from hospitals and abattoirs. He indicated that the facility will be located east of the Eccles Industrial Estate. Mr. Ceres further explained that groundwater contamination will not occur because of the geology of the area. He outlined some of the preventive/mitigatory mechanisms that will be implemented at the facility, such as: recompact clay liner, flexible membrane, leachate collection system, storm water control and explosive gas monitoring system. Mr. Ceres also stated that the facility may have a special cell for the disposal of hazardous waste.

Mr. Ceres assured the public that as a technocrat, he will ‘go where the data take him’ and will reject the site if it is determined that the area is not suitable for the development of such a facility. He examined the alternatives to the project and the regulatory framework within which the project will be implemented. Mr. Ceres indicated that the maintenance of a buffer zone at the perimeter of the project as well as issues of population distribution, proximity of businesses and education facility and cumulative impacts will be addressed in the EIA study.

Mr. Ceres candidly stated that the development of the facility may result in the following: the Eccles industrial area being constrained; an increase in employment in the area; a decrease in property value; and the aesthetics of the area being adversely affected since the view of residents will be obstructed by the 10 metre high landfill. He concluded by outlining some aspects of the project, such as the remedial measures, impacts that cannot be mitigated and monitoring programmes (air, surface and ground water) that will be addressed in the EIA.

Ms Simmons then invited members of the public to express their concerns about the development.

Questions/Concerns

Mr. Michael Grant – Will the presence of junkies/vagrants as a result of the development of the landfill be monitored?
A female resident – Will there be burning at the facility? Will the site be open? If so, how will this affect asthmatics?

A male resident – Will there be accidental burning due to the methane gas that will be produced?

A male resident – Where is the proposed landfill site in Eccles?

Mr. Ceres reiterated that questions are not answered at the public scoping exercise, but the questions/concerns voiced are incorporated in the TOR for the EIA study.

Mr. Neil Kumar (CDC and the Policing Group) – stated that he was not given proper information about the site and that the project area was not defined. He expressed concerns about the proximity of the facility to other projects and the

drainage system in the Eccles area. Mr. Kumar indicated that he is vehemently opposed to the development of the facility at the proposed location in Eccles.

Mr. Robert Williams responded to Mr. Kumar stating that 75 acres of the land that was initially earmarked for the development of the project were allocated to the Industrial site and the housing scheme.

Bert Carter – stated that it is unfair that questions are not being answered at this meeting. He asked the following questions: What is the spatial display of the facility from east of the public road? What is the depth of the polyethylene basin? What is the height of the landfill above the natural height (of the ground)? What is the envisaged generation of methane gas? What is the anticipated life of the facility?

Mr. Ceres – The height of the landfill is 10 metres above existing ground surface level. The life of the landfill is estimated to be 20 years.

Mr. Sagl – referred to the Kyoto Protocol and sited the Netherlands as a country that is below sea level and as a result of that, does not have landfills. He asked – ‘Can you say that the project will not affect the environment?’ and ‘Where will the leachate go?’

At this point, the residents loudly objected to the development of the landfill facility at the proposed location and efforts to restore order were futile. The meeting was adjourned at approximately 6:30 pm.

The recording of the minutes was severely limited by the loud chanting and chatter of the residents.

Minutes of the Public Scoping for the Georgetown Solid Waste Management Programme (Eccles Landfill) held on Sunday February 8, 2004 at the Peter's Hall Primary School at 3:00 pm

Present were:

At the Head Table

Ms Denise Simmons	Member, EAB
Mr. Maurice Veacock	Member, EAB

Others present

Mr. Philip Hamilton	Permanent Secretary, MoLG & RD
Ms Eliza Florendo	Director, EMD – EPA
Mr. Rufus Lewis	Director, MSWMD
Mr. Charles Ceres	Consultant, Ground Structures Eng.
Mr. Clifton Paul	SEO, EMD – EPA
Ms Preeya Rampersaud	SEO (a.g), EMD - EPA
Ms Simone Osborne	EO, EMD – EPA
Mr. Ronald Cumberbatch	EO, EMD – EPA
Mr. Suraj Nauth	EO, EMD - EPA
Attached hereto:	Members of the Public (attendees)

Ms Denise Simmons of the Environmental Assessment Board (EAB) commenced the meeting at 3:45 pm after apologising for the delayed start which was largely due to the late arrival of the public address system. Ms. Simmons outlined the purpose of the public scoping exercise. She requested that the process be respected and stated that questions should be asked during the time allotted on the Agenda for Comments/Questions.

Mr. R Gaskin indicated that he would like to make a preliminary objection. He referred to the EP Act 1996 and stated that the EAB is an appellate body to which appeals against the EIA process are made. He further stated that the EAB should not be chairing the public scoping exercise as this may constitute a conflict of interest. He demanded that the functions of the EAB be clearly defined before the public scoping proceeds.

Ms. Simmons with the assistance of Mr. Veacock outlined the functions of the EAB. The public was dissatisfied with the response and refused to proceed with the meeting. Mr. Terrence Simmons requested that the question posed by Mr. Gaskin be answered since there may be conflict of interest if the body (EAB) which conducts the public scoping also hears appeals.

Mr. C. Paul of the EPA attempted to make his presentation on 'the EIA Process' as well as clarify the functions of the EAB. He outlined the role of the EAB as stated in the EPA's *Roles and Procedures for Conducting and Reviewing EIAs, Volume I*. His efforts were interrupted by some members of the public. The residents also indicated that they had already heard the presentations at the previous meeting and did not want the presentations to be made again. Mr. Phillip Hamilton, Permanent Secretary, MoLG & RD attempted to restore order.

Mr. Paul Geer stated that he would like to know the outcome of the previous meeting. He indicated that he had raised a number of concerns at the previous meeting and wanted to know if they were addressed.

Mr. Gaskin then stated that the residents of Eccles do not want the project. He said that the residents made that position clear at the previous public scoping but the EAB is still trying to "sell the same propaganda". Some residents called on Mr. Ceres to apologise for a remark made by him at the previous public scoping.

As a result of further disruption of the meeting by the public, Ms Simmons enquired whether or not the public would like the Agenda to be suspended. With the public's agreement, Ms Simmons invited comments and questions on the project. She advised the public that their concerns would be incorporated in the TOR for the EIA study. Mr. Veacock assured the public that the views expressed would be documented (and if most persons are against the project this will be taken into consideration).

Comments/Questions

Ann Geer – What is the location of the landfill site? How many miles will it be away from residential areas?

Mr. Rufus Lewis – Referred to pg 34 of the 'Environmental Improvement of the Georgetown Interim Disposal Site – Selection Document' and stated that Guysuco under instruction from the Government of Guyana liberated 300 acres of land in Eccles for the development of the project. He further stated that a buffer zone of 100 acres of thick vegetation will be maintained from the western boundary of the landfill. Mr. Lewis also explained that even though the Eccles site was the most feasible of the sites considered, it may not be the chosen site if the EIA findings preclude it.

A male resident - indicated that Mr. Rufus Lewis had promised to provide a plan of the proposed area for the development of the landfill. He stated that drawings that show the exact location of the site should be made available to the public. Mr. Lewis assured him that plans are available.

Paul Geer and Ian Chang made references to the project summary and concluded that the project was a 'done deal'.

Dr. David Singh – outlined his understanding of the EIA process. He indicated that alternatives should be examined. He questioned whether the EIA process is going to ensure that residents are not affected and whether there are legal provisions that will ensure that the situation which exists at the Mandela Dumpsite does not recur. He stated that there should be clear delineation of a buffer zone so that residents will not be adversely affected by the project. Dr Singh further proposed that liability should be addressed and suggested that an environmental bond be established to remedy any adverse effects of the project on the environment and public health.

Ann Geer – Stated that along the Linden Soesdyke Highway there are many eroded areas where waste can be disposed.

Terrence Simmons – Referred to Mr. Rufus Lewis' statement that the buffer zone will be 100 acres and stated that the distance between the site and the housing/industrial areas would be about 4-5 miles. He noted that residents at the back of South Ruimveldt and other areas which are north/east of the proposed project site were not present at the meeting and wondered why they were excluded.

Ann Geer – What are the impacts on the stadium?

Terrence Simmons – Questioned the access route through Eccles Housing Scheme to the landfill and asked why another access road was not considered.

A resident – Requested that the distance of the project from housing areas be given in feet.

Mr. R. Lewis – Indicated that the distance is 300m east of the western boundary of the landfill.

Paul Geer – Enquired about the source of the information given by Mr. Lewis. Mr. Lewis indicated that the information was taken from the 'Environmental Improvement of the Georgetown Interim Disposal Site – Selection Document'.

A resident – Where is the dense vegetation for the buffer zone?

Ann Geer – Stated that the distance of the buffer zone is the size of ten (10) house lots.

A male resident - Stated that the buffer zone will be about 1000 ft.

R. Gaskin – Suggested that residents vote for or against the project. Paul Geer agreed, stating that the Chairperson may want to get a feel of the outcome of the meeting and suggested that residents vote by a show of hands.

Denise Simmons – Explained that a Social Impact Assessment (SIA) which will include public surveys will be done as part of the EIA study, stating that there is no need for residents to vote (by a show of hands) at this forum.

Paul Geer – Stated that there were approximately 125 persons at the meeting and voting will give an assessment of whether the residents are for or against the project.

Denise Simmons – Indicated that the results of the vote would not be reflected in the TOR.

A male resident - referred to the 'Government of Guyana – Waste Disposal Facility' document (which was circulated by Mr. Sahadeo Kandhai of the Little Diamond/ Herstelling NDC and was reportedly prepared by MoLG & RD) which

APPENDIX J

SITE OPERATIONS MANUAL

SITE OPERATIONS MANUAL

SANITARY LANDFILL IN HAAGS BOSCH

MAY 2005

REF. NO. 35919 (3)

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GLOSSARY OF TERMS, ACRONYMS AND ABBREVIATIONS

ADC	alternate daily cover
AES	Atmospheric Environmental Service (Canadian Climate Centre)
bgs	below ground surface
BOD ₅	5-day biochemical oxygen demand
BVA	Brown, Vence & Associates, Inc.
cfm	cubic feet per minute
CH ₄	methane
COD	chemical oxygen demand
CQA Plan	Construction Quality Assurance Plan
CRA	Conestoga-Rovers and Associates
D & O Report	Detailed Design and Operations Report
Drawing C-01	Example drawing from the Drawing Package for the Construction of New Sanitary Landfill in Haags Bosch, provided under separate cover (see Appendix A for cover page)
E & A	E & A Consultants, Inc.
EIA	Environmental Impact Assessment
ERM	Environmental Resources Management Limited
FML	flexible membrane liner
ft	feet
GD	Georgetown Datum
GHG	greenhouse gas
GPL	Guyana Power & Light, Inc.
GOG	Government of Guyana
GuySuco	GuySuco Sugar Company
ha	hectare
HDPE	high-density polyethylene
IDB	Inter-American Development Bank
km	kilometre
kPa	kilopascals (pressure)
L & SC	Land and Survey Commission (Guyana)
LCS	Leachate Collection System
LEL	lower explosive limit
LFG	landfill gas
KOP	knock-out pot
m	metre
MLGRD	Ministry of Local Government and Regional Development

GLOSSARY OF TERMS, ACRONYMS AND ABBREVIATIONS

mm	millimetre
MSW	municipal solid waste
MSWMD	Municipal Solid Waste Management Department (Georgetown)
m/s	metres per second
m ³ /d	cubic metres per day
NH ₃ -N	ammonia nitrogen
NMOC	non-methane organic compound
O ₂	oxygen
PLC	programmable logic controller
PPE	personal protective equipment
ppmv	parts per million by volume
Project Team	Trow International Inc., Conestoga Rovers & Associates, and E & A Consultants Inc.
Property	full 162 ha parcel of land donated by GuySuco including landfill Site and buffer zones
PS	pump station
PVC	poly vinyl chloride
SDR	standard dimension ratio
Site	New Sanitary Landfill in Haags Bosch
SWM	surface water management
SWMHYMO	StormWater Management Hydrogeologic Model
SWMP	Solid Waste Management Program
Trow	Trow International Inc.
UEL	upper explosive limit
UPS	uninterrupted power supply
VOC	volatile organic compound

1.0 INTRODUCTION

This Site Operations Manual (Manual) has been prepared for the Ministry of Local Government and Local Development (MLGRD), of the Government of Guyana (GOG) hereby referenced as the Owner to provide detailed operating procedures for the new integrated solid waste management facility (new sanitary landfill) located in Haags Bosch (Site). The directions in this Manual are to be followed by the selected contractor (Contractor) who enters into an agreement with the Owner to operate the Site in accordance with terms and conditions set forth in the Contract. The selected Contractor is encouraged to review the Detailed Design & Operations Report for the New Sanitary Landfill in Eccles (December 2004 D & O Report), to more thoroughly understand the engineering philosophy for the Site.

The Contractor will be responsible only for operating and maintaining the Site in accordance with the terms and conditions of the Contract. At this time it is not anticipated that the Contractor will be responsible for any proposed and/or future infrastructure construction works required for the Site.

Included with this Manual is a set of detail design drawings, which were prepared on behalf of the Owner to have the Site infrastructure work tendered and constructed. Within this Manual there are a number of references to the design drawings which will assist in better understanding the Site topography and the sanitary engineering principles that must be thoroughly understood by the Contractor to effectively operate the Site in accordance with the terms and conditions of the Contract with the Owner.

The detail design drawing set is included in Appendix A of this Manual.

1.1 SITE BACKGROUND

The new sanitary landfill and associated support facilities have been constructed to provide for the Municipality's long-term solid waste management and disposal needs. The proposed Site in Haags Bosch is located approximately 4 kilometres (km) south of the geographical center of Georgetown on a 162 hectare (400 acre) parcel of land that was previously owned by the GuySuco Sugar Company (GuySuco) (Property) and was used to grow sugar cane. The waste fill area of the new sanitary landfill covers a total of approximately 26 hectares (64 acres) and is situated in the eastern portion of the Site.

The regional setting and Site location is shown on Figure 1.1. A detailed Site location plan is shown on Figure 1.2.

1.2 WASTE TYPE AND SERVICE AREA

The landfill services the City of Georgetown, which covers an area of approximately 40 km², and has a population of more than 200,000 people. If the outlying areas are included, the total service area population is estimated to be between 300,000 and 350,000 residents.

The largest component in the landfill is reported to be food waste, which accounts for 41 percent of the total waste stream. The next largest components are paper waste, and glass, metals, and plastic, which account for 24 and 13.5 percent of total waste stream, respectively. The landfill design is compatible with both the current waste quantity/quality characteristics and will also be suitable for effective management of solid wastes as the collection and disposal practices continue to evolve in Georgetown. This includes any at-source separation/recycling initiatives and composting pilot program that may be adopted.

The current waste profile of waste received at the Mandela Avenue dumpsite which includes the commercial, domestic, construction, and landscaping waste described above is provided in Table 1.1.

1.3 SITE OPERATION RESPONSIBILITIES

The Contractor shall operate the Site using competently trained personnel. As part of Site operations, staff will be trained and required to handle a number of tasks that are categorized into specific areas summarized as follows.

Site Security and Scalehouse Operations

- Control of Site entrance gates and access to the Site by authorized persons.
- Prevention of unauthorized waste scavenging and assistance in managing the waste picker activities within the authorized areas.
- Preventing the use of any burning or open flames.
- Monitoring the quantities and types of waste entering the Site to ensure adherence to the acceptance of approved materials and the rejection or rerouting of any disallowed materials.

- Screening and prohibiting the off-loading of wastes not approved for disposal at the Site, including the following wastes:
 - a) hazardous wastes;
 - b) liquid waste unless specifically authorized as in the case of some present/future biological sludges;
 - c) medical and pathological waste;
 - d) any banned materials (note that a listing of banned materials may develop over time as various recycling, recovery and reuse programs evolve); and
- e) radioactive waste or other wastes not permitted for disposal in the Site.

Administrative and Supervisory Operations

- General administrative functions.
- Recording and tracking waste disposal records and accounts.
- Providing reception services for public inquiries.
- Invoice and account management for the tipping fees that may be assigned to some or all of the commercial and industrial users of the Site.
- Supervising purchasing and requisitions for materials and equipment for operating and maintenance functions.
- Supervising and communications with all of the other portions of the waste management division not resident at the Site (e.g., the waste transfer stations and any independent hauling contractors).

Waste Disposal and Site Maintenance Operations

- Operations including control of the tipping face.
- Waste placement and compaction.
- Daily cover placement.
- Maintenance and construction of temporary on-Site hauling roads.
- Repair of any leachate seeps by placing additional cover on weak areas or excavating and correcting the seep area before replacing cover.
- Control of surface water runoff by grading and berming the Site in order to keep surface water away from the waste and to contain surface water that has come in contact with waste and subsequently treated as leachate.
- Placing and covering of special wastes.

- Maintenance and cleaning of main access road into Site.
- Progressive placement of final cover as areas become ready.
- Cleaning and maintenance of leachate collection piping.

Leachate and Stormwater Management Systems

- Operation and maintenance of the pumping systems that comprise the stormwater discharge systems.
- Operations and maintenance of the leachate pumping stations.
- Operations and maintenance of the leachate treatment system.
- Field laboratory testing and analyses for the leachate treatment facility.

Landfill Gas Control

- Operation and maintenance of landfill gas (LFG) management systems that will be a future function required when these facilities become necessary and are constructed in future.

Monitoring Programs

- Groundwater, surface water, and LFG monitoring will be a specific activity that will require fully trained on-Site staff. Some of these activities may be combined with the operations of the associated leachate, stormwater, and LFG management systems.

1.4 SITE ACCESS

Access to the Site is from the west along the extension of the south service road from the new bypass highway that it is to be constructed to the west of the Site. The primary entrance to the Site is across the bridge over the south irrigation canal at the southwest corner of the Site. The south service road extends from a an intersection with the bypass highway along the top of the existing drainage canal berm adjacent to the south Property boundary. The service road extension is paved to the Site entrance and inside the Site to the area surrounding the weigh scale. A second emergency gate and Site entrance is located at the northwest corner of the Site to give access to the canal berm on the north side of the property. There will be some future upgrades to this canal berm on the north side of the Site to allow it to be used as an emergency access point into the landfill.

Primary Site access and emergency access gates are indicated on Drawing C-03, provided in Appendix A.

2.0 DESIGN CONSIDERATIONS

In order to effectively operate and maintain the Site it is important for the Contractor to understand the planned development and sequencing for the landfill cells and associated environmental controls proposed. It is also important to understand the relationship between the different environmental control systems and how they are integrated.

The following sub-sections have been prepared to provide the Contractor with a general understanding of the Site development, administration facilities and environmental control systems currently constructed at the Site. For more complete details on the operation and maintenance requirements for each of the environmental control systems discussed refer to the Manual section referenced.

2.1 DEVELOPMENT OF SITE

The Site will be developed in four stages. The total duration of landfilling in each stage is expected to be approximately 6 to 7 years based on the airspace volume available per stage. Landfilling of each successive stage will overlap with previously landfilled stage(s), to attain final waste/daily cover elevations. The sequence of development of the landfill will be to commence filling in Stage 1 and progressing into Stages 2 through 4 as the waste disposal capacity becomes required. The general direction of filling will initially be from east to west until the waste has been placed completely below grade in Stage 1.

The Site development sequencing is provided on Drawings C-04 to C-06 in Appendix A.

2.2 ADMINISTRATION FACILITIES

There are a number of administration facilities currently provided to assist the Contractor in effectively operating and maintaining the Site in accordance with the terms and conditions of the Contract.

These include, but are not limited to, the following:

- an administration building including reception area and staff facilities;
- a maintenance garage area forming part of the main building;
- a scale and scalehouse;

- staging and recycling areas;
- a continuous perimeter chain link fence along the west Property limit between the drain canal to the north and the irrigation canal to the south;
- provisions for vehicle and tire cleaning area prior to exit from the Site; and
- a row of palm trees planted inside the west limit of the Property to provide supplementary visual screening between the Site and the planned future bypass highway to be constructed to the west.

The layout for administration building and maintenance garage is presented on Drawings C-39 to C-41, provided in Appendix A.

2.3 SITE UTILITIES

Site utilities including electricity, washroom facilities, potable water, and telephones will be available to the Contractor.

Primary electrical power and phone services to the Site will be provided via overhead lines run from the industrial area. Non-potable process water will be provided via a 100 mm diameter high density polyethylene (HDPE) forcemain to the administration/maintenance building. Sanitary services for the washrooms in the administration building will be managed via a septic holding tank. Wash water from the floor drains of the maintenance garage will be discharged through an oil/water separator and treated at the leachate treatment facility.

A portable fuel tank will be provided for vehicle fuelling. A storage area has been allocated in the maintenance garage for lubricant and other fluid storage.

2.4 LEACHATE COLLECTION AND TREATMENT

The base of the landfill cell consists of a pre-engineered landfill liner system, which is essentially a clear stone leachate underdrain layer overlying a compacted layer of clay. Leachate, which is generated within the waste mass drains from the leachate underdrain to perimeter base collector and perimeter header pipes and on to a number of leachate/stormwater pump stations. This system, which is designed and constructed to capture and handle leachate is called the leachate collection system (LCS). The LCS will be constructed in stages in conjunction with the development of each of Stages 1 through 4.

Operating details and maintenance requirements for the LCS are provided in Section 6.1 of this Manual.

During operation of the Site, leachate generated from the active fill areas and the stormwater that accumulates in the active disposal cells during the preparation of each stage base is collected by the LCS at the base of the landfill and conveyed through forcemain piping to the leachate treatment system. The leachate is subsequently treated to remove any compounds that could impact the downstream waterways and local groundwater table before being discharged.

Operating details and maintenance requirements for the leachate treatment system are provided in Sections 5.1 and 6.2 of this Manual, respectively.

2.5 SURFACE WATER MANAGEMENT

Three stormwater sedimentation and control ponds that are designed for both sedimentation and interim storage prior to release to the canal system have been constructed at the Site. Surface water, which has not been in contact with the waste may be discharged directly to the stormwater management pond prior to release to adjacent canals or drainage. Surface water, which has been in contact with the waste shall be collected by the LCS and treated as leachate. Rainwater that has accumulated in any open excavations that have not received any waste may be discharged directly to one of the three stormwater management ponds and release from the system to the adjacent canals or drainage ditches.

Operating details and maintenance requirements for surface water management is provided in Section 5.3 of this Manual.

2.6 LANDFILL GAS COLLECTION AND FLARING

It is anticipated that there will be adequate LFG generation to support the operation of an active control system to collect and flare gas in approximately 10 years after the Site has been opened for operation. Therefore, LFG collection and flaring will not be an immediate design concept or operational and/or maintenance consideration until such time as an active collection and flaring system is commissioned at the Site.

3.0 SITE OPERATIONS

3.1 SITE STAFFING

The anticipated requirement for operating the Site, in terms of staff resources is provided in Appendix B.

3.2 OPERATING EQUIPMENT

The equipment is owned by the Owner but operated and maintained by the Contractor, who will be responsible for provision of all fuels and lubricants and required insurances. The equipment will be under guarantee for one year. However, beside this limited guarantee full maintenance, including provision of spare parts and parts subject to wear and tear, will be the responsibility of the Contractor. The Contractor will be fully responsible for repair or replacement of the equipment during the 10 years of operation and has to include the related cost in his financial proposal. The Contractor shall ensure that an annual check and service of the equipment is provided. The Contractor shall prepare a maintenance plan acceptable to the Owner and will be reviewed related to the maintenance.

The equipment provided at the Site is provided in Table 3.2 provided in Appendix B.

3.3 SITE SECURITY

Overall Site security can be readily managed at the Site because it is bounded on three sides by canals. A security fence will be constructed across the western side of the landfill between the canals. The main access gate located at the southwest corner of the Site will facilitate access control and make it relatively easy to maintain good records and control of public/private access to the Site. The secondary access gate to be constructed at the northwest corner of the Site will be kept normally locked and will be used for emergency purposes only.

Signage shall posted at the main gate with the following indicated:

- operating authority, telephone number, and address;
- contact information including telephone number;
- waste types acceptable for disposal at the Site; and
- hours of operation.

A single scale with traffic signals will be located at the Site entrance so that waste material entering the Site can be weighed and recorded. Provisions will be made for an optional second scale as warranted by waste disposal traffic and quantities. A daily record of weighing operations shall maintained by the scale operator. The information contained in this record should include the date, quantity of waste in tonnes, and type of waste received. Tipping fees can be assigned and could be charged for wastes entering the Site, predominantly based on weight.

3.4 HOURS OF OPERATION

The Site shall open to receive waste from 7:00 a.m. to 5:00 p.m. Monday to Friday and from 7:00 a.m. to 2:00 p.m. on Saturdays. Operating hours may be extended up to 2 hours to allow for preparation of areas for waste disposal and compaction of waste/daily cover subsequent to dumping of waste; however, no Site operations shall take place outside of daylight hours. The Site operating hours will be posted at the Site entrance.

Loads that are unavoidably delayed by specified conditions may be received after normal operating hours (5:00 p.m.), provided that competently trained Site personnel are available to ensure proper placement of the waste and record their receipt.

3.5 INSPECTION AND RECORD KEEPING

All waste received at the Site will be inspected by Site personnel including the weighbridge operator and the waste spotter.

The weighbridge personnel shall question drivers as to contents of their load and visually inspect the load of incoming waste for unsatisfactory or prohibited waste. If the contents or driver are suspect then these personnel should notify the waste spotter of the vehicle's description for further examination at the working face, or direct the truck for detailed investigation after contacting the site supervisor.

There shall be three opportunities for inspection of the waste material brought to the Site for disposal, and they are:

- preliminary inspection of each load of waste brought to the Site by the weigh-bridge operator;

- inspection of the waste at the tipping face prior to incorporation into the cell by the waste spotter; and
- random load inspections at the Site by the waste spotter, which includes suspect loads identified by the weigh-bridge operator.

A potential reason why a waste load may be questionable or suspect is that it may contain unacceptable waste as follows:

- the type of waste indicated by the driver is inconsistent with the type of generator, from which the load comes;
- easily observable, potentially unacceptable waste on top of the load, or protruding out of the side or at the end of the vehicle;
- waste emanating an odour, suggesting the presence of an unacceptable waste type;
- driver or company (if it is a commercial customer) known to have previously brought unacceptable waste to the Site, or the driver is acting nervous and non-committal when questioned as to load contents; and
- load is packaged or covered in such a way that suggests some unacceptable material is being hidden from inspection.

If any inbound load is found to be on fire or deemed to be highly combustible and in danger of catching fire, it shall unloaded without delay into the designated inspection area, and the fire put out and waste made safe for subsequent disposal at the tipping face. A record of the incident shall made and a copy given to the driver with an appropriate notice of the costs to be borne by the waste generator and/ or the transporter.

If any of the Site personnel spot a vehicle dumping unacceptable waste, they should direct the vehicle to reload the material and refer them to the waste spotter for further disposal directions of the material. This may be as simple as redirecting the vehicle to the designated location within the site (e.g., tire or recycling depot).

If the vehicle has dumped and left unacceptable waste in the tipping area and it is still on-Site, the waste spotter should contact the weighbridge operator and have them direct the vehicle back to the tipping area to retrieve the unacceptable waste and move it to the designated inspection area for a detailed inspection.

However if the vehicle has dumped unacceptable waste in the tipping area and has since left the site, the Contractor should remove the waste to the inspection bay and inform

the weighbridge operator to note the customers license number for removal at the next opportunity. In all cases, a waste inspection form (WIF), shall completed by the Contractor and contents of the unacceptable waste distinctly recorded.

A copy of a waste inspection form is provided in Appendix B.

If a load, deemed unacceptable after inspection and recording (except fire loads, as noted above), is received at the Site, a report shall made to record the incident noting the hazardous or illegal nature of the load.

An appropriate notice of costs to be borne by the waste generator and/or transporter will be filed with the Owner. However in case of partially unacceptable loads, the waste spotter may allow the acceptable portion of the load to be landfilled.

A detailed summary of waste inspection (and documentation) procedure is provided in Appendix C.

3.6 PROCEDURES FOR PAYMENT OF TIPPING FEES

The fees collected for waste delivered to the Site will cover operation and maintenance and a percentage of the capital costs.

The majority of waste arriving at the site will be delivered by licenced waste collection companies that collect waste from households and small commercial enterprises under contracts with the Georgetown Municipality. The Georgetown Municipality will pay these contractors for collection services, and will pay the landfill operator for disposal services.

Some waste will arrive from licenced collection companies that collect waste from large enterprises and other organizations that have been given approval to have their waste delivered directly to the landfill site. These companies will pay a tipping fee, to be collected by a representative of the Owner, when the waste is delivered to the site. The tipping fee is likely to vary for different types of waste.

Once all registration, weighing and inspection procedures have been carried out, the tipping fees for those vehicles that apply to the second category above will be collected. Appropriate documentation on the payment shall completed and filed appropriately. Payments shall registered in the landfill accounts and receipts shall provided to the driver of these vehicles.

The Contractor shall be paid for disposal services, based on the quantities delivered to the site and determined at the weighbridge. The terms and conditions of the Contract provide details on payment mechanisms and bidding price requirements.

3.7 CO-ORDINATION WITH OWNER ON INFORMATION ON WASTE DELIVERIES

The majority of the information in waste deliveries shall obtained by the Contractor. However, the Contractor will be required to communicate with the Owner on a regular basis related to waste deliveries at the Site. The reasons for this communication include the following:

- payments by Georgetown Municipality to waste collection companies under the first category above will only be made upon evidence that waste has been delivered to the landfill (i.e., reports from the Contractor including weighbridge data). This will provide appropriate levels of enforcement and control in the system and ensure waste is delivered to the landfill and not illegally dumped; and
- the information on waste quantities will assist the Owner in planning further waste management improvements in Georgetown.

4.0 WASTE MANAGEMENT

The tipping face is the active part of the Site, where waste is placed and compacted on a daily basis. The location of the tipping face within the Site changes as more waste is added. As waste accumulates in the Site, the tipping face also proceeds higher in elevation along with the increase in the height of the deposited waste. The size of the tipping face will be adjusted according to the number of vehicles likely to be at the tipping face at any time.

The operations at the tipping face consist of the following primary tasks:

- preparation of the tipping face and the site road;
- relocation of direction signs;
- notification to the site personnel and weighbridge staff as soon as the area is ready to accept waste deposition vehicles;
- directing the vehicles at the tipping face;
- spread waste maintaining required slope;
- compact waste to required density;
- apply daily cover at the end of the day;
- arrange for the following day's tipping location; and
- shut down landfill site and equipment.

4.1 PLACEMENT OF WASTE

Waste will be placed by utilizing the area method, that is, the waste will be filled and compacted over the prepared base, in layers, and daily cover will be applied following the waste segregation and recycling activities carried out by the Site's licenced waste pickers.

Waste hauling trucks will unload at the designated drop-off area within the landfill footprint for waste diversion activities including access for waste pickers. Waste pickers will be given access to a number of restricted areas of the Site and will be given a specified time allocation to have access to the waste. An area close to the tipping face will be designated for waste pickers. The waste placement must be staged such that after the allocated time period for recycling/segregation activities has expired, that all waste pickers will be required to vacate the specific area and the waste will be pushed

into the disposal cell and compacted. Waste pickers will not be granted access to the active tipping face areas due to safety and operational concerns.

The waste pickers will be allowed to move recoverable materials to the assigned staging area for subsequent sorting and cleanup. Any residual wastes from the sorting operation will be placed in a separate designated area to be returned to the filling area on a daily basis. Residual wastes will not be retained in the sorting area for more than 24 hours. Waste pickers that do not adhere to the above procedures may lose their Site access privileges.

For the placement of the initial layer (lift) of waste at the Site, the following procedures and considerations are to be followed:

- a site road shall constructed to the pre-determined access point for waste placement, from the ramp running from the site service road to the landfill base, for the placement of the initial lift of waste above the leachate collection system. The initial site road will be part of the construction works contract. However, the maintenance and extension during the operation period will be an obligation of the Contractor;
- a turnaround area and tipping platform designed to accommodate a minimum of three trucks also has to be built of materials suitable for the season, which will support dumping and turning by the waste ferrying vehicles. The initial construction work will be part of the construction works contract. However, the maintenance and extension during the operation period will be an obligation of the Contractor; and
- the minimum thickness of the initial lift shall 0.6 m layer of selected waste at the base and at least an additional 1.5 m of waste above that.

As indicated in the earlier sections of this document, the selected waste will consist of residential waste or other suitable wastes without sharp metallic objects or material likely to damage the leachate collection system. Typically, general residential wastes do not contain large and/or sharp objects that could damage the leachate collection system.

Drivers shall keep a minimum of 2 m from the edge of the initial lift and use caution whilst working in that area. Aggressive handling of the waste could cause the filter fabric or drainage layer to shift thereby reducing the effectiveness of the leachate collection system.

Waste hauling vehicles shall kept away from the edge of the initial lift to prevent them from getting into the selected waste and damaging the leachate collection layer.

A light or medium sized bulldozer or excavator shall used to push and level the waste for the initial lift. Equipment operators should take extreme care in levelling the waste, as no compaction shall applied other than during spreading. The operator should not attempt to drive over the leading edge of the lift. At no time should the thickness of the waste on which the equipment is operating for the initial lift be less than 1 m above the upper element of the leachate collection system. The landfill compactor must not be used to compact the initial lift.

The initial lift of residential waste will act as filter for the leachate collection system. Accordingly, heavy compaction of this initial lift is to be avoided so as not to reduce the ability of the initial layer to protect the leachate collection system, and also not to reduce the flow of leachate to the collection system.

The Contractor will build an all weather site road over the waste as filling progresses. This road will serve as access to the tipping face and maintained to give rear-wheel drive vehicles access in all weather conditions.

Waste will be compacted in lifts not exceeding 2.0 m thick using multiple passes with the landfill compactor (typically two to five passes), depending on the equipment available and the material being compacted. Daily cover consisting of native soils, wood chips, and suitable imported material designated as ADC will be placed in accessible portions of the working face prior to the end of each operating day. The type, amount, and area that the daily cover has been applied to will be included in the Site operator's daily report.

The estimated average daily volume of waste/daily cover landfilled will be approximately 200 to 250 tonnes per day based on the average annual disposal rate of approximately 67,000 tonnes per year.

Typically daily cover for active areas of the Site shall approximately 100 to 150 mm in thickness to ensure reasonable cover of the waste. The daily cover shall placed by a bulldozer and not by a waste compactor. A waste compactor will render the daily cover materials ineffective for litter and vector control unless it was placed in a much thicker lift of material that is not recommended and which would place greater stress on soil resources.

4.2 WASTE COMPACTION

The Contractor must increase the in-situ density of the solid waste delivered at the site, through compaction, to meet the maximum density of 700 kg/m³ for the designed life span of the site. Compacting the waste is intended to maximize the waste density to best utilise available void space, which in addition, also offers significant other benefits, including:

- minimising the daily cover requirements;
- reducing the chance of differential settlement;
- minimising leachate production;
- enhancing the structural stability of the landfill;
- reducing the potential for fire;
- reducing problems of infestation by vermin, flies, pests and birds; and
- minimising odour problems.

The Contractor shall take into consideration the following points while spreading and compacting the waste:

- attempt to push only the amount of waste that the equipment can move without excessive wheel slippage, as it will damage the previously compacted layer;
- progressively raise the blade of compactor/ bulldozer as it travels up a slope of waste. The operator should maintain an average waste thickness of 0.5 m;
- distribution and co-disposal of different types of waste on the tipping face is considered as a means to improve compaction;
- waste placement, spreading and compaction is best achieved by pushing waste up slope not be steeper than 1:5 (H:V);
- after the equipment operator has pushed and spread a layer of waste over the entire slope area the waste will be compacted a minimum of three passes to achieve the minimum waste deposited density of 700 kg/m³;
- when dealing with low-density waste that rebounds after compaction such as brush, leaves, tree trimmings, agricultural wastes, and low-density plastics, special measures are to be taken to ensure that they are compacted sufficiently;
- maintain a smooth tipping face slope and horizontal surface to ensure need of only minimal daily cover soil and to promote surface water drainage;

- whenever possible, wet waste and dry waste from different vehicles are to be mixed; and
- during periods of above normal precipitation, the Contractor should reduce the tipping area and increase the slope [no steeper than 1:5 (H:V)] to reduce the infiltration of water and thereby, reduce the generation of leachate.

4.3 COVER OPERATIONS

Use of clay materials for daily cover on the tipping face and on the working lift platforms is not the ideal material because it can tend to produce localized perched areas in the landfill which promote lateral flows to the sideslopes of the landfill, resulting in potential leachate seeps. To promote good hydraulic connection throughout the waste in the landfill, the use of alternative daily cover (ADC) materials shall encouraged, when these materials can be made available. ADC materials can include the following:

- construction and demolition debris;
- woodchips and other vegetative matter;
- solid, non-hazardous wastes such as contaminated soils or other industrial or commercial wastes suitable as daily cover; and
- other cost-effective ADC technologies such as tarp systems and binder sprays.

The use of alternative daily and interim cover would have some inherent benefits for the landfill performance and would reduce any potential future costs of importing materials. ADC material selected for use at the Site will depend upon availability of local materials. The waste-to-daily cover ratio is expected to be in the range of 6:1. Thus, the volume of daily cover material required to complete the Site is approximately 335,000 m³.

Interim cover is a term used to apply to an area that is not yet completed but is expected to be inactive for waste filling for 6 months or more. In these areas, which are typically the working platforms above the major lift lines, a thicker layer of interim cover is placed on the waste in the range of 300 mm in thickness. Note that interim cover materials shall be removed prior to placing the next lift of waste to try to ensure a good hydraulic connection through the waste, and minimize the potential for leachate seepage. After surplus cover is removed, the waste compactor should traverse the area before the next lift of waste is placed to co-mingle the remaining cover and waste to mitigate against localized perched leachate conditions within the Site.

4.4 UNACCEPTABLE WASTE

Site personnel actively involved with day-to-day landfill operations will be trained to identify waste loads that may be unacceptable for landfilling at the Site. If a load is refused due to an unacceptable waste profile, efforts will be made to obtain the following information:

- the source of the load;
- name of driver;
- licence number of vehicle; and
- company name on truck.

This information, including date and reason for refusal, will be maintained on Site for record-keeping purposes.

There will be a list of prohibited materials posted on signs at the Site entrance. The nature of the weigh scale operation will permit tracking of licence numbers of offending vehicles and companies to permit follow-up response measures to be taken in the event that the non-compliance by some parties becomes a chronic issue. It is also expected that over time, the list of restricted materials may be modified by the waste management authorities. These types of changes will require public consultation and notification as well as a phase in period to ensure that all users of the Site become aware of any changes to policy and the Site-specific requirements.

5.0 SYSTEM OPERATIONS

5.1 LEACHATE TREATMENT SYSTEM

Landfill leachate is the inorganic and organic containing liquid mixture produced when water percolates through and contacts solid waste. Leachate generated from the active waste fill areas and the stormwater that accumulates in the active disposal cells during the preparation of each stage base will be collected in the LCS at the base of the landfill. This liquid will be collected at each of four leachate pumping stations corresponding to the low points of each stage, and conveyed via a common forcemain to the leachate treatment system. Collected liquid is routed either through the leachate treatment system or directly to the stormwater sedimentation and control pond depending upon whether the stage is actively accepting any waste and if the liquid has contacted any of this waste. Any liquid that has contacted waste will be routed through leachate treatment system.

The full leachate management system is comprised of the following elements:

- leachate collection system;
- aerobic equalization;
- secondary biological treatment;
- clarification;
- sludge storage; and
- stormwater sedimentation and control pond.

Secondary biological treatment, clarification, and sludge storage are processes conducted at the leachate treatment facility. Each of the following subsections provides information regarding the safe operation of the leachate management system.

5.1.1 LEACHATE TREATMENT SYSTEM OVERVIEW

The purpose of this section is to provide a general overview of the pathway and treatment systems that the collected leachate would endure prior to final discharge. A process schematic for the leachate treatment system is provided on Figure 5.1.

All waters to be treated would be collected in the aerobic equalization lagoon, by pumping stations located at the low point of each landfill. The location of these pump stations are indicated on Drawing C-11, provided in Appendix A. These stations are

operated in an automatic mode with level indicators so as to minimize the amount of time the operator is required to be off-Site. The pumps will switch ON/OFF by themselves.

The first treatment step in the system is the aerobic lagoon. Both high strength and dilute influent streams can be mixed and temporarily stored in the aerobic equalization lagoon. The lagoon also acts as a flow stabilization step within the process. The lagoon also acts as additional storage capacity for the leachate treatment facility under heavy rainfall conditions to ensure that the design capacity of the facility is not exceeded. Under normal operating conditions, the collected high strength leachate may be discharged directly to the leachate treatment facility (i.e., bypassing of the aerobic lagoon). The lagoon is equipped with aeration equipment to control and mitigate any odour issues. It has a capacity of 20,000 m³, and with a working water depth of 2.43 m. From the aerobic lagoon, the water is pumped directly into the splitter box of the secondary biological treatment step.

The secondary biological treatment step is comprised of an anoxic/oxic biological treatment system. It is designed to biologically remove contaminants, both nitrogenous and carbonaceous in nature, down to meet the designed effluent discharge criteria. Two equal sized anoxic/oxic trains will be utilized at the leachate treatment facility in order to accommodate the varying treatment flows experienced through the year.

The raw water would enter the anoxic tank first, where it would undergo biological denitrification. It is in this tank that the nitrogen, in the form of nitrates, is reduced to molecular nitrogen and emitted to the atmosphere. Furthermore, the anoxic system allows for rapid removal of the carbonaceous material during the denitrification process. To assist in this biological process, the raw water influent provides a source of organic carbon, and as needed, may be supplemented at the site by the addition of sugar cane or molasses. Phosphorus would need to be added as a nutrient required to sustain the biological process and would be done at the site. The anoxic tank is well mixed by an mechanical stirrer but is not aerated.

From the anoxic tank, the water overflows into the oxic tank. The oxic tank is well mixed and aerated to provide oxygen to the bacteria present in the system. It is in this tank that the nitrogen, in the form of ammonia, is oxidized to nitrates. With having the majority of the carbonaceous materials removed during anoxic treatment, this allows for the optimum nitrification conditions to occur during oxic treatment. The water from the oxic tank is recirculated back to the anoxic tank at a very high flow (e.g., four times influent flow rate) to ensure adequate time for denitrification to occur. The water is also overflowed to a clarifier.

As needed, excess phosphorus is to be removed from this system by the use of supplemental chemical feed. Alum or ferric chloride would be dosed to the system to assist in solids separation during clarification as well as a means of chemically reacting with the excess phosphorus to ensure compliance with the discharge effluent criteria.

The clarifier acts as a solids removal step. It is here that settling of the solids in the oxic tank effluent occurs, to minimize the amount of suspended solids being discharged in the final effluent. The thickened solids from the clarifier would be collected and either returned to the splitter box of the anoxic tank. Overflow from the clarifier would be directed to the stormwater sedimentation and control pond for final polishing prior to discharge to the drain canal.

Sludges collected from the leachate treatment facility would be disposed of in the active landfill area. The sludges would undergo aerobic sludge digestion prior to landfill disposal. These would be transported by a pump truck to the landfill.

5.1.2 START UP OF THE LEACHATE TREATMENT SYSTEM

The purpose of this section is to provide guidance and direction for the safe operation of the leachate treatment system. This section deals with the treatment of the influent wastewater, which is presumed to be mainly due to stormwater from the open stages. This section of the operations and maintenance manual is intended for the first 12-18 months of the leachate treatment facility operation.

The leachate/stormwater pumping stations may need to be activated to direct water from the LCS to the aerobic equalization tank. The pumps are to be manually activated to transfer the accumulated water to the aerobic equalization lagoon. This operation is only to be used provided that there was a visual confirmation that there is water accumulating in the pump station. This operation would continue as a manual function until there is a sufficient enough influent flow to allow the system to be operated in an automatic mode.

Leachate collection system pump station operation:

1. Visually confirm that there is water accumulating in the pump station.
2. Turn on the pump by depressing the ON switch for the pump.

3. Continue pumping water until there is no more water movement out of the pump.
4. Depress the OFF button for the pump.

Water is allowed to accumulate in the equalization lagoon. When the liquid level in the equalization lagoon is at a 2 m height (approximately 3/4 full), then daily sampling of the lagoon water is to commence. The daily sampling would consist of chemical oxygen demand (COD) and ammonia (NH₃-N) using grab samples and the HACH analysis instrument. All analyses are to be performed in accordance with the HACH manufacturer instructions. In the event that there is a noticeable odour emanating from the aerobic equalization lagoon, then this is an indication that there is sufficient strength water to support anaerobic biodegradation of the contaminants, and as such the lagoon's aeration system is to be activated. This will halt the generation of the anaerobic bacteria and reduce the odours emanating from the lagoon. The following instructions are provided below to guide the operation of the equalization lagoon aeration system.

Operation of the Aerobic Equalization Lagoon:

1. Sample the equalization lagoon water.
2. If an odour is noticeable, activate the equalization lagoon aeration system. Analyze water samples for COD and NH₃-N using the HACH instrument and following the supplier's instructions.
3. If no odour is present, analyze the water using the HACH instrument and instructions for COD and NH₃-N.
4. If the measured lagoon water is COD >100 mg/L and/or the NH₃-N >5 mg/L, then the equalization lagoon aeration system is to be activated. If there is an ongoing influent flow to the equalization lagoon at this time, then the lagoon water is to be pumped forward to the secondary biological treatment system.
5. If the measured lagoon water has a COD <100 mg/L and NH₃-N <5 mg/L, then the lagoon water may be pumped forward to the primary stormwater sedimentation and control pond via the bypass sewer.
6. If the level in the lagoon exceeds 2 metres of liquid depth (i.e., greater than 3/4 full), then the aerobic lagoon transfer pumps are to be activated to maintain the liquid level between 1.5 and 2 metres liquid depth. If the sample analysis indicated a clean water in the lagoon (i.e., COD <100 mg/L and NH₃-N <5 mg/L), then the aerobic lagoon water may be transferred forward to the primary stormwater sedimentation and control pond via the bypass sewer. If the sample analysis indicated that the aerobic lagoon water was impaired (i.e.,

COD>100 mg/L or NH₃-N>5 mg/L), then the lagoon water is to be treated in the leachate treatment facility.

Operation of the Aerobic Lagoon Blowers:

In the event that there is an odour emanating from the aerobic lagoon and/or there is a sufficient amount of COD or ammonia in the lagoon water (i.e., COD>100 mg/L NH₃-N>5 mg/L), the aeration system is to be activated, according to the following procedure:

1. Ensure the air intake to the blower to be activated is clear of debris. As needed, clear the air intake prior to starting up the blower.
2. Follow the manufacturer's operations manual for safe start up of the Blowers.

If the daily sampling results from the aerobic lagoon indicate that there is very little contamination present, then the aeration system can be halted. This is determined by the HACH sample analysis with COD<100 mg/L and NH₃-N<5 mg/L, and that there is no noticeable odour emanating from the lagoon after the aeration equipment has been halted.

Operation of the Leachate Treatment Facility

In the event that the lagoon water tested results in COD>200 mg/L and/or NH₃-N>10 mg/L, it will be necessary to treat this water in the biological treatment facility. At this time, water from the aerobic equalization lagoon would not be discharging directly to the stormwater sedimentation and control pond. It is strongly recommended that the start up of the biological treatment facility occur under the guidance of an experienced professional familiar with such undertakings.

1. Drain the anoxic tank to allow for room to inoculate the anoxic/oxic tanks with active biological sludges. This is to be done by having approximately three truckloads of returned activated sludges from neighbouring municipal wastewater treatment works discharged directly into the anoxic tank. Ensure that there is no overflow from the clarifier by topping up the system with the aerobic lagoon water until the clarifier is 0.5 m from the weir. It is recommended that the sludges being obtained have been demonstrated to be strongly nitrifying. Confirm this with the municipal plant supplying the activated sludges.

2. Activate the blower system by starting up Blowers #2 and #3, by following the instructions in the manufacturer's operations manual. Adjust the blowers speed to maintain the dissolved oxygen in the oxic tank to between 1.5 and 2.0 mg/L.
3. Start up the anoxic mixer. Follow the manufacturer's instructions for the operation and start up of the mixer.
4. Measure the influent water for soluble phosphorus. Take a grab sample from the aerobic lagoon and measure its phosphorus content using the HACH and following the supplier's instructions. If the measured soluble phosphorus is <0.5 mg/L, then supplemental phosphorus will be to be added by the phosphate tank. Follow the manufacturer's operations manual for operating the phosphate pump.
5. Start up the supplemental carbon nutrient system. Additional organic carbon will be necessary to quickly acclimatize the sludges to the leachates. Follow the manufacturer's instructions for the safe operation of this equipment. Add supplemental carbon to the anoxic tank so as to maintain a COD:N:P ratio of 100:5:1.
6. Activate the sludge return pumps and the internal recirculation pumps. Do not waste any sludges during this time. Measure the clarifier effluent for COD, NH₃-N, and soluble phosphorus. As needed, adjust the chemical dosing pump to assist in removing any excessive phosphorus.
7. Allow the system to stabilize for 24 hours. Monitor for COD, NH₃-N, and soluble phosphorus in both the anoxic and oxic tanks. If all the monitored parameters are in line and it is apparent that the biology has taken hold in the system, then leachates can slowly be introduced. Depending upon the influent leachate COD, the supplemental carbon dosing will need to be adjusted accordingly to maintain the COD:N:P ratio of 100:5:1.
8. Slowly pump the aerobic lagoon water directly into the anoxic tank. The influent pumping rate for the aerobic lagoon should be adjust so as to maintain a 2 metre liquid level in the aerobic lagoon.

As needed, daily monitoring of the system is to take place. As needed, adjust the supplemental carbon dosing rate to the point that more leachates can be treated by the system.

5.1.3 OPERATION OF THE LEACHATE TREATMENT FACILITY

This section is provided to give directions for the safe operation of the leachate treatment system. It is intended that the leachate treatment facility would now be needed to treat the high strength leachates from the landfill sites. It is assumed that the anoxic and oxic treatment systems have been commissioned and inoculated with viable bacteria to allow for proper treatment of the high strength sludges.

Sample in incoming raw water to the leachate treatment facility. If the leachate strength is low, as determined by the sample analysis results from the HACH instrument of $\text{COD} < 100 \text{ mg/L}$ and $\text{NH}_3\text{-N} < 5 \text{ mg/L}$, then this water may bypass the aerobic equalization lagoon and pumped directly to the stormwater sedimentation and control pond.

If the sample analysis results in having a $\text{COD} > 100 \text{ mg/L}$ or $\text{NH}_3\text{-N} > 5 \text{ mg/L}$, then the raw water is to be sent to the leachate treatment facility.

Maintain the lagoon at a 2 m depth and have all additional influent water being pumped to the leachate treatment facility. If there is a noticeable odour emanating from the aerobic equalization lagoon during this time, the aeration system is to be activated. Please refer to Section 5.1.2 for the operation of the aeration system for the aerobic lagoon.

Sample the water entering the biological treatment facility and analysis using the HACH instrument and following the supplier's instructions for soluble phosphorus. If the soluble phosphorus in this sample is less than 0.5 mg/L , then additional phosphorus is required to maintain optimum biological treatment of the leachates. Start up the phosphorus addition system and adjust the feed rate of the pump to achieve the desired soluble phosphorus concentration in the influent wastewater. This is to be done in accordance with the supplied phosphorus guidance sheet.

In the event that the soluble phosphorus is greater than 8 mg/L , then additional chemicals are required to maintain the effluent within the discharge criteria. Start the alum/ferric chloride addition system and adjust the feed rate to remove the excess soluble phosphorus.

As the system starts to generate additional solids, commence slowly sludge wasting to maintain the mixed liquor suspended solids in the oxic tank in the range of $2,000 \text{ mg/L}$.

5.1.4 OPERATOR ROUTINE CHECKS

As part of the operators regular duties, the operator will be responsible for performing daily, weekly, and monthly checks on the equipment and operations of the leachate treatment facility. These checks are to be recorded on log sheets to allow for the tracking of the performance of the leachate treatment facility, ensuring adherence to the supplier's recommended maintenance schedules, and to assist with any troubleshooting of operational difficulties which may arise during the course of the facility's operation. As needed, the operator will complete the log sheet and submit it to his immediate supervisor for tracking and record keeping.

A sample log sheet to be completed daily by the operator has been provided in Appendix B.

Some of the routine monitoring tasks that are to be performed by the operator are listed below.

5.1.4.1 DAILY MONITORING

Blowers:

- All blowers intakes are free and clear of any obstructions. Remove all obstructions to ensure proper operation of the blower equipment.
- No noticeable oil leaks in the vicinity of blower equipment. Clean up any noticeable oil leaks and determine the source of the leak. As needed, tag and lock out the affected equipment and enact maintenance procedures to bring equipment back online.

Aerobic Lagoon system:

- Discharge pump intakes are free and clear of any obstructions. Remove all obstructions to ensure proper operation of the lagoon pumps equipment.

Biological Treatment Facility:

- Clarifier overflow weir is free and clear of debris, remove all obstructions to ensure proper operation of the clarifier.

- Remove and visually inspect all instrumentation probes such as DO, pH, and ORP. Clean probes to ensure good contacting surface.
- Grab samples from the aerobic lagoon, anoxic, oxic, and clarifier effluents for chemical analysis.
- Record the amount of sludge wasting.
- Adjust supplemental chemical, phosphorus, and carbon dosing feed rates as needed.

5.1.4.2 WEEKLY MONITORING

Biological Treatment Facility:

- Calibrate pH meters in accordance with the supplier's instructions.
- Perform sludge settleability tests upon anoxic and oxic sludges, record results.
- Perform oxygen uptake tests upon oxic sludge, record results.
- Record all chemical storage tank levels as needed, place a request for restocking of chemical if needed.
- Dispose of sludges to the landfill after undergoing aerobic digestion. Record the amount of sludges transferred to the landfill.

5.1.4.3 MONTHLY MONITORING

- Perform oil changes on all motorized equipment on a monthly basis. As needed, record oil levels and top up if necessary. Record and report any excessive oil consumption to immediate supervisor.
- Measure the depth of solids in the aerobic lagoon. Record the result.
- Calibrate the DO and ORP meters in accordance with the supplier's instructions

5.2 LANDFILL GAS COLLECTION SYSTEM

An active LFG control system has been developed and shall implemented upon reaching specified triggering levels or conditions that would initiate the installation and operation of the LFG collection and flaring system.

The LFG management system will be composed of a number of elements. The four key elements are as follows:

- LFG collection field consisting of horizontal trenches;
- main header pipe network and laterals to convey the collected LFG to the LFG management facility;
- condensate management system; and
- LFG management facility consisting of centrifugal blower and flare.

The first phase of the LFG management system construction would be limited to the installation of the main header during infrastructure development in the first year of the Contract. The LFG horizontal trenches shall be installed in the second last lift of waste prior to progressive capping of the Site.

The LFG management facility would be constructed to coincide with the completion of the first phase of the progressive closure, permitting the installed LFG collection trenches to be commissioned as they are installed and LFG collection operations to commence. It is assumed, for the purpose of this report, that the first phase of progressive closure would be completed approximately 10 years after commencement of site development activities.

The pipe network is envisioned to include two components to be installed in the initial construction phase of the proposed Site:

- main header; and
- lateral header "T" connections.

The main header will be constructed of 300 mm (12-inch) diameter SDR 26 HDPE pipe. The 150 mm HDPE "T" couplers will be fused at 40 m intervals along the main header, extended to the surface at a minimum slope of 2 percent and blind flanged at surface to facilitate the connection of the LFG extraction trenches during progressive closure of the Site.

The main header shall sloped towards two low points along the header alignment at a minimum slope of 1 percent. These two low points should coincide with the locations of the leachate pump stations.

The primary components of the LFG management facility include the following:

- condensate knock-out pot (KOP);
- piping and valves;
- LFG instrumentation (quantity and quality);
- LFG extraction blower; and
- Enclosed flare.

Due to the temperate climate of the region, a simple roofed enclosure structure will be required to shelter the control plant instrumentation and blower systems and to provide security for the equipment and control panels.

The blower should have a design capacity of 2,000 m³/hour and be equipped with an explosion-proof electric motor and spark-proof fan assembly.

The installation of the flare is recommended for the purpose of combusting the LFG in a cost-effective manner.

NOTE:

At the time of this writing, complete details for the operation and maintenance of the LFG collection and flaring are not available since the system has not been designed and commissioned. As previously discussed, it is anticipated that the LFG collection and flaring system will be required after approximately 10 years of operating Site life. When the LFG collection and flaring system has been constructed and commissioned a final operation and maintenance guideline will be prepared and submitted for review and evaluation by the Owner.

5.3 SURFACE WATER MANAGEMENT

Surface water control in the proposed landfill Site will be achieved through the construction of temporary berms around the base excavations and the upper limits of the active disposal area. All surface water contacting exposed waste will be collected by the LCS and will be treated as leachate.

Once the waste contours have reached the proposed top of waste/daily cover elevation, interim cover of at least 300 mm in depth will be placed and maintained. Final cover for the completed areas will be placed within 12 months of an area reaching final grade and being deemed ready for closure. The surface water from these areas will be allowed to

drain directly to the stormwater sedimentation and control pond (via the drainage ditches), as exposed waste will not be present.

When any section of final cover or ditch is at its proposed final grade, the area shall revegetated in accordance with the planting specifications provided. Until such time as the vegetation is fully established in that area and upstream drainage areas, silt control fences or other similar measures shall be put in place to minimize silt losses into the stormwater management ditches and ponds. Periodically on an as needed basis, the silt is to be removed and placed into the landfill.

The Contractor will be required to operate, clean and maintain the stormwater ditch and pond systems. The actual operation of the stormwater pumping stations could be either a municipal employee or the independent operations contractor. Isolation of inactive areas may be accomplished by the use of temporary berms and intermittent pumping during large storm events.

Once the waste contours have reached the proposed top of waste/daily cover elevation, interim cover of at least 300 mm in depth will be placed and maintained. Final cover for the completed areas will be placed within 12 months of an area reaching final grade and being deemed ready for closure. The surface water from these areas will drain directly to the stormwater sedimentation and control pond (via the drainage ditches), as exposed waste will not be present.

When any section of final cover or ditch is at its proposed final grade, the area will be revegetated in accordance with the planting specifications provided. Until such time as the vegetation is fully established in that area and upstream drainage areas, silt control fences or other similar measures shall be put in place to minimize silt losses into the stormwater management ditches and ponds. Periodically on an as needed basis, the silt is to be removed and placed into the landfill.

6.0 SITE MAINTENANCE

Maintenance activities are necessary to ensure that all of the required infrastructure and systems are able to satisfy the compliance and performance requirements for the Site. The level of maintenance required will be defined in the operating manuals and other documentation that will support the various systems that will be constructed and commissioned at the Site. These systems will be required to be operated according to specifications of the manufacturer and such additional specifications as are provided for the operations of the overall systems. The following provides an overview of some of the key elements and considerations that will be included in the detailed documentation that will accompany the completed works.

6.1 LEACHATE COLLECTION SYSTEM

The LCS requires cleaning to remove:

- sludge caused by biological growth;
- sludge caused by chemical activity of the leachate; and
- particulate migrating into the collection system from the drainage layer and cover soil.

The leachate collection pipes shall be cleaned and maintained by the Contractor through the side slopes riser cleanout pipes, which are accessible at the top of the toe bund and from the north end of the Site.

The collection pipes can be cleaned by inserting a self-propelled nozzle with pressurized water attached to the end of a hose into the riser cleanout pipes. The pipes shall be cleaned once per year, or more often if it is suspected that there is some impediment in the LCS. Such a suspicion can be raised by an unusual reduction in leachate entering the treatment ponds that cannot be correlated to weather conditions.

A leachate pump can be affected by:

- sludge build up around the pump intake;
- corrosion causing pump impeller failure, as the leachate can be acidic;
- particulate build up, which is especially true in new systems;

- electrical failure of the motor, as the seals may fail and cause motor failure; and
- collapse of the Leachate intake line.

6.2 LEACHATE TREATMENT SYSTEM

The Contractor shall inspect all the leachate treatment ponds and tanks on a daily basis for the presence of large items of debris, for the functioning of aerators, and the general condition of the system. Large, or potentially damaging items of debris are to be removed as soon as possible to avoid damaging aerators, liner material, or blocking the flow of leachate through pipes. If debris could potentially damage aerators, then the aerators of concern shall be switched off as quickly as possible and not restarted until the debris problem is rectified.

The Contractor shall check the accumulation of sludge in the leachate treatment ponds and tanks by taking sludge depth measurements in at least four locations in each of the pond, two times per year.

When the sludge volume reaches 25 percent of the operating volume of a pond, the Contractor should empty the pond and remove the sludge. The sludge shall be manually removed using a pump and a hose and disposed of in the Site.

The functionality of all the aerators shall be inspected on a regular basis following the manufacturer's guidelines. A minimum of one year's recommended spare parts for the aerators shall be stored on-site at all times.

To maintain or repair an aerator, the Contractor shall disconnect its moorings and use a pontoon boat to float the aerators to the lagoon edge, and then make use of a mobile crane type hoist (i.e., back hoe) to remove and replace the aerators in the pond. Care shall be taken so that the aerators are not damaged during this process. Also, when removing the aerators from the ponds, careful attention must be taken to protecting the HDPE liner.

6.3 GENERAL MECHANICAL AND ELECTRICAL

Where possible, the same model for pumps and other mechanical equipment required for the Site operations have been selected for multiple purposes in order to simplify operations and maintenance requirements. Each piece of mechanical or rotating equipment should have a specific service cycle depending upon the mode and nature of

the service and on the manufacturers requirements. This will include but not be limited to the following where applicable:

- lubrication cycles;
- corrosion assessment and replacement of components;
- develop and maintain spare parts inventory of key items;
- periodic equipment performance assessment against design and manufacturers specifications; and
- establish equipment rebuild/replacement cycle for all equipment items.

Only competently trained personnel should work on electrical equipment even after equipment has been isolated from the power supply. A lockout/tagout procedure must be developed and enforced for all works of this type. Most electrical failure in motors and other components are caused by dirt, moisture, corrosion, lack of use, friction, or vibration. A routine maintenance program shall implemented to maintain electrical motors and other equipment in a clean, dry condition. Any chatter in the contacts or buzzing in electrical motor starters or fusible/unfused disconnects shall observed and noted for further investigation and possible repair.

A regular electrical maintenance program shall implemented for equipment based on the duty cycle that includes the following:

- clean the exterior of electrical and control enclosures regularly to prevent dirt, oil, and dust from entering when cabinets are opened by qualified personnel;
- check motors for overheating, uneven temperatures around the stator area, bearing noise, dirt around open drip-proof and fan-cooled motors, loss of phase, and amperage on each phase. Note any unusual conditions or indicating lights to be replaced;
- check motor starters for grounds, loose connections, pitted or corroded contacts, cleanliness of the starter cabinet, thermal overload relays, overload heaters, fuses and fuse clips, etc.;
- check electrical cords or receptacles for signs of overheating or mechanical damage, check for unduly noisy ballasts or for lights which require bulb replacement. Check ground fault receptacles and/or breakers prior to use and regularly check operation of the emergency lighting system;
- manually operate or change selection of the lead pumping or other unit to ensure that all equipment is run at reasonable intervals;

- where alarm test circuits are provided make frequent checks that alarms are operating properly. Run fans manually if necessary at regular intervals to check operation, check damper motors and warm motors and windings to dry out any condensation; and
- inspect motor windings for insulation cracks and for dust and dirt in cooling passages. Megger windings yearly and check with readings when new. Megger critical electrical supply circuits. After any maintenance work check motor rotation before restoring to service.

6.4 ROADS

All Site roads shall cleaned regularly in periodic intervals, and this frequency shall increased depending upon the weather conditions. The distance from the wheel wash facility to the public roads should preclude any mud or dust being tracked off the Site and to the public highway network. However, if mud or dust is tracked from the Site to the public roads, the Contractor shall clean that portion of the road within 4 hours of the incident, unless other arrangements have been agreed upon with local authorities.

Temporary on-Site roads and other non-paved Site roads should also be maintained on a regular basis, as this aids in promoting better drainage, improving traction, reducing wear on vehicle tyres and suspension, and increasing safety of the roads.

All Site roads shall maintained at all times and repaired, as necessary.

<i>Roads and Pavement</i>	All unpaved and paved areas shall inspected on a fortnightly basis for cracks, potholes or other damages, and shall repaired or resealed, as required.
<i>Ditches</i>	All road ditches, storm water ditches and outfalls shall inspected weekly for obstacles, which shall removed immediately. Erosion repair shall arranged, if necessary.
<i>Signs</i>	All directional signs shall inspected daily and repaired or replaced as required.

6.5 MOBILE EQUIPMENT

A comprehensive inspection and maintenance programme is essential to prolong the operating life of the mobile equipment. An inspection and maintenance log shall maintained for all major pieces of mobile equipment and stored on-site. The logs are to

be accurately and sufficiently completed upon the completion of all inspections and maintenance activities.

All mobile equipment shall regularly and frequently inspected for wear and damage. Maintenance personnel should check the Site during the preventative maintenance process. During this inspection, damage to the unit should have to be assessed and documented.

While the on-Site maintenance staff at the maintenance facility will handle the regular maintenance, major overhauls and specialised work may be off-site by sending the units to qualified companies, approved and accepted by the Contractor and the Owner.

The Mobile equipment operators, who shall trained to inspect the equipment for fluid levels and general condition of the equipment at the start of their shift, will provide the second level of inspection. Any damage, malfunction, or deviation from proper standards shall reported to maintenance personnel and recorded immediately.

Reference shall made to the manufacturers' manuals for the recommended maintenance procedures. As a guide, the following sequence of inspection and actions shall followed daily:

- visual check of the plant or equipment;
- check for fluid leak and levels;
- check for loose parts;
- check tires (if appropriate) and pressures;
- check any safety equipment separately;
- fill out Daily Log in the Log Book;
- refuel at end of the day's work;
- visual inspection after refuelling;
- clean the equipment;
- park safely and securely; and
- fill out the daily log and hand over to the Supervisor for inspection.

Equipment suppliers shall carry out annual service and check of equipment. Performance indicators and penalties related to maintenance are specified in the Contract.

6.7 WHEEL WASH

All vehicles exiting the site will not use the wheel-wash. Typically, only larger waste transport trucks and vehicles that have noticeably dirty wheels or undercarriages will proceed through the wheel wash, as directed by the weighbridge operator or other personnel of the Contractor.

The maintenance procedures for the wheel-wash includes:

- monitor the water level in the holding tanks on a daily basis and change the water if the turbidity is high;
- inspection of the solids sump four times per year for the accumulation of solids. If the solids sump is likely to be full before the next scheduled inspection, then the solids shall removed from the sump and landfilled;
- loading of grease nipples on the pump motor four times per year in heavy conditions, or three times per year in moderate conditions;
- inspection of spray jets for clogging four times per year; and
- once a week, the face lenses on the opti-eye shall cleaned with a wet towel.

6.8 WEIGH BRIDGE

The daily maintenance activity for the weighbridge will be to broom and sweep the dirt from the scale deck each morning, and once a week, wash the scale deck of dirt (after sweeping).

Specialist maintenance tasks should include:

- Calibration of the scale every 6 months;
- Checking the bumper bolts every 6 months, and adjusting it as necessary; and
- Checking the junction box desiccant bags every 6 months or after wet periods, and replacing them as required.

6.9 LITTER

Preventative litter control measures are steps taken to minimize the blowing of litter from the active area of a landfill. The following measures shall be employed at the Site to be used during site operations to achieve this goal:

- daily cover will be applied to waste that will be exposed after it has been removed from the waste picker area and placed into the tipping face, thereby confining light weight material;
- waste picker/recycling areas will need to have perimeter fencing and wind breaks established to mitigate against blowing litter;
- all vehicular traffic transporting waste to and around the Site will be tarped, if required, to prevent litter from blowing out of the vehicle;
- the working face location will be selected based on the direction and intensity of the wind to provide maximum shelter for the active area. The aerial extent of the working face will be kept to a minimum on windy days;
- temporary, moveable, litter control fencing, approximately 3 m in height, will be utilized at the active disposal area;
- disposal operations will be reduced or stopped and relocated to alternate disposal areas if prevailing weather conditions cause off-Site litter impacts; and
- a litter control program that includes Site perimeter maintenance and off-Site litter control will be implemented, for monitoring and cleanup of litter along the primary access route.

All of the above activities are expected to be the responsibility of an independent contractor hired by the municipality pursuant to the operations contract.

6.10 ODOUR

Landfills typically have three types of odour emissions to consider and address:

- leachate;
- fresh or raw waste odour; and
- LFG odour.

Leachate related odours are generally associated with open exposure to raw leachate in the landfill cells or in the LCS. This can be effectively controlled by ensuring that exposed standing leachate in the base of the cells is not permitted for any extended

periods and that the pump station manholes are properly constructed and vented. The leachate treatment system will address any odour concerns with the treated leachate.

Waste odour is generated by recently disposed waste and can be controlled by effective management of the tipping face, i.e., keeping the size and open area controlled, and the application of daily cover. There are masking agents and odour control agents that can be used on an as-needed basis, however, it is generally recognized and understood that proper tipping face management is the appropriate means for effective control. Care must be taken to not leave residual wastes in the waste picker area for any extended periods. This can lead to odour problems and to problems with rodents and other vectors.

LFG odour is generated during the anaerobic decomposition of organic waste material. There is a distinctly different odour associated with the LFG from that of either of the other two potential sources. In fact, the primary constituents of LFG have no odour or odour potential. It is the various trace gases and other residual compounds and decomposition products in the LFG that may have odour potential. The primary trigger for active LFG controls is not health and safety concerns but rather quality of life odour related impacts. An active LFG control system can also provide supplementary benefits for odour control if it is properly interconnected with the LCS for the Site. The trigger for installation of the active LFG control system is based upon nuisance odour to the users of the Site.

All of the above cover placement and related activities are expected to be the responsibility of a independent contractor hired by the municipality pursuant to the operations contract. Responsibility for the installation and operations of any future LFG control facilities by either municipal employees or an independent contractor will be determined in future when the system is required.

6.11 DUST

Dust generation is a common problem at many landfill sites due to the handling of soils and the movement of vehicles along sand or dirt roads. The specific natural conditions and the extensive buffer zone for the proposed Site are such that this is not considered to be a frequent concern for this Site. The active area of the landfill will be buffered by approximately 121 hectares (300 acres) of cane fields owned by the Guyana L & SC. There are several drainage and irrigation canals immediately adjacent to the north and south limits of the Site. There are three large stormwater sedimentation and control ponds to be installed as part of the infrastructure for the Site. Under these operation

conditions, dust generation will be localized and removed from potential receptors and, based on prevailing weather conditions at the Site location, expected to be very infrequent.

In order to minimize dust impacts that may occur, the following measures are suggested:

- during dry periods, the speed limit of vehicles operating on Site shall limited to 15 km/hour for on-Site waste and daily cover trucks;
- during dry periods, secondary access roads used by waste trucks shall applied with dust suppressants on an as needed basis (e.g., watered or covered with wood chips, etc.); and
- on extremely dry and windy days, the soil unloaded for daily cover or berm construction and subsequently worked by compactors or bulldozers shall watered to provide significant reduction in dust emissions.

Further reductions in dust emissions could be accomplished by:

- wetting of working and stockpiling areas when required;
- cleaning of paved roads in the vicinity of the Site; and
- accelerating the establishment of the vegetative cover in completed or inactive areas of the Site.

In addition, daily and interim cover soils for the active disposal area will be excavated during the preparation of adjacent landfill stages and transported directly to the location where it is required to minimize double handling of soils and the quantities of materials that may need to be stockpiled. It is anticipated that the active stockpiles of cover materials that will be required for the proposed Site operations will be oriented and operated from the lee side of the stockpiles. The exposed inactive faces of all stockpiles will be provided with interim vegetation to minimize wind erosion concerns to the extent practical.

All of the above activities are expected to be the responsibility of an independent contractor hired by the municipality pursuant to the operations contract.

6.12 VECTOR AND VERMIN

The terms vector and vermin refer to objectionable insects, rodents, and birds that sometimes establish habitat at a landfill. Common landfill vector and vermin are flies, rodents, and birds. The following discusses appropriate landfill operations and management measures to effectively control vector and vermin at the Site.

Flies are a common occurrence at any type of waste disposal operation, and have historically been a particular problem experienced at the Mandela Avenue dumpsite. The flies breed and the maggots develop in the waste material, especially food wastes. Normal landfill operation procedures such as covering the waste material on a daily basis reduces the number of flies at a landfill because the layer of cover material and the steadily advancing active face prevents mature flies from being able to leave the waste material. Thus, the fly population at a well maintained landfill site is usually minor.

Should an outbreak of flies occur at the Site, an insect exterminator could be used as an interim measure to control the flies at the source but this is essentially a short-term response to a symptom. The true issue would be inadequate use and application of cover materials. The only true solution is to address this operational problem and rectify it. The primary areas of concern would be the cover placement activities and the handling of residual waste materials at the waste picker area. The amount of time allotted for the waste pickers to carry out recycling activities must be controlled and enforced. In addition, the hygiene and cleanup of the waste picker area must be enforced.

The above measures should prevent the problems experienced at the Mandela Avenue dumpsite, which essentially has large areas remaining open and uncovered or only partially covered.

Similar to the comments and control measures noted for insects, the normal operation procedures for a well maintained landfill usually effectively control and restrict the rodent population around the Site. The ambient wet conditions and the presence of the adjacent irrigation and drain canals will make it important that this Site maintain clean conditions and not allow uncovered wastes for any extended periods or rodent populations could develop. Occasional rodents and other vermin occur at any landfill site, but in most cases the active waste face is moving on a regular basis and these animals do not find the landfill operation conducive to stable habitation. Should an outbreak of rodents or other vermin occur at the Site, it may be required that the vermin be exterminated or controlled as an interim measure. The extermination of rodents would be conducted by a licenced exterminator in a manner that is appropriate for the

vermin in question. However, it is reiterated that the only cost effective and practical method to control rodent populations is effective management of the landfilling operations. The most important aspect of control is regular placement of cover and good control of the waste picker areas such that waste is not kept exposed for any extended periods.

As the use of transfer locations that will route the waste to the Site increases, there is one additional concern and that is the length of time and condition in which the transferred materials arrive at the Site. The mode and timing of transfer station operations is critical to a number of areas of the landfill management, particularly vermin and odour control. There will also be a requirement to inspect inactive portions of the landfill to ensure that the interim cover is adequately maintained and that rodent populations are not allowed to develop in those areas.

Various bird species are most commonly present at a landfill site due to the presence of food wastes. As with the previous vectors, the application of daily cover generally reduces access to food scraps and other attractive material available to the local bird population. Consistent implementation of this measure should help to limit the local bird population in the vicinity of the Site. The stormwater sedimentation and control ponds that will be constructed on the Site should also be operated and maintained in a manner that does not encourage resident bird populations. The stormwater sedimentation and control ponds will provide an alternative location for local birds to reside, and should disperse the birds over a larger area further away from the active landfill area. There are numerous control measures available to control birds, but they are expensive and likely unnecessary if good housekeeping measures are maintained for the active tipping face and waste picker/recycling area. It is also important to note that reducing the loafing areas that are cleared without any significant vegetation is an important factor in reducing resident bird populations. Therefore, re-vegetation of disturbed or completed areas as quickly as practical is recommended.

6.13 FIRES

It is recognized that landfill fires have been a problem experienced at the Mandela Avenue dumpsite. The majority of this has been due to waste scavenging activities, as fires are set to uncover recyclable materials from the remaining waste. Site access will be controlled to prevent scavenging, and recycling will be carried out only by the Site's licenced waste pickers.

Open burning of waste must be prohibited at all times during operation of the Site. No smoking or open flames of any type shall be permitted within the landfill cell areas or near the LFG collection and management facility once installed and operational. This may be a difficult restriction to enforce but is a critical factor for the Site and to protect against accident liabilities. Designated areas for smoking and for any open flames must be established. A "hot work" permit process shall be established for any maintenance or repair activity that requires the use of an open flame such as for a torch or welding equipment.

Should a surface or underground fire occur, it will be contained and extinguished as soon as possible using on-Site equipment. Never use excavation equipment to try to open up any area where there is a suspected fire. This is a practice that is still undertaken at landfill sites in North America and elsewhere. It is a fundamentally incorrect and dangerous approach, which must not be used. The only way to address a landfill fire effectively is to smother it and force it to extinguish itself by a lack of the oxygen necessary to sustain the combustion. The risks associated with fire from natural occurring events at the new landfill Site are quite low. If fires occur they will almost certainly be induced by human activity.

LFG will be generated and emitted from the landfill Site. It is important to understand how the gas is generated and how it vents both under passive conditions and under active extraction of LFG. The issue of potential fires is higher when operating an active LFG control system, as it requires more skill and knowledge to control than under passive venting conditions.

In the event of a fire at the landfill, this Site has an ideal water supply base available at all locations on the property for use to extinguish a fire. There are canals on three sides of the Site and there will be three stormwater sedimentation and control ponds, all of which can be sources of water for fire suppression. This Site represents a lower than typical risk of landfill fires because it is shallow and will have a very high moisture content due to the nature of the wastes and the local conditions. Any fire that is started will burn very close to the surface of the landfill.

Fire fighting can be augmented by addition of cover soils adjacent to the area of a suspected fire if it is deemed necessary. If there is an active LFG collection system operating and there is a suspected or known fire, LFG collection from any vertical wells or horizontal trenches in the vicinity of the suspected fire must be temporarily shut down. Such a measure will have two effects. It will remove a potential oxygen supply source from the area of the fire and, contrary to what may be expected, assist in allowing the gas generation in the landfill itself to assist in smothering the fire.

Any fire noted at the Site will be reported to the Site supervisor and MSWMD. It must be reiterated that the Site will produce LFG and that there will be a fuel source with the potential for fires near the surface of the landfill at all times until well after the Site has been capped and closed. There shall be a ban on any open flame, spark, smoking or maintenance activities on top of the waste disposal areas without specific and extensive precautions in place. The rules and qualification requirements for waste picker licensing will be quite stringent and will focus heavily on Site safety, with the open flame issue being one of the most critical issues.

6.13 NOISE

Potential noise impacts from the Site will generally result from operation of the landfill construction equipment. The operation of this equipment will be conducted in such a manner as to minimize noise impacts, wherever possible.

As the approved location of the Site is now a considerable distance from the closest residential area (more than 1,500 m), there is a reduced likelihood that residents would be impacted by the noise produced by the operation of equipment. In addition, it is noted that the noise of the landfill operations will be limited to the daylight hours. Given the Site location, vegetated screens and setback distances, noise is not considered to be a significant issue for this Site. It is still recommended as good practice that all equipment being utilized at the Site be kept in a good state of repair with all sound suppression systems or components (e.g., muffler systems) in a good state of repair in accordance with the manufacturer's specifications.

6.15 LEACHATE SEEPS

Leachate breakout or side slope seeps (seeps) are expected to be an infrequent and localized occurrence at the Site due to the full underdrain LCS proposed for the Site, and use of permeable daily cover materials wherever practical. This system will ensure, to the extent possible, free draining of leachate to the LCS. If a seep is found, Site personnel will evaluate size, duration, flow, and impact to determine the appropriate response. Generally, additional clay cover is applied and compacted in the area of the breakout or seep. If the area is large or initial remedial efforts are unsuccessful, the excavation may be filled with granular material to improve drainage into the landfill and an improved hydraulic connection to the leachate collection drain blanket and piping will be installed as a french drain or toe drain. Any disturbed cover areas will be repaired and compacted with clay soil. Leachate breakouts or seeps will also be

evaluated in the context of Site operations as a performance indicator. All seep locations and repair methodology will be recorded.

7.0 HEALTH AND SAFETY

A landfill is an industrial establishment, which presents the same safety hazards found in many industrial facilities. Proper safety procedures and equipment appropriate to the task at hand are absolutely essential to safe working conditions. Many safety features are incorporated in the landfill design and in the mechanical and electrical/control equipment to assure safe operation of the Site.

In order to minimize the hazards involved in the daily operation of the Site both management and operators must be continuously vigilant in following safe working procedures. All employees must exercise caution in all activities in and around the Site and each employee is responsible to protect others working at the Site. A good safety program, continuing worker education, and safe working procedures are the best method of being in compliance at all times with all applicable Guyanese regulations.

Any injury or incident at the Site indicates that there may be a problem in standard operating procedures, equipment function, employee awareness or employee assignment or capability. Potential problems at the Site shall identified and corrected before a safety related incident occurs. If an accident or injury does occur, the equipment established procedures or implementation of procedures shall carefully examined and any deficiencies in equipment, working procedures, and operator capability or other cause shall corrected immediately. The procedures will be reviewed and updated regularly as changing equipment and practices warrant.

The applicability of the Health and Safety Program extends to all personnel who will be working at the Site, including subcontractors and visitors. Subcontractors who will be conducting project activities at the Site will be responsible for the health and safety of their own personnel.

7.1 GENERAL SAFETY

As many safety features as possible have been incorporated in the design of the Site to prevent injury and reduce potential hazards to employees. To be effective it is essential that all safety devices and equipment be used correctly and consistently. Safety devices which are not used or which are used incorrectly or which may be bypassed invite an accident or injury. The most important factor in Site personnel safety involves developing and using correct operating procedures and developing guidelines for proper maintenance and use of safety equipment at all times. Deviation from use of proper procedures could lead to a serious accident, or possible injury.

General safety and personal hygiene rules for the Site should include:

- i) eating or drinking at the Site is limited to administration building and an area designated for the waste pickers;
- ii) smoking on or near the waste footprint, LFG collection piping, or LFG management facility, when installed, is prohibited and smoking is only allowed in designated areas;
- i) the "buddy system", i.e., working in pairs, is to be used for all activities at the Site other than routine monitoring and light maintenance activities;
- ii) Site security personnel are to retain records of entry and exit of all Site personnel, subcontractors, and visitors;
- iii) individuals getting wet to the skin with effluent from the leachate treatment facility, leachate from the landfill, any waste matter or chemicals from the leachate operations must wash the affected area immediately. If clothes in contact with skin are wet, then these must be changed;
- iv) hands must be washed with soap and water before eating, drinking, smoking, and before using lavatory facilities;
- v) waste produced on Site will be properly stored until such time that it is disposed of in accordance with appropriate regulations;
- vi) all spills be immediately cleaned up to prevent slipping and cross-contamination of Site areas;
- vii) all appropriate personal protective equipment (PPE) including splash shields on hard hats, chemical-resistant aprons, and gloves must be worn when there is a potential for contact with hazardous substances;
- viii) the administration building must be kept clean at all times; and
- ix) all first-aid, safety, and emergency response equipment must be inspected periodically including the stationary and portable eyewash units, and portable fire extinguishers. All eyewash units must be flushed monthly with fresh water, and a record maintained of this occurrence.

7.2 PERSONAL PROTECTIVE EQUIPMENT

Different levels of equipment are required depending upon the nature of the work task to be performed at the Site. For the purpose of this health and safety program outline, all activities performed at the Site involving contact with potentially impacted materials will be considered operations requiring personal protective equipment.

The basic PPE requirements for all personnel at the Site include:

- i) full length pants;
- ii) safety footwear;
- iii) safety glasses with side shields as needed;
- iv) work gloves for any waste pickers or workers in contact with waste and recyclable materials;
- iv) hearing protection in designated areas; and
- iv) hard hat as needed. The use of hard hats shall include all work areas in proximity to operating construction equipment for cell development activities, waste filling activities or other similar works.

Upgrades to the personal PPE required for activities such as the laboratory testing of leachate samples shall be specified for these individual tasks.

Typically, there are no Site conditions related to air emissions or odours that are expected to require supplementary PPE requirements except under confined space entry conditions. In the event that there is a specific odour concern, workers are requested to remove themselves from the affected area and obtain directions from supervisory personnel before continuing to work in this area. Approaches to atypical events or conditions must be based on Site-specific conditions. The actions could range from vacating a particular area until there have been cover system improvements or possibly forced ventilation in some specific locations such as the installation sites of gas wells or other features in the waste. Although not typical, there have been instances of hydrogen sulphide emissions at some landfills that have required supplementary control measures. In the event of sustained high level of odour concerns and complaints, it will be necessary to initiate the construction of the active LFG control system.

Due to the inherent moist Site conditions, and high relative humidity, dust generation is not expected to be a frequently recurring problem. Should dust become more of an issue in drier months, reducing the speed of on-Site vehicle traffic and wetting of soil stockpile areas and roads should provide effective control of dust. Dust masks may be employed as a temporary control measure for the comfort of on-Site operating personnel and waste pickers.

All regular operators of landfill equipment will be provided with hearing protection consisting of ear plugs or cap-mounted ear muffs. Any other Site personnel working in

the immediate vicinity of the landfill equipment should also wear the same hearing protection.

7.3 STORAGE OF FUEL/FLUIDS

A variety of replacement and used fluids are stored in the maintenance building, some of which are potentially combustible. Replacement oils and fluids inventory shall monitored to ensure no more than reasonable quantities are on hand. It is also important that these materials are stored in a cool, dry area in a separated area or room away from regular maintenance activities. Used oils and fluids shall stored in approved containers to be emptied periodically by a licenced waste hauler. Oils and fluids shall stored so that any spills or leaks are contained and spilled materials can be treated with absorbents suitable for their clean up. Welding or other activities that could create heat or sparks and set off a fire shall carried out away from the oil and fluid storage area. Fire extinguishers shall located throughout the building so that personnel can attack a small fire. Open flame shall only be permitted within the designated maintenance areas of the main building. Any open flame undertaken anywhere else on the Site shall be required to obtain a "hot work" permit that documents all aspects of the proposed activity and any supplementary safety measures that may be required.

Compressed gases used for cutting and/or welding shall stored in racks and chained to ensure safe storage. Tanks, when transported to a work area, shall chained into a carrier with valve covers in place, and not allowed to free stand as they could fall or be knocked over resulting in potential damage to the tank valve assembly which could lead to an explosion and/or fire. Only gases in use shall in the work area, with both spare and spent tanks stored away from the work area. As noted previously, hot work permits are required for any activity that can generate and open flame or spark in any other area than the maintenance building or other Site location.

It is expected that a portable fuel tank may be kept on Site for refueling equipment. Any portable tank shall be a dual walled tank or a secondary containment area shall be provided.

7.4 FIRE OR EXPLOSION

Outbreak of fire is one of the most extreme emergencies that could be attributed to waste in the landfilling area. If there is any indication of a fire, the suspect area must be isolated and the Site supervisors and fire departments contacted immediately. Under no

circumstances should the waste be dumped at the active landfill area if there is any sign or suspicion of smoke or fire on an incoming vehicle.

Site Activities

Welding or grinding activities that could ignite oils or fluids or fuels shall be confined to specific areas of the building. Where possible, adjacent areas and/or pieces of equipment shall be shielded from welding and grinding activities. Welding or grinding should not commence unless a fire extinguisher is located within easy reach.

Electrical fires can occur in any industrial building. To minimize potential for electrical fires, electrical conduit, wires, extension cords, prongs, sockets, and outlet boxes shall be inspected periodically to check for evidence of impact, or wear, or damage, and worn or defective materials replaced. Wiring near welding or grinding or other hot activities shall be encased in metal conduit. Outlet boxes should not be overloaded. Fuses shall be the correct size. Burnt out lamps shall be replaced immediately.

Electrically powered tools shall be repaired or replaced when determined to not be operating correctly.

Fire extinguishers for electrical fires shall be maintained within the building at several locations to allow immediate attack of small fires.

Landfill Gas Considerations

LFG will migrate through and collect in the LCS and it shall be assumed to be present in any activity associated with in-ground chambers and/or piping systems. Methane in LFG is potentially explosive at a concentration of 5 to 15 percent by volume in air. Any equipment used within the LFG management structures or leachate collection structures shall be explosion proof, intrinsically safe, and checked routinely for damage or deterioration.

It is recommended that certain supplementary precautions and safety measures be considered in the buildings, facilities and systems that service the landfill. For example, combustible gas alarms will be incorporated into the leachate treatment facility.

When the active LFG collection system is constructed, the status of the blower would be continuously monitored and a blower failure would trigger an alarm signal. Motor and bearing selection for the blower were for long term continuous operation, and regularly scheduled maintenance helps prevent unexpected shutdowns. For a shutdown, valves

are closed to stop the flow of LFG and the blower repairs carried out as quickly as possible to prevent LFG from building up and releasing from the waste.

7.5 WEATHER MONITORING

Site personnel will be responsible for checking weather forecasts for the next day and week of work to provide advance notification of any severe weather conditions. Severe weather conditions likely to be experienced at the Site (e.g., heavy precipitation, extremely high temperature, or wind) may cause unsafe conditions and in some situations work may have to be temporarily suspended.

Preventative measures that will be implemented if necessary are as follows:

- i) restriction of Site activity;
- ii) battening down light equipment or building materials;
- iii) partially enclosing localized work areas;
- iv) selection of preferred filling locations that are better protected; and
- v) reduction or stoppage of some or all work activities.

7.6 CONFINED SPACE ENTRY

A confined space refers to a space in which, because of its construction, location, contents, or work activity therein, the accumulation of a hazardous gas, vapour, dust, or fume, or the creation of an oxygen-deficient atmosphere or other potentially hazardous condition may occur.

Confined spaces must never be entered without having at least one other person at all times to act as an attendant and equipped with a means of summoning emergency rescue services. An entrant must be provided with a lifeline and respiratory protection equipment as required. An emergency rescue procedure must be developed prior to entry and rescue equipment must be readily available.

Before entering any confined space first verify using the LEL/O₂/Toxic gas meter that:

- oxygen levels are normal;
- there are no explosive vapours; and
- there are no toxic gases (such as carbon monoxide or hydrogen sulfide).

Ventilate or purge the space by means of portable fans of sufficient capacity and for sufficient duration to render the space safe. Extraction equipment and support facilities for the removal of personnel that may need to enter a confined space shall be provided. The importance of these rules cannot be over-emphasized.

7.7 LOCKOUT/TAGOUT

Maintenance will be carried out on mechanical equipment occasionally such as pumps and/or blowers. It is recommended that a lockout/tagout procedure be adopted to ensure proper communication and coordination between Site personnel.

Personnel must never work on, attempt to make adjustments, remove protective guards, or attempt to check equipment while in operation or with high pressure air feeding the equipment. Guidelines for lockout/tagout program prior to starting work is as follows:

- place motor starters in the OFF position and tag;
- physically disconnect the electrical supply at the non fusible disconnect;
- tag the disconnect and the machine (place a warning that it is not to be started); and
- padlock the disconnect.

Personnel must never assume that placing the starter in the OFF position is sufficient to provide safe procedures since most motors may be out of sight of the control centre. Someone else could unknowingly place the switch in the ON or AUTO position.

Equipment safety guidelines are as follows:

- isolation valves, gates, switches or electrical disconnects which are turned OFF to complete maintenance or required repairs must be tagged with a warning to notify others that they are to remain OFF until the lock and tag are removed;
- all isolation valves, gates, switches, or disconnects of equipment, air operated valves, or tanks being worked on MUST be tagged and padlocked;
- bleed pressure safely from high-pressure water, air, or chemical feed lines; and
- prepare a detailed checklist for electrical/other isolation procedures and general safety procedures required for each piece of equipment, line, tank, or valve, and follow the checklist at all times.

8.0 SITE RESTORATION ACTIVITIES

8.1 FINAL COVER SYSTEM

A detail of the components of the final cover system is presented on Drawing C-12, provided in Appendix A. The final cover is expected to be installed as a progressive rehabilitation activity as portions of the landfill are completed to their final grade and are ready for closure.

The intended purpose of the final cover system is the following:

- provide isolation from direct contact with the waste (human or animal);
- help mitigate any potential odour impacts;
- provide visual screening of the disposal operations and improve aesthetics;
- ensure proper drainage of stormwater;
- control the rate of precipitation infiltrating into the waste;
- support a healthy vegetative cover on the cover system; and
- assist with controlling the emissions of LFG.

The final cover system will consist of the following components:

- top vegetative layer rooted in minimum of 100 to 150 mm topsoil;
- a geonet drainage layer will be placed in the more steeply sloped perimeter areas of the final cover;
- compacted clay layer of minimum 700 mm thickness having a minimum permeability criteria of 1×10^{-6} cm/s; and
- minimum of 150 mm of daily or interim cover soil will also be provided on the upper lift of waste as part of the ongoing landfilling operation.

The vegetative layer will be developed on the surface of the landfill cover system. This layer is integral in maintaining the long-term effectiveness of the landfill cover system. The vegetative layer serves to perform the following functions:

- stabilize the soil against erosion due to runoff and wind;
- minimize percolation of precipitation;
- maximize evapotranspiration of soil moisture; and
- increase the aesthetic value of the final cover.

The local plant species ultimately utilized for the final cover shall be selected with all of the above considerations in mind. This plant species would also have the ability to thrive in low nutrient soils with minimum nutrient addition, and to survive and function with little or no maintenance. The vegetative layer shall be developed such that root penetration remains within the cover topsoil and not into the depth of the cover drainage layer or low permeability layer. Should a deeper root system be required, the depth of the topsoil may be increased to accommodate this accordingly.

The perimeter drainage layer is intended primarily as a safety measure to protect against localized slope failure resulting from localized saturated conditions.

8.2 LANDFILL SETTLEMENT

Settlement of solid waste fills is typically characterized by rapid (primary) settlements within a few months to years after completion of construction, followed by a gradual secondary compression due to decomposition over an extended period of years. Due to the high amount of rainfall that is generally received in the geographic region of the Site, high associated moisture composition of the waste and relatively low initial waste compaction, a high degree of settlement is expected for the Site.

The final contours for the proposed Site are shown on Drawing C-08, in Appendix A. Due to the high degree of landfill settlement that is expected for the Site, it is intended each of the stages in the waste fill area will be overfilled or overbuilt above the final contours shown on Drawing C-08 with initial side slopes of 3.5:1 (H:V). It is critical to maintain a good top slope on the final landform to ensure that infiltration rates that generate leachate can be maintained during the post-closure care period.

In order to minimize the impact of waste settlement on the integrity of the final cover, the complete final cover system, including vegetative and drainage layers, shall progressively be completed in the year following the final placement of any wastes and application of interim cover in each respective area or stage. Interim cover consisting of minimum 300 mm compacted clay will be placed over any area that is not expected to receive any waste for an extended period of time (i.e., 6 months).

8.3 SITE AFTERCARE

Monthly inspections shall be carried out by landfill personnel of the various Site features including the landfill cover system, channels, ditches, culverts, access roads, and perimeter Site fence. The inspections of the above-mentioned features will consist of:

- inspect landfill cover for signs of erosion and to ensure the cover is intact;
- inspect vegetative cover and identify areas requiring attention;
- inspect perimeter fence and gates to ensure they are intact;
- inspect landfill cover for areas of erosion and surface water ponding;
- inspect landfill cover for evidence of exposed waste or leachate seeps;
- inspect landfill cover for evidence of animal burrows;
- inspect on-Site access roads to ensure they are driveable; and
- inspect ditches for sediment accumulation and erosion.

A detailed checklist and recommended inspection forms will be provided concurrently with the final design for the Site. A typical inspection check list for the various items that must be monitored at an active landfill site is provided in Appendix B.

9.0 MONITORING AND PERFORMANCE

All of the Site monitoring programs shall reviewed periodically as the database for the Site is further developed. Any suggested revisions to the monitoring program shall noted as a recommendation in the annual monitoring and operations report for review by the relevant governing authorities before implementing any changes to the program.

9.1 WASTE/SOIL VOLUME MONITORING

A survey of the active landfill stages shall conducted each year of active landfilling during Site operations. The survey data will be used to calculate the volume of landfill space that has been utilized and to develop an estimate of the refuse density of the waste placed to date.

From this data, the cover soil balance will be updated, along with prediction of the Site capacity remaining. These projections are also important for planning purposes to establish the schedule for the continuing cell development, capital purchases for equipment, and materials to continue the Site development.

9.2 GROUNDWATER MONITORING

The proposed groundwater quality and quantity monitoring program will be established to verify the performance of the Site. The key elements are as follows:

- installation and maintenance of six on-Site shallow groundwater wells to be placed adjacent to the limit of waste in each landfill stage;
- monthly water level measurements in all on-Site groundwater monitoring wells to ensure the performance of the hydraulic trap; and
- groundwater quality sampling and analyses at all monitoring well locations.

It shall noted that during the first year of Site operation, the full list of groundwater parameters will be monitored and analyzed for all monitoring wells for all quarterly monitoring events in order to develop a more complete initial database for the Site

9.3 LEACHATE COLLECTION SYSTEM MONITORING

A leachate collection system monitoring program will be established to ensure that the hydraulic trap is maintained.

The proposed leachate collection system monitoring program will include the following:

- installation and maintenance of six leachate monitoring wells at the toe of slope around the perimeter of the landfill;
- monthly water level measurements in all leachate monitoring wells to ensure the performance of the hydraulic trap;
- leachate quality sampling and analyses are discussed with the leachate treatment system monitoring; and
- water level measurements recorded at each of the leachate pump stations (PS 1 to 4) along with pumping records maintained at each station maintained by the Site operator.

Leachate pump operations will be monitored by the Site operator, as part of regular maintenance activities. Any pumping system malfunctions will be recorded as well as the remedy to the operations problem.

9.4 SURFACE WATER MONITORING

The proposed surface water quality and quantity monitoring program applies to the effluent from the on-Site stormwater sedimentation and control ponds, which discharge to the adjacent north and south drainage canals. The monitoring program will be staged according to construction of the individual stormwater sedimentation and control ponds. The surface water monitoring program will include the following:

- installation and maintenance of a surface water monitoring network consisting of four monitoring locations in the north and south drainage canals at points upstream and downstream of the Site as indicated on Figure 9.1;
- monthly flow measurements at all canal surface water monitoring locations;
- surface water quality sampling and analyses at all canal monitoring locations including stormwater pump stations (PS 5 to PS 7) with frequency as indicated in Table 9.1, and list of analysis parameters as indicated in Table 9.2; and
- semi-annual inspection of ditches for evidence of excessive erosion and/or sediment buildup.

The stormwater management pumps will be monitored by the Site operator, as part of regular maintenance activities. Any pumping system malfunctions will be recorded as well as the remedy to the operations problem.

9.5 LEACHATE TREATMENT SYSTEM MONITORING

The leachate effluent monitoring program will include the following:

- leachate flow measurement shall be monitored through use of the run time meters and pumping system records from both the leachate pump stations and the pumps for the leachate treatment facility; and
- raw leachate quality sampling and analysis from the leachate pump stations and treated effluent samples from the leachate treatment facility.

9.6 LANDFILL GAS MONITORING

The only area where the monitoring of LFG migration through the soils is warranted is in the built up area of the administration building and other service facilities. The relative risks and potential for migration are low but installation of these probes is a prudent supplementary safety measure.

The LFG monitoring program will include the following:

- installation and maintenance of three on-Site LFG probes in the vicinity of the administration buildings and leachate treatment facility; and
- quarterly monitoring of the major constituents of LFG.

A portable field measurement instrument can provide all of the required data that will also be useful in monitoring gas levels in the various leachate pumping stations and other in-ground installations.

The more significant monitoring parameter for LFG at the Site is the associated with the incidence and relative frequency of any odour complaints. The following prescribed procedures are recommended to be followed for odour complaints. The Site supervisor/operator should ensure that the following information is recorded for every odour complaint received at the Site including the following:

- description, time, and date of the incident;
- current status of all Site operations that may have triggered the event;
- wind direction at the time of the incident; and
- description of the measures taken to address the cause of the incident and to prevent a similar occurrence in the future.

Site personnel should investigate and determine, if possible, the source of the problem and take appropriate action.

9.7 COMPLAINT RESPONSE

Regular Site inspections will be conducted by Site personnel to verify that nuisance factors associated with housekeeping procedures such as dust, litter, and odour, are under control, thereby preventing routine operation nuisances from developing into more serious environmental problems. These inspections will be conducted on a monthly basis. Site personnel will maintain a checklist of housekeeping items that need to be implemented on a regular basis. Records of observations made during the Site inspections and all regular housekeeping activities carried out will also be maintained.

In addition, the scale attendant will ensure that all material entering the Site is recorded as to the type, source, and quantity/weight of each load.

9.8 REPORTING REQUIREMENTS

It is recommended that an operations report for the Site be prepared on an annual basis to ensure compliance with all Site operations and maintenance procedures. The following topics are recommended for discussion in this annual report:

- results and interpretive analysis of all leachate, groundwater, surface water, and LFG monitoring programs, particularly:
 - assessment of leachate/groundwater elevation data with respect to trigger elevations, and
 - assessment of the need to amend the monitoring program;
- assessment of the operation and performance of all engineered facilities, the need to amend the design or operation of the Site, and the adequacy of and need to implement the contingency plans;

- Site plans showing the existing contours of the Site, areas of landfilling operations during the reporting period, areas of intended operation during the next reporting period, areas of excavations during the reporting period, the progress of final cover and intermediate cover application, previously existing Site facilities, facilities installed during the reporting period, and Site preparations and facilities planned for installation during the next reporting period;
- calculations of volume of waste, daily and intermediate cover, and final cover deposited or placed at the Site during the reporting period and a calculation of the total volume of Site capacity used during the reporting period;
- calculation of the remaining capacity of the Site and an estimate of the remaining Site life;
- summary of the quantity of any leachate removed, and/or treated and discharged from the Site during each operating week;
- summary of the weekly, maximum daily and total annual tonnage of waste received at the Site;
- summary of any public complaints received by the owner and the responses made; and
- discussion of any operational problems encountered at the Site and corrective actions taken.

9.9 QUALITY ASSURANCE

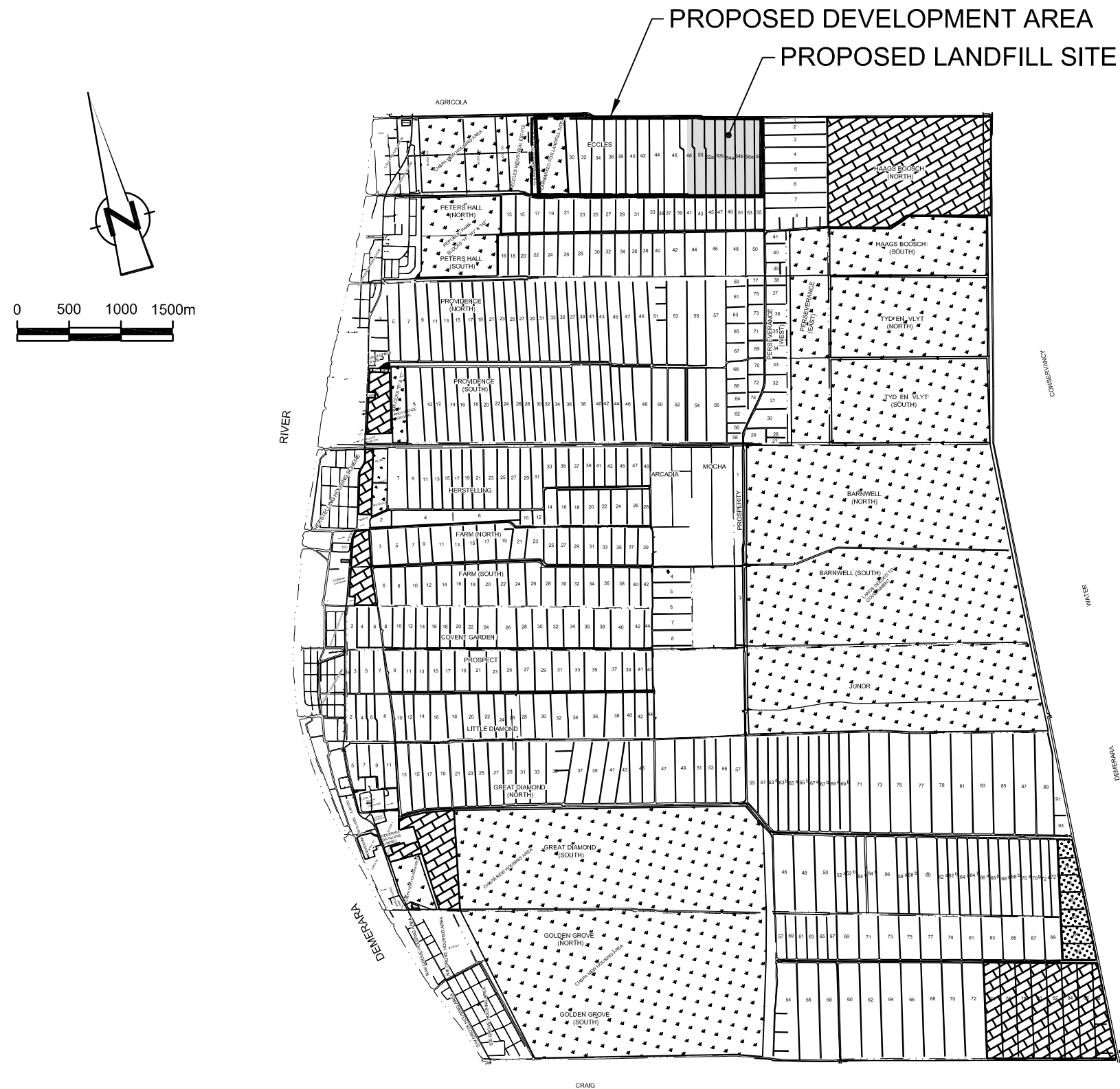
The Construction Quality Assurance (CQA) plan presents the construction quality assurance/quality control procedures to be implemented during the construction of the Site. More specifically the following construction components will be dealt with:

- construction facilities and temporary controls;
- base of landfill grading and preparation;
- sand and aggregate liner materials and installation;
- geocomposite liner materials and installation;
- stormwater collection system materials and installation;
- leachate collection and treatment system equipment, materials and installation; and
- LFG collection system piping materials and installation.

A preliminary summary of CQA inspections and testing is given in Appendix B.

The objective of the CQA plan is to ensure that the above components are constructed to meet all material and design criteria, as laid out in the approved drawings and specifications.

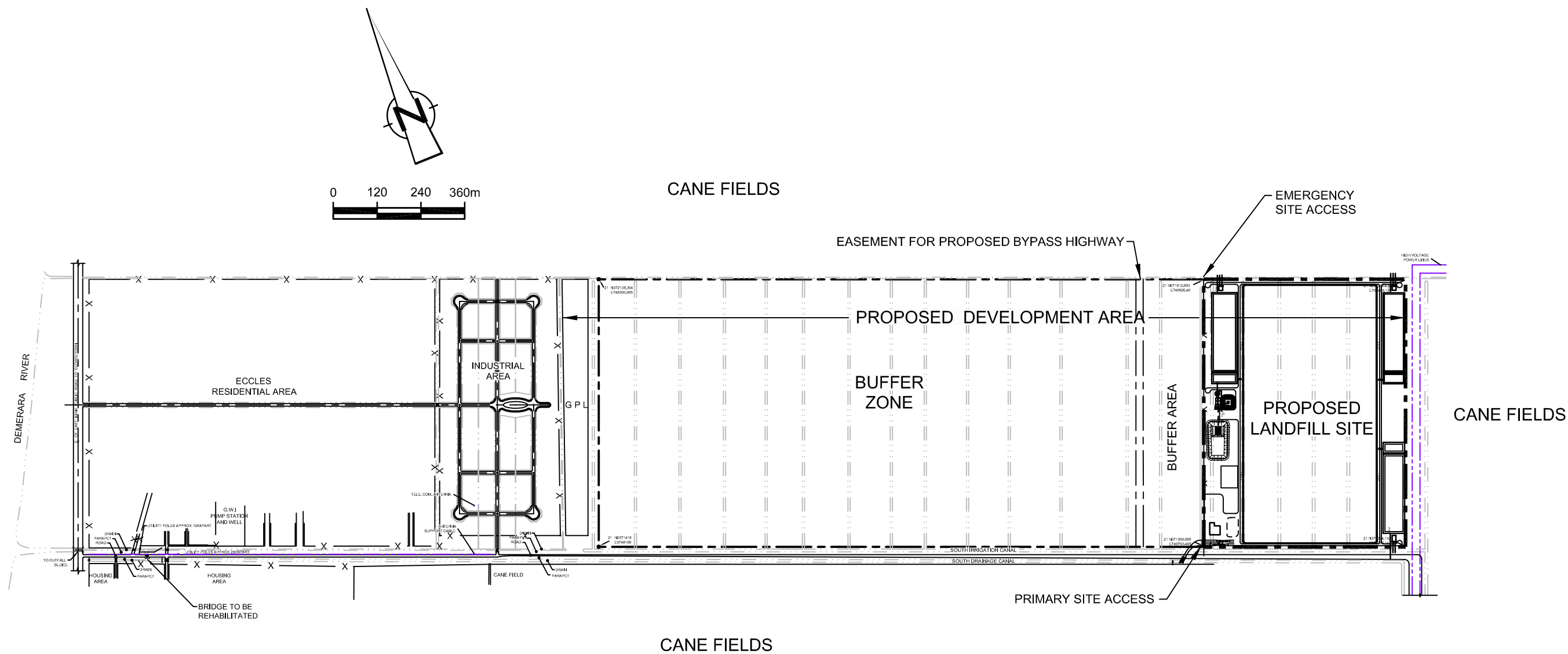
Throughout construction there will be numerous inspections and testing requirements for specific work tasks. The inspection and testing requirements will ensure compliance with the specifications, as well as completion of the work tasks to the highest level of quality. Inspections and testing will provide a qualitative means of monitoring the quality and progress of work performed.



SOURCE: TROW ASSOCIATES, INC.



figure 1.1
REGIONAL SITE LOCATION
SITE OPERATIONS MANUAL
SANITARY LANDFILL IN HAAGS BOSCH, GUYANA
Ministry of Local Government and Regional Development



LEGEND	
	PROPERTY BOUNDARY
	SITE BOUNDARY
	CANAL
	FENCE
	BRIDGE
GPL	GUYANA POWER AND LIGHT
GWI	GUYANA WATER INC.

SOURCE:
SITE PLAN FROM TROW ASSOCIATES INC.
JUNE 2004

NOTES:
1) ALL MEASUREMENTS IN METRES
UNLESS OTHERWISE INDICATED
2) NORTH AND SOUTH DRAINAGE
CANALS DRAIN WEST TO THE
DEMERARA RIVER.

figure 1.2
SITE LOCATION PLAN
SITE OPERATIONS MANUAL
SANITARY LANDFILL IN HAAGS BOSCH, GUYANA
Ministry of Local Government and Regional Development



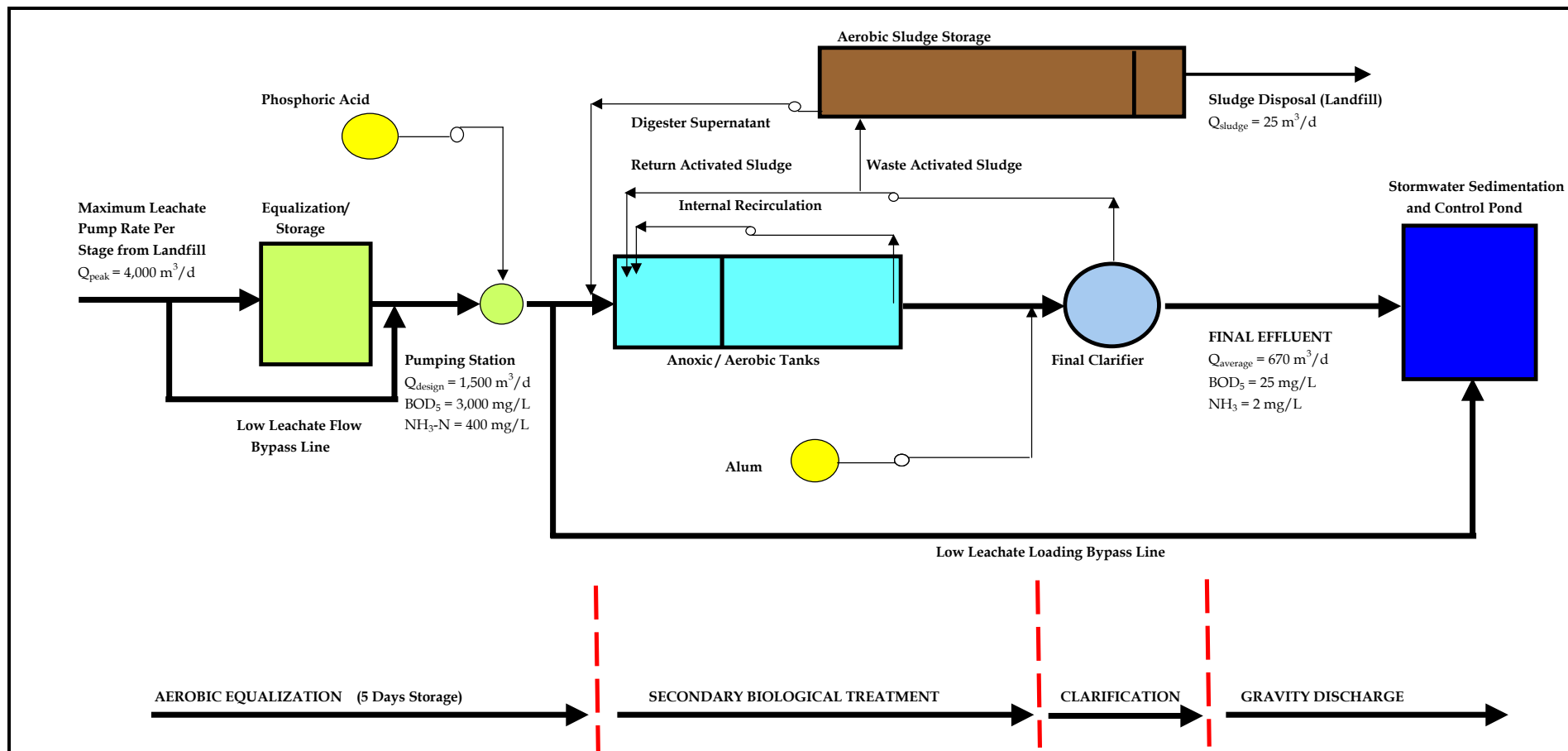
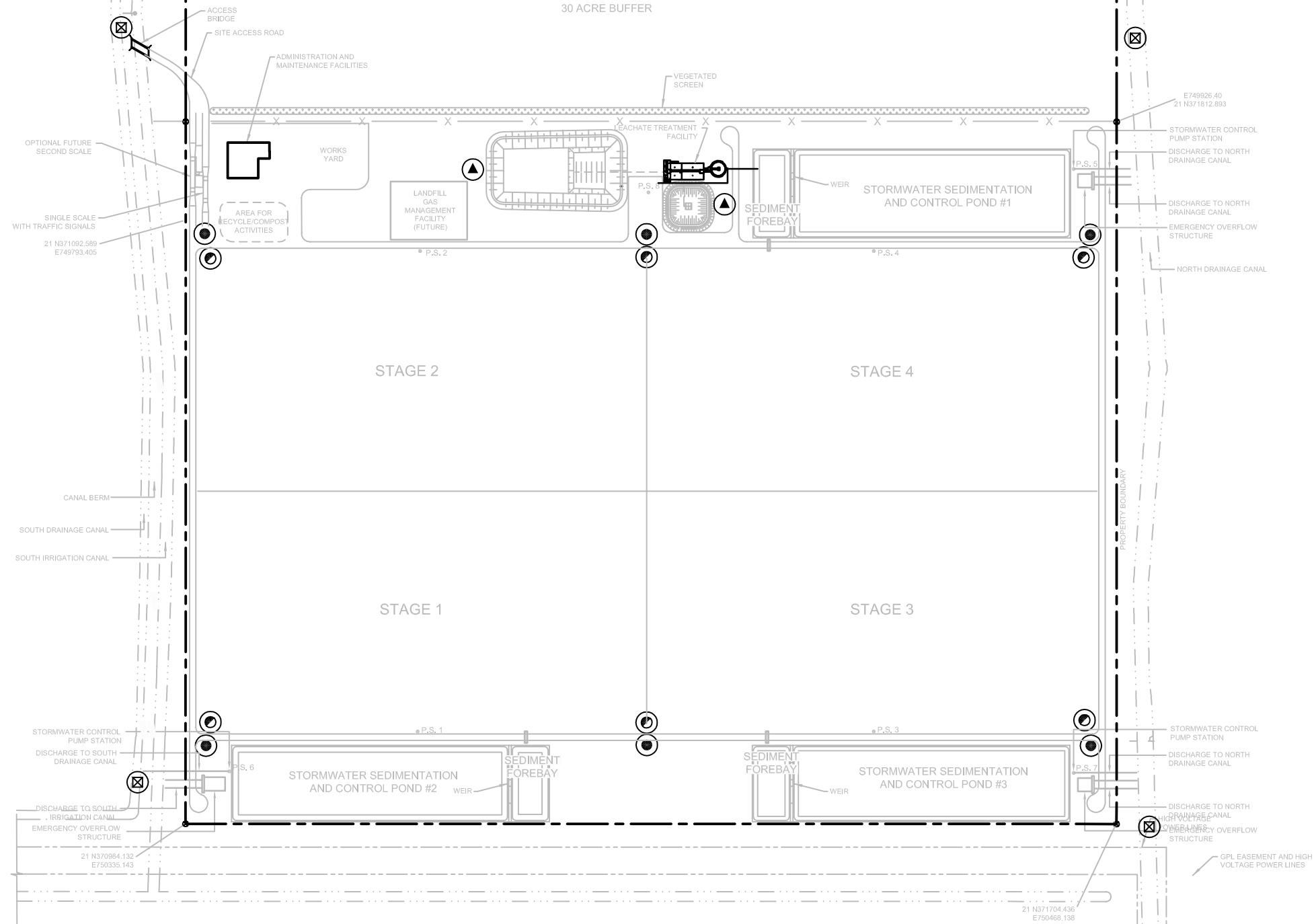
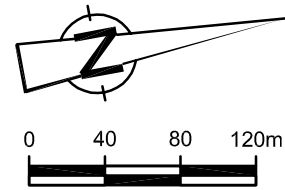


figure 5.1
PROCESS FLOW SCHEMATIC FOR LEACHATE TREATMENT SYSTEM
SITE OPERATIONS MANUAL
SANITARY LANDFILL IN HAAGS BOSCH, GUYANA
Ministry of Local Government and Regional Development





LEGEND

- PROPOSED GROUNDWATER MONITORING LOCATION
- ⦿ PROPOSED LEACHATE MONITORING LOCATION
- ⊠ PROPOSED SURFACE WATER MONITORING LOCATION
- ▲ PROPOSED LANDFILL GAS MONITORING LOCATION

figure 9.1

MONITORING NETWORK LOCATIONS
SITE OPERATIONS MANUAL
SANITARY LANDFILL IN HAAGS BOSCH, GUYANA
Ministry of Local Government and Regional Development



TABLE 1.1
WASTE COMPOSITION⁽¹⁾
SITE OPERATIONS MANUAL
SANITARY LANDFILL IN HAAGS BOSCH
GUYANA

<i>Waste Stream</i>	<i>Truck Load Percentage</i>	<i>Estimated Total Tonnage During Study Period</i>
Low and Middle-Income Residential Waste	64	56
High-Income Residential Waste	8	10
Middle-Income Residential and Commercial Waste	3	4
Commercial Waste	7	9
Market Waste	18	21

<i>Waste Type</i>	<i>Percentage</i>
Food Waste	41
Paper Waste	24
Glass and Metals	3.4
Plastics	10.1
Construction and Demolition Waste	1.8

Source:

- (1) Waste composition data provided by Brown, Vence and Associates in their report entitled, "Pre-Investment Study for Georgetown Solid Waste Management Program: Waste Characterization and Facility Siting.", May 2000.

TABLE 9.1
COMPLIANCE MONITORING FREQUENCY
SITE OPERATIONS MANUAL
SANITARY LANDFILL IN HAAGS BOSCH
GUYANA

<i>Monitoring Locations</i>	<i>Daily</i>	<i>Monthly</i>	<i>Quarterly</i>	<i>Annually</i>
<i>Groundwater Monitoring Wells (6 wells)</i>				
• Groundwater Quality Monitoring ⁽¹⁾⁽²⁾			√	√
• Groundwater Hydraulic Monitoring		√		
<i>Leachate Monitoring Wells (6 wells)</i>				
• Leachate Hydraulic Monitoring		√		
<i>Leachate Pump Stations (4 stations)</i>				
• Leachate Quality ⁽¹⁾⁽²⁾			√	√
• Leachate Hydraulic Monitoring	√			
• Leachate Quantity	√			
<i>Leachate Treatment Process Effluent</i>				
• Influent Quality ⁽¹⁾⁽²⁾			√	√
• Influent Quantity	√			
• Effluent Quality ⁽¹⁾⁽²⁾			√	√
• Effluent Quantity	√			
<i>Surface Water Monitoring (4 locations)</i>				
• Surface Water Quality ⁽¹⁾⁽²⁾			√	√
• Surface Water Quantity		√		
<i>Stormwater Pump Stations (3 stations)</i>				
• Surface Water Quality ⁽¹⁾⁽²⁾			√	√
• Surface Water Quantity	√			
<i>Landfill Gas Probes (3 probes)</i>				
• Gas Quality			√	

Notes:

- (1) Reduced parameter list for quarterly groundwater, surfacewater, and leachate analyses as indicated on Table 13.2. Full list of parameters for annual monitoring event.
- (2) Full list of parameters for quarterly groundwater, surfacewater, and leachate analyses during first year of Site operation only.

TABLE 9.2
COMPLIANCE MONITORING PARAMETERS
SITE OPERATIONS MANUAL
SANITARY LANDFILL IN HAAGS BOSCH
GUYANA

<i>Surface Water Sampling</i>	<i>Groundwater Sampling</i>	<i>Leachate Sampling</i>	<i>Landfill Gas Sampling</i>
BOD *	BOD *	BOD *	Methane
COD *	COD *	COD *	Carbon Dioxide
pH ⁽³⁾ *	pH ⁽³⁾ *	pH ⁽³⁾ *	Oxygen
NH ₃ -N *	NH ₃ -N *	NH ₃ -N *	Temperature
TDS	TDS	TDS	Pressure
TSS *	TSS *	TSS *	
VSS	VSS	VSS	
TKN *	TKN *	TKN *	
Total Phosphorous *	Total Phosphorous *	Total Phosphorous *	
Alkalinity *	Alkalinity *	Alkalinity *	
Hardness (Ca and Mg)	Hardness (Ca and Mg)	Hardness (Ca and Mg)	
Chloride	Chloride	Chloride	
Fluoride	Fluoride	Fluoride	
Phosphate	Phosphate	Phosphate	
Sulphate	Sulphate	Sulphate	
Nitrate	Nitrate	Nitrate	
Nitrite	Nitrite	Nitrite	

Notes:

* Indicates parameter on reduced list.

- (1) Reduced parameter list for quarterly groundwater, surfacewater, and leachate analyses.
Full list of parameters for annual monitoring event.
- (2) Full list of parameters for quarterly groundwater, surface water, and leachate analyses
during first year of Site operation only.
- (3) Includes both field and lab analysis.

COD Chemical Oxygen Demand.

BOD Biological Oxygen Demand.

NH₃-N Total Ammonia Nitrogen.

TDS Total Dissolved Solids.

TSS Total Suspended Solids.

VSS Volatile Suspended Solids.

TKN Total Kjeldahl Nitrogen.

APPENDIX A

DETAILED DESIGN DRAWINGS – CONSTRUCTION OF A NEW SANITARY LANDFILL IN HAAGS BOSCH

APPENDIX B

OPERATIONS AND MAINTENANCE CHECKLISTS

TABLE B.1

**SITE OPERATIONS MANUAL
SANITARY LANDFILL IN HAAGS BOSCH**

Waste Inspection Form – Eccles landfill

Date & Time on Weighbridge:

Details of Vehicle Carrying the Waste:

License Plate No.
Make and Model of Vehicle
Capacity of Vehicle in tonnes and cubic metres
Weight of Waste
Volume of Waste

Personnel Details:

Name of Driver
Name of Owner
Address of Owner

Origin of Waste:

Brief Description of the Waste:

Reason for Refusal:

Action Taken:

Inspection Performed by:	Date:	Time:
Accepted by:		
Signature of the Driver (Transporter)		

TABLE B.2

**SITE OPERATIONS MANUAL
SANITARY LANDFILL IN HAAGS BOSCH**

Complaint Form

Date and Time of Complaint:

Details of Person(s) making the Complaint:	
Name:	
Address:	
Telephone No.	

Complaint Details. Use additional sheet if necessary.

Date and Time of Incident:

Weather Conditions at Time of Incident

Attach photos if available

Follow-up Actions:

Complaint Recorded by:

Date and Time:

TABLE B.3

**SITE OPERATIONS MANUAL
SANITARY LANDFILL IN HAAGS BOSCH**

Monthly Returns

This Form should be filed every month. The form is due at the Client's Office no later than the first Friday after the end of the month covered by the return. The Operator's Superintendent should keep a diary of events, attendance, and plant & equipment usage sufficient to enable him to fill in the following details each month.

Return for the Month of: Year:	
-----------------------------------	--

No. of Violation Notices issued: Attach copies of each notice with Inspection Report.	
--	--

Summary and brief description of Complaints Received during the Month: Attach complaint reports.

Tonnage of waste placed in the Eccles landfill during the month:	
Description of the area(s) used for placing the waste:	
Estimated quantity of Daily Cover material used:	
Estimated quantity of Intermediate Cover used:	

TABLE B.4

**SITE OPERATIONS MANUAL
SANITARY LANDFILL IN HAAGS BOSCH**

Plant & Equipment List	Days Working	Days Idle	Fuel Consumed
Compactor			
Dozer			
Traxcavator			
Shovel			
Bowser			
Aerators			
Leachate Sump Pump			
Other equipment:			

TABLE B.5

**STAFF REQUIREMENTS
SITE OPERATIONS MANUAL
SANITARY LANDFILL IN HAAGS BOSCH**

<i>PERSONNEL</i>	<i>NUMBER OF PERSONNEL</i>		
	<i>PER SHIFT</i>	<i>GENERAL</i>	<i>TOTAL</i>
SITE SUPERINTENDENT		1	1
WEIGHBRIDGE OPERATOR		1	1
LEACHATE TREATMENT FACILITY OPERATOR		1	1
LANDFILL DOZER OPERATOR	1		1
LANDFILL COMPACTOR OPERATOR	1		1
EXCAVATOR OPERATOR	1		1
TRACKED LOADER OPERATOR	1		1
DUMP TRUCK OPERATOR / WATER TRUCK OPERATOR	1		1
ENVIRONMENTAL TECHNICIAN		1	1
GENERAL GROUNDS MAINTENANCE / LITTER PICKER	2		2
TRAFFIC CONTROL / WASTE SPOTTER	2		2
GUARD	1	1	2
TOTAL PERSONNEL			15

TABLE B.6

OPERATOR LOG SHEET
SITE OPERATIONS MANUAL
LEACHATE TREATMENT FACILITY
SANITARY LANDFILL IN HAAGS BOSCH

			Date: _____						
			Time: _____						
Normal Operating Range	Units	Parameter	7:00	9:00	11:00	13:00	15:00	17:00	19:00
Aerobic Lagoon									
	metres	Liquid Level							
	mg/L	COD							
	mg/L	NH3-N							
	Yes/No	Blower On?							
	L/s	Influent air flowrate							
	m3/s	Discharge pump rate							
		pH							
	Yes/No	Bypass to stormwater pond							
Biological Treatment Facility									
<i>Anoxic Tank</i>									
	mV	ORP							
	mg/L	COD							
	mg/min	Supplemental Carbon addition rate							
	mg/L	NH3-N							
	mg/L	NO3							
	mg/L	Alkalinity							
		pH							
	mg/L	Soluble phosphorus							
	mg/min	Supplemental phosphorus addition rate							
Microscopic observations of anoxic sludge sample									
<i>Oxic Tank</i>									
	mV	ORP							
	mg/L	Dissolved Oxygen							
	L/s	Influent air flowrate							
	mg/L	COD							
	mg/L	NH3-N							
		pH							
	mg/min	Chemical addition rate							
Microscopic observations of oxic sludge sample									
<i>Clarifier</i>									
	mg/L	COD							
	mg/L	NH3-N							
	mg/L	TSS							
	m3/s	RAS pump rate							
	m3/s	WAS pump rate							
Enter any other observations or actions taken during the course of the day:									
Operator's Initials									

APPENDIX C

PRELIMINARY WASTE INSPECTIONS

APPENDIX C

SITE OPERATIONS MANUAL SANITARY LANDFILL IN HAAGS BOSCH

Preliminary Waste Inspections

As indicated earlier, the Contractor shall post, at the entrance of the Site, a sturdy and durable signboard indicating the type of wastes acceptable and not acceptable. To enforce the disposal of only acceptable wastes, each load of waste entering the Site should undergo a cursory level of inspection. The weighbridge operator will carry out the preliminary inspection by:

- asking the customer the type of waste they wish to dispose;
- origin of the waste;
- informing the customer of unacceptable waste and recyclables; and
- complete a brief visual inspection of the load.

As earlier, it should be taken in to consideration that many vehicles accessing the site will be enclosed and a visual inspection may not always be possible at all instances except at the tipping face.

If a preliminary inspection indicates only acceptable waste, then the vehicle may proceed to the tipping face area. If the preliminary inspection clearly indicates that a load contains unacceptable waste or the vehicle driver volunteers information that indicates the load contains unacceptable waste, the weighbridge personnel will inform the vehicle operator that the waste cannot be accepted and refer them to alternate approved facilities or the waste will be disposed of temporarily in the Inspection Bay.

If the preliminary inspection suggests (i.e. not conclusive) that unacceptable waste is present in a load, or the vehicle operator provides information about questionable wastes, then the weigh-bridge personnel will direct the vehicle to the Inspection Bay for a detailed waste inspection. They should explain that a technician or supervisor of the Operator would inspect the load and provide assistance for the correct disposal method.

If the driver does not wish to have the load inspected and is refused entry, the weighbridge personnel should complete a Waste Inspection Form (WIF) regardless, and the information recorded. The form is also to be filled out if an inspection is conducted in the Inspection Bay.

Inspection at the Tipping Face

The Contractor will be responsible for inspection of the waste at the tipping face prior to incorporation into the cell. This will involve a further check that the waste is acceptable and that tipping procedures are followed.

If wastes are found to be unacceptable, then staff should advise the vehicle of other alternate approved facilities where the unacceptable waste could be disposed.

Random Waste Inspections

Spot check waste inspections may appear to be random, but they actually involve a structured, consistent and planned procedure. The procedure may target certain type of waste vehicles, waste categories, previously suspect vehicles, waste generators or geographic areas.

Each inspection may be targeted to provide:

- compliance of governmental regulations and guidelines;
- enforcement of acceptable wastes;
- information on recycling efforts, and any hazardous waste diversion program;
- information on banned materials and measurement of public participation in such programs;
- maintenance of strict compliance with regulations;
- historical data of due diligence practiced at the site;
- preventative measure to protect site personnel; and
- continuous waste audit of material.

The Contractor shall perform regularly scheduled spot check inspections of incoming waste at the Site as part of the regular activities. As indicated earlier,

the Contractor shall thoroughly inspect at least one load of randomly selected waste carrying vehicle every second week.

One of the main purposes of conducting regular spot checks of incoming waste is to make sure that only acceptable waste categories are received and disposed at the Site, and thereby minimizing the environmental and health impacts of disposing unacceptable wastes. Procedures for random load checks, and the reason for them, should be prepared and handed out to customers.

The Contractor is to devise a format for conducting regular waste inspections and will consider the following in devising the inspection format:

- type of vehicles or materials to be selected for inspection;
- frequency of inspection (e.g., every tenth vehicle);
- location of inspection (tipping face area or Inspection Bay);
- date, time and duration of inspection; and
- Site personnel to be involved with inspection.

Detailed Waste Inspection Procedure

A detailed waste inspection is to occur if the weighbridge personnel notice suspicious, questionable or unacceptable waste during their preliminary waste inspection or other landfill personnel believe that a load contains suspect waste. A detailed waste inspection is also carried out as part of a regular spot check waste inspection programme, and should be carried out in the Inspection Bay.

The first component of a detailed waste inspection is to instruct and direct a vehicle to the inspection area. The following initial steps are to be followed by the Contractor:

- inform weighbridge personnel of the inspection event;
- indicate the vehicle to be inspected;
- weighbridge staff notifies driver that the load is to be inspected, and notes inspection on weight ticket;
- weighbridge staff directs the driver to the Inspection Bay; and
- weighbridge staff notifies personnel that the relevant vehicle is proceeding to the Inspection Bay.

Once a vehicle has been directed to the Inspection Bay, the following procedures are to be carried out in conducting the detailed inspection:

- offer the driver the opportunity to observe the inspection;
- if possible and safe to do so, inspect load, when it is still in the vehicle. If necessary, have driver empty load from the vehicle;
- visually divide the load into front, middle and rear sections;

Inspect each of the three sections using suitable tools (e.g. rakes, shovel, forks), and being careful not to allow workmen from utilizing their bare hands. The inspection staff will have to use appropriate personal protective equipment (PPE), as required for the task. If necessary, heavy equipment can be used to move and spread the load to provide a good understanding of the type of waste. Besides looking for visual indications of unacceptable waste, the inspection personnel should also be aware of any unusual odours emanating from the waste.

They should check labelling on the containers for any indication of unacceptable waste:

- stake and mark problem area or materials, if found, for pictorial evidence;
- take different pictures of the questionable waste from various angles, and note description of each picture;
- separate subject material from load. Do not move unknown materials;
- contact the weighbridge office and the senior management and secure the area, should a serious problem occur;
- complete the WIF and a copy of the completed form to the driver, send another copy to the Client, and maintain the original of the form in the Operator's on-site files. This form should be filled out for every detailed waste inspection, whether the load is accepted or rejected;
- if no unacceptable waste is found, then thank driver for his time and inform him to proceed to the tipping face for unloading the waste; and
- if unacceptable waste is found during the inspection, notify the driver, and indicate on the WIF the reason(s) why the load did not conform with the regulations.

The weighbridge staff can advise the driver of other alternate approved facilities, where the unacceptable waste could be disposed.

Waste Inspection Documentation

The Contractor is to accurately and orderly maintain a set of originals of all waste inspection documentation and photographs at the site office. Any off-site storage of the same has to be first approved in writing by the Owner.

Copies of all WIFs are to be forwarded by the Operator to the Client on a weekly basis, with the exception to provide them immediately, if the incoming load contained waste of hazardous nature.

The Operator should also maintain the records and provide to the Client with a monthly and yearly summary of waste inspections carried out in the Eccles landfill.