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Prepared By:

exp

56 Queen St. East
Brampton, Ontario L6V 4M8
Canada
T: 1.905.796.3200
F: 1.905.793.5533
www.exp.com

_____
Alida Saleh, M.A., B.A., LEED AP
Project Manager

_____
Stan E. Gonsalves, M.Eng., P.Eng.
Executive Vice-President

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FINAL EIA UPDATE
TABLE OF CONTENTS

Page

FINAL EIA UPDATE
TABLE OF CONTENTS

LIST OF ACRONYMS

EIA - Environmental Impact Assessment
EPA - Environmental Protection Agency
MOLGRD - Ministry of Local Government and Regional Development
EMP - Environmental Management Plan
AERMOD - Air Dispersion Screening System
GSWMP - Georgetown Solid Waste Management Program
HBSL - Haags Bosch Sanitary Landfill
IDB - Inter American Development Bank
GoG – Government of Guyana
ERM – Environmental Resource Management
LFG – Landfill Gas Control
ETZ - Equatorial Trough Zone
ITCZ - Inter Tropical Convergence Zone
GM – General Manager
NDC - National Democratic Council
PEU – Project Execution Unit
RDC - Regional Democratic Council
GDB – Guyana Defense Board
COD - Chemical Oxygen Demand
LCS - Leachate Collection System
ADC - Alternative daily cover
EMD - Environmental Management Division
WMO - Waste Management Officer
QA/QC – Quality Assurance/Quality Control
CRA - Conestoga Rovers & Associates
UNCED - United Nations Conference on Environment and Development
BKI - BK International
MoH - Ministry of Health
WMO - Waste Management Officer

LIST OF APPENDICES

1. Authors of the EIA (names, affiliations, qualifications, relationship to project sponsor)
2. Terms of Reference for preparation of the EIA
3. Record of stakeholder/public consultation activities (e.g., meetings, training sessions, etc.)
4. Results of AERMOD Air Dispersion Assessment
5. Bibliography/References
6. Environmental, health and safety permits/authorizations – **No new permits issued since initial EIA**
7. Revised General (Site) Plan Drawing (G-1.0)

1.0 EXECUTIVE SUMMARY

An Environmental Impact Assessment (EIA) Update report has been prepared for the 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). This Environmental and Social Assessment Update has been prepared in compliance with the IDB & EPA policies concerning environmental protection.

The initial Environmental Impact Assessment base report was initiated by Ground Structures Engineers Consultants Inc. and modified/completed by Trow International Ltd. in association with Conestoga Rovers & Associates (CRA) in 2005. The EIA (2005), through the community consultation process, established a buffer area of 2 km. However, the Government of Guyana, through its Ministry of Housing and Water, recently initiated a new housing initiative to be located in the perimeter covered by the current buffer zone agreed in the 2005 EIA, decreasing the buffer area to approximately 260 meters. In addition, the government has decided to consider including a special cell on the lands adjacent to the new landfill to receive hazardous and healthcare waste. As such, the GOG has retained exp International Services Inc. (formerly Trow International Ltd.) to update to the EIA with reference to these changed conditions.

The specific objectives of this Project are to update of the original EIA and to undertake an environmental and social audit of the Program. Exp was requested to limit its work to the following activities, considering that the scope of the works and conditions described in the original EIA (2005) have not substantially changed:

1) Provide a concise description of any changes that have occurred to the original Project's general conditions, with an explanation of the change and its reasons and assess the project's geographic, ecological, social, and temporal context.

2) Describe any changes that have occurred to the legal and institutional framework, indicating flaws and proposing measures to strengthen actions, while duly considering the documents that have been produced within the Program.

3) Undertake a review and update of the environmental and social baseline and detect the gaps between the original document and the current conditions. Identify the major baseline aspects that need to be restudied, and update the

baseline by performing the necessary actions, where possible, to obtain new data/information.

4) Perform an independent review of the environmental and social practices set in place for the Program, while paying particular attention to:

   a. Compliance with all applicable environmental, health, safety and labor Guyana regulatory requirements, and applicable IDB environmental and social policies during the construction and the first operational phase of the project;

   b. Evaluate the operational observance of the procedures, regulations and objectives identified through the 2005 Environmental Management Plan (EMP) and the EIA;

   c. Review of the process set in place to involve the waste pickers and review the status of these actions. Propose detailed activities in order to improve and accelerate the process and implementation arrangements.

5) Identify and assess the impacts and risks that a reduction of the buffer and assess the impacts and risks stemming from the disposal of hazardous and healthcare wastes at the landfill. Review the environmental monitoring program currently in place. The focus will be on making recommendations on how to improve the monitoring mechanism and consider the activities related to the monitoring of the water quality during and after the useful life of the Project. Propose any mitigation measures and identify opportunities for environmental and social enhancements. Develop a mitigation plan that is feasible and cost- effective and that may potentially reduce significant adverse environmental and social impacts to acceptable levels.

6) Organize two (2) stakeholder/public consultation meetings with representatives of the relevant stakeholders to perform the assessments described above on the buffer zone reduction and on the inclusion of hazardous waste in the landfill.

OVERVIEW

Theoretically and conceptually, the HBSL can function with the reduced buffer zone, provided that it is operated in an environmentally sound manner. However, there are significant operating issues including matters of compliance that need to be addressed. These issues are discussed in detail in the body of this report. With respect to the siting of the hazardous waste cell, it is our opinion that the proposed facility could be considered in the location shown but a number of specific items need to be put into place before it could be given final consideration and subsequent approval. The hazardous waste cell has extensive service interconnections with the Sanitary Landfill, and some of these items such as leachate management for the Sanitary Landfill must be resolved before the final direction for the hazardous waste cell could be developed and finalized. Simply stated, issues with the Sanitary Landfill site must be resolved before considering integration of a hazardous waste cell. Recommendations for next steps have been provided in the body of the report.

SITE PREPARATION AND DEVELOPMENT

The site development and staging has been amended somewhat from the original design concept. The construction and sequence of development for the site have been altered and stressed by the early opening of the facility before the infrastructure was put into place and service. The sequence of filling is essentially moving forward in a random manner. This sequence of filling can be redesigned to be effective. However, the longer that it proceeds in the present manner, the more site capacity will be lost and the more difficult it will become to correct the operating conditions on the site.

The entire subject of daily, interim and final cover does not appear to be well understood by the operating contractor. It was observed at times that large portions of the site were completely exposed with limited or no cover in place. The lack of suitable equipment and resources are a key problem that needs to be corrected. Recent training interventions have led to an increase awareness of the issues and approaches that represent good practice. However, execution remains a work in progress.

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 management and effective use of the available soil materials is a critical element for an effective operating plan for the site. Alternative daily cover materials (ADC), which can viably augment the daily cover system may be utilized to cover waste as daily cover, but

to date there has been no significant recognition of the use and benefits of this type of material.

The initial design basis assumed that the waste density should be at least 0.600 tonnes/m^3 after initial filling and compaction. Effective compaction of the waste can only practically be achieved with a waste compactor. Typical bulldozers and other similar track equipment do not apply enough loading to provide effective compaction, nor does this type of track equipment assist in breaking down the very heterogeneous waste material in a manner that has any prospect of achieving the design requirement.

The expected quantity of waste to be received at the site was originally estimated by ERM to be in the range between 60,000 and 70,000 tonnes per year. The current rate of filling dramatically exceeds this rate by more than 50%. One of the key implications of this increased rate of filling is that the need and stress on odour control will be increased proportionately to this increase.

To date, largely because of the higher rate of waste receiving at the site and equipment deficits, the incoming materials are not being placed and compacted properly. Also note that poorly compacted waste will end up requiring more cover material and will prevent the filling plan from ever being implemented effectively. Unless current practices are modified, the site life will be reduced to less than 15 years.

The operating staff must be trained with regard to the concept of "overbuilding" and management of differential settlement considerations to maximize the site's capacity and potential. Note that overbuilding is simply the process whereby an area is filled to an interim height (elevation) that is above the final contour elevation in recognition of the rapid settlement that will occur during the operating life of the landfill such that the final height at closure reflects the final contour grade. This also includes the sideslope grade. Generally the sideslopes at closure of the site are designed as 4 horizontal to 1 vertical. However, the sideslopes can initially be constructed at 3:1 to safely allow for the settlement effects both from the waste and underlying compressible clay. From an overall height perspective, the central fill areas can be initially filled to approximately 2.5 metres above the proposed finished final contour. This is a net benefit for the site and is consistent with the intent of the final grading plan.

The surface water management and handling remains essentially as per the initial design concept of most of the elements. However, there are a few changes of concern that are not presently in place and active. The present design modification for the leachate treatment program directs all leachate into the stormwater management system

along the northerly part of the site. There is a pumped discharge control to move the stormwater into the canal on the east side of the site. None of this system is presently in place and this must be addressed as an urgent compliance item relevant to both the leachate management and the stormwater management.

The leachate management systems as generally envisaged in the original design for the Haags Bosch Landfill Site have evolved substantively in scope and nature from the original design. The initially proposed leachate treatment system has been proposed to be modified as outlined in a report issued by HydroPlan in August 2010. The basic concept can be made to work if implemented in a progressive manner with contingency provisions to upgrade and modify the sequential pond system as may be needed in the future. It is assumed that this need will be established by a suitable monitoring and enforcement program.

There are presently no measures in place for the leachate treatment system. As of this date, the leachate treatment consists simply of surface discharge into the former sugar cane ditches crossing the property and eventually discharging primarily to the canal adjacent to the northern limit of the site. The relatively long flow path and dilution effect in the existing internal ditches does provide some limited attenuation and mixing but it is not a suitable or sustainable condition. The proposed Leachate Collection System (LCS), will still need to be constructed in stages in conjunction with the development of each of Stages 1 through 4. The leachate pumping stations and force mains for adjacent cells need to be installed immediately to make the system functional.

A concept for active LFG control system has been developed and should be implemented upon reaching specified triggering levels or conditions that would initiate the installation and operation of the LFG collection and flaring system.

The proposed landfill for hazardous waste has not yet been developed to a 'buildable' level. Some additional items that need to be considered include the following:

There needs to be contingency storage at the hazardous waste area in the event of a potential compliance problem; There needs to be plans developed for a pre-treatment step to be located at the hazardous waste landfill; and there needs to be rigorous monitoring program developed to confirm the health and performance of the wastewater treatment at the Haags Bosch Landfill that also considers more appropriate input parameters and the peaking effects through the site development and coordination with leachate input from the hazardous waste site.

INSTITUTIONAL AND LEGAL FRAMEWORK ASSESSMENT

There have been some changes in the institutional framework since the original EIA issued in 2005. At that time, the executing unit for Solid Waste Management rested within the Municipality. This was changed in 2009. It is our understanding that the prime responsibilities for waste management now rests within the Ministry of Local Government and Regional Development (MOLRD) and the Environmental Protection Agency (EPA).

The Guyana EPA retains legislative and regulatory responsibilities, including enforcement, issuance of permits and licenses, while implementation, monitoring and policing rests within the MOLGRD. This is a reasonable arrangement given the in place network associated with MOLGRD. Some refinements in the present EPA structure and its Environmental Management Division are required to ensure consistency and clearer definitions of roles of responsibilities. Parties are committed to cooperate in order to develop procedures and guidelines to service the needs described in the roles and responsibilities identified above. However, it has been observed that the agencies still lack the institutional capacity to execute the respective responsibilities and navigate intra-government priorities. This should continue to be addressed by a program of institutional strengthening, training and the use of best practices from other developed jurisdictions adapted for Guyanese conditions. The necessary human and fiscal resources should be available for this purpose.

In summary, while the institutional framework, including defined roles and responsibilities of key agencies, is considered reasonable, program delivery is impaired by the lack of capacity within these key institutional units. This should be addressed by formalizing the desired level of intervention in the waste management program, prioritizing the involvement, assessing human and other resources required for delivery and conducting a gap analysis referencing existing capacity. Based on this analysis, commit the resources for necessary training, policy and guideline development and program execution by the key agencies.

DESCRIPTION OF PHYSICAL AND SOCIAL 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 and industrial development within 260 meters of the facility.

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).

REGIONAL GEOLOGY

The regional geology of the Haags Bosch area is located within the Guyana Coastal Plain and remains consistent with the data outlined in the 2005 EIA.

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. Accordingly, it has the same extent as the coastal plain. Recharge from rain and seepage loss from streams in the catchment area replenishes the groundwater reservoir.

SURFACE WATER

It is the surface water which is the primary receptor of concern for any environmental releases associated with this site.The present concept for leachate and surface water control is enhanced natural attenuation by integrating these 2 systems. The revised design for the leachate treatment, combined with the much reduced buffer zone and the potential addition of the hazardous waste cells has acted to increase substantively the attention and sensitivity for the monitoring and management of these combined systems.

BIOLOGICAL RESOURCES

Project activities, namely, implementation, construction and operation are not likely to have an impact on the nearby biological resources. No threatened or endangered plant or animal species or rare ecosystem is known to occur or is associated with the Haags Bosch site.

NOISE

Noise releases will be short term and will not cause long term environmental distress.

TRAFFIC

Traffic impacts will be marginal for inclusion of the hazardous waste cell.

SOCIO-ECONOMIC ENVIRONMENT

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 population of Guyana, obtained from the 2002 Population and Housing Census, consists of approximately 751,223 persons.

NEGATIVE ENVIRONEMNTAL IMPACTS

This project environment is well known and means/methods and mitigations are proven effective in their intentions provided that the site is operated in accordance with good practice, the recommended systems are in place, functioning and are shown to be so by a rigorous program on monitoring mitigation. Negative impacts are not expected to be significant. However, existing operational issues must be addressed in a timely manner.

POSITIVE ENVIRONMENTAL IMPACTS

The construction and sound operation of the Haags Bosch Sanitary Landfill is intended to satisfy a demand for environmentally sound management of wastes generated in GM and surrounding NDCs and will result in a diminished level of illegal dumping and improved management of solid waste. However, implementation of the Programme will only eliminate illegal dumping to the extent that there is adherence to good solid waste disposal practices by the population.

BUFFER ZONE REDUCTION

The buffer zone has been progressively reduced from 2 km to the presently proposed 260 metres. Our assessment is based on a minimum separation of 200m to any

development and the location of on-site facility has been set. There are modern generation landfill sites in North America and Internationally with buffer zones as small as 100 metres. These include landfill sites that also have properly designed, built and operated hazardous waste facilities. However, it should be recognized that the smaller the buffer zone the higher is the sensitivity to the engineered controls that must be in place. This also applies to the associated performance monitoring and enforcement programs that are needed to ensure that the site is effectively managed from both an environmental perspective and from all of the aesthetic and public nuisance related concerns that can be associated with waste filling sites.

It is difficult to accept and recommend any reduced buffer zones or inclusion of hazardous waste facilities until the requisite engineered control systems, monitoring and enforcement programs are in place and operating effectively. However, should the considerations and measures in this regard and as discussed above be integrated into a comprehensive program, with firm official sanction, we believe the buffer zone could be reduced to the proposed 260 metres separation to the industrial lands. The buffer needs to be set for all directions bordering the landfill site.

KEY RECOMMENDATIONS

- Consideration should be given to setting buffer and protected zones with appropriate legal and institutional safeguards.
- Complete and commission the leachate treatment system with associated monitoring
- Adhere to applicable Environmental Management Plan (EMP) and associated QA/QC issues
- Continue training and Institutional Strengthening
- Continue and enhance community participation

2.0 UPDATE OF PROJECT DESCRIPTION

2.1 OVERVIEW

The design, construction and operation of the Haags Bosch Sanitary Landfill Program was set up to provide an environmentally sound Solid Waste Management Program to the residents of Georgetown and the surrounding NDCs. A number of changes have occurred to the surrounding environment, pertaining to land use and the design of the landfill. The following summarizes some key changes that have occurred to the general conditions of the site:

- The Government of Guyana, through its Ministry of Housing and Water, recently initiated a new housing initiative to be located in the perimeter covered by the current agreed upon 2km buffer zone in the 2005 EIA, decreasing the buffer area to approximately 260 meters and this assessment is based on a minimum buffer zone of 200 meters. Part of this new development includes industrial activities, some of which are in waste management related areas. As illustrated on the concept plan below (Figure 1), provided through the IDB by the Ministry of Housing and Water, the industrial area occupies a zone between 260 and 500 meters with housing being allocated beyond that point. Buffer zones to the south has been defined, however other boundaries (north and east) remain undefined. A general site plan is included in Appendix 7 (Drw No. G-1.0).

Figure 1: Housing Scheme and Future Plans of Ministry of Housing and Water

The proposed housing is reported to be conventional single family homes, typical of the area with water service provided by municipal sources. Sanitary systems will likely involve septic tanks common to the Georgetown area and storm run-off will likely be directed to the Canal System already in place. More recently, it was observed that much of the road network was in place and some housing construction started. The proposed industrial complex is reported to be set between the housing and the new redefined buffer zone proposed for the landfill site. The designated area for the industrial development backs on to the canal to the north, which is the receiving watercourse for efficient (presumed treated) from the landfill site. Municipal water will service the industrial complex. Storm water will drain to the canals. It is assumed that specific sanitary controls and other necessary industrial waste controls will be in accordance with local EPA requirements and municipal regulations.

- The Ministry of Local Government and Regional Development (MLGRD), requested that a provision be made to include a special cell in the Haags Bosch Sanitary Landfill to receive some hazardous and healthcare waste. The Senes report includes some information, a summary of which is included in this document. The information provided by Senes is, in our opinion, a preliminary design concept. This EIA Update is limited to looking at and commenting on the suitability of a hazardous waste cell at the location as proposed, based on the information provided only, commenting on and considerations related to the buffer zone reduction and providing recommendations regarding additional work and actions necessary to make a decision whether or not to undertake this cell construction. The scope of this study does not involve developing hazardous waste facility to a 'buildable' status. It is recommended that such development be done by the retained consultant for the Hazardous Waste Facility to ensure compliance with all applicable standards and EPA regulations and policies.

  It is our opinion that the proposed facility could be considered in the location shown but a number of specific items need to be put into place before it could be given final consideration. The hazardous waste cell has extensive service interconnections with the Sanitary Landfill, and some of these items such as leachate management for the Sanitary Landfill must be resolved before the final direction for the hazardous waste cell could be developed and finalized. Simply stated, issues with the Sanitary Landfill site must be resolved before considering integration of a hazardous waste cell. Recommendations for next steps have been provided.

- The leachate management systems, as generally envisaged in the original design for the Haags Bosch Landfill Site, have evolved substantively in scope and nature from the original design. The new scheme, illustrated in Drawings prepared by Hydroplan, removes some of the more active mechanical treatment elements and replaces it with a more passive approach. It is reported that the decision to move to this more passive system of leachate treatment was adopted by the PEU and GoG to reduce long-term maintenance issues and enhance the sustainability of the system. More recently, additional changes in the form of some simplification, completion of details and incorporation of as built conditions have been commissioned by the IDB on behalf of the GoG, although the overall concept remains the same.

2.2 BACKGROUND

The impacts of improper solid waste management have become a critical environmental problem in Georgetown and throughout Guyana. In May 2006, the Board of Directors of the IDB approved LO-1730/SF-GY for US$18.07 million to finance the Georgetown Solid Waste Management Program (GSWMP). The goal of the Project is to implement sustainable solutions for solid waste management in the Metropolitan Area of Georgetown, Guyana. Based on the contract/BID documents prepared and issued by GOG and developed from the base document issued by the Trow International Ltd. Team, BK International (BKI) was awarded the contract to build and operate the HBSLF in November 2009, A Draft Environmental Impact Assessment base report was initiated by Ground Structures Engineers Consultants Inc. and modified/completed by Trow International Ltd. in association with Conestoga Rovers & Associates (CRA) in 2005. The EIA (2005), through the community consultation process, recognized a buffer area of 2 km. However, the Government of Guyana, through its Ministry of Housing and Water, recently initiated a new housing initiative with some industrial activity to be located within the perimeter covered by the initially envisaged buffer zone established in the 2005 EIA. This effectively decreases the buffer area to approximately 260 meters. In addition, the government decided to include a special cell in the new landfill to receive hazardous and healthcare waste. As a result the Government of Guyana has retained exp International Services Inc. (formerly Trow International Ltd.) to update the EIA and to identify and assess the impacts and risks that a reduction of the buffer would impose. In addition, exp will assess the impacts and risks stemming from the disposal of hazardous and healthcare wastes at the landfill based on available data. In undertaking this task, the exp Team reviewed the following reports:

- Draft Second Progress Report on Healthcare Waste Management Volume II prepared by SENES Consultants Limited in February 2010 for the Guyana Ministry of Local Government and Regional Development

- Alternative Leachate Treatment Plant Design and Storm water Management report prepared by Hydroplan for the Guyana Ministry of Local Government and Regional Development in August 2010

- EIA Addendum prepared in March 2011 for the Guyana Ministry of Local Government and Regional Development by SENES Consultants Limited. To date the report has not been approved by the EPA

- Site Operations Plan Version 1.0 prepared by Hydroplan for the Guyana Ministry of Local Government and Regional Development in May 2011

2.3 SITE PREPARATION AND DEVELOPMENT

The site development and staging has been amended somewhat from the original design concept. This includes the sequence of development and filling of the 4 Stages of the Site as well as the lift filling being undertaken in the initial Stage 1 area. The sequence of filling is essentially moving forward in a random manner that is primarily a function of a few key factors:

- There is a lack of suitable equipment to operate the tipping face, compact the waste and move forward in a controlled manner;
- The use and application of cover are not done correctly and this is, at least in part, also a function of equipment and resources as well as training and education;
- The rate of filling far exceeds original projections and there has been no plan modification to reflect this condition; and
- There has been some ongoing training with respect to management of the tipping face and progression of filling. The effectiveness of this remains essentially unknown and cannot be properly assessed until the site has adequate equipment and resources to operate as intended.

The sequence of filling in the present manner is also going to affect how landfill gas management is developed and constructed as the filling to date has already been done in a manner that is not consistent with the original design concept for filling. This item will need to be addressed over the next year.

In summary, the sequence of filling can be redesigned to be effective and the longer that it proceeds in the present manner, the more site capacity will be lost and the more difficult it will become to correct the operating conditions on the site. The adaptation with respect to the sequence of site development is not considered a major change and does not pose any fundamental difficulties to the site development as long as the related sequence of site filling and implementation of the site services, roads, buried piping etc. is adapted to be compatible with this revision. Based on observations to date, the changed site development plan has not been updated and upgraded to be compatible with the current staging. Some of these matters may have been a result of the forced early opening of the site before the requisite infrastructure was in place but the various elements need to be rectified before it is too late to address some of these items in an economically and environmentally sound approach that still satisfies the objectives for the program and facility.

There appears to be a fundamental misunderstanding by the Contractor regarding the purpose and value of the Landfill Site. A landfill site's primary resource is the air space that is available to be used to fill with waste in a properly constructed, controlled and managed operation. The use of the "airspace asset" is fundamental to this site and to any site constructed for this purpose. All of the infrastructure must be put in place to ensure that the air space optimization can be done cost effectively and in a manner that is protective of the environment and makes effective use of the site. Specific examples of major shortfalls and failures in these areas include, from an operating standpoint, essentially no compaction of the waste and no functional leachate treatment system. These examples generate both concerns for the environment and for the economics and long-term value of the site. These fundamental problems then lead to additional issues with operations, environmental controls and also the health and safety of staff and recyclers on the site.

The sanitary landfill consists of four stages, which will be developed progressively to coincide with the rate of waste disposal based on information obtained from the site operator. The rate at which the site is receiving waste is approximately 50% higher than the projected filling rate provided at the time the design concept was approved. The site can certainly accept and adapt to this rate of filling at well over 100,000 tonnes per year but there are a number of changes necessary to meet the demands of this rate of waste input. Care needs to 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. To date, this practice is not being observed, likely because it is not fully understood and the operating staff has not been

fully trained to understand the relevance of the site filling to the performance of the engineered systems. This practice must be changed immediately and will be a key focus in the upcoming training and education program proposed as part of exp's mandate.

A further consideration of the much higher rate of filling is the stress that this will place on the odor control systems, which will also be needed earlier than originally envisaged because of the higher annual input. This will be discussed further in a subsequent section on landfill gas management.

2.4 FINAL SITE CONTOURS

The key criteria of the final grading plan at Site closure is approximately 10 metres above the existing ground elevation with a maximum side slope around the perimeter of the four stages of the landfill at 4:1. No change to this plan or to the total available capacity of the site has been proposed. This may warrant further consideration. However, the increased rate of waste receiving at the site coupled with an inadequate area preparation to receive waste has stressed all of the systems and has essentially encouraged poor filling and compaction practices.

There are 2 extremes noted at the site. In some areas there has been rapid waste filling with almost no compaction and in others there has been very shallow thin lifts of waste place with a very high ratio of cover soil to waste placed. Neither condition is appropriate and results in loss of equivalent waste disposal capacity. These practices can be corrected through better education and training. However, it is also noted that there is not enough cell base being prepared and opened to allow the waste to be placed in the correct sequence and lift lines. More recent relatively heavy activity by the contractor in advancing cell construction will serve to significantly mitigate this condition. However, this rapid overfilling in central areas of the disposal cell will result in greater difficulties with respect to differential settlement. Another concern is that the overuse or misuse of cover soils may result in a shortage of material necessary to close and progressively cap the site as areas of it reach final contour.

The operating staff must be trained with regard to the concept of "overbuilding" and management of differential settlement considerations to maximize the site's capacity and potential. Note that overbuilding is simply the process whereby an area is filled to an interim height (elevation) that is above the final contour elevation in recognition of the rapid settlement that will occur during the operating life of the landfill such that the final height at closure reflects the final contour grade. This also includes the sideslope

grade. Generally the sideslopes at closure of the site are designed as 4 horizontal to 1 vertical. However, the sideslopes can initially be constructed at 3:1 to safely allow for the settlement effects. From an overall height perspective, the central fill areas can be initially filled to approximately 2.5 metres above the proposed finished final contour. This is a net benefit for the site and is consistent with the intent of the final grading plan.

This was emphasized in recent training sessions and should continue to be reinforced. Overbuilding is essentially the process of using limited overfilling both in the overall depth of waste and in the side slope inclines to account for the extremes of settlement that occur in a landfill site, such that the final grading and contouring can reasonably reflect the proposed final grading plan upon closure of the site. This concept also is important for optimizing the use of the landfill capacity and ensuring that areas are not closed too early and in a manner that is not compatible with good drainage and cover maintenance.

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, but the use and management of cover materials need to be better conveyed to operating staff with clear rationale on how this system element is to be managed. While it is recognized that the available on site soil is not ideal for use as cover, particularly during adverse weather it certainly needs to and can be used for this purpose. The entire subject of daily, interim and final cover does not appear to be well understood by the operating contractor. It was observed at times that large portions of the site were completely exposed with limited or no cover in place. Again the lack of suitable equipment and resources are a key problem that needs to be corrected. Training and education will mitigate these issues however, without the means to implement them with adequate equipment they will be ineffective. In the current unconsolidated (uncompacted) condition of the site, the use of cover is very inefficient.

2.5 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 m^3. As noted previously, the management and effective use of the available soil materials is a critical element for an effective operating plan for the site. In the early stages of filling, there is a tendency to be sloppy and somewhat wasteful in the use of the

available cover materials. The implications of this use of soil materials does not appear evident in the early stages of site development but rather ends up being a back end cost for the operations of the site as it ages and the final cover is progressively being applied to the site. This practice can be addressed through education and training of the operations staff for the facility. There should be an ongoing tracking of this asset to ensure that it is effectively managed through the entire site life.

Alternative daily cover materials (ADC), which can viably augment the daily cover system may be utilized to cover waste as daily cover, but to date there has been no significant recognition of the use and benefits of this type of material. As indicated, one concern for the on-site materials is that they are not ideal for use as daily cover. Certainly it is expected that this material will need to be used. However good practice would be to accept and use construction and demolition debris and other types of coarser materials as daily cover whenever they can become available. This improves the overall performance of the leachate collection systems and helps to prevent perching of leachate in portions of the waste mass.

2.6 WASTE VOLUMES AND SITE LIFE PROJECTIONS

The initial design basis assumed that the waste density would be approximately 0.600 tonnes/m^3 after initial filling and compaction. It was also estimated that the ultimate average density of the landfill mass prior to placing final cover will be approximately 0.850 tonnes/m^3. These are valid ranges for a site that is properly filled and compacted in a well managed operating program. However, to date and largely because of the higher rate of waste receiving at the site, the incoming materials are not being placed and compacted properly. Further, the concept of filling to grade and maximizing the site capacity by managing the controlled settlement of the waste and the use of daily cover has not been effective to date. This poses a major concern for 2 reasons. The site life is a function of the waste density. Any changed condition that reduces this density has a direct relationship to the maximum capacity of the site and therefore the site life. This essentially means that the combination of the higher incoming rate of waste delivery and the current handling practices will result in a substantially reduced site life as well as poorer leachate collection. Unless current practices are modified, the site life will be reduced to less than 15 years.

2.7 SURFACE WATER HANDLING

The surface water management and handling remains essentially as per the initial design concept of most of the elements. However, there are a few changes of concern that are not presently in place and active. The present design modification for the leachate treatment program directs all leachate into the stormwater management system along the northerly part of the site. There is a pumped discharge control to move the stormwater into the canal on the east side of the site. None of this system is presently in place and this must be addressed as an urgent compliance item relevant to both the leachate management and the stormwater management.

2.8 LEACHATE MANAGEMENT SYSTEMS STATUS UPDATE

The leachate management systems as generally envisaged in the original design for the Haags Bosch Landfill Site have evolved substantively in scope and nature from the original design. This technical review will assess the following:

- Observations regarding the current status of the leachate collection works;
- Identification of any deficiencies or corrective measures that may be required for leachate collection;
- Assess the currently proposed leachate treatment system for the non-hazardous waste landfill;
- Review the concept design and implications for discharging leachate from the proposed hazardous waste disposal cells into the treatment facility for the non-hazardous waste landfill;
- Review the implications of the leachate management and control from a Risk Assessment perspective; and
- Provide comments with respect to the schedule and timing of the necessary response measures that are recommended.

2.8.1 OBSERVATIONS AND CURRENT STATUS OF LEACHATE MANAGEMENT SYSTEMS

The primary elements of the leachate management systems are comprised of leachate collection system within each of the landfill cells or stages, the pumping chambers, pumping systems and force main(s) to direct the leachate and the leachate treatment system itself.

The Leachate Collection in the Cells has been modified somewhat with respect to the nature and use of the aggregate materials necessary to install functional drain systems at the base of the cells. These issues have been noted under separate cover. With adoption of the previously noted measures, the leachate collection system at the base of the cells can be recovered and extended into a suitably functional base drain layer. The measures recommended previously should be adopted and extended to all of the subsequently developed disposal areas.

The leachate pumping chambers and force main systems have been modified into an unusual configuration that in our opinion is more difficult to construct and would likely be more costly. The issue of deep excavations in soft clays needs to be considered. The basic principles for the leachate pumping systems are still in place but the original 4 pumping stations have been replaced with 2 pumping stations, one on each of the east and west sides of the site. As of this date none of these pumping systems and force mains have been completed or are functional.

There are presently no measures in place for the leachate treatment system. As of this date, the leachate treatment consists simply of surface discharge into the former sugar cane ditches crossing the property and eventually discharging primarily to the canal adjacent to the northern limit of the site. The relatively long flow path and dilution effect in the existing internal ditches does provide some limited attenuation and mixing but it is not a suitable or sustainable condition.

2.8.2 IDENTIFICATION OF DEFICIENCIES OR CORRECTIVE MEASURES – LEACHATE COLLECTION/PUMPING

The leachate collection underdrains have been discussed under separate cover and no further comment is needed except to reinforce that the grading, shaping and drainage routing originally established should be followed and greater care needs to be made to restrict and limit any fine materials being eroded into the drain layer from the landfilling/cover operations and plugging portions if it, thereby reducing its intended drainage capacity.

In the new configuration, the leachate from the adjacent cell on each of the east and west cells of the landfill is presently planned to be drained by gravity to the pumping stations #3 and #4 respectively. This can be made to be workable, however, there are a number of considerations that have not been addressed. The gravity drains form Stage 1 to 3 and from Stage 2 to 4 will be much deeper and difficult to construct in the native conditions at the Site. Although this approach can be made to work, any perceived cost

savings will likely be lost because of constructability and depth related issues and this will be a much more expensive approach overall. Further, this entails constructing Pumping Station 3 immediately together with all of the gravity drains, force mains and pumping systems that are associated with this. It will be a much more onerous approach and even if this approach is considered to be maintained, the pumping station should be considered to be relocated to the Stage 1 Chamber together with the force main that is needed as soon as possible. Stability / base heave issues from a geotechnical standpoint should be checked for all stages of the proposed construction.

There is also a complex multiple sump and drain system that, in our opinion, is both difficult to construct and which may be partially redundant and of limited value. It is highly recommended that this system be simplified to a single chamber routing system, although it is not clear with respect to what is currently in place where this is still possible for Stage 1. Further, the chamber currently installed in Stage 1 is within the cell limits and will be fully surrounded with waste. It is unclear what has actually been constructed with respect to the drain release and how it can be picked up and routed appropriately in a manner that can be serviceable and be maintained. Confined space issues for man entry must also be examined and addressed. There were no records available and the specific depth and location of the discharge piping is not known. This is a significant item that must be addressed immediately before any further filling or work adjacent to this chamber is undertaken.

2.8.3 ASSESS CURRENTLY PROPOSED LEACHATE TREATMENT SYSTEM

2.8.3.1 Overview and Background

The leachate management systems as generally envisaged in the original design for the Haags Bosch Landfill Site have evolved substantively in scope and nature from the original design. This technical review will comment on the following:

1. Proposed design and operating system proposed by HydroPlan
2. Expected performance of passive treatment system under post-closure scenario
3. Expected performance of the system during more realistic peak annual leachate generation profile
4. Expected performance of the system during more realistic peak operating scenario that is controlled by pumping system capacity and cell retention capacity
5. Summary and recommendations

2.8.3.2 Design & Operating Basis Currently Proposed Leachate Treatment System

The leachate treatment system has been proposed to be modified as outlined in a report issued by HydroPlan in August 2010. The basic concept can be made to work if implemented in a progressive manner with contingency provisions to upgrade and modify the sequential pond system as may be needed in the future. However, the system itself has been based on a water balance and series of assumptions with respect to leachate generation and characterization that are, in our view, not ,correct and demonstrate some misunderstanding regarding these aspects of a waste management system and landfilling for a specific site in Guyana with its particular considerations. The quantities of leachate to be handled for this specific site and the local conditions are interpreted incorrectly. Further, with leachate management systems, there needs to be a fundamental integration with the operating plan to understand the peaking effects related to leachate generation at various stages of the site development and how this needs to be managed to maintain a site that is compliant with environmental requirements and good practice. Simply stated the design basis needs to reflect a more appropriate set of input assumptions and values. The following discussion does not include the impact and considerations for the possible receipt of leachate from the proposed hazardous waste cell(s), which has been discussed elsewhere.

2.8.4 REVIEW CONCEPT FOR TREATMENT OF LEACHATE FROM PROPOSED HAZARDOUS WASTE CELL

As assessment and concept outline for hazardous waste disposal was undertaken by Senes in an EIA Addendum Report issued in March 2011. In this report, it clearly states that the author believes that the leachate from the hazardous waste cell can be discharged into the leachate treatment system for the Haags Bosch Landfill. The primary basis from this opinion and recommendation appears to be that the relative quantity would be so small that it would not have any negative or non-compliant effects on the treated leachate leaving the site and entering the canal to the north of the site. If this understanding is correct, then the fact that the leachate quantity characteristic is so significantly underestimated should further reinforce the assumption that the hazardous waste cell leachate will not negatively impact the wastewater treatment program and that it is suitable for discharge. At this point we are unable to fully support this premise as the data is limited or non-existent and the issues associated with toxicity and inhibitory effects in the treatment train being proposed for the Haags Bosch Landfill cannot be quantified based on the available information. We think that it may be adequate, at least in the initial years. It should be noted that the proposed passive treatment program utilitizes natural processes and long retention time to achieve its

desired treatment and attenuation results. However, this also means that the biology to be maintained in the sequential pond system will be somewhat sensitive to toxicity effects from some of the potential compounds even at the dilution levels and retention times envisaged. We believe that this type of program could move forward but with four major supplementary considerations;

1. There needs to a fully developed and defined analytical monitoring program to characterize the leachate at the hazardous waste landfill before releasing to the leachate treatment facility with defined trigger levels for action-response to unexpected/unacceptable quality;

2. There needs to be contingency storage at the hazardous waste area in the event of a potential compliance problem;

3. There needs to be plans developed for a pre-treatment step to be located at the hazardous waste landfill; and

4. There needs to be a corresponding and quite rigorous monitoring program developed to confirm the health and performance of the wastewater treatment at the Haags Bosch Landfill that also considers more appropriate input parameters and the peaking effects through the site development and coordination with leachate input from the hazardous waste site.

2.9 LANDFILL GAS UPDATE

In the original site development concept, the need for an active LFG control system was reviewed and it was determined at that time 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. A concept for active LFG control system has been developed and should 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.

The expected quantity of waste to be received at the site was originally estimated by ERM to be in the range between 60,000 and 70,000 tonnes per year. The current rate of

filling dramatically exceeds this rate by more than 50%. One of the key implications of this increased rate of filling is that the need and stress on odour control will be increased proportionately to this increase. This factor coupled with the current proposals to reduce the buffer zones to the north of the landfill from 2 km to approximately 260 metres will increase the potential for odour impacts such that immediate consideration for gas control must be addressed. A further complication is the fact that the initial filling is not consistent with the intended sequence of site development. The site was intended to utilize a series of horizontal gas collectors, with the first layer being installed at approximately the existing grade level or about 3 metres above the base of the landfill. The irregular filling undertaken in the initial phase of site development will make it difficult to install these collectors and there will be some added concerns for even greater differential settlement than would be typical, which must be considered and addressed.

2.10 CONSTRUCTION PROGRESS TO DATE

The construction and sequence of development for the site have been altered and stressed by the early opening of the facility before the infrastructure was put into place and service. Further, the high rate of waste receiving at the site has placed a demand on the site development phasing which would mean that the cell base and opening of additional areas must be accelerated to match this condition. To date, these conditions have not been addressed and they require that some reconsideration of the timing and sequence of development. Essentially none of the engineered controls for the landfill are presently in place and the site opened in early 2011.

Remedial efforts are needed to put all of the requisite systems in place. The program must consider the revised filling rates and will need to prioritize these works given the added stress that this is now an operating landfill. The operating requirements for the landfill will need to be taken into account and take precedence over the construction work when there are access conflicts etc. for the installation of all of the in-ground piping and other related works.

The proposed Leachate Collection System (LCS), will still need to be constructed in stages in conjunction with the development of each of Stages 1 through 4. However, with the revised cell development sequence, a number of the leachate pumping stations and force mains for adjacent cells need to be installed immediately to make the system functional.

2.11 SANITARY LANDFILL OPERATION

The early opening of the site was initiated without much of the key infrastructure in place. As important was the development of a modified operating plan together with training and education of the new operations staff. At this point, the operating staff are essentially operating the site as an emergency fill site and the balance of the infrastructure needs to be put into place together with a series of operating procedures and protocols to manage the site.

2.12 MONITORING PROGRAMS

Likely as a result of the emergency site opening, we are not aware of any of the required monitoring programs being put into place as yet to demonstrate the safe and effective performance of the site. The various areas of compliance and operations monitoring and their respective status as of this date are noted below.

Waste/Soil Volume Monitoring

The weigh scale is operational and incoming waste quantities are being recorded. There should also be tracking and inventory control for the soil resources on the site. This does not appear to be in place as yet.

Groundwater Monitoring

There are no groundwater monitors in place as yet.

Leachate Head Monitoring

The first cell is still open at the base and as such there is no requirement for leachate head monitoring. This should be initiated as soon as the first lift of waste covers the base of Stage 1.

Surface Water Monitoring

Not in place as of this date. One of the ponds is in place and functional.

Leachate Collection and Pumping Monitoring

Not in place as of this date.

Landfill Gases Monitoring

Not in place as of this date. However, it is observed that the emissions are noted in the immediate vicinity of the site and the reduced buffer and increased waste receiving rate will stress this aspect of site operations much sooner than originally projected.

Leachate Treatment System Monitoring

Not in place as of this date. An interim testing plan should be put in place until such time as the leachate treatment system is constructed and commissioned.

Inspection, Record Keeping and Reporting

The records to date appear to be limited to the waste quantity records. A full record keeping and reporting structure need to be developed and adopted.

3.0 INSTITUTIONAL AND LEGAL FRAMEWORK ASSESSMENT

The Environment Impact Assessment Update Process for development and operation of the Haags Bosch Sanitary Landfill project has been undertaken in accordance with the legislative and regulatory framework detailed below.

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. The legislative and Regulatory framework for the project was comprehensively covered in the 2005 EIA and are summarized as follows:

International Policy:

- United Nations Conference on Environment and Development (UNCED): Chapter 21 to General Assembly resolution 44/228, section I, paragraph 3

National Policy:

- National Environmental Action Plan (NEAP), 2000

Environmental Protection Regulations:

- Hazardous Waste Management Regulations
- Environmental Protection Water Quality Regulations 2000
- Environmental Protection Air Quality Regulations 2000
- Environmental Protection Noise Management Regulations 2000

IDB Policies and Regulations:

- Environmental and Safeguard Compliance Policy, OP-703
- Disaster Risk Management, OP-704
- Involuntary Resettlement, OP-710 OP-102
- Gender Equality in Development Policy OP-761

Other Sectoral National Policy and Legislation:

- Town and Country Planning Act
- Occupational Safety and Health Act 1997
- The Local Democratic Organs Act 1980;
- Municipal and District Councils Act 28:01;

- The Public Health Ordinance Chap 145, 1953 Ed.;
- City of Georgetown (Collection and Disposal of Waste) By.1aws 1981; and
- Delegation of Powers under section 118 by Minister to Regional Democratic Councils BLS 25th June 1983 under Local Democratic Organs Act 1980.

A combination of National, International and Regional Policies, Regulations, Legislations and Guidelines was reviewed and no significant changes have been enacted to date. The Revised Draft Solid Waste Management Bill was provided by the PEU. The legal and Institutional Framework for the execution of the Environmental Impact Assessment Update for the Haags Bosch Sanitary 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 project. The requirements of the Inter-American Development Bank (IDB), which encompass those of the named local environmental agencies, have been included.

There has been some changes in the institutional framework since the original EIA issued in 2005. At that time, the executing unit for Solid Waste Management rested within the Municipality. This was changed in 2009. It is our understanding that the prime responsibilities for waste management now rests within the Ministry of Local Government and Regional Development (MOLRD) and the Environmental Protection Agency (EPA). In essence, the role originally envisaged for the Advisory Board and Mayor and City Council of Georgetown rests directly with the MOLGRD. A Steering Committee which included representatives of the NDCs and the MOLRD functioned until the most recent national elections in November 2011. Since then, this Steering Committee has not been active and proposals for reinstatement are ongoing.

Based on a review of the reference documentation provided by the PEU, it is understood that the following is the current institutional relationship between the EPA and MOLRD with respect to the control of waste management issues.

<u>MOLRGD Roles:</u>

- Establish and maintain Environmental Units within each Regional Democratic Council (RDC) /National Democratic Council (NDC).
- Review Environmental Impact Assessments (EIAs) for compliance with the Environmental Protection Act for development projects and advise the EPA on the issuance of Environmental Authorizations.
- Confirm that the RDCs annual report on the environmental activities is prepared;

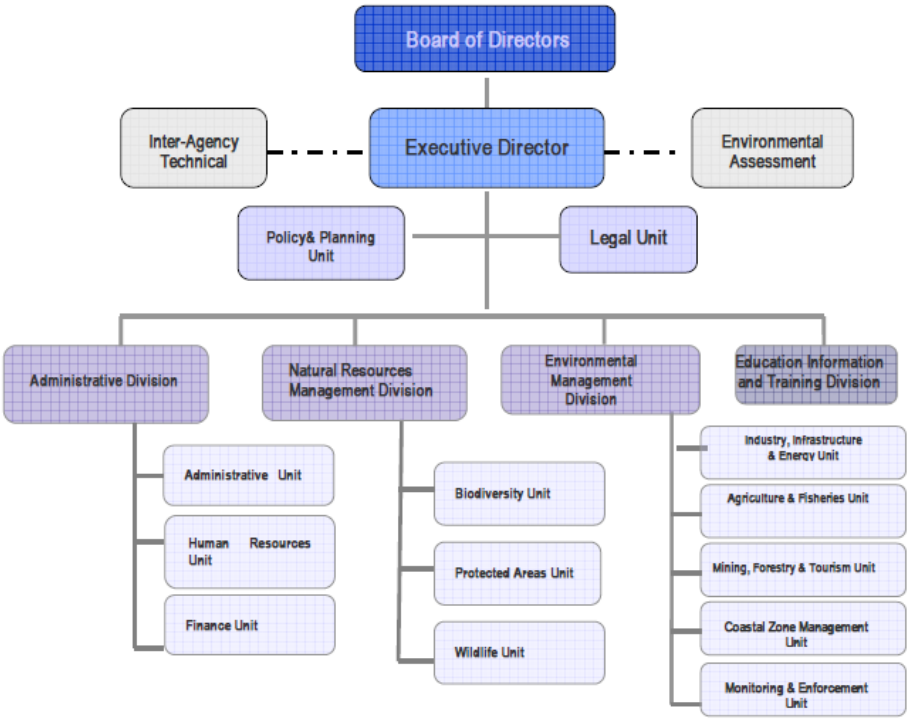
- Investigate and report on pollution complaints and perceived non-compliance activities to the EPA related to environmental authorization and permits.
- Ensure appropriate measures are undertaken to prosecute offenders for illegal dumping of waste throughout Guyana.
- Address RDC and NDC operational level waste management issues including collection and disposal.

EPA's Roles:

- Institutional strengthening of MOLGRD relating to environmental management aspects essential for program delivery.
- Regulatory enforcement responsibilities for waste management activities.
- Acting on notice of perceived non-compliance activities received from MOLGRD.
- Develop methods of collaboration, cooperation and functional aspects of the agencies.

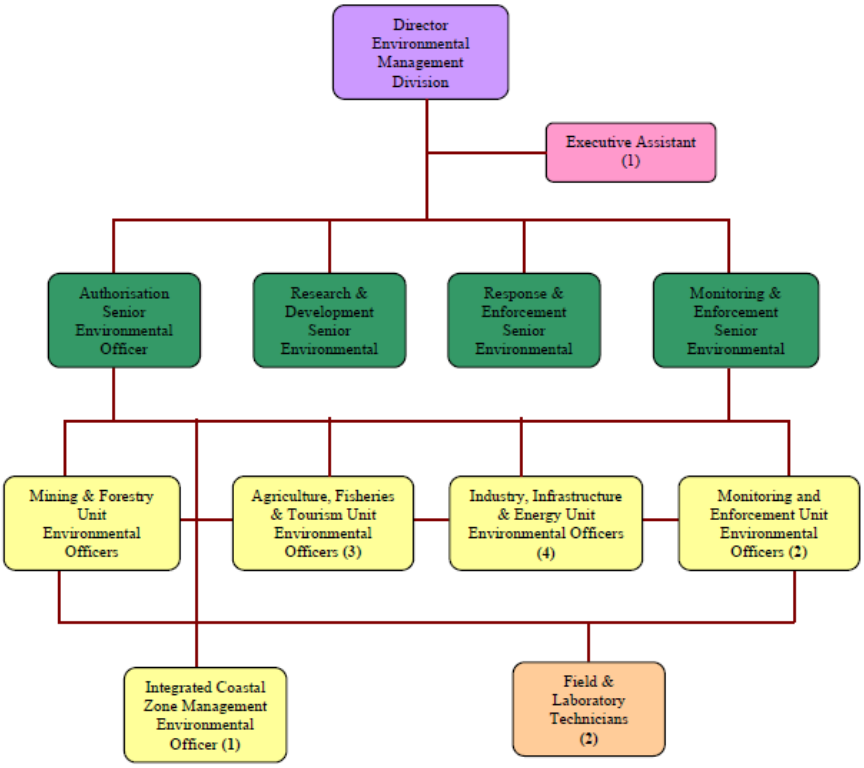
The following charts depict the current organizational structure of the EPA in Guyana and the Environmental Management Division of the EPA.

Current Organizational Structure of EPA in Guyana



Source: Senes Report on Haags Bosch-EIA Addendum, March 2011

Current Organizational Structure of Environmental Management Division of Guyana EPA



Source: Senes Report on Haags Bosch-EIA Addendum, March 2011

While the structure is generally sound there are conditions that should be addressed to ensure consistency, a smoother functioning organization and a clear definition of roles and responsibilities. More specifically, the Environmental Management Division (EMD) structure needs to be adjusted to more clearly reflect functional responsibility including the issuance of permits and related matters. Further, consistency with the overall EPA structure must also be established.

Based on the preceding review, the Guyana EPA retains legislative and regulatory responsibilities, including enforcement, issuance of permits and licenses, while implementation, monitoring and policing would rest within the MOLGRD. This is a reasonable arrangement given the in place network associated with MOLGRD. Parties are committed to cooperate in order to develop procedures and guidelines to service the needs described in the roles and responsibilities identified above. However, it has been

observed that the agencies still lack the institutional capacity to execute the respective responsibilities and navigate intra-government priorities. This should continue to be addressed by a program of institutional strengthening, training and the use of best practices from other developed jurisdictions adapted for Guyanese conditions. The necessary human and fiscal resources should be available for this purpose.

As an example of potential execution difficulties within the current institutional framework and resource base, reference is made to the siting of housing and industrial complex within the previously designated buffer/protected zone. Infrastructure installations and housing construction are currently underway. Notwithstanding any technical assessment of the acceptability of this development within a reduced buffer zone, clearly the process employed in initiating that development was inconsistent with the role of MOLGRD (specifically the item identified in the second bullet under MOLGRD roles listed above).

Good practice would have an approving authority such as the Minister of Housing and his/her assigns evaluate the merits of the plan for such elements as:

- Conformity with official plan
- Compliance with zoning by-laws
- Suitability of land for proposed purpose
- Flood protection
- Adequacy of water supply, sewage disposal and traffic management

This would all be executed with due consideration of and respect for the roles and responsibilities of the MOLGRD and the EPA. At a minimum these agencies need to be involved as commenting agencies on environmental impact issues for lands adjacent to but outside landfill designated areas. Typically, the landfill site would be surrounded by a minimum Buffer and an additional Protected Zone defined for specific periods of the life of the landfill from development, through operating and ultimate closure. The connected defined minimum Buffer would be under control of the MOLGRD and EPA and the Protected Zone controlled under the planning and zoning acts. This would provide the appropriate control but allow some flexibility, as the landfill enters the closure phase, to re-evaluate land use in the Protected Zone for other beneficial but environmentally safe activities.

The preceding example relates to the siting of new development near existing waste disposal facilities (Haags Bosch) and identifies issues with the intra-government approvals process. Similarly, in the development and siting of new waste facilities within existing communities the process should respect intra-government roles and responsibilities and the following general principles:

- Choices should consider Environmental, economic and social costs
- Protection of the Environment is a shared responsibility
- Local circumstances are incorporated
- Manage waste as close to the source of generation
- Optimum diversion and recovery of value from the waste stream
- Sustainability
- Public participation and transparent decision making

In summary, while the institutional framework, including defined roles and responsibilities of key agencies, is considered reasonable, program delivery is impaired by the lack of capacity within these key institutional units. This should be addressed by formalizing the desired level of intervention in the waste management program, prioritizing the involvement, assessing human and other resources required for delivery and conducting a gap analysis referencing existing capacity. Based on this analysis, commit the resources for necessary training, policy and guideline development and program execution by the key agencies.

Other specific items that should be given some consideration are the speedy re-activation of the Steering Committee identified above and the possible appointment of an Environmental Commissioner. This Commissioner or equivalent, would serve as an independent watchdog, appointed by the legislative assembly and tasked with monitoring and reporting on compliance in key environmental areas including the waste management sector and the government's success in achieving stated environmental goals. This would have to be further examined for compatibility and functionality within the current institutional framework

4.0 ENVIRONMENTAL AND SOCIAL CONDITIONS UPDATE

This chapter provides a description of the existing environmental and social conditions at the project within and adjacent to the project area.

4.1 DESCRIPTION OF PHYSICAL AND SOCIAL 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 260 meters of the facility. A number of significant housing developments with some industrial development have been undertaken by the Central Housing and Planning Authority (CHPA). It is intended that approximately 1500 new house lots will be made available to the public in the Eccles and Herstelling areas in the current year. The subject site surroundings/morphology remain consistent with that outlined in the 2005 EIA.

Update to the 2005 baseline physical environment is detailed below.

4.1.1 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). According to data from the Hydromet Office, Guyana experienced La Nina conditions in 1996, 2000, 2008 and 2011 which extended to March of each of those years.

Guyana being a low lying coastal state is extremely vulnerable to sea level rise and climate change. The climate change main impact is the increase of the frequency of the extreme weather conditions and the rise of sea level, the combined effect of both phenomena results in the increase of flooding risks due to heavy rains as well as the rise of the high water tide levels.

An emergency response plan for flooding and other emergencies should be prepared including the emergency response equipment and personnel for quick reaction in case of need for reparations and protection of the landfill components.

Air emissions at Haags Bosch result primarily from traffic along roads in the study area and the current construction process and waste placement at the landfill. Project activities, namely, implementation, construction and operation may all contribute to temporary release of fugitive dust emissions. Contracting parties should be required to develop, implement and enforce a number of project specific plans including, but not limited to the following: Emergency Response Plan, Emergency Cleanup Plan, Hazardous Substance Management Plan, Health and Safety Plan and procedures, Standard Operating procedures and maintenance plans.

In addition, emissions occur from the New Eccles Housing Development Scheme resulting from the use of unpaved roads. Other sources of emissions originate from the Eccles Industrial Estate and are primarily dust. In addition there are aerial emissions associated with GuySuCo aerial spraying of agricultural lands. Hence, there is a need to monitor air quality and particulate matter concentrations and volumes within the study area.

4.1.2 REGIONAL GEOLOGY

The regional geology of the Haags Bosch area is located within the Guyana Coastal Plain and remains consistent with the data outlined in the 2005 EIA.

4.1.3 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. Recharge from rain and seepage loss from streams in the catchment area replenishes the groundwater reservoir.

Groundwater monitoring data was unavailable and is presumed to be unaltered from the data provided in the 2005 Environmental Impact Assessment report. As discussed previously, the primary aspect of groundwater monitoring is to demonstrate effective hydraulic control of the disposal cells and to manage the release of treated effluent to the surface water management system. To date, there is no current monitoring in place and the coordinated and integrated monitoring systems that are discussed herein are critical elements of the site operations. Staff require training with respect to how to undertake this monitoring, and also how to interpret and utilize the data for the effective control of the site.

4.1.4 SURFACE WATER

The drainage network around the Haags Bosch site is separated from the drainage network around the Eccles Housing development and the industrial estate.

Surface water monitoring data was unavailable. This remains one of the most important considerations for this site. It has been reiterated that it is the surface water which is the primary receptor of concern for any environmental releases associated with this site. The nature of the underlying soils for the entire area are such that groundwater impacts are protected effectively by the natural soil conditions and by the engineered controls.

The present concept for leachate and surface water control is enhanced natural attenuation by integrating these 2 systems. In the original design for the site, the nearest resident is a minimum distance of 2.5 km from the site. The revised design for the leachate treatment, combined with the much reduced buffer zone and the potential addition of the hazardous waste cells has acted to increase substantively the attention and sensitivity for the monitoring and management of these combined systems. Reference is made to the various measures and programs that have been indicated as necessary to be environmentally protective and to document the satisfactory performance of the site. The proposed measures and the contingency response program are critical elements for the effective management and operation of the site.

4.1.5 BIOLOGICAL RESOURCES

The entire area of approximately 40 hectare (100 acres) proposed as the new site for the sanitary landfill is located within GuySuCo cultivated area. The site and surrounding areas have historically been cultivated with sugar cane *(Saccharum officinarum*) which presently covers the area and its immediate surroundings. 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*). Project activities, namely, implementation, construction and operation are not likely to have an impact on the nearby biological resources.

Conversion of the area to a sanitary landfill will only marginally alter the area available for sugar cane cultivation. Mitigation measures consisting of daily cover are being used to control the presence of birds and insects at the landfill site. A surface water

monitoring program must be enacted to ensure that effluent discharges from the facility are adequate to sustain aquatic life in the canals bordering the facility.

4.1.6 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.

4.1.7 NOISE, ODOR AND DUST

Noise will be generated during implementation and construction. These releases will be short term and will not cause long term environmental distress. Contractors must have procedures in place to address potential sources of noise in proximity to the existing site and for dust suppression. Standard Construction hours will be 0700 to 1900 Monday to Friday. A dispersion screening assessment for Odour indicates acceptable conditions assuming good operating practices at the landfill site. Details are included in the Appendix.

4.1.8 TRAFFIC

Waste is being delivered to the Site via the bypass road and the extended southern service road. Construction traffic and service vehicles access the Site via the existing East Bank Demerara Roadway and the road separating Eccles from Bagotstown.

Traffic flows to the landfill will approximate to 4 ten-tonne trucks per hour. Traffic impacts will be marginal and must be managed by restricting traffic to the new bypass road located west of the Site.

4.1.9 SOCIO-ECONOMIC ENVIRONMENT

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.

The population of Guyana, obtained from the 2002 Population and Housing Census, consists of approximately 751,223 persons. 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. The population in Eccles/Ramsburg NDC has been fairly constant over the last two decades. However there is a greater percent of homes in the NDC are single family homes. Out-migration and economic situation have contributed to the stagnation. However the Town has seen rapid geographical growth as housing areas have expanded in the vicinity of the project.

4.2 POSITIVE ENVIRONMENTAL IMPACTS

The construction and sound operation of the Haags Bosch Sanitary Landfill will satisfy a demand for environmentally sound management of wastes generated in GM and surrounding NDCs and will result in a diminished level of illegal dumping and improved management of solid waste. The Programme implementation will result in enhanced aesthetics in GM and NDCs. The availability of the sanitary landfill at Haags Bosch will reduce unregulated disposal of waste in NDCs and the associated likelihood of health impacts associated with improper waste disposal in these areas.

However, implementation of the Programme will only eliminate illegal dumping to the extent that there is adherence to good solid waste disposal practices by the population. The health impacts on residents of Georgetown adjacent to the Mandela Site will be partly mitigated by closure of the dump after the sanitary landfill becomes operational. These impacts will extend over the duration of the Programme and will have positive residual impacts on the health and aesthetics of the NDCs and Georgetown.

Implementation of the Programme will permanently eliminate open dumps used by NDCs and will contribute to improved aesthetics in these communities. It will also reduce expenditures for maintenance of drainage infrastructure, compromised by illegal waste dumping, in NDCs. Implementation of the Programme will also eliminate open burning and illegal dumping of waste and their associated threats to health and the environment. These impacts will extend over the duration of the landfill operations.

Composting will result in beneficial use of the organic stream of the waste and may generate revenues for GM and the Site Operator. It may also lower the initial investment cost for waste management facilities for waste from GM and the NDCs. Both of these impacts will extend over the duration of landfill operations.

4.3 NEGATIVE ENVIRONMENTAL IMPACTS

The primary negative impact of the Programme is due to construction and service vehicles passing along the road that separates Eccles from Bagotstown. These trucks may emit noise above levels currently common to the area. 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 construction and service vehicles each day accessing the Site will be significantly less than those hauling aggregate. Noise will be mitigated by incorporating specific equipment performance criteria for construction and service vehicles and limiting operating hours.

Gaseous exhaust consisting primarily of carbon monoxide and unburned hydrocarbons and fugitive dust emitted by heavy construction equipment may impact air quality at the site itself. Receptors are too far removed from the site for their air quality to be impacted. Noise will be generated during the construction process and is expected to be short term and will not cause long term environmental distress.

Several people gain their livelihood by collecting waste from the Mandela dump for sorting and sale of objects and materials such as glass, metals, plastics, paper/cardboard and textiles. Closure of the Mandela Site and operation of the Hague Bosch Sanitary Landfill will result in permanent cessation of this activity and permanently displace persons who currently earn a livelihood from scavenging. This impact is temporary and will be mitigated as waste pickers have been relocated to the Hague Bosch Sanitary Landfill.

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 these generators. This risk will be managed by using Waste Management Officer (WMOs) to enforce sanctions against littering and illegal dumping.

In assessing the potential environmental impacts of the project described in this Report, it is understood that there will be significant positive changes to the environment will result from the proposed project. None of the net effects from this project were determined to be significant and all are localized in nature. No offsite impacts are anticipated. The project environment is well known, and the methods and mitigations are proven effective in their intentions. The implementation of mitigation measures during the various project activities will reduce environmental liability and the likelihood of future negative environmental impacts. It is however, important to implement a Monitoring Program to record the successful implementation of the project components, this include surface water sampling and air quality monitoring and to comply with all other elements of the EMP.

5.0 ENVIRONMENTAL AND SOCIAL IMPACTS AND RISKS

The following table identifies major project risks and recommends mitigating measures.

RISK ASSESSMENT							
TYPE OF RISK	RISK	PROBABILITY RATING	IMPACT RATING	RISK CLASSIFICATION (HIGH=3, MEDIUM=2, LOW=1)	MITIGATION MEASURE	PERFORMANCE INDICATOR	RESPONSIBILITY
Design	Modified leachate treatment system design may be inadequate to deal with Hazardous Waste	1	3	2	Obtain expert/consultant opinion on adequacy of the modified treatment system and design for worst case scenario including allowance for treatment upgrade	Monitoring program including triggering levels of marker contaminant parameters	Operator
Design	Reduction in buffer zone resulting in negative environmental and social impacts	3	1	2	Implement a rigorous monitoring program to ensure environmental compliance. Ensure proper construction/operation of leachate treatment systems	Technical review and assessment in the context of best practices and international standards. Implement monitoring program	GOG and Operator
Construction & Development	Inadequate rate of cell construction	2	2	2	Ensure cell construction is adequate to receive the expected volume of Waste. Consider weather impacts in	Cell development sequence in sync with anticipated volumes. Review actual quantities of waste	Contractor/Operator

Risk Assessment							
Type of Risk	Risk	Probability rating	Impact rating	Risk Classification (High=3, Medium=2, Low=1)	Mitigation Measure	Performance Indicator	Responsibility
					development lead capacity.	received and future predictions. Site observations QA/QC Inadequate number of equipment in use for construction of cells	
Construction & Development	Delay in construction of leachate treatment system (and constructability issues)	3	3	3	Prioritize and accelerate construction. Address contractor issues resulting in development delay. Assess base stability issues for deep excavations in soft clay. Use appropriate construction techniques including sheeting as and if required Implement interim leachate storage measures.	Monitor base heave and stability. Monitor schedule. Monitor downstream water quality	Contractor/Operator
Construction & Development	Inadequate grade control	2	3	3	Ensure and monitor contractor compliance to technical standards including requirements for on-site resources	QA/QC	Contractor/Operator and GOG
Construction & Development	Material Storage (double handling)	2	2	2	Contractor planning and resources	Site observations QA/QC	Contractor/Operator
Operations	Incorrect operation and improper waste disposal	2	2	3	Training and contactor implementation;	QA/QC Program/Procedures	IDB and GOG Contractor/Operat

Risk Assessment							
Type of Risk	Risk	Probability rating	Impact rating	Risk Classification (High=3, Medium=2, Low=1)	Mitigation Measure	Performance Indicator	Responsibility
	sequence				Enforce contractual requirements	implemented; training performed ,	or
Operations	Failure to implement an environmental monitoring program	2	3	3	Implement a rigorous monitoring program. Enforce contractual requirements	QA/QC	Contractor/Operator
Governance	Lack of alignment / communication between contractor and other parties involved in the project	3	3	3	Resolve contractual issues including final contract drawings, specifications, establish communications protocol	Project progress report and claim status	Contractor/Operator and GOG
Macroeconomic	Inflation negatively impacting project scope and sustainability and increase in exchange rates impacting project cost	2	1	1	-	-	-
Environmental and Social	Construction works resulting in workplace accidents	2	2	2	Environmental and occupational safeguards enforcement by GOG and civil-works supervisor.	Number of accidents	Contractor/Operator
Environmental and Social	Improper waste disposal practice within local community	2	2	2	Implement public awareness campaign on 3R (reuse, recycle, reduce)	Number of waste generated at each household	GOG
Environmental and Social	Groundwater and/or surface water pollution caused by improper construction of leachate treatment system.	1	3	2	Enforce approved construction plan	Monitoring program	Contractor/Operator

Risk Assessment							
Type of Risk	Risk	Probability rating	Impact rating	Risk Classification (High=3, Medium=2, Low=1)	Mitigation Measure	Performance Indicator	Responsibility
Environmental and Social	Flooding and/or erosion of site during excavation and/or operation, particularly during extreme weather conditions (rain/hurricanes)	2	3	3	Ensure proper storm water management practices are in place	Observation of site conditions	Contractor/Operator
Sustainability	Impediments in the application of new and/or modified tariff policies impacting costs.	2	2	2	-	-	-
Sustainability	Weak institutional capacity impacting the use and sustainability of capital investment in the project.	2	2	2	Capacity Training	Project progress	GOG
Reputation	Corrupt and/or fraudulent practices	2	2	2	Transparent disclosure of project information and implement regular project audits	Annual audit reports reviewed	IDB/GOG
Monitoring and Accountability	Non-compliance of civil works to technical standard	2	2	2	Implement a rigorous monitoring program. Enforce contractual requirements	QA/QC	Contractor/Operator
Monitoring and Accountability	Inconsistency in the definition, measurement and verification of performance indicators.	2	2	2	Apply best practice	Conformance to international standards and project progress report	GOG

5.1 BUFFER ZONE REDUCTION

During the siting of HBSL, a minimum 2 km buffer zone existed between the limits of the proposed site and the nearest existing residential development. Some industrial development occupied intervening zones. These conditions were judged to be well suited to manage all environmental and public nuisance issues associated with a solid waste landfill facility including appropriately designed hazardous components. While exp has not to date obtained official development plans, it is understood that the need for public housing development has sparked proposed residential development within sections of the initial existing buffer zones. Further some additional industrial development is also being considered. Infrastructure for these developments is noted to be underway.

The buffer zone has been progressively reduced from 2 km to the presently proposed 260 metres. Our assessment is based on a minimum separation of 200m to any development and the location of on-site facility has been set. There are modern generation landfill sites in North America and Internationally with buffer zones as small as 100 metres. These include landfill sites that also have properly designed, built and operated hazardous waste facilities. However, it should be recognized that the smaller the buffer zone the higher is the sensitivity to the engineered controls that must be in place and the associated performance monitoring and enforcement programs that are needed to ensure that the site is effectively managed from both an environmental perspective and from all of the aesthetic and public nuisance related concerns that can be associated with waste filling sites. These include:

Item	Impact Category(s)	Issues	Monitoring and Mitigation
Leachate Management	Health and Safety Environmental Aesthetic	• surface water quality • human health • fish habitat • vegetation stresses • odour concern • leachate seepage • property value impact	• up gradient and down gradient monitoring on site and in canals • trigger levels and contingency planning • leachate treatment system upgrades • proper land use designations and planning for adjacent lands
Litter	Aesthetic	• nuisance from blowing litter off site	• litter screens near working faces

Item	Impact Category(s)	Issues	Monitoring and Mitigation
		• visual impact • property value impact	• proper use of daily and interim cover • control of incoming vehicles (tarping etc.) • proper perimeter fencing/screening • off site cleanup as required
Dust	Health and Safety Aesthetic	• particulate inhalation & related health concerns • nuisance related to dust accumulation • traffic and visual hazard • property value impact	• proper cover use • vegetate areas as done • traffic speed controls • road surfacing controls • road cleaning controls • dust suppressants (water and other)
Odour	Aesthetic (refer to results of Air Dispersion Model)	• multiple sources of odour (gas, leachate, fresh waste) • quality of life issue • property value impact	• proper use of cover • proper management of tipping face • gas control measures • proper control of leachate treatment system
Noise	Aesthetic	• quality of life issue • property value impact	• proper visual and noise screening • setbacks/buffer distances • modern equipment with noise protection features • hours of operation
Vectors & Vermin	Health and Safety	• disease transmission • nuisance • quality of life • property value impact	• proper use of cover • proper management of tipping face • final cover when area ready • hygiene and cleanup of waste picker and service areas • re-vegetation • exterminators
Landfill Gas Hazards	Health and Safety	• Fires • explosions	• proper use of cover • prohibition of open

Item	Impact Category(s)	Issues	Monitoring and Mitigation
	Environmental	• odour • worker health & safety • property value impact	burning and smoking • equipment maintenance not on waste • hot work permits • water supply/suitable on site equipment • fire management planning • waste picker licensing • fire control training (unique approach required for fire control)
Visual	Aesthetic	• Nuisance • quality of life • property value impact	• setbacks/buffer distances • visual screening and berms • site line restrictions and height restrictions

The landfill when operating as designed, functions as a 'hydraulic trap.' Previous assessments for the site included a contaminate transport model (Pollute) to examine potential impact on ground water with the landfill constructed as designed and for a number of possible operating conditions. The impacts were not of significance as reported, and similar conclusions can be drawn for the site under the reduced buffer zone. In the case of addition of hazardous waste cell of the nature described in the SENES Report, it is assumed that the proposed double liner systems, set on the native clay barrier will be suitably designed to conform to these requirements. Consequently, potential groundwater impact is not considered an impediment to acceptance of the proposed reduced buffer zone.

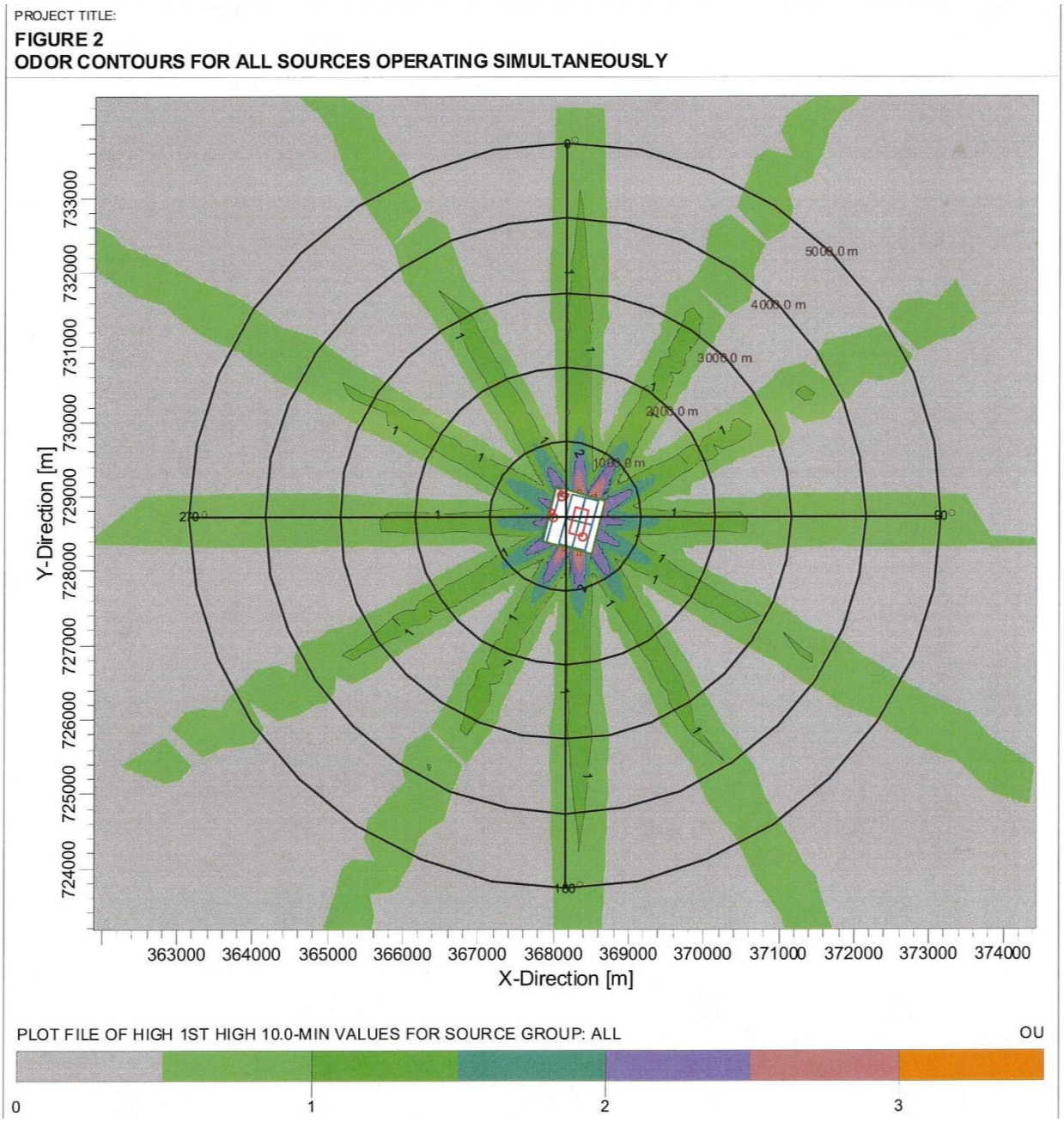
As indicated in several areas, the key potential impact is surface water contamination and this is controlled at the discharge point. Provided that the designed system is built, functions as intended and is proven to be so by the monitoring program, the impact beyond the newly defined reduced buffer zone is expected to be within acceptable standards.

Reliability, consistency and sustainability are key considerations for a good monitoring program. A baseline set of conditions needs to be established for the site and adjacent watercourses. However, the practical realities of setting up a monitoring plan based on analytical programs used for similar sites in North America and Europe is not realistic

or sustainable at this time in Guyana. This is evidenced by the lack of available and sufficient quality monitoring data to date at the Haags Bosch site. The extensive list of compounds that are often analysed for landfill sites in developed countries and initially proposed for Haags Bosch, are based on the assumed availability of reasonable cost analyses at fully equipped analytical labs in close proximity to the site. It's therefore advocated that the monitoring plan employs a reduced or 'marker' parameter list for routine and frequent analytical testing employing local, and preferably on site resources. This reduced program should be capable of being executed relatively inexpensively and regularly (monthly) while still providing sufficient information for judging the general effectiveness of the Leachate treatment system. This list at a minimum, should include PH, COD (Chemical Oxygen Demand), Total Ammonia, Total Nitrogen/Nitrates and Soluble Phosphorous. Off-site validation of the full parameter list can be done biannually or annually to satisfy the requirements of the Guyana EPA and the IDB.

The results obtained from the monitoring program would be the triggering mechanism to determine if further mitigation in the form of enhanced treatment facilities are needed. There is available space to implement these measures should the need arise.

To further address potential impact with the reduced buffer zone, on Air Dispersion Screening (AERMOD) assessment was conducted using odour as a critical or marker parameter. The detailed findings are summarized in Appendix 4 attached to this report. Figure 2 shown below and taken from that assessment report, presents the odour contours for all sources operating simultaneously. Based on this assessment, the reduced buffer zone would be acceptable from an odour standpoint, assuming good operating practices at the landfill site.



Theoretically and conceptually, the HBSL can function with the reduced buffer zone. Good planning practice adjacent to landfill sites includes staged development between the landfill and residential use. For example this could include areas zoned industrial/commercial situated such that these lands act as a supplementary or enhanced buffer to the residential areas. The above assumes that all industrial commercial and industrial activities are run in compliance with applicable laws and

regulations, particularly those pertinent to storm and sanitary discharge management. As summarized in the above table, industrial and commercial use can provide for items such as enhanced visual screening, noise reduction, security and access control.

It is difficult to accept and recommend any reduced buffer zones until the requisite engineered control systems, monitoring and enforcement programs are in place and operating effectively. However, should the considerations and measures in this regard and as discussed above be integrated into a comprehensive program, with firm official sanction, we believe the buffer zone could be reduced to the proposed 260 metres separation to the industrial lands. It is recommended that the buffer zone be given clear title as an integral part of the waste disposal facility. At a minimum 100 m of the buffer in closest proximity to the landfill site should be so treated/designated. This includes the undefined buffers on the north and east boundaries. Areas beyond can be addressed as Protected zones with land use covered by zoning and planning by laws.

5.2 LEACHATE TREATMENT SYSTEM

There are various risk management considerations for this aspect of the site development and operation. The risks can be characterized as financial, regulatory/compliance and technical. Some of the key considerations are:

Financial

There are 2 areas of primary financial risk. The Site is presently opened and operating but it is not approaching compliant status. The highest risk to the project is the loss of financial support for the capital works program, which is necessary if the Site has any hope or expectation of being brought into a compliant condition.

The 2nd area of financial risk is the operating phase of the project. The IDB is supporting the initial operating phase of the project to allow it to be developed into a modern landfill. This includes direct support for education, training of the operators, waste pickers and administrative staff. For the system to become sustainable, the technology and skills transfer is one of the most critical elements to ensure effective waste management systems are established and maintained over the long-term. This project is one of the few opportunities to fund and support this technology transfer. Any loss of this funding and support will pose a substantive risk to the safe and effective implementation of modern waste management practices in Guyana.

Regulatory/Compliance

Currently the site is non-compliant in many areas and therefore it is difficult to categorize the risks of each of the individual components of the overall leachate management system. Essentially, the existence on future operation of the site is at high risk until compliance can be restored. The presently defined emergency situation allowed some tolerance but based on current conditions, it will take most of the next year to bring the site into a compliant status. This applies to all of the components of the leachate management system. At this point no one subsystem is compliant or at any lessor level of sensitivity so the entire group of related components both for leachate collection and treatment are in a similar risk classification, all of which would be deemed at high risk until basic compliance is established and acknowledged.

As a related item, we believe that the non compliant status places an even higher onus on performance monitoring, which is another key area of non-compliance. The current practice is attempting to use natural attenuation as a short term control mechanism, but in a generally uncontrolled manner. The monitoring should be implemented immediately.

Technical/Environmental

Leachate source function needs to be reviewed and corrected. It poses a risk to the environment if a clear program based on monitoring data and performance is not established as the controlling basis for the ongoing development and operation of the leachate management system.

There needs to be a fully integrated leachate management program put in place that coordinates the development and operation of all components of the leachate management program, both collection and treatment. It is hard to categorize technical risks at this point as essentially all of the major components and functions have not as yet been implemented. The focus of all of the environmental concerns are related to managing and controlling the direct release of leachate into the natural environment via the surface water system. At this point, there is direct discharge of leachate into the natural environment.

There is a secondary but very important technical issue. The operating program as it relates to the use of cover and the long-term performance of the infiltration into the waste is directly related to the placement and compaction of waste and the subsequent

covering with natural soil. The Operators need training to understand the importance of this aspect of operations and how to manage it effectively or the value of the entire engineered system can be compromised and not able to perform as intended. The waste picker practices have not been implemented in a controlled manner. If immediate attention is not given, the site practice will become re-established similar to that at the previous landfill in Mandela. These practices, once ingrained into the site practice, will be difficult, if not impossible to correct. The site operating practices must be addressed now. This is not a specific leachate management system risk but the range of implications are interconnected and as such pose a risk for leachate management as well.

5.2.1 SCHEDULE AND TIMING CONSIDERATIONS FOR LEACHATE MANAGEMENT SYSTEM WORKS

It is our understanding that the Site was required to open early as a result of an emergency situation and the immediate forced closure of the former dump site at Mandela. Given this, the context of the schedule and timing is based on the current status with a moving forward approach to put appropriate measures in place as quickly as is practical. There are a few key milestones and tasks that should be integrated into the program based on the issues and considerations discussed above.

Leachate Quality/Quantity Source Function

The leachate source function needs to be redefined and the concept treatment designed needs to be refreshed and revisited with the corrected assumptions. There may be some offsetting errors/assumptions that could leave the proposed approach as a viable option, however, a detailed operating program and compliance monitoring program should be prerequisites for approval and implementation. This work could be undertaken quickly and should preferably precede field construction for the leachate system. Given the urgent nature of these items, it will still take a minimum 4 week period to consider, develop and obtain approval for these items. It is critical that the leachate treatment facility construction move forward as quickly as practical as this entire aspect of the site development is a compliance matter and can only be rationalized on the basis of the emergency closure and waste diversion.

Hazardous Waste - Leachate Management Plan

In our opinion a fully developed and integrated program must be developed for the leachate management before this work could proceed. The specific elements needed are

discussed above and hinge upon the Leachate Treatment Re-Evaluation and Update noted above.

Leachate Collection System

The most important considerations are ongoing development of cell area over the dry season to prepare enough area to receive waste through 2012. This work should be proceeding immediately to the south of the currently developed area. Recent increased activity by the contractor is this regard is encouraging.

Leachate Pumping and Force main System

This item needs to be addressed immediately with a release to initiate the works within 4 weeks. It should all be completed before the next wet season.

5.3 PROPOSED HAZARDOUS WASTE DISPOSAL SITE

The concept design for the proposed hazardous waste disposal site has been reviewed. We believe that the location could be adapted for a suitably controlled site. However, we would not recommend that this cell area be developed until all of the engineered features and monitoring programs discussed previously are put in place and demonstrated to be functioning properly.

Subject to the above being satisfied, there still needs to be a much better developed concept for the hazardous waste containment cells. The concept design for the cell base and the various measures for stabilization etc. have not been fully developed. There are no definitive protocols and procedures developed for the various types and classifications of hazardous wastes and as such any approval at this point is premature.

5.4 WASTE PICKERS

Informal waste pickers at the Mandela dump have developed livelihoods and some totally support their families based on recovery and resale of recyclables from wastes disposed at this site. These individuals would lose their income source after operations cease at the Mandela dump.

A Formalization Plan for eligible recyclers was prepared in 2004 and included in the EIA for operation GY-0055, in order to ensure that their livelihoods conditions after the

intervention would be equal to or better than those prior to it. The Plan proposed the transfer of the recycling livelihoods activities to the new HBSLF sanitary landfill.

Surveys conducted between December 2003 and June 2004 identified 121 recyclers working at Le Repentir, while another survey conducted shortly before the site's closing in 2010, counted 67 (the closing occurred on January 31, 2011).

Bank resettlement policy requires that all 67 individuals who were regularly working at Le Repentir before its closing be accounted for and that appropriate actions taken to improve their livelihoods and/or compensate any losses. While a number of the registered recyclers began working at the HBSLF starting in February 2011, others continued to work with private buyers at or near the landfill and still others were hired by BKI, while a final group of recyclers on the list remained unaccounted for.

Despite the actions taken so far, there nevertheless remain several areas in which they may be completed, complemented, expanded and/or improved. Some key planned actions lag in implementation or have yet to be implemented (e.g., providing IDs, finishing the shed, specifically addressing special needs and vulnerability, and removing recyclers from the pile). A draft Informal Recycler Upgrading Plan is currently under preparation through BKI International.

The goal of this Plan is to restore the incomes of all recyclers affected by the closure of the Le Repentir dumpsite to levels equal or superior to than those prior to the closure while improving their living and working conditions. Specific goals are:

(i) to ensure them adequate, safe and easy access to recyclable materials;
(ii) to improve the health, safety and security of their working conditions;
(iii) to improve the effectiveness, efficiency and profitability of their professional activities;
(iv) to formalize these activities and allow the recyclers access to recognition and benefits as professionals;
(v) to build their capacity, skills and organization; and
(vi) to address the special needs of particularly vulnerable groups (e.g., women, children, the elderly, the sick and the physically challenged).

In order to finalize this Plan, it was therefore necessary that all persons on the recyclers list be accounted for, consulted, informed of their rights under the Project and allowed access to the proposed compensation options and consultation, grievance and other mechanisms.

Proposed Upgrading Options

Based on the available baseline information, consultation process and final diagnostic, the Plan proposes a set of upgrading options for the recyclers current work, including: (i) collective working arrangements (e.g., a cooperative); (ii) separation under safer and more sanitary conditions; (iii) work in pilot source collection programs; and (v) other work-for-compensation mechanisms, both within and outside of the proposed new integrated solid waste management system.

While it is standard practice in compensation plans to offer sets of viable alternative options, the operation at the HBSLF has already allowed for the effective restoration of the livelihoods of those recyclers who have chosen to transfer there along with a substantial improvement in their working conditions. With the addition of accessible daily transport to the landfill, free for a period of at least six (6) months, anyone who could reach the Le Repentir site should also be able to reach the HBSLF at no additional cost. To the extent that the recyclers have their lost access to materials at Le Repentir restored under this Plan, this solution should constitute fair compensation both under Bank policy and according to their own expressed input during consultations. To the extent that particular individual may require or demand alternate forms of compensation, these may be analyzed and addressed on a case-by-case basis.

Given this situation, "alternative options" in this Plan will mainly consist of actions that are not mutually exclusive, but rather overlapping or complimentary. In this "package" approach, several or even all of the eligible recyclers may simultaneously benefit from multiple alternatives (e.g., new infrastructure, a cooperative, transport, and/or training). Participation in any alternative or combination of alternatives would be the result of a personal choice by each eligible recycler.

The proposed upgrading options may be divided into the following categories:

1. Control of Access, Registration and Rules;
2. Dedicated Recycler Facility ("Picker Shed");
3. Health, Safety and Security Measures;
4. Materials Storage;
5. Transport;
6. Formalization Options;
7. Training;
8. Upgrading of Recyclables Collection;

9. Further Operational Improvements;
10. Organization
11. Gender, Children and Vulnerability; and
12. Phasing, Sequencing and Long-Term Options

The plan is primarily being undertaken to ensure the health and safety of the waste pickers at the Haags Bosch Sanitary Landfill site (the IDB continues to support development of these areas through the services of International Consultants such as P. Cohen).

6.0 STAKEHOLDER & 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 will be undertaken as available to ensure the process includes both affected and interested parties. Participation techniques since 2005 have included assemblies, surveys, interviews, meetings consultation forums, and information dissemination techniques such as pamphlet, panels, leaflets and media communications.

The objectives for the stakeholder/public participation program are to:

- Ensure all interested parties are informed of all relevant project information;
- Ensure an awareness and understanding of the studies allowing for meaningful input from affected parties and the community at large;
- Develop a positive stakeholder/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.

Key stakeholders for this project include groups and individuals directly involved in managing the interest of the affected people by the project. Key stakeholders include individuals likely to be directly affected due to their proximity to the proposed site, the public and/or private sector organizations that 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 Environmental Protection Agency (EPA) and the Ministry of Health (MoH) and the Inter-American Development Bank (IDB).

The first stakeholder meeting was undertaken on July 1, 2011. Stakeholders represented at the meeting included EPA, IDB and GOG. A comprehensive overview of the project was discussed, concerns with regards to the buffer zone and the acceptance of hazardous waste at the site was discussed. The meeting minutes have been appended within this document.

The second stakeholder/public awareness meeting took place on September 28 and 29, 2011. The objectives for this series of stakeholder meetings are somewhat atypical from the conventional process, but which we believe are very valuable and necessary if the

end point for this process is a successfully operated and maintained sanitary landfill that is an asset to Georgetown and the Country of Guyana.

The stakeholder meetings were implemented as training and education sessions for the applicable stakeholders, site operators, contractors and government staff, and representatives of the community. One of the key understandings necessary for effective landfill management is to understand and accept that the site performance is truly more a function of how the site is operated and maintained than even the importance of the site design and engineered systems developed for the site. Our project team has structured these stakeholder events in consultation with and as directed by representatives of the GDB and IDB, as progressive training and education sessions for the above noted parties and to provide access to resources to answer questions and facilitate the various works and remedial measures necessary to achieve the objectives of the Guyana and the IDB. Information provided and documentation for these sessions are documented under separate cover.

7.0 SUMMARY OF KEY CONCLUSIONS AND RECOMMENDATIONS

Theoretically and conceptually, the HBSL can perform satisfactorily with the reduced Buffer Zone, provided that it is operated in an environmentally sound manner and shown to be so by appropriate monitoring. The hazardous waste cell can be considered for the location proposed but a number of specific items need to be addressed and/or implemented before it could be given final consideration and subsequent approval.

The landfill site should be surrounded in all directions by a defined minimum Buffer Zone and an additional Protected Zone defined for specific periods of the life of the landfill from development, through operating and ultimate closure. The connected, defined, minimum Buffer zone should be controlled by the MOLGRD and the Protected Zone controlled under planning and zoning acts.

The leachate treatment system should be completed and commissioned as quickly as possible. Compliance monitoring should be similarly instituted.

The hazardous waste facility proposed needs to be further developed. Issues include but are not limited to: Characterization of leachate at the hazardous waste landfill by a defined analytical monitoring program and corresponding action / response protocols; contingency hazardous waste storage; Pretreatment requirements.

Strict adherence to the EMP and associated QA/QC issues is required. Updates should be made as necessary to accommodate changed conditions.

Training and institutional strengthening remain of paramount importance and must be continued. While the overall institutional framework is considered reasonable, including the roles and responsibilities of key agencies, program delivery is impaired by the lack of capacity in these key agencies. Resources must be committed for necessary staffing, training, policy and guideline development and program execution.

The community participation program must be followed throughout the life of the landfill and beyond. The public complaints mechanism must be maintained and community awareness of waste management issues enhanced.

Appendix 1 –
Authors of EIA

Authors of the EIA Update

This report was prepared by:

Alida Saleh, M.A., LEED AP
Project Manager at Exp International Services Inc.

Ms. Saleh completed a Masters degree in Environmental Management and Sustainability at Harvard University. She is a Project Manager and Environmental Scientist. Ms. Saleh provided environmental consultation on projects in Guyana, including Haags Bosch Sanitary Landfill.

Frederick Mosher, P.Eng.
Consultant with Exp International Services Inc.

Mr. Mosher is an International landfill design expert and has served as landfill design manager on the original Haags Bosch Sanitary Landfill design. He has been active in Guyana on follow-up trainings related to landfill operations.

Stan E. Gonsalves, M.Eng., P.Eng.
Execitive Vice President at Exp International Services Inc.

Mr. Gonsalves is the Executive Vice President at Exp and served as Project Director and technical expert on the initial Haags Bosch Sanitary Landfill design and EIA. He has a long history of international geotechnical and environmental consultation including landfills. He has been involved in a number of projects sponsored by the IDB including Guyanese projects.

Exp International Services Inc. was retained by the Government of Guyana (GOG) to update the EIA.

Appendix 2 –
Terms of Reference

TERMS OF REFERENCE

Preparation of an Environmental and Social Audit and
Environmental Impact Assessment (EIA) Update
Haags Bosch Sanitary Landfill Facility

Background

During the years, the impacts of improper solid waste management have become the critical environmental problem in Georgetown and all over Guyana. This problem has become more and more acute over time, and besides creating unpleasant esthetics conditions, it is a serious health threat to the urban population. The negative impacts of improper waste disposal methods were heavily felt during the January 2005 flood when the waste filled canals did not drain as fast as expected.

The Inter-American Development Bank (IDB)'s involvement in solid waste management in Guyana dates from December 1998, when GOG requested support to find a solution for the then acute solid waste disposal problem in Georgetown. During the last six years the Bank and the GOG have adopted a series of measures in order to improve the conditions in the sector.

In 2007 the IDB Board of Directors approved the US$18,070,000 Georgetown Solid Waste Management Program (GY0055; Loan LO-1730/SF-GY). The objective of the Program is to improve the quality of life of residents of Georgetown and its environs through effective solid waste management. The project aim is to solve the solid waste disposal problem in Georgetown and its environs by construction and operation of a sanitary landfill at Eccles with participation of the private sector. In 2010, the IDB Board of Directors approved also the US$2,000,000 Georgetown Solid Waste Management Program Supplementary Financing (GY-L1034; Loan 2326/BL-GY), with the solely purpose of covering the cost overruns of the project (GY0055) financed with. The new solid waste management system is intended to prevent pollution, to be acceptable to stakeholders and to protect human health and the environment. The Program has four distinct components which are as follows:

1) Institutional Strengthening and Capacity Building for Solid Waste Management
2) Community Participation and Public Awareness Program
3) Design, Construction and Operation of the Sanitary Landfill
4) Studies and Investments in Healthcare Waste

The Loan Agreement was signed by the Government of Guyana in February 2007, and is currently being implemented by a Program Executing Unit (PEU) within the Ministry of Local Government and Regional Development.

To prepare the Program, in 2004 an Environmental Impact Assessment (EIA) had been prepared and approved. In this report, a buffer area of 2 km was established as a result of the community consultation process. However, the Government of Guyana, through its Ministry of Housing and Water, has recently initiated a new housing initiative which will be located in the perimeter covered by the current buffer zone agreed in the current EIA, decreasing the buffer area to 450 meters. Also, the government has decided to include a special cell in the new landfill to receive hazardous and healthcare waste.

After seven years from the preparation of the original EIA, and after three year of project implementation, **there is now the need to prepare an update the EIA**, considering the following reasons:

- The change in conditions within the **buffer zone**, where as mentioned above a new housing scheme has been planned by the Government of Guyana. The buffer zone area would decrease from the 2 Km originally agreed to approximately 450 meters.
- The decision to accept **hazardous and healthcare wastes** at the sanitary landfill.

The execution of this initiative will demand the review of the current environmental and social conditions and develop a supplementary Environmental Impact Assessment. Additionally, according to the agreement between the Government of Guyana and the IDB, an environmental and social audit needs to be performed after half of the resources have been disbursed (which will happen during this year of execution).

Scope of the consultancy

The Government of Guyana is looking for a consulting firm (from now on: the Consultant) to carry out the tasks described here-below, with the scope of: (i) Preparing an update of the original EIA; (ii) Perform an environmental and social audit of the Program. Considering that the scope of the works and conditions described in the original EIA have not substantially changed, the Consultant will limit his work to the following activities:

1) Project description: Concise description of any changes occurred to the original Project's general conditions, with an explanation of the change and its reasons (e.g. technology changes, use of the site, change in materials, etc.). The Consultant will also consider the project's geographic, ecological, social, and temporal context.

2) Legal and Institutional Framework: Description of any changes occurred to the legal, and institutional framework, indicating flaws and proposing measures to strengthen actions, duly considering the documents produced within the Program.

3) Complete review and update of the environmental and social baseline and detect the gaps between the original document and the current conditions. The Consultant will identify the major baseline aspects that need to be restudied, and will duly update the baseline performing the necessary actions to obtain the necessary new data or information (e.g. population distribution, landscape issues, emissions, acoustic baseline, etc).

4) Environmental and social audit: the Consultant should perform a specific independent review of the environmental and social practices set in place for the Program, paying particular attention to:

    a. Compliance with (i) all applicable environmental, health, safety and labor Guyana regulatory requirements associated with any environmental, health and safety related permit and (ii) applicable IDB environmental and social policies, including OP-703 "Environmental and Safeguard Compliance Policy", OP-704 "Disaster Risk Management"; OP-710 "Involuntary Resettlement (with regards to the waste-pickers); OP-102 "Access to Information Policy; and the new Gender Equality in Development Policy OP-761 and other international standards and requirements that will be applied to the project (e.g., IFC Performance Standards, best/good management practices) during the construction and the first operational phase of the project.

    b. In order that various issues and recommended mitigation measures identified in the original EIA are effectively captured and implemented during the construction and operational phases of the Program, an Environmental (and Social) Management Plan (EMP) was developed. The environmental and social auditing should evaluate the

operational observance of the procedures, regulations and objectives identified through the EMP and the EIA.

c. Review of the process set in place to involve the waste pickers who will be relocated from Le Repentir (Mandela) Site: according to the Program, the new final disposal facility included in its original design a designated area to build a plant for the waste-pickers to carry out sorting activities under improved and adequate technical, safety and sanitary conditions. The Consultant will review the status of these actions and will propose detailed activities that will improve and accelerate this process, including schedule of implementation and implementation arrangements and costs,

An outline of the EIA Update is attached in Annex 2. As mentioned above, considering that the scope of the works and conditions described in the original EIA have not substantially changed, the Consultant should focus on the changes that occurred in the various items listed above.

5) Environmental Impacts Assessment Update :

a. Identification and assessment of the impacts and risks that a reduction of the buffer zone from the 2 Km originally agreed to 450 meters (consequence of the development of a new housing scheme that will occupy more than 50% of the existing buffer zone area) would imply. The Consultant will evaluate, among others (as mentioned in the 2004 EIA) the following issues: (i) monitor and update the data related to the groundwater, soil contamination, air quality, soil indicators in the area of influence (comparing the results with the ones obtained with the monitoring system currently in place); (ii) analysis and description of the groundwater and surface water, flow characterization, aquifer characterization (water quality), water table behavior through time, aquifer recharge and its volume, (iii) develop a mathematical model to establish potential contamination plume behavior according to potential permeability/leaking scenarios; (iv) assess the existence and potential development of potable water sources in the influence area; and (v) assess the impacts of the plume on those sources and other sensitive targets; (vi) assess overall impact of the plume, odors, vectors, etc on the housing development . The Consultant will evaluate if the current number and location of the monitoring wells fit the control and monitoring plan of the landfill. The Consultant will propose new locations and/or number of wells if as a result of their analysis there is a better configuration for the monitoring wells with the new buffer area. The consultant will drill additional wells, as many wells as necessary, to get the groundwater input data for the model. The costs of the drilling will be covered with Program's resources. Impacts and risks will be evaluated in comparison to international standards (e.g. IFC Performance Standards). The results will be shown with different simulated conditions (scenarios) including a defined base case and its related scenarios such as leachate infiltration episodes, heavy rainfall, landfill growth, landfill closure, landfill post closure ,etc.

b. Identification and assessment of the impacts and risks stemming from the disposal of hazardous and healthcare wastes at the sanitary landfill. This activity will focus on a detailed review of the report prepared by SENES Consultants Limited, the consultancy firm selected within the Program to carry out the component of hazardous and healthcare wastes. Specifically the Consultant will evaluate the technical and operational design appropriateness of the security cell, the materials selection, permeability, operation recommendation, contingency plan, local regulatory standards, etc. Proposed design will be compared with international/regional standards best practices.

c. Public consultation: the Consultant will organize at least 2 public consultation meetings with representatives of the relevant stakeholders in the area of influence of the Program, to perform the assessments described above on the buffer zone reduction and on the inclusion of hazardous waste in the landfill. The PEU of the Georgetown Solid Waste Program will support with the organization of these events.

6) Mitigation measures, and any residual negative impacts that cannot be mitigated, should be identified, particularly related to the two issues listed in point 5 above and to any issue that emerged during the past 7 years and have not been identified and addressed within the previous original EIA. Opportunities for environmental and social enhancement should be explored. The extent and quality of available data, key datagaps, and uncertainties associated with predictions should be identified/estimated, when needed. Topics that do 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.

7) Mitigation Plan: the environmental and social mitigation measures should be summarize in a mitigation plan, presenting the feasible and cost- effective measures identified that may reduce potentially significant adverse environmental and social impacts to acceptable levels, and estimation of the potential environmental and social impacts; capital and recurrent costs; and institutional responsibilities, training, and monitoring and reporting requirements.

8) Environmental Monitoring Plan. The Consultant will review, in collaboration with the Project Manager, the site Supervisor and the Contractor, the Environmental Monitoring Specification currently set in place. The review will focus on the type of monitoring currently in place, who should do it, how much it costs. The Consultant will make recommendations on how to improve the monitoring mechanism, paying special attention to all the activities related to the monitoring of the water quality during and after the useful life of the Project.

9) Public workshop, which will be organized by the Consultant with the support of the PEU of the Ministry of Local Government and Regional Development. During the workshop the first version of the final report will be presented and comments and responses will be incorporated in the final deliverable.

Available Reports

The following reports will be made available to the Consultant:

1) Environmental Impact Assessment (EIA) and TOR;

2) Original Environmental and Social Management Report (ESMR), prepared as a summary of the EIA and TOR prepared for the program GY0055; and the ESMR prepared for the Supplementary Financing GY-L1034

3) SENES consultants. Report on Hazardous and Healthcare Wastes;

4) Project Documents and other Studies produced.

5) Emergency Response and Contingency Plan

6) Health and Safety Plan

Consultant requirements
The consulting firm that will be selected is required to have at least 10 years of experience in similar works (including modeling) in other countries. The consultancy manager will also be required to have at least 10 years of experiences in similar works.

Coordination
The Consultant will work in coordination with the PEU within the Ministry of Local Government and Regional Development, the site Supervisor, and representatives from the Ministry of Housing and Water. Monthly meetings will be organized with the Project Executing Unit and the Bank to review the progress of the consultancy.

Reporting and deadlines:

The consultant will prepare 6 copies of the EIA in English language (3 copies to the PEU within the Ministry of Local Government and Regional Development, 2 copies to the IDB in Washington and one copy to the IDB in Guyana).

The EIA shall be submitted in a draft version after 90 days from the signature of the contract, followed by a first final version based on comments made by the IDB and the PEU. As mentioned above, the first version of the final report will be presented during a public workshop, where copies of the Executive Summary of the EIA shall be distributed. The results of the public workshop and the modifications of the EIA shall be incorporated in an addendum to the report, which will represent the final deliverable.

ANNEX 1

Activities implemented for the original EIA:

- 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
- 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;
- Investigation of surface water conditions as well as meteorological conditions;
- Study of socio-economic conditions in the project area;
- Examination of peoples affected by the project and development of Resettlement or Compensatory Plan to conform to IDB Policy on Involuntary Resettlement, OP-710
- Impact modeling and prediction;
- Impact assessment for design, construction, operation and closure phases including socio-economic effects on GM, NDCs and neighboring communities;
- Risk assessment of technical facility (e.g. leakage, contaminations), natural hazards (e.g. flooding) and road transport accidents;
- Mitigation planning on feasibility level specifying environmental requirements and design measures including protection zones etc;
- 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,
- Design an environmental monitoring program indicating variables, frequency of sampling, duration, costs and responsibility for execution and supervision;
- Develop cost estimates of environmental protection and mitigation measures; and
- Specify Closure measures to the level of feasibility;
- 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.
- Identify project risks that can threaten the sustainability of the project and propose of remedial actions/measures to minimize potential project risks.

ANNEX 2
The EIA Update must include, as a minimum, the items listed below:

- An executive summary highlighting the main arguments, evidence and recommendations from the standpoint of environmental quality and social impacts and risks.
- A description of the operation, its objectives, and the environmental and social conditions in its area of influence.
- A description of the institutional and legal environmental framework associated with the project, including any project specific legal (e.g., concession contracts, etc.) or other requirements.
- An analysis of the direct and indirect environmental and social impacts and risks.
- A record of the process and a summary of the results of consultation with affected groups.
- Options and recommendations for preventing, avoiding, reducing, eliminating or compensating

the impacts of the selected alternative.

- The schedule, assignment of responsibility and budget for the environmental quality and social impact management measures.
- The monitoring, reporting and evaluation requirements during the execution of the operation and thereafter.
- A description and quantification (when possible) of the environmental and social benefits, and of the costs of any unmitigated environmental and social impacts.

As mentioned above, considering that the scope of the works and conditions described in the original EIA have not substantially changed, the Consultant should focus on the **changes** that occurred in the various items listed below.

OUTLINE FOR the EIA Update

1.0 EXECUTIVE SUMMARY

Discussion of key and significant aspects, including the following: project description; applicable environmental, health and safety legal requirements; environmental and social conditions; principal project impacts; proposed mitigation and monitoring measures; project alternatives, and public consultation.

2.0 PROJECT DESCRIPTION

Description of the project (including any associated project facilities and operations): project basis and objectives, implementation arrangements, site location(s), facilities (direct, associated and indirect), process, inputs, products, hazardous materials, residues/wastes, emissions/discharges, including GHG, associated infrastructure, construction / operation / closure activities (as appropriate), project time schedule for construction and operation, project costs.

3.0 INSTITUTIONAL AND LEGAL FRAMEWORK

Applicable host country environmental and occupational safety and health institutions and legal requirements: national, state or province, local (e.g., municipal or city) institutions and legal requirements (including specifically all necessary permits/authorizations and all applicable standards or limits for emissions, discharges, and ambient conditions); relevant requirements of applicable international treaties/conventions/agreements; other applicable legal requirements (e.g., concession contract, etc.); other requirements that will be applied to the project (e.g., international standards or guidelines, best/good management practices, requirements of potential investors, lenders and insurers); Requirements must cover all environmental, social, health and safety related areas, including, but not limited to,: EIAs, air quality, water supply, waste water, protection of sensitive areas and endangered species, land use control, waste management (both non-hazardous and hazardous), hazardous materials, worker health and safety.

4.0 ENVIRONMENTAL AND SOCIAL CONDITIONS

Description, including quantitative data and information, on the existing environmental and social conditions at the project site(s)/location(s) and the complete direct and indirect project area of influence, including Land Use, Climate and Meteorological Conditions, Air Quality, Noise, Geology, Soils, Natural Hazards (seismic, faults, sink holes, flooding, hurricanes, tornadoes, etc.), Water Resources (surface and ground water, coastal, etc.), Flora, Fauna, Endangered and Threatened Species (including sensitive species, economically important species), Visual Resources, Population and Settlement Patterns, Livelihoods (level of employment and income patterns), Health and Education Levels (including endemic diseases), Services and Infrastructure, Social Organizations and Groupings, Gender, and Sensitive Populations (elderly, poor, disabled, young).

5.0 ENVIRONMENTAL AND SOCIAL IMPACTS and RISKS

Description of the anticipated project specific environmental, social and health and safety impacts: impacts associated with the environmental and social conditions presented in section 4.0; impacts related to all project phases (e.g., construction, operation, closure) and all directly associated project facilities and operations; negative and positive impacts; direct and indirect impacts; and unmitigated, irreversible, unavoidable impacts.

6.0 ENVIRONMENTAL AND SOCIAL MANAGEMENT

Adequacy of the project environmental and social management plan (ESMP): (a) environmental and social control and mitigation measures for project construction and operation; (b) environmental and social monitoring program for both construction and operation; (c) worker health and safety plan, procedures and controls; (d) environmental contingency plan and procedures; (e) environmental, health and safety management system (including personnel, training, documentation, auditing, etc.); and (f) project specific supervision and evaluation actions to be implemented. For each component listed above, the time schedule (i.e., when initiated, when completed, frequency), responsibility for implementation, estimated costs.

8.0 PUBLIC PARTICIPATION

Actions performed related to disclosure of project-related environmental and social information: Method (including the exact date, location and form) of public disclosure of the project EIA or any other related documents. A complete record of public participation activities should be presented as an appendix.

APPENDICES

- Authors of the EIA (names, affiliations, qualifications, relationship to project sponsor)
- Terms of Reference for preparation of the EIA
- Complete record of public consultation activities (e.g., meetings, public hearings, etc.)
- Environmental, health and safety permits/authorizations

- Complete results of ambient monitoring or sampling performed for EIA
- Complete results of mathematical modeling (or related quantification) of project impacts
- Bibliography and References

Appendix 3 –
Record of Stakeholder/Public Consultation Activities

1) **Minutes of Meeting No.1 in July 2011**

2) **Awareness/Training Session in September 2011**
   Attendees (detailed list filed with MOLGRD)
   Representatives of:
   - **BK Contracting**
   - **Pooran Brothers**
   - **EPA**
   - **PEU**
   - **IDB**

Meeting Minutes

Date: July 11, 2011	Meeting Date: July 1, 2011
Project Name: Guyana EIA Update	Project #: INT-00010340-A0
Subject: Stakeholder Meeting	
Participants: Mr. Walter Willis, PEU Mr. Gordon Gilkes, PEU Mr. Marcello Basani, IDB Ms. L. Ramjag, IDB Ms. Shabana Yusuf, EPA Ms. Tashoue Redmond Mr. Osbert Ellis, EPA Mr. Stan Gonsalves, Exp Team Mr. Rick Mosher, Exp Team Ms. Alida Saleh, Exp Team	
Location: IDB Office	Prepared By: Alida Saleh
Distribution:	

The Scope of Project was discussed to confirm that the terms of reference and mandate was appreciated by all stakeholders. Main points shared:

1. Stan Gonsalves of Exp presented an overview of Terms of Reference and Exp (Trow) mandate and scope of work
2. EIA update to include
    - 2.1 Project description – changes in project conditions since initial EIA issued
    - 2.2 Changes in legal and institutional framework
    - 2.3 Environmental and social audit
    - 2.4 Evaluate the impact of change in buffer zone area from 2km to 450km (~ 300 m as hazardous waste is in the buffer zone)
        - 2.4.1 Odour
        - 2.4.2 Dust
        - 2.4.3 Vectors and vermins
        - 2.4.4 aesthetics
    - 2.5 Evaluate the impact/risks from disposal of hazardous and health care waste in the landfill
        - 2.5.1 Hazardous waste leachate treatment system
    - 2.6 Access health and safety and sanitary conditions for waste pickers
    - 2.7 Public Consultation – Mr. Gonsalves indicated that international landfills, including those in North America, had typical buffer zones of 300 m, although legal requirements were often as close as 100 m or slightly less. In that context, the proposal to reduce the buffer zone was theoretically

acceptable. The key was the proper development and operation of the site and the monitoring to ensure compliance with design standards and expectations. It was noted that potential residents in area between the proposed and old the buffer zones would be making choices being fully aware of the presence of the landfill at Haags Bosch.

2.7.1 It was suggested and agreed upon by all parties that the public consultation/stakeholder meeting process be used:

(i) As an opportunity to interact with institutional representatives (local EPA etc). These interactions would focus on the status of key items related to the development and operation of the landfill under the initial conditions at time of approval and the potential impact of the changed conditions identified.

(ii) Provide an educational process to assist the public in making more informed choices when purchasing land within the vicinity of the landfill

3. An interactive session ensued in which the general observations of the Exp team based on site visits were discussed. Key items are as follows.

Timeline for project delivery:

3.1 As part of the assignment the Exp (Trow) Team was to review the monitoring data on groundwater, surface water and leachate

3.2 Due to unavailability of significant data it would be more pragmatic to review the planned program and efforts to bring it back on track and await the test results prior to issuing the reports

3.3 Need to establish new timelines once the monitoring reports are issued

4. Other issues of key concerns to the project:

4.1 Hazardous Waste Issues

4.1.1 Design basis – Stan Gonsalves requested confirmation that the Senes EIA document reflected the new leachate treatment process. Mr. Willis would pursue.

4.1.2 Location / size / capacity / waste types (liquid vs solid)

4.1.3 Leachate Collection/Treatment system completion – new system is sequential lagoons. Need to address the point of discharge of treatment water to be the point of compliance

4.1.4 Monitoring program. Laboratory capability was noted as an issue.

4.1.5 Baseline conditions were discussed

4.2 Water Management Plan

A discussion on controlling stormwater to minimize leachate generation

4.3 Construction Plan / schedule status / timing & sequencing

4.3.1 Development of cell sufficient ahead however, as needed provisions to be made to avoid storm water contact with waste

4.3.2 Minimization of leachate

4.3.3 Health & Safety Plan too generic, needs to be modified to reflect issues that may arise from development of HBSL

4.4 Existing Site – Interactive discussions on the following items followed:

4.4.1 Cell development sequence

4.4.2 Leachate management – status of construction of system

4.4.3 Status of monitoring to EMP

4.4.4 Contractual milestones and commitments

4.4.5 Waste quantity increase & Height of waste

4.4.6 Liner material / Liner Edge Protection

4.4.7 Grading / Compaction

4.4.8 Cover
4.4.9 Waste Pickers – (some interaction with IDB consultant possible in mid-July in Guyana)
4.4.10 Communication
4.4.11 Storage of excavated materials

5. Suggestions for improving construction/operational method and use of materials:

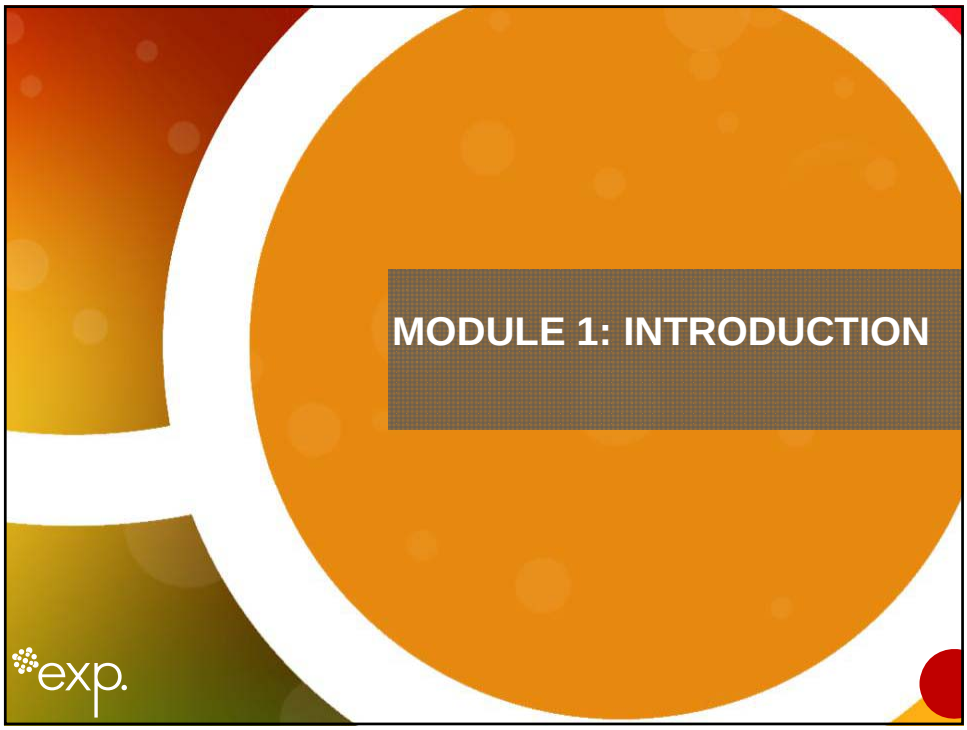
5.1 Exp would offer some comments on best practices in separate correspondence. It was noted that the most critical element in developing a landfill is operations and it was recommended that the contractor explore training opportunities, particularly for key staff.

Action Items	Responsibility
Project team to provide the client and IDB with a list of observations and recommendations for improvements to be considered at the landfill site	Exp (Trow)
Client to revise scope of work/Terms of Reference to reflect new timelines and deliverables	Mr. Willis
Client to initiate monitoring program	Mr. Willis
Project team to submit revised work plan upon receipt of revised TOR	Exp (Trow)

Next project team site visit: mid to late July 2011

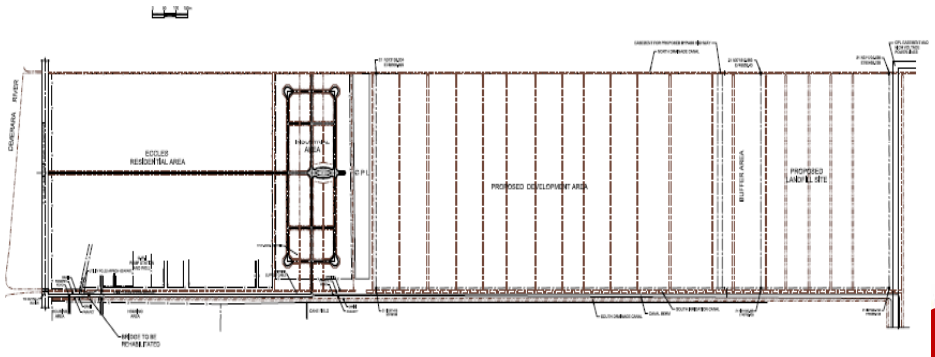
Exp will communicate on specific issues within two weeks. These minutes were prepared by A. Saleh from the Exp Team.


exp.
The new identity of Trow International Ltd.
Guyana Landfill Training
Frederick Mosher, P.Eng.
Stan E. Gonsalves, M.Eng., P.Eng.
Alida Saleh, M.A., LEED® AP


MODULE 1: INTRODUCTION
exp.

SITE BACKGROUND

- Location of Landfill:
  - Haags Bosch Greater Georgetown Area, Guyana



WASTE AND SERVICE AREA

Wastes that the landfill receives

- Municipal waste
- Industrial waste
- Commercial waste
- Solid waste:
  - Organic waste (60%)
  - Plastic, paper, glass, etc
- 250-300 tons accepted daily from domestic, residential, and market area
- Medical Waste and other hazardous waste as part of hazardous waste cell to come

SITE ACCESS

- To Cell 1 and 2: access through south and east boundary
- To leachate treatment system and stormwater retention ponds: access through use of maintenance roads at west, south and east boundaries
- Primary site access and emergency access gates: entrance of landfill at southwest portion

SITE OPERATIONS

- Administrative and Supervisory Operations
- Site and Scalehouse Operations
- Waste Disposal and Site Maintenance Operations
- Leachate and Stormwater Management Systems
- Landfill Gas Control (to come)
- Monitoring Programs

Operator's Responsibilities:
A. Site 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.

(cont'n.)

- Screening and prohibiting the off-loading of wastes not approved for disposal at the Site, including the following wastes:
  - hazardous wastes;
  - liquid waste unless specifically authorized as in the case of some present/future biological sludges;
  - medical and pathological waste;
  - any banned materials; and
  - radioactive waste or other wastes not permitted for disposal in the Site
- Medical and other approved hazardous waste to be accommodated in hazardous waste cell once approved and constructed

Operator's Responsibilities:
B. 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.

Operator's Responsibilities:
C. Waste Disposal & 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.

(cont'n.)

- Control of surface water runoff by grading and berming the Site to keep surface water away from the waste and to contain surface water that has come in contact with waste
- 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.

Operator's Responsibilities:
D. Leachate & Stormwater Management Systems

- Operation and maintenance of the pumping systems that comprise the leachate treatment systems.
- Operations and maintenance of the leachate treatment system.
- Maintenance of stormwater system
- Field laboratory testing and analyses for the leachate treatment facility.

Operator's Responsibilities:

E. Landfill Gas Control

- Operation and maintenance of landfill gas (LFG) vents and monitoring probes.
- Installation:
  - Triggers - waste thickness and quantity
    - odour
    - estimate 2-3 years
  - Headers - horizontal runs
    - spacing
    - level
- Issues:
  - Examine transition zones
  - Gas traps

Operator's Responsibilities:

F. Monitoring Programs

- **Monitoring of the following:**
  - Groundwater
  - Surface water
  - Air quality
  - Leachate
  - Stormwater and
  - Landfill gas (LFG) , and LFG management systems.

MODULE 2: SITE COMPONENTS

ADMINISTRATION FACILITIES

- The Administration Facilities are composed of the following:
  - an administration building including reception area and staff facilities;
  - a scale and scale house;
  - waste diversion area;
  - unacceptable waste storage area; reflected in site procedures
  - wheel-washing facility;
  - fuel storage depot;
  - waste picker area; and
  - a continuous perimeter chain link fence along the property limit.

SITE UTILITIES

- This includes the following:
  - Electricity
  - Washroom facilities
  - Service and Potable water
  - Telephones
  - Fuel depot
  - Storage area for lubricant and fluid storage

LEACHATE COLLECTION AND TREATMENT

- The facility includes the following:
  - Leachate Collection System (LCS)
    - Handles leachate from both landfill cells
    - Sanitary cells bases consist of native clay, GEOWEB, clear stone or geocomposite drainage layer, geotextile, ballast sand
    - Hazardous waste cells to have native clay, HDPE liner, gravel – to be finalized
    - Perforated collection pipes
    - Collection pipes (standpipes and cleanouts)
    - Pumping station
    - Leachate treatment lagoon system

SURFACE WATER MANAGEMENT

- Includes the following:
  - Stormwater sedimentation and control ponds
    - Uncontaminated rainwater goes straight to the ponds and are released to adjacent lands
    - Contaminated water is collected by the LCS and treated as leachate

LANDFILL GAS COLLECTION

- Includes the following:
  - Horizontal collectors are headers
  - Passive gas vents (odour)
  - Gas probes – used to monitor landfill gas migration
  - Longer term gas collection and possible co-gen use

MODULE 3: SITE OPERATIONS

SITE STAFFING

- Staff requirement: 12-15
  - Site Superintendent
  - Weighbridge Operator
  - Leachate Treatment Facility Operator
  - Landfill Dozer Operator
  - Landfill Compactor Operator
  - Excavator Operator
  - Dump Truck Operator / Water Truck Operator
  - Environmental Technician
  - General Grounds Maintenance / Litter Picker
  - Traffic Control / Waste Spotter
  - Guard (24 Hour)

OPERATING EQUIPMENT

- The operator will provide for fuels and lubricants
- The following are the equipment to be used:
  - Compactor
  - Dozer
  - Loader/Backhoe
  - Truck
  - Leachate Pumps
  - Other equipment

SITE SECURITY

- Fenced facility
- Main access gate at southwest corner- facilitate access control and make it relatively easy to maintain good records and control of public/private access to the Site

cont'n

- Signages posted at main gate with the following information:
  - name and address of facility owners;
  - name and address of facility operators;
  - hours and days of operation;
  - waste types acceptable for disposal at the Site; and
  - emergency contact information.

- Single scale with traffic signs at entrance gate
  - for measuring and recording volume of waste
- Daily record of weighing operations should be maintained by operator.
- Record should contain the following information:
  - Date
  - Quantity of waste in tons; and
  - Type of waste received
- Tipping fees to be collected based on weight

HOURS OF OPERATION

- Site open from 7 AM – 5 PM daily including Saturday and Sunday
- Operations include spreading, disposal, and compaction of waste
- All management and administrative activities are limited to daylight hours
- Waste delivery will be within 30 minutes only

INSPECTION AND RECORD KEEPING

- All waste received at the Site will be inspected by Site personnel including the weighbridge operator and the waste spotter.
- Weighbridge personnel: inspect waste load
- For unsatisfactory or unacceptable waste
  - Notify waste spotter
  - Detailed investigation of the matter

- All, or any one or two conditions shall be conducted for inspection of waste:
  - 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.

- Potential reasons why a waste load may be questionable or suspect :
  - 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.

- For highly combustible waste :
  - Unloaded in designated inspection area and fire put out before disposal to tipping face
  - Incident shall be recorded
  - Copy will be given to driver with appropriate cost to be borne by waste generator / transporter

- Spotted dumping of unacceptable waste:
  - Direct the vehicle to reload material
  - Refer to waste spotter for further disposal direction of material
  - May redirect vehicle to unacceptable waste storage area

- If vehicle dumped and left unacceptable waste in tipping area but is still on site:
  - Waste spotter to contact weighbridge operator
  - Direct vehicle back to tipping area to retrieve unacceptable waste
  - Move it to designated inspection area for detailed inspection

- For vehicles dumping unacceptable waste and has left site:
  - The Operator will remove the waste to the inspection bay
  - Inform the weighbridge operator to note the customers license number for removal at the next opportunity
  - A waste inspection form (WIF) shall be completed by the Operator and contents of the unacceptable waste distinctly recorded

- If a load, deemed unacceptable after inspection and recording (except fire loads, as noted above), is received at the Site, a report shall be 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.
- In case of partially unacceptable loads, the waste spotter may allow the acceptable portion of the load to be landfilled.

PROCEDURES FOR PAYMENT OF TIPPING FEES

- Tipping fees still to be determined

THANK YOU!

MODULE 4: WASTE MANAGEMENT

INTRODUCTION

- Tipping face
  - 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 moves as more waste is added.
  - As waste accumulates, the tipping face also proceeds higher in elevation along with the increase in the height of the deposited waste.
  - 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.

PLACEMENT OF WASTE

- Waste will be placed by utilizing the area method
  - The waste will be filled and compacted over the prepared base, in layers
  - Daily cover will be applied following the waste segregation and recycling activities carried out by the Site's 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 and specific area
- Waste placement must be staged such that after the allocated time period for recycling / segregation activities has expired
- 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 and 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 are to be followed:
  - a site road shall be 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.
  - a turnaround area and tipping platform designed to accommodate a minimum of three trucks has to be built of materials suitable for the season, which will support dumping and turning by the waste ferrying vehicles.
  - the minimum thickness of the initial lift shall be 0.6 m layer of selected waste at the base and at least an additional 1.5 m of waste above that.

- For the case with HDPE Liner (Haz Waste) Waste should not contain sharp or metallic objects that will likely damage LCS.
- Waste hauling vehicles shall be kept away from the edge of the initial lift to prevent them from getting into the selected waste and damaging the leachate collection layer
- light or medium sized bulldozer or excavator shall be used to push and level the waste for the initial lift
- Equipment operators should take extreme care in leveling the waste, as no compaction shall be applied other than during spreading

- The thickness of the waste on which the equipment is operating for the initial lift be should be less than 1 m above the upper element of the leachate collection system
- The type, amount, and area that the daily cover has been applied to will be included in the Operator's daily report.
- The estimated average daily volume of waste/daily cover landfilled will be approximately 50 m^3 per day based on the average daily disposal rate of approximately 600 m^3 /day.
- daily cover for active areas of the Site shall be approximately 100 mm in thickness to ensure reasonable cover of the waste

WASTE COMPACTION

- Benefits of waste compaction
  - minimizing the daily cover requirements;
  - reducing the chance of differential settlement;
  - minimizing 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
  - minimizing odour problems.

- Operator 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 the 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 density of 700 kg/m^3 ;
- 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 Operator will 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.

COVER OPERATIONS

- Alternative Daily Cover (ADC) is encouraged instead of clay materials. It 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.

- 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.
- The waste-to-daily cover ratio is expected to be in the range of 6:1.

UNACCEPTABLE WASTE

- If a load is refused due to an unacceptable waste profile, the following information should be obtained:
  - the source of the load;
  - name of driver;
  - license number of vehicle; and
  - company name on truck;
  - date and reason for refusal.
- A list of prohibited materials shall be posted at the site entrance.

MODULE 5: SYSTEM OPERATIONS

LEACHATE TREATMENT SYSTEM

- Landfill leachate
  - inorganic and organic containing liquid mixture produced when water percolates through and contacts solid waste
  - Collected at the LCS at the base of landfill
  - Liquid is collected at the leachate pumping stations corresponding to the low points of each cell, and conveyed to the leachate treatment system
  - Any liquid that has come into contact with waste will be routed through leachate treatment system.

LEACHATE TREATMENT SYSTEM OVERVIEW

- The leachate Treatment System consists of wastewater stabilization ponds (anaerobic, facultative, maturation) and free flow wetland
- Designed to treat a leachate volume of 131 m^3/day;

START UP OF THE LEACHATE TREATMENT SYSTEM

- Initiate pumping system
- Fill reservoirs
- Monitor to steady state conditions
- Continue to execute monitoring and review program in context of performance parameters and triggering events

OPERATION OF THE LEACHATE TREATMENT FACILITY

- The Leachate Treatment Facility employs a primary passive system, but employs necessary pumping
- Monitor
- Maintenance program (detailed in later module)

OPERATOR ROUTINE CHECKS AND MONITORING

- Duties of Operator
  - Perform daily, weekly, and monthly checks on the equipment and operations of the leachate treatment facility
  - Checks are recorded on log sheets to allow for the tracking of the performance of the leachate treatment facility and submit to supervisor
  - Assist with any troubleshooting of operational difficulties which may arise during the course of the facility's operation

LANDFILL GAS COLLECTION SYSTEM

- Initially, landfill gas generated on-Site will be passively vented to the atmosphere. Monitoring and buffer zone issues may dictate active requirements
- Some maintenance/monitoring activities are required especially is there has been physical damage to the vents because of settlement.
- If damaged, the vents will be restored.
- Odour issues will be monitored
- Possible flaring or incorporation into co-gen scheme subject to appropriate approvals

SURFACE WATER MANAGEMENT

- Surface water control is achieved through the construction of diversion swales around the base excavations and the upper limits of the limit of waste of landfill cells. All surface water contacting exposed waste will be collected by the LCS and will be treated as leachate.
- When waste contours have reached the proposed top of waste/daily cover elevation, interim cover is placed and maintained.
- Area shall be vegetated when section has reached final grade.

- Silt control fences or other similar measures shall be put in place to minimize silt losses into the stormwater management ditches and ponds.
- Silt is periodically removed and placed into the landfill.
- The operator is responsible for operating, cleaning, and maintaining the stormwater ditch and pond systems.

MODULE 6: SITE MAINTENANCE

LEACHATE COLLECTION SYSTEM

- The leachate collection system (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.

- Leachate collection pipes
  - Shall be cleaned and maintained by the Operator through the side slopes riser cleanout pipes
  - Cleaned by inserting a self-propelled nozzle with pressurized water attached to the end of a hose into the riser cleanout pipes
  - Pipes shall be cleaned once per year or more often if it is suspected that there is some impediment in the LCS

- 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.

LEACHATE TREATMENT SYSTEM

- Operator shall inspect all the leachate treatment ponds on a daily basis for the presence of large items of debris and the general condition of the system
- Operator shall check the accumulation of sludge in the leachate treatment ponds 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 Operator will 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.

GENERAL MECHANICAL AND ELECTRICAL

- Requirement for pumps, mechanical or rotating equipment:
  - 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.
- A routine maintenance program shall be implemented to maintain electrical motors and other equipment in a clean, dry condition.

- Regular electrical maintenance program shall be implemented for equipment based on the duty cycle 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.

ROADS

- Site roads shall be cleaned regularly in periodic intervals, and this frequency shall be increased depending upon the weather conditions
- If mud or dust is tracked from the Site to the public roads, the Operator will 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 tires and suspension, and increasing the safety of the roads

- All Site roads shall be maintained at all times and repaired, as necessary.
- For Roads and Pavement:
  - All unpaved and paved areas shall be inspected every two weeks for cracks, potholes or other damages, and shall be repaired or resealed, as required.
- Ditches:
  - All road ditches, stormwater swales, and outfalls shall be inspected weekly for obstacles, which shall be removed immediately. Erosion repair shall be arranged, if necessary.
- Signs:
  - All directional signs shall be inspected daily and repaired or replaced as required.

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MOBILE EQUIPMENT

- inspection and maintenance log shall be maintained for all major pieces of mobile equipment and stored on-site
- All mobile equipment shall regularly and frequently be inspected for wear and damage by maintenance personnel during preventive maintenance process.
- The Mobile equipment operators, who shall be 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

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- Maintenance procedure:
  - 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 refueling;
  - 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.

WHEEL WASH

- Not all vehicles exiting the Site will use the wheel washing facility.
- Only larger waste transport trucks and vehicles that have noticeably dirty wheels or undercarriages will proceed through the wheel wash, as directed by the Operator

- The maintenance procedures for the wheel-wash facility include:
  - 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 be 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.

WEIGH SCALE

- The daily maintenance activity for the weigh scale will be to broom and sweep the dirt from the scale deck each morning, and once a week, wash the scale deck of dirt
- Specialized maintenance tasks should include:
  - Calibration of the scale every 6 months or as specified by the manufacturer;
  - 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.

LITTER

- To minimize the blowing of litter from the active area of a landfill the following measures shall be employed:
  - 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/storage 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 clean-up of litter along the primary access route.

ODOUR

- LFG odour is generated during the anaerobic decomposition of organic waste material
- Leachate related odours are generally associated with open exposure to raw leachate in the landfill cells or in the LCS
- 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
- Landfills typically have three types of odour emissions to consider and address:
  - Leachate;
  - Fresh or raw waste odour; and
  - LFG odour

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
- To minimize dust impacts that may occur, the following measures are suggested:
  - during dry periods, the speed limit of vehicles operating on Site shall be limited to 15 km/hour for on-Site waste and daily cover trucks;
  - during dry periods, secondary access roads used by waste trucks shall be 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 and subsequently worked by compactors or bulldozers shall be 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.

VECTOR AND VERMIN

- 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.
- Control of vermin and vector:
  - Cover the waste material at the landfill
  - An insect exterminator could be used as an interim measure
  - Hygiene and cleanup of the waste picker area must be enforced
  - Re-vegetation of disturbed or completed areas

FIRES

- Landfill fires can be a problem at landfill sites
- Open burning of waste must be prohibited at all times
- No smoking or open flames of any type shall be permitted within the landfill cell areas or near the LFG vents once installed and operational.
- A "hotwork" permit process shall be established for any maintenance or repair activity that requires the use of an open flame such as 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
- In the event of a fire at the landfill, this Site shall have a water supply base available at all locations on the property for use to extinguish a fire.
- Stormwater, sedimentation and control ponds and retention pond are all potential sources of water for fire suppression
- Addition of cover soils adjacent to the area of a suspected fire if it is deemed necessary
- Stringent rules and qualification requirements for waste picker licensing

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.
- The noise of the landfill operations will be limited to the daylight hours
- Vegetated screens and setback distances will be used to minimize the noise impact from this Site
- Good practice that all equipment being utilized at the Site

LEACHATE SEEPS

- Infrequent occurrence
- If a seep is found, Site personnel will evaluate size, duration, flow, and impact to determine the appropriate response.
- Additional clay cover is applied and compacted in the area of the breakout or seep.
- Any disturbed cover areas will be repaired and compacted with clay soil
- All seep locations and repair methodology will be recorded.

GENERAL SAFETY

General safety and personal hygiene rules for the Site should include:

- eating or drinking at the Site is limited to administration building and an area designated for the waste pickers;
- smoking on or near the waste footprint or LFG vents is prohibited and smoking is only allowed in designated areas;
- 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;

- Site security personnel are to 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 must wash the affected area immediately. If clothes in contact with skin are wet, then these must be changed;

GENERAL SAFETY

- Hands must 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 must 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 must be worn when there is a potential for contact with hazardous substances;
- The administration building must be kept clean at all times; and
- 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.

PERSONAL PROTECTIVE EQUIPMENT

- The basic PPE requirements for all personnel at the Site 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.

STORAGE OF FUEL/FLUIDS

- Replacement and used fuel
  - Stored in fuel depot
  - Store at reasonable quantities
- Used oil to be stored in approved containers and hauled by accredited waste hauler
- Welding or other activities that could create heat or sparks and set off a fire shall be carried out away from the oil and fluid storage area.
- Fire extinguishers should be placed in accessible areas.

- Compressed gases used for cutting and/or welding shall be stored in racks and chained to ensure safe storage.
- “Hot work” permit shall be required for any activity that can generate and open flame or spark in any other area than the maintenance building or other Site location

FIRE OR EXPLOSION

- Suspect area must be isolated
- Site supervisors and fire departments should be conducted.

WEATHER MONITORING

- 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:

- 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.

THANK YOU!

MODULE 8: SITE RESTORATION ACTIVITIES

FINAL COVER SYSTEM

- Purpose of the final cover system:
  - 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 system; and;
  - assist with controlling the emissions of LFG.

- 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.
- Local plant species ultimately utilized for the final cover shall be selected

- The perimeter drainage layer is intended primarily as a safety measure to protect against localized slope failure resulting from localized saturated conditions

- 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
- Side slopes of 3:1 (H:V).

SITE AFTERCARE

- Monthly inspection to cover the following:
  - 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 drivable; and
  - inspect swales for sediment accumulation and erosion.

MODULE 9: MONITORING AND PERFORMANCE

WASTE/SOIL VOLUME MONITORING

- Survey of the active landfill stages shall be conducted each year 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.
- Cover soil balance will be updated
- Important for planning purposes:
  - to establish the schedule for the continuing cell development,
  - capital purchases for equipment, and
  - materials to continue the Site development

GROUNDWATER MONITORING

- Key elements:
  - maintenance of on-Site shallow groundwater wells 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.

- Water quality parameters to be measured:
  - pH , Temperature, Conductivity, Chloride, Sodium, Hardness, Iron, Manganese, Boron, Color, Dissolved Oxygen, Biochemical Oxygen Demand (BOD), Total Dissolved Solids (TDS), Nitrate-Nitrogen, Chromium VI, Oil and grease, Arsenic, Cadmium, Lead, Mercury, Total coliforms, Fecal coliforms

LEACHATE COLLECTION SYSTEM MONITORING

- Leachate collection system monitoring program is established to ensure that the leachate head on the underdrain collection system is maintained at acceptable levels
- Leachate collection system monitoring program includes the following:
  - installation and maintenance of inclined standpipes at the toe of slope around the perimeter of the landfill;
  - monthly water level measurements in all inclined standpipes;
  - leachate quality sampling and analyses are discussed with the leachate treatment system monitoring; and
  - water level measurements recorded at all leachate pump stations along with pumping records maintained at each station maintained by the Site operator.

- Parameters monitored:
  - pH, Temperature, Conductivity, Chloride, Sodium, Hardness, Iron, Color, Dissolved Oxygen, Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Nitrate-Nitrogen, Chromium VI, Oil and grease, Arsenic, Cadmium, Lead, Mercury, Total coliforms

SURFACE WATER MONITORING

- surface water quality and quantity monitoring program applies to the effluent from the on-Site stormwater sedimentation and control ponds
- surface water monitoring program includes the following:
  - installation and maintenance of a surface water monitoring network consisting of monitoring locations in the north and south ponds;
  - monthly flow measurements of raw and treated leachate and quarterly monitoring of all stormwater discharge locations; and
  - semi-annual inspection of swales for evidence of excessive erosion and/or sediment buildup.

- Parameters monitored:
  - pH, Temperature, Conductivity, Chloride, Sodium, Hardness, Iron, Colour, Dissolved Oxygen, Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Nitrate-Nitrogen, Chromium VI, Oil and grease, Arsenic, Cadmium, Lead, Mercury, Total coliforms

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

LANDFILL GAS MONITORING

- The relative risks and potential for gas migration are low but installation of these probes is a prudent supplementary safety measure .
- The LFG monitoring program include the following:
  - installation and maintenance of on-Site LFG probes in the vicinity of the administration buildings and leachate treatment facility; and
  - monthly monitoring of the major constituents of LFG.

- In case of odor complaint, the following information are recorded:
  - 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.

REPORTING REQUIREMENTS

- Contents of annual report:
  - results and interpretive analysis of all leachate, groundwater, surface water, noise, and air quality 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;

REPORTING REQUIREMENTS

- 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;

REPORTING REQUIREMENTS

- 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.

Appendix 4 –
Results of AERMOD Air Dispersion Assessment

CONESTOGA-ROVERS & ASSOCIATES

651 Colby Drive, Waterloo, Ontario, Canada N2V 1C2
Telephone: (519) 884-0510 Fax: (519) 884-0525
www.CRAworld.com

DRAFT MEMORANDUM

TO:	EXP Project Team	REF. NO.:	078058
FROM:	Stephen Koo/Tej Gidda/cb/1	DATE:	June 19, 2012
RE:	**AERMOD Air Dispersion Screening Assessment for Odor Guyana Solid Waste Management Authority, Georgetown, Guyana**		

INTRODUCTION

Conestoga-Rovers & Associates (CRA) completed a screening assessment for odor at a proposed solid waste management (SWM) facility located in Georgetown, Guyana (Facility). The SWM will include four landfill cells, a leachate storage and treatment area, and a hazardous waste area. The modeling was performed to estimate the potential impact of odor on local sensitive receptors.

SITE DESCRIPTION

Based on the information provided, the Facility will have a total footprint of approximately 50 hectares (ha). The preliminary Facility design will include the following components:

- Administration and control buildings
- Four landfill cells, of which only one will be active at any time
- Three storm water sedimentation and control ponds, with associated support functions
- Leachate storage (storage recommended to be eliminated) and treatment ponds
- Composting area
- Waste picking and recycling area
- Hazardous waste area

Odor emissions were assumed present from the active landfill cells, the leachate storage (note subsequent recommendation made to eliminate the storage source) and treatment ponds, and the hazardous waste area. The modeling assessment only focuses on these three odor sources and does not consider any other potential odor sources.

ODOR EMISSION RATES

Landfill Cell

The landfill will operate four cells. However, it was assumed that only one cell expected to operate at any one time. Based on the proposed operating conditions, peak landfill gas generation was estimated to reach 2,615 cubic meters per hour (m^3/hr) using the Scholl-Canyon model and a yearly fill rate of 1,050 tonnes per year (t/yr) up to a maximum capacity of 1.5 million tonnes. Figure 1 provides the estimated gas curve for the active landfill cell. The USEPA assigns a typical landfill gas odor concentration of 10,000 odor units (OU) under worst-case conditions. Therefore, total landfill odor emission rates are expected to reach 7,264 OU per second (OU-m^3/s). For conservatism, half the odor emission rate was used under the assumption that portions of the landfill will be under cover at all times. An odor emission rate from the active cell was then estimated to be approximately 3,632 OU-m^3/s. As emissions will be released across the surface of the landfill cell, the per square meter emission rate is estimated at 0.058 OU-m^3/m^2-s.

Leachate Storage (Note previous comments regarding storage pond elimination) and Treatment Ponds

The leachate storage and treatment ponds are expected to contain leachate from the landfill area, but not as active or odorous as the landfill itself. Therefore, the odor emission rate was assumed at two orders of magnitude lower than those emitted from the landfill area (i.e., 0.00058 OU/m^2-s).

Hazardous Waste Area

The hazardous waste area will handle hazardous items such as spent petroleum products, electronics, and household paints and thinners. Although this area is not expected to be a major source of odor, it was not considered insignificant due to the potential for accepting odiferous items. Therefore, an odor emission rate for this area was estimated to be approximately three orders of magnitude lower than those emitted from the landfill area (i.e., 0.000058 OU-m^3/m^2-s).

A summary of modeled emission rates is provided in Table 1.

SCREENING AIR DISPERSION MODELING

Model Executables

The following approved dispersion models and pre-processor models were used in the assessment:

- MAKEMET screening meteorological pre-processor
- AERMIC air dispersion model (AERMOD), version 11353
- Building Profile Input Program (BPIP), version 04274

Screening Meteorological Data

Meteorological data was not immediately available for the modeling assessment. Therefore, a screening meteorological dataset was developed and used in the assessment to estimate worst-case odor impacts and impact distances. This screening dataset was developed using the USEPA MAKEMET meteorological pre-processor. A MAKEMET dataset contains a matrix of worst-case meteorological conditions based on

local temperature ranges and land use. For the Facility, the minimum and maximum annual temperature ranges for Georgetown, Guyana were used (minimum of 24.1°C and maximum of 29.7°C; www.wikipedia.com) with land use characteristics (surface roughness, albedo and Bowen ratio) for open water, cultivated lands, and urban environments. In total, the MAKEMET matrix contained over 17,850 unique meteorological conditions.

Averaging Periods and Time-Based Concentration Conversion

Odor levels are typically based on 10-minute concentrations. An odor unit (OU) is defined as a threshold where 50 percent of the population would detect, but not identity, the odiferous compound. Therefore, an odor concentration of 3 OU means that it would take 3 dilutions to reduce the odor to 1 OU. This definition is normally applied at sensitive receptors. Sensitive receptors may include residences, camping grounds, schools, community centers, day care centers, recreational centers and outdoor public recreational areas.

AERMOD cannot model averaging periods less than a single hour. Therefore, for 10-minute peak odor, the 1-hour averaging period was used with the resulting predicted concentrations converted to the shorter 10-minute averaging period using the following equation:

$C_0 = C_1 \times F$

Where:

C_0 = the concentration at the averaging period t_0

C_1 = the concentration at the averaging period t_1

F = factor to convert from the averaging period t_1 to the averaging period t_0
$= (t_1/t_0)^n$

n = 0.28 (based on neutral stability class for atmospheric conditions)

Based on the above equation, the 1-hour to 10-minute time-based conversion factor is 1.65.

Digital Elevation Modeling Data

Digital elevation modeling (DEM) data was not used as part of the odor screening assessment. Surrounding land formations were assumed flat.

Source Input Parameters

Sources at the Facility were modeled as area sources based on their description and geometry. The area sources were located within Facility boundaries as shown in the provided site drawings. All sources were conservatively assumed to be operating simultaneously, continuously, and at maximum emission rates. For the landfill cells, only one cell (of four cells) is assumed active at any time. Therefore, only the active cell area was modeled for odor.

A summary of the AERMOD source input parameters are provided in Table 2.

Receptor Grids

A receptor grid was defined based on a bounding box that encapsulates all the modeled sources. The grid was then tiered starting from the edge of the bounding box with a fine resolution, and progressing to coarser resolutions at further distances. All tiered distances were defined relative to the bounding box. The receptor grid used is described as follows:

- 20 m spacing within 200 m of the edge of the bounding box
- 50 m spacing from 200 to 500 m
- 100 m spacing from 500 to 1,000 m
- 200 m spacing from 1,000 to 2,000 m
- 500 m spacing from 2,000 to 5,000 m
- 1,000 m spacing from 5,000 to 10,000 m

A property line ground level receptor grid with 10 m spacing was used to evaluate the maximum property boundary concentration. No receptors were placed inside the Facility's property line.

SCREENING DISPERSION MODELING RESULTS

The AERMOD models were developed and executed following the methods described above.

The MAKEMET screening meteorological data included 17,850 unique meteorological conditions. The resultant 1-hour calculated odor concentrations were converted to 10-minute odor concentrations using the time-based conversion factor of 1.65.

Based on the screening assessment modeling, the maximum Facility-wide 10-minute odor impact is predicted at 3.2 OU. The potential minimum distance of the Facility to exceed 1 OU is estimated at 2.5 kilometers. The potential maximum distance of the Facility to exceed 1 OU is estimated at 4.5 kilometers.

Figures 2 through 5 presents the maximum 10-minute odor contours based on the screening meteorology. Figure 2 presents the odor contours for all sources operating. Figures 3 through 5 presents the odor contours for each of the individual sources.

As shown in Figure 5, the majority of the odor impact is a result of the landfill emissions. The hazardous waste area (Figure 3) and leachate ponds (Figure 4) do not significantly contribute to the overall odor impact.

LIMITATIONS OF RESULTS

Care should be taken when reviewing the results. The assessment models are limited in their results for the following reasons.

Reliance on Engineering Estimates for Odor Emission Rates

Odor emission rates were estimated based on proposed design and operational conditions. For the landfill, assumptions included waste acceptance rates, maximum capacity, methane generation rates, and useful lifespan of the landfill. For the leachate ponds and hazardous waste area, assumptions included general operating conditions, surface flux rates, area producing the odor, and the estimation of odor emission rates.

Assumptions in the Characterization of Sources

Sources were characterized based on drawings of the proposed Facility. Although the sources characterized would typically be modeled as area sources, they may be over (or under) estimated in size and configuration depending on the final operating conditions.

For example, odor from the hazardous waste area is likely over-predicting odor impacts as the current assumption is that the entire waste area is a source for odor. In practice, this may not be the case; actual Facility operations may limit odor emissions to a small portion of the waste area, or operations may not generate odor at all. Similarly, odor impacts from the leachate ponds may be lower in practice if they are operated as covered ponds (as opposed to open ponds). Further, it is noted that the storage ponds are recommended to be eliminated and as such would make the analyses more conservative in nature, which would further reduce the stress on off-site odor.

Use of Screening Meteorological Data

The use of MAKEMET to generate screening meteorological dataset typically results in worst-case conditions being modeled, which in turn results in highly conservative odor impacts. Refinement of the meteorological dataset to include locally recorded conditions is typically recommended. This information is usually acquired from local meteorological climate stations and airports, where available. When information is unavailable, it may be replaced or supplemented with information derived from numerical climate models, such as the fifth-generation Penn State/National Center for Atmospheric Research mesoscale model (MM5).

Meteorological refinement is recommended as it shifts odor impacts from theoretical worst-case conditions to real-world conditions based on local atmospheric conditions.

Site Uncertainty and Local Land Use

The model currently does not site the Facility in a geographic location, as this information was not available at the time the models were developed and executed. Geographic location and local land use were, therefore, not considered. Both these factors can have an impact on odor modeling. Geographic location introduces terrain variations that can affect plume behavior (e.g., plume terrain following near the earth's surface, plume splitting if the plume encounters a significant terrain feature, etc.). Location can also provide information on local land use, which would affect meteorology (during pre-processing) and plume behavior in the model (heat island affects in an urban setting).

Modeled Odor Impacts as Absolute Values

The odor impacts presented in Figures 2 to 5 represent worst-case (i.e., maximum) values. These odor values do not provide any indication of how frequently an odor value above a specific threshold occurs, or how pervasive an odor may be.

For example, a high odor impact at a location may occur only once at that particular location, out of the entire meteorological dataset. At all other times, the predicted odor may be below the target threshold. However, simply presenting the single high odor value does not show that it represents an anomalous condition. Similarly, a lower odor impact may not be considered immediately offensive, but may be occurring on a regular basis and, as such, may result in chronic odor complaints. This may occur even when modeled odor impacts indicate that the low odor impact location should not be experiencing significant odor.

Therefore, frequency assessments at locations of interest should be considered to further determine overall odor impacts on the surrounding area.

Appendix 5 – Bibliography/References

Bibliography/References

1) Draft Second Progress Report on Healthcare Waste Management Volume II prepared by SENES Consultants Limited in February 2010 for the Guyana Ministry of Local Government and Regional Development.

2) Alternative Leachate Treatment Plant Design and Storm water Management report prepared by Hydroplan for the Guyana Ministry of Local Government and Regional Development in August 2010.

3) EIA Addendum prepared in March 2011 for the Guyana Ministry of Local Government and Regional Development by SENES Consultants Limited. To date the report has not been approved by the EPA

4) Site Operations Plan Version 1.0 prepared by Hydroplan for the Guyana Ministry of Local Government and Regional Development in May 2011

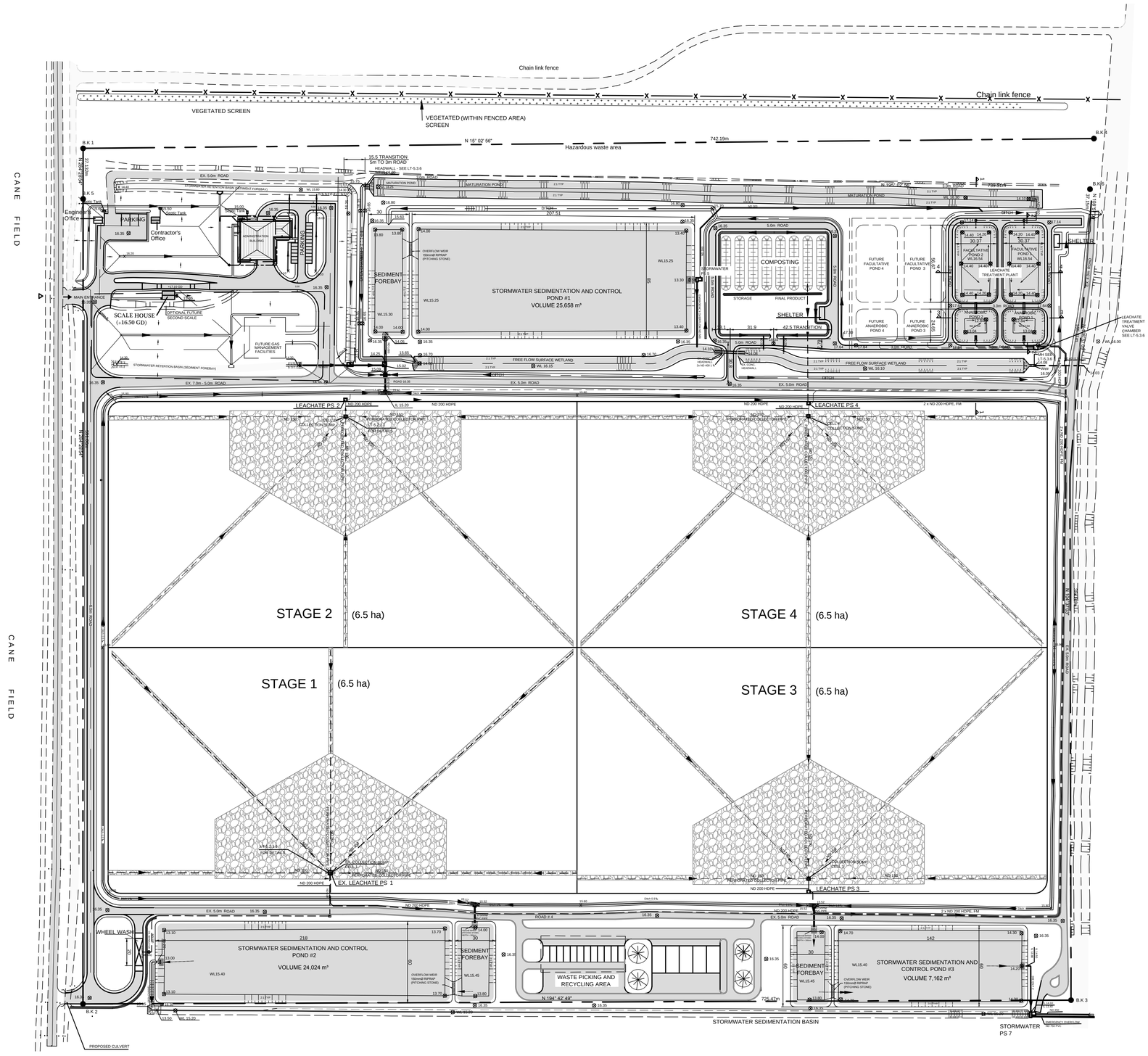
5) EIA prepared by Trow International Ltd in May 2005.

6) Environmental and Social Management Plan prepared by Trow International Ltd in May 2005.

Appendix 6 –
Environmental, Health and Safety Permits/Authorizations

No new permits issued since initial EIA

Appendix 7 –
Revised General (Site) Plan Drawing (G-1.0)



Key Map (not to scale)

No.	REVISIONS	Date	By	App.
B	ISSUED FOR INFORMATION	NOV. 20 2012	T.M.	S.G.
A	ISSUED FOR INFORMATION	JULY 12, 2012	M.S.	S.G.

exp Services Inc.
T: +1.905.796.3200 | f: +1.905.793.5533
56 Queen Street East, Suite 301
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Project:

CONSTRUCTION OF SANITARY LANDFILL IN HAAGS BOSCH

Title:

REVISED GENERAL PLAN

Designed By:	Drawn By:	Checked By:
Scale: 1:1500	Date: JANUARY, 2012	Drawing No.: PG. 03 (G-1.0)
Report No.: 35919-30	Report No.: 002	