9.0 CONCLUSIONS

9.1 THE EXISTING ENVIRONMENTS FOR SAN PEDRO, CAYE CAULKER AND BELIZE CITY DISPOSAL SITES

- All three sites are inappropriately located, improperly managed and have led to contamination of surrounding areas.
- All three sites are located in mangrove wetland areas with direct contamination from the disposal of municipal waste.
- These sites are breeding sites for pests and other unwanted species such as vultures.
- The water table is just a few inches below the ground in these areas and in a few instances it is exposed with garbage thrown directly into it.
- All three sites are near residential areas with the land having very limited agricultural value.

9.2 POTENTIAL IMPACTS AND MITIGATION FOR SAN PEDRO, CAYE CAULKER AND BELIZE CITY DISPOSAL SITES

- All three sites would occasionally burn. Although burning of waste is no longer intentionally practiced in the Belize City site, it sometimes spontaneously catches fire on a regular basis often requiring the support of the National Fire Service and Ministry of Works. The disposal sites for SanPedro and Caye Caulker are sometimes intentionally lit to reduce the volume of the waste. During burning residents immediately surrounding the site are subjected to the smoke generated by these fires.
- It is important to note that one of the main sources of dioxins and furans emissions in Belize was identified as those resulting from the open burning of garbage dumps. During the months of October-February it is not uncommon for the entire Belize City to be affected by the smoke brought down as a result of an atmospheric inversion.
- In addition residents and travellers are subjected to the pungent, malodorous gases released from the decomposition of the organics present within the municipal solid waste.
- Leachate also poses an environmental risk, particularly to surface water. An assessment Conducted by ETEISA in June of 2008 indicated that the

ground water and surface water on and near this site is being contaminated by leachate.

- The proliferation of vermin and other pests (vultures and other scavengers) in the area is another potential negative impact of concern particularly associated with the potential spread of environmental diseases such as Malaria and Dengue.

9.3 THE EXISTING ENVIRONMENT FOR MILE 22

- Surface drainage in the general project area is dominated by flow from the higher onsite areas eastward through to various drainage courses and the Cox Lagoon,Mussel Creek system to eventually breach the Belize River.

- The site is underlain by a thick layer of dense clay (observed to be greater than 13 meters), believed to then grade to marl and then limestone bedrock. The layers of clay are of very low hydraulic conductivity and substantial thickness, and would thus be very suitable for comprising a natural liner for the proposed sanitary landfill. The site contains clay and other materials that would provide both interim and final cover for the Landfill. In addition there is sufficient good construction material to construct the access road from the site to the Western Highway at Mile 22.

- Wind direction is predominantly from the east and to a lesser extent the southeast, with some seasonal winds from the north, northeast and northwest. Relatively rarely do winds blow from the west, southwest or south.

- The site lies in the Coastal Plains Orchard/Pine savannah vegetation type. This type of vegetation is well represented in Belize on the leached, acid soils of the

Pine series and as such, there will be no significant loss of forest or agricultural resource in clearing of the area required for the landfill.

- Equally, it is unlikely that any sensitive habitats for plants or wildlife exist in the vicinity of the site, although the site is in close proximity to potentially sensitive areas.

- Given the poor quality of the soils in this area, there is limited agriculture in the
- vicinity of the proposed landfill site, and there is no designated land use of the site at present. In the past, the site has been used as a gravel quarry, which activities have left the site in a degraded condition and not suitable for normal uses.

- There are no active dwellings within 5 kilometers of the proposed landfill.

- In terms of future land use, major residential developments and subdivisions for lands situated at Mile 22 to 26 of the Western Highway were proposed several years ago. These developments were expected to provide over 6000 lots, as well as parks, retail lots, and provision for light commercial activity. The Jih Chan and Lu Fin residential developments are located approximately 4 km to the southwest of the site. The Black Orchid Development is proposed for an area to the southeast of the site and is approximately one kilometer distant, when considering their additional buffer.

- Because the site is distant from any major river or areas likely to contain caves, and because much of the surface layers at the site have already been removed or disturbed by quarrying activities, it is unlikely that historic artefacts would be found in the area.

9.4 POTENTIAL IMPACTS AND MITIGATION FOR MILE 22

9.4.1 Air Quality

- Potential air quality impacts of the development could include: generation of landfill gas from the landfill site; landfill odors reaching future residential development, or smoke and dust from fires and the activities of on-site machinery at the landfill site.

- Without mitigation, there is the potential for odors from waste material in the landfill to reach future adjacent residential development. Smoke from fires and dust from the activities of machinery at the landfill are other possible irritants to nearby human populations.

- Landfill gas (chiefly carbon dioxide and methane) is normally produced as a result of decay processes in any sanitary landfill facility. Mitigative measures for landfill gas control include some absorption of these gases by broad leaf plants such as trees in the buffer areas and, if required, the installation of gas collection wells.

- It will be both necessary and feasible to prevent odors from being a problem to neighbouring facilities by applying adequate cover material to the landfill frequently and effectively. There is an ample supply of inert granular material existing on the site, which can be used for this purpose. The Environmental Mitigation Plan in this EIA Report sets out the methods for applying cover. It is also recommended that the active face of the landfill be minimized at any given time.

- Dust problems can be minimized by maintaining the site roads, applying water to internal access roads when necessary, and ensuring that internal permanent access roads are compacted and/or graveled.

- Fire prevention and contingency measures are set out in the Environmental Mitigation plan.

- With the measures of the Environmental Mitigation and Monitoring plan implemented effectively, air quality concerns can be kept to acceptable levels.

9.4.2 Soils and Terrain

- Potential Impacts to soils and terrain include erosion of bare slopes during construction and operational phases; and slope erosion in the post-closure phase of the landfill. Particulate matter may be carried to the retention pond where it would settle out, with no consequent effects on surface water quality beyond the pond.

- Contouring of the landfill facility and surface water diversion channels shall be constructed so that surface water is diverted into the existing drainage courses. The concept shall be based on maintaining surface water flows that are no more, in terms of instantaneous flows, than what would be considered as the natural site condition.

- For the post-operational phase, the landfill shall be capped, contoured, and vegetated appropriately, with full attention to providing effective drainage and erosion prevention. With such measures in effect, the landfill may be constructed, operated and decommissioned with no significant adverse effects to soil erosion.

9.4.3 Surface Water

- One concern that has been raised is the possibility that contaminants from the waste might enter surface runoff water from the landfill and reach adjacent surface waters such as the Cox Lagoon, Mussel Creek and then the Belize River. A number of measures are proposed as part of the Environmental Mitigation and Monitoring plans to ensure that surface water quality is protected. All landfill surface runoff will be directed to an on-site holding pond where it will undergo

natural aerobic stabilization and sedimentation. This pond will be sized to handle a 1/100 year 1-hour return storm event, during normal operations of the landfill. Only surface water that **has not** come into contact with the waste material (i.e., non-contact surface water) will be allowed to directly enter the holding ponds.

- All contact water will be conveyed to the leachate retention and storm water treatment ponds. In the initial stages of each cell's operation all surface water will be diverted to the leachate collection system. This will be continued until the two liquid sources can be safely separated into their own handling systems.

- During construction, appropriate measures including berms, silt traps, etc., will be taken to ensure that significant amounts of sediment do not pollute adjacent watercourses. Upon closure of the landfill, the surfaces will be contoured and revegetated in such a way as to prevent erosion and resulting sedimentation of adjacent surface waters.

- Monitoring of surface water quality shall be conducted at regular intervals at critical points in the watershed throughout the construction and operational life of the landfill, including the Sibun River.

- Provided the above measures are implemented during the construction operations and closure phases of the landfill development, no significant adverse impacts on surrounding surface waters are anticipated.

9.4.4 Ground Water

- A potential impact that must be avoided at any sanitary landfill site is the possibility that leachate from the waste cell might enter the ground water underlying the site. This could have long-term adverse effects on ground water quality, well water quality, and surface water quality stemming from discharge of the ground water to the surface water.

- The proposed sanitary landfill at the Mile 22 Western Highway site has been selected largely to take advantage of the depths of impermeable clay on the site, which will act as a natural liner, preventing percolation of leachate into groundwater. In addition, a high density polyethylene liner will be installed in each leachate collection trench. Leachate will be collected from each cell and conveyed to a series of three leachate retention cells, where it will undergo natural treatment before draining to a large evaporative pond. No leachate shall be released from the evaporation area until it has been determined suitable for release.

- In the post-operational phase, an impermeable layer of clay or similar material will be placed on top of the closed cells, to curtail the percolation of water into the cell and hence the production of leachate.

- With these and other measures in place as outlined in the Environmental Mitigation and Monitoring plans, no significant effects on the local ground water or local wells are anticipated.

9.4.5 Vegetation and Wildlife

- The development of any landfill site entails clearing and re-contouring activities, as well as the operations of the facility itself. This can result in loss of habitat for wildlife and natural vegetation, as well as a tendency to act as a barrier to wildlife movement. .

- The current design for the landfill site incorporates a minimum undisturbed buffer zone of 50 meters to be established around the site using existing and planted trees and other vegetation, in order to reduce the effects of noise and other disturbance to surrounding human and wildlife populations. The site perimeter is not to be fenced, so as to facilitate wildlife dispersion through the buffer zone areas. In addition, a 50m buffer has been incorporated on either side of on-site creeks.

- Favorable contouring and re-vegetation of the decommissioned landfill shall be conducted so as to promote its value as habitat. This could have the advantage of preserving the area as consistent with the requirements of the proposed wildlife dispersion corridor. Other plans in surrounding areas could be made in the meantime, with the knowledge that this area will be restored to compatible land use.

- While some loss of habitat will occur due to the development of the landfill facility, the vegetation communities that currently exist there (i.e. forest, pine savannah, thicket) are well represented on the coastal plains of Belize, and this will not represent a significant loss in terms of habitat for plants or animals, for commercially important plants/animals, nor for sensitive habitats. In addition, the site is already significantly degraded as habitat due to past excavation activities.

- The development of a future Interpretive Center to explain the mitigation and monitoring features of the sanitary landfill and the importance of reducing and recycling solid wastes, should be considered.

- The proposed plan will offer the long-term option of returning the land to a higher value of habitat than presently exists there due to the past gravel mining activities. With the above mitigation in place, it is anticipated that there will be no significant adverse effects on vegetation and wildlife, and indeed in the long term there may be a net positive impact.

9.4.6 Current and Proposed Land Uses

- The land which has been proposed for the Mile 22 Western Highway landfill facility is privately owned and presently unused. The landowner has expressed verbal agreement with the possibility of sale of the land proposed for the use as a sanitary landfill.

- While there have been several proposals for residential areas in the vicinity of the proposed landfill, the implementation of these plans have not moved to the point where irresolvable land use conflicts are inevitable. When such plans are considered for approval, the regulatory agency should ensure that land use or other conflicts involving the landfill facility are avoided.

9.4.7 Traffic

- Truck traffic resulting from the operation of the regional waste management facility at Mile 22 of the Western Highway is estimated to amount to an additional 20-30 trucks per day travelling to and from the facility. This represents an increase in total traffic of approximately 2-3%, and of heavy traffic approximately 10-15%, based on data from the nearest available assessment point.

- The increase in heavy traffic, from about 200 vehicles per day to about 220-230 vehicles per day is not so great as would represent a significant threat to safety, provided that the timing of waste management vehicle transit is more or less distributed in time over the course of any day, or days during the working week.

- The location of the recommended landfill access point, at the beginning of a long stretch of straight highway with no substantial visual obstructions for more than 3 kilometers will provide excellent visibility to the west. Visibility to the east is between 300 – 500 meters and some selective bush clearing is required to maximize this site distance to the east.

- The location of the alternative access road entrance point requires 400-500 meters of service road to the east of the existing junction to provide adequate site distance to the west.

- Provision is to be made for turn lanes at the Sanitary Landfill access point, in the form of paved shoulder lanes both eastbound and westbound. In addition a free right turn ramp will be suggested for west bound traffic

- With the above mitigation measures in place, there should be no significant reduction in traffic safety or efficiency of traffic flow as a result of the operation of the landfill facility.

9.4.8 Disturbances

- While some degree of noise from landfill machinery may be heard in surrounding areas, the establishment and maintenance of a treed buffer zone around the site will serve to reduce noise levels beyond the site.

- Dust suppression measures will be used during construction and operational phases of the landfill, for example compaction of travel surfaces and the use of water on access and other roads.

- Application of daily cover material is critical in reducing the landfill's attractiveness to pests such as rodents, insects, feral dogs and cats, and birds (e.g., vultures). In addition, the working face of the landfill must be confined, reducing the amount of fresh waste exposed to the air. Compaction of the waste in the landfill serves not only to reduce odor and pest problems, but to minimize the escape of windblown litter.

- To control litter, all incoming vehicles should be covered (e.g., with netting or tarp), and site staff should be assigned as necessary to regularly retrieve litter which might escape from trucks travelling the access road or from the landfill site. In terms of aesthetics, the treed buffer zone will minimize visual impact from the perspective of adjacent areas during construction and operations. After landfill

closure, the landfill will be re-contoured and re-vegetated such as to provide an acceptable visual presentation.

- With the measures of the Environmental Mitigation and Monitoring plans fully implemented, it should be possible to prevent significant adverse impacts in the form of nuisances to neighbouring institutions or residences.

9.4.9 Historical Resources

- Because the site is far from any major river and not in an area with abundant
- caves, artefacts of historical importance are not likely to be found at the proposed landfill site. Furthermore, much of the surface layers at the site have already been removed or disturbed by ongoing quarry activities.

- If mounds, clayworks or other artefacts of possible historical importance are found on the site during clearing or construction, the Institute of Archaeology is to be contacted to determine the potential importance and the recommended action.

9.4.10 Other Results

- There will be considerable environmental benefit resulting from the development of the Solid Waste Management Plan including the regional sanitary landfill, in terms of an improved waste disposal system for Belize, resulting in less litter, odor and pests.

- In order for the landfill to operate successfully it is imperative that all the Transfer Stations in the Waste Management Plan be developed as part of this development.

- A positive feature of using the Mile 22 Western Highway site for a regional sanitary landfill is the abundance of cover material. This could be used not only for cover material for that site, but also for closure covering of other existing problem disposal sites.

9.5 INSTITUTIONAL NEEDS

9.5.1 Staffing and Training

- In order that the proposed new waste disposal facility is operated in a satisfactory and environmentally sound fashion, trained and qualified staff should be available for various key areas, including: fire control and prevention; waste segregation and handling; leachate management; application of cover material; landfill gas collection, treatment and monitoring of leachate; ground water and surface water quality sampling procedures; dealing with the public; addressing pest problems; and awareness of relevant environmental issues. These points should be addressed in a comprehensive operation manual.

9.5.2 Legislation and Institutional Arrangements

- Refinements or additions are needed for: the Solid Waste Management Authority (SWMA) Act; the relationship between the Department of Environment (DOE) and the SWMA; the Environmental Protection Act; and the Littering and Derelict Vehicle regulations.

- It is recommended that the Environmental Protection Act be amended to establish regulatory mechanisms for the issuance of permits to construct and operate landfills. The Act should also empower the DOE to license redemption depots where containers could be deposited as well as the licensing of the processing of recyclables; and the licensing of other solid waste processing facilities.

- It is recommended that the SWMA be responsible for the operation and management of solid waste facilities; while the Department of Environment be responsible for granting permits for the location, design

and operational parameters of landfills and solid waste sites, for monitoring and enforcement, and for policy development.

9.6 OPERATIONS

All thee municipal disposal sites will need to be rehabilitated and converted to tranfer stations with the specific recommended mitigation measures as an implementation requirement.

In order to ensure the landfill and transfer stations are operated to a high standard and meets the Mitigation Plan the operator should post a Performance Security (recommended at $BZ100,000) as a guarantee of compliance with the operations plan. This Performance Security could be accessed by the Department of Environment to correct operational deficiencies.