

## 12. ALTERNATIVES FOR DEVELOPMENT

12.1 Present all reasonable alternatives for development in comparative form, exploring each alternative. Include the no-action alternative, and the reason why certain alternatives were recommended or eliminated. These alternatives should look at the following components:

- I. Siting of the necessary support infrastructure and all facilities;
- II. Earth Movement Activities (evaluate the different extraction/dredging methodologies, extraction/dredging points (burrow sites), extraction/dredging volumes, material fill sites etc.);
- III. Liquid and Solid waste treatment and disposal options (evaluate the different treatment technologies and methodologies); and
- IV. Boat storage marina/docking facilities (siting, design, etc.) facilities.

### ALTERNATIVES TO DEVELOPMENT

The alternatives for development are itemized in **Table 44** and described in further detail as follows.

**Siting Options** are limited to the proposed development site owing it being private land. The design layout for the proposed development satisfies both the economic and density objectives of the development, changes in which would only serve to either reduce economic feasibility, and hence economic benefit of the project. Consequently, and given that public benefit strongly favors the project's implementation, it is reasonable to accept the proposed siting option as the preferred option for development.

**Land-Based Transportation Options** concern proposed development of 43 kilometers of roads and trails within the Year 1-5 timber management zone; 87 Km of new access roads and 6Km of alleys within the residential tourism development; and 14 Km of easement access between the Old Northern Highway at Maskall Village and the road matrix within the timber management zone, for a total of approximately 150 Km of new and/or refurbished roads, alleys and trails. No other design options for land based transportation are available to the development, save for the non-development option (see **Page 104**). Hence, the proposed option is reasonable to accept as the preferred option for development.

**Sea-Based Transportation Options** chiefly concerns (1) the design and location of the navigable canal system planned for placement on the coastal savanna; and (2) the design and location of the marina and other boating-related facilities proposed for placement on Bennett's Lagoon. The options for the inland waterway/navigable canal system include: (1) acceptance of the proposed development option; (2) addition or modification of select components and/or reduction in canal system scale; or (3) rejection of the first two options altogether and acceptance of the non-development option. Modification of the master plan for the development would require its comprehensive redesign, which in turn would likely cause the proponent to abandon the development's placement in Belize, along with the substantive economic resources that would otherwise accompany its placement, and hence, result in election of the 3<sup>rd</sup> or non-development option by default.

**TABLE 44**  
**SUMMARY OF DEVELOPMENT ALTERNATIVES AND IMPACTS<sup>1</sup>**

IMPACT CATEGORY	OPTION 1	OPTION 2	OPTION 3
<b>Land-Based Transportation</b>	<u>Proposed Road Scheme</u> Nominal Impact Following Landfill Operations	<u>Non-Development</u> Loss Of > US \$ 100 M In Foreign Exchange Over Next 10 Years	.....
<b>Sea-Based Transportation and Boat Storage</b>	<u>Proposed Marina</u> Incremental Risk Of Manatee Mortalities, Which Can Be Mitigated Through Enforcement Of Conservation Guidelines	<u>No / Limited Boat Marina Capacity</u> Transfers Viability Risk To Proponent, And Will Likely Result In Project Failure,	<u>Non-Development</u> Loss Of > US \$ 100 M In Foreign Exchange Over Next 10 Years
<b>Material Supply</b>	<u>Cut And Fill Actions As Planned</u> Loss Of Forest Cover, And Risk of Bennett's Lagoon Erosion	<u>Non-Development</u> Loss Of > US \$ 100 M In Foreign Exchange Over Next 10 Years	.....
<b>Freshwater Supply</b>	<u>Direct extraction from Bahia Chetumal</u> Best Water Resource Strategy For Developer And Environment	<u>Non-Development</u> Loss Of > US \$ 100 M In Foreign Exchange Over Next 10 Years	.....
<b>Liquid Waste Management</b>	<u>Batch Plant Treatment</u> Highest Level Of Treatment Effectiveness.	<u>Non-Development</u> Loss Of > US \$ 100 M In Foreign Exchange Over Next 10 Years	.....
<b>Solid Waste Management</b>	<u>Partial Source-Separation With Storage At Designated MSW Site At 27 Miles from Orange Walk Town</u> Lowers Storage Requirement At Designated MSW Site And Cost To Development	<u>Complete Off-Site Storage</u> Nominal Environmental Risks, But Significant Elevation In Development Cost	<u>Non-Development</u> Loss Of > US \$ 100 M In Foreign Exchange Over Next 10 Years

<sup>1</sup>Note: Green shading indicates the preferred option for implementation by the proposed development

Given this consideration, and the fact that the savanna habitat in question, while supporting several species of wildlife, offers little to no economic value for agriculture or other revenue generating activities, it seems reasonable to accept the proposed option along with the caveat or requirement for (1) physical preservation of or increase in the number of the savanna habitats' adjoining microhabitats; and (2) placement of natural bridges that are unsuited to human use, in order to afford terrestrial wildlife continued access to natural or landscaped green spaces within the residential tourism development zone, which might otherwise be less accessible for the human presence being proposed for the area.

Scale options for the proposed marina facilities are limited to the reduction in wet slips (assuming that increased dry dock capacity, as a trade off for fewer slips, would not constitute a material reduction in prop injury risk to Manatee). A reduction in wet slip number, while likely to proportionately reduce the above-quantified incremental risk of pollution and prop injury to Manatee, would not eliminate either risk, nor the need for enforcement of Manatee conservation, and hence would simply transfer the nominal Manatee-risk to the proponent and Belize by jeopardizing the viability of the development. Consequently, and given that no alternative sea-based transportation design options are available which can both reduce pollution and manatee risks without jeopardizing the economic viability of the proposed development, the proposed marina development plan and represents the preferred options for development.

**Material Supply Options** concern a modified version of the proposed option, or the non-development option. The proposed option will serve to improve drainage of rainwater runoffs, increase coastal aquatic habitat, and provide a readily available reservoir of water for fire-fighting and manufacture of potable water, albeit at substantial cost to the proponent. The downsizing of the proposed option, principally through reduction of canal lengths, include lower development cost to the proponent, albeit with reduced amenity value and hence, a possible reduction in sales. The non-development option insures the landscape will not become degraded from abandonment should the development fail, albeit with the forfeiture of an attraction for European tourism that is presently being sought through facilities expansion of Belize's international airport; as well as the foreign exchange and economic growth that would otherwise result from successful implementation of the proposed development. Given these considerations, it seems reasonable to conclude that relocation of material requirements within the proposed development sites as dictated by the project master plan should be the preferred option for development.

**Freshwater Supply Options** available to the proposed development include abstraction of ground water, rainfall catchments in cisterns, abstraction from non-navigable canals and/or Bahia Chetumal, and purchase from commercial distributors located in Orange Walk Town. Supply from ground water is unlikely to be practical for the proposed development owing to the relatively low yield of area ground water resources, which are reputed to range from 0.04-40.0 M<sup>3</sup>/minute at 10 – 50 M depth (see Buckalew *et al* 1998 & **Illustration 54**). Rain water catchment in cisterns coupled with abstraction from non-navigable canals and/or Bahia Chetumal are likely to be suitable sources of water supply owing to: (1) their volume capacity, low salinity content and hence, low brine yield, particularly from the western end of the non-navigable canal network where essentially salt-free freshwater seepage and runoffs are conveyed from higher elevations (see **Page 50**);

and (2) the non-oceanic salinity of Bahia Chetumal (see **Page 64**), which might otherwise be readily combined with canal water resources for brine management. Supply from commercial vendors in Orange Walk Town is unlikely to be a cost effective source of bulk water need owing principally to the distance and generally poor road conditions between the Town and the BJE. Consequently, rainwater capture in cisterns coupled with abstraction from non-navigable canals and/or Bahia Chetumal of Belize River water, along with polishing of brackish water sources by reverse osmosis, is likely to be the most practical and hence, preferred option for freshwater water supply to the proposed development.

**Liquid Waste Treatment Options** available to the proposed development include: employing large-scale plant that is economical and efficient to operate at capacity development, and the second of which employs a distributed batch plant system, which improves treatment effectiveness by mirroring the developments actual rate of build out. The former approach is more economical to operate because all of the components are common to a single location, albeit with the trade off of concentrating effluent in a way that plant failure might compromise the entire developments capacity for treatment. The latter approach on the other hand is more costly to build and operate than the former system, but this cost is incurred in smaller amounts over time, rather than as a single, up-front cost. A distributed system may well serve to reduce infrastructure costs for irrigation since the point sources of effluent will be in closer proximity to their application point. Moreover, the distributed system provides the surety that if one component in the network fails for any reason; it will not disrupt the operation of the remaining treatment capacity. Although either approach to treatment is suitable for the proposed development, the later or distributed approach reduces failure risk and therefore might best reflect the preferred option for development.

**Solid Waste Treatment Options** for management of solid waste produced by the proposed development are essentially limited to onsite treatment of some or all the solid waste produced; or offsite treatment and storage of some or all solid waste at the National Solid Waste Storage Facility designated for the Orange Walk region of Belize. Owing to the volume of waste anticipated to be produced at capacity occupation of the Section-1 development, as well as the sites some 27 mile distant location from Orange Walk Town, source separation for material recycling might serve to reduce and/or offset a significant portion of transportation costs to the NSW storage facility. The key components of waste that may be best suited to separation for recycling include paper, plastic, glass and metal waste, the paper fraction of which can be incinerated in smokeless incinerators to reduce solid waste volume by 15% (*provided* safety measures are observed to prevent runway fires in the savanna & broadleaf forest habitats), and the remaining inert fractions of which could be buried on site to reduce solid waste transport requirements by another 21%, for a total of 36%. Onsite composting might further reduce transport requirements by an additional 47%, for a total of 83%. Soil characteristics of the BJE (see **Page 50**) are likely to be suitable for the onsite burial of septic tank sludge, brining the total reduction to 93%, but not petroleum and other forms of toxic waste (see **Page 47**).

Hence, source separation and incineration of paper waste, separation of plastic, glass, and metal wastes for recycling, and onsite composting of organic waste will be likely to offer the greatest overall reduction in municipal solid waste transportation and storage costs to the proposed development, and therefore should be elected as the preferred treatment plan for solid waste.

**Energy Use Options** include purchase from the public utility, Belize Electricity Limited (BEL), and/or petroleum/wood scrap-based self generation. Owing to the scale of the project being proposed, petroleum/wood scrap-based self generation while likely to produce substantially cheaper electricity than purchase from BEL at present industrial rates, will require greater capital and management investments which the proponent is not prepared to commit to at start-up. The developer is likely, however, to elect to use BEL as a primary source of energy, perhaps with co-generation from petrochemical or wood scrap engaged at a later date to reduce overall rates. Consequently, BEL as the primary source of electrical energy has been elected as the preferred option for development in order to simplify project management.

## 13. MITIGATION MEASURES AND MONITORING PLANS

- 13.1 Based on the investigations, develop a mitigation matrix outlining mitigation measures for all potential negative environmental impacts including, but not limited to, construction activities, waste treatment and disposal, habitat alteration and erosion control, and management of pests and vectors (rodents, mosquitoes, flies, etc.).
- 13.2 Provide a detailed monitoring plan to be implemented for the entire operation, identifying any agency/body responsible for its implementation and any training that may be necessary for the implementation of the plan. The plan should include monitoring of wastewater discharge characteristics (if any), changes in ecological species (including endangered species), contingency measures to emergency response to accidental events (fire, flood, hurricane, leakages, spillages, etc.).
- 13.3 Provide a detailed plan for the decommissioning and rehabilitation of the site to other uses in the event that the project is discontinued.
- 13.4 Identify and develop a water quality monitoring program able to detect any change (s) in ground water or surface water quality, that will impact:
  - I. Public health;
  - II. Forest, wetland and adjacent aquatic habitats; and
  - III. Endangered or threatened species in the project area and zone of influence.

### MITIGATION MEASURES FOR THE PROPOSED DEVELOPMENT

A summary of the potential impacts of the proposed development, and the measures proposed for their mitigation is shown in **Table 45**.

**Land-Based Transportation Impacts** concern the reduction of broadleaf forest and coastal savanna habitats, which is an unavoidable impact and can only be mitigated by non-development. Indirect impacts include the increased potential for fire starts from (human) smoking, and/or operation of poorly maintained heavy equipment within either the timber management zone or residential tourism development; and increased potential for rainwater, sediment and petroleum-based pollution runoffs to accumulate in ground and/or surface waters such as local cenotes, coastal lagoons and/or Chetumal Bay; both of which constitute avoidable, but more than likely irreversible impacts. Residual negative impacts include increased potential for public injury risk from increased traffic loads likely to be produced by the proposed development, which also constitutes an avoidable impact.

Avoidable impacts can be mitigated by placing settlement ponds into the overall landscape plan for the development, and insuring all drainage from these settlement areas discharges into the inland waterway/canal system planned for development where ever possible; achieving zero-fire starts through smoking and/or open fire restrictions; outfitting all petroleum powered vehicles with spark arresters, along with maintenance of electrical connections on all vehicles for the prevention of electrical spark generation; utility mapping of all natural surface water sources suited for use in fire control;

**TABLE 45**

**SUMMARY MITIGATION MATRIX OF DEVELOPMENT IMPACTS**

CATEGORY	NEGATIVE IMPACT RISKS	MITIGATION MEASURES
<p><b>Land-Based Transport Impacts</b></p>	<ul style="list-style-type: none"> <li>I. Reduction of broadleaf forest and coastal savanna habitat along carriageway alignments;</li> <li>II. Increased fire risk to the broadleaf forest and/or savanna habitat from increased human presence and operation of either electric or petroleum based vehicles;</li> <li>III. Delivery of fresh water, sediment and/or petroleum-based run-offs into area ground and/or surface waters;</li> <li>IV. Increased risk of public injury.</li> </ul>	<ul style="list-style-type: none"> <li>I. None, non-development;</li> <li>II. Achieve zero-fire starts through smoking and/or open fire restrictions; outfitting all petroleum powered vehicles with spark arresters, along with maintenance of electrical connections on all vehicles for the prevention of electrical spark generation; utility mapping of all natural surface water sources suited for use in fire control; and outfitting all work crews and/or maintenance vehicles with fire fighting equipment such as round point shovels, chemical foam extinguishers, and water uptake, storage &amp; dispensing equipment;</li> <li>III. Place settlement ponds into the overall landscape plan for the development, and insure all drainage from these settlement areas discharge into the inland waterway/canal system planned for development where ever possible;</li> <li>IV. Place signage and traffic stops to limit vehicle traffic speed through residential areas; ensure staff are properly trained to operate vehicles; and adhere to public licensing requirements in regard to operation of vehicles by staff residents or guests.</li> </ul>
<p><b>Sea-Based Transport Impacts</b></p>	<ul style="list-style-type: none"> <li>I. Increased risk to any manatee that may frequent the site of propeller injury;</li> <li>II. Increased risk of public injury;</li> <li>III. Placement of marina and fuel facilities on Bennett's Lagoon, may lead to contamination of the Lagoon with petroleum effluents;</li> <li>IV. Presence of petroleum point source on Bennett's Lagoon may lead to emigration of area marine life.</li> </ul>	<ul style="list-style-type: none"> <li>I. Place and enforce signage on navigational regulations in the vicinity of Bennett's Lagoon and the Corozal Bay; provide education to development occupants in regard to manatee injury risk and conservation requirements; promote use of safety propellers on guest, staff and resident boats;</li> <li>II. Place signage to limit boat traffic speed; ensure staff are properly trained to operate boats; adhere to public licensing requirements in regard to operation of boats by staff residents or guests;</li> <li>III. Insure drainage of the 9500-acre site through the Bennett's Lagoon watershed for the purpose of facilitating flushing of petroleum residues in wet weather.</li> </ul>
<p><b>Material Supply Impacts</b></p>	<ul style="list-style-type: none"> <li>I. Alteration of sea floor and Bennett's Lagoon floor bathymetry, savanna topography, and alteration of the rainfall runoff characteristics of the coastal savanna habitat;</li> <li>II. Release and entry of erosion products into Bennett's Lagoon and Bahia Chetumal during excavation activities; Canal wall slump during excavation activities;</li> <li>III. Reduction of savanna groundcover and the sparse marine flora established offshore;</li> </ul>	<ul style="list-style-type: none"> <li>I. None, non-development;</li> <li>II. Deploy silt screens capable of limiting sediment travel to the immediate vicinity of the marina basin or canal works; Place retaining walls concurrently with canal and marina excavations in defense of both the pre-existing and final land and shoreline grades;</li> <li>III. None, non-development;</li> </ul>

*Continued...*

**TABLE 46**

**SUMMARY MITIGATION MATRIX OF DEVELOPMENT IMPACTS**

(Continued)

CATEGORY	NEGATIVE IMPACT RISKS	MITIGATION MEASURES
<p><b>Material Supply Impacts</b> (Continued)</p>	<p>IV. Perturbation of the terrestrial landscape and marine habitat during construction and operating activities, and hence the displacement of intolerant terrestrial &amp; marine wildlife presently extent in the area (e.g. migrant &amp; specialist birds, and Manatee);</p> <p>VI. Permanent displacement of mobile terrestrial and marine invertebrate and vertebrate wildlife during material movement activities;</p> <p>VII. Short-term elevation in water turbidity within Bennett's Lagoon and the near shore marine habitat from canal &amp; marina construction and beach revetment activities;</p> <p>VIII. Long term sedimentation of the canal system and marina basin from savanna runoffs</p>	<p>IV. Re-landscape the project site with native vegetation and exclude fencing from use on the development site in order to promote re-colonization and interior movement of wildlife displaced during material movement activities; Deploy silt screens capable of limiting sediment travel to the immediate vicinity of canal works, and/or the marina basin;</p> <p>V. Re-landscape the project site with native vegetation and prohibit the use of fencing in order to promote re-colonization and interior movement of wildlife displaced during material movement activities;</p> <p>VI. Use silt screens to prevent downstream silt and sediment travel during construction of the marina facility;</p> <p>VII. Employ silt screens on the downstream side of canal construction activities and surrounding marina excavation activities; Postpone canal opening to the greater marine environment by leaving earthen plugs in place until canals have been constructed and adjacent lands stabilized.</p>
<p><b>Freshwater Supply Impacts</b></p>	<p>I. Aquatic wildlife may become entrained at water intake point;</p> <p>II. Change in botanical wildlife biodiversity along the non-navigable canal system;</p> <p>III. Change in animal wildlife biodiversity along the non-navigable canal system;</p> <p>IV. Landscaping runoffs, pool water &amp; brine discharge, and septic leach-fields percolation may increase toxic chemical and nutrient concentrations in the lower reaches of the non-navigable canal system and Bennett's Lagoon, thereby significantly diminishing water quality in these surface waters;</p> <p>V. Contaminants may render the marine environment unsuitable for use by coastal wildlife, particularly birds and Manatee;</p>	<p>I. Provide for water to be extracted from within a screened intake pipe to reduce the potential for aquatic wildlife entrainment at the water pump intake site;</p> <p>II. None; Positive impact;</p> <p>III. None; Positive impact if wildlife biodiversity increases;</p> <p>IV. Use the non-navigable canal system as photo-oxidation and settlement ponds for any nutrient, landscaping residue and pool chemical runoffs; Ensure through monitoring, that abstracted or discharged water is devoid of these constituents, as well as any noxious microbial blooms;</p> <p>V. Use mixing and stop gates to manage flow through the non-navigable canal system and provide opportunity for photo-oxidation of toxic chemicals, dilution of salinity concentrations, and reduction of storm induced colloid or phytoplankton turbidity prior to release into Bennett's Lagoon; while ensuring, through monitoring, that abstracted or discharged water is devoid of these constituents, as well as any noxious microbial blooms.</p>
<p><b>Liquid Waste Treatment Impacts</b></p>	<p>I. Nominal reduction in land cover associated with plant placement;</p> <p>II. Reduces soil percolation capacity and/or water distribution characteristics through loading with particulate organic matter</p> <p>III. Alters direction of subsoil water transport &amp; may potentially promote subsoil erosion</p>	<p>I. None, non-development;</p> <p>II. Construction of septic tank and drain field according to specifications, insuring that leaching rate does not exceed background percolation rate;</p> <p>III. Same as (II)</p>

Continued...

**TABLE 46**

**SUMMARY MITIGATION MATRIX OF DEVELOPMENT IMPACTS**

*(Continued)*

CATEGORY	NEGATIVE IMPACT RISKS	MITIGATION MEASURES
<p><b>Liquid Waste Treatment Impacts</b> <i>(Continued)</i></p>	<p>IV. Sewage loading promotes excessive vegetation growth, and subsequent blocking of irrigation leach field effectiveness;</p> <p>V. Increased risk to wildlife within the non-navigable canals and Bennett's Lagoon of nutrient toxification.</p> <p>VI. Creates risk of contamination of ground water, water features, the non-navigable canals and Bennett's Lagoon with nutrients and human Pathogens;</p> <p>VII. Increased risk of low-level eutrophication of the non-navigable canals and Bennett's Lagoon.</p>	<p>IV. Use shallow root system vegetation such as grasses and/or annual flowers to cover irrigation leach fields; Regularly inspect, repair and thin excessive vegetation growth over irrigation leach fields;</p> <p>V. Regularly lime leach field in support of bacterial denitrification processes; adhere to manufacturer's specifications for tank sludge removal rates, which can be as frequent as every 4-6 months for large scale systems supporting heavy loading rates;</p> <p>VI. Ensure leaching rate does not exceed background percolation capacity; limit placement of leach field(s) to ≥ 100 meters distance, to reduce potential for effluent pooling; monitor water quality in the interior waterway and nearshore waters to ensure bacteria and nutrient levels do not exceed background levels;</p> <p>VII. As above (VI).</p>
<p><b>Solid Waste Treatment Impacts</b></p>	<p>I. Nominal land cover removal required for conduct of waste management practices;</p> <p>II. Public safety risk from onsite operation of smokeless incinerators.</p>	<p>I. None, non-development;</p> <p>II. Ensure incinerators are operated to specifications and that operators are properly trained in their operation.</p>
<p><b>Energy Supply/Usage Impacts</b></p>	<p>I. Increased road use for transportation of fuel to the project/power generating site; release of exhaust smoke during incineration and refueling of wood scrap, as well as fire risk during stockpiling of raw material for incineration;</p> <p>II. Creation of spill risk, particularly in the newly constructed canal system or coastal lagoons; accidental fire starts pose direct threats to area timber stands and wildlife.</p> <p>III. Improper reporting of incidental or accidental spills may cause environmental damage before mitigating measures can be imposed;</p> <p>IV. Increased risk of electrocution where poor electrical engineering standards are employed or from storm damage to utility lines; increased risk of chemical contamination, explosion, smoke inhalation and or fire;</p> <p>V. Remote location of development site may aggravate personal injury status;</p> <p>VI. Long-term exposure to petrochemical, noise or smoke from generating facilities may cause hearing loss or lung damage to staff;</p>	<p>I. None, non-development; Train staff in safe fuel handling and fire management procedures, and regularly inspect all fuel usage sites and handling practices.</p> <p>II. Maintain all fuel containers and generating equipment in fuel bonds; train staff in safe fuel handling procedures and fire management along with regularly monitoring of fuel storage and generating sites for spills;</p> <p>III. Regularly monitor fuel storage and generating sites for spills;</p> <p>IV. Ensure accredited electrical engineers during the design and construction phase of the development; use public utility endorsed protocols for handling storm damaged power lines; maintain fuel storage facilities at safe distance from generating equipment and provide warnings about inflammable device use near fuel storage areas;</p> <p>V. Have at least two full-time staff receive emergency medical training at Belize City BERT Center;</p> <p>VI. Provide staff with proper clothing, gloves and noise protection, smoke protection and firefighting equipment; insure staff have been trained in appropriate safety protocols for handling and maintenance of fuel storage facilities and fires.</p>

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**TABLE 46**

**SUMMARY MITIGATION MATRIX OF DEVELOPMENT IMPACTS**

(Continued)

CATEGORY	NEGATIVE IMPACT RISKS	MITIGATION MEASURES
<p><b>Energy Supply/Usage</b> (Continued)</p>	<p>VII. Production of noise or smoke pollution and up to <math>2.0 \times 10^{11}</math> BTUs of thermal waste per year.</p>	<p>VII. Place generating equipment in specially designed noise-retarding shelters; and discharge exhaust waste into baffled exhaust pipes buried underground.</p>
<p><b>Aquatic &amp; Marine Wildlife Habitat Impacts</b></p>	<p>I. Bank modification and extirpation of Riverine Mangrove Forest habitat where the Marina is to be established in Bennett's Lagoon; disturbance/removal of marine sediments for creation of the marina basin;</p> <p>II. Increased risk of sediment or turbidity-based degradation of the canal system and coastal lagoon water quality conditions necessary for existing marine life, during beach revetment activities, or construction of the inland canals and marinas; Petroleum-based contamination of the canal system and coastal lagoons from spill accidents and gas-diesel-kerosene-powered boating activities; chemical or pesticide-induced impacts on marina and aquatic flora &amp; fauna from utilization of the canal &amp; lagoon system for drainage of the golf course and other amenities.</p>	<p>I. None, Non-Development;</p> <p>II. Leave plugs in the canal system until any construction borne turbidity either settles or can be gradually diluted to pre-existing conditions; and use of silt screens during any dredging activities associated with beach revetment or marina construction; use bonds for storage of all petroleum-based products, along with construction and closure of canal gates in the event of a spill accident to afford time for clean up procedures to be undertaken; offer of preferential docking/storage rates for boat operators using 4-cycle engines or non-petroleum based power schemes; require the use of pest-specific compounds (i.e. pesticides which are non-toxic to untargeted species of wildlife) that also contain binders to reduce or eliminate their potential wind or water borne migration from the application site. The latter characteristic also being complimented by (1) design of the golf course and other effluent-bearing amenities (e.g. swimming pools) to drain into designated holding ponds for photo-oxidation of any effluent born chemicals or pesticides prior to discharge into the canal or coastal lagoon systems, and (2) pesticide application in dry, low wind conditions suited to binder adhesion.</p>
<p><b>Terrestrial Wildlife Habitat Impacts</b></p>	<p>I. Increased fractionation of the Xaibe Landsystem Broadleaf Forest ecosystems through creation of logging conveyances, and reduction of savanna habitat vegetation cover from landfill, canal excavation, and road &amp; building construction activities; and</p> <p>II. Increased risk for accidental fires to become ignited within the residential tourism development from novice human occupation of the area, followed by subsequent fire-burn to the remaining savanna habitat and Xaibe Landsystem Broadleaf Forest ecosystems; emigration of resident, but uncommon specialist species of wildlife (e.g. littoral birds) that are dependent on the absence of human interventions in the area, followed by their replacement with more common generalist species, and hence, an overall reduction in area biodiversity.</p>	<p>I. None, non-development;</p> <p>II. Economize in the construction of any new inter-forest conveyances by insuring that such conveyances will offer multiple, rather than solitary, stem yields; examine the feasibility of forest product eco-certification registration and/or carbon sequestration credits to improve economic yield per stem, and hence, reduce new conveyance demands; replant exposed soils with native vegetation; along with creation and designation of buffer zones, particularly for fire management along existing tracks of Glady and Littoral/Beach Forest.</p>

Continued...

**TABLE 46**

**SUMMARY MITIGATION MATRIX OF DEVELOPMENT IMPACTS**

(Continued)

CATEGORY	NEGATIVE IMPACT RISKS	MITIGATION MEASURES
<p><b>Species-Specific Wildlife Impacts</b></p>	<p>I. Increased potential abandonment of the area by the Great Curassow, and other resident endangered species such as the black catbird, in response to the construction activity and human occupation being proposed; increased risk of rookery abandonment by resident wood storks and wading bird species as a result of excess tourism-based disturbance; increased risk of boating-based noise disorientation and mortality risk to Manatee from reciprocating engine operation and prop-injuries,</p> <p>II. Increased potential for predator/prey equilibrium (e.g. the jaguar- peccary-agouti food chain) to become disturbed by newly engineered access constraints and/or long term human occupation of the area; increased potential for biodiversity reduction over time from highly diverse specialist species abandonment of the area in favor of less diverse generalist species.</p>	<p>I. Immediate re-landscaping of barren and/or filled areas with landscaping strategies that include adequate mixtures of native plant species having diverse food value, density &amp; height arranged in contiguous corridors that extend between the broadleaf forest, savanna and littoral/beach habitats, in order to afford specialist species safe avenues of movement between key habitats along corridors with improved food value and hence, carrying capacity;</p> <p>II. Concerted adherence to visitation management regulations which are designed to insure all visitation is supervised by trained tour guides, that visitation frequency is not excessive, and that visitation is neither disruptive or intrusive on rookery activities; provide for enforcement of Manatee conservation guidelines in the vicinity of the proposed development, particularly as they pertain to the imposition of: (1) demarcation of no wake zones with signage along approved navigation routes leading to the entrance to Bennett’s Lagoon, marina, docking facilities, and access to navigable canals that are marked with lighted navigational buoys; (2) public education, particularly for all development residents and staff concerning Manatee tourism guidelines; and (3) a mechanism for enforcement and penalty collection, in the event a Manatee is killed as a direct violation of the navigational and/or tourism guidelines for Manatee conservation.</p>
<p><b>Cultural &amp; Social Impacts</b></p>	<p>I. Potential / accidental damage to one or more of cultural sites during the construction phase of development;</p> <p>II. Release Potential looting by development staff, guests and/or residents, which also constitutes an avoidable impact.</p> <p>III. Reduction Proposed development will create jobs and increase foreign exchange earnings through unit sales revenue of savanna groundcover and the sparse marine flora established offshore;</p> <p>IV. Remote location of proposed development site may increases risk of complications from accidental / serious injury to workers</p>	<p>I. Eliminate or set aside these archaeological areas as green space; Provide for arrangement with the Institute of Archaeology for an archaeological monitor to be present during land clearing and construction of the proposed development;</p> <p>II. Provide for education of development staff, guests and residents as to the importance and legal obligations for conservation for cultural sites and artifacts in Belize, perhaps along with designation of one or more sites for managed tourism use;</p> <p>III. None, positive impact;</p> <p>IV. Have a minimum of 3 - 5 full-time staff on-site trained in emergency medical practices at the BERT facility in Belize City</p>

...End

and outfitting all work crews and/or maintenance vehicles with fire fighting equipment such as round-point shovels, chemical foam extinguishers, and water uptake, storage and dispensing equipment; providing for slow speed (i.e. < 15 mph), sign placements along roads and trails, placement of traffic stops in residential areas, appropriate training for all development staff operating vehicles at the site, and adherence to public licensing requirements for all vehicle operators, inclusive of staff, residents and guests.

**Sea-Based Transportation Impacts** concern the increased risk of prop injury to Manatee; increased potential for public injury risk, both are irreversible but avoidable impacts. Residual negative sea-based transportation impact risks concern increased potential for public injury risk. Water impacts on area water resources posed by the proposed development concern the potential for contamination of area surface waters with petroleum effluent; and the reduction of marine flora and fauna in response to petroleum contamination, both are avoidable and reversible.

Mitigation measures for the irreversible impacts include: establishing regulations and placing signage in near shore waters of Bennett's Lagoon and the Corozal Bay indicating boat speed, and approved navigational corridors for boats approaching or departing from Bennett's Lagoon and the Corozal Bay, as well as the reporting and procedural requirements in the event of prop injury to Manatee; providing education for all boat operators using the marina about (1) navigational regulations for the area; and (2) the importance of Manatee conservation and the need for responsible navigation practices and slow operating speeds when navigation in the vicinity of Bennett's Lagoon and/or Corozal Bay. Mitigating measures for the water impacts include: insuring drainage of the 9500-acre site through the Bennett's Lagoon watershed for the purpose of facilitating flushing of petroleum residues in wet weather; insuring the responsible storage and handling of petroleum products at the marina's fuel depot, and hence prevent or eliminate the risk of petroleum spills and contamination of area waters; and educational measures that communicate the advantages of 4-cycle marine engine use.

**Material Supply Impacts** concern the alteration of sea floor and Bennett's Lagoon floor bathymetry, savanna topography, and alteration of the rainfall runoff characteristics of the coastal savanna habitat due to material excavation. These impacts are largely unavoidable and irreversible and can only be mitigated by non-development. Indirect impacts include the release and entry of erosion products into Bennett's Lagoon and Chetumal Bay during excavation activities and canal wall slump during construction. Measures available for impact mitigation include: deployment of silt screens capable of limiting sediment travel to the immediate vicinity of canal works, and/or the marina basin, to pre-existing levels of turbidity; and placement of retaining walls concurrently with canal and marina excavations in defense of both the pre-existing and final land and shoreline grades.

Biological impacts include: reduction of savanna groundcover and the sparse marine flora established offshore from the excavation and fill activities proposed; perturbation of the terrestrial landscape and marine habitat during construction and operating activities, and hence the displacement of intolerant terrestrial and marine wildlife present in the area (e.g. migrant and specialist birds, Wood stork and Manatee).

Mitigation measures include thorough re-landscaping of the project site with native vegetation and exclusion of fencing from use on the development site in order to promote re-colonization and interior movement of wildlife displaced during material movement activities; as well as deployment of silt screens capable of limiting sediment travel to the immediate vicinity of canal works, and/or the marina basin, to pre-existing levels of turbidity.

Water resource impacts concern the potential for short-term elevation in water turbidity within Bennett's Lagoon and the near shore marine habitat from canal and marina construction and beach revetment activities; long term sedimentation of the canal system and marina basin from savanna runoffs, which are avoidable and reversible impacts. These impacts can be mitigated by employing silt screens on the downstream side of canal construction activities and surrounding marina excavation activities; and postponement of canal opening to the greater marine environment by leaving earthen plugs in place until the canals have been constructed and adjacent lands stabilized.

**Freshwater Supply Impacts** concerns the potential for aquatic wildlife entrainment at the pump station's water intake point, which is an avoidable impact. Biological impacts from freshwater delivery to the project site includes that likely change in vegetation cover and wildlife occupancy in irrigated areas and along the non-navigable canal system, the vegetation component of which is a positive impact, and the wildlife occupancy component of which may be undesirable if net biodiversity decreases within the BJE, both of which are avoidable impacts. Water resource impacts from landscaping runoffs, pool water and brine discharge, and septic leach field's percolation may increase toxic chemical and nutrient concentrations in the lower reaches of the non-navigable canal system and Bennett's Lagoon, thereby significantly diminishing water quality in these surface waters. Indirect and Residual negative water resource impacts include the potential for rendering the marine environment unsuitable for use by coastal wildlife, particularly birds and Manatee. Measures available for mitigating these impacts include: extraction of water from within a screened intake pipe to reduce the potential for aquatic wildlife entrainment at the water pump intake site; and the incorporation of mixing and stop gates to manage flow through the non-navigable canal system and provide opportunity for photo-oxidation of toxic chemicals, dilution of salinity concentrations, and reduction of storm induced colloid or phytoplankton turbidity prior to release into Bennett's Lagoon; while ensuring, through monitoring, that abstracted or discharged water is devoid of these constituents, as well as any noxious microbial blooms.

**Liquid Waste Discharge Impacts** concerns: the amount of land cover removal required for plant placement; gradual reduction of percolation capacity and/or alteration of water distribution characteristics as may result from subsoil loading with particulate organic matter during landscape irrigation applications; and subsoil erosion from leakages and/or ground settlement after construction. These physical impacts can be mitigated by construction of pipe works and irrigation fields to specification, and ensuring that leaching rates at all irrigation endpoint are less than background percolation capacity. Biological impacts include: excessive irrigation leach-field damage from root growth and subsequent reduction in effectiveness; increased risk to aquatic wildlife in the non-navigable canals and Bennett's Lagoon from toxification by sewage leachate from pipe cracks or damaged irrigation leach fields.

These biological impacts can be partially or wholly mitigated by: using shallow root system species such as grasses and/or perennial flowers as groundcover for irrigation leach fields; regular inspection and thinning of excessive vegetation growth over irrigation leach fields, regular repairs to and liming of leach fields in support of bacterial denitrification processes; and adherence to manufacturer's specification for tank sludge removal rates, which can be as frequent as every 4-6 months for large scale systems supporting heavy loading rates.

Water Resource Impacts from sewage effluent discharge concerns risk of contamination of groundwater, the non-navigable canals and Bennett's Lagoon with nutrients and/or human pathogens. Indirect and residual impacts include the potential for low level eutrophication of the proposed developments non-navigable canals and Bennett's Lagoon. These impacts can be partially or wholly mitigated by: ensuring leaching rate does not exceed background percolation capacity, placement of leach field(s) at  $\geq 100$  meters distance, to reduce potential for effluent pooling; and ensuring the interior waterway and near shore waters are regularly monitored for Coliform bacteria, Vibrio bacteria and nitrogen levels in defense of background levels in the waters surrounding non-navigable canals and Bennett's Lagoon and as a check to ensure proper septic tank and leach field function.

**Solid Waste Storage Impacts** concern land cover removal requirement; and potential injury to incinerator operators. Mitigating measures include insuring proper training of incinerator operators.

**Energy Use Impacts** concern increased road use for fuel supply due to fuel impacts from petroleum-based energy generation; and the release of exhaust smoke during incineration and refueling, as well as fire risk during stockpiling of raw material for incineration. Potential indirect negative petroleum-based fuel impacts concern spill risk, particularly in the canal system or adjoining coastal lagoons, and potential residual negative fuel impacts concern improper reporting of incidental or accidental spills, which may cause environmental damage without mitigating measures being imposed.

Potential indirect negative wood scrap-based fuel impacts concern the impact of accidental fire starts on area timber stands and wildlife, but potential residual negative wood scrap-based fuel impacts are nil owing to the end-product (ash) being inert. Measures available for mitigation of these potential impacts include: construction of fuel bonds and maintenance of all fuel containers and generating equipment within these structures; and training of staff in safe fuel handling and fire management procedures, and regular inspections of all fuel usage sites and handling practices.

**Health and Safety** impacts concern increased risk of electrocution where poor electrical engineering standards are employed or from storm damage to utility lines, which are avoidable and reversible impacts. Direct negative impacts concern increased risk of chemical contamination, explosion, smoke inhalation, and/or fire. Potential indirect negative health and safety impacts from petroleum or wood scrap-based energy generation concern increased risk of personal injury aggravation due to the proposed development's remote location; the effect of long-term exposure to petrochemicals, noise or smoke associated with generating facilities.

These impacts may be partially or wholly mitigated by: using accredited electrical engineers during the design, construction and operating phases of the development and the use of public utility endorsed protocols for handling storm damaged power lines; and development of a safety protocol for all fuel handlers, maintaining fuel storage facilities at safe distances from generating equipment, providing warnings against use of inflammable devices near fuel storage areas, having at least two full-time staff receive emergency medical training at the Belize City BERT Center, and providing staff with proper clothing, gloves and noise pollution protection equipment, and/or fire fighting equipment, to reduce potential for health effects.

**Pollution impacts** from energy supply concerns the proposed development's production of noise pollution and thermal waste up to  $2.0 \times 10^{11}$  BTUs per day at capacity development (based on capacity demand of 60 mW, and a conversion rate of 138,707 BTUs or 41 kW hrs/gal Diesel). Other impacts include noise induced hearing loss in staff, petroleum contamination of groundwater or adjacent canal and marine waters, and/or smoke-based air pollution. Mitigation measures for these impacts include: placement of generating equipment in specially designed noise-retarding or smoke-arresting shelters, and the discharge of exhaust waste into baffled exhaust pipes buried underground; and providing staff with proper safety clothing and noise pollution protection equipment; and the implementation of regular wildlife monitoring protocol to determine the presence/absence of noise or smoke-related impacts.

**Wildlife Impacts** concern lagoon bank modification and extirpation of *Riverine Mangrove Forest* habitat where the marinas are to be established in Bennett's Lagoon, and disturbance/removal of marine sediments for creation of the marina basin, which directly affects marine and aquatic habitats. Other impacts include: increased risk of sediment or turbidity-based degradation of the canal system and coastal lagoon water quality conditions necessary for existing marine life, during beach revetment activities, or construction of the inland canals and marinas; petroleum-based contamination of the canal system and coastal lagoons from spill accidents and gas/diesel/kerosene-powered boating activities; and chemical or pesticide-induced impacts on marina and aquatic flora and fauna from utilization of the canal and lagoon system for drainage of the golf course and other amenities.

Mitigation measures for the above mentioned impacts include; leaving plugs in the canal system until any construction borne turbidity either settles or can be gradually diluted to pre-existing conditions; and use of silt screens during any dredging activities associated with beach revetment or marina construction; use of bonds for storage of all petroleum-based products; construction and closure of canal gates in the event of a spill accident to afford time for clean up procedures to be undertaken; offer of preferential docking / storage rates for boat operators using 4-cycle engines or non-petroleum based power schemes; use of pest-specific compounds (i.e. pesticides which are non-toxic to untargeted species of wildlife) that also contain binders to reduce or eliminate their potential wind or water-borne migration from the application site. The latter characteristic also being complimented by (1) design of the golf course and other effluent-bearing amenities (e.g. swimming pools) to drain into designated holding ponds for photo-oxidation of any effluent-born chemicals or pesticides prior to discharge into the canal or coastal lagoon systems, and (2) pesticide application in dry, low wind conditions suited to binder adhesion.

Terrestrial habitat impacts from implementation of the proposed development concern the increased fractionation of the Xaibe Landsystem Broadleaf Forest ecosystems through creation of logging conveyances, and reduction of savanna habitat vegetation cover from landfill, canal excavation, and road & building construction activities; all of which are avoidable impacts. Other terrestrial habitat impacts concern the potential for accidental fires to become ignited within the residential tourism development from novice human occupation of the area, followed by subsequent fire-burn to the remaining savanna habitat and Xaibe Landsystem Broadleaf Forest ecosystems; along with emigration of resident, but uncommon specialist species of wildlife (e.g. littoral birds) that are dependent on the absence of human interventions in the area, followed by their replacement with more common generalist species, and hence, an overall reduction in area biodiversity, both of which also constitute avoidable impacts.

Mitigating measures for the terrestrial habitat impacts include: the economical construction of any new inter-forest conveyances by insuring that such conveyances will offer multiple, rather than solitary, stem yields; and examine the feasibility of forest product eco-certification registration and/or carbon sequestration credits to improve economic yield per stem, and hence, reduce new conveyance demands; immediate replanting of exposed soils with native vegetation; along with creation and designation of buffer zones, particularly for fire management, along existing tracks of Glady and Littoral / Beach Forest.

Species-specific impacts concern the potential abandonment of the area by the Great Curassow, and other resident endangered species such as the black catbird, in response to the construction activity and human occupation being proposed; increased risk of rookery abandonment by resident wood storks and wading bird species as a result of excess tourism-based disturbance; and increased risk of boating-based noise disorientation and mortality risk to Manatee from reciprocating engine operation and prop-injuries, all of which represent avoidable impacts. Other impacts include: the potential for predator/prey equilibrium (e.g. the jaguar/peccary/agouti food chain) to become disturbed by newly engineered access constraints and/or long term human occupation of the area; and the potential for biodiversity reduction over time from highly diverse specialist species abandonment of the area in favor of less diverse generalist species.

Mitigating measures of species-specific impacts include: immediate re-landscaping of barren and/or filled areas with landscaping strategies that include adequate mixtures of native plant species having diverse food value, density & height arranged in contiguous corridors that extend between the broadleaf forest, savanna and littoral/beach habitats, in order to afford specialist species safe avenues of movement between key habitats along corridors with improved food value and hence, carrying capacity; adherence to visitation management regulations which are designed to insure all visitation is supervised by trained tour guides, that visitation frequency is not excessive, and that visitation is neither disruptive or intrusive on rookery activities; and *enforcement* of Manatee conservation guidelines (see **Addenda 5**) in the vicinity of the proposed development, particularly as they pertain to the imposition of: (1) demarcation of no wake zones with signage along approved navigation routes leading to the entrance to Bennett's Lagoon, marina docking facilities, and access to navigable canals that are marked with lighted navigational buoys as shown in **Illustration 52**;

(2) public education, particularly for all development residents and staff concerning Manatee tourism guidelines; and (3) a mechanism for enforcement and penalty collection, in the event a Manatee is killed as a direct violation of the navigational and/or tourism guidelines for Manatee conservation.

**Culture, Customs and Social Impacts** concern the potential / accidental damage to one or more of cultural sites of antiquity during the construction phase of development; potential looting by development staff, guests and/or residents.

Mitigation measures include: eliminate or set aside these archaeological areas as green space; arrange with the Institute of Archaeology for an archaeological monitor to be present during land clearing and construction of the proposed development; and provide education for development staff, guests and residents as to the importance and legal obligations for conservation for cultural sites and artifacts in Belize, perhaps along with designation of one or more sites for managed tourism use. Other impacts include the possibility of the remote location, increasing serious injury risk to residents, guests or workers; which can be mitigated by 3 - 5 full-time staff trained in emergency medical practices at BERT facility in Belize City.

## **CUMULATIVE IMPACTS & MITIGATION MEASURES**

Potential cumulative impacts presented by the proposed development are summarized in **Table 46**.

### **Land Use Impacts**

Cumulative land use impacts of the proposed development concern the disturbance of approximately 4,178 acres of *Marine Salt Marsh*; 100 acres of *Littoral Forest*; and reduction of *Coastal Rhizophora mangle Forest* habitats, which are underprotected habitats in Belize, through canal excavation, landfill and beach revetment activities. These activities constitute unavoidable impacts that can only be partially mitigated by replanting landfill sites with natural vegetation immediately following the construction activities being proposed.

### **Infrastructure Impacts**

Cumulative infrastructure impacts of the proposed development, particularly new roads, canals, buildings and mechanical plants concern: (1) Increased fractionation of the Xaibe Plain / Lowland Broadleaf Forest Land System from construction of new logging trail conveyances, which ultimately results in displacement of specialist species of high conservation value, and is an unavoidable impact that can only be partially mitigated by optimizing new conveyance placement within the timber management zone (see **Page 158 - 164**); (2) Increased risk of development-born chemical and petroleum pollution of coastal waters from dredging and excavation activities, swimming pool treatment with chlorine, brine production during production of potable water from sea water, and petroleum release from depots, boats, and vehicles, all of which are largely avoidable impacts that can be mitigated through use of plugs and silt screens to retain & settle sediments, use of holding

**TABLE 46**  
**MITIGATION MATRIX OF CUMULATIVE IMPACTS**

CATEGORY	NEGATIVE IMPACT RISKS	MITIGATION MEASURES
<b>Land Use</b>	<p>I. Disturbance of approximately 4,178 acres of <i>Marine Salt Marsh</i>; 100 acres of <i>Littoral Forest</i>; and removal of 100 acres of <i>Coastal Rhizophora mangle Forest</i>; or all of their present extent within the Stage 1 development through canal excavation, landfill and beach revetment activities.</p>	<p>I. Replant with natural vegetation. .</p>
<b>Infrastructure</b>	<p>I. Increased fractionation of the Xaibe Plain / Lowland Broadleaf Forest Land System from construction of new logging trail conveyances, which ultimately results in displacement of specialist species of high conservation value,</p> <p>II. Increased risk of development-born chemical and petroleum pollution of coastal waters from dredging and excavation activities, swimming pool treatment with chlorine, brine production during production of potable water from sea water, and petroleum release from depots, boats, and vehicles; and</p> <p>III. Additional vehicles will be operated throughout the national highway infrastructure, imposing further reductions in existing carriageway lifespan, and increased risk to public injury.</p>	<p>I. Optimize new conveyance placement within the timber management zone;</p> <p>II. Use plugs and silt screens to retain &amp; settle sediments, use of holding ponds to photo-oxidize coloring in pool effluent and afford slow release of brine into brackish coastal waters, use of bonds for petroleum storage, and incentives for boat owners to use 4-cycle diesel outboard engines; and</p> <p>III. Collection of taxes from new community residents for proportional remuneration of maintenance and depreciation costs.</p>
<b>Traffic</b>	<p>I. The significant level of employment and occupancy anticipated by the proposed development will undoubtedly increase passenger traffic levels along roads leading to/from the proposed development site, which will in turn impose cumulative traffic impacts in the form of noise pollution (duration), wear on public roads, and increased risk of accidental injury to area residents and facility staff alike,</p>	<p>I. Insure all vehicles used to access the project site comply with licensing regulations, and are driven by licensed operators.</p>
<b>Water Quality</b>	<p>I. Cumulative water quality abstraction impacts are anticipated to be nil, owing the development principally relying on rainwater catchment in cisterns, with only partial abstraction and treatment of canal and bay waters by reverse osmosis, neither of which are limiting in supply.</p> <p>II. Increased risk of development-born chemical and petroleum pollution of coastal waters from dredging and excavation activities, swimming pool treatment with chlorine, brine production during production of potable water from sea water, and petroleum release from depots, boats, and vehicles.</p>	<p>I. None, Nil.</p> <p>II. Use water features as photo-oxidation and settlement ponds for any nutrient, landscape and pool chemical runoffs. Ensure through monitoring, that abstracted or discharged water is devoid of these constituents, as well as any noxious microbial blooms.</p>
		<i>Continued...</i>

**TABLE 46**  
**MITIGATION MATRIX OF CUMULATIVE IMPACTS**

(Continued)

CATEGORY	NEGATIVE IMPACT RISKS	MITIGATION MEASURES
<b>Wildlife</b>	<p>I. Incremental mortality risk posed to Manatee from potential contamination of coastal waters with chemical and/or petroleum-based pollutants and prop injury from increase outboard motor presence on the previously rural coastline of Northern Belize.</p> <p>II. Cumulative impacts on terrestrial wildlife concern endangered species habitat loss from development-born landscape modification and endangered species emigration from the BJE from increased human presence and unmanaged tourism visitation, particularly among resident and transient coastal birds, but also among predator-prey systems.</p>	<p>I. Both of these impacts are avoidable and can be partially or wholly mitigated through the contaminant control measures outlined above, and observance of Manatee tourism guidelines outlined in Addenda 5.</p> <p>II. While the former of these impacts is not avoidable, it may be partially or wholly mitigated through design engineering measures that either defend or create wildlife corridors through the development footprint. Conversely however, the latter of these impacts is avoidable through use of trained tour-guides administration of wildlife viewing within the BJE development site</p>
<b>Cultural &amp; Social</b>	<p>I. Potential damage or destruction and loss of culturally important artifacts during landscape modification activities, and/or looting of found sites having cultural importance represent continuing and widespread impacts on Belize's cultural resources that must be administered by the IOA.</p> <p>II. The proposed development will clearly have an important positive impact on employment in the Sarteneja, Maskall, Shipyard, Chunox, Copperbank and Corozal communities and perhaps even more importantly, increase foreign revenue earnings and national economic growth.</p>	<p>I. These impacts are avoidable, and in the former case can be mitigated by ensuring an IOA-approved archaeological observer is present on site during all landscape modification activities to evaluate the significance of any finds and to make recommendations as to an appropriate course of action regarding their preservation, while in the latter case can best be mitigated by proactive supervision and control of the sites rich potential for ecotourism through supervision by trained guides.</p> <p>II. This growth however, will also be likely to increase demand on area social services (i.e. schools and health care services), which can only be mitigated through taxation and GOB provision of the material &amp; intellectual resources.</p>
		<i>...End</i>

ponds to photo-oxidize chlorine in pool effluent and afford slow release of brine into brackish coastal waters, use of bonds for petroleum storage, and incentives for boat owners to use 4-cycle diesel outboard engines; and (3) the proposed development site will undoubtedly bring new and additional vehicles to be operated throughout the national highway infrastructure, imposing further reductions in existing carriageway lifespan, and increased risk to public injury, which are unavoidable impacts that can only partially be mitigated through collection of taxes from new community residents for proportional remuneration of maintenance costs for public road use.

### **Traffic Impacts**

The significant level of employment and occupancy anticipated by the proposed development will undoubtedly increase passenger traffic levels along roads leading to/from the proposed development site, which will in turn impose cumulative traffic impacts in the form of noise pollution (duration), wear on public roads, and increased risk of accidental injury to area residents and facility staff alike, the former two being direct, unavoidable impacts, and the latter being an indirect impact which can be either partially or wholly mitigated by insuring all vehicles used to access the project site comply with licensing regulations, and are driven by licensed operators.

### **Water Quality Impacts**

Cumulative water quality abstraction impacts are anticipated to be limited to the potential for wildlife entrainment on pump screens, owing the development principally relying on rainwater catchment in cisterns, with only partial abstraction and treatment of canal and bay waters by reverse osmosis, neither of which are limiting in supply. Development born pollution impacts of the variety detailed above embody the types of cumulative water quality impacts that can arise from the proposed development, but are avoidable by the above-recommended measures.

### **Impacts On Wildlife Abundance**

Cumulative impacts on aquatic wildlife concern the incremental mortality risk posed to Manatee from potential contamination of coastal waters with chemical and/or petroleum-based pollutants and prop injury from increase outboard motor presence on the previously rural coastline of Northern Belize. Both of these impacts are avoidable and can be partially or wholly mitigated through the contaminant control measures outlined above, and observance of Manatee tourism guidelines outlined in Addenda 5.

Cumulative impacts on terrestrial wildlife concern endangered species habitat loss from development-born landscape modification and endangered species emigration from the BJE from increased human presence and unmanaged tourism visitation, particularly among resident and transient coastal birds, but also among predator-prey systems. While the former of these impacts is not avoidable, it may be partially or wholly mitigated through design engineering measures that either defend or create wildlife corridors through the development footprint. Conversely however, the latter of these impacts is avoidable through use of trained tour-guides administration of wildlife viewing within the BJE development site.

## **Cultural & Social Impacts**

The cumulative social impact risks of the proposed development concern the potential damage or destruction and loss of culturally important artifacts during landscape modification activities; and/or looting of found sites having cultural importance; both of which represent continuing and widespread impacts on Belize's cultural resources that must be administered by the IOA. These impacts are avoidable, and in the former case can be mitigated by ensuring an IOA-approved archaeological observer is present on site during all landscape modification activities to evaluate the significance of any finds and to make recommendations as to an appropriate course of action regarding their preservation, while in the latter case can best be mitigated by proactive supervision and control of the sites rich potential for ecotourism through supervision by trained guides.

The proposed development will clearly have an important positive impact on employment in the Sarteneja, Maskall, Shipyard, Chunox, Copperbank and Corozal communities and perhaps even more importantly, increase foreign revenue earnings and national economic growth. This growth however, will also be likely to increase demand on area social services (i.e. schools and health care services), which can only be mitigated through taxation and GOB provision of the material & intellectual resources.

## 14. MONITORING PLANS

- 14.1 Provide a detailed monitoring plan to be implemented for the entire operation, identifying any agency/body responsible for its implementation and any training that may be necessary for the implementation of the plan. The plan should include monitoring of wastewater discharge characteristics (if any), changes in ecological species (including endangered species), contingency measures to emergency response to accidental events (fire, flood, hurricane, leakages, spillages, etc.).
- 14.2 Provide a detailed plan for the decommissioning and rehabilitation of the site to other uses in the event that the project is discontinued.
- 14.3 Identify and develop a water quality monitoring program able to detect any change (s) in ground water or surface water quality, that will impact:
  - I. Public health;
  - II. Forest, wetland and adjacent aquatic habitats; and
  - III. Endangered or threatened species in the project area and zone of influence.

### MONITORING PLANS FOR THE PROPOSED DEVELOPMENT

The parameters and scheduling of monitoring activities recommended for the development are shown in **Table 46**; and recommended monitoring points are shown in **Illustration 62**.

**Land-Based Transportation Monitoring Requirements** consist of inspections of fire fighting equipment to be conducted weekly; while roadway runoff settlement areas for containment integrity should be inspected monthly; and staff operating licenses should be inspected annually for necessary renewal requirements.

**Sea-Based Transportation Monitoring Requirements** concern the need to establish the degree, if any, of petroleum contamination occurring within the navigable canal system and/or Bennett's Lagoon on a quarterly basis; and for the development to support and/or participate in enforcement of Manatee conservation in the area by conducting weekly monitoring patrols to educate and enforce navigational regulations in the area, particularly as they relate to boat speed and Manatee injury. Manatee conservation education effectiveness should be assessed at least once yearly.

**Material Supply Monitoring Requirements** concern the need to conduct monthly inspections of canal and marina embankments for slump and/or erosion, as well as monthly inspections of turbidity in Bennett's Lagoon during the construction phase of the development and the wet weather season to insure that area water quality does not fall below background levels.

**Water Resource Monitoring Requirements** Monitoring requirements primarily concern the need for monthly checks of water quality in all water features for total nitrogen, pesticide, chlorine and Coloform and Vibrio bacteria levels.

**Liquid Waste Monitoring Requirements** include quarterly inspection of land adjacent to irrigation leach fields for excessive vegetation growth, pruning of vegetation and liming of leach fields in support of bacterial denitrification processes. Area water quality should be monitored on a quarterly basis for Coliform and Vibrio bacteria population levels and nitrogen levels in defense of background levels in the proposed development's non-navigable canals and Bennett's Lagoon and as a check to ensure proper septic tank and leach field function.

**Solid Waste Monitoring Requirements** consist of the need for the annual inspection of incinerators and staff operation to insure safe operating conditions are procedures are in place.

**Energy Monitoring Requirements** for public energy use should include monthly inspections of power lines and primary electrical connection points for damage from storms and/or tree falls. Monitoring requirements for petroleum or wood scrap-based self-generation should include regular (weekly) signed inspections of all fuel storage and power generating equipment for repair and/or maintenance requirements before and during operation

**Wildlife Monitoring Requirements** will include weekly inspection of all petroleum stores & pool effluent and brine ponds for leakages; quarterly inspection canal and lagoon water quality, including dissolved oxygen, turbidity, salinity, and temperature; and Annual survey of wildlife abundance and use of landscaped corridors established as replacement land cover within the design scheme of the overall residential tourism development.

**Culture, Customs and Social Monitoring Requirements** will require the need for an archaeological monitor, approved by the Belize Institute of Archaeology, to observe all land clearing and construction activities at the project site, for the purpose of advising preservation requirements in the event of an archaeological find during construction; and the proponent will need to develop a monitoring program in conjunction with the Institute of Archaeology for inspection of known sites for damage or looting by development staff, guests or residents.

**TABLE 47**

**RECOMMENDED MITIGATION-MONITORING PROGRAM FOR THE PROPOSED DEVELOPMENT**

DEVELOPMENT CATEGORY	PROGRAM OR ACTION TO BE UNDERTAKEN	CRITICAL LEVELS, PARAMETERS OR CHARACTERISTICS	COMPLETION DATE OR FREQUENCY	MAP SYMBOL REFERENCE <sup>1</sup>
<b>TRANSPORTATION</b>	<p><i>Land Based:</i> Inspect all firefighting equipment on a weekly basis, and staff vehicle operating licenses should be inspected on an annual basis for renewal requirements.</p> <p><i>Sea Based:</i> Identify marine pollution status on a quarterly basis by assessing water quality in coastal canals and lagoons. Support enforcement of manatee conservation and navigational regulations, as well as assess manatee conservation education effectiveness yearly.</p>	Water Quality Assessments Should Be Conducted As Shown In <b>Table 11, Page 64</b>	<p>Land Based: Weekly / Annually</p> <p>Sea Based: Quarterly / Annually</p>	<p>---</p> <p><b>WQ / M</b></p>
<b>MATERIAL SUPPLY</b>	Inspect canal & marina walls on a monthly basis, and monitor turbidity in Bennett's Lagoon on a quarterly basis during the construction phase of development.	As Above	Monthly / Quarterly	<b>W</b>
<b>FRESHWATER SUPPLY</b>	Conduct quarterly determinations of chemical and biological water quality in all water features.	As Above	Quarterly	<b>WQ</b>
<b>LIQUID WASTE MANAGEMENT</b>	Inspect leach fields for maintenance needs on a quarterly basis, and conduct quarterly determinations of chemical and biological water quality in all water features.	Lime Leach Fields: 150g-Each As Above	Quarterly	<b>WQ</b>
<b>SOLID WASTE MANAGEMENT</b>	Inspect incinerator equipment (s), burial sites, and operational practices a quarterly basis for effective operation.	None	Quarterly	<b>SW</b>
<b>ENERGY USE</b>	Conduct quarterly inspections of power lines and primary electrical connection points for storm damage and/or tree falls; and conduct weekly inspections self-generation operations for fuel bond leakage, and equipment maintenance.	None	Quarterly / Weekly	<b>ELEC</b>
<b>WILDLIFE</b>	Conduct weekly inspections of petroleum bonds for leakage and quarterly evaluation of surface waters for contamination with chemical or biological pollutants.	As Above	Weekly / Quarterly	<b>WQ</b>
<b>CULTURE, CUSTOMS &amp; SOCIAL FACTORS</b>	Arrange For Archaeological Monitoring With IOA during land modification activities.	None	Prior To Construction	---

<sup>1</sup>Monitoring sites are shown in **Illustration 62**.

ILLUSTRATION 62:  
MONITORING SITES WITHIN THE STAGE 1 DEVELOPMENT

