

## Chapter 11

### 11.0 Impact Mitigation

#### 11.1 General Principles Underpinning Environmental Impact Mitigation

The mitigation measures to be implemented are in relation to circumventing or ameliorating those impacts that have been assessed as having a ‘moderate adverse impact’, or a ‘major adverse impact’, as shown in Table 10.1. The six (6) main developmental issues requiring specific mitigative responses are: dredging, domestic effluents, solid wastes management, energy generation, potable water sourcing, and socio-economic concerns.

#### 11.2 Specific Mitigation Measures

##### 11.2.1 Mitigation Measures In Relation To Dredging and Land Reclamation Activities

The issues of concern related to the dredging operation are the navigational and berthing of the dredge at the burrow site, as well as the dredging or excavation activity itself. The issue related to the navigation and the berthing of the dredge is the threat of physical harm and injury arising from collision at sea accidents. The mitigative responses to this are in large part in relation to the placement of navigational aids such as buoys and beacons to alert and ward off mariners. This is dealt with in Table 11.1 below.

**Table 11.1:** Mitigation Responses in relation to Dredging Impacts

<b>Development Activity</b>	<b>Primary Impacts or Environmental Disturbance</b>	<b>Secondary and Tertiary Level Environmental Impacts</b>	<b>Mitigation Measures</b>
1. Actual Dredging or Burrowing of ‘Cutter Head’	1a. Disturbance of seafloor, the suspension of fine sediments and the re-deposition of coarse fractions.	1a1. Direct physical destruction of benthic habitat, and attenuation of light - impeding photosynthesis of seagrass, macro-algae and other autotrophs.	1a1a. Use of ‘Silt Curtains’ at burrow pit, ensuring that lower end of ‘skirt’ is resting upon the seafloor, and ensuring that top of the ‘skirt’ is always above the surface of sea.

<b>Development Activity</b>	<b>Primary Impacts or Environmental Disturbance</b>	<b>Secondary and Tertiary Level Environmental Impacts</b>	<b>Mitigation Measures</b>
			1a1b. Monitoring and where necessary repairing and/or replacing leaky pipes and faulty couplings of the spoil discharge pipes.
			1a1c. Applying velocity reduction measures where spoils are deposited such as baffles to precipitate solids and curtail turbid influences in effluent stream.
			1a1d. Decrease time frame over which the dredging operation is to take place, to avoid the daily re-suspension of sediments.
			1a1e. Ameliorate the impacts of the daily re-suspension of sediments by the suctioning of sediments that have resettled.

<b>Development Activity</b>	<b>Primary Impacts or Environmental Disturbance</b>	<b>Secondary and Tertiary Level Environmental Impacts</b>	<b>Mitigation Measures</b>
			1a1f. Ameliorate re-suspension of sediments by confining dredging operations to calmer sea states.
			1a1g. Assist re-colonization of seafloor by benthic plants and invertebrates by ensuring that the gradient or slope of the walls of burrow pit or channel is not at an angle that is steeper than 35 degrees.
		1a2. "Blanketing" or smothering effects on benthic habitat and sessile and slow-moving invertebrates.	1a2a. Institute monitoring programme to ensure that light penetration at seafloor is at least 25% of surface irradiance 2,000 ft. downstream of silt curtains.
	1b. Decrease in Dissolved Oxygen and increase in BOD.	1b1. Physiological stress and lethal effects on benthic invertebrates and to a lesser extent, fin-fishes.	1b1a. Completion of dredging operation in as short a time-frame as possible.

<b>Development Activity</b>	<b>Primary Impacts or Environmental Disturbance</b>	<b>Secondary and Tertiary Level Environmental Impacts</b>	<b>Mitigation Measures</b>
	1c. Increase in temperatures brought about by the re-suspension of sediments with a 'specific heat capacity' capable of raising water temperatures by as much as 4 – 6°C.	1c1. Lethal and sub-lethal effects on sessile and slow-moving benthic invertebrates.	1c1a. Proper deployment of 'silt curtains' to ensure that suspended sediments at burrow sites are contained and that any re-deposited sediments are 'suctioned' and rapidly deposited at the reclamation site on the caye.
2. Navigation, Berthing of Dredge and Deployment of Spoil Discharge Pipes.	2a. Navigational hazard.	2a1. Threat of injury and possibly death associated with boat traffic.	2a1a. Ensure that marker buoys and navigational lights are deployed and activated on the dredge, the sediment curtains and the spoil discharge pipes – Buoys are to be large and brightly colored: Navigational lights are to be fully operational from 6:00 p.m. to 6:00 a.m. on a daily basis.

The primary impacts related to the actual dredging or excavations itself are sedimentation and turbidity [See Table 10.1]. The mitigation response to deal with this is to mechanically 'contain' or 'corral' the sediment plume arising from the excavation process through the deployment of 'sediment curtains' [See #1a1a., in Table 11.1]. Other related responses include activities to circumvent or ameliorate the re-suspension of sediments, as well as measures that would decrease or ameliorate the physiological stress on sessile and slow-moving organisms. Secondary effects related to sediments in the water column such as temperature increases are also relevant. Responses to these impacts include: the rapid undertaking of the overall dredging operation to conceptually decrease the severity and range of impacts in space and time, the suctioning or 'vacuuming' of re-

suspended sediments ashore to decrease the potential of the expansive dispersal of sediments, and adjusting the overall mechanics of the dredging operation to allow for the re-colonization of the area by benthic plants and sessile and slow-moving invertebrates [See Table 11.1].

### 11.2.2 Mitigation Measures In Relation To Human Wastes and Domestic Effluents

The primary impacts associated with human wastes and domestic effluents are: eutrophic or nutrient-enrichment, increases in the risks of pathogenic diseases, increases in BOD and suspended solids. The mitigative responses to these impacts include the application of BESST Sewage Treatment Technology and the recycling and reuse of effluents [See Table 11.2]. These responses reduce the levels of macro-nutrients, BOD substances and suspended solids to levels where they do not constitute a threat to human health or a risk to the integrity of the environment [See Table 11.2].

The various impacts and the consequent responses to these have been detailed in Table 11.2.

**Table 11. 2:** Summary of impacts associated with human wastes and domestic effluents

<b>Development Activity</b>	<b>Primary Impacts or Environmental Disturbance</b>	<b>Secondary and Tertiary Level Environmental Impacts</b>	<b>Mitigation Measures</b>
1.0 Human Waste and Domestic Effluents	1a. Nutrient enrichment from the injection of macro-nutrients into the environment.	1a1. Stimulus to plant growth on land and in the water column, in the case of the latter this includes phytoplanktons, seagrass and macroalgae, including the possibility of the overgrowth of reefs by macroalgae.	1a1a. Installation of BESST Treatment technology (Biologically Engineered Single Sludge Treatment) to treat waste to 'Secondary' Levels, where Total Nitrogen Loads are reduced to less than 10 mg/l and Phosphorus are reduced to 2-3mg/l..
			1a1b. Reduce effluents going into the environment by recycling effluents to flush toilets – effluents from BESST Treatment Plant will be stored and disinfected through chlorination before it is reused for flushing toilets.

<b>Development Activity</b>	<b>Primary Impacts or Environmental Disturbance</b>	<b>Secondary and Tertiary Level Environmental Impacts</b>	<b>Mitigation Measures</b>
			1a1c. Reduce further nutrients going into the water column by using stored effluents from BESST Treatment Plant to irrigate lawn and hedgerows.
	1b. Pathogenic microbes that can negatively impact human health.	1b1. Infection of tourists and staff at resort facilities by pathogenic viruses and bacteria.	1b1a. Thorough disinfection of effluents potentially going into water column or otherwise making contact with humans by use of BESST Sewer Treatment Plant, which incorporates chlorination of effluents.
			1b1b. Reduction of effluents going into the environment by use of BESST Treatment Plant, and incorporation of recycling and reuse of effluents for flushing of toilets and watering of lawn.

<b>Development Activity</b>	<b>Primary Impacts or Environmental Disturbance</b>	<b>Secondary and Tertiary Level Environmental Impacts</b>	<b>Mitigation Measures</b>
	1c. Suspended Solids from undissolved components of human waste and domestic effluents.	1c1. Suspended solids would impeded light penetration in the water column and erode or arrest photosynthesis.	1c1a. Application of BESST Treatment technology reduces TSS to less than 10 mg/l, this in combination with effluent recycling and reuse regime reduces suspended solids to insignificant levels in the water column.
	1d. Sedimentation associated with settlement of flocculent fraction of human waste and domestic effluents.	1d1. Blanketing of seafloor and suffocation of slow-moving and sedentary invertebrates.	1d1a. Application of BESST Treatment technology reduces TSS to less than 10 mg/l, this in combination with effluent recycling and reuse regime reduces to insignificant levels suspended solids to insignificant levels in the water column.

<b>Development Activity</b>	<b>Primary Impacts or Environmental Disturbance</b>	<b>Secondary and Tertiary Level Environmental Impacts</b>	<b>Mitigation Measures</b>
	1e. Increase in BOD substances and consequent reduction in dissolved oxygen.	1e1. Precipitation of physiological stress and in extreme circumstances death in relation to sessile and slow moving invertebrates.	1e1a. Application of BESST Treatment technology reduces BOD to less than 10 mg/l, this in combination with effluent recycling and reuse regime reduces BOD to insignificant levels in the water column.

### **11.2.3 Mitigation Measures In Relation To Solid Wastes**

The solid waste accruing from the general commissioning of the False Caye operation includes biodegradable and non-biodegradable components. The biodegradable components includes in large part discarded and unconsumed food from the restaurant and bar and refreshment stands. The non-biodegradable component relates to packaging materials, construction wastes and damaged and abandoned equipment and equipment parts. A major component of the non-biodegradable wastes would be ‘plastics’ in general in the form of bottles, cups, boxes and wrappings.

One of the major impacts of the wastes generated by the development would be the attraction of feral animals and household pests such as rats, crocodiles and birds to the area to scavenge. The mitigative response to be implemented by False Caye Development is the judicious collection and segregation of the wastes into biodegradable and non-biodegradable components [See Table 11.3]. These wastes are to be composted and/or transported from the caye on a regular and recurrent basis [See Table 11.3]. The implementation of a public education campaign focused on the core clientele and transient visitors is also a part of the mitigative response [See #1a1b, Table 11.3].

The entanglement and ingestion of plastics by sea turtles, birds and other fauna is also a relevant concern that will be dealt with in a judicious manner [See Table 11.3]. The full range of impacts and mitigative responses has been dealt with in the appropriate details in Table 11.3 below.

**Table 11.3:** Mitigation Matrix in Relation to Solid Wastes

<b>Development Activity</b>	<b>Primary Impacts or Environmental Disturbance</b>	<b>Secondary and Tertiary Level Environmental Impacts</b>	<b>Mitigation Measures</b>
<p>1.0 Commissioning of all aspects of the development including the hotel and restaurants and bars and beach infrastructure.</p>	<p>1a. Discarding of waste food and food containers.</p>	<p>1a1. Attraction of feral animals such as rats, crocodiles, and birds to the area to scavenge and in effect shift the ecological balance in a way not induced by nature.</p>	<p>1a1a. Judicious collection of discards by staff with composting biodegradable component and storage of non-biodegradable component in impervious plastic bins for transportation to the Placencia Municipal Dump Site.</p>
			<p>1a1b. Definition and implementation of a public education campaign focused on tourists and visitors in general, in the form of interactive posters and brochures posted in strategic locations such as restaurants, gift shops, rest rooms and beach.</p>

### 11.2.4 Mitigation Measures In Relation To Potable Water

The primary source of potable water for the proposed False Caye Development is from ground-water. It has been theorized that the aquifer supplying the Placencia and Mango Creek areas may extend geographically to the False Caye area. The mitigation measures that will be put in place are mainly in relation to depletion of supplies of the source. The mitigation measures have been summarized in Table 11.4 below:

**Table 11.4:** Mitigation in Relation to Potable Water Sourcing

<b>Development Activity</b>	<b>Primary Impacts or Environmental Disturbance</b>	<b>Secondary and Tertiary Level Environmental Impacts</b>	<b>Mitigation Measures</b>
11.1 Provision of potable water for the resort	11.2 Excessive draw-down on groundwater stores resulting in lowering of water table and possible salinization of soils as well as subsidence of land.	11.3 Depriving vegetation of moisture and changing soil chemistry which may also be injurious to growth and survival of particular introduced vegetation.	11.4 Adequate pump testing of well and monitoring of recharge rate during life of source.
			11.4b Develop multiple wells and stagger use to avoid localized depletion.

<b>Development Activity</b>	<b>Primary Impacts or Environmental Disturbance</b>	<b>Secondary and Tertiary Level Environmental Impacts</b>	<b>Mitigation Measures</b>
			<p>11.4c Institute water economy measures especially during the dry season: These should include restrictions on the watering or irrigation of lawns and hedgerows, as well as the installation of low flush toilets, and the recycling of waste water for non-potable purposes such as the washing of boats and tools, and fire fighting purposes and irrigation.</p>
			<p>11.4d The utilization of complimentary measures to source potable water including rainwater harvesting from roofs and reverse osmosis or desalinization technology.</p>

### 11.2.5 Mitigation Measures In Relation To Energy Generation

The primary source of electrical energy is to be from the national BEL Grid. This is to be complemented by standby power in the form of diesel generators. The mitigation measures that are to be put in place are mainly in relation to the running of the power lines as well as in relation to noise and petroleum pollution. These have been summarized in Table 11.5 below:

**Table 11.5:** Mitigation Measures in relation to Power Generation

<b>Development Activity</b>	<b>Primary Impacts or Environmental Disturbance</b>	<b>Secondary and Tertiary Level Environmental Impacts</b>	<b>Mitigation Measures</b>
Energy Generation (Integrating into National Power Grid)	Loss of vegetation cover along path of above ground lines.	Alteration and loss of roosting habitats for birds.	Restrict clearing to 15 m along path of line
			Leave undergrowth and saplings along route of line as wildlife corridors
			Run lines along existing road network.
	Physical damage to benthic habitat and attached invertebrates	Decline in fish and aquatic invertebrate life	Choose path of underwater cable that would avoid coral formations.
	Excessive noise from backup diesel generator.	Disturbance of wildlife with cases of abandonment of site.	Enclose house with generator engine with acoustic tiles.
			Route mufflers underground to muffle vibrations.
	Pollution risk due to accidental spill from fuel and oil storage tanks.	Toxic impacts on attached and slow-moving aquatic invertebrates.	Place fuel tank in an enclosed bond-wall with 110% capacity of fuel tank.

<b>Development Activity</b>	<b>Primary Impacts or Environmental Disturbance</b>	<b>Secondary and Tertiary Level Environmental Impacts</b>	<b>Mitigation Measures</b>
			Transport fuel in sealed containers in seaworthy vessels only.
	Air pollution and combustion fumes.	Impacts on human health, particularly those challenged by respiratory diseases.	Keep machines properly serviced use recommended fuels and additives only.

### **11.2.5 Social Impact Mitigation**

Possible mitigation measures for the negative impacts are:

- a. Competition with Belizeans in the tourism sector --- BTIA membership would offer a platform for the control on the number and type of tourism related businesses by locals and foreigners.
- b. Increase in crime rate --- increase the number of resident policemen from seven to at least 10; formation of neighborhood watch groups; advice to residents in the Peninsula and nearby villages to secure their homes.
- c. Sexually transmitted diseases --- institute an awareness program in Peninsula villages on this social ailment.
- d. Migrant labor is already settling permanently --- village council leaders to develop a village planning and expansion scheme together with the Lands Department.
- e. Potable water supply to the development --- the developer uses adequate sources with appropriate technology.

In general the mitigation measures to be employed in relation to the social impacts of the project has been summarized in Table 11.6 below:

**Table 11.6:** Summary Mitigation Measures in Relation to Socio-Economic Impacts

<b>Activities and Conditions</b>	<b>Potential Impacts</b>	<b>Mitigation Measures</b>	<b>Residual Impacts Magnitude/ Direction/Duration/Scope</b>
<b>Current and Proposed Land Use in Area</b>	<ul style="list-style-type: none"> <li>• Location and size of development</li> <li>• Beach Erosion</li> </ul>	<ul style="list-style-type: none"> <li>• Adequate of control development proposals, especially during the construction phase, take into consideration future development activities being undertaken in the island to be developed.</li> <li>• Beach erosion prevention methods should be highly considered.</li> </ul>	<p>High/ positive/high/long</p> <p>High/negative/decades/local</p>
<b>Activities during Construction and Post Construction Phase Activities</b>	<ul style="list-style-type: none"> <li>• Transportation of construction materials and equipment during all phases of development</li> <li>• Operation of construction machinery</li> <li>• High population densities during construction and post construction</li> <li>• Housing and sanitary facilities for construction workers at the development site in the targeted island</li> </ul>	<ul style="list-style-type: none"> <li>• All vessels/vehicles transporting construction materials should be covered, and equipment secured to allow for safe transportation to the site; this should be monitored</li> <li>• Operators should be trained and involved in development plans</li> <li>• Workers should be trained in the safety procedures; operation of machinery and use of safety gear used</li> <li>• Adequate transportation, proper housing, and other basic facilities are available for workers in the island.</li> </ul>	<p>High/negative/months/local</p> <p>High/positive/decades/local</p> <p>High/positives/decades/local</p> <p>High/positives/decades/local</p>

<b>Activities and Conditions</b>	<b>Potential Impacts</b>	<b>Mitigation Measures</b>	<b>Residual Impacts Magnitude/ Direction/Duration/Scope</b>
<b>Marine and Terrestrial Traffic</b>	<ul style="list-style-type: none"> <li>• Increased number of sea vessels and vehicles</li> <li>• Increased traffic of work boats and barges between peninsula and the island</li> </ul>	<ul style="list-style-type: none"> <li>• Movement of workers, machinery/equipment and cargo, should be scheduled in advance</li> <li>• Marine traffic should also be regulated by routing marine vessels to designated “shipping lanes”</li> <li>• Management systems such as buoys, markers, and signs should be designated</li> <li>• Materials transported should be properly covered and secured to prevent them falling into the sea</li> </ul>	<p>High/negative/months/local</p> <p>High/negative/months/local</p> <p>High/negative/months/local</p> <p>High/negative/months/local</p>
<b>Population</b>	<ul style="list-style-type: none"> <li>• Increased population density in the area</li> <li>• Pressure on existing resources and social infrastructure</li> <li>• Attraction of spontaneous and unplanned nearby settlements</li> <li>• Marginalization of local minority groups</li> </ul>	<ul style="list-style-type: none"> <li>• A settlement plan be envisioned or additional temporary quarters be constructed</li> <li>• Institutional capability and services strengthened</li> <li>• Workers be transported to an from the site during all phases of construction</li> <li>• Institutional capability and services strengthened</li> </ul>	<p>Low/ no change/months/local</p> <p>High/decades/decades/long</p> <p>High/decades/months/long</p> <p>High/positive/decades/long</p>

<b>Activities and Conditions</b>	<b>Potential Impacts</b>	<b>Mitigation Measures</b>	<b>Residual Impacts Magnitude/ Direction/Duration/Scope</b>
<b>Housing</b>	<ul style="list-style-type: none"> <li>• Increase housing needs at site</li> <li>• Need for housing of voluntary populations from within Belize</li> <li>• Need for housing for involuntary populations and migrant workers</li> </ul>	<ul style="list-style-type: none"> <li>• Additional staff quarters can be constructed on the property to ease demand</li> <li>• Migrant workers should not be encouraged to commence spontaneous settlement</li> </ul>	<p>High/positive/long/local</p> <p>High/positive/long/local</p>
<b>Culture</b>	<ul style="list-style-type: none"> <li>• Pressure on existing institutions and social groups; pressure on existing lifestyles</li> <li>• Marginalization of minority groups and locals</li> </ul>	<ul style="list-style-type: none"> <li>• Locally strengthen existing institutions and social groups or develop new ones</li> <li>• Strengthen existing institutions, and regulatory systems</li> </ul>	<p>Medium/positive/long/local</p> <p>Medium/positive/long/local</p>
<b>Education/Health Services</b>	<ul style="list-style-type: none"> <li>• Increased pressure on existing educational institutions</li> <li>• Locals become marginalized in development process</li> <li>• Increased pressure on health and sanitary facilities</li> </ul>	<ul style="list-style-type: none"> <li>• Local education and health facilities should be strengthened and coordinated</li> <li>• Locals should continue to have first access to all existing infrastructure facilities</li> <li>• The establishment of a full range of services will account for the needs of new residents and workers</li> </ul>	<p>High/positive/decades/long</p> <p>High/positive/decades/long</p> <p>High/positive/decades/long</p>

<b>Activities and Conditions</b>	<b>Potential Impacts</b>	<b>Mitigation Measures</b>	<b>Residual Impacts Magnitude/ Direction/Duration/Scope</b>
<b>Employment</b>	<ul style="list-style-type: none"> <li>• Skilled laborers from the region not employed during construction and post construction phase</li> </ul>	<ul style="list-style-type: none"> <li>• Employment of individuals from the villages encouraged which will strengthen local/regional skills and will include the potential for long-term employment</li> <li>• Laborers should also be paid as per skill requirement (s)</li> <li>• The Belize labour laws should also be observed</li> <li>• Crew be provided with restroom facilities, adequate drinking water, basic health services, and safety equipment</li> </ul>	<p>High/positive/decades/long</p> <p>High/positive/decades/long</p> <p>High/positive/decades/long</p> <p>High/positive/years/long</p>
<b>Noise Nuisances</b>	<ul style="list-style-type: none"> <li>• Disturbance of machinery during post construction phase and other phases from construction machinery</li> </ul>	<ul style="list-style-type: none"> <li>• All machinery and equipment used during all phases of construction should be maintained in proper running condition</li> <li>• The construction site is about one mile from the shoreline thus resulting in a low level of noise pollution during construction to peninsula residents.</li> </ul>	<p>Medium/positive/months/local</p> <p>Low/negative/months/local</p>