
SECTION FIVE

ENVIRONMENTAL IMPACT ANALYSIS

5.1 Introduction

It must be a basic premise that all developments will produce some environmental impacts and therefore the basic question is how much is acceptable under the circumstances? The obvious consensus is that the country needs development but only of the kind that is sustainable and in conformity to national development priorities. The challenge throughout is to find an acceptable level that will strike the necessary balance between the need to develop and the need to protect vital environmental resources. Also important is the planned scale of the infrastructural development and their potential to unravel the social fabric and lifestyles of the people in the area within which they are based.

The following sections describe the environmental impact analysis from its conceptual approach to its cumulative impact analysis. This analysis is directly related to the environmental management plan described in Section Six of this document.

5.2 Conceptual Approach Towards Development

The impacts of this development will be felt mainly in the areas of physical alterations to the surrounding ecosystem, solid and liquid waste disposal, water supply and distribution, energy generation, effects on the native wildlife species of the area from a combination of factors, extraction of materials and transportation. The point has been made that no project of this size can be successfully implemented without some negative environmental impacts, however it is incumbent on the developer to reduce these to their lowest possible level, or negate them entirely if the situation allows. The developer will be aided in this undertaking by the impacts and mitigation discussion in the relevant sections of this study which have been identified by the DOE as liable to produce significant environmental impacts among others.

These impacts have been extensively studied by the CEQ and they have defined the appropriate abatement measures that can be integrated into the project to guide the development.

1. *Avoiding* the impact
2. *Minimizing* the impact by limiting the degree or magnitude of the action
3. *Rectifying* the impact by repairing, rehabilitating, or restoring the affected environment.
4. *Reducing* or eliminating the impact over time
5. *Compensating* for the impact by replacing or providing substitute resources or environments.

These measures illustrated in Fig. 5.1 have been promulgated by the Council for Environmental Quality (CEQ) and is the approach taken by the proposed project proponents.



Fig. 5.1: CEQ's Impact Structure

5.2.1 Impact Assessment

Figure 5.2 summarizes the potential impacts associated with the proposed development. As may be seen from Fig. 5.2 these impacts are in relation to both sea-based and land-based activities.

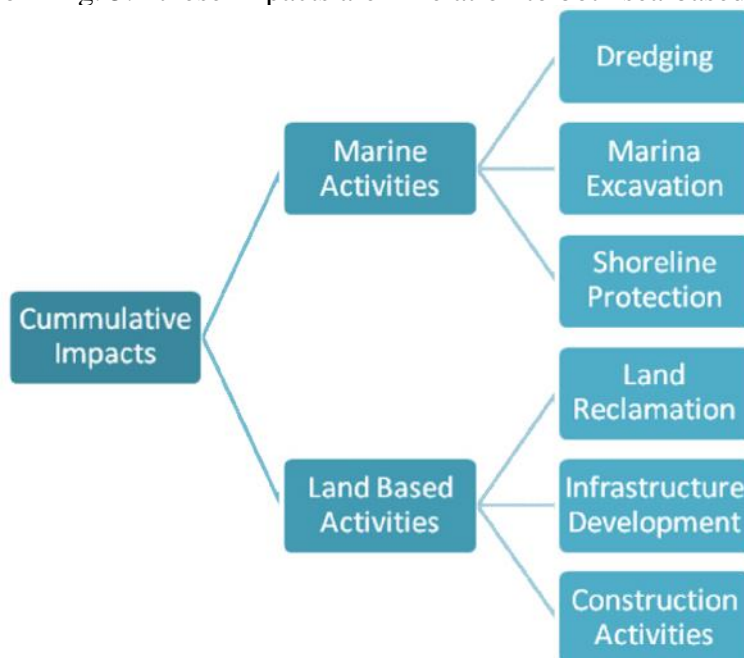


Fig. 5.2: Cumulative Potential Impacts

The detailed analysis of these impacts have been outlined in the modified Leopold Matrix (See Table 5.1) first used by Tunich Nah Consultants and Engineers in the US Capital Energy EIA submitted to the DOE in 2007. As may be seen from the matrix both the ‘primary’, or ‘direct’ impacts are assessed as well as the ‘secondary’ or ‘residual’ impacts.

It should also be noted that the Modified Leopold Matrix focuses on both the ‘deleterious’ or ‘negative’ impacts, as well as the ‘beneficial’ or ‘positive’ impacts arising from the development.

It should also be noted that the major deleterious ecological impacts associated with the project are from sedimentation and turbidity influences, land-clearing and the displacement of wildlife, as well as the sourcing of potable water, nutrient enrichment or eutrophication, the generation of solid waste, and human health and safety issues. It may also be seen that the most severe deleterious socio-economic impacts are associated with the threat to economic livelihood of which the threat to human health and safety is a major component (See Table 5.1). The potential conflicts and discomfiture associated with the encounter between different cultures is also another significant consideration (See Table 5.1).

The main beneficial impacts are associated with the geographic expansion of the aquatic environment at the project site, vis-à-vis the construction of the marina basin and related access channels. The deepening of the nearshore areas and the creation of a marina basin with a flow-through arrangement via twin access/egress canals/channels improves circulation and in general water quality profiles, particularly for the limiting parameter of Dissolved Oxygen (DO). This bodes well for both pelagic and benthic fin-fishes, as well as invertebrates.

The magnitude and direction of the impacts shown in Table 5.1 reflects the actual design of the project with mitigation.

5.3 Details of the Potential Environmental Impacts

The environmental impacts for the proposed undertaking are divided into two (2) main areas, viz, ecological impacts and social impacts. Other impacts of similar significance will also be covered.

5.3.1 Ecological Impacts

The ecological impacts are broken down into three (3) main categories, viz: the physical environment, ecology and nature conservation and the human environment (See Table 5.1).

5.3.1.1 Dredging and Land Reclamation

Dredging and land reclamation is subdivided into two (2) main areas, viz: the physical extraction of the seafloor and land-based excavation of the perimeter canal on the southern boundary of the property, and the deposition of the dredged and excavated spoils. The physical dredging of the seafloor is taken to be more ecologically sensitive than the land-based extraction given the sensitivity of much of the biota to turbidity and sedimentation influences and the sessile and slow-moving nature of much of the invertebrate fauna.

The two (2) main activities associated with the dredging event are the physical extraction of the seafloor and the land-based deposition of the spoils (See Table 5.1). The primary impacts associated with these processes are salinization of the soils in the area where it is deposited and the mechanical removal of the biota from the seafloor. Although the volume of material to be extracted from the seafloor is relatively large the impact has been assessed as ‘moderately deleterious’, given the limited geographic extent of the burrow site, which is a function of the availability of the fill material in the immediate vicinity of the project site.

The ‘moderate deleterious’ characterization of the salinization impacts is a function of the relatively short time-frame that the natural precipitation and irrigation of the golf course and associated areas are expected to take to desalinate the soils in the area (See Table 5.1).

The moderate characterization of the dredging and reclamation impacts is also a function of the nature and status of the receiving environment. The proposed project site is an estuarine environment that is four (4) miles downstream of the outfall of the Rio Hondo. This area is characterized by broad and frequent changes in water quality, including sedimentation and turbidity influences. Thus the dredging event will take place in an ecologically robust environment that has evolved along the lines of being able to cope with sedimentation and turbidity influences.

The judicious deployment of the dredge equipment to curtail the broadcasting of sediments is the most important determinant in assessing the impact of the dredging event as ‘moderately deleterious’. Dredging will be accompanied by the deployment of silt curtains: Other measures include undertaking such activities only during relatively calm sea-states and ‘trenching’ or ‘cutting’ the seafloor at an angle less than 35⁰ which would prevent slumping and accommodate the re-colonization of the area by macro-algae and seagrass, as well as sedentary invertebrates such as sponge and tunicates (See Sect. 6).

It also needs to be kept in mind that the receiving environment would not be characterized as ecologically fragile relative to the barrier reef ecosystem (See Table 5.1) given its robust facility to cope with extreme and rapid environmental changes.

5.3.1.2 Land Clearing

Land-clearing entails the removal of most of the trees and shrubbery. The landscaping plan does call for culturing selected hardwood and shade trees in a nursery before strategically replanting them. The impact related to this issue is two-fold: firstly there is the matter of shoreline erosion and secondly there is the issue of the displacement and disturbance of wildlife. In regard to shoreline erosion, the impact has been characterized as ‘marginally deleterious’ (See Table 5.1). This is based on the fact that there are no plans to clear-cut and denude the area whereby the woodland and savannah areas would be exposed to airborne and/or run-off erosion. The preservation or non-disturbance of the fringing mangrove zone would mitigate shoreline and/or beach erosion (See Table 5.1).

In relation to wildlife impacts, it is anticipated that the greatest impacts will be the loss of the area as a source of foraging for a number of species, as well as a habitat for abode and shelter. It

is anticipated that the species to be affected range from the Blue Land Crab, to the Spiny Iguana and a range of lizards, as well as a number of bird species (See Table 5.1). The latter are possibly the ones that would be most greatly affected.

The wildlife impacts has been assessed in the ‘marginally deleterious’ category (See Table 5.1), given the short-term and temporary nature of the loss of woodland vegetation and indeed the limited size of the property relative to the surrounding area, much of which is also heavily forested.

5.3.1.3 Sewage and Golf Course

The two (2) most important contributors to the water quality of the adjacent sea during the operational phase of the proposed development are the effluents from sewage and domestic wastewater as well as the golf course. Both sources are major contributors of the macro-nutrients phosphate and nitrate. As a general rule phosphates is thought to be the limiting nutrient in freshwater situations whereas nitrates are thought to be the limiting macro-nutrient in marine situations. The low salinities of the project site, at least during the times of the sampling event (See Figs. 2.5, 2.6 & 2.7), would suggest some relevance of phosphate in the nutrient enrichment process.

The macro-nutrients for the facilities would derive mainly from urine and detergents as far as sewage and gray water effluent goes and from fertilizers as far as the golf course is concerned.

The macro-nutrient impact has been assessed as ‘marginally deleterious’ (See Table 5.1). This has been largely a function of the effluent management strategy for sewage and domestic wastewater (See Sects. 3 & 6). There is in effect a non-discharge strategy which entails the recirculation of post-treated and chlorinated effluents: This source is used mainly for flushing toilets, irrigation, washing surfaces and firefighting (See Sects. 3 & 6).

In relation to the golf course, water conservation measures are to be put in place that is based on the minimum irrigation requirements (See Sect. 3).

The prospects for nutrient enrichment or eutrophication are thus remote or non-existent (See Table 5.1). This is relevant not only because of the reduced macro-nutrient levels going into the environment, but also because of the nature and status of the receiving environment. The ecology of Corozal Bay and indeed the project site have developed along the lines of major inputs and fluxes in macro-nutrient (See Table 5.1).

Apart from the issue of nutrient pollution the two (2) other impacts specifically associated with sewage are the BOD loading of the water column and the human health impacts from bacterial and viral pathogens associated with human feces. The BOD impacts have been assessed in the ‘negligible deleterious’ category (See Table 5.1). This is as a consequence of the non-discharge and post-treatment chlorination of the sewage and gray water effluents.

Table 5.1: Impact Matrix – With Mitigation

Topic Area	Dev. Activity	Specific Area	Primary or Direct Impact	Secondary or Indirect Impact	Mag. & Dir. Impact	TS & Rev	Geo. Scope			Mit. Avail.
							L	R	N	
Physical Environment	Dredging	Soils	Land-based deposition of dredged spoils leading to salinization of soils.	Suffocation of root systems and hypersaline conditions in soils resulting in wilting and death of mangroves and littoral forest vegetation...Negative implications for deer, iguanas, and other lizards, as well as woodland birds.	-3	MT, Rv				
		Sea-floor sediments	Physical extraction of seafloor with attendant sedimentation and turbidity influences.	Mechanical destruction of algal-dominated hard benthos as well as denuded soft seafloor, and other benthic habitat...Also effects from sedimentation and turbidity influences in form of blanketing of sedentary and slow-moving benthic invertebrates as well as impairment of photosynthesis and secondary production in macro-algal dominated benthos.	-3	MT, Rv				

Topic Area	Dev. Activity	Specific Area	Primary or Direct Impact	Secondary or Indirect Impact	Mag. & Dir. Impact	TS & Rev	Geo. Scope			Mit. Avail.
							L	R	N	
Physical Env. cont'd	Land Clearing	Soils	Exposure of soils to aerial and sea-based shoreline Erosion.	Initial loss of vegetation and change in species composition, with negative implications for native fauna, such as iguanas, land crabs, lizards and woodland birds.	-2	ST, Rv				
	Inst. & op. of Sewage System and golf course	Water Quality	Production and liberation of eutrophic or nutrient enrichment substances.	Liberation of nitrates and phosphates from sewage into water column of adjacent seas may lead to increase in photosynthesis and primary production at lower end of pollution spectrum...At extreme end of spectrum leads to mass mortalities or 'crash' of micro-algal blooms...Also stimulus for macro-algae growth and seagrass growth.	-2	LT, Rv				

Topic Area	Dev. Activity	Specific Area	Primary or Direct Impact	Secondary or Indirect Impact	Mag. & Dir. Impact	TS & Rev	Geo. Scope			Mit. Avail.
							L	R	N	
Physical Env. cont'd			Prod. & lib. of BOD substances in the form of feces and other proteinaceous materials.	Liberation into surrounding seas would lead to stripping of water column of dissolved oxygen (DO) resulting in physiological stress and death to aquatic fauna, especially sedentary and slow-moving inverts...Also generally results in simplification of food webs with domination of polychaete worms.	-1	LT, Rv				
	Transportation	Water Quality	Dissolved fraction from outboard and diesel engines from boats, also heavier fraction from lubricating oils.	Direct toxic effect of petroleum pollutants on aquatic fauna, especially sedentary invertebrates ...Spillage of heavier lubricating oils potentially deleterious to seabirds in regards to loss of waterproofing and buoyancy.	-1	LT, NRv				

Topic Area	Dev. Activity	Specific Area	Primary or Direct Impact	Secondary or Indirect Impact	Mag. & Dir. Impact	TS & Rev	Geo. Scope			Mit. Avail.
							L	R	N	
Physical Env. cont'd	Transportation cont'd	Soils	Land-based spillages of lubricating oils, petrol and diesel from fuel pump, generators, and land-based vehicles.	Direct toxic effects to soil microbes with consequent negative consequences of soil fertility, including denuding areas of vegetation with attendant erosion from wind and rain.	-1	ST, NRv				
		Vegetation & run-off rates	Pre-construction land clearing and construction of roads and walkways.	Vegetation loss and acceleration of runoff rate with beach erosion and attendant sedimentation and turbidity influences of nearshore waters, with negative implications for benthic productivity.	-2	ST, Rv				

Topic Area	Dev. Activity	Specific Area	Primary or Direct Impact	Secondary or Indirect Impact	Mag. & Dir. Impact	TS & Rev	Geo. Scope			Mit. Avail.
							L	R	N	
Ecology and nature conservation	Solid Wastes Accumulation	Food discards	Attraction of feral and household pests in the form of crocodiles, coatis, raccoons, rats and vagrant birds.	Intensification of predation from feral animals attracted to the area, as well as competition and displacement of resident fauna...Also potential for introduction of parasite/and disease organisms to site .	-2	LT, Rv				
			Alteration of species diversity driven by induced and incidental introduction of non-native flora and fauna.	Disruption of ecological balance by introduction of non-native vegetation on golf course and lawn that may not be fodder for herbivores in the area and may indeed stimulate a whole new class of herbivory.	-2	LT, Rv				
		Non-biodegradable components	Interaction of land-based and aquatic fauna with plastics, glass, tin-cans, rubber, etc.	Ingestion of plastic bags by juvenile sea turtles mistaken for prey items such as jelly fishes... Entrapment of sharks by Six Pack Ring Beer Containers etc.	-2	LT, Rv				

Topic Area	Dev. Activity	Specific Area	Primary or Direct Impact	Secondary or Indirect Impact	Mag. & Dir. Impact	TS & Rev	Geo. Scope			Mit. Avail.
							L	R	N	
Ecology and nature conservation cont'd			Leaching of toxic, pH altering and oxidative substances from discards.	Direct mortality and morbidity to land-based fauna such as iguanas, geckos, blue land crabs crows and vultures.	-1	LT, NRv				
	Land Clearing	Loss and or alteration of food source	Site-specific loss of fruit trees with land-clearing to site facilities and infrastructure.	Large-scale clearing of forest including fruit trees erodes and eliminate area as source of feed for certain species of birds which includes both resident and migratory stocks.	-2	LT, Rv				
	Dredging and Deposition of Spoils	Declines in productivity	Loss of primary and secondary productivity from mangroves, algal stands and seagrass beds.	Destruction and demise of algal stands and seagrass meadows at burrow site by 'cutter head' of dredge and land-based deposition of spoils coupled with land-clearing results in mangrove destruction ... These results in net loss of primary and secondary productivity of the marine environment and consequently decrease in the abundance of	-2	MT, Rv				

Topic Area	Dev. Activity	Specific Area	Primary or Direct Impact	Secondary or Indirect Impact	Mag. & Dir. Impact	TS & Rev	Geo. Scope			Mit. Avail.
							L	R	N	
Ecology and nature conservation cont'd				fin-fishes and macro-invertebrates such as the Blue Crab (<i>Callinectes sapidus</i>) and the Mangrove Oyster (<i>Crassostrea rhizophorea</i>)						
	Potable water infrastructure	Resource depletion and salinization	Exhaustion of groundwater sources leading to saline intrusion and possible subsidence of land.	Wilting and demise of grasses on golf course and lawns from irrigation with saline source, as well as flooding and water-logging of area from subsidence and consequent drowning of root system of woodland vegetation.	-2	LT, NRv				
	Berthing and navigation in marina basin and access channels.	Habitat modification.	Deepening of benthos and alteration of flow regime.	Physical expansion of nektonic regime and greater available of habitat to fin-fishes and pelagic invertebrates such as octopuses and squids, as well as settlement surfaces for attached invertebrates such as oysters, clams, barnacles and ship worms.	+3	LT, Rv				

Topic Area	Dev. Activity	Specific Area	Primary or Direct Impact	Secondary or Indirect Impact	Mag. & Dir. Impact	TS & Rev	Geo. Scope			Mit. Avail.
							L	R	N	
Ecology and nature conservation cont'd	Traffic	Injury and death from collision with endangered species.	Death and injury from collision of power boats with manatees	Decline in manatee populations would mark decrease in herbivory in wider Corozal Bay: Also impact in food web with Crocs as top predators.	-2	ST, Rv				
	Noise from construction activities	Wildlife disturbance	Noise disturbing bird populations, especially during breeding season.	Displacement of birds having direct impact on herbivory and prey/predator relationships.	-1	ST, Rv				
Human Environment	Loss of livelihood	Socio-economic	Decline in benthic vegetation from sedimentation and turbidity as well as mechanical removal and destruction.	Decline in fish stocks including the Gray Snapper (<i>Lutjanus griseus</i>), the Tuba (<i>Cichlasoma synspilum</i>) and the Silk Drummer (<i>Bairdiella ronchus</i>) with attendant decrease in subsistence harvest.	-1	LT, Rv				

Topic Area	Dev. Activity	Specific Area	Primary or Direct Impact	Secondary or Indirect Impact	Mag. & Dir. Impact	TS & Rev	Geo. Scope			Mit. Avail.
							L	R	N	
Human Environment cont'd			Noise and boat traffic causing injury and displacement of manatees	Decline and displacement of manatees compromising future opportunities of Tour Guides whom would have manatee viewing as part of nature-oriented tourism package.	-2	LT, Rv				
		Human Health & Safety	Attraction of and introduction of feral animals and household pest to site as a consequence of availability of food and suitable habitat.	Presence of large crows and raccoons scavenging garbage and discards and possibility of attacks on guests and tourists... Also attraction of poisonous snakes to site which are a threat to residents, workers and visitors...Rats & mice as well as raccoons are carriers of diseases such as Leptospirosis and Rabies, these may be transmitted to guests/tourists as well as workers through biting and other forms of contact with these animals.	-2	LT, Rv				

Topic Area	Dev. Activity	Specific Area	Primary or Direct Impact	Secondary or Indirect Impact	Mag. & Dir. Impact	TS & Rev	Geo. Scope			Mit. Avail.
							L	R	N	
Human Environment cont'd			Berthing of dredge and deployment of spoil discharge pipes during land reclamation operation poses a threat to human health and safety.	Berthing of dredge and spoil discharge pipes poses significant threat to mariners in terms of 'Collision at Sea' accidents.	-1	ST, Rv				
			Threat of injury and death to swimmers, waders and snorkelers as well as subsistence fishers from boat accidents.	Subsistence fishers and recreational users of nearshore beach environment at risk of injury and death from motorized crafts operating in the area.	-1	LT, NRv				

Topic Area	Dev. Activity	Specific Area	Primary or Direct Impact	Secondary or Indirect Impact	Mag. & Dir. Impact	TS & Rev	Geo. Scope			Mit. Avail.
							L	R	N	
							L	R	N	
			Introduction of pathogenic organisms into the water column from sewage such as <i>E. coli</i> and <i>Shigella</i> .	Introduction and permeation of pathogenic viruses and bacteria into sea poses threat of diseases to snorkelers and swimmers as well as wading subsistence fishermen utilizing area.	-1	LT, Rv				
Human Environment cont'd			Standing water in tin cans, tires, plastic bottles forming habitat for the breeding of mosquitoes	Mosquitoes are carriers of various diseases such as Malaria and Yellow Fever which may be transmitted to human beings, including tourists, residents and workers of the facilities.	-1	LT, Rv				
		Traditional Access	Excluding traditional users from access to traditional areas	Area accessed by both sea and land for subsistence fishing by fishermen from the surrounding villages and homesteads...Target species exclusively fin-fishes associated with the existent marina basin and nearshore shallows in the area.	-1	LT, Rv				

Topic Area	Dev. Activity	Specific Area	Primary or Direct Impact	Secondary or Indirect Impact	Mag. & Dir. Impact	TS & Rev	Geo. Scope			Mit. Avail.
							L	R	N	
Human Environment cont'd		Contact between local and foreign cultures	Contact between tourists and locals with differing traditions and language and value systems can make for unplanned and unanticipated negative consequences.	Foreign tourists and residents that are clientele of the proposed development may be discomfited with and perhaps even take umbrage to the unimpeded access of subsistence fishers who have traditionally used the area: This is especially in relation to the area of the beach and marina basin.	-1	LT, R				

Key to Scoring Magnitude and Direction:

0 = No Impact

-1 = Minimal or Negligible Deleterious Impact

-2 = Marginally Significant Impact Mostly Reversible after Short Time-frame

-3 = Moderately Significant Impact Occasionally Reversible

-4 = Major Impact Partly Reversible with mitigation

-5 = High Impact Long-term Effects

+1 = Minimal or Negligible Positive Impact

+2 = Marginally Positive Impact

+3 = Moderately Positive Impact

+4 = Major Positive Impact

+5 = Highly Positive Impact

Key to Abbreviations and Acronyms:

L = Local

R = Regional

N = National

LT = Long Term

ST = Short Term

MT = Medium Term

Mag. & Dir. Impact = Magnitude and Direction of Impacts

TS & Rev = Timeframe and Reversibility

Mit. Avail. = Mitigation Available

Geo. Scope = Geographic Scope

The human health impact from pathogenic virus and bacteria have been assessed in the ‘negligible deleterious’ category (See Table 5.1). The non-discharge and post-treatment chlorination of sewage effluents denatures and destroys fecal pathogens, thus the ‘negligible deleterious’ characterization. The lack of fecal pathogens in the nearshore waters of the project site (See Annex IV) is an indication that the area is in many ways pristine or near-pristine. This situation should not change as a consequence of the implementation of the proposed project.

5.3.1.4 Transportation

Transportation issues relates to both land-based vehicles and marine crafts. The impacts as discussed relates to both the construction and operational phases of the project. Transportation thus, has six (6) primary impacts. These are the impacts on: water quality, soils, vegetation, wildlife, and human health and safety (See Table 5.1). Water quality impacts relate to the potential for hydrocarbon pollution that would impact the aquatic fauna and flora of the area. Although this would be derived mainly from water-based crafts, there would also be an appreciable contribution from terrestrial sources, largely in the form of run-off.

The water-based hydrocarbon pollutants are a function of emissions from outboard engines and diesel motors, as well as the heavier lubricating oil fraction. This impact has been characterized as ‘negligible deleterious’ (See Table 5.1). This is a function of the mitigation measures that are the main feature of the project design, as it relates to the stewardship of the environment. Two (2) of the main mitigation measures are the prohibition of any bilging activities in the marina and seafront facilities of the development, and the policy to curtail spillages and conserve fuel (See Sect. 6). The decision to not have a full-service marina and to mandate any maintenance work on vessels to take place on Dry-Dock are also significant mitigation interventions (See Sects. 3 & 6). The specter of the deleterious impacts of oil on the water proofing of seabirds is thus not relevant to the proposed project.

The impacts of hydrocarbon pollution to soils are a consequence of a range of possibilities including the land-based spillage of lubricating oils, petrol and diesel from the marina fuel pump, standby generators, and land-based vehicle emissions (See Table 5.1). The main impact from land-based spillages of petroleum products is the direct toxic effects to soil microbes and consequently the decline in soil fertility (See Table 5.1). This impact has again been assessed as ‘negligible deleterious’ given the mitigation measures to curtail such spillages that are a part of the project design (See Sect. 6).

The vegetation impact relevant to transportation is mainly in relation to land clearing for roadways (See Table 5.1). The secondary impacts are not related to petroleum pollution but to soil and shoreline erosion (See Table 5.1). The vegetation impact has been assessed as ‘marginally deleterious’ (See Table 5.1). This is a function of the absolute amount of the area that would need to be cleared for roads: This is of course not the greatest requirement for land-clearing given functions such as the need to clear areas for the placement of buildings and the utility zone.

The wildlife impact would be the most politically sensitive if not functionally significant. Given the designation of the Corozal Bay as a Wildlife Sanctuary to protect the Antillean Manatee

(*Trichechus manatus manatus*) (See Sect. 2 and Annex XIV), every effort needs to be made to safeguard the species. In addition to the designation of the area as a Wildlife Sanctuary, the species is also protected from hunting by national laws. The manatee has also been listed as endangered by the U.S. Fish and Wildlife Service and as being 'Vulnerable to Extinction' by IUCN: It is also protected under the CITES Regulations, where it has been placed on Appendix I of the 'Species List' (See Sect. 2).

The greatest threat to manatees in the area would be from collision-related injuries and death from motorized crafts particularly powerboats that are propelled in large measure by out-board motors in Belize.

The impacts to wildlife as it relates to manatees has been characterized as 'marginally deleterious' (See Table 5.1). This is a function of the mitigation measures that are being put in place such as confining nearshore traffic to definitive sea-lanes, and navigating in the deeper channels as opposed to shallow seagrass areas (See Sect. 6). Another consideration is that although the wider Corozal Bay has been identified in successive aerial surveys (1977, 1989, Jan. 1994; May 1994; Jan. 1995 and 2003) as one of the areas in Belize with a fairly robust manatee population, there is a definitive lack of any documented presence of the species at the site. Apart from organized scientific efforts, a canvassing of the opinions of Subsistence Fishers utilizing the area during three (3) Tunich Surveys also yielded no evidence of the presence of manatee at the project site. This could be partly understood given the lack of aquatic vegetation that would form fodder for the animal. The seafloor in the area of the project site lacks any significant stands of manatee grass (*Syringodium filiforme*) or Turtle Grass (*Thalassia testudinum*). Thus it is likely that if manatees use the area it would most probably be for transient navigation or as a rest stop. It is not likely that the nearshore areas within 50 to 75 yards of the shoreline would be relevant in this regard given the lack of contiguous navigable depths for the species (See Sect. 2). Thus until proven otherwise the area cannot be considered as prime habitat for the species. This does not obviate the fact however that it would be expected that as the marina basin and associated channels are excavated they would assist access of said manatees to the site.

The lack of any definitive presence of manatees at the project site can also be understood from observation in the scientific literature by Morales-Vela et al (1999) in which it has been stated that most of the manatees associated with the area has been observed in the lagoonal and riverine systems, as well as those areas of the Bay with spring-water upwelling or direct lotic input: Thus three (3) of the more important areas where manatees congregate are Laguna Guerrero and Dos Hermanos on the Mexican Side of the Border, and Rocky Point on the Belize side of the border (Morales-Vela et al, 1999). The New River and Four Mile Lagoon have also been cited as definitive habitats for the species.

Although Chetumal Bay and its associated waterways is an important habitat for Manatees, Morales-Vela et al (1999) found the waters of the Cayes of Belize City and the Placencia Lagoon and Indian Hill Lagoon to be the most important habitats for the species in their 1994 & 95 surveys.

Morales-Vela et al (1999) inferred the potential for Tourism Development in the Bay and recommended that any development that would impact the habitat of manatees would need to take into account the changes that could be wrought to the species as well as the habitat. These are a part of the environmental management programme for the proposed development (See sect. 6). Other mitigation measures include the installation of 'NO WAKE' zones, and designated sea-lanes as well as the use of 'Prop Guards' and education programmes for those residents and visitors utilizing the marina and its related infrastructure (See Sect. 6).

The impacts in relation to Human Health and Safety relate to the potential for collision at sea incidents with the Dredge berthed in the area during the construction phase of the project as well as in relation to boats impacting and injuring or killing subsistence fishers and those using the nearshore areas of the beach for recreational purposes (See Table 5.1). Both of these impacts have been classified in the 'negligible deleterious category' (See Table 5.1). These are attributable to the built-in mitigation measures that are a function of the design of the project. In the case of the Dredging operation the 'negligible deleterious category' is also attributable to the short-term and temporary nature of the dredging event. This categorization is also justified by the fact that the seas adjacent to the project area falls outside of the definitive lane for marine traffic in Corozal Bay. The deployment of buoys and warning lights to demarcate the position of the dredge, spoil discharge pipes and boom in the case of Clam and Bucket Excavation interventions are some of the mitigation measures that would ward off mariners from the area (See Sect. 6).

The threat of injury and death to those utilizing the nearshore areas from power boats will be greatly diminished and/or eliminated by the demarcation of the nearshore waters adjacent to the beach as non-navigable for boats. This bodes well for both the recreational users of the beach as well as subsistence fishers plying the area.

5.3.1.5 Solid Waste

The issue of solid waste is highly relevant to both the construction and operational phases of the proposed venture. This issue is related to both ecological considerations and human health and safety concerns (See Table 5.1). The impacts related to the bio-degradable and non-biodegradable components differ in orientation (See Table 5.1). One of the more significant components of the biodegradable component is food discards. The primary impact associated with this aspect of the project is largely related to the operational phase of the undertaking and relates to the attraction of feral stocks and household pests such as crocodiles, coatis, raccoons, rats and vagrant birds that includes the Great Tailed Grackle (*Quiscalus mexicanus*) and the Herring Gull (*Larus argentatus*) (See Table 5.1). The characterization of this impact is 'marginally deleterious' (See Table 5.1). This is understandable given the solid waste management strategy to collect, secure and transport off-site all food discards (See Sect. 6).

The other primary impact associated with food discards is the alteration of species diversity driven by induced and incidental introduction of non-native flora and fauna. This impact has also been categorized as 'marginally deleterious' (See Table 5.1). This conservative categorization is a function of the in-built mitigation measure to discourage and dissuade the presence of feral stocks that would be attracted to the site.

The impacts of the non-biodegradable component are related to both ecological and human health and safety issues (See Table 5.1). The ‘marginally deleterious’ categorization associated with the ecological impact is also related to the in-built mitigation measures associated with the design of the project. The ecological issues are related to the interaction of marine fauna with plastics such as sea turtles and sharks (See Table 5.1). The primary impacts associated with this component of the project are the interaction of land-based and aquatic fauna with plastics, glass, tin-cans and rubber (See Table 5.1).

The human health and safety aspects associated with solid waste are in relation to the threat of injury from feral stocks attracted to the site to either forage or alternately to prey on the vagrant and opportunistic stocks that have been also been attracted to the site. The possibility of vector borne diseases such as malaria as a consequence of solid waste forming a habitat for such vectors is also a relevant concern (See Table 5.1). The threat of attack and injury or death from feral stocks has been assessed as a ‘marginally deleterious’ impact. This is based on the fact that the judicious management of the biodegradable component of solid waste will greatly erode or eliminate feral stocks encroaching on the property.

In the case of pathogenic diseases, old tyres, tin cans, and plastic buckets forms the breeding habitat for mosquitoes that will bite residents and visitors thereby raising the specter of the possibility of contracting malaria. This impact has been assessed as ‘negligible deleterious’ (See Table 5.1). This is understood given the judicious management of solid waste that would entail the collection and removal of those items of discards that would form a habitat for mosquitoes and other vectors (See Table 5.1).

5.3.1.6 Potable Water

The main source of potable water is from groundwater stores (See Sect. 3). The main threat or primary impact in regards to this aspect of the proposed development is depletion and saline intrusion into the stores or aquifer (See Table 5.1). The secondary impacts associated with the rapid drawdown and depletion of groundwater stores includes subsidence of land, which may become prone to flooding and water-logging (See Table 5.1). The characterization of this impact for the proposed development is ‘Marginally Deleterious’ (See Table 5.1). This characterization has been determined on the basis of the assessed capacity of the groundwater stores (See Sect. 3) and the water conservation strategies that are to be employed by the project proponents.

5.3.1.7 Loss of Livelihood

The issues that have been unaddressed thus far in the ensuing monologue are the socio-economic aspects as well as the economic livelihood issue relating to traditional access (See Table 5.1): The contact between local and foreign cultures is also another pertinent consideration (See Table 5.1).

The socio-economic aspects relate to the decline in benthic vegetation from sedimentation and turbidity as well as the physical extraction of the seafloor associated with the dredging/excavation event (See Table 5.1). The secondary impact associated with the decrease in benthic vegetation is the decline in fish stocks and the attendant decrease in subsistence harvests (See Table 5.1). This is in effect a food chain issue with the benthic vegetation being the primary

producers and base of the food chain. The characterization of this impact is in the ‘negligible deleterious’ category (See Table 5.1). This is understandable given the limited geographic extent of the dredging and the facility for re-colonization by benthic biota which includes seagrasses and attached macro-algae.

The other impact related to the socio-economic impacts of the proposed project is the noise and boat traffic that could result in injury and displacement of manatees. Although there are no known nature-oriented tour guiding service based on manatee watching utilizing the area, this opportunity could be compromised if studied and responsible interventions are not put in place. The impacts in this regard has been characterized in the ‘marginally deleterious’ category (See Table 5.1). This is understandable given the varied mitigation measures that are to be put in place to safeguard manatees and consequently any economic opportunities that may be associated with the species.

The main concern in regards to the economic livelihood and culture issue is the potential for the erosion of access or exclusion of traditional users from the area. The area is accessed from both sea and land by subsistence fishers from the neighbouring communities. The characterization of this impact has been assessed as ‘Negligible Deleterious’ (See Table 5.1). This is because there will be no interruption in access of traditional users to the site. This is however contingent on maintaining the safety and security of the facilities. It is envisioned that this should not be a problem and the two (2) events can co-exist in perpetuity.

The contact between local and foreign cultures is an issue of concern as it relates to the EIA process. This is based on the fact that contact between tourists or foreign residents and local citizens with differing traditions, language, ethnicity, race, religion, social and economic status as well as value system can make for unplanned and unanticipated consequences. Most of the parties that are to be the clientele of the proposed development are ‘white’ or ‘near-white’ citizens from the United States, Europe and to a lesser extent Asia.

This issue has been characterized in the ‘negligible deleterious’ category (See Table 5.1). This comports well with the fact that most residents in the area has been exposed to the mores and cultures of citizens from the United States and other OECD destinations.

5.3.2 Social Impacts

The social impact assessment will cover both the social/economic and cultural impacts of the project. This assessment will also include the overall value and changes of the resources taking into account the future value of the natural resources by users and impacts of the proposed development on these areas; the general role of traditional users in response to both the fishery and tourism value, and future value of the fishery resource, as well as other impacts on increased usage of the area during the post-construction phase of the development (See Table 5.2).

Development Activities

large population and equipment movement and use during all phases of construction

- demand for services
- marine traffic increase
- transportation of materials

During all phases of construction increased boat and human activity to the region will increase. Increased traffic to and from the site will include worker populations, and transportation of equipment, supplies and materials to the site (not to include the already regular scheduled trips to the project site by the investors). Demand for services by worker populations will also increase during all phases of construction.

Current and Existing uses of the area

Potential or proposed Impacts

- disruption of traditional user activities
- regulated use of traditional activities
- access to the area by traditional users
- ability of users to adapt to changes
- increased use by other newcomer users

One of the major concerns indicated by stakeholders was proposed dredging activities in ‘traditional fishing grounds’ areas. Continued access and use of the area and views of the developers in respect to traditional uses is another main concern.

Economic & Cultural

Potential or Proposed Impacts

- impact on fishery resources
- decreased economic benefits by ‘traditional users of the area’
- Pressure on existing institutions and social groups
- Marginalization of minority groups and locals
- Pressure on existing lifestyles

Development activities of this nature, especially in areas of marine importance to fisher folk, do have impact to some degree. The major impact could see decreased economic benefits to those fishermen who utilize the fishing grounds and impact on the fishery resource.

Employment

One of the major concerns is the availability of jobs, mainly for skilled laborers to satisfy the project’s demand. Major impacts include the lack of adequate hospitality training as well as minimum wages for unskilled labor.

Transportation / Sea Traffic

Potential or proposed Impacts

Increase in number of vessels to the area and the region
Impact on natural environment by increased boat usage
Operation of construction and all machinery
Safety for traditional users

Emergency and Health Services

Potential or proposed Impacts

Increased pressure on health and sanitary facilities

Population and Housing

Potential or proposed Impacts

Increased population density in the area
Increased housing needs at site

The proposed development will experience a temporary increase in population (workers) during all phases of construction. The site can also support the proposed amount of temporary workers to be employed during all phases of construction.

Social Impacts of Note

The development is classified as a both “Residential” and a “Resort” for people from North America, Europe and Belize. The main **positive** concerns identified by those interviewed on the proposed development are:

- increased employment and job creation and the possibility for local residents to enter or expand their business, such as restaurants, hardware supplies, handicraft marketing at the boutiques or shops to be established in the resort;
- a general sentiment by community leaders is that they hope the developer does “the right thing” to seek a balance between “tourism-natural environment-fishing” by following the proper protocols and getting the required permits before starting construction;
- the availability of a new and nearby market for the farm products and marine products produced by the farmers and fishing cooperatives and the shrimp farms who will increase their income potential;
- increased income to the Town Council from property tax and vehicle licensing by the owners of the condos and residencies in the development;
- a general increase in business activity and revenue generation during the construction and post-construction phase of the development; and
- there is always a window of opportunity to negotiate to make the development a win-win situation for all.

Other indirect benefits may result for existing tourism businesses that will cater to an increased retiree population and who may also specialize in tourism-related catering and related service businesses to this new population. The main negative concerns identified, in no order of priority, are:

- the sedimentation from the dredging will “scare and chase” the important fishing species
- the main question on the dredging is where the source of fill material will come from since there is not much fill material;
- the cutting of mangroves resulting in lost breeding grounds (nursery habitat) and lack of protection from storms;
- cutting of mangroves will also remove the nesting areas for Spoon Bills, Ibis, etc;
- disposal of solid and sewerage waste will increase this already existing problem;
- the vision for this development is short term and there is no need to recreate what already exists in the USA and Cancun;
- employment of people from the town will be limited to lower positions while the senior management position will go to foreigners;
- an increase of immigrant population will stress further the school and health services; and
- the cultural impacts that may result from workers coming from other districts and are not sensitive to the local environment as it relates to water usage and sewage treatment.

The other potential negative impact on local and regional tourism sector is the competition with Belizeans of the area that may arise should the retirees become investors and compete with locals. One of the direct effects of such competition is the possible increase in the price of land.

5.3.3 Other Related Impacts

Other related impacts include the issue of ‘pathogenic disease’ relates to those associated with insect pests such as mosquitoes and roaches and nuisance pests such as botflies and sand flies. The development if allowed to proceed in an environmentally irresponsible way that would for example result in an increase in ‘standing water’ would provide a habitat of mosquitoes, which would increase the risk of malaria. The increased contact of tourists/residents/guests with certain activities increases the potential for insect-borne pathogenic diseases. The focus on handling solid wastes in a responsible way should leave no additional breeding habitat for mosquitoes.

The issue of ‘sand-flies and associated pests’ are relevant in the context of nuisance pests. They are generally discomfiting to humans in modest numbers and are intolerable to many when in abundance. The plying of tourists, residents and guests in unspoiled environments brings with it insect pests. The reclamation of the development areas in part would eliminate a number of inundated areas.

These reclamations in themselves eliminates breeding grounds for mosquitoes, however in many cases they provide additional habitats for doctor flies. In the case of the latter, a number of species breed in mangrove areas. Given that these pests could be in formidable numbers and given that if they are not managed in an environmentally sound way, this could also cause harm to the environment thereby requiring the need for some mitigative measures.

Table 5.2 Potential Social Impacts & Residual Impact Rating on Proposed Activities for Project Implementation

Activities and Conditions	Potential Impacts	Comments by Consultants	Residual Impacts, Magnitude/ Direction/Duration/Scope
Current and Proposed Land Use in Area	<ul style="list-style-type: none"> Location and size of development. 	Adequate control development proposals, especially during the construction phase, take into consideration future development activities being undertaken in the island.	High/ positive/high/local
Activities during Construction and Post Construction Phase Activities	<ul style="list-style-type: none"> Transportation of construction materials and equipment during all phases of development. Operation of construction machinery High population densities during construction and post construction Housing and sanitary facilities for construction workers at the development site. 	<ul style="list-style-type: none"> All vessels/vehicles transporting construction materials should be covered, and equipment secured to allow for safe transportation to the site; this should be monitored. Operators should be trained and involved in development plans. Workers should be trained in the safety procedures; operation of machinery and use of safety gear used. Adequate transportation, proper housing, and other basic facilities are available for workers in the island. 	<p>High/negative/years/ Central Coastal Zone (CCZ)</p> <p>High/positive/years/local</p> <p>High/positives/local/local</p> <p>High/positives/years/local</p>
Marine and Terrestrial Traffic	<ul style="list-style-type: none"> Increased number of sea vessels and vehicles 	<ul style="list-style-type: none"> Movement of workers, machinery/equipment and cargo, should be scheduled in advance. Marine traffic should also be regulated by routing marine vessels to designated “shipping lanes”. Management systems such as buoys, markers, and signs should be designated Materials transported should be properly covered and secured to prevent them falling into the sea. 	<p>High/negative/years/CCZ</p> <p>High/negative/years/CCZ</p> <p>High/negative/decades/CCZ</p> <p>High/negative/years/CCZ</p>
Worker Population & Housing	<ul style="list-style-type: none"> Increased population density in the area during construction and post construction phases 	<ul style="list-style-type: none"> Temporary quarters be constructed, if necessary Workers be transported to and from the site during all phases of construction 	<p>Low/ no change/years/local</p> <p>High/no change/decades/local</p>

Activities and Conditions	Potential Impacts	Comments by Consultants	Residual Impacts, Magnitude/Direction/Duration/Scope
Education & Health Services	<ul style="list-style-type: none"> Increased pressure on existing educational and health institutions. 	<ul style="list-style-type: none"> Local education and health facilities should be strengthened and coordinated. 	High/positive/decades/district
Employment	<ul style="list-style-type: none"> Skilled laborers from the immediate area not employed during construction and post construction phase. Skills training may be required for some local employees. 	<ul style="list-style-type: none"> Employment of individuals from Corozal Town and other parts of the country encouraged and will strengthen local/regional skills and will include the potential for long-term employment Laborers should also be paid as per skill requirement (s) The Belize labor laws should also be observed. This skills training will be required especially in the post construction phase. 	<p>High/positive/decades/local</p> <p>High/positive/decades/district</p> <p>High/positive/decades/district</p> <p>High/positive/years/local</p>

5.4 Conclusion

The analyses of the environmental impacts are an important tool in determining the appropriate mitigation measures to be employed. Identifying the related impacts is an exhaustive process that always has to be updated. In considering the anticipated development, the impacts are not that different from any other private residential subdivision development involving dredging and land reclamation activities.

What sets the projects apart is the size and magnitude of the anticipated development. The most important impact for the proposed development is the dredging activities and its associated effects on the rest of the development as well as the operation of the golf course. The other impact of note is the social aspect of the development. It is anticipated that the potential impacts of the development will not have any detrimental effect on the receiving environment, especially to Corozal Bay Wildlife Sanctuary.