Summary Environmental Impact Assessment for the Baker's Bay Club, Great Guana Cay, Abaco

Prepared for

Bahamas Environment, Science and Technology Commission,
Government of The Bahamas,
Nassau

By

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Coral Gables, Florida
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WHAT IS THE BAKER’S BAY EIA?

An Environmental Impact Assessment considers the potential effects of land use change, so that development decisions can be taken with full knowledge of the likely environmental consequences.

The Bahamas Environment, Science & Technology Commission is the government agency that reviews EIA’s submitted by private developers. The BEST Commission is part of the Ministry of Health and advises the government on all environmental matters.

The EIA process parallels the overall development planning and implementation process to minimize environmental damage. Research is funded by the developer but conducted by independent experts pre-approved by the BEST Commission.

The Commission can direct changes to the development planning to take account of environmental concerns. Consultation and public participation are integral to the process.

The Baker's Bay EIA was supervised by Dr Kathleen Sullivan Sealey, a marine biology professor at the University of Miami. The developers contracted the university to conduct the assessment.

Working with Dr Sealey were doctoral students Nicolle Cushion (the project´s environmental manager and coordinator); Kate Sermon and Cloe Waterfield (project biologists), and Keith Bradley, a botanist from the Institute for Regional Conservation.

The environmental impacts of the Baker’s Bay project were assessed in a three-part document structured according to guidelines provided by the BEST Commission.

Part 1 covers the resort itself, including site information, general environmental impacts, mitigation recommendations and monitoring. Part 2 addresses the marina development. Part 3 deals with supplemental information on housing. All three parts have shared appendices of supporting material.

This document is a condensed version of the original EIA approved in June, 2005.

INTRODUCTION

In 2003, the Discovery Land Company of California proposed construction of a 585-acre low-density residential resort community on Great Guana Cay in the Abacos.

The design philosophy was to use the best available technologies and practices to build a development called the Baker's Bay Club that would be environmentally and architecturally compatible with the surrounding landscape and seascape.

Great Guana Cay has already undergone extensive private and commercial development over the years. There are two existing marinas, some 49 private docks and three second home developments. Long-term sustainability of the 1100-acre island depends on minimal clearing of native vegetation, preservation of coastal setbacks and strict pollution control.

The Baker's Bay Club will include up to 450 residential units, an 18-hole golf course, 180-slip marina, 100 villa-style hotel rooms, a beach club and commercial centre, as well as employee housing and central services.

About 70 per cent of the project's land area will remain as open space. This will include a nature preserve, the golf course, coastal setbacks and native vegetation corridors between homes. Only 17 per cent of the land will be used for housing. The overall project density, including both employees and residents, is 1.67 per acre.

The project will feature modern infrastructure and utility systems designed for a small island ecosystem. The developers will provide island-wide logistical support for solid waste processing as well as common community facilities and public beach access.

A central sewerage treatment plant will address the long-term pollution problems posed by individual septic tanks and provide water for irrigation. Housing guidelines will minimize lawn size and promote the use of well-adapted native plants. A state-of-the-art solid waste facility will recycle and compost as much material as possible.

The golf course will be designed around and within the natural landscape to retain native plants, conserve fresh water resources and control chemical use. The course will slope inland to prevent nutrient runoff into the sea and will be irrigated with recycled water circulated through lined ponds.

The marina and its entrance channel were carefully chosen both to minimize impacts and to create a natural look and feel. The area selected for the marina basin was formerly an open lagoon. Sediment curtains will be used during all dredging activities.

ENVIRONMENTAL MITIGATION

The Baker’s Bay site has already been seriously impacted by previous development of a shore facility and approach channel for cruise ships. The developers have committed to a remediation programme for this area at a cost of over $1 million. This will include the removal of hazardous waste, trash, abandoned equipment, derelict buildings and invasive vegetation, as well as the restoration of beach dunes and wetlands.

The shore facility catered to thousands of passengers a week between 1989 and 1993, after which it was simply abandoned. It included dolphin pens, a 500-seat ampitheatre, canteens, walkways, restrooms, shops, jetties and other infrastructure spread over 90 acres. Cruise ships accessed the shore facility via a 45-foot deep, three-mile channel into Baker’s Bay with a 3000-foot turning basin.

The jetty that was originally built for water taxis will be used temporarily as a logistics dock by the Baker's Bay developers, and will then be removed. The natural beach dunes will be restored and native vegetation will replace the invasive casuarinas, which contribute to coastal erosion.

This previous development introduced invasive plants and insects that now threaten the natural flora and fauna of the island. Immediate landscape management and coastal stewardship is needed to prevent further degradation.

Australian pine and Hawaiian beach cabbage (Scaevola sericea) are prevalent in the impacted areas. Both of these species are on the BEST Commission's list of invasive alien plants to remove and eradicate from coastal landscaping.

Beach dunes will be restored with native species. The non-native insect pests present on the island are likely to have been imported with exotic plants. So the developers will be replanting from a locally cultivated nursery. Rare and protected plants will be rescued from areas of development and stored at the nursery for later replanting.

In addition to removing trash and debris from inshore waters, the developers are also transplanting corals to artificial patch reefs to replace those that were smothered by the cruise ship dredging. The artificial reefs will be used as an environmental education snorkeling trail.

ENVIRONMENTAL MANAGEMENT

The overall environmental goals of the Baker´s Bay Club are:

1. To maintain 80 per cent of the island´s native vegetation.
2. To maintain onshore and near shore water quality at pre-construction levels.
3. To enhance wildlife habitat in protected areas.
4. To promote coastal stability.

To achieve these goals, the developers will implement a monitoring programme through the Great Guana Cay Foundation – a non-profit partnership between the developers, the University of Miami and community interests.

A complete ecological assessment of the property was undertaken prior to development, to establish measurable goals and develop scorecards. This will help both developers and scientists to understand the environmental "break points" of small island development.

The monitoring team includes Dr Livingstone Marshall, senior vice president of environmental and community affairs for Baker's Bay; an environmental manager overseeeing day-to-day affairs; a local nursery and landscaping expert; a Phd-led group of five researchers from the University of Miami; and an internationally recognized plant expert from the Institute for Regional Conservation.

This team is establishing an innovative model for post-EIA monitoring and management in The Bahamas. Regular reports will be submitted to the BEST Commission comparing field research to pre-development data and offering solutions to any problems that may arise. The island's heritage preserve - as well as other special conservation areas - will be closely monitored.

A critical component of this programme is incident reporting of unplanned negative impacts to the environment that may potentially violate EIA guidelines. The reporting system formalizes a continuous dialogue between the developers and the scientific team to ensure that environmental standards are upheld.

The monitoring programme outlines four components that set a model for private land stewardship in the country, with technologies and protocols appropriate for use in national parks and publicly held lands:

1. Measurable environmental goals.
2. Educational outreach and training
3. Clear management and project communications.
4. Independent reporting and verification.

CHAPTER 1: PROJECT OVERVIEW

Site Description

The Baker's Bay property consists of 585 acres at the northern end of Great Guana Cay in the Abacos, about 10 miles north of Marsh Harbour.

Site elevations range from two to 60 feet above mean sea level, with most of the site in the 10 to 20 foot range. The property runs for 2.25 miles along its southeast to northwest axis and varies in width from 0.125 to 0.75 miles in a southwest to northeast direction. The property extends from its southeastern boundary east of Little Joe's Point to the northwest shoreline of Great Guana Cay.

There are four small islands to the north of Great Guana Cay. The largest – Gumelemi Cay is eight acres in size with an elevation of about 16 feet. The other smaller cays are mostly rocky outcroppings. All these islands are part of the development property. The spoil island produced by dredging of the cruise ship channel is not part of the property.

Project Description

The Baker's Bay resort community will be developed over six to 10 years and will have a market value of some $500 million at full build-out. The construction phase will provide 500 full-time jobs and the final resort operation will employ about 150 people. The development will also generate ancillary jobs and spin-off business for other communities in Abaco.

Major amenities will include a Tom Fazio golf course, a private180-slip marina and sea plane ramp, secure moorings for large yachts, a private resort club, a commercial centre, villa-style hotel, restaurants, pool, spa and fitness facilities, tennis and volleyball courts, as well as water sport operations.

All of these facilities have been carefully designed and scaled to fit comfortably within the natural environment of Great Guana Cay. They are served by a central sewerage and solid waste system, as well as a water purification and recycling plant. These facilities will be available to the entire island.

The commercial centre will be open to all residents of Guana Cay and will include a general store and post office, medical clinic and fire/police station. A heritage preserve adjacent to the beach will be set aside as a public park.

Some 450 homesites will be marketed to North Americans and Europeans. They will include beachfronjt lots with protected dunes, rocky shore lots with protected areas, marina lots, and interior or golf course lots.

Land Use

Private land	452 acres
Crown land	105.5 acres
Treasury land	43.9 acres
Total	585 (these numbers don't tally)

Heritage preserve	89 acres
Mangrove mediation	16 acres
Buffer zones/coastal setbacks	53 acres
Marina basin and waterways	33 acres
Services area	27 acres
Gumelemi Cay	8 acres
Golf course	205 acres
Open space	428 acres
Residential/commercial land	105.5 acres

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Development Philosophy

This project will be unlike any other development in the Bahamas. The design will preserve natural vistas and viewscapes. The shoreline will retain its natural "uninhabited" appearance due to coastal setbacks and the absence of private docks. Housing will not be obvious and shaded paths and boardwalks in the coastal zone will protect wildlife habitat and maintain coastal stability. Beach access steps will be provided every 200 feet.

The development's open space will allow residents to appreciate the island's natural vegetation and ecosystems. The coastal coppice and wetlands will be incorporated into the development and golf course design. Landscaping will rely heavily on native plants and seed stock, with an aggressive programme to protect and re-locate the slow-growing hardwood trees.

In many Bahamian developments, homes are built too close to the shorelines and rely on poorly adapted imported plants. Lack of knowledge and appreciation of the natural environment leads to a sameness in the look of most Bahamian resorts. The Baker's Bay developers seek to achieve a uniquely Bahamian project, and fully recognise the vulnerability of island ecosystems.

The main development threats to small island environments stem from:

1. Chronic eutrophication leading to a loss of biodiversity and habitat.

2. Loss of critical wildlife habitats due to land clearing.
3. Increased sediment run-off and erosion due to land clearing.

These threats can be reduced by appropriate site design and construction techniques, such as creation of a coastal buffer zone, management of solid waste and pollution control. The Baker's Bay developers are committed to the following:

1. Construction of a resort community with the highest level of environmental protection for long-term sustainability of the island's natural systems, particularly the coastal zone.
2. A process of documentation and learning to improve industry-wide knowledge of compatible development practices for small islands, including educational outreach.
3. Exploration of options and innovations to minimize acute impacts during construction phases.
4. Co-operation with the government in an active environmental monitoring programme through regular progress reports, external reviews and site inspections.

Figure 1.3: Satellite image of Great Guana Cay

CHAPTER 2: EXISTING CONDITIONS AND IMPACTS

General Background

Five hundred years ago, Great Guana Cay existed in an ecologically intact state. The island would have had more wildlife, notably monk seals and sea turtles using the beaches. Sea grass beds would have been dominated by large queen conch, and the reefs would have teemed with fish and lobster, all performing important ecological functions of cycling nutrients in an oligotrophic (or nutrient-poor) tropical system.

The arrival of humans began a cascade of ecological changes, with damage being less conspicuous up to the last quarter century because of low population densities and limited resources.

Northern Guana Cay has had a history of both agriculture and development, and has been altered by both the direct impacts of land use and the indirect impacts of hunting, collecting, harvesting, fishing and foot .

Until its purchase by Bakers Bay Ltd, the site had an absentee owner, with no stewardship of the island's natural resources. This would have led to continued degradation of the island's ecological systems and loss of biodiversity from the impacts of past development and unregulated use by residents and yachtsmen.

The following chronic active impacts occur on the island now, with no stewardship:

1. Trash and debris accumulate on the beaches and pose a threat to wildlife.
2. Yachts anchor in sea grass beds and on the reefs with no mooring buoys, which can cause long term damage.
3. Unregulated collection of land crabs from the property occurs with use of bleach.
4. Hunting of pigeons.
5. Removal of orchids, beach lilies and other rare native plants.
6. Unplanned trails and paths promote erosion of the dune system.
7. Vandalizing of abandoned facilities disperses hazardous waste and leads to ground water contamination.

The following chronic passive impacts occur on the island now, with no stewardship:

1. Continued colonization and spread of invasive plant and insect species.
2. Continued beach erosion.
3. Continued contamination from abandoned storage tanks, dumps and septic tanks.

Toxin Dispersal

When it closed, the cruise ship shore facility left hazardous materials and structures which are now dilapidated and a cause for concern. A site assessment by QORE, Inc identified the following conditions:

1. Above ground fuel storage tanks, one without concrete containment.
2. Generator room with concrete floor stained with oil and diesel.
3. Abandoned 55-gallon fuel drums.
4. Pad-mounted electrical transformer.
5. Dilapidated buildings and structures built with arsenic-treated wood.
6. Reef degradation due to channel dredging and a former dolphin enclosure.

Soil analysis found Total Recoverable Petroleum Hydrocarbons around the transformers at levels above those permitted by the State of Florida. The US Environmental Protection Agency notes that “Even a small spill (from a storage tank) can have a serious impact”. Soil excavation is recommended to avoid leaching into ground water and the sea.

Oil seepage into the ground near the generator room was detected. The contents of the drums are unknown, but they are heavily rusted. The degradation of the near shore ecosystem and reefs from the dolphin pen is evident from the conspicuous absence of corals and sea grass in this area. If left without mitigation, these areas will further degrade.

Invasive Species Dispersal

In the absence of environmental management, invasive species will continue to spread on Great Guana Cay. The island is currently suffering adverse impacts from introduced plants, vertebrates, and insects.

A study by the Institute for Regional Conservation reported that plant pests are now well established in disturbed areas of the island, particularly around the cruise ship facility, which is a huge seed source for Australian pine (*Casuarina equisetifolia*) and beach cabbage (*Scaevola sericea*).

Other exotic plants established here include Bermuda grass (*Cynodon dactylon*), Queensland umbrella tree (*Schefflera actinophylla*), jumbie (*Leucaena leucocephala*), and Portia tree (*Thespesia populnea*).

Each of these plants has been expanding following the abandonment of the shore facility. Many have already begun to invade undisturbed habitats. This will continue, aided by natural disturbances such as hurricanes, and will decrease biodiversity and degrade habitat quality.

While these species are currently restricted to areas where they can be easily controlled, if left unmanaged the difficulty and expense of their removal will become prohibitive.

Introduced rat species (*Rattus norvegicus* and *N. rattus*) have been shown to have adverse impacts on island ecosystems by depleting populations of birds, reptiles, and terrestrial invertebrates.

Rats can have also have ecosystem-wide effects on the distribution and abundance of native plant species. For example, *R. norvegicus*, has been shown to restrict the regeneration of many plant species by eating seeds and seedlings.

On Great Guana Cay, there is extensive evidence of *R. norvegicus* feeding on native orchid species. In many cases large plants were seen with almost all of their pseudobulbs consumed. This will lead to the decline of orchid species on the island.

Trespassing, Trash and Poaching

The Baker's Bay site is a heavily visited area for boaters and picnickers. Site inspections have noted considerable accumulations of trash around the property.

Poaching of rare plant species is a common. In the absence of protection many endangered species will continue to be poached, including four native orchid species and the large Bahama tree cactus (Cephalocereus bahamensis).

CHAPTER 3: ALTERNATIVE CONSIDERATIONS

Other islands in the Abacos that are large enough to provide the physical environment needed for such a development (e.g. Green Turtle Cay) do not have available land for sale. The development was built around the availability of the privately-owned Baker's Bay property.

Marina and Entrance Channel

The marina and its entrance channel are critical components of the development, as no individual private docks or other shoreline structures will be allowed. The following criteria were considered in the selection of sites for the marina:

1. Adequate space to accommodate homeowner boats (about 180 slips).
2. Adequate space for the associated infrastructure around the marina.
3. Safe harbour conditions during prevailing winds and storm events.
4. Minimal impact on terrestrial or wetland biological diversity or habitat.
5. Stable shoreline morphology for marine entrance.
6. Natural topography for vistas and scenic views of the marina area.
7. Natural feel of marina integrated into mangrove wetlands of property.
8. Stable coastal morphology with predictable sand movement to minimize dredging.
9. Economical feasibility in depth and hardness of dredged substrate.
10. Usability of fill substrate for other project components.

Initial site selection placed the entrance of the marina through the wetland known as Joe's Creek. The benefits of this design were minimal dredging to reach deep water and a stable rocky shore at the mouth of the marina. However, the desire to incorporate a nature preserve within the development led to consideration of other sites for the marina.

In addition to the marina itself, a mooring basin will feature several single-point moorings to accommodate mega-yachts.

Prior to beginning work on the marina, erosion and turbidity control measures will be implemented. During excavation the top layer of organic soil will be removed and stockpiled for later use on the golf course.

The construction team will attempt to excavate the basin in the dry and will adjust construction methods if dewatering is impractical. It is estimated that there will be 2,200 linear feet of bulkhead along the marina and 5,700 linear feet of bulkhead around the islands in the marina basin.

Housing and Lot Locations

The residential site plan for the development is designed to take the best advantage of ocean views while maintaining natural corridors along the oceanfront to allow residents access to the ocean.

Marketing considerations place a premium on coastal lots and the placement of these lots is a function of the type of coastal environment present combined with the available upland for development.

Criteria for the design and configuration of the housing lots are:

1. Lots should have sufficient room for appropriate coastal setbacks.
2. Lots should conserve the natural beauty of the island, particularly outstanding trees and clusters of plant species of special interest.
3. Lots should be designed for privacy from adjacent lots.
4. Lots should feature ease of access and prudent road placement.

Temporary Marketing Facility

During the initial construction, a temporary marketing facility will be built that will eventually be converted into a clubhouse and associated amenities. Temporary housing for marketing staff will also be provided during this period.

Construction workers will be ferried from Treasure Cay daily, directly to the construction site, by chartered ferry. Eventually, on-site housing will be provided for up to 80 workers.

Septic tanks will be installed initially and replaced with composting toilets within six months. Additionally, an artificial wetland will be developed for treating wastewater. Solid waste will be composted and recycled wherever possible.

Air curtain destructors like those used by the US Forest Service will be used when disposing of slash, wood, and other burnable waste. These devices are recommended in place of usual methods of debris disposal.

CHAPTER 4: BASELINE ENVIRONMENTAL DESCRIPTION

Geology and Topography

The Abacos are a large and complex island group that includes a considerable number of cays along the eastern shore. Abaco occupies most of the eastern half of the Little Bahama Bank, extending in an arc for some 115 miles (185 kilometers).

The outer cays extend for about the same distance but start and end some 35 miles (56 kilometers) further north, and generally follow a straight NW-SE line as far south as Elbow Cay. Abaco is the second largest Bahamian island. For the most part it is at least five miles (eight kilometers) wide, but is broken up into smaller units at intervals by isthmuses such as Crossing Rocks in the south. Just north of Coopers Town there is a complete separation into Great Abaco and Little Abaco Islands.

Great Abaco's relief is dominated by a complex ridge running along the eastern side of the island and reaching heights of 120 feet (37 meters). Little Abaco lacks this ridge and is much flatter. Inland is largely flat rock land 5-15 feet (1.5 to 5 meters) above sea level, occasionally relieved by old beach ridges reaching 30-40 feet (9 to 12 meters). The western shore is extensive wetland with mangroves eventually grading into wide tidal flats and an area of numerous small cays known as the Marls.

The topography of the offshore cays like Great Guana is similar, if smaller in scale. The exposed eastern coast of the cay is protected to some extent by an offshore reef tract, but coasts are high energy, receiving the full force of winter storms and hurricanes from the north Atlantic.

Great Guana Cay is a series of dune ridges and swales with some consolidated rocky shores and cliffs - part of the remnants of a twin dune-ridge reaching 40 to 60 feet (12 to 18 meters) on most islands. None of Abaco's offshore islands are more than half a mile wide (0.8 kilometers), but some can be quite long, notably Great Guana itself, which extends for some six miles (9.6 kilometers) (Figure 4.2).

As is typical of small offshore cays in the Abacos, Great Guana features poor soil development with predominantly sandy substrates. The Baker's Bay property represents the largest intact tract of broad-evergreen coppice remaining in northern Abaco, but is already degraded from previous uses and invasive alien species of plants and insects.

FIGURE 4.2: Topographic map of Great Guana Cay, showing elevation contours in 2-foot (0.6 meter) intervals.

Climate

The northerly location of Abaco and its large size combine to give it one of the heaviest rainfalls in the Bahamas, along with a fairly pronounced winter season. Rainfall averages about 60 inches (1.54 meters) a year, and winter temperatures are cool, but do not reach the minimums of Grand Bahama and North Andros which are closer to the landmass of North America.

The Atlantic Ocean exposure ensures that the NE Trade Winds are predominant throughout the year, but makes the island vulnerable to hurricanes heading northwards along the edge of the archipelago. Hurricane Floyd in 1999 did considerable damage to the outlying cays. Storm tracks like Hurricane Floyd represent a significant threat to property development on the smaller islands.

The level of rainfall has supported extensive growth of Caribbean pine, which covers the main island except where it has been clear-felled. Pine rock lands cover most of the area south and west of Marsh Harbour - some 20,000 acres (8,000 hectares). Coppice, or broadleaf evergreen forest, dominates the offshore islands and cays. Rain can be highly variable from year to year, so vegetation on the offshore cays is drought resistant.

Small islands throughout The Bahamas have been historically limited for development because of scarce fresh water resources and the inter-annual variability of rainfall. Landscaping practices must accommodate these natural climate extremes.

Storms can cause severe property damage, and even the abandonment of island developments. A sound property protection and hurricane preparation plan is essential for the long-term viability of such developments. Storm preparation must include the protection of a coastal buffer zone and shoreline stabilization through natural landforms.

In any given year, there is a 50 per cent chance of a hurricane hitting the northern Bahamas. Even if a storm does not directly impact Great Guana Cay, travel for residents, delivery of supplies and even rainfall patterns can be affected. Site design and construction must address storm energy and rainfall stresses to minimize property and shoreline damage.

Hydrology and Flooding

The threat of flooding on small islands comes from two sources: large storm surge events, and rapid accumulation of rainfall in low-lying areas that exceeds drainage capacity. Flooding is evident in natural environments by the presence of seasonal wetlands.

The lowest lying area of Great Guana Cay is associated with mangrove creek and wetland areas at the southern end of the Baker's Bay property. There is a coastal ridge along the Atlantic side of the property, but this ridge is at its lowest point at the narrow isthmus just north and east of the large wetland areas. Trails and breeches in this dune system have increased the potential for flooding and over-wash events.

Air Quality and Noise Pollution

Air quality and emissions are addressed in The Bahamas by the Environmental Health Services Act of 1987. The government must provide a certificate of approval for discharges of any contaminant or pollutant into any part of the environment.

There are no evident air or noise pollution issues associated with the Baker's Bay development at this time. Air and noise pollution issues will be temporary during the construction phase of this project.

Ecology

The coastal zone dominates small island ecology. It includes dunes, beaches, rocks, low cliffs, wetlands, bays and coves, and refers to both the marine and terrestrial habitats that occur near the shoreline.

Because of the effects of currents, waves, tidal changes, storms, and hurricanes, the coastal zone is a dynamic environment. It includes many diverse and interconnected ecosystems and communities, so that any impact on one can directly affect all others that are connected to it through the life histories of species that travel between them.

The coastal zone provides critical habitats and resources for many species, such as sea birds, sea turtles, and marine mammals. Additionally, coastal zones provide people with benefits such as hurricane buffer zones, tourist attractions, educational opportunities, and living resources.

For this discussion, the coastline of the Baker's Bay site is divided into five types of environment. Each needs a defined boundary and management plan to function as part of the larger ecological landscape, and to provide protection to the constructed property of the development.

As the water level of a coastal zone area is constantly changing so that an intertidal area can be an aquatic environment at one moment and a terrestrial environment at the next, these areas deserve a specialized classification system, and can be characterized by sediment type and wave energy:

Sediment Type
•Soft, unconsolidated sand or mud, found on beaches and mangrove communities
•Consolidated carbonate sediments, found on rocky shores

Wave Energy
•High, medium and low energy shorelines

Generally, higher wave energy corresponds with a wider beach, since the magnitude of the waves determines how far sand can be transported up the shore. Each type of shoreline has associated subtidal, intertidal and terrestrial components.

Sediment type determines what kind of plants grow adjacent to the shore to form and stabilize the coastal zone. The different combinations of sediment type and wave energy create a variety of environments that react differently to erosional and depositional processes, with some of the environments better suited for human habitation and development.

Coastal Environments on Great Guana Cay

Beach Strand Communities
High relief beach strands slope to herb-shrub lands, then to broadleaf forest or shrub thickets. An element common to beaches is the sand dune. Salt-tolerant plants, including railroad vine, sea purslane, stunted sea grape, and the exotic casuarinas, inhabit the coastal dunes that build up behind a beach.

The dune vegetation plays an important role in fixing the soft sand sediments and preventing the spread of sandy sediments inland. The dunes themselves store fresh water and provide a natural sea wall against storms.

High energy beaches produce higher dunes. Beach rock is exposed beneath, shoreward, and seaward of modern beach sands, and exists in tabular, laminated beds that dip gently seaward. Laminations are defined by slight variations in grain size between fine and medium sand.

Low energy beaches occur along more protected coasts (such as Sea of Abaco shorelines), and can transition to coastal wetlands, and mangrove communities. Low relief beaches occur on Great Guana Cay in two forms:

•beach to lowland subtropical evergreen forest/woodland/shrub land transition
•beach to palm-dominated lowland subtropical evergreen shrub and transition

As with high-energy beaches, dunes and beach rock also occur.

Wetland Communities
Although their specific structural and functional characteristics may vary greatly, mangroves are generally found in areas sheltered from high-energy waves. There are two types of coastal mangrove areas on the island:

1. Overwash and creek systems have high water flow and nutrient input, and low interstitial salinity. These areas have the highest degree of structural development.

2. Fringing systems have high salinity levels and lower nutrient input. They are flooded by most tides and often backed by hypersaline lagoons or salt flats.

Inland basin mangrove forests are also present on Great Guana Cay. They have developed over areas influenced by seawater and occupy the highest levels subject to tidal intrusion. Tidal flushing is less frequent, or may only occur with storms.

Mangrove communities serve many useful purposes, including removal of excess nutrients and heavy metals from runoff, acting as storm buffers, providing nurseries for fish, sanctuaries for birds and bees, and homes for orchids and bromeliads.

Rocky Shore Communities
These are the most common coastal type on Great Guana Cay. The eastern high-energy rocky shores (with consolidated sediments) can feature cliffs or a broad spray zone with sparse vegetation. They are characterized by an abrupt transition from a microphyllous evergreen shrub land to a lowland subtropical evergreen forest/woodland/shrub land.

Low energy rocky shores demonstrate a wide, long transition from a microphyllous evergreen shrub land to a lowland subtropical evergreen forest/woodland/shrub land. Both shores have a clearly visible tidal zonation of white, grey, black, and yellow zones, which provide the habitat for intertidal snails, mussels, and crabs.

The island has only two low-impact coastal segments. There are significant areas of the fore dune dominated by Australian pine, with areas of recent seed introduction from storms. Also in the area of the cruise ship facility, dunes have been removed or flattened. This coastal zone needs remediation and restoration in some areas to maintain the shore profile and native plant communities.

FIGURE 4.7: A. List of four major anthropogenic impacts on coastal zone and ranking system used to assess the current coastal environmental of Great Guana Cay and B. Criteria for scoring the condition of coastal zones to identify areas for remediation.

A

FOUR WAYS THAT HUMANS ALTER COASTAL ENVIRONMENTS

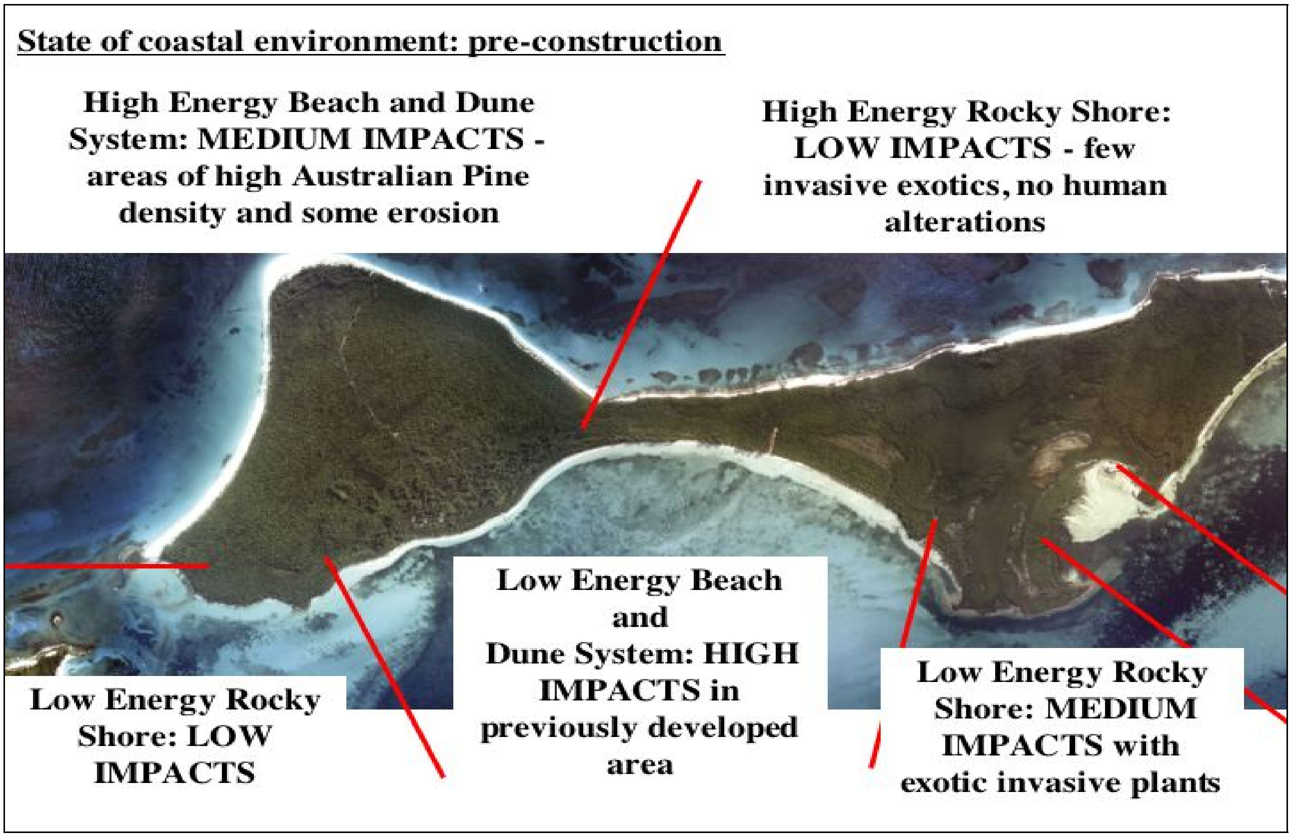
1. **Physical restructuring** the shoreline = Dredge and Fill development
2. **Destructive use and vegetation loss** = sand mining, dump sites
3. **Landcover change and vegetation replacement =** houses and resorts
4. **Introduce exotic species** = C *Casuarina* and *Scaevola sericea*

B

SCORING HUMAN IMPACT

1 = Physical restructuring the shoreline = Dredge and Fill development	*2 = Destructive use and vegetation loss = sand mining, dump sites*	*3 = Coastal development and vegetation replacement = houses and resorts*	*4 = Volunteer exotic invasions = Causarina spp. and Scaevola sericea*
NONE, MODERATE, SEVERE	NONE, MODERATE, SEVERE	NONE = no strucutres w/I 500 m, MODERATE some roads, structures, SEVERE = most landcover is human	NONE less than 10% coverage, MODERATE = 10 - 70% coverage, SEVERE = >70%

Figure 4.8: Condition of the coastal zone on Great Guana Cay: Low impact areas ranked “none” on all four scoring criteria, with less than 10% invasive plants. Medium impact areas have no physical restructuring or development, but medium to severe invasive plants. High impact areas have physical restructuring, development and high invasive plant coverage. These areas require reconstruction of coastal profiles and replanting.



Vegetation Communities
A simplified vegetation classification is used to illustrate the major vegetation classes on the island, where the development impacts will occur.

DESIGNATION	DESCRIPTION
COPPICE	Coppice, (Broad-leaved Evergreen Communities) in the Bahamas, are areas that contain the highest plant diversity of any natural community. Coppices are usually found well back from the shoreline, behind coastal dune and/or coastal shrubland communities. These areas contain a mixed humic soil-leaf-litter layer. At the Site, the substrate in these areas primarily consists of sandy substrate, but Broad-leaved Evergreen Communities often may have a rocky limestone substrate with scattered solution holes.
COASTAL MANGROVES	Mangroves are characteristics of low- energy, soft-sediment coastal environments. Coastal mangroves on this property vary in their specific structural and functional characteristics. All mangroves are generally found in areas sheltered from high-energy waves. Coastal mangrove areas can be divided into three subclasses based upon their hydrology and geomorphology: • Overwash and Creek Systems: Water flow and nutrient input is high and interstitial salinities are variable with evaporation and rainfall, which mean that these areas have the highest degree of structural development • Fringe: Fringe mangroves occur along the seaward edges of protected shorelines or around overwash islands Fringe areas are characterized by salinity levels similar to seawater and lower nutrient input.

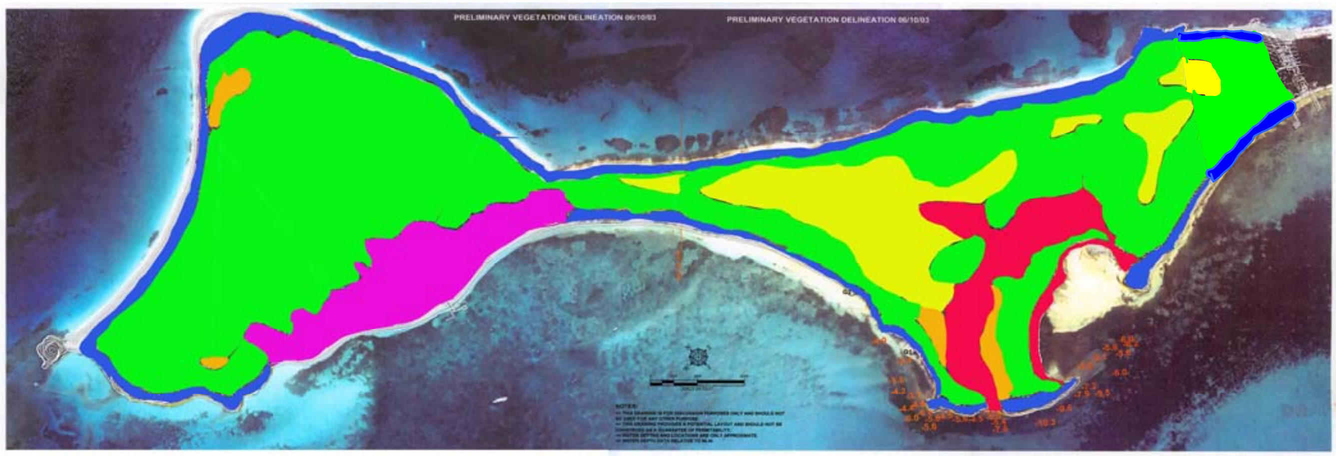
INTERIOR MANGROVES/ SHRUB THICKET WETLANDS	Isolated and inland Basin mangrove wetlands develop over inland basins influenced by seawater and occupy the highest levels subject to tidal intrusion. Tidal flushing is less frequent than in fringes or overwash creek systems, and is sometimes limited to the highest tides of the year or during storms. Interior mangroves are a type of wetland.
CASUARINA FOREST/ HUMAN ALTERED LANDSCAPE	The primary human-influenced and disturbed areas on the property now are dominated by invasive Australian pines trees forming a dense forest. These areas represent a loss of habitat for native plants and animals. Two of the four most invasive and problematic plants species in the Bahamas are Casuarina (Casuarina equisetifolia) and Hawaiian Seagrape or Half-flower (Scaveola sericea).
COASTAL STRAND	Coastal Strand Communities consist of vegetation on sandy or rocky substrate with direct exposure to coastal wind and wave energies. These communities include the pioneer zone, foredune, backdune, and associated coastal wetlands and interdunal communities.
GRASSY EPHEMERAL WETLANDS	Wetlands include areas of saline or saturated soils, and are dominated by salt-tolerant grasses and herbs. These are very small features on the landscape, measuring meters in diameter. These wetland features are included as a subset of the Coastal Strand community, particularly the grassy wetland behind the dune system along the northern beach of the property.

Although the flora of The Bahamas contains few endemic species, upland and wetland plant diversity is a critical issue for all islands. The introduction of invasive alien plants as well as the alterations to island hydrology have dramatically reduced plant diversity throughout the Bahamas. There are few studies of plant community ecology, and it is not clear what the long-term impact of fragmentation will have on broadleaf formations in particular.

But based on studies in the Florida Keys, there are three categories of native plants of concern. There is already a well-established list of invasive plants that need to be managed in The Bahamas prepared for the BEST Commission. This list will be use as a guide for plants to be eradicated from the project site.

Native plants of concern can be grouped into three categories:

1. **Critical species** - plants that are naturally rare, or occur in specific ecotomes, that may require specific habitat conservation measures. These include orchids and bromeliads.
2. **Threatened species** - trees protected by law that need to be managed on the site. This list includes mahogany and narrow-leaf blolly.
3. **Indicator species** - plants that may be indicative of healthy habitats and useful for monitoring purposes. Indicator species are identified in the plant diversity conservation plan for the property.



Vegetation Community	*Color*	*Total Area in Acres*	*Total Area in Hectares*
Broadleaf Evergreen Formations	*Green*	***371.2***	***148.5***
Coastal Strand	*Blue*	***17.5***	***7.0***
Wetlands	*Orange*	***16.7***	***6.7***
Coastal Mangroves and Creeks	*Red*	**75.9**	***30.4***
Inland mangrove-dominated wetlands	*Yellow*	***42.1***	***16.9***
Casuarina-dominated human altered areas	*Pink*	***75.2***	***30.1***

Common Terrestrial Fauna

Land crabs and Invertebrates

Land crabs and other invertebrates play an important ecological role. The three species of crab on the island are critical foragers on the coppice floor, recycling plant and animal matter.

The Hermit crab lives near the water, only returning to the sea to lay eggs. The Black crab is numerous in the broadleaf evergreen coppice areas, with thousands of individuals per hectare. The less numerous White crab lives within 5 km of the ocean and is the preferred species for harvesting.

Land crabs require high quality habitat, and clean ground water. Since they spend much of their time in burrows, any contaminants (especially pesticides) can have devastating impacts. There is a conspicuous absence of crabs in the area of the former cruise ship facility.

These crabs hibernate in burrows during the winter and breed in the summer, feeding on buttonwood, tallyberries, sea grapes, mangroves, coco plums and other fruits and leaves. They also feed on carrion when available, which can include dead dogs and excreta, so traditionally Bahamians do not eat crabs caught within the boundaries of a settlement.

The biology and habitat requirements for land crabs are not fully understood. However, based on anecdotal information, the White crab is probably in decline throughout the country due to habitat loss, harvesting pressure, and pollution.

Crabs have been indiscriminately harvested on the Baker's Bay site for years, but their important ecological role means that this should be controlled and replenishment zones established. Land crabs act as critical indicators of environmental.

Resident and Migratory Birds
All vegetation communities on the island contain plant species that provide food or habitat for birds. Bird life on the island will benefit from an upland plant conservation plan, and the maintenance of corridors of native vegetation throughout the island.

Reptiles and Amphibians
Reptiles (snakes and lizards) and amphibians (frogs) within the Bahamas are largely endemic species or subspecies. All native reptiles and amphibians are at risk from loss of habitat or competition/predation from introduced species. Lizards on the island include the Bahamian brown anole (*Anolis sagrei*) and the Curly Tailed Lizard (*Leiocephalus carinatus*).

The harmless Bahamas Boa (*Epicrates striatus*) is extremely threatened. Many laborers will kill a snake on sight based on its Biblical representation of evil. The snake is not appreciated for its useful role in eating rats and mice.

Common Marine Fauna

Benthic Communities
There is a mosaic of soft-bottom and hard-bottom marine benthic communities adjacent to the site. Soft-bottom communities dominate the leeward side, including the bay. Dense to sparse sea grass beds (dominated by *Thalassia testidium*) provide critical habitat for finfish and invertebrates, as well as foraging areas for juvenile sea turtles.

The windward side of the site has important hard-bottom habitats that include windward hard bar, patch reefs, fringing reefs, and deep reef resources. All reef habitats are critical for important fisheries like grouper and lobster.

Sea Turtles
The island's high energy beaches have been used as nesting areas for three species of marine turtles: Green, Loggerhead and Hawksbill. Nesting adults and hatchlings may potentially use these beaches throughout the year. In addition, the marine environments adjacent to the island provide abundant habitat for all five turtle species.

Near shore sea grass beds are important foraging habitats for juvenile turtles. They need to be protected from degradation of water quality, boat traffic, and loss of habitat. It is likely that the 1988 dredging of the cruise ship channel and turning basin did significant damage to juvenile turtle habitat in the northern Sea of Abaco. Every effort should be made to protect remaining turtle habitat and near shore water quality.

Sea Birds
Sea birds need large areas of coastal oceans to forage and isolated rocky islands to nest. The most endangered sea bird in the Audubon's Shearwater, which occurs in the Abacos. Although there is little specific information about sea bird use of the Baker's Bay site, (and adjacent small islands), further development of the outer cays is of general concern for the loss of sea bird habitat and foraging areas.

Several efforts are underway to document the status and abundance of sea bird nesting sites, but evidence suggests that many historical nesting sites have been abandoned due to egg poaching, disruption of nesting, introduction of rats or feral cats, and destruction of habitat by development.

There are five species of terns that would use the Great Guana Cay environs: Audubon shearwaters, White-tail tropic birds, Frigate birds, Least tern and Brown noddy tern. The Audubon Shearwater and tropic birds nest in small colonies on rocky outcroppings and cliffs.

There has not been a thorough inventory of the remaining nesting sites, and it is recommended that an ornithologist investigate the possibility of these species nesting in the vicinity of the development.

Sea birds are believed to be undergoing a serious decline in The Bahamas. The Caribbean Ornithological Society has called for a country-wide assessment of their status. Efforts are needed to protect existing nesting sites through education and protection during the nesting months of May to July.

Marine Mammals
The northern Abacos platform margin is an active foraging area for several species of marine mammals, a surprising number of which are known to occur in The Bahamas. But little is known about population structure or abundance.

Some species of whales are only seasonal residents of Bahamian waters. Coastal development and increased boat traffic pose potential threats to whales and dolphins. Humans also compete with some species (e.g. spotted and bottlenose dolphins) for fisheries resources. Of particular concern is the right whale calving area to the north of Great Guana Cay, and migration routes for humpback whales offshore of the Abaco cays.

There are 11 species of whales and dolphins that can occur seasonally in the Great Guana Cay environs. Slower-moving species can be hit by fast, large ships, so the protection of these mammals will require a long-term monitoring and observation programme to identify migratory routes or foraging areas.

The Bahamas Marine Mammal Survey operates to the south of the Baker's Bay site, and can provide a protocol for initiating long-term observations at Great Guana Cay.

Biological Diversity and Species of Special Importance
Biodiversity within small island nations such as the Bahamas is considered low in relation to larger continental nations with greater habitat, although islands may support a greater degree of endemism.

Within the Bahamas, biodiversity of flora and fauna is highest within broadleaf evergreen communities and coral reefs. The Bahamian archipelago, which includes the Turks and Caicos, has 1,370 species of vascular plants of which 125 are endemic (9.0%).

Preliminary vegetation surveys at the Baker's Bay site revealed 78 species within broadleaf evergreen communities, 42 species within beach strand communities, 17 species within rocky shore communities and 16 within wetland communities.

Great Guana Cay represents a large expanse of relatively old-growth broadleaf evergreen communities (coppice). The island may be important as an important seed source for some species, and high densities (thus higher genetic diversity) of other species.
The rate at which islands are being developed in the northern Bahamas makes all land conversions from natural vegetation communities significant. The goal will be to establish permanent vegetation plots throughout the project site to monitor long-term decreases in plant diversity, while trying to maintain large patches of intact coppice. Without such environmental stewardship, the existing biological diversity is in jeopardy.

Legislation that relates to the protection of the environment will be incorporated into site planning. The Conservation and Protection of the Physical Landscape of the Bahamas Act, No 12. of 1997 provides a list of protected trees which will be preserved, transplanted or replaced whenever possible.

Prior to construction, a plant nursery will be established to cultivate non-invasive garden plants and native plants. In addition, a list of critical coastal plants has been developed for conservation and planning purposes.

In addition to adopting any Bahamian guidelines specific to biodiversity and species conservation, the developers will seek to comply with the following U.S. regulations:

- The Endangered Species Act, which prohibits the capture of any listed species.
- The Marine Mammals Protection Act, which prohibits the capture of any listed species.

CHAPTER 5: SOCIOECONOMIC AND CULTURAL ASPECTS

The settlement on Great Guana Cay is approximately 2.7 miles from the project site. This was traditionally a fishing community, but has recently developed tourism activities in surrounding second-home developments, rental properties, restaurants and other businesses. The ferry service from Marsh Harbour allows for regular movement of people and goods.

There are some 450 homesites for sale on the island both north and south of the settlement. Some are accessed by paved roads, including a new road from the settlement to Guana Seaside Village.

There are two 10,000 gallons per day reverse osmosis water plants in the settlement, which allow residents to fill cisterns during dry periods. There is no centralized sewerage treatment in the settlement, nor any sewarage treatment planned for the housing developments. Solid waste disposal is a growing problem for the island.

Daily arrivals of workers to the island exceeds 65 people on most weekdays. Workers arrive with the early morning ferry, and depart in the late afternoon.

Three separate construction contractors were operating from the Guana Cay settlement in winter 2003-2004. About 12 homes per year are built on the island (from permit records over the past 5 years). The average house size is about 2000 square feet (on permit), with the estimated cost of land and construction in excess of $300,000. There are about 49 private docks, and two commercial marinas on the island, with a commercial dock rate of $6 per foot per day.

There are 17 licensed businesses on the island, which has a long history of self-sufficiency. Adjacent to the settlement to the north and to the south are other residential developments, which include lots for sale, and houses built primarily by foreign tourists to use as seasonal homes.

Great Guana Cay is undergoing rapid growth, and has outstripped much of the existing infrastructure. A sold waste transfer station near the Orchid Bay marina handles household garbage, but many large items such as cars and appliances are stacked near the harbour waiting for a disposal solution.

All structures have on-site wastewater disposal (septic tanks or soak-aways). There are likely already pollution problems in the harbour as evidenced by blue-green algae blooms along the shoreline, sea grass die-offs in the harbour, and anoxic sediments accumulated in dredged channels.

Bahamian law vests responsibility for protection of the cultural resources to The Antiquities, Monuments and Museums Corporation, which reviews applications for development in cooperation with the BEST Commission, the Ministry of Finance and other agencies.

Cultural resources representing the national patrimony that are of interest to the Corporation include archaeological sites and ruins, historic buildings, cemeteries and landscape features of traditional cultural importance.

The developers met with the Corporation and provided aerial photographs of the property for examination. There are no recorded sites of pre-European native peoples on the property, and fieldwork did not discover any. The coastal areas of the island would have been the most likely sites for Amerindian settlement, and much of this area has been heavily impacted by past development.

The only obvious archeological site documented was the remains of a sisal plantation.

Sisal plantations were short-lived in Bahamian history. Sisal production was initiated in 1889 and the largest plantations were on San Salvador and Andros. A smaller plantation was established on Great Guana Cay in the 1890s. After 1902 the market collapsed, with only a trickle of production persisting through World War II. It is not known how long the plantation on Great Guana Cay operated.

If cultural resources on the property are deemed significant by the Corporation, preservation actions may be required at the developer’s cost, including but not limited to:

•Site preservation in place through green spacing
•Excavation of threatened archaeological remains
•Marking or moving human remains
•Stabilization, rehabilitation or restoration of significant structures
•Stabilization of ruins
•Public access to sites and locations
•Public interpretation through signage, kiosks, publications, exhibits and museums
•Participation of local residents in cultural resource decisions and actions

The developers have agreed to these conditions, and are committed to working with the Corporation to fulfill these requirements for the protection of any cultural and historical resources there may be on the property.

CHAPTER 6: INFRASTRUCTURE AND SERVICES

The provision of services for an upscale private resort community on a small island will require new ideas and innovations. There are challenges to provide services that tourists demand, while educating them on the limitations of life on a small island.

The infrastructure must minimize ground water contamination and be designed to withstand the tropical climate and storms. The developers have looked at new technologies and models to provide services for sustainable living.

The service area will be located on Treasury land at the southern end of the property, and will include franchise agreements with the government for water production through reverse osmosis and for wastewater treatment in a centralized sewerage treatment facility. The goal is to provide services in the most environmentally compatible manner, with on-going monitoring and improvements as needed.

The service area will be designed to accommodate:

- Lay down area
- Communications centre
- Water storage facilities
- Maintenance and grounds facilities
- Solid waste processing and transfer station
- Public access beach park

Power Generation

Power generation will be provided in co-operation with the state-owned Bahamas Electricity Corporation through a franchise agreement.

On-site utility infrastructure will include below-ground service to individual houses and buildings, and include back-up and emergency systems. Plans for on-site fuel storage and back-up power generation will meet emergency power needs for freezers, communications and security, but not for individual homes.
Bulk fuel storage should be avoided on small islands and represents a challenge to ensure protection from spills, leaks and storm damage. Small-scale emergency power generation is necessary, but alternative energy sources such as solar and wind generation will be explored to augment regular service.

Communication Services

Communications services will be provided in cooperation with the state-owned Bahamas Telecommunications Corporation as required by Bahamian law. These will include:

- High-speed wireless internet service
- Satellite television
- Local and international telephone services
- Local dedicated radio frequencies for the marina, security services and management staff

Out Island Internet, based in Marsh Harbour, already provides internet service for residents on Great Guana Cay and BTC has microwave towers in place in northern Abaco (including the settlement of Guana Cay). Most communications services can be provided with existing infrastructure for existing developments.

Water Management

Water management is vital on Great Guana Cay, where fresh water is both limited in quantity and expensive to acquire and store. Water also poses one of the most insidious environmental threats to the near shore marine environment and enclosed waterways of the marina.

There are only three potential sources of water on the island: groundwater, collected rainwater and water manufactured from reverse osmosis. Changes to the island hydrology, pollution of groundwater sources, or introduction of pathogens, nutrients or excessive organic matter can all pose serious and irreversible environmental impacts. An overall water management plan is critical to coordination of all phases of resort development.

Near shore water quality and marina water quality are critical components of the site-monitoring plan. The developers are able to draw from the information base developed in the Florida Keys to establish safety guidelines to protect both the environment and public health.

Restrictions are placed on chemical or noxious materials that can contaminate the groundwater; and regulations state that no oil, garbage, liquid, sewage or other waste may be discharged into inland waterways.

Water quality is fundamental to both species and natural community distribution in coastal zone environments, and the impact of water quality degradation is complex. Small islands such as Great Guana Cay place all the upland areas in close proximity to the ocean and mangrove wetlands and changes in water quality parameters will occur with human alterations of coastal hydrology and runoff patterns.
Because water quality parameters such as temperature, salinity and turbidity vary naturally with tidal, diurnal and seasonal cycles, changes in natural variability are difficult to document without a history of baseline water quality information. Documenting changes in coastal water quality would require some knowledge and monitoring of pre-development conditions.

The following activities are known to increase coastal eutrophication and will be avoided in the Baker's Bay development:

1. **On-site disposal systems or soak-aways** - Most island homed rely on septic tanks, which include a series of underground filters to digest organic material in sewerage and wastewater. In tropical environments, soils are often very thin, and effluents from septic tanks migrate rapidly to groundwater. Poorly constructed soak-aways are essentially cess pits that afford very little wastewater treatment, and pollutants move rapidly through groundwater to coastal waters. This can lead to degradation of water quality in adjacent canals and lagoons.

2. **Package plants and injection wells** - Injection wells are used in more densely populated hotels and resorts. Most are not designed to remove nutrients. Injection wells make use of cavities and caves in the carbonate platform, and inject both raw sewerage and secondary treatment effluent into wells of varying depths. This is the "out of sight-out of mind" philosophy and over time, contaminated groundwater can migrate to coastal waters.

3. **Live-aboard boats and yachts** - The Bahamas has long been a mecca for yachtsmen, who dump sewerage directly into coastal waters if holding tanks are not required. Raw sewage or disinfected sewage can be pumped overboard and rapidly diluted by tidal currents. This "solution to pollution is dilution" concept has long applies to many anchorages in The Bahamas, but increased yachting tourism is presenting a problem in some areas. Holding tanks will be required for resident boat owners at Baker's Bay.

4. **Storm water runoff –** Storm water runoff is totally untreated, and heavy rains can carry nutrients and hydrocarbons (petroleum and oils) from roads, bridges, rooftops and yards into coastal waters. Most rainwater soaks into the porous carbonate rock, but heavy rains can carry significant pollution into coastal waters from populated areas. Storm water management can be accomplished through planned drainage systems away from the sea and by maintaining a healthy coastal vegetation buffer zone.

Sewerage and wastewater discharge are notorious for long-term impacts in tropical marine environments. Human activities on land inevitably increase nutrient inputs to coastal waters from deforestation, wastewater, fertilizer, and other sources. The Bahamas is not unlike the Florida Keys, where the process of near shore eutrophication has been studied intensively.
Major pathways of nutrient input to Florida Keys waters include on-site sewage disposal systems and submarine groundwater discharge. One big difference between the Florida Keys and the central Bahamas is circulation. The Bahamian islands are not adjacent to a continental peninsula and have not been targeted for any significant fill between islands for causeway construction. Thus, in general, the surface circulation around islands should be higher for the Bahamian archipelago.

In fact, water quality studies around Nassau Harbour do not show elevated nutrient concentrations compared to waters adjacent to undeveloped islands. Despite alteration to 100 per cent of the shoreline along Eastern Road, with loss of reef and sea grass habitats, the patterns of water quality variability with tides and seasons are not statistically different from lightly developed islands in the Exuma Cays.

The ability to detect and document changes in inorganic nutrients in tropical near shore waters is limited to point sampling on tidal, diurnal or seasonal cycles and only extreme values for parameters such as total nitrogen appear higher. Most coastal development studies have documented the ecological changes to coral reefs rather than establishing pollution sources, quantities and pathways for non-point, land-based pollution.

The water quality monitoring programme in the Florida Keys National Marine Sanctuary involves a massive sampling effort of over 1400 stations throughout the region. This program is only beginning to characterize water quality parameters for Florida Bay, the near shore Keys waters, and the Keys reef tract, with the only obvious water quality degradation near, and in, dredged residential and commercial canal systems.

Water quality degradation will occur with coastal development and land-cover change. The Baker's Bay water management plan will quantify the additional water added to the island system, and estimate approximate nutrient loading. Mitigation efforts are based on the assumption that near shore eutrophication will occur and will need to be addressed, particularly on the low-energy shoreline of the project site.

However, this development is unique in providing centralized wastewater treatment from the outset. There will be no on-site wastewater disposal.

Detailed water quality monitoring is essential for remediation of problems associated with coastal development, but not necessary for the identification or prediction of ecological impacts.

The most significant water quality impacts of coastal development that can be documented are likely to be manifested after severe storms and hurricanes. Human alteration of the coastal zone will exacerbate natural disturbances, primarily in the scope and severity of nutrient and sediment transport from land to sea.

The developers have drafted a water production franchise agreement in consultation with Dr. Richard Cant of the Water and Sewerage Corporation and may provide fresh water to the settlement at a pre-negotiated price.

The developers are also drafting a wastewater processing franchise agreement with the Corporation and the Department of Public Works to re-cycle wastewater for irrigation of the gold course.

Constructed Wastewater Wetland

In recent years, there has been growing interest in using artificial wetlands for processing and eliminating wastewater and sewerage.

The use of natural systems for treating waste is called bioremediation (or phytoremedation when plants are involved). Wetlands, with their diverse communities of bacteria and hardy, fast-growing plants adapted to taking advantage of high nutrient loads, have proved to be especially capable of biodegrading domestic sewage and even some toxic industrial effluents.

Constructed wetlands can provide a highly effective, partial solution towards sustainable water use on tropical islands. In fact, these already exist on Eleuthera and Exuma.

Wastewater travels through a constructed wetland and emerges both filtered and lower in nutrients so that it can be used for general irrigation. As tropical islands' soils tend towards low nutrient concentrations, many native plants are not adapted to dealing with rich soils, and have adverse reactions to over-fertilization.

It is relatively inexpensive to build such a wetland, which produce no foul odours or increased mosquito populations. There is flexibility with regard to design, as wetlands are generally very robust and forgiving. Wastewater wetlands can be added in a series of linked modules.

It is possible (especially in warm climates) to build a wetland large enough so that it has no output or overflow, where all the grey water that went in would be lost ton evapotranspiration. Generous water consumption rates have been estimated at about 150 litres of waste per day per person for toilets, showers, kitchen and laundry. The waste water should take five days to travel from one end of the wetland to the other. The typical capacity for constructed wetlands is about three cubic metres per person.

Modules for 10 people would be a metre deep, three metres wide by 10 metres long (or 300 cubic meters of wetland). Modules can be added to increase capacity, or "stored" by drying down to decrease capacity.

Solid Waste Disposal

Solid waste in all forms will have to be managed and contained entirely within the development - a unique challenge for small islands.

The ecological balance of the island will depend on a balance in the accumulation and fate of organic matter on the landscape. Solid waste management will aim to recycle and re-use as much material as possible, and then compact material for export. Solid waste and hazardous material management will be the responsibility of the on-site project manager and will be monitored by the environmental team.

Table 4.8: Types of solid waste generated at the Baker's Bay Club.

TYPE OF SOLID WASTE	DESCRIPTION	FATE OR DEPOSITION
Plant material, garden waste and cuttings	All plant material, including exotic plant removal from coastal areas, shrubs and trees trimmed from homes and the resort, as well as golf course clippings	Chip and compost small material. Export large Casuarina trees, as needed, No burning of garden waste.
Household/ Food Organic Material	High nitrogen organic wastes generated from food preparation	Compost at communal composting or permiculture in employee settlement
Construction Debris and Wastes	Large pieces of waste from Removal of Disney Treasure Island complex, concrete, wire and lumber, not toxic	Lumber recycled in landscaping, Unusable material compacted for removal from island

Re-cycled Material	Glass, tin, paper, plastic and glass	Any material, particularly from packaging that can be recycled will be separated and stored. PPS will work with local environmental groups on recycling processing for the region
Last discard- appliances, cars, etc.	Large, disposable items	Compaction and store for removal from island
House-hold wastes	Compactable household and resort waste that can not be recycled	Compaction and store for removal from island
Toxic and hazardous wastes	Contaminated soil removed from the Disney Treasure Island complex, paints, used oil, and other materials requiring special consideration in disposal	Special storage facilities and processing for removal from island
Sludge from Sewage and Waste water treatment	High organic content, potential public health hazards	Removal from island or deep well injection?

Production of solid waste is expected to increase substantially as the island's projected population could exceed 6000 within 10 years – so this is a key planning consideration. American households produce about 9 lbs of trash daily - 39% paper, 4.6% yard wastes, 9.5% plastics, 7.6% metals, 7% wood, 6.7% food wastes, 6.3% glass, 3.2% other wastes, 3.1% textiles, and 3% rubber and leather.

Projected population with full build-out of currently approved developments.

Location on Guana Cay	**Type of development**	**Estimated Number of residences**
Baker's Bay Club	Resort development with houses and hotel	350
Kent Smith's Development	Housing lots – open access	550
Settlement	Small businesses, rental units and homes	250
Orchid Bay	Resort Community development	300
Total		**1450**

Waste disposal for the entire island will be centralized at the Baker's Bay Club transfer station, which will be built on Treasury land. The transfer station will sort and process waste for composting, recycling or disposal.

There is a need for site-specific guidelines to ensure that the development is in compliance with national regulatory authorities and environmental standards.

The transfer station will be located in an area where the potential for degradation of air, land, and water is minimal. It will be fed by roads able to withstand anticipated loads, with easy access to dock facilities for export.

Any solid waste disposal site in The Bahamas poses a critical threat to ground water quality, and leachates should be contained or avoided by minimizing ground contact and exposure to heavy rains.

The transfer station should include a leachate collection system, a weighing facility, covered tipping and loading areas, exhaust systems for enclosed areas and a security fence. Hazardous wastes and corrosive materials should be contained in corrosion-resistant tanks and prevented from contaminating the ground or water.

Waste disposal will be effected in accordance with guidelines included in the Environmental Management Plan, partcularly the monitoring of potential vector organisms. With the introduction of exotic mosquito species to The Bahamas, a vector control plan is important throughout the property, but especially within the transfer station where standing water can be hidden in waste storage areas.

Work at the site will conform to appropriate health and safety guidelines established by the US Occupational Safety and Health Administration. Education programmes should be implemented for workers and residents, and the government should be provided with a closure plan in case the transfer station ceases operations.

Composting and Recycling

On a small island, there are no opportunities for on-site disposal other than composting and recycling. The reuse of organic material can minimize plant diseases and insect pests, prevent erosion, cut chemical use, and reduce waste disposal costs. Composting requires skilled attention and management, but is essential for compatible small island development.

Sewerage treatment by composting toilets conserves water and prevents eutrophication of sensitive wetlands and coastal areas. And the composting toilet allows nutrients in human excreta to be captured and re-used as fertilizer.

The breakdown of waste in a composting toilet is carried out by bacteria and fungi that thrive in warm temperatures and are able to convert nitrogen in the waste into a form which plants need for growth.

Since grey water (from sinks, showers, and washing machines) contains only about 10 per cent as much nitrogen as human waste, it's far less of a pollution problem. When grey water is put into the aerobic environment of topsoil, plants and organisms use the nutrients it contains. However, as the low-nutrient soils found on tropical islands are intolerant to excess nutrients, grey water must be processed through a constructed wetland before being used for irrigation.

Although limited recycling takes place in The Bahamas, this is an important requirement for small island communities and the developers will exercise leadership in this area, particularly for glass, aluminium and scrap metal. Even with relatively small quantities, a transfer and recycling center in Marsh Harbour could be economically beneficial over time, and alleviate pressure on landfills. Community outreach programmes should emphasize the importance of sorting and recycling solid wastes wherever possible.

CHAPTER 7: ENVIRONMENTAL IMPACTS

Overview of Regional Impacts

It is important to consider the wider geography of the northern Abacos. This is a rapidly growing and changing landscape, and the Baker's Bay development will contribute to increasing urbanization and infrastructure needs.

The "project environs" can be defined as the area from Marsh Harbour to the terminus of Little Abaco, with the associated offshore cays from Elbow Cay to Carter's Cay. The long-term impacts of the loss of wetlands and wildlife habitats throughout this region must be evaluated:

- What is the role of the Baker's Bay property in the ecology of the island chain from Carter's Cay to Elbow Cay?
- What are the unique environmental considerations of northern Great Guana Cay compared to other cays, and the Great Abaco landscape?
- What are the likely consequences of the loss of natural areas associated with the development?

Tropical islands present a particular challenge in balancing coastal development needs and environmental protection for both cultural and ecological reasons. Development poses an especially difficult challenge in the oligotrophic, carbonate environments of the Bahamian archipelago.

In the Bahamas, small islands are acutely impacted by development activities, particularly the reclamation of wetlands and pollution of coastal waters. Coastal development can produce significant ecological impacts:

- Changes in coastal species abundance and diversity (including local extirpation)
- Changes in near shore natural community structure
- Changes in coastal water quality

- Changes associated with exotic species invasion

Fragmentation and chronic eutrophication of tropical near shore marine environments can have negative effects on fisheries production and the life cycles of reef fishes and invertebrates.

The smaller islands often pose the greatest challenges for development. A comparison with the Florida Keys can offer some precautionary guidelines for sustainable development in The Bahamas.

Impact Assessment Methods

Resort and residential development on small islands requires an objective standardized process of risk and impact assessment. There are standard tools and accepted mitigation options for the most important ecological impacts – loss of habitat, changes to island hydrology and pollution.
A series of questions and appraisals are used to rank and prioritize all potential hazards and risks. All stakeholders must be educated, informed, and participate in mitigation options for positive resolution of disputes.

Assessment criteria are used to rank activities according to their environmental impact. Each phase and component of the development is described and then evaluated for impacts, with mitigation options outlined. Ranking can be defined as follows:

•Significant: a high impact corresponds to an effect upon a substantive any environmental or socioeconomic condition or area that can generate significant change, and is largely irreversible by natural means. The site condition is affected for the long term and there may be human health threats.

•Moderate: a moderate impact is an effect upon a portion of any environmental or socioeconomic condition or area. The effect occurs for a limited period and is naturally reversible in the medium-term.

•Negligible: a low impact corresponds to an effect that is barely perceptible, is of short duration, generates naturally reversible changes in the short-term, and does not diminish or alter any environmental or socioeconomic condition or area.

Table 5.1: Criteria for impact assessment.

Qualitative Criteria	Choices	Description
NATURE	• Direct • Indirect	Refers to the origin/source of an impact – does the SOURCE activity DIRECTLY or INDIRECTLY act on the environmental target (species or natural communities).
TYPE	• Positive • Negative	Positive impacts imply species or natural communities will have a higher likelihood of persistence and increase in viability, Negative impacts imply the opposite.
LIKELIHOOD	• Not Likely • Potential • Certainty	***Not likely*** means there is roughly a 10% chance of an impact occurring, ***Potential*** means 10 to 70% and ***Certainty*** means that in impact has a greater than 70% chance of occurring.
SCALE	• Specific habitats • Island environs • Regional • National or International	Scale of the impact will be defined as restricted to specific habitats, impacts that impact the entire island environment of northern Great Guana Cay, regional impacts refers to the northern Abacos and international impacts refer specifically to CITES species or species whose survival on Great Guana Cay is linked to its global survival.
DURATION	• Temporary • Long-term	Temporary refers to impacts that last less than 3 years, meaning species recover to pre-impact levels, or natural communities recover to no noticeable impacts. Long-term re(more than 3 years)
REVERSIBILITY	• Reversible or • Irreversible	Reversible implies that the impacted species or natural community will recover, Irreversible impacts mean that the species or natural community is lost to the project site, and impact should be mitigated

For example, an impact assessment of the construction of a single house on a lot on a small island will involve the clearing of land for construction that could have a variety of impacts, including direct impacts on the vegetation community removed, and indirect impacts on the near shore marine environments.

But if a small area (less than 4 hectares) of previously disturbed land is cleared during the dry season, and a wide coastal buffer of vegetation is retained, the environmental impacts will be much.

On-site monitoring is critical to reduce the significance of the impacts and to ensure that the best environmental practices are followed.

Consider an example documented on Great Guana Cay. A 30-acre (12 hectare) site was cleared during the dry season. There was evidence of previous slash and burn agriculture and a high percentage of weedy or invasive alien plants. Only about a third of the area was broad-leaf evergreen shrub thicket. And there is a 30-meter natural buffer from the shoreline to the cleared area.

This activity on this site could be evaluated using the above criteria, and suggestions offered to minimize long-term environmental impacts. The follow-up would include photo documentation of the recovery of the site and monitoring of the agreed-upon mitigation plan.

Overall, the activity at this site has a moderate impact on the island environs, primarily through the bulldozing of several acres of coppice. There was no replanting of native trees and shrubs, and no record kept of the tree species protected by law.

Table 5.2: Impact matrix for land clearing and home construction.

Nature	***Direct***	*Direct impact on upland vegetation and wildlife habitat in the large area cleared. The repeated clearing or burning of coppice on these small islands increases the threat of invasive alien plant species replacing native plants. Indirect impacts on adjacent marine environment avoided by intact coastal buffer zone.*
Type	***Negative***	*Loss of natural communities, and potential loss of wildlife species*
Likelihood	***Certainty***	*Impact will occur*
Scale	***Specific Habitat***	*Broadleaf evergreen formations – habitat specific impact with loss of habitat.*
Duration	***Temporary***	*Temporary IF recovery plan is put in place quickly, Irreversible damage if site is allowed to sit, and soil erosion occurs, or invasive alien plants invade.*
Overall Significance	***Moderate***	*On a small island experiencing rapid development, the removal of large areas of upland vegetation is important. The lack of native plant recovery from the area adds to the impact*
Mitigation Options	*1.) Ideally, no more than 10 acres (4 hectares) should be cleared in a continuous area with a bulldozer at one time. Areas should be cleared in a mosaic to prevent total loss of wildlife habitat, and allow the removal of critical and threatened plant species. Invasive alien plants are actively removed from the site.* *2.) Native trees and vegetation would be used extensively (ideally exclusively*	

	in the landscaping of final project. Developer should agree to active removal of invasive alien species during the site recovery *3.) Mulch or chipped wood should be used as ground cover to prevent soil erosion, keep soil moisture, and encourage recovery of the site*

The magnitude and significance of the interaction between an element of the project with the environment depends upon how, where, when, and with what frequency or likelihood each activity occurs. These questions are addressed in the implementation plan. For example, construction can be timed and adjusted to minimize acute impacts on adjacent coral reefs.

This example illustrates some important planning features of a development that determine the scale and scope of impacts. Mitigating measures that need to be included in the impact assessment of a particular development component include:

- Planning: designing the project to reduce environmental impacts
- Scheduling: timing project activities to avoid sensitive periods
- Operational: adjusting the way in which project activities are carried out
- Technological: using techniques and devices to control dangerous impacts

In the example presented above, each of these mitigating measures would have a significant effect and would be cost-effective in the long-term. Restoration costs are always higher than the cost of measures to minimize environmental impacts.

Planning of housing lots to allow for corridors of natural vegetation will promote native plant diversity as well as rapid recovery of the area after construction. Housing guidelines must specify a maximum construction foot print on the property, as well as maximum clearance areas.

Ideally, construction could take place in the winter dry season to minimize erosion. However, the coppice is important to migratory birds during this time. Scheduling activities is likely to be very site specific, with the greatest consideration given to the impacts of heavy rainfall or storm events. It is important to minimize grading during the wet season, to avoid problems with erosion that can increase turbidity in near shore waters.

Operational guidelines are critical to the best outcome of a construction project, and follow-through requires a knowledgeable, on-the-ground environmental staff. In this example, operational guidelines would include the selective removal of invasive alien plants, with the identification and protection of native species.

Technologies such as synthetic ground covers, mulching of removed vegetation, and sediment curtains can contribute to reducing impacts. The Baker's Bay project will feature an on-site web cam to monitor various phases of construction. This will help prevent problems from occurring and guide restoration efforts.

Major Impact Areas

The pre-construction/construction activities and project operations to be considered as part of the environmental impact assessment include:

SITE PREPARATION AND INFRASTRUCTURE
Demolition and cleanup at the former cruise ship shore facility, construction of roads and receiving areas, waste disposal, and construction of common buildings.

About 65 acres of invasive alien plant species will be removed and about 40 acres of roads, lay-down areas and infrastructure will be impacted by construction. The restored areas will eventually be private homesites with native plant corridors and coastal setback zones.

The site clean up includes removal of debris and dead vegetation left from the passage of Hurricane Floyd (1999); removal of storage tanks, transformers, and petrochemical spill sites along with contaminated soil; restoration of the old dock and removal of the dolphin pen and other navigation hazards; removal or restoration of damaged water storage facilities; removal of Australian pines in the coastal zone; restoration of dunes and native plants in coastal set backs.

The import of any sand, fill or soil material will be evaluated for the potential introduction of invasive species to the island. A list of appropriate plants for landscaping and gardens will be developed in the interest of both water conservation, and to prevent the introduction invasive plants.

Many native plants do not grow in the leaf litter of Australian pine, so the area needs to be completely cleared, re-contoured and replanted in small sections. The smaller pines (less than 20 cm diameter) can be chipped and used as mulch for use on roadbeds and construction areas to prevent soil compaction and damage to root systems of native trees. Trees that need to be cleared in other areas can be re-located to the restoration area .

As the development is completed, the management of coastal strands will be contracted out to the Great Guana Cay Foundation to protect the biological diversity and natural beauty of the island.

MARINA AND LOGISTICS DOCK
Marina dredging, deposition of dredge spoils, entrance channel construction and logistics pier construction.

Construction will involve dredging 20 acres for the marina and seven acres of waterways and entrance channel; deposition and movement of dredge spoils; stabilization of marina sides; ensure flushing of marina area; mitigate impacted adjacent wetlands, and building the logistics pier.

The marina represents the most severe land cover alteration in the development – converting emergent wetlands or uplands to deep water marine environments.

Most of the area to be dredged is red mangrove shrub thicket – dense mangroves of similar age and size reaching a height of about 17 feet. Historical descriptions suggest this area was previously an open lagoon. Sediments to the depth of six feet are sandy and saturated at the surface with brackish water. Water levels fluctuate tidally but there are no open creeks or channels.

The movement of fill from the marina basin will be used to create two artificial islands within the marina for housing lots. The other major sea floor alteration includes the construction of the logistics dock and dredging required for the entrance of the marina as well as access to the pier.

Ideally, marina dredging would occur during months of minimum rainfall. Preventative measures need to be in place to prevent run-off to adjacent near shore areas. This can be accomplished with sediment curtains. Construction in near shore environments should avoid the summer month when recruitment of juvenile fish and invertebrates occurs.

Of particular concern is the dredging process and sub-contracting of this phase of the project. The marina area is particularly sensitive ecologically because of the diversity of small-scale vegetation communities. Offshore, there are important patch reefs and hard bottom marine habitats at the mouth of Joe's Creek. These areas need special protection in the dredging process.

Table 5.4 Impact Matrix for the Marina and Logistics Dock for *Passerine at Abaco* RDC

Qualitative Criteria	Choices	Description
NATURE	Direct	Direct impacts on about 30 acres covered from vegetated habitats to open water marina basin and waterways, and impact on additional 20 acres to be filled to increase elevation for golf course or housing development. Direct impact on hydrology of the island to be prevented by use of "aquaclude" walls and bulkheads to maintain adjacent wetlands. Direct impact on the adjacent marine environments with dredging access channels.
TYPE	Negative	Loss and severe alteration of inland mangrove areas and
LIKELIHOOD	Certainty	Will occur with marina construction
SCALE	Habitat – specific impact (Inland Mangroves, Coastal Strand)	Inland mangrove areas are reduced in area, and changes to the adjacent wetland areas. Some loss of habitat in coastal strand areas and broadleaf forest areas that will be used in waterways and entrance channel.
DURATION	Long-term	Changes will be permanent to the landscape.
REVERSIBILITY	Irreversible	Changes to wetland hydrology will need to be monitored to prevent eutrophication and localizes water

		quality degradation within the marina
OVERALL SIGNIFICANCE	Moderate	Overall impacts are moderate in nature, the marina is relatively small to accommodate only club member boats, with a total area of 27 acres.
MITIGATION OPTIONS	1.) Maintain "ecotones" or buffer areas around the preserved wetlands that have high diversity of epiphytes and orchids (critical plant species). Avoid these areas in dredge impact areas. 2.) Maintain hydrological separation between marina and adjacent wetlands to maintain gradient of fresh to brackish to seawater that now occurs in the inland wetlands. 3.) Restore and manage wetlands to north of marina as mitigated wetlands. 4.) Maintain and manage preserve area that includes mangrove creek system as well as coastal strand and upland community components 5.) Minimize impact zone of heavy machinery used in dredge removal and fill operations.	

GOLF COURSE
Grass and landscape plant selection, clearing and re-contouring, and irrigation systems.

The protection of the existing environmental setting and water conservation issues will be paramount in the design of the golf course. Limited areas will be cleared before shaping and grassing begins so as to minimize soil loss and allow for some native plant recovery.

Water conservation is the key to successful operation of a golf course on a small dry tropical island. Irrigation systems will use a mixture of grey, brackish and manufactured water. The sprinkler system will be designed to minimize run-off and drainage systems will help recycle rainwater.

The location of a golf course near the coastline is cause for concern about pollution of the near shore marine environment, as well as groundwater. Golf courses are intensive production systems, and the frequent mowing and application of chemicals requires careful management to avoid damage to the surrounding environment. Monitoring of chemical movement from turf areas is essential.

A series of wells will be established in the first year of the project to determine and evaluate specific golf course management practices that protect water quality. Additional research will be conducted on fertilizer handling, application and storage, clipping handling and other practices such as vegetative filter strips. Undisturbed natural areas of native plant species will be incorporated into the golf course as far as possible. Soil and water monitoring will be undertaken for nitrogen, phosphorous, and selected pesticides.

The design will seek to preserve natural rock outcroppings that are archaeologically or geologically significant, and sensitive or critical habitat or environmental features. Representatives of each of vegetation type should be protected throughout the course area, this includes grassy wetlands and broadleaf evergreen forest communities.

Areas for restoration, replanting, and enhancement of disturbed habitat to re-establish wildlife migration corridors and linkages between fragmented habitat areas will be identified. This includes areas currently dominated by Australian pines and coconut palms that will require some restoration.

The design will protect drainage systems that support retained vegetation. Structures and buildings should be located so that impacts on habitats and significant natural areas are avoided. Invasive alien plants will be removed and introduction of exotic plant species will be avoided. Ponds will be developed that mimic natural conditions in terms of both aesthetics and habitat, to the extent feasible.

Design of the course will avoid adverse impacts to surface water or ground water. This may include techniques such as the use of under-drain systems or other approved means of capturing and directing leachate away from ground water, and directing flow from underground drains to peat-sand filters in areas of permeable soils to ensure adequate filtration. Paved areas should be limited in order to reduce surface runoff. When possible, cart paths should be mulched and not paved.

Impervious liners for detention/retention ponds and water hazards will be used to protect ground and surface water quality. Areas of critical concern may use underground water-retaining buffers (aquacludes). Buffer strips, oil/grease separators and other techniques for parking area drainage systems will be applied.

Grease traps and other technologies for golf cart maintenance and wash areas will be used to prevent untreated runoff from entering the natural environment. The overall drainage system will be designed to insure that there is no increase in the velocity or amount of off-site flows during major storm events.

The developers will use a variety of Paspalum salt-tolerant grass for the course turf and will employ a variety of measures to limit sediment and other pollution during construction. Grassed surfaces reduce runoff velocities and remove contaminants. Gravel pads at the points of vehicular access reduce the mud transported onto public roads and other paved areas.

Temporary sediment barriers composed of native mulch or silt fences placed across or at the toe of a slope can intercept and detain sediment and decrease flow velocities from drainage areas of limited size. Small ponding areas, formed by earthen embankments with a gravel outlet across a drainage swale will detain sediment-laden runoff from small disturbed areas for enough time to allow most of the sediment to settle out.

But the best way to prevent pollution on construction sites is to use “good housekeeping” practices - maintaining the site in a neat and orderly condition. Specific measures should be used to retain runoff and to deal with toxic substances and materials. An overall plan for the control of non-point source pollution is advisable.

Erosion and sediment control measures are to be placed prior to, or as the first step in, construction. Sediment control practices will be applied as a perimeter defense against any transportation of silt and/or water turbidity off the site.

Silt screens and turbidity barriers must remain in place and in good condition as required until the soils are stabilized and vegetation has been established. Materials from work will be contained, and not allowed to collect on any off-site perimeter areas or in waterways. These include both natural and man-made open ditches, streams, storm drains, lakes and ponds.

Table 5.7 Impact matrix of the golf course construction for *Passerine at Abaco RCD*.

Qualitative Criteria	Choices	Description
NATURE	Direct	Land cover alteration from shrub thicket and forests to open grassy areas will directly impact the overall plant diversity on the island
TYPE	Negative	Large area of continuous Broadleaf Evergreen Forest will be fragmented and converted to turf-grass fairways and greens. Of the original 372 acres, about 40% will remain in small patches and corridors. Patches of vegetation do not offer the same ecological value as a contiguous forest, and thus wildlife habitats and plant diversity may be lost.
	Positive	Upland vegetation communities will be fragmented, but a management program for the lobate lac scale will help control the current infestation on native trees,
LIKELIHOOD	Certainty	Impacts will occur with land conversion to golf course.
SCALE	Habitat–specific impact	Impacts are the further fragmentation of the contiguous coppice (broadleaf evergreen forest) areas. This fragmentation may lead to a long-term loss of plant diversity if not monitored. There are very specific threats to the groundwater quality throughout the project site.
DURATION	Long-term	Impacts will be more acute with construction, with some recovery of trees and vegetation with time. A KEY CONCERN is the use of Paspalum grasses that can grow with brackish water. This increased salinity of irrigation water, or contamination of ground waters may lead to the demise of native vegetation.

REVERSIBILITY	Irreversible	It is unlikely that a forest will ever recover from the golf course conversion, even if site is abandoned.
OVERALL SIGNIFICANCE	Moderate	This is a moderate impact overall on the project site. The current infestations of fire ants and lobate lac scale do pose a threat to native plants and wildlife, thus the management development does offer better long-term stewardship of island biological diversity, with removal of invasive pest species.

MITIGATION OPTIONS

1.) Chip and use removed invasive plants for mulch to protect soil and cart paths, follow "best practices" in utilization of native vegetation that is compatible with Paspalum turf grass species.
2.) Complete groundwater well monitoring system, and environmental management plan for application of pesticides and herbicides,
3.) Design course to maintain natural landforms and elevation changes.

HOME CONSTRUCTION

Design of lots, services provided at the lot line, and construction of individual homes.

Coastal protection guidelines will be clearly established during construction as well as for individual lot owners. The purpose is to prevent long-term damage to the coastal buffer zone and conservation areas on the island, as well as to maintain as much intact upland vegetation as possible within the project design

These guidelines will include a detailed and clearly marked survey of areas not to be disturbed in the initial construction phase as well as permanent coastal setback zones. The coastal type determines coastal setback distances.

High Energy Beach and Dunes	**10 meters back from Dune Crest** or high point of dune system. For restored dune areas, dune crest is based on restored shore profile.
High Energy Rocky Shores	**5 meters back from cliff crest**, well above white zone of the upper tidal platform
Low Energy Beaches	**15 meters back from permanent vegetation line**, avoiding palm-dominated scrublands that are prone to flooding.
Low Energy Rock Shores	**15 meters back from permanent vegetation line**.
Mangrove Coastlines	No construction or setbacks, mangrove coastlines are within proposed preserve area

Excellent guidelines for prudent coastal development in the Caribbean region are outlined in the United Nations Environmental Programme Planning for Coastal Change report by Dr. Gillian Chambers.

A coastal development setback is defined as a prescribed distance to a coastal feature, such as a line of permanent vegetation, within which all types of development are prohibited. Access to beaches across setback zones should be on raised wooden structures to preserve vegetation zones and avoid erosion from trails and tracks.

The basic formula for setback distances looks at three factors: 1) historical changes in coastline position, 2) change in the coastline likely to result from a category 4 hurricane, and 3) predicted coastline retreat that may result from sea level rise.

Stability of coastal structures such as houses and resorts are based on at least a 40 to 50 year life of the building. The setback distance is from the line of permanent vegetation (not the pioneer zone of beaches). Setbacks are then dependent on coastal types.

In high-energy areas the setback distance is calculated from the primary dunes. Mean high tides were not used due to seasonal fluctuations. The distances are standardized: 5m from cliff crest on high energy rocky shore, 10m from dune crest on high energy beaches, 15m from edge of vegetation on low energy rocky shores and 15m from edge of vegetation on low energy beaches.

Re-vegetation of coastal areas on the Baker's Bay property will use native plant species found on the island. The import of any sand, fill or soil material will be evaluated for the potential introduction of invasive species to the island. A list of appropriate plants for landscaping and gardens will be developed in the interest of both water conservation, and preventing known invasive exotic plants to introduced to the island.

Table 5.7 Impact matrix for construction of private homes and villas at *Passerine at Abaco* RCD.

Qualitative Criteria	Choices	Description
NATURE	Direct	Direct impacts on the coastal strand and broadleaf evergreen forest communities. Vegetation communities will be fragmented. Increased non-point source of pollutants with homes.
TYPE	Negative	
LIKELIHOOD	Certainty	Impacts and benefits will result from completed actions outlined,
SCALE	Habitat – specific impact (Broadleaf-Evergreen Forest)	Impacts are positive to restored coastal strand and dune communities as well as better health of broadleaf evergreen trees.
	Island environs	Removal of the Hawaiian beach cabbage and Australian pines will reduce seed sources to other beaches around the island
DURATION	Long-term	Native Plant communities will re-establish and

		recover from limited clearing. Central wastewater management will help reduce on-site impacts of houses.
REVERSIBILITY	Reversible	Small "footprint" of houses will create a reversible impact on native vegetation.
OVERALL SIGNIFICANCE	Negligible	With the restoration of coastal areas currently impacted by Australian pine and the establishment of coastal vegetation buffer zones, the overall environmental impact of the houses themselves will be small.
MITIGATION OPTIONS	1.) Enforce home owner guidelines for lot development and building 2.) Use native plants or non-invasive ornamental plants for landscaping 3.) Minimize need for watering or irrigation of landscaping 4.) Extend management to eradicate lobate lac scale on private lots, and develop a management and education programs to control this pest insect attacking native trees. 5.) Limit pets on the island to "on a lease" regulations. 6.) Develop deed restrictions to maintain coastal setback distance in perpetuity. Provide guidelines and material recommendations for boardwalks and walk-ways across coastal setbacks to beach and shore areas.	

PROPERTY MANAGEMENT
Coastal setbacks, hurricane preparation plan, and monitoring for invasive species.

The on-going management of private homes and residences includes maintenance of coastal setbacks, hurricane restoration planning, and ongoing removal of invasive alien plant species.

Residents will be educated to "love The Bahamas as they are", and embrace native plants in a more natural landscaping style. An aggressive outreach programme will target foreign residents, employees and local residents. A new paradigm for vacation homes can be created on the premise of environmentally sound management principles.

MARINA MANAGEMENT
Maintenance of marina perimeter, managing spills and hazardous wastes, and preventing eutrophication.

GOLF COURSE MANAGEMENT
Irrigation, pest control, and landscape maintenance.

The Baker's Bay development will require monitoring programmes to insure protection of ground water quality around the golf course. A contingency plan should be provided for use in the event that monitoring shows a developing problem.

Environmental standards for the maintenance of water quality and management of pest control chemicals include the following:

1. To minimize the need for chemical application, turf areas should allow for native vegetation to remain between fairways.
2. Drainage design and buffers should be utilized to minimize adverse impacts of runoff.
3. Storage and use of pesticides, herbicides, and fertilizers will be limited to and in conformance with US EPA and State of Florida standards. Chemical use is minimized through spot treatment and applicators are licensed and trained in all safety-related aspects of chemical use.
4. Integrated pest management systems should be employed to insure judicious use of pesticides by certified applicators.
5. Use of slow-release, less soluble, and least mobile chemical fertilizers, pesticides, and herbicides is encouraged. These products should be used at the smallest rates of active ingredient to accomplish the desired result.
6. Drought, pest, and disease resistant grass species should be selected.
7. Lined, artificial storage ponds should not be located in prime groundwater recharge areas.
8. Turf grass species and landscaping plants should be selected that are native as well as drought-resistant.
9. State-of-the-art irrigation systems with site meteorological monitoring capability should be used to minimize water use.
10. If on-site wells are to be used as the irrigation water source, analysis will be required to determine the safe yield in order to prevent aquifer depletion.

Many golf courses use a non-potable water supply to irrigate turf areas. This can be combined with the appropriate low-flow fixtures to be used throughout the development to promote water conservation measures critical to island living.

CHAPTER 8: MITIGATION MEASURES

Overview

There are seven proposed components of the mitigation plan. The goal of each component is proposed and explained, but the operation details are not presented. Criteria and conditions for accomplishing these mitigation goals will guide the development of operational plans.

An environmental mitigation plan addresses impacts that have been previously identified and assessed. There does not have to be a single measure for every adverse impact, but there are often several options that would help.

Mitigation can be implemented through project design, scheduling of activities, operational techniques, protective technologies, restoration of disturbed sites, preventive management plans and compensation for unavoidable impacts.

The Environmental Management Plan for the Baker's Bay development outlines the monitoring programmes and site management that are required to control and mitigate adverse impacts on natural resources. Mitigation measures for the site include:

Removal of existing sources of land-based pollution and contaminants.

Removal of Australian pines and other invasive plants.

Restoration of beach dunes where necessary.

Replanting of native trees and vegetation.

Removal of debris and trash in coastal waters.

Creation of artificial reefs in impacted near shore areas using DERM modules.

Restoration and protection of essential wetlands.

Protection of conservation areas including Joe's Creek.

Preparation of hurricane recovery plans for the coastal zone.

Recommendations for landscaping with native vegetation.

Environmental education and public outreach.

Sea Turtle Protection

Sea turtles face many natural hazards while in their hatchling and juvenile stages and are being pushed to the brink of extinction by human activities. Human factors in turtle decline include disruption of nesting sites, overharvesting and pollution of near shore waters with oil and debris.

Baker's Bay will implement a sea turtle protection programme that will protect and stabilize the coastline, regulate beach use that can interfere with turtle nesting, and protect near shore marine habitats used by turtles.

Critical turtle nesting times in the northern Bahamas are between mid-April and late October. The turtles crawl from the surf at night to lay their eggs in sandy burrows. Two months later, hundreds of hatchlings emerge and scramble back to sea.

The Bahamas is a signatory to the International Convention on the Trade of Endangered Species, so there are legal obligations to protect sea turtles and their habitat. Interference with nesting attempts may constitute a violation of the law, which protects all sea turtles from harm and harassment.

Beach Regulations to Protect Sea Turtles

•No walking on dunes or native dune plants. Beach access is provided by boardwalks
•Limited use of flashlights, flash cameras and other lighting on beaches at night
•No interference with turtles coming ashore to nest
•No littering
•Don't leave lounge chairs, sailboats, and other obstructions on nesting beaches at night
•Don't drive vehicles or ride horses on nesting beaches
•Dogs should be controlled at all times from March 16 to October 31
•No fires or fireworks should be permitted on windward beaches
•Watch for and avoid hatchlings emerging from a nest

Lighting is one of the most critical issues for coastal development. There are ways to avoid the disorientation of turtles, and make the beach usable by both people and turtles. The goal is to keep lights away from the beach, including flash cameras and flashlights.

Hatchling turtles are guided to the ocean by an instinct to travel away from the dark silhouettes of dune vegetation and toward the brightest horizon, which was the light from the sky reflecting off the ocean.

Artificial lighting near the beach can deter females from nesting and disorient hatchlings, causing them to travel inland where they often die from dehydration, predation or road traffic.

Beach front property owners can modify their lights to prevent them from being seen from the beach. Decorative lighting (such as runner lights or uplighting of vegetation) should not be used in areas that are visible from the beach. Lights should be shielded and faced away from the beach wherever possible. Only low intensity ‘turtle friendly’ bulbs should be used for beach lighting. Vegetation buffers can be used to screen light from the beach. Efforts should also be made to reduce spillover from indoor lighting.

CHAPTER 9: PUBLIC CONSULTATION

The developers are committed to a process of public consultation and outreach. This process includes surveying residents and visitors to gather views and perceptions on development in general, and the Baker’s Bay Club in particular.

A list of stakeholder groups is identified and relevant information produced on a variety of issues and concerns. Stakeholders include repeat visitors, homeowners, boaters, area businesses, civic groups and local inhabitants. Mechanisms are then created to share this information and allow feedback on legitimate concerns.

Baker's Bay is part of a growing trend towards the construction of more second homes and resort communities in the northern Abacos, and will change the landscape of the region, as well as the quality of life for many residents.

Public consultation should aim to provide accurate basic information on the development to all stakeholders. The implications of development for the future of small island communities should also be discussed. Issues like sewerage treatment, solid waste disposal, pollution, invasive plants, and coastal protection all need to be addressed.

Through the public consultation process, the developers will have personal contact with key stakeholders to detect problems before they occur. A solid communications plan executed in good faith can yield long-term support and focus attention on legitimate issues. The consultation process should include town meetings, speaking engagements, community participation, press statements, and a web site for posting updates.

CHAPTER 10: ENVIRONMENTAL MANAGEMENT PLAN

Overview

There is currently no environmental stewardship of any of the properties or developments on Great Guana Cay. But the Baker's Bay project will be unique in the transparency of its site management and environmental reporting. This project will be an experiment in sustainability for small island developments, with the goal of documenting ecological hazards and safeguards.

The Baker's Bay Environmental Management Plan sets a model for private land stewardship in The Bahamas, particularly for resort communities. The plan relies on technologies and protocols that are appropriate for use in national parks and public land trusts.

It is often difficult to document the real ecological costs of development until many years after the contractors have left. And the long-term environmental impacts can pose a significant financial burden to residents of the resort community they leave behind.

For example, resort development in the Florida Keys commonly underestimated the flushing rates of residential finger canal systems. Decades after construction, residents are now faced with expensive mitigation options to improve near shore and canal water quality, with millions of dollars to be invested in treatment plants, backfilling canals, and re-landscaping canal margins.

The Baker's Bay developers have shown a willingness to work with researchers and scientists to better understand and sustain the environment of Great Guana Cay. It is common for development and resort companies to say, "we adhere to the highest environmental standards", but what those standards are, and how appropriate existing practices are for small tropical islands has yet to be established.

Based on an initial ecological assessment of the property prior to development, measurable environmental guidelines and goals have been set. This will help both the developers and scientists to better understand the economic ‘break points’ in small island development.

For example, are golf courses always the highest impact component of such resorts? And how can the known impacts be reduced or mitigated? This plan will address the critical need for measurable environmental goals assessed in an objective and independent manner to report on the long-term implications of small island development.

The plan includes monitoring programs, mitigation measures, educational outreach, and reporting and research. The property will be monitored before, during and after construction. Impact matrices and ‘score cards’ will be used to gauge and measure adherence to environmental goals and objectives.

Mitigation, outreach and reporting will be ongoing and adaptive to each stage of development. All data will be made available for publication in the spirit of documenting best practices.

EMP Components

•Ecological Monitoring
Prior to construction a Rapid Ecological Assessment was performed on wetland, upland, coastal and marine habitats to gather baseline data. This data– together with on-site inspections, webcam recordings and aerial photos - will be used to monitor housing, marina and golf course construction. Special attention will be paid to dredging operations, land clearing and other ecological parameters.

•Geographic Information Systems
A GIS database will help monitor land use changes in a format that is easily understood by stakeholders. By mapping land cover before, during and after construction, environmental impacts can be easily depicted and analysed. Software and guidelines developed by the US National Oceanic and Atmospheric Administration will be used.

•Environmental Monitoring
Waste disposal, sewerage treatment and water quality management will be closely monitored and mitigation measures applied as necessary. Education outreach will improve coordination between government agencies, stakeholders and scientists. A database and web site will distribute information.

•Reporting and Research
The monitoring team will document incidental occurrences on a regular basis and report this information directly to the developers, government agencies and other stakeholders.

CHAPTER 11: CONCLUSION

The Baker's Ba***y*** project is based on a unique partnership between ecologists and developers that offers a rare opportunity to document best management practices for small island development.

The overall goal of the collaboration is to maintain and celebrate the unique features of Great Guana Cay, and to create a uniquely Bahamian resort setting.

The planned land conversion is substantial for a small island, but the investment in mitigation, management and advanced technologies can provide a model for sustainable development through The Bahamas.

References

Davison, Leigh, Mark Bayley, Tony Kohlenberg and John Craven. *Performance of Reed Beds and Single Pass Sand Filters with Characterisation of Domestic Effluent - NSW North Coast*.
Davison, Leigh. *On-site secondary treatment by reed bed: five years experience in northern NSW*.
McQuire, Stuart, 1995. *Not Just Down the Drain*.
Mobbs, Michael, 1998. *Sustainable House: Living for Our Future*. Marrickville, N.S.W: Choice Books.
Reuse Options For Household Wastewater (Publication 812). EPA Victoria, November 2001
Arukwe, A (2001) Cellular and molecular responses to endocrine-modulators and the impact on fish reproduction, Mar. Poll. Bull, 42, 8, 643-655.

Downs, CA, Mueller, E, Phillips, S, Fauth, JE, and Woodley, CM (2000) A Molecular biomarker system for assessing the health of coral (Montastraea faveolata) during heat stress, Mar. Biotechnol., 2, 533-544.

Glynn, PW, Rumbold, DG, and Snedaker, SC (1995) Organochlorine pesticide residues in marine sediment and biota from the northern Florida reef tract, Mar. Poll. Bull., 30, 6, 397-402.

Harrison, PL, Ward, S (2001) Elevated levels of nitrogen and phosphorous reduce fertilization success of gametes from scleractinian reef corals, Mar. Biol., 139, 1057-1068.

Mansingh, A and Wilson, A (1995) Insecticide contamination in the Jamaican environment 3: baseline studies on the status of insecticidal pollution of Kingston harbour, Mar. Poll. Bull., 30, 640-645.

McCloskey, LR and Chesher, RH (1971) Effects of man-made pollution on the dynamics of coral reefs. In Scientisits-in-the-sea, ed. JW Miller, JG Van Der Walker and RA Waller, Vol. 6, 229-37. Washington, US Department of Interior.

Morgan, MB, Vogelien, DL, and Snell, TW (2001) Assessing coral stress responses using molecular biomarkers of gene transcription, Env. Toxic. And Chemistry, 20, 3, 537-543.

Oloffis, PC Albright, LJ, Szeto, SY and Lau, J. (1973) Factors affecting the behaviour of five chlorinated hydrocarbons in two natural waters and their sediments. J. fish Res. Bd Can., 30, 1619-23.

Olafson, RW (1978) Effect of agricultural activity on levels of organochlorine pesticides in hard corals, fish and mollusks from the Great Barrier Reef, Marine Env. Res, 1, 87-107.

Peters, EC, Gassman, NJ, Firman, JC, Richmond RH, and Power, EA (1997) Ecotoxicology of tropical marine ecosystems, Env. Toxicol. And Chemi., 16, 1, 12-40.

Portmann, JE (1975) The bioaccumulation and effects of organochlorine pesticides in marine animals. Proc. R. Soc. Lond. B, 189, 291-304.

Ramachandran S, Rajendran, N., Nandakumar, R, and Venugopalan, VK (1984) Effect of pesticides on photosynthetic and respiration of marine macrophytes. Aquat. Bot. 19, 395-399.

Randall, JE (1972) Chemical pollution in the sea and the crown-of-thorns starfish (Ancanthaster planci), Biotropica, 4, 3, 132-144.

Rees, JE, Setiapermana, D, Sharp, VA, Weeks, JM, and Williams, TM (1999) Evaluation of the impacts of land-based contaminants on the benthic faunas of Jakarta Bay, Indoneisa, Oceanologica Acta, 22, 6, 627-640.

Rawlins, BG, Ferguson, AJ, Chilton, PJ, Arthurton, RS, and Rees, JG (1998) Review of agricultural pollution in the Caribbean with particular emphasis on small island developing states, Mar. Poll. Bull., 36, 9, 658-668.

Richmond RH (1993) Coral reefs: present problems and future concerns resulting from anthropogenic disturbance. Am. Zool., 33, 524-536.

Singh, NC and Ward, RE (1992) Land based pollution sources and marine environmental quality in the Caribbean, Chemical Ecology, 6, 259-270.

UNEP (1992) Environmental problems affecting the marine and coastal environment in the wider Caribbean region. UNEP (OCA)/CAR IG.9/INF.5.

Walsh GE, Hansen, DL, and Lawrence, DA (1982) A flow-through system for exposure of seagrass to pollutants, Mar. Environ. Res., 7, 1-11.