Caribbean Regional Fund for Wastewater Management

Baseline Assessment Study on Wastewater Management

Jamaica

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Baseline Assessment Study on Wastewater Management Jamaica

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LIST OF ACRONYMS

AAS	Atomic Absorption Spectrophotometer
AOSIS	Alliance of Small Island States
BOD	Biochemical Oxygen Demand
CAREC	Caribbean Epidemiology Centre
CARPHA	Caribbean Public Health Agency
CBD	Convention on Biological Diversity
CBO	Community-Based Organization
CDC	Centers for Disease Control and Prevention
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COD	Chemical Oxygen Demand
COP	Conferences of Parties
CReW	Caribbean Regional Fund for Wastewater Management
CWIP	Coastal Water Quality Improvement Project
DHF	Dengue Haemorrhagic Fever
DSS	Dengue Shock Syndrome
EFJ	Environmental Foundation of Jamaica
EIA	Environmental Impact Assessment
EHL	Environmental Health Laboratory
EHU	Environmental Health Unit
ENGO	Environmental Non-Governmental Organization
EU	European Union
FAO	Food and Agriculture Organization
FRA	Forest Resource Assessment
FS	Faecal Sludge
FSMA	Food Safety and Modernization Act
GDP	Gross Domestic Product
GE	Gastroenterology
GOJ	Government of Jamaica
GPS	Global Positioning System
HACCP	Hazard Analysis and Critical Control Points
HAJL	Housing Agency of Jamaica Ltd.
IDB	Inter-American Development Bank
IMF	International Monetary Fund
IPCC	Inter-governmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
LBS	Land-Based Sources
JaNEAP	Jamaica National Environmental Action Plan
JPSCo	Jamaica Public Service Company
JWOA	Jamaica Wastewater Operators Association
KAP	Knowledge, Attitudes and Practices

KMA	Kingston Metropolitan Area
KSA	Kingston and St. Andrew
MBR	Membrane Bioreactor
MDG	Millennium Development Goal
MLD	Million Litres per Day
MGD	Million Gallons per Day
MMR	Measles, Mumps and Rubella
MOA	Ministry of Agriculture
MOH	Ministry of Health
MP	Member of Parliament
MPN	Most Probable Number
NEPA	National Environment and Planning Agency
NGO	Non-Governmental Organization
NHDC	National Housing Development Corporation
NHT	National Housing Trust
NPHL	National Public Health Laboratory
NPV	Net Present Value
NRCA	Natural Resources Conservation Authority
NSDI	National Spatial Data Infrastructure
NSWMA	National Solid Waste Management Authority
ODPEM	Office of Disaster Preparedness and Emergency Management
PCJ	Petroleum Corporation of Jamaica
PDC	Parish Development Committee
PIOJ	Planning Institute of Jamaica
PSP	Paralytic Shellfish Poisoning
RIA	Rapid Impact Assessment
SIA	Social Impact Assessment
SIDS	Small Island Developing State(s)
SPAW	Specially Protected Areas and Wildlife
SRC	Scientific Research Council
STD	Sexually Transmitted Disease
STP	Sewage Treatment Plant
TD	Travellers' Diarrhoea
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
WHO	World Health Organization
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund
UNFCCC	United Nations Framework Convention on Climate Change
UNFPA	United Nations Population Fund
USAID	United States Agency for International Development
UTech	University of Technology, Jamaica

WCR	Wider Caribbean Region
WRA	Water Resources Authority
WWTP	Wastewater Treatment Plant

1. INTRODUCTION

This National Baseline Assessment on Wastewater Management for Jamaica was prepared to provide information for a Regional Baseline Assessment Study on Wastewater Management for the Wider Caribbean Region. The regional assessment will assist these governments in meeting the requirements of the Protocol Concerning Pollution from Land-Based Sources and Activities (LBS Protocol), with particular emphasis on meeting the effluent standards specified in Annex III of the Protocol. The Regional Assessment will assist the United Nations Environment Programme-Caribbean Regional Coordinating Unit (UNEP-CAR/RCU) in the design and implementation of future capacity building activities. It will be the foundation of information for a broad group of stakeholders to understand the general and the specific needs that should be considered in the development of national domestic wastewater management plans.

The National Baseline Assessment is structured as follows:

- **National Context** – the social, environmental and economic characteristics of Jamaica
- **Methodology** – the assessment methodology
- **Mathematical Model** – the mathematical model used for analysis of the data
- **Overview of wastewater management** – Jamaica's wastewater management infrastructure, technologies and practices
- **Pollution problems and their cost –** the impacts of current wastewater management practices and their social, environmental and economic costs
- **National capacity –** the legislative, policy and institutional capacity for wastewater management
- **Surveillance and enforcement** – the capacity and systems for monitoring and enforcement to promote good wastewater practices
- **Manpower capacity** – the availability of staff and capacity needs for wastewater management
- **Financing** – existing and required financing for wastewater management
- **Knowledge, attitudes and practices** – current knowledge, attitudes, behaviours and practices regarding water and sanitation
- **Information** – systems and capacity for collecting, sharing and using data to facilitate improved wastewater management
- **Supporting organizations** – the presence and participation of non-governmental and community-based organizations in water and sanitation
- **Climate change impacts** – impacts of climate change on water and sanitation services

The assessment concludes with a **summary of main findings** and **recommendations for action**.

2. THE NATIONAL CONTEXT

DESCRIPTION OF THE COUNTRY

History

Jamaica is an island nation in the Caribbean Sea and a part of the group of islands that is known as the Greater Antilles[1]. Jamaica is located approximately 145 kilometers (90 miles) south of the island of Cuba and was discovered by Christopher Columbus in 1494. At that time, the island was inhabited by the Arawakan-speaking Taino people, who had named it Xaymaca, which means the "Land of Wood and Water" or the "Land of Springs". Upon possession by the Spanish, it became known as Santiago, and then Jamaica after it was possessed by the British in 1655. Jamaica achieved independence in 1962.

National Government and Local Government

Jamaica has a constitutional monarchy, represented by a Governor General who is the local representative of Queen Elizabeth II (the de facto head of state with the title, Queen of Jamaica). The Governor General is nominated by the Prime Minister. The government is bicameral, with a House of Representatives and a Senate. Members of the lower house (Members of Parliament or MPs) are directly elected and it is from these MPs that the Prime Minister is chosen. Members of the Senate are chosen by the Prime Minister and the Leader of Opposition.

Administratively, the nation is divided into 14 parishes within which exist 63 parliamentary constituency seats and numerous parish councils. The country has traditionally had a two-party system which has been dominated by the People's National Party and the Jamaica Labour Party. The Jamaican system of government exhibits a relatively stable democracy. Since independence, the country has not had a coup d'état and elections, especially in recent times, have been judged free and fair.

Jamaica is an active member in CARICOM (Caribbean Community), a regional free-trade association based in Guyana whose main purposes are to promote economic integration and cooperation among its members and to coordinate foreign policy. The Treaty of Chaguaramas establishing CARICOM was signed on 4 July, 1973; a revised treaty was signed in 2001.

Jamaica is also a member of the Alliance of Small Island States (AOSIS), a coalition of small island and low-lying coastal countries that share similar development challenges and concerns about the environment, especially their vulnerability to the adverse effects of global climate change.

Growth Rates, Demographics

Jamaica is the third most populous anglophone country in the Americas, after the USA and Canada. The 2011 Census of Population indicates that at 2011, Jamaica had a resident population of 2,697,983. Demographically, Jamaica's population has consistently comprised four major ethnic groups: black: 90 per cent; East Indian: 1.5 per cent; white: 0.4 per cent; and multi-racial: 7.4 per cent.

[1] The Greater Antilles comprise Cuba, Hispaniola (Haiti and the Dominican Republic), Jamaica and Puerto Rico

Health Indicators

According to Jamaica's National Report on Millennium Development Goals (MDGs) prepared in 2009, Jamaica is lagging with respect to the MDG targets for health indicators, *i.e.*, those related to child mortality, maternal health, and combating HIV/AIDS and other diseases. However, there has been progress toward meeting these targets. In 2012, under-five mortality was approximately 17 deaths per 1,000 live births (the MDG target is 10 deaths per 1,000 live births). Jamaica's HIV prevalence has fallen since 2000 (but is still above 1990 levels) and since 1990, there has been a significant reduction in estimated tuberculosis (TB) mortality and in 2011, measles immunization was 93 per cent (the MDG target is 100%) (Commonwealth Foundation, 2015). However, Jamaica's maternal mortality ratio in 2007-2011 was 95 deaths per 100,000 live births, significantly higher than the target of 15.

However, Jamaica's life expectancy (73 years in 2009) is comparable to many developed countries and far higher than the average of 65 for developing countries. This positive statistic is reflected in Jamaica's high ranking among developing countries on the Human Development Index[2]. The national estimate for MMR (measles, mumps and rubella) incidence was 106.2 per 100,000 in 2006 (this is higher than the UNFPA State of the World Population 2007 estimate of 87). The crude birth rate was 17.0 per 1,000 mean population. Total fertility rate for the same year stood at 2.5 /1,000 women in the 15 – 49 years age group. Immunization coverage for the major vaccines on the Government's immunization schedule were: DPT, OPV, BCG[3] for children 0-11 months, 87 per cent; and MMR for children 12- 23 months, 87.2 per cent.

In terms of morbidity, communicable diseases, including reemerging ones, and the high prevalence of chronic, noncommunicable diseases pose a major challenge. Between 2000 and 2008, prevalence of diabetes rose from 7.2% to 7.9%, hypertension from 20% to 25%, obesity from 9.7% to 25%, and sedentarism from 17% to 30%. According to the survey on health and lifestyles, the prevalence of chronic, noncommunicable diseases and risk factors is on the rise. Surveys from 2000 and 2008 show few changes in health-related behaviors (PAHO 2012). Thus, Jamaica's disease profile has changed rapidly from one that was characterized predominantly by infectious diseases to one that is dominated by chronic, largely lifestyle illnesses, more in keeping with the profile of a developed country. This is shown in Table 1 which lists the most common reasons for visits to primary health care facilities.

It must be noted that Jamaica's epidemiological transition during the past century was achieved at considerably less cost for each gain made than was achieved in many developed countries. This has resulted in Jamaica being rated by the World Health Organization (WHO) as having a highly efficient health service (defined in terms of health status per unit cost).

[2] The HDI is a standard means of measuring well-being and is a comparative measure of life expectancy, literacy, education, standards of living, and quality of life for countries worldwide.
[3] DPT is diphtheria, pertussis (whooping cough), and tetanus; OPV is oral polio vaccine; BCG is the vaccine against tuberculosis

Table 1: Curative Visits to Primary Health Care Facilities By Leading Conditions and Region, Public Health Sector, 2008 (Jan-Sep)						
Diagnosis	**Jamaica**	**SERHA**	**NERHA**	**WRHA**	**SRHA**	
	No. Visits	No. Visits	No. Visits	No. Visits	No. Visits	% of top 6 visits
Hypertension	104 565	39 412	18 260	21 488	25 405	22.9
Diseases of the Respiratory Track	111 093	59 709	16 955	12 169	22 260	24.3
Skin Disease	83 247	38 691	14 955	12 658	16 943	18.2
Genito-Urinary Diseases (including STDs[4])	76 631	45 252	9 114	9 782	12 483	16.8
Musculoskeletal	45 127	17 164	9 404	8 336	10 223	10.0
Psychiatric	35 818	17 525	5 172	6 848	6 271	7.8
TOTAL	**456 481**	**217 753**	**73 860**	**71 281**	**93 585**	**100**

Data reveal marked increases in the utilization of public facilities after 2007, but no corresponding increases in the capacity of the facilities. For example, the mean bed complement declined from 4,207 in 2007 to 3,896 in 2008, but the casualty attendance rose from 627,578 to 864,044 over the same period (an increase of approximately 38 per cent). However, the data also show a notable increase in the number of discharges over the same period (up from 147,775 to 190,505 – a 29 per cent increase). This would provide some balance to the increased intake.

GEOGRAPHICAL CHARACTERISTICS

Jamaica is the third largest island in the Caribbean. The island is approximately 230 km long, oriented in an east-west axis and is approximately 80 km at its widest point. Land area is 10,990km^2, of which about 160 km^2 are water bodies and the coastline is approximately 1,022 km long.

The terrain is characterized by a mountainous region along the island's east west axis and narrow coastal plains. The highest elevation is Blue Mountain Peak which is 2,256 m above sea level. Most major towns and cities are located on the coast, with the chief towns and cities being the capital Kingston, Montego Bay (its second city), Ocho Rios and Port Antonio. Only two major parish capitals are located inland: Mandeville and Spanish Town.

The local climate is tropical, with coastal areas having hot and humid weather and inland areas having a more temperate climate. Jamaica lies in the hurricane belt of the Atlantic Ocean and historically has experienced strong tropical hurricanes. The more recent ones, Hurricanes

[4] Sexually transmitted diseases

Sandy (2012), Dean (2007) and Ivan (2004), have created huge infrastructural damages and some loss of life.

Jamaica's freshwater resources come from surface sources (rivers and streams), underground sources (wells and springs) and rainwater harvesting. Groundwater supplies most water demands (approximately 80 per cent of production) and represents 84 per cent of the island's exploitable water. The island's water sources are associated with major rock formations and their interrelationships. The three dominant hydro-stratigraphic units are basement aquiclude, limestone aquifer and alluvium aquifer/aquiclude. The island is divided into ten hydrological basins.

Raw water supplies are directly affected by changes in climatic conditions. Changes in the amount of rainfall as well as its frequency and intensity determine the amount of water that will be available for exploitation. The changes to the amount of total rainfall that Jamaica may receive under the climate change scenarios are uncertain; however, even minor changes in Jamaica's rainfall patterns could have significant impacts on its water resources.

ECONOMY BY SECTORS

Tourism, Manufacturing, Agriculture, Livestock, Mining, Banking and Finance, Fisheries

Jamaica operates a mixed economic system where there are prominent state enterprises alongside a viable private sector. The major sectors of the Jamaican economy are mining and quarrying, tourism, agriculture and manufacturing, with tourism and bauxite mining (and remittances) being the leading foreign exchange earners. The economy has become more service-driven over time, growing from 72.9 per cent in 2007 to 79.4 per cent in 2013 (PIOJ 2014).

Tourism and private remittance inflows each provides approximately 30 per cent of annual GDP. The Jamaican tourism product is dominated mainly by resort ("sun, sea and fun") tourism and is location-specific. The north coast areas (i.e., Montego Bay, Ocho Rios and Negril) are the dominant areas for both stopover and cruise ship visitors (GOJ 2011).

While the contribution of agriculture to Jamaica's GDP is small, the sector is a large employer and is important to rural development. Agriculture's contribution to GDP was 6.7 per cent (including approximately 0.05 per cent from fisheries) in 2013, and the sector currently employs 18 per cent of the national workforce. Food exports from the island increased by 22.3 per cent, moving from US$224 million in 2011 to US$274 million in 2012 (JTI 2014).

THE ENVIRONMENT

Solid Waste, Liquid Waste, Hazardous Waste, Flora, Fauna, Biodiversity

Solid Waste

The main environment-related issues related to the management of solid waste in Jamaica are:

- Lack of comprehensive and integrated waste management policy
- Limited options for the environmentally sound management of solid waste
- Low levels of public awareness
- Limited collection efficiency which contributes largely to the improper disposal of waste (disposal in gullies etc. and burning). Most waste disposed of in gullies eventually ends up in coastal areas which not only results in poor aesthetics, but more importantly the depletion of coastal resources. Pollution due to fires at the waste disposal site as well as the discharge of leachate and the emission of methane which is characteristic of waste disposal sites compared to sanitary landfills

Over the past 30 years, the generation of solid waste per capita in Latin America and the Caribbean has doubled, increasing from 0.2-0.5 kg/day to 0.5-1.0 kg/day. This trend has been seen in Jamaica, where, for example, there was a 50 per cent increase in the per capita generation of solid waste from 1999 to 2004, moving from 1.0 to 1.5 kg per day[5] . Also, there has been a change in the composition of waste with more non-biodegradable and hazardous materials which are detrimental to human and environmental health. In general, the country's changing socioeconomic and demographic variables have been influencing both the type and quantity of waste being produced. These factors include population size and structure; consumption patterns and lifestyles; changes in household size and composition; changing gender roles; urbanization and shifts and expansion of economic activities (PIOJ 2007).

A waste characterization study of the Riverton City dumpsite conducted in 2013, reported that the Metropolitan Parks and Markets wasteshed produces in excess of one million tonnes of household solid waste annually (NSWMA 2013). Riverton receives approximately 60 per cent of the country's wastes and therefore it can be determined that the country produces more than 1.6 million tonnes of household waste each year.

The National Solid Waste Management Authority (NSWMA) estimates that 70 to 75 per cent of the country's household waste is collected, while the remainder is uncollected due to inaccessibility, competing disposal practices and improper waste management practices.

According to the Survey of Living Conditions 2012, 63.4 per cent of households used a public or private garbage collection system, while 31.9 per cent burned their garbage. Collection of garbage by public authorities was high in the KMA, with 91.6 per cent of households in this region reporting this facility. On the other hand, 45.4 per cent of rural area households, and one in five households in other towns, burned their garbage. Other disposal methods include burying and dumping on open lots and in gullies. Jamaica has no sanitary landfills but has eight

[5] Estimated from Waste Characterization Study at the Riverton Landfill, National Solid Waste Management Authority, 2006.

authorized disposal sites which are managed by the NSWMA (NEPA 2011). Furthermore, poor location, operation and control of existing dump sites are the cause of many public health and environmental problems.

Proper management of solid waste is posing a serious challenge to Jamaica's sustainability. One of the main problems is that, like many other developing countries, Jamaica lacks the technical and financial resources to adequately manage waste. This has resulted in inefficient and inadequate collection, treatment and disposal. This problem is further exacerbated by the lack of a comprehensive and integrated waste management policy and the double role that the NSWMA plays as both a service provider and as a regulator.

Another challenge is related to the complexities brought about by the different types of wastes with which the country has to contend. Waste characterization studies carried out by NSWMA in 2006 and 2013 reported that over 60 per cent of the solid waste produced in Jamaica is organic, which means there is great potential for waste reduction through composting initiatives. Domestic solid waste represents approximately 70 per cent of the estimated total solid waste generated while commercial/industrial solid waste represents about 30 per cent.

The garbage that is dumped into the country's dump sites ranges from domestic waste to commercial and industrial waste. In the dump or along the access roads it is possible to observe refrigerators, air conditioners, water boilers, TVs, old computers and transformers among other items. The waste items are exposed to the open air, there is no collection of leachate, recyclable parts are taken in an ad hoc manner, and the rest is left without any supervision regarding proper disposal.

Liquid Waste

The proportion of the population using an improved sanitation facility has been selected as one of the MDG environmental indicators. The 2012 Survey of Living Conditions states that 99.8 per cent of households in Jamaica have access to an improved sanitation facility, i.e. either water closet or pit toilet.

In 2012, water closets, which have been increasing relative to pit toilets, accounted for 73.8 per cent of toilet facilities. In the KMA, 92 per cent of households have flush toilets, while in other towns 60 per cent of households have this facility. However, 42.4 per cent of households with flush toilets are not linked to wastewater treatment facilities (sewers), indicating that soil absorption systems are the predominant means of sewage disposal for the country (NEPA, 2010). See the section on Water and Sanitation for detailed data related to sewage management.

The country's groundwater continues to be polluted as a result of soak-aways and absorption pits – traditionally the most common method for on-site treatment of wastewater (residential and commercial black and grey water). The contamination of groundwater is due in part to the predominant limestone geological formation which allows sewage to enter the groundwater

table. This has resulted in a number of wells in Kingston becoming unusable, for the most part because of high level of nitrates present in the ground water.

Consequently, absorption pits as standalone treatment/disposal options are no longer sanctioned for new housing developments and – as prescribed by the Water Resources Authority (WRA) – in areas with high water tables, only methods effecting tertiary treatment are allowed.

An opportunity exists for using waste products from sewage treatment. Sludge is left behind from the wastewater treatment process and is suitable for generating energy through processes such as gasification to produce syngas, incineration to generate electricity, or anaerobic digestion. However, in order for a national system to be developed to process wastewater sludge for energy generation, centralized wastewater treatment plants are necessary.

Wastewater is also generated from agri-businesses. However, industrial wastewater treatment facilities in the agro-industrial sector are plagued with poor trade effluent discharge quality. This is of particular concern in the sugar industry, coffee industry, distilleries, and abattoirs. Codes of Practice have been developed for the coffee and sugar industries which aim to improve the quality of effluents. Industrial wastewater treatment facilities in the agro-industrial sector, where end-of-pipe treatment options are typically used as the first solution, generally have poor trade effluent discharge quality.

Hazardous Waste

Although there is limited data on the actual quantities generated, the general view is that the quantity of hazardous waste is increasing. In 2010, the proportion of the population that owned computers and mobile phones increased by 9.3 per cent when compared to the previous year. However, there was a 45 per cent decline in motor vehicle imports from 2007 to 2010 and a corresponding decrease in the quantity of lead acid batteries imported.

Although a large quantity of hazardous waste ends up un-separated at disposal facilities, there are some categories of hazardous waste that are collected for reuse and recycling. Reuse and disposal of certain hazardous materials occurs as follows:

- Used petroleum oil - used as a supplemental fuel and lubricant; also used inappropriately in pest control (in drains to control mosquitoes and on animals to eradicate ticks) and for dust control
- Asbestos - asbestos waste is accepted by the NSWMA at the Riverton site once it is packaged according to the National Environment and Planning Agency's (NEPA's) requirements and it is disposed of in a designated area of the site
- E-waste - NSWMA receives and stores discarded computers in a designated area at the Riverton Disposal site
- Medical waste - much of the medical waste generated is separated and incinerated, however, some medical waste does end up in municipal disposal sites
- The main sources and types of hazardous waste generated in Jamaica are:

- Industrial - e-waste, solvents, waste oil, asbestos, heavy metals
- Agricultural – pesticides
- Commercial - e-waste, paint, toners, asbestos, car batteries (lead acid)
- Household - cleaners, disinfectants, paints, dugs, batteries, e-waste, fluorescent bulbs
- Medical - contaminated needles, bandages, drugs, radioactive material

The main issue regarding the management of hazardous waste in Jamaica is an overall lack of suitable treatment and disposal options. The larger industries, such as bauxite, petroleum and the lead acid battery sector export their hazardous wastes for recycling, recovery or disposal (MAJ 2007). However, the cost to export this waste is prohibitive for many small- and medium-sized enterprises. The lack of necessary local infrastructure has therefore resulted in illegal dumping of these toxic materials, leading to contamination of soil and water.

Flora, Fauna, Biodiversity

One of the four targets for the Millennium Development Goal 7 related to the environment addresses biodiversity. The inclusion of this target in the MDGs demonstrates the importance of biological diversity to a healthy environment. The target, set in 2000, calls for a significant reduction in the rate of loss of biodiversity by 2010. The state of Jamaica's biodiversity can be determined by examining the condition of its ecosystems as well as the plant and animal species within these ecosystems (NEPA 2010).

Jamaica's many ecosystems are the repositories of biodiversity. Therefore, conservation and sustainable use of these forests, coral reefs, wetlands etc., is a critical component of Jamaica's overall biodiversity conservation strategy (NEPA 2010).

There are over 3,304 vascular plant species in Jamaica (of which 28 per cent are endemic), 600 species of ferns, 116 species of butterflies, and 256 known species of birds (106 indigenous to Jamaica as well as migratory birds). There are thirty birds endemic to Jamaica, including the yellow-billed and

Table 2: Terrestrial Species Diversity in Jamaica

Fauna and Flora	Total # of Indigenous Species	Total # of Endemic Species
Rotifer	211	<21
Land Snails	514	505
Grapsid Crabs	9	9
Jumping Spider	26	20
Fireflies	48	45
Butterflies	133	20
Ants	59	6
Amphibians	22	22
Reptiles	43	33
Shore and Sea Birds	39	1
Land Birds	67	30
Bats	21	2
Other Mammals	2	2
Bromeliads	60	22
Orchids	230	60
Ferns	579	67
Cacti	20	10
Palms	10	7
Grasses	200	1

Source: Fourth National Report to the Convention on Biological Diversity

the black-billed parrot and the streamer tail hummingbird – Jamaica's national bird. Table 2 shows terrestrial species diversity in Jamaica. As can be seen from the table, endemism is very high in land snails (98 per cent), grapsid crabs (100 per cent), fireflies (~94 per cent), and amphibians (100 per cent) (NEPA 2010).

With respect to marine biodiversity, there are well over 3,500 different plants and animals (not including bacteria, viruses and fungi) in the shallow, shore or shelf waters of the Jamaican marine environment (Warner and Goodbody 2005). Few deep-sea studies have been conducted, but it is likely that the greatest proportion of new species may be discovered in this environment. Table 3 shows the estimates of marine species in Jamaican shallow, shelf, or shore waters. Seagrasses can be found throughout the Jamaican coastal areas, but are more abundant on the south coast where the island shelf is broader. The three species found in Jamaican waters are Shoal Grass (*Halodule wrightii),* Turtle Grass *(Thalassia testudinum),* and Manatee Grass *(Syringodium filiforme)*.

Important large aquatic and marine-related animals include the West Indian Manatee, dolphins and whales, sea turtles and crocodiles (NEPA 2010), as described below:

- The West Indian Manatee (*Trichechus manatus manatus*) is endangered and is now rare in Jamaica. The numbers of manatee seen in the Alligator Pond area (at the border of Manchester and St. Elizabeth), where they were most often seen, is extremely low.

- Dolphin and whale species in Jamaica's waters (Creary 2008; O'Sullivan 2006) include:
    - Bottlenose dolphins (*Turslops truncates*) – the most numerous species;
    - Atlantic spotted dolphin (*Stenella frontalis*), the Pantropical spotted dolphin (*S. attenuate*), and the stripped dolphin (*S. coerulealba*) – these are commonly seen
    - Killer whale (*Orcinus orca*), short-finned pilot whales (*Globicephalus macrocephalus*), Risso's dolphin (*Grampus griseus*), melon-headed whale (*Pepenocephala electra*), Sperm whale (*Physeter catadon*), pygmy sperm whale (Kogia breviceps) and the humpback whale (*Megaptera novaeanglae*) – small numbers of which exist.

Table 3: Estimates of Marine Species in Jamaica Shallow, Shelf or Shore Water

Taxon	Number of Species	Taxon	Number of Species
Phytoplankton	374	Mollusca	825
Macroalgae	386	Bryozoa	64
Porifera	194	Chaetognatha	10
Cnidaria	204	Echinodermata	88
Ctenophora	6	Hemichordata	2
Nematoda	81	Chordata	75
Annelida	100	Cephalochordata	1
Crustacea	455	Vertebrata	637
Source: George R. Wamer and Ivan Goodbody "Jamaica" In Caribbean Marine Diversity: The Known and the Unknown (Lancaster. DEStech Publication, 2005), 57-70			

- The American Crocodile (*Crocodylus acutus*) is the only species of crocodile found in Jamaica and is listed as vulnerable by the International Union for Conservation of Nature (IUCN). This means that the species is "facing a high risk of extinction in the wild in the medium-term future". The crocodile is protected by law and is found mainly on the south coast in mangrove swamps, marshes, shallow bays, rivers, and other water bodies. There are a few isolated populations present on the north coast (Bogue Lagoon in St. James and Salt Marsh in Trelawny). The risk of extinction is mainly due to a significant loss of habitat by wetland reclamation for development and also human encroachment. Subsequently there also is an increase in the number of human/crocodile confrontations as the animals seek out new areas (storm drains, micro-dams, and sewage and fish ponds).

  In 2010, the two areas with the greatest crocodile populations were the Milk and Rio Minho Rivers along with their associated wetlands and the Greater Portmore/The Flashes area. Sizes ranged from 0.305 m to 3.962 m in these areas. Surveys for nesting sites indicated that nesting activity takes place in all the wetlands, however Rolling Bay (Clarendon) and Font Hill (St. Elizabeth) showed the highest density (6 nests/km and 2 nests/km, respectively) (NEPA 2010).

- There are four species of sea turtles that can be found in Jamaican waters: the Green sea turtle (*Chelonia mydas*),
- The Hawksbill sea turtle (*Eretmochelys imbricata*), the Leatherback turtle (*Dermochelys coriacea*), and the Loggerhead sea turtle *(Caretta caretta)*. Of the four, the Leatherback is listed as critically endangered by IUCN, and the others are listed as endangered. All sea turtles are protected by the CITES convention[6] and the Jamaican Wild Life Act (NEPA 2010).

The proportion of species threatened with extinction has been selected as one of the Millennium Development Goals environmental indicators. The IUCN describes three categories of threatened species, depending on the degree to which they are threatened: vulnerable, endangered and critically endangered. A number of Jamaica's plant and animal species are labeled as "threatened" and are in danger of becoming extinct. Jamaica is ranked sixth on the IUCN Red List for mammals of endangered species (i.e. at risk of extinction) because of threats to the country's bats and the Hutia. In 2006, the existence of one species of bat that was thought to be possibly extinct was recorded. However, there are approximately four species which have not been recorded for more than ten years. Over the last five years, there has been no noted increase in the number of endangered species. Tables 4, 5 and 6 show Jamaica's threatened plant and animal species (NEPA 2010).

[6] The Convention on International Trade in Endangered Species of Wild Fauna and Flora

Table 4: Threatened Animals and Plants in Jamaica

Species	1996	2006	2010
Mammals	4	5	5
Birds	7	10	10
Reptiles	8	8	5
Amphibians	4	17	6
Fish	-	16	15
Molluscs	5	-	-
Other Invertebrates	...	5	11
Plants	...	209	209
Total	...	270	261

Note: -none; ... not known
Source: International Union for Conservation of Nature

Table 5: Number of Animals and Plants in Danger

Status	2006		2010	
	Plants	Ani-mals	Plants	Ani-mals
Extinct	5	2	...	3
Extinct in the Wild	10	...	...	...
Critically Endangered	8	40	...	13
Endangered	17	53	1	8
Vulnerable	16	116	1	27
Near Threatened	5	73	...	20
Data Deficient	209	5	...	30
Least Concern	270	1	36	372
Total	**540**	**290**	**38**	**473**

Note: - none; ... not known
Source: International Union for Conservation of Nature

Table 6: Threatened Species by Type 2010

Species	Critically Endangered	Endangered	Vulnerable	Near Threatened	Total
Amphibians	5	1	...	...	6
Birds	2	1	7		10
Velvet Worm	1	...	...	1	2
Fish	4	2	7	...	13
Mammals	1	...	4	...	5
Insect	...	1	...	...	1
Reptiles	3	1	1	...	5
Total	16	6	19	1	42

Note: - none; ... not known
Source: International Union for Conservation of Nature

LAND USE, LAND USE CHANGES AND FORESTRY

Land uses in Jamaica include arable land – land cultivated for crops like wheat, maize and rice that are replanted after each harvest; permanent crop land – land cultivated for crops like citrus, coffee and rubber that are not replanted after each harvest, which includes land under flowering shrubs, fruit trees, nut trees, and vines, but excludes land under trees grown for wood or timber; and "other" – any land not arable or under permanent crops and includes permanent meadows and pastures, forests and woodlands, built-on areas, roads, barren land, etc.

For the National Forest Inventory Report 2003 (Camirand and Evelyn 2004), the island's land uses were determined using 1992 color aerial photographs following the procedures outlined in the Forestry Department Aerial Interpretation Manual (Forestry Department, 2001). The classes were then aggregated to 11 categories (see Table 4 in Camirand and Evelyn, 2004). At the national level, these categories were further divided into three broad categories: Forest, Mixed and Non-Forest. This classification is shown in Table 7 together with how they relate to the GHG Inventory classes (GOJ 2011).

Table 7: National Land Use/Cover Classes and Equivalent GHG Categories[7]				
Code	**Jamaica National Land Use Class**	**Definition**	**GHG Inventory Land Use Category**	
Forest (1)				
PF	Closed broadleaf	Closed primary forest with broad leaf trees at least 5 m tall and crown interlocking, with minimal human disturbance	Forest Land	
SF	Disturbed broadleaf	Disturbed broadleaf forest with trees at least 5 m tall and species-indicators of disturbance such as *Ceropia peltata* (trumpet tree)	Forest Land	
WL	Tall open dry	Open natural woodland or forest with trees at least 5 m tall and crown not in contact, in drier parts of Jamaica with species indicators such as *Bursera simaruba* (red birch)	Forest Land	
SL	Short open dry	Open scrub, shrub, bush or brushland with trees or shrubs 1-5 m tall and crowns not in contact, in drier part of Jamaica with species indicators such as *Prosopis juliflora* (cashaw) or *Stenocereus hystrix* (columnart cactus)	Forest Land	
SW	Riparian/Swanp	Edaphic forest (waterlogged soil) with a single tree storey with species indicators such as *Symphonia globulifera* (hog phurn) and *Roystonea princeps* (royal palm)	Forest Land	
MG	Mangrove	Edaphic forest (areas with brackish water) composed of trees with stilt roots or pneumatopores, species indicators such as *Rhizophora mangle* (red mangrove)	Forest Land	
PP	Carib Pine Plantation	Forest plantation with *Pinus caribaea*	Forest Land	
HP	Other Species Plantation	Forest plantations with other species such as *Hibiscus elatus* (blue mahoe), *Swietenia macrophylia* (Honduras Mahogany), *Tectona grandis* (teak), *Eucalyptus saligna, Cedrela odorata* (cedar), etc.	Forest Land	
Mixed				
SC	Disturbed Broadleaf forest & Non-forest land use	>50% Disturbed Broadleaf forest;	75% Forest Land	
		> 25% Non- Forest Land Use (2)	25% Other land	
CS	Non-Forest land use	>50% Non-Forest Land Use (2)	75%	76% Other land 24% Grassland
	Disturbed broadleaf	>25% Disturbed Broadleaf forest	25% Forest Land	

[7] Modified and extended from Camirand and Evelyn (2004)

Non-Forest (3)			
	Non-forest land use	Non-forest land use	20% Cropland, 64% Grassland, 3% Wetland, 12% Settlements, 1% other land
(1) Forest land use/cover > 75% minimum unit: 25 hectare (2)Fields (herbaceous crops, fallow, cultivated grass/legumes); bamboo, bauxite extraction. (3)Trees/ shrub crops (sugar cane, bananas, citrus, coconuts); fields (herbaceous crops, fallow, cultivated grass/legumes); herbaceous wetland; buildings and other infrastructures; surface mining/ bauxite; bare sand/rock, small islands; lakes and rivers.			

The area of forested lands estimated in 2005 after reclassification and calibration for the Food and Agriculture Organization (FAO) Global Forest Resource Assessment (FRA) 2005 Country Report (FAO 2005) was 341,000 ha, 30 per cent of the island's surface area. Most of this land could be classified as managed forest following the 2006 Inter-governmental Panel on Climate Change (IPCC) Guidelines definitions. This is because anthropogenic activities, such as extraction of wood and non-wood forest products, are taking place in almost all the forests of Jamaica. About 114,300 ha of this area has been designated as Forest Reserves and other protected areas, and therefore is under continuous management as stipulated by the Forest Act, 1996 Section 8 (1) and the Natural Resources Conservation Authority (NRCA) Act, 1991 (GOJ 2011).

It is of note that areas of forests reported for 2000 and 2005 in the FRA report will differ from those reported in this report to the extent that estimates of the forest cover in the "Mixed" category are included in this report but were not calculated in the FRA report. The reasons these areas are included in this report is that they represent a significant amount of carbon and an assessment of the mean volume per hectare for these areas was calculated and reported in Jamaica's National Forest Inventory Report 2003. This made it possible to calculate the biomass for these areas (GOJ 2011).

Agricultural Land

The most recent census of agriculture for Jamaica conducted in 2007 identified approximately 319,000 hectares of land in farms. This represents 29 per cent of the total land area of approximately 1.099 million hectares. As Table 8 shows, there has been a continued decrease in the proportion of land allocated to agriculture since 1978. Population growth, leading to increased demand for land for housing, together with industrial and commercial expansion are two main factors contributing to this decline.

Table 8: Land in Farms – 1978, 1996, 2007

Census Year	Total Land Area ('000 ha)	Land in Farms	
		Total Area ('000 ha)	% of Total Land Area
1978	1,099.0	533.8	48.6
1996	1,099.0	421.6	38.4

Table 8: Land in Farms – 1978, 1996, 2007			
Census Year	Total Land Area ('000 ha)	Land in Farms	
		Total Area ('000 ha)	% of Total Land Area
2007	1,099.0	319.2	29.0
Source: Statistical Institute of Jamaica			

There is limited information on the total area of agricultural land that has been converted to nonagricultural use. However according to the Ministry of Agriculture and Fisheries (Raynor-Williams 2010), of the 17 per cent of Jamaica's land area that is flat and arable (186,155 ha), approximately 25 per cent has been lost to other forms of development.

The parishes with the most agricultural land are Clarendon (14 per cent of area in parish), St. Elizabeth (12 per cent), St. Ann (11 per cent) and St. Catherine (11 per cent). Table 9 shows the arable land in these parishes which has been converted to urban/residential uses between 1950 and 2008.

Table 9: Conversion of Arable Land to Urban Uses in Select Parishes			
Parish	Total Arable Land in 1950 (ha)	Total Arable Land Used for Urban Purposes (2008)	
		Area (ha)	% of Arable Land
Clarendon	31,806	3,174	10
St. Elizabeth	32,169	1,359	4
St. Ann	-	-	-
St. Catherine	23,557	-	-
Source: Ministry of Agriculture and Fisheries			

Approximately 61 per cent of the farmlands identified in the 2007 census may be classified as active farmland, that is, land allocated to crops and pasture. Farming in Jamaica is dominated by small holders. In 2007, about three quarters of farms accounted for only 15 per cent of area in farm land. A total of 151,931 farms of under one hectare were reported with total area of 47,713 hectares. There were 368 farms of 50 hectares and more (0.2 per cent of all farms), but occupied 125,578 hectares (40.6 per cent of total farm land).

DISASTERS

Jamaica has been subject to a number of natural emergencies and disasters occasioned by extremes of weather, earthquakes and disease (human, animal, plant). As industry has developed in Jamaica and the population has increased, so has the incidence of man-made emergencies/disasters increased. Man-made incidents have been mainly industrial, marine (oil spills) and transportation accidents.

Hurricanes are annual features of life in the Caribbean causing damage and destruction by extreme wind conditions, storm surges and flooding from heavy rains. Severe damage and loss of life have accompanied many Jamaican hurricanes, the events of 1722, 1744, 1780, 1880, 1902, 1903, 1944, 1951 and 1988 being particularly severe. In each of these cases, it appears that the eye either made landfall or passed very close to Jamaica's coast.

Strong storm surge effects on the south coast have caused major loss of life and the potential for significant losses have increased with the concentration of population on the exposed coastal areas in St. Thomas, St. Catherine, Clarendon, St. Elizabeth and Westmoreland within recent years. The major developments at risk on the north coast are tourist resorts.

High winds in hurricanes cause relatively few deaths but can do significant damage to structures and agricultural production. Severe damage to agriculture, structures and infrastructure accompanied the 1944, 1951 and 1988 hurricanes. The banana and fishing industries are particularly sensitive to hurricane effects but many other sectors of agriculture are vulnerable (orchard and ground crops, chicken houses, horticulture, coconuts).

Flooding can occur at any time but is often associated with hurricanes or tropical depressions, for example on June 12, 1979, 35 inches of rain fell in 24 hours in western Jamaica exceeding (at that time) the known historical extremes. In severe floods, low-lying plains as well as closed limestone valleys are inundated. Flood rains are often accompanied by landslides particularly in the non-limestone areas.

Droughts have been experienced on several occasions causing severe agricultural loss. The traditional response has been trucking domestic water at a considerable cost. Significant parts of the South Coast receive very little rainfall and depend on pumped water.

The earthquake catalogue (Tomblin and Robson 1977) for Jamaica lists seismic events. The two largest were the Port Royal (1692) and Kingston (1907) events and both affected a wide area of Jamaica. Descriptions of these events are given in Shepherd (1971) and accompany a discussion of earthquake risk in Jamaica. Secondary effects included ground liquefaction as well as landslides and tsunamis which followed the earthquake. In 1692, Port Royal liquefied and sank, and in the 1907 event, significant damage was caused by fire to commercial property in Kingston. Currently, earthquake activity in Jamaica is monitored by a series of seismographs and accelerographs operated by the Earthquake Unit at UWI Mona. According to the Unit, about 200 earthquakes are located in and around Jamaica per year most of which are minor, having magnitudes less than 4.0 (UWI 2014).

Recent physical development in Jamaica includes landfilling and high-rise construction, both of which are vulnerable to earthquakes. Disaster management methodologies must therefore include an evaluation of historical earthquake data as well as extrapolation of data based on the behavior of similar developments in earthquake-prone areas elsewhere.

CLIMATE CHANGE IMPACTS

Jamaica, like many small island developing states (SIDS), is highly vulnerable to climate change impacts. In general, the island is subject to the threat of tropical weather systems and faces direct threats from climate change because of its geographical location. Coastal areas in Jamaica, which are experiencing increasing physical development, are directly affected by storm surges and sea level rise which will be exacerbated by climate change. With sea levels projected to rise by an average of 2-3 mm per year during the first half of this century, the effects on coastal areas, which include erosion and coastal land subsidence, will be severe.

Under the aegis of the United Nations Framework Convention on Climate Change (UNFCCC), Jamaica finalized its first and second national communications on climate change in 2002 and 2011 respectively. Both national communications identified the areas and sectors that are most vulnerable to the impacts of climate change as being human health, water resources, agriculture, tourism and the coastal zone. In response to the findings of the national communications, the Government is pursuing a multi-sectoral approach to climate change adaptation and mitigation involving policies related to agriculture, forestry, land use, watershed, energy, biodiversity and natural hazards. This approach is presented in the draft Jamaica National Climate Change Policy and Action Plan 2012. A number of priorities for climate change adaptation and mitigation have been identified by the GOJ. Among the priorities identified are:

- watershed management
- forest resources management
- water sector adaptation
- climate change awareness building

RELEVANT NATIONAL, REGIONAL AND INTERNATIONAL CONVENTIONS AND AGREEMENTS

Jamaica is a signatory or a party to each of the international conventions, treaties, programmes and plans listed below, which impact the national, regional or global environments. These agreements or programmes have implications for remediation of pollution, conservation and protection of natural resources, and protection of endangered wildlife.

- Vienna Convention for the Protection of the Ozone Layer (1985)
- Montreal Protocol on Substances that Deplete the Ozone Layer (1987)
- Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (1990)
- Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal (1989)
- United Nations Framework Convention on Climate Change (1992)
- Convention on Biological Diversity (1993)
- Cartagena Protocol on Biosafety to the Convention on Biological Diversity (2000)

- Convention on the International Trade in Endangered Species of Wild Fauna and Flora (1975)
- Law of the Sea Convention (1982)
- International Convention for the Prevention of Pollution from Ships (MARPOL 1973 and 1978)
- International Coral Reef Initiative (1994)
- Agenda 21 (1992)
- Barbados Programme of Action for the Sustainable Development of Small Island Developing States (1994)
- Wider Caribbean Initiative on Ship-Generated Waste
- UNEP Global Programme of Action for the Protection of the Marine Environment from Land-based Activities
- Action Plan of the Summit of the Americas
- Programme of Action of the UN Commission on Sustainable Development
- Programmes of action from Conferences of Parties (COPs) from UN conventions
- International Convention for the Prevention of Pollution of the Sea by Oil (1954)
- Amendments to the International Convention for the Prevention of Pollution of the Sea by Oil, 1954, Concerning Tank Arrangements and Limitation of Tank Size (1971)
- Amendments to the International Convention for the Prevention of Pollution of the Sea by Oil, Concerning the Protection of the Great Barrier Reef (1969)
- International Convention on Civil Liability for Oil Pollution Damage (1976)
- International Convention relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (1969)
- Protocol relating to Intervention on the High Seas in Cases of Marine Pollution by Substances Other than Oil (1973)
- International Convention on the Establishment of an International Fund for Compensating Oil Pollution Damage as Amended 1992
- Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region (Cartagena Convention) (1993)
- Protocol Concerning Co-operation in Combating Oil Spills in the Wider Caribbean Region (1983)
- Protocol Concerning Specially Protected Areas and Wildlife (SPAW) in the Wider Caribbean (1990)
- Protocol Concerning Pollution from Land-Based Sources and Activities (1999)
- Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention, 1971)
- UN Convention to Combat Desertification (1994)

Jamaica's national legislation and plans governing environmental issues, include the following:

- The Morant and Pedro Cays Act (1907), the first piece of legislation promulgated to protect biodiversity, which protects the sea birds and seas turtles on these cays
- The Wild Life Protection Act (1945) and its later regulations which protect designated species of animals and regulate hunting in Jamaica

- National Strategy and Action Plan on Biological Diversity (2003), which is the framework for implementation of the Convention on Biological Diversity and includes issues related to coastal and marine plants and animals
- The Beach Control Act (1956) and associated regulations that address licensing, safety measures and hotel, commercial and public recreational beaches
- The Fishing Industry Act (1976) and regulations, including the 2000 regulations for conch
- The Maritime Areas Act (1996)
- The Aquaculture, Inland and Marine Products and By-products Act (1999) and associated regulations addressing inspection, licensing and export
- The Natural Resources Conservation Authority (NRCA) Act (1991) and regulations that address wastewater, hazardous waste, marine parks, national parks, and permits and licences for certain development activities.

WATER AND SANITATION COVERAGE

National, urban, rural water and sanitation coverage

Water Supply

The Census of Population 2011 indicates that in 2011, 79.2 per cent of the population was served with piped water and 3.6 per cent fetched water from springs and rivers (Table 10).

Table 10: Drinking Water Coverage by type of source

	Number of Homes	Percentage
Piped into Dwelling	504,971	57.3
Piped into Yard	140,678	16.0
Standpipe	52,371	5.9
Catchment	98,141	11.1
Spring or River	31,281	3.6
Trucked Water/Water Truck	19,164	2.2
Total	**881,078**	

Sanitation

Coverage of sewerage services has increased significantly in recent years, but it is less extensive than the coverage of water services. Significant investments and operational improvements are needed in this area. Data from Census 2011 indicate that in 2011, about 71 per cent of households had access to water closets; pit latrines were being used by 23 per cent of households; and approximately 2.1 per cent of all households reported no toilet facilities. Entitlement to use the facilities was related to the occupancy of the dwelling in which they were located and as such public facilities were excluded. Approximately 82 per cent of households had exclusive use of toilet facilities in 2011 (Table 11). The Survey of Living

Conditions 2012 indicates that this positive trend has continued, with 73.8% of the households with access to water closets and 83.2% with exclusive use (i.e. not shared) of toilet facilities.

Table 11: Percentage Distribution of Households by Availability and Type of Toilet Facilities: 2001 and 2011

Type of Toilet Facilities	2011	2001
Total	881,078	748,329
Water Closet (%)	70.88	57.01
Pit (%)	22.75	36.49
Other (%)	0.10	*
No Facilities (%)	2.09	2.54
Not Reported (%)	6.25	3.96
Availability of Toilet Facilities		
Total	824,912**	699,720**
Shared (%)	17.90	21.15
Water Closet (%)	11.77	10.66
Pit (%)	6.13	10.49
Not Shared (%)	82.10	78.85
Water Closet (%)	63.93	50.31
Pit (%)	18.17	28.54

*No allowance made for a category 'other' in 2001.
**Based on households reporting water closet and pit only.
Source: Survey of Living Conditions 2011

Coverage by type of technology: latrine, septic tanks (onsite treatment), sewerage

According to the Survey of Living Conditions 2007, 21.8 per cent of the population was served with sewerage (35.9 per cent urban and 4.2 per cent rural), 42.0 per cent was linked to a septic tank (46.2 per cent urban and 36.9 per cent rural) and 34.3 per cent was using a latrine (16 per cent urban and 57.2 per cent rural). Table 12 presents the sanitation coverage in 2007 according to the Survey of Living Conditions 2007.

Table 12: Type of Sanitation Technology used in Jamaica 2007

		% House-holds – Urban	% House-holds – Rural	% House-holds Total
Flush toilet total		82.1	41.1	63.8
Flush toilet: to pipe sewer system	WC linked to server	35.9	4.2	21.8
Flush toilet: to septic tank	WC not linked	46.2	36.9	42.0
Latrine: Dry: Unimproved-Traditional	Pit	16.0	57.2	34.3

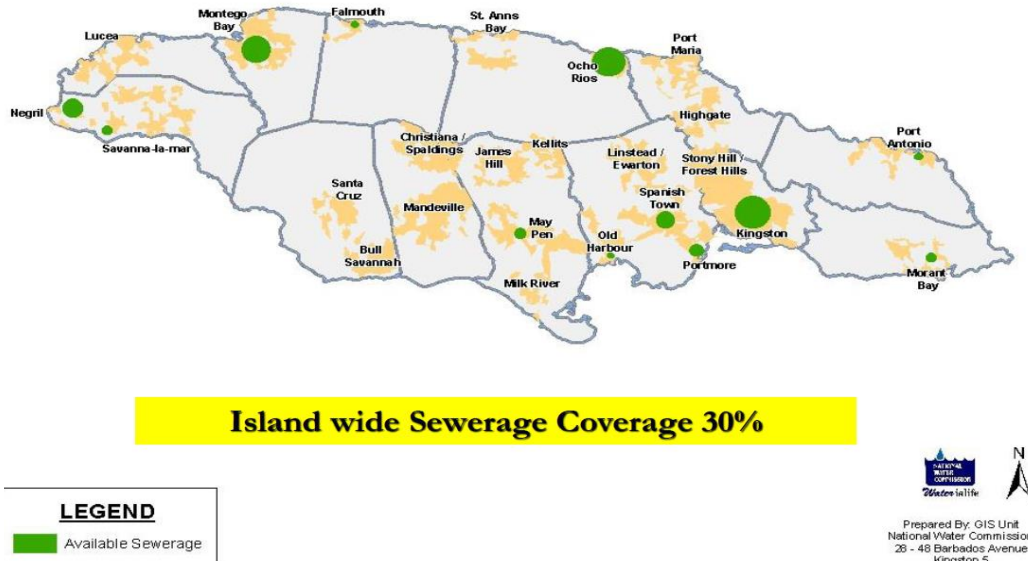
Table 12: Type of Sanitation Technology used in Jamaica 2007				
		% House-holds – Urban	% House-holds – Rural	% House-holds Total
latrine				
No facility, bush, field	**None**	**1.4**	**1.6**	**1.5**
Other unimproved: Other	Other	0.5	0.1	0.3
Total	**Total**	**100.0**	**100.0**	**100.0**
Source: Survey of Living Conditions 2007				

Coverage by sewerage clustering: onsite individual household systems, community-based systems and centralized municipal systems

As noted above, sanitation services exist in most major urban areas and are being improved. In the Kingston Metropolitan Area, 92 per cent of households have flush toilets, while in other towns 60 per cent of households have this facility. However, 42.4 per cent of households with flush toilets are not linked to wastewater treatment facilities (by sewers). While coverage by sewerage services has increased significantly in recent years, only 30 per cent of the population island-wide is connected to sewage treatment facilities. In the KMA the percentage is considerably higher with 60 per cent of households linked to sewer systems, while in other towns only 11 per cent of households are connected, most of which are in housing developments. Thus, the predominant means of sewage disposal is through soak away systems, septic tanks, tile fields, pit latrines etc. However, soak away pits may lead to contamination of groundwater as seepage reaches aquifers through the porous limestone base.

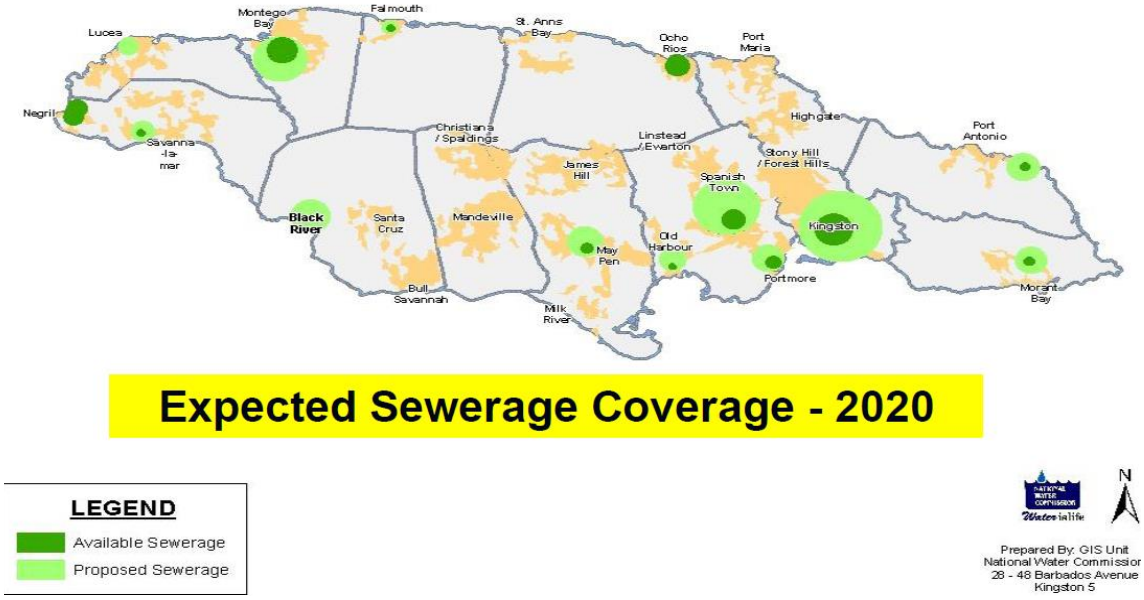
The National Water Commission (NWC) is a statutory organization charged with the responsibility of providing wastewater services for the people of Jamaica. The NWC operates the largest number of plants and has a fairly large network of sewerage systems in major cities and towns (Figure 1). Major urban centres in parishes such as Kingston and St. Andrew, St. James and St. Catherine account for approximately 90 per cent of the sewage handled by the NWC. The NWC is currently implementing a programme to expand the sewer connections in the KMA, and has recently completed the construction of a new sewerage system in the Montego Bay area. The draft National Sanitation Policy envisions the expansion of sewerage and sanitation services through the sewering of all major towns by 2020 (Figure 2).

Figure 1: Existing Situation Sewerage System



Source: GIS Unit NWC

Figure 2: Strategic Plan Major Sewage Schemes

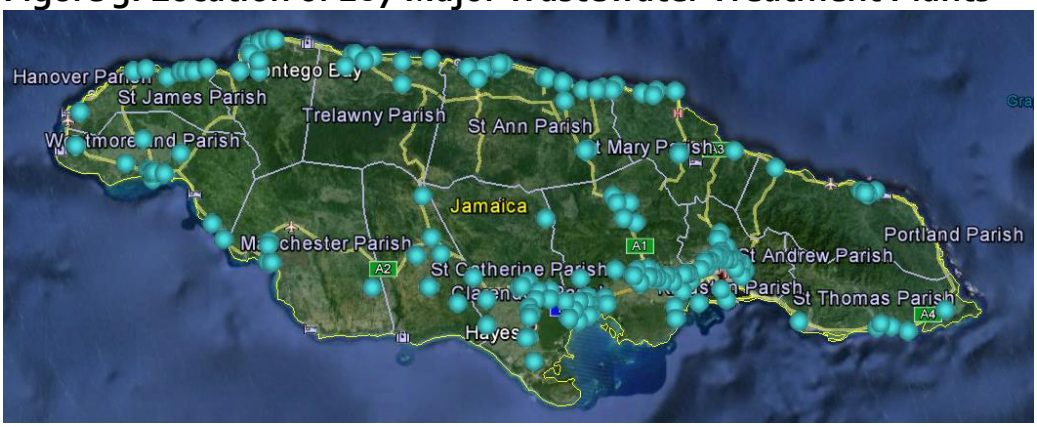


Source: GIS Unit NWC

There are a number of entities that own and operate wastewater treatment facilities in Jamaica. For example, sewage treatment plants are owned by hotels, strata corporations and public housing development agencies. There are presently 306 sewage treatment plants in Jamaica, 68 of which are owned by the NWC. Figure 3 shows the location of 187 wastewater

treatment plants that are monitored by the Environmental Health Unit (EHU), Ministry of Health (MOH).

Figure 3: Location of 187 Major Wastewater Treatment Plants



Jamaica's wastewater sector generally has a low level of performance, and sewage effluent quality from most treatment plants has generally not met the NRCA's sewage effluent standards. Of the 165 plants monitored by the Environmental Health Unit between January and September 2010, only 66 (40 per cent) plants were in compliance. Of the 66 NWC plants monitored, only 17 (26 per cent), were compliant (Table 13).

This lack of compliance is mainly due to issues such as improper plant designs, old technology, overloading, lack of maintenance and improper operations. This problem has been alleviated somewhat by the 2007 commissioning the Soapberry Wastewater Treatment Plant with a capacity of approximately 30 million cubic metres per year. The plant provides tertiary treatment of sewage from Kingston and St. Andrew and South East St. Catherine (Portmore) and will be able to handle the sewage of approximately 800,000 persons from across Kingston, St Andrew, and St Catherine.

Table 13: STPs in Compliance, January – September 2010, By Ownership Groups

Owner Group	No. Plants	No. in Compliance	% in Compliance
NWC	66	17	26
Hotel	28	17	61
Government	38	14	37
Hospitals	9	0	0
Source: Environmental Health Unit, Wastewater Report January-October 2010			

3. METHODOLOGY

The methodology for this National Baseline Assessment consisted of a literature review, interviews with key experts and data analysis of a questionnaire using a mathematical model (described in Section 3).

LITERATURE REVIEW

Several documents produced to support the CReW project were reviewed in conducting the Regional Baseline Assessment. The following reports were examined:

1. Assessment of Wastewater Management Technologies in the Wider Caribbean Region
2. Gap Analysis and Regional Best Practices in Wastewater Management
3. Wastewater Management in the Wider Caribbean Region: Knowledge, Attitudes and Practice (KAP) Study
4. International Best Practices
5. Situational Analysis, Regional Sectoral Overview of Wastewater Management in the Wider Caribbean Region
6. Testing a Prototype Caribbean Regional Fund for Wastewater Management (CReW)

The analysis of each document helped to identify key areas and issues that needed to be included in the assessment. The areas identified for evaluation are as follows:

1. Wastewater treatment management
2. Pollution problems and their cost
3. National capacity (policy framework, legislative and institutional framework)
4. Surveillance and enforcement capacity
5. Manpower capacity
6. Financing
7. Best practices and innovative technological treatment solutions
8. Current knowledge, attitudes, behaviours and practices
9. Information collection and sharing
10. Water and sanitation diaspora organizations
11. Climate change impacts

These documents were supplemented by an internet search for other studies and research on the wastewater sector (provided in the References section).

INTERVIEWS WITH KEY EXPERTS

Meetings were held with the following persons:

- CReW Focal Point, Mrs. Paulette Kolbusch, Senior Manager at NEPA and Mr. Oswald Chinkoo, Manager Pollution Monitoring and Assessment Branch at NEPA to discuss a proposed questionnaire and the proposed strategy to collect the required information for the baseline assessment
- Ms. Nilsia Johnson, Environmental Health Unit, Ministry of Health and Mr. Leonard Smith, Acting Director, Environmental Health Laboratory, National Public Health Laboratory, Ministry of Health

4. MATHEMATICAL MODEL USED

RATIONALE FOR THE MODEL

The study and analysis of the documents mentioned in Section 3 helped to identify key areas that needed to be included in the assessment. Based on the identified areas, a list of issues was identified. Each issue contains a set of attributes to be identified to assist in measuring the adequacy of the issue. The list of issues is as follows:

1. Sanitation coverage
2. Disposal of treated/untreated wastewater
3. Wastewater reuse
4. Type of reuse
5. Quality of reused effluent
6. Industrial wastewater management
7. Tourism/ hotel wastewater management
8. Institutional wastewater management
9. Volume of wastewater discharged
10. Quality of discharge
11. Septage/biosolids management
12. Infrastructure condition
13. Pollution problems and their cost
14. Policy framework
15. Legislative framework
16. Institutional framework
17. Surveillance and enforcement capacity
18. Availability of staff for wastewater management
19. National/regional training needs for wastewater management
20. National/regional training opportunities for wastewater management
21. National/regional training areas for wastewater
22. Financial issues
23. Best practices and innovative technological treatment solutions
24. Current knowledge, attitudes, behaviours and practices
25. Information collection and sharing
26. Organizations' support for wastewater management
27. Climate change impacts

A questionnaire was created based on these 27 issue areas, using the associated attributes. The questionnaire comprised a total of 284 questions. The questions can be seen in Annexes 2 and 3 which present the raw data from the questionnaire and the results of the analysis using the mathematical model, respectively.

The instrument was prepared so that the evaluation could be quantitative if information was available, or qualitative if it was not. Each question was divided in five columns. The first column indicates presence or absence, the second, third and fourth columns measure the adequacy of the attribute evaluated.

The methodology can be applied at the national level, parish level or basin level. Due to time and economic constraints, this evaluation was conducted at the national level. The grading of each answer took into consideration: 1) presence or absence (Yes/No), 2) degree of adequacy (score from 1 to 3), and 3) significance for meeting the LBS Protocol.

The assessment used the scaling of the Rapid Impact Assessment (RIA) Tool. This methodology is designed to help national and local organizations such as parish councils by providing a preliminary assessment and screening of potential environmental impacts of a project or proposal before a final decision on a proposed activity is taken.

To enhance visual representation the scale was colour coded as follows:

Scale Score 1-3 (RED): Negative Environmental Impact
Scale Score 4-7 (AMBER): Neutral Environmental Impact
Scale Score 8-10 (GREEN): Positive Environmental Impact

In this case each factor was scored on a scale of 0 to 100 as follows:

0 to 10 = significant adverse adequacy impact
20 to 30 = negative adverse adequacy impact
40 to 70 = neutral adequacy
80 = good positive adequacy impact
90 = very good positive adequacy impact
100 = excellent positive adequacy impact

10	20	30	40	50	60	70	80	90	100
Significant	Negative		Neutral				Good	Very good	Excellent

A mathematical model was developed to grade each question and to be able to present the information at the national level. Examination of the results of the evaluation will allow for the identification of priorities at the national and regional levels. Also it will allow countries to measure their level of compliance with Annex III of the LBS.

CONSTRAINTS/LIMITATIONS OF THE MODEL

The process of modelling might be defined in the following way:

- Identify the problem to be investigated.
- Determine the important factors.
- Represent those factors and their interplay in a mathematical way and analyze the mathematical relationships.
- Interpret the mathematical results in the context of the real-world phenomenon.
- Evaluate how applicable the results are to the real-world situation.
- If necessary, re-examine the factors that were considered and structure of the initial model.

Any mathematical model has its weaknesses and strengths as outlined below.

Weaknesses

Potential weaknesses of the model that was developed for this study include the following:

- The answers should represent the whole country; therefore it is very difficult to grade the adequacy of a question using a small amount of data. Review of a large amount of information is necessary to provide a valid response.
- Answers to the questions involve a group of experts that agree to the answer to be included.
- Information required is not available in one institution and in one report and is not available in the form that the assessment requires it.
- Information applicable to some questions is not available.
- It is difficult to build a complete model of real processes due to lack of available data.
- Computational complexity is a possible limitation - a model sufficiently accurate may require enormous computer power.

Strengths

Strengths of mathematical models include the following:

- A mathematical model is systematic, results can be repeated, and the model can be refined. This would be in contrast to prediction systems based on emotion or "soft" events such as observation of human behaviour.
- There are several situations in which mathematical models can be used very effectively as an introductory evaluation.
- Mathematical models can help many stakeholders understand and explore the meaning of equations or functional relationships.
- Mathematical modelling software such as Excel programmes make it relatively easy to create a learning environment in which introductory stakeholders can be interactively engaged in guided inquiry, and heads-on and hands-on activities.
- After developing a conceptual model of a physical system it is natural to develop a mathematical model that will allow one to estimate the quantitative behavior of the system.
- Quantitative results from mathematical models can easily be compared with observational data to identify a model's strengths and weaknesses.
- Mathematical models are an important component of the final "complete model" of a system which is actually a collection of conceptual, physical, mathematical, visualization, and possibly statistical sub-models.
- A mathematical model helps to establish relationships among a multiple amount of factors that in the past were not included.
- The model used in this study helps to present in a pictorial way the complexities of wastewater management.

5. OVERVIEW OF WASTEWATER TREATMENT AND MANAGEMENT

DOMESTIC WASTEWATER TREATMENT SYSTEMS

The National Water Commission (NWC) is a statutory organization charged with the responsibility of providing wastewater services for the people of Jamaica. However, there are a number of other entities that own and operate wastewater treatment facilities in Jamaica. The NWC operates the largest number of plants in Jamaica and has a fairly large network of sewerage systems in major cities and towns. The NWC collects wastewater from over 600,000 households across the island. As connections are made to recently completed systems in Negril, Ocho Rios and Montego Bay and along Hope Road in Kingston, the number of persons served will continue to increase.

There are presently 306 wastewater treatment plants in Jamaica. Seventy six are owned by the National Water Commission, the largest provider of sewerage services in Jamaica (Figure 4). However, of the 76 plants, 5 have been taken out of operation. A list of the plants is presented in Table 14.

Figure 4: NWC Sewerage Systems by Parish

Source: National Water Commission

Major urban centres in Kingston and St. Andrew, St. James and St. Catherine account for approximately 90 per cent of the wastewater handled by the NWC. Within the NWC system, wastewater treatment plant capacities range from 0.0528 to 52.8 MLD (million litres per day) with about 90 per cent of plants less than 2.65 MLD. There are a variety of technologies utilized within the NWC network, namely contact stabilization, oxidation ditch, aerated lagoons and stabilization ponds. The main type of technology used is oxidation ditch, followed by contact stabilization and oxidation ponds (Table 15).

The Environmental Health Unit reported in 2010 that of 165 plants surveyed 66 (40 per cent) of them were in compliance. St. Thomas and St. Ann were the parishes with the highest level of compliance (See Table 16).

Table 14: Wastewater Treatment Plants Operated by National Water Commission

#	Name of Plant	Parish	Type	Cpacity (MLD)	#	Name of Plant	Parish	Type	Cpacity (MLD
1	Bushy Park Gardens (formerly bushy park)	Clarendon	Aerated Lagoon	150,000	39	Moneague H-Scheme I (Rose Hall)	St. Ann	Oxidation Ditch	0.34
2	East Prospect	St Thomas	Aerated Lagoon	0.41	40	Nightingale Grove	St. Cath	Oxidation Ditch	0.38
3	Ebony Vale	St. Cath	Aerated Lagoon		41	Norwood H-scheme	St. James	Oxidation Ditch	
4	Lionel Town	Clarendon	Aerated Lagoon	1.14	42	Ocho Rios	St. Ann	Oxidation Ditch	
5	Lime Tree Grove	St. Cath	Aerated Lagoon	0.38	43	Old Harbour Glades, Claremount	St. Cath	Oxidation Ditch	13.2
6	Rhyne Park	St. James	Contact Stabilisaiton	0.27	44	Paisley Gardens	Clarendon	Oxidation Ditch	INACCESSIBLE
7	Cornwall Court	St. James	Contact Stabilisation		45	Red Ground (Colbeck Heights)	St. Cath	Oxidation Ditch	
8	Harbour View	KSA	Contact Stabilisation		46	Shrewsbury	Westmoreland	Oxidation Ditch	
9	New Harbour Village	St. Catherine	Contact Stabilisation		47	Steer Town H-Scheme	St. Ann	Oxidation Ditch	
10	Old Harbour Villa	St. Catherine	Contact Stabilisation	0.61	48	Stockholm Park, Highgate	St. Mary	Oxidation Ditch	0.23
11	Tawes Pen Housing	St. Catherine	Contact Stabilisation	0.42	49	Vanzie lands	Trelawny	Oxidation Ditch	0.95
12	Widcombe	KSA	Contact Stabilisation	0.32	50	Anchovy	Portland	Oxidation Ditch	
13	Bay Farm Villa	KSA	Contact Stabilization/Package Plant	0.23	51	New Bowens Phase 1	Clarendon	Oxidation Ditch	
14	Acadia	KSA	Contact Stabilization/Package Plant	0.16	52	Prideex	Clarendon	Oxidation Ditch	
15	Barbican Mews	KSA	Contact Stabilization/Package Plant	0.11	53	Woodstock	Portland	Oxidation Ditch	
16	Elleston Flats	KSA	Contact Stabilization/Package Plant	0.32	54	Boone Hall	KSA	Package Plant/Pond/Sand Filter	0.41
17	Grove Manor	KSA	Contact Stabilization/Package Plant	0.27	55	Greenwich	KSA	Primary Treatment	
18	Hughenden	KSA	Contact Stabilization/Package Plant	0.23	56	Western	KSA	Primary Treatment	
19	Whitehall (Victoria Court)	KSA	Contact Stabilization/Package Plant		57	Port Royal	KSA	Sand Filter	0.17
20	Bridgeport	St. Cath	Contact Stabilization/Package Plant	7.6	58	New Works	St. Catherine	Sand Filter Slow	
21	Oakwood	KSA	Extended Aeration		59	Knollis	St. Cath	Septic Tank/Filter Bed	0.11
22	Spring Field	St. Thomas	Extended Aeration		60	Belair	St. Ann	Septic Tank/Tile Field	
23	Independence City	St. Cath	Extended aeration/Packaged Plant	13.3	61	Boscobel	St. Mary	Septic Tank/Tile Field	
24	Ensom City	St. Cath	Extended aeration/Packaged Plant	3.8	62	Providence	St. James	Septic Tank/Tile Field	
25	Red Hills Pen	St Thomas	Extended aeration/Packaged Plant	0.17	63	Caymanas Gardens	St. Catherine	Oxidation Ponds	
26	Twickenham Park	St. Cath	Extended aeration/Packaged Plant		64	Claremont	St. Catherine	Oxidation Ponds	
27	Aviary	St. Cath	Oxidation Ditch	2.54	65	De la Vega City Housing	St. Catherine	Oxidation Ponds	
28	Charlie Mount	St. Cath	Oxidation Ditch	0.61	66	Soapberry	KSA	Oxidation Ponds	0.579744
29	College Green	KSA	Oxidation Ditch		67	Yallahs	St Thomas	Oxidation Ponds	Disfunctional
30	Cornwall Courts (same as Green Pond)	St. James	Oxidation Ditch	1.5	68	Blackwood Gardens	St. Cath	Oxidation Ponds	0.57
31	Crofts Hill	Clarendon	Oxidation Ditch	45,000	69	Bogue, Montego Bay	St. James	Oxidation Ponds	3.8
32	Eltham Park	St. Cath	Oxidation Ditch	3.8	70	Greater Portmore	St. Cath	Oxidation Ponds	15.32
33	Hamilton Gardens	St. Cath	Oxidation Ditch	0.76	71	Hayes Phase I	Clarendon	Oxidation Ponds	0.27
34	Horizon Park	St. Cath	Oxidation Ditch	1.9	72	Hayes Phase II	Clarendon	Oxidation Ponds	0.76
35	Innswood Village	St. Cath	Oxidation Ditch	0.61	73	Landilo Phase IV, III, V	Westmoreland	Oxidation Ponds	0.878688
36	Landillo Phase I & II	Westmoreland	Oxidation Ditch	0.3348864	74	Negril Sewage Works	Westmoreland	Oxidation Ponds	4.444416
37	Longville Park	Clarendon	Oxidation Ditch	1 mil GPD	75	New Bowens	Clarendon	Oxidation Ponds	
38	Mineral Heights	Clarendon	Oxidation Ditch	1.32	76	Orange Bay (NHT)	Hanover	Oxidation Ponds	

Source: National Water Commission, table prepared by Homero Silva
Note: The plants highlighted in red have recently been taken out of operation.

Table 15: Type of Technologies used in NWC Wastewater Treatment Plants

Type of Plant	Number
Package Plant + Pond + Sand Filter	1
Primary Treatment	2
Sand Filter	2
Septic Tank +Filter Bed or Tile Field	4
Aerated Lagoon	5
Extended Aeration	6
Oxidation Ponds	14
Contact Stabilization	15
Oxidation Ditch	27
Total	**76**

Table 16: Sewage Treatment Plants in Compliance, Jan-Sep 2010			
Region/Parish	**No. Plants**	**No. Compliant**	**% Compliant**
KSA	18	10	55.6
St. Thomas	4	4	100.0
St. Catherine	33	9	27.3
St. Ann	20	14	70.0
Portland	7	2	28.6
St. Mary	8	3	37.5
St. Elizabeth	4	2	50.0
Clarendon	20	7	35.0
Manchester	6	2	33.3
St. James	17	6	35.3
Trelawny	6	1	16.7
Westmoreland	15	3	20.0
Hanover	7	3	42.9
Total	**165**	**66**	**40.0**

The Soapberry Wastewater Treatment Plant in St. Andrew is an example of an innovative approach to addressing a long-standing problem. The construction of the new wastewater treatment plant commenced in July 2005 and was completed in 2007, along with the trunk conveyance facilities and rehabilitation of a major pump station. The new plant has replaced the dysfunctional Greenwich and Western sewage treatment plants. This new plant will be expanded as the sewerage network is expanded over time to serve other communities in St. Andrew and Portmore (in St. Catherine). This expansion is critical to the Kingston Harbour Clean-up Project as it would result in properly treated effluent being discharged into the Harbour.

Within the past decade, the NWC has completed three other wastewater treatment facilities in Ocho Rios, Montego Bay and Negril. This was necessary because tourist destinations have seen rapid growth in population resulting from migration into the areas, which has strained and overloaded the existing infrastructure. The five largest sewage treatment plants (STPs), which account for 60 per cent of sewage collected, are:

1. Soapberry
2. Greater Portmore
3. Negril
4. Montego Bay
5. Ocho Rios

The Ocho Rios STP discharges its effluent into the sea through an outfall and the Greater Portmore plant discharges into wetlands. Sewage treatment ponds have resulted in improved effluent quality. Of particular note is the Soapberry Treatment Ponds, the first phase of which was commissioned in 2008 to provide tertiary treatment of sewage collected from Kingston

and St. Andrew and South East St. Catherine (Portmore). This is the only municipal sewage treatment plant in the English-speaking Caribbean that treats sewage to the tertiary level (Smith 2013).

In addition to the NWC, sewage treatment plants are owned by hotels, strata corporations and public housing development agencies. In regard to this, there are about 32 wastewater treatment plants installed in housing schemes. A list of them is presented in Table 17. Public sector housing developers such as the National Housing Trust (NHT) and the Housing Agency of Jamaica Ltd (HAJL) (formerly the National Housing Development Corporation (NHDC)) construct and operate sewage treatment plants associated with their developments. The intention is to hand them over to the NWC but the sewage effluent quality from some is unable to meet the NRCA's sewage effluent standards and the NWC is reluctant to take them over. Also, private sector housing developers construct and operate sewage treatment plants, many of which are also eventually taken over by the NWC. Table 18 presents the technology used for wastewater treatment at housing schemes. From the table it can be seen that oxidation ponds are the main type of treatment utilized, followed by oxidation ditches.

Table 17: List of Wastewater Treatment Plants installed in Public and Private Housing Schemes

	PROPERTY	LOCATION	TREATMENT TYPE	FLOW RATE (MLD)
1	Mona Great House	KSA	Contact Stabilization/Package Plant	0.27
2	Gardens of Acadia	KSA	Contact Stabilization/Package Plant	Inaccessible
3	Harbour View	KSA	Extended Aeration Package Plant	
4	New Harbour Village,	St. Catherine	Oxidation Ditch	0.05
5	Grantham Meadows	St. Mary	Oxidation Ditch	Out
6	Moneague H-Scheme 2 (Moneague Gardens)	St. Ann	Oxidation Ditch	0.19
7	Bushy Park Gardens (Mews)	Clarendon	Oxidation Ditch	
8	Twin Palms	Clarendon	Oxidation Ditch	
9	Vanzie Lands	Trelawny	Oxidation Ditch	
10	Rhyne Park (Gore)	St. James	Oxidation Ditch	0.53
11	Rosevale, Spot Valley	St. James	Oxidation Ditch	0.46
12	Hellshire Heights	St. Catherine	Oxidation Ponds	
13	Morris Meadows Grange Lane, Morris Lane	St. Catherine	Oxidation Ponds	
14	Portmore Villas	St. Catherine	Oxidation Ponds	
15	Caribbean Estate	St. Catherine	Oxidation Ponds	0.41
16	West Albion	St. Thomas	Oxidation Ponds	0
17	Monymusk Housing Dev	Clarendon	Oxidation Ponds	
18	Luana	St. Elizabeth	Oxidation Ponds	0.47
19	South Sea Park	Westmoreland	Oxidation Ponds	Inaccessible
20	Albany, Westmoreland	Westmoreland	Oxidation Ponds	No flow

Table 17: List of Wastewater Treatment Plants installed in Public and Private Housing Schemes				
	PROPERTY	**LOCATION**	**TREATMENT TYPE**	**FLOW RATE (MLD)**
21	Tryall Housing Dev	Hanover	Oxidation Ponds	No flow
22	Irwin Cancara		Oxidation Ponds	
23	Melrose Mews	Manchester	Rotating Biological Contactors/Ponds	
24	Long Pond H-scheme	Trelawny	Septic Tank	Inaccessible
25	Palmetto Meadows	Clarendon	Septic Tank + Sand Filter	
26	Riva Ridge, St. Andrew	KSA	Septic Tank/Gravel Filter	0.14
27	Belle Aire, Relocation 2000	St. Ann	Septic Tank/Outflow Filter	0.27216
28	Dillsborough Meadows, St. Andrew	KSA		
29	Meraglar Apts, 17 Dillsbury Ave	KSA		
30	Lot 4 and 5 Upton, Bonham Spring-	St. Ann		Out
31	Toby Heights	Clarendon		
32	Whicon			

Table 18: Type of Technology used in Housing Schemes		
Type of Treatment	**Number**	**%**
Oxidation Ponds	11	42
Oxidation Ditch	7	27
Septic Tanks + Filter	4	15
Contact Stabilization	2	8
Extended Aeration	1	4
Rotating Biological Contactor	1	4
Total	**26**	**100**

In 2002, the National Environment and Planning Agency (NEPA)[8], through the Coastal Water Quality Improvement Project (CWIP) (funded by USAID and Government of Jamaica), commissioned a special study on the performance of the domestic wastewater sector. Over the period 2001-2003, a combined total of 60 plants were monitored by NEPA through CWIP and the voluntary compliance Section 17 Programme. The results presented an alarming situation with low levels of compliance with both the NRCA Sewage Effluent Standards and the LBS Protocol. For example, only 23 (40 per cent) of the plants met the national NRCA Sewage Effluent Standard for Biochemical Oxygen Demand (BOD). When the data for all the plants are combined, the average values exceeded all the respective standards. Effluent data

[8] The National Environment and Planning Agency , established in 2001, is an amalgamation of the Natural Resources Conservation Authority, the Town Planning Department and the Land Development and Utilization Commission

also indicated a significant deterioration in the performance and level of compliance of the sector over the previous three years.

WASTEWATER REUSE

There are several wastewater reuse initiatives in Jamaica. Some hotels have used wastewater treatment effluent for golf course irrigation, while the major industrial water users, the bauxite/alumina companies, engage in extensive recycling of their process waters. The analysis of beach waters in Jamaica indicates that the water quality is better near the hotels with wastewater reuse projects than in beach areas where reuse is not practiced. Beach #1 in Table 19 is near a hotel with a wastewater reuse project, while Beach #2 is not. From an aesthetic point of view also, the presence of lush vegetation in the areas where lawns and plants are irrigated with reclaimed wastewater is further evidence of the effectiveness of this technology (UNEP 2007).

Table 19: Water Quality of Beach Water in Wastewater Reuse Project in Jamaica

Site	BOD*	TC*	FC*	NO_3*
Beach # 1	0.30	<2	<2	0.01
Beach # 2	1.10	2,400.00	280.00	0.01
Source: Basil P. Fernandez, Hydrogeologist and Managing Director, Water Resources Authority, Kingston, Jamaica.				

* Typical water quality indicators: Biochemical Oxygen Demand, Total coliforms, Faecal Coliform, Nitrogen Oxide

No information was found on the amount of water being recycled, but some examples are presented below.

Water Recycling Project at Denbigh 4-H

This is a grey water recycling project for irrigation purposes, with a cost of approximately US$200,000. Water from the 4-H Centre's bathroom face basins and kitchen sinks is collected and channeled into one central system. Note that the water collected does not include "black water" - wastewater containing sewage. The water is then filtered and stored in a 20,000 gallon storage tank. From the tank, it is pumped back to irrigate lawns during the drought period as well as the organic vegetable production plot at the centre.

Recycled Water for Electricity Generation at Bogue

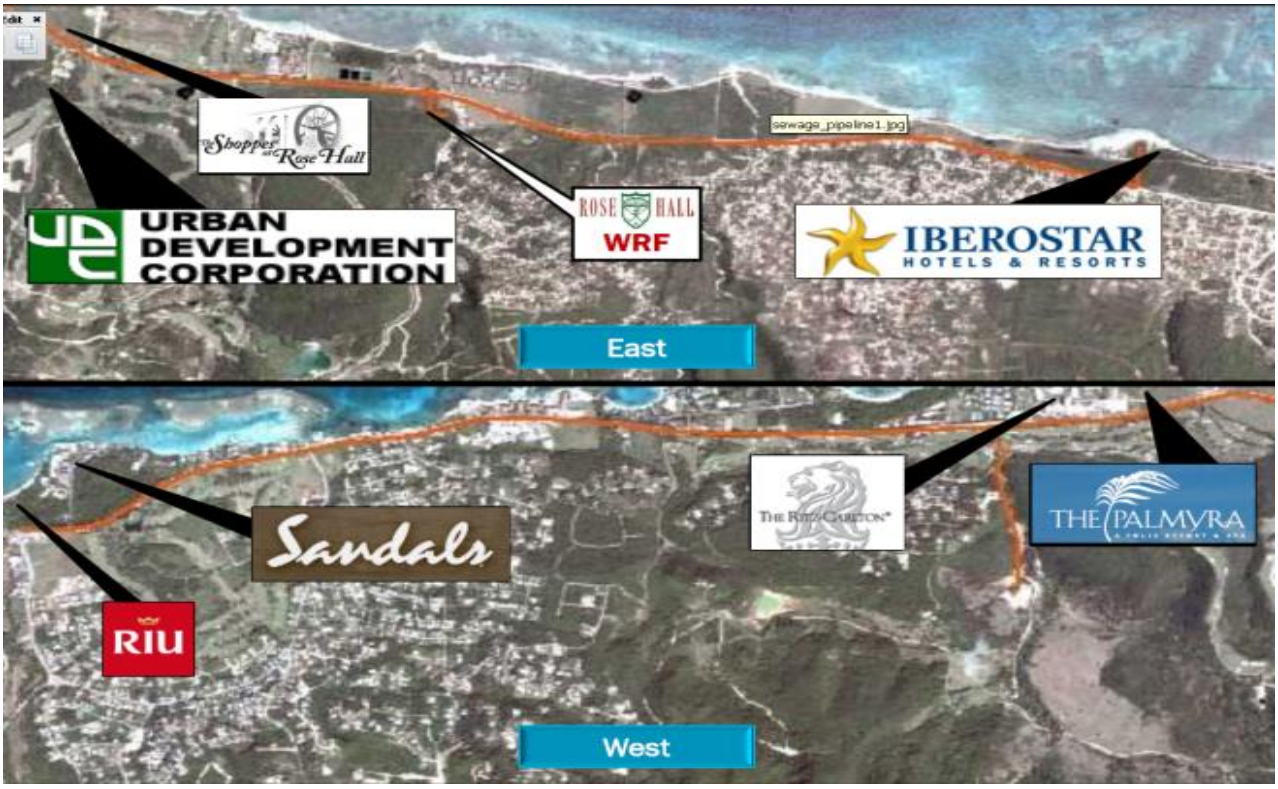
The Jamaica Public Service Company (JPSCo) is using STP effluent for cooling and other purposes in the electricity generation process. The most recent addition to JPSCo's generating fleet is its 120-megawatt generating unit at the Bogue Plant in Montego Bay and the utility has entered a partnership with the NWC to use the effluent from the Bogue STP. This type of recycling is unprecedented in Jamaica. Underground pipes were specially installed to transport the water between the NWC and JPSCo sites. To facilitate the recycling process, JPSCo also built its own facilities to treat and purify the grey water from the NWC plants to potable water

standards. The water is used for various processes in the plant, including water injection for nitrogen oxide emission control and cooling. Given that the Bogue plant utilizes up to one million gallons of water per day, the use of wastewater represents a significant saving on the demand for clean water and reduces the demand on the environment for this precious natural resource.

Rose Hall Utilities Limited

In 2008, a 1.25 MGD[9] water reclamation facility was constructed by Rose Hall Utilities Limited. Including 15 km of pipeline from the RIU Hotel to Iberostar Hotel, this water reclamation initiative provides water for irrigation of a golf course and gardens at several hotels (See Figure 5). Wastewater is treated with a membrane bioreactor (MBR) with a capacity of 1.25 MGD. This membrane bioreactor replaces conventional clarification, aeration and filtration by combining the physical barrier characteristics of a membrane with biological treatment and produces high quality effluent at all times. Table 20 presents the characteristics of the plant. The monthly flows of reclaimed water average approximately 9 MGD and the quality of the effluent reported by the operator meets the national standards (as shown in Table 21).

Figure 5: Wastewater Reuse Scheme in Rose Hall



[9] Million gallons per day

Table 20: ZeeWeed®MBR Effluent Quality Rose Hall WWTP	
Permitted Capacity	2.5 MGD
Civil Infrastructure	1.25 MGD
Clear Well	125,000 US gallon
BOD*	< 3 mg/L
TSS*	< 3 mg/L
NH_3-N*	< 0.5 mg/L
TP*	< 0.05 mg/l (requires coagulant addition)
TN*	<3 mg/l
Turbidity	< 0.2 NTU**

* Typical water quality indicators: Biochemical Oxygen Demand, Total Suspended Solids, Ammoniacal nitrogen, Total phosphorus, Total nitrogen

** Nephelometric Turbidity Unit

Table 21: Rose Hall Water Reclamation Facilities				
Parameter	**Permit Limits**	**2009 Effluent Average**	**Environmental Loading**	
	mg/L	**mg/L**	**kg/yr.**	**lbs/yr.**
BOD	15	2.2	763	1,682
TSS	15	<1	< 347	< 764
Total Nitrogen	10	4.6	1,595	3,517
Phosphates	4	3.5	1,214	2,676
COD*	< 100	13.4	4,646	10,244
Residual Chlorine	1.5	0.09	31	69

* Chemical Oxygen Demand

Recycling in the Bauxite/Alumina Industry

The recycling of industrial effluent was spearheaded by the bauxite/alumina companies operating in Jamaica, and they are the largest recyclers at the present time (Fernandez 1991). The bauxite/alumina industry produces a waste product known locally as "red mud", which consists of over 70 per cent water, enriched with caustic soda and organics. The waste is thickened to 28 per cent solids and sprayed on a sloping drying bed in a layer 8 to 10 cm thick. The liquid fraction is collected at the toe of the drying bed and is channeled via pipelines to a sealed holding pond. Pumps move the effluent from the holding pond back to the plant via a pipeline where it is recycled through the process. The system consists of:

- Deep mud thickeners (conical vessels)
- High pressure pumps and pipelines to the drying beds
- Drying beds, sealed to prevent infiltration of the effluent to the groundwater
- An effluent holding pond also sealed to prevent infiltration of the effluent to the groundwater
- Recycling pumps and pipelines to the plant

This technology is used at four bauxite/alumina plants in Jamaica. Efforts are under way to encourage other industries to follow suit and recycle process and waste waters.

Initial capital costs vary and are dependent on the volume of work to be done in preparing the site, resettling persons living on or near the site and making the necessary changes in the plant infrastructure. The minimum investment to date in any one system has been US$50 million. Operation and maintenance costs are not available as this information is confidential and proprietary to the bauxite companies.

The system, as designed and operated, is very effective in reducing contamination of groundwater resources. Because it is completely sealed, it does not allow infiltration of liquid effluents and recycling this fraction reduces the risk of contamination of groundwater resources from effluent disposal. The use of this system has reduced groundwater contamination in one area by 44 per cent since 1985, as reported by the Water Resources Authority. Despite some disadvantages, due predominantly to the large land areas consumed by the drying beds and holding ponds, the application of this technology, in all cases, has proved to be advantageous. Advantages include the following:

- Use of this technology reduces the rate of freshwater withdrawal from aquifers; savings of 4 to 5 Mm^3/year of freshwater have been recorded.
- Recycling of process water reduces the volume of caustic soda solution needed, as the caustic soda is recycled with the effluent.
- The use of energy, to pump freshwater from depths greater than 100 m, is reduced, thereby saving on the import bill (foreign exchange) for oil.
- Contamination of groundwater is reduced by removing and recycling the liquid fraction of the waste stream that is a risk to groundwater quality; likewise, the retention of a high percentage of the caustic soda in the thickened mud (solid fraction) and in the recycled process water makes this contaminant less available for migration to the groundwater.
- The bauxite/alumina companies are better able to meet the ISO 9000 and ISO 14000 certifications and thereby gain a competitive advantage in the marketplace.
- The decreased input costs reduce operational costs, resulting in higher profit margins for the companies and more tax revenue for the government, increasing both the level of investment in the country and the GDP.
- Better environmental management by the corporate sector results in fewer governmental regulations; other multinational corporations are likely to see such conditions as favourable and invest in Jamaica.
- The incidence of water pollution is reduced, increasing the availability of freshwater for domestic and irrigation uses and reducing the cost of water to citizens; this increases the standard of living and government popularity.

Potential disadvantages include the following:

- There is an increased risk of pollution of surface water resources, due to the large size of the holding ponds and the possibility of spillages.

- Technical problems within the plants may be experienced, reducing the level of production and affecting the volume of recycled effluent; hence, storage volumes can increase to the point where overflows occur, affecting the environment.
- The quality of effluent may vary significantly, affecting the degree of treatment provided by this technology and thus, potentially, the level of production at the plants.
- The technology is capital-intensive, not labour-intensive, and provides few spin-offs for nearby communities where unemployment may be high.
- As a result of the land-intensive nature of this technology, its implementation may result in the relocation of residents, disrupting their lives and causing great inconvenience; for farmers and other small businesspeople, a new location may be less suitable and/or create the need to seek other employment.
- Agricultural land may be lost in some cases, decreasing food production.

Recycling in the Sugar Industry

Several sugar companies have been involved in recycling of wastewater for irrigation purposes. Among those industries are Worthy Park, Long Pond, Bernard Lodge, Monymusk and Appleton. Initiatives at these sites are described below.

Worthy Park – Pollution control measures such as the recycling and reuse of water were instituted at Worthy Park. It is said that necessity is the mother of invention. Due to the scarcity of raw water at this particular estate, selective washing of canes was done. During the 1999 out-of-crop period, Worthy Park carried out certain modifications to their system to recycle and reuse the water from the vacuum pan booster pumps and also from three boiler feed water heaters. The total amount of water recycled and reused in the 2000/2001 crop year was 76.94 per cent.

Appleton – Most of the water sent to the cooling tower is recycled and reused in the factory.

Bernard Lodge – All sugar spillage is recycled back into the system. The cane wash water now goes into a settling pond which eventually is used for surface irrigation of cane fields. The overflow from the spray pond is also used for irrigation.

Monymusk – All of the cane wash water at Monymusk goes into a settling pond and then is used for irrigation of cane lands.

Long Pond – During the 2000/2001 sugar crop, a project was launched to pipe all the effluent from the distillery to an aeration pond to be used as a fertilizer for cane fields.

INDUSTRIAL WASTEWATER MANAGEMENT

Discharges from the agricultural, industrial and mining sectors contribute significantly to water pollution. Most of the industrial wastewater generated in Jamaica is from agro-based

industries – breweries, coffee and sugar processing, distilleries, dairy producers and slaughterhouses. Effluent from these sources contains high concentrations of nitrates and phosphates, which can cause eutrophication when discharged into surface water bodies. These industries account for the generation of over 50 million m^3 of wastewater per annum. Industrial facilities, especially those with a large number of employees have sewage treatment plants as well.

There are 20 industrial entities with wastewater plants (Table 22). While the technologies used vary widely, contact stabilization is the most common type of plant.

Table 22: Industries with Wastewater Treatment Plants and Type of Treatment

	INDUSTRY	LOCATION	TREATMENT TYPE	FLOW RATE (MLD)
1	Juici Patties, Manchester Ave	Clarendon	Biodigester Septic Tank	
2	Walkerswood	St. Ann	Biodigester Septic Tank/Reed Bed	No flow
3	Wray & Nephew 232 Spanish Town Road	KSA	Contact Stabilization/Package Plant	Inaccessible
4	Red Stripe, 214 Spanish Town Rd	KSA	Contact Stabilization/Package Plant	4.63
5	Master Blend	St. Catherine	Contact Stabilization/Package Plant	0.08
6	Mount Oliphant	Manchester	Contact Stabilization/Package Plant	
7	Jamaica Private Power Company,	KSA	Contact Stabilization/Package Plant + Reed Bed	0.49
8	Rockfort (Cement Co)	KSA	Imhoff Tank Reed Bed	2.43
9	Ethanol Plant, Old Harbour Bay	St. Catherine	Oxidation Ditch	0.07
10	Denbigh Industries	Clarendon	Oxidation Ditch	
11	Grace Food Processor	Westmoreland	Oxidation Ponds	0.1296
12	Jamaica Broilers	St. Catherine	Oxidation Ponds	3.87
13	Jamalco, Halse Hall	Clarendon	Packaged Plant/??	
14	Alpart Mining Venture	Manchester	Recycling Filter plant	0.03
15	Alpart Alumina Plant	St. Eliz	Recycling Filter plant	30,000
16	Lydford, Ocho Rios	St. Ann	Reed Bed	out
17	Dairy Industries Ltd	KSA	Sequential Batch Reactor	0.04
18	Juici Patties	Clarendon	Sequential Batch	

Table 22: Industries with Wastewater Treatment Plants and Type of Treatment				
	INDUSTRY	**LOCATION**	**TREATMENT TYPE**	**FLOW RATE (MLD)**
	(Clarendon Park)		Reactor	
19	Nestle Jamaica	St. Catherine		0.91
20	Wysinco Ltd.			0.18

Industrial wastewater treatment facilities in the agro-industrial sector are also plagued with poor trade effluent discharge quality. This is of particular concern in the sugar industry, coffee industry, distilleries, and abattoirs. Wastewater tends to have high biochemical oxygen demand, total suspended and dissolved solids. End-of-pipe treatment options tend to be looked at as the first solution to the problems. However, Codes of Practice have been developed for the coffee and sugar industries which aim to improve the quality of effluents. Also, NEPA has been encouraging waste generators to look at integrating environmental management principles through waste minimization and cleaner production as alternative solutions which usually end up saving scarce financial and natural resources through reduced consumption of water, raw materials and energy.

In terms of mining, the bauxite/alumina industry (the largest subsector) in the early days of the industry disposed of residues, which contain caustic soda and sodium carbonate, into mined out pits. The ponding of these caustic "red mud" wastes has leached sodium into the underground water system and has contaminated ground water resources. For example, groundwater near Moneague and Nain has been contaminated by leachate from red mud ponds used to store sodium-rich waste from bauxite refining (GOJ 1987). However, new attempts are being made to reduce the extent of contamination of underground and surface water caused by these "mud lakes". New thickened mud and dry stacking disposal systems have led to reductions of sodium leaching to the water table and there has been an improvement in water quality around the bauxite/alumina plants.

The sugar industry has been working to comply with the environmental standards set by NEPA and has created a Sugar Industry Action Plan. For most factories, implementation of the plan has been an uphill task, mostly due to financial constraints (Manning ND). The plan requires an evaluation of the wastewater quality and disposal practices at sugar factories, including the collection of wastewater samples at three different periods during the crop year and submission of pollution control reports to NEPA. The major parameters examined as set out in the trade effluent standards include the biological oxygen demand (BOD_5), chemical oxygen demand (COD), temperature and pH (Manning ND).

Another important aspect of the programme was the establishment of factory-level environmental committees to oversee the implementation of the plan. Some of the achievements obtained by these committees are as follows:

- Of the eight sugar factories, two have quantified, to a certain degree of accuracy, the amount of wastewater being emitted from their sites.

- Five factories have developed and submitted flow diagrams of factory drains including the wastewater sampling points.
- Two factories have seriously done any investigation into their water supply and usage. Worthy Park has been practising the recycling and reuse of their water throughout the factory. Frome is presently considering the installation of an automatic valve to control the washing of canes. This is with a view to reducing the use of raw water for cane washing and hence the amount of pollution to the Dutch Canal.
- Most factories have in place an active health and safety committee which is working to improve the safety aspects of their operations.
- All factories have been providing NEPA with information on their pollution control monitoring programmes.
- Two factories, Frome and Appleton, have received approval from the Office of Disaster Preparedness and Emergency Management (ODPEM) for their emergency response plans. Other factories are yet to submit the document for approval.

The results of wastewater samples tested during the processing of sugar cane during the period 1998-2001 indicated that factories were still out of compliance with some aspects of the trade effluent standards. Parameters such as the BOD, COD, TSS, faecal coliform and total coliform far exceeded the required standard at most of the factories. However, in most instances parameters such as oil and grease, sulphate, pH and temperature were usually within acceptable limits (Manning).

As expected, the results for the out-of-crop period were usually within the specifications except in a few cases where the pH values were high due to washing of vessels. It must be pointed out that the samples collected are grab samples and not a composite of the total flow. The off-season BOD and COD values were very low as expected and in some case zero. In the off season, the flow of water was negligible at some factories; hence a representative sample could not be collected.

Some factories have made significant progress in terms of putting in certain control measures to reduce the levels of pollution in their wastewater. As noted above, this has enabled the factories to reuse their wastewater within the facility. Some of the control measures at individual factories are described below (Manning).

Worthy Park

Pollution control measures such as the recycling and reuse of water were instituted at Worthy Park. In addition to water reuse measures described above, other pollution control measures included the following:

- Replacement of the head box vapour ports of an evaporator in order to reduce entrainment
- Replacement of a defective condenser baffle of a vacuum pan to prevent entrainment to the spray pond

- Re-paving of the No.3 mill imbibition sump area thus eliminating juice leaks into the spray pond
- Increasing the height of the concrete wall situated at the work shop side of the spray pond thus eliminating contaminants from getting into the spray pond
- Modification of the sides of a filter press spreader to reduce spillages
- Modification of the filter press overflow trough to eliminate spillages from the filter agitator arm

Worthy Park made the decision that, as of the 2000 crop year, the washing of burnt canes would not be done during the dry season as long as there was no significant impact on steam generation, clarification and filtration.

Frome

Frome has been working over the years to reduce the pollution potential of their wastewater to the environment, in part due to increasing requests from the Big Bridge Community for the factory to reduce its negative environmental impact. This has resulted in more and more dialogue with the community and the development of a working relationship between the factory and the community to deal with this problem. There has been a concerted effort to dredge the Dutch Canal and to flush the Carbaritta River. In 1996, a 500 m^3 demonstration anaerobic sludge bed reactor was installed at Frome. This plant however could only treat approximately 3 per cent of the total wastewater from the factory. Based on a 1999 report on the plant by the Scientific Research Council (SRC) the COD removal for the crop year 1996/97 and 1997/98, was 81 and 72 per cent, respectively. This translated into an average COD reduction from 682 mg/l to 127 mg/l (1996/1997) and 360 mg/l to 101 mg/l (1997/1998). It could therefore be deduced from the results of the demonstration plant that a full-scale anaerobic treatment plant could reduce the levels of COD to acceptable limits within the trade effluent standards.

Also, guards were placed at mills to prevent spillage since the sumps that were built to recover spillage were abandoned due to increased efforts to control dextran. Mild steel tanks were replaced with stainless steel tanks at the mills to lessen the chances of leaks due to rot.

A 120,000 lb/hr suspension type boiler has been installed resulting in a reduction in the washing of canes (in the dry season) due to the additional steam generation. Frome has also placed oil traps in place to recover any oil that may be spilt from the mills or boiler area. Waste oils are usually stored and then burnt in the furnaces.

Appleton

Appleton has embarked upon a series of modifications and automations to their factory with the aim of increasing production, production efficiency and ultimately to reduce pollution to the environment. During the 2000/2001 sugar crop, a project was launched to pipe all the effluent from the distillery to an aeration pond to be used as a fertilizer for cane fields. This has resulted in a drastic reduction of approximately 80 per cent the COD values from that waste

stream. Other measures included the installation of a 250,000 lb/hr suspension type boiler which it is hoped will eliminate the washing of canes.

Bernard Lodge
Some control measures have been put in place at Bernard Lodge. All sugar spillage is recycled back into the system. The cane wash water now goes into a settling pond which eventually is used for surface irrigation of cane fields. The overflow from the spray pond is also used for irrigation. Waste oil is stored in drums and most of it is used on cane field intervals to control marl dust.

Monymusk
All of the cane wash water at Monymusk goes into a settling pond and then used for irrigation of cane lands. A sump in the boiling house is used for the recovery of massecuites, molasses and sugar. The spillage is then sent to a remelt tank and put back into the sugar production process.

Long Pond
Most of the water sent to the cooling tower is recycled and reused in the factory. A concerted effort has been made to correct all leaks in the factory and to cut back on spillage. Plans to repair major drains and install oil traps to recover oil spills are subjected to the availability of funds.

TOURISM /HOTEL SECTOR WASTEWATER MANAGEMENT

The tourism industry in Jamaica is a large component of the economy with over 158 licensed hotels and approximately 13,500 rooms on the island. Tourism, while vital for job creation and economic growth, can place a strain on the infrastructure and the natural resources of a destination by inflating the population of an area with large numbers of transient guests. High-density tourism in coastal areas can result in potable water scarcity, water quality degradation as well as and mangrove, wetland and reef destruction.

Hotels operate sewage treatment facilities, some of which are very large. Some hotels find it challenging to consistently meet effluent standards. There have been complaints that some hotels are not treating wastewater sufficiently and that the effluent is having an adverse impact on marine water quality (Smith 2013). There are approximately 34 hotels with wastewater treatment plants (WWTPs) (Table 23). The most common type is extended aeration followed by oxidation ditch and oxidation ponds (Table 24).

Table 23: Wastewater Treatment Plants Installed in Hotels

No	Hotel	Parish	Type of WWTP	Flowrate (MLD)
1	Beaches Boscobel	St. Mary	Activated Sludge Aeration	0.88
2	Breezes Runaway Bay	St. Ann	Contact Stabilization Tank	0.49

Table 23: Wastewater Treatment Plants Installed in Hotels				
No	**Hotel**	**Parish**	**Type of WWTP**	**Flowrate (MLD)**
3	The Jewels Hotel	St. Ann	Contact Stabilization/Package Plant	0.79
4	RIU Mamee Bay	St. Ann	Contact Stabilization/Package Plant	1.80
5	Couples Hotel Ocho Rios	St. Mary	Extended Aeration	0.99
6	Couples San Souci Hotel	St. Mary	Extended Aeration, SBR?	0.66
7	Club Ambiance	St. Ann	Extended aeration/Package Plant	0.07
8	Eaton Hall Hotel	St. Ann	Extended aeration/Package Plant	INACCESSIBLE
9	Fiesta Hotel, Point, Hanover	Hanover	Extended aeration/Package Plant	1.11
10	Holiday Inn	St. James	Extended aeration/Package Plant	0.38
11	Bahia Principe, Pear Tree Bottom	St. Ann	Extended aeration/Package Plant	1.03
12	Royal de Cameron	St. Ann	Extended aeration/Package Plant	0.29
13	Sandals Grande Sport, Ocho Rios	St. Ann	Extended aeration/Package Plant	0.50
14	Sandals Whitehouse, Westmoreland	Westmoreland	Extended aeration/Package Plant	0.32
15	Starfish (Breezes Trelawny)	Trelawny	Extended aeration/Package Plant	0.13
16	Rose Hall Development	St. James	Extended Aeration/Package Plant/ Membrane Filtration	1.18
17	Grand Lido Braco (Breezes Rio Bueno)	Trelawny	Oxidation Ditch	
18	Hedonism III	St. Ann	Oxidation Ditch	CLOSED
19	Hylton Rose Hall Resorts	St. James	Oxidation Ditch	0.67
20	Runaway Bay Heart Academy	St. Ann	Oxidation Ditch	0.00
21	Sandals Montego Bay	St. James	Oxidation Ditch	0.26
22	St. Mary Country Club	St. Mary	Oxidation Ditch	INACCESSIBLE
23	Orange Bay Country Club	Hanover	Oxidation Ponds	NO FLOW
24	Rose Hall Pond (Sea Castle)	St. James	Oxidation Ponds	0.76
25	Seacrest Resort	St. Ann	Oxidation Ponds	0.21
26	Round Hill Resort	Hanover	Oxidation Ponds + Reed Beds	2.87
27	Golden Eye	St. Mary	Package Plant	0.53
28	F.D.R.	St. Ann	Rotating Biodisc	NO FLOW

Table 23: Wastewater Treatment Plants Installed in Hotels				
No	**Hotel**	**Parish**	**Type of WWTP**	**Flowrate (MLD)**
29	Coyaba, Ironshore	St. James	Rotating Biological Contactors	0.40
30	Robins Bay Beach Resort	St. Mary	Septic Tank	INACCESSIBLE
31	Tryall Golf Club	Hanover	Septic Tank/Reed Bed	INACCESSIBLE
32	Half Moon Resort, Rose Hall	St. James	Sequential Batch Reactor	0.01
33	FDR Pebbles (N RESORT)	Trelawny	Sequential Batch Reactor Cromaglass	
34	Whitters Golf Course			0.35

Table 24: Type of Wastewater Treatment Plants Installed in Hotels		
Type of Treatment	**Number**	**%**
Extended Aeration	12	36
Oxidation Ditch	6	18
Oxidation Ponds	4	12
Contact Stabilization	3	9
Septic Tank	2	6
Sequential Batch Reactor	2	6
Rotating Biological Contactor	2	6
Activated Sludge	1	3
Package Plant	1	3
Unknown	1	3
TOTAL	**34**	**100**

A multi-year, multi-phase project funded by USAID implemented in the late 1990s improved environmental management in over 30 hotels in Jamaica, reducing resource consumption and minimizing the environmental impacts of the hotels (Meade and Gonzalez, 1999).

A program of water use efficiency activities was successfully designed and implemented as part of this environmental management project, which has institutionalized "best practices" in the tourism industry in Jamaica. These best practices include equipping all areas of the hotel with water conservation devices, such as faucet aerators, low-flow showerheads, flow restrictors and water saving toilets; installing drip irrigation and low pressure sprinkler systems in landscaped areas; installing sub-meters to monitor water use in key areas; and implementing voluntary towel reuse programmes in guestrooms. These measures contributed to water savings of over 41.4 million imperial gallons among the participating hotels as well as reduced energy and chemical use. Significant improvements in water use efficiency and reduced chemical use help protect the sensitive coastal ecosystems that attract tourists.

In addition to implementing these conservation measures, the project focused on training and awareness building for both staff and guests to conserve water, reduce pollution and protect coastal ecosystems. The project has served as a model throughout the Caribbean for industry programmes to meet voluntary environmental standards for the protection of water and related land resources and has established Jamaica as a leader in sustainable tourism in the Caribbean. Currently, efforts are underway to replicate this project in other areas of the Caribbean.

There are several sewage outfalls from hotels, including: Eaton Hall, Hedonism III in Runaway Bay, Club Ambiance and Club Caribbean Royal Decameron.

COMMERCIAL AND OTHER INSTITUTIONS

Virtually all health facilities have sanitation facilities, some of which function better than others. The Ministry of Health has plans that are far advanced to implement a project called the Hospital and Health Centre Project to construct new sewage treatment facilities and upgrade existing ones (Smith 2013). There are seven health facilities with wastewater treatment plants (Table 25). A study funded by UNEP and PAHO in 2009 and 2010 and implemented by the Environmental Health Unit, Ministry of Health found that 37.5 per cent are in compliance with NEPA effluent regulations.

Table 25: Wastewater Treatment Plants in Health Facilities

	Hospital	Parish	Treatment Type	Flowrate (MLD)
1	Savanna-la-Mar Hospital	Westmoreland	Extended aeration/Package Plant	0.27
2	Black River Hospital	St. Elizabeth	Extended aeration/Package Plant	0.43
3	Annotto Bay Hospital	St. Mary	Extended aeration/Package Plant	0.6
4	St. Ann's Bay Hospital	St. Ann	Oxidation Ditch	0.82
5	Portland Health Department	Portland	Oxidation Ditch	
6	Spanish Town Hospital	St. Catherine	Oxidation Ditch	
7	May Pen Hospital	Clarendon	Rotating Biological Contactors + Reed Bed	

Source: Environmental Health Unit, Ministry of Health

Information was obtained from six parishes that contain 149 facilities (Table 26). Eighteen facilities are connected to sewers and the remaining facilities have either absorption pits or septic tanks. Sixty-six per cent were found to be in satisfactory condition.

Table 26: Sanitary Facilities and Wastewater Treatment in 6 Parishes											
Parish	**No. Health Facilities**	**Water Closet**		**Latrine**	**Central sewage**	**WWTP**	**Septic Tank**	**Absorption Pit**	**Satisf**	**Unsatisf**	**OK**
		Yes	No								
St. Thomas	17	17		0	0		17		2	15	
St. Mary	31	27	1	3	0	1(U)	8	14	11	8	12
St. Ann	26	26	1	1	1	1(U)	1	23	16	10	
St. Catherine	28	28		2	3	1(U)	25		26	2	
KSA	47	45	2	2	23		34	26	44	1	2
Total	149	143	4	8	27	0	85	63	99	36	14
%		96	3	5	18		57	42	66	24	9

The majority (53 per cent) of the 17 commercial institutions with wastewater treatment plants use mechanical plants, mainly of the Cromaglass and oxidation ditch types.

Based on the Ministry of Education's 2012/2013 census, all public schools have sanitation facilities. A small percentage (<15 per cent) have only pit latrines (Table 27). Information on the sanitation facilities in private schools was not available. However the Ministry of Education indicated that twice yearly checks are conducted at private schools to ensure that they have adequate sanitation facilities. The records of these checks are maintained at the parish level (Smith 2013).

Pit latrines are still in use in fairly significant numbers by public schools, from infant to secondary, throughout the country, especially in rural areas. St. Catherine is the parish with the largest number of schools (120) and the largest number of schools (43) with pit latrines. St. Elizabeth and Westmoreland have the largest percentage of schools with pit latrines (50 per cent and 54 per cent, respectively). There are no schools in Kingston with pit latrines and only 8 schools in St. Andrew (7 per cent of the total within the parish) with pit latrines. While many schools are equipped with toilets and piped water, the infrastructure is often not in satisfactory condition. The data show that in most parishes, about 40 per cent of the public schools do not have satisfactory toilet facilities and 40 per cent do not have an adequate or reliable water supply (Ministry of Education 2003-4).

Table 27: Sanitation Facilities in Schools 2012/2013							
Parish	**No. of schools with flush toilets**	**% of schools with flush toilets**	**No. of schools with pit latrines**	**% of schools with pit latrines**	**No. of schools with periodic flush toilets**	**% of schools with periodic flush toilets**	**Total Number of schools in parish**
Kingston	33	71.7	0	0	17	36.9	46
St. Andrew	79	74.5	5	4.7	25	23.5	106

Table 27: Sanitation Facilities in Schools 2012/2013							
Parish	**No. of schools with flush toilets**	**% of schools with flush toilets**	**No. of schools with pit latrines**	**% of schools with pit latrines**	**No. of schools with periodic flush toilets**	**% of schools with periodic flush toilets**	**Total Number of schools in parish**
St. Thomas	34	70.8	20	41.6	7	14.5	48
Portland	35	68.6	18	35.2	11	21.5	51
St. Mary	42	60.0	22	31.4	18	25.7	70
St. Ann	46	58.2	34	43.0	10	12.6	79
Trelawny	26	65.0	7	17.5	11	27.5	40
St. James	44	77.1	2	3.5	8	14.0	57
Hanover	24	57.1	9	21.4	11	26.1	42
Westmoreland	41	61.1	22	32.8	17	25.3	67
St. Elizabeth	53	61.6	39	45.3	15	17.4	86
Manchester	42	58.3	29	40.2	12	16.6	72
Clarendon*	41	38.6	35	33.0	24	22.6	106
St. Catherine	77	64.1	34	28.3	25	20.8	120
Total	617	-	276	-	211	-	990
Average	-	63.3	-	29.0	-	21.7	-
*There was no data provided for twenty seven (27) schools in the parish of Clarendon Source: Summarized data from the Ministry of Education by Smith (2013)							

VOLUME OF SEWAGE DISCHARGED INTO WATER BODIES

The exact volume of wastewater discharged into water bodies is unknown; the only information available is from NWC plants. The amount of treated waste discharged into water bodies by NWC is 59.764 MGD.

SEPTAGE/BIOSOLIDS MANAGEMENT

The following information is from the Pan-American Health Organization (PAHO) document "Final report, Situational Analysis: Development of Guidelines, Standards and Regulations for the Management of Septage and Sludge" prepared by Forrest and Associates.

> *A study supported by PAHO (2000) estimated that approximately 1.9 million cubic meters of septage are generated annually. Verification of this figure was difficult within the scope of the investigation however; a review was done of on site systems in major population centers in the country. The results shown in Table 28 show that for the seven major towns, septage generation rates were in the order of 155,000 cubic meters each day. However, this figure does not necessarily represent the volume which has to be disposed of as that will be dependent on many factors including septic tank size, pumping frequency and water supply characteristics. The difference in the two numbers point to be need to have a reliable method of estimating*

septage generation rates in order to adequately address the establishment of disposal facilities.

The sparity of reliable data in this regard points to the need to incorporate into any future management framework a data gathering mechanism which allows for better quantification and prediction of septage generation rates to facilitate better planning and management of the sector.

Table 28: Percentage on Site Sewage Treatment System in Major Towns In Jamaica

Town	Percentage Onsite System	Estimated Septage Generated (m^3)
Kingston	61.0	116,000
Black River	68.0	703
Negril	-	9,400
Montego Bay	-	22,600
Falmouth	78.2	2,500
Ocho Rios	67.0	1,800
Port Antonio	86.0	2,500
	72.04	155,503

Source: Literature Review Development of Jamaica's National Program of Action (NPA) for the Protection of the Coastal and Environment

The transport of septage is operated by private sector cesspool haulers who are located throughout the country. Tables 29 and 30 list the operators and location of the operations on a parish by parish basis.

Table 29: Cesspool Operations

Citywide Cesspool Emptier	St. Andrew Cesspool
Intra Island Cesspool (May Pen)	Alpha Cesspool Service
Mandeville Cesspool Services	Water & waste Environmental Solution
Cesspool Specialist (Old Harbour)	Jamaica Cesspool
Citywide Cesspool Emptier	St. Andrew Cesspool
West Indies Cesspool	Stephen Plumbing Service and Cesspool
All Island Cesspool Emptier	Kingston Cesspool Emptier
Central Cesspool Services	Adolph's Cesspool Emptier
Roy McGill Cesspool Emptier	Burkett & Sons Cesspool Emptier
Kelly Cesspool (Spanish Town)	Wards Cesspool and Construction

Table 30: Location of Cesspool Operators	
Parish	**Number of Cesspool Haulers**
Kingston	10
St. Catherine	3
Clarendon	2
St. James	4
Westmoreland	4
St. Ann	1
Manchester	2

The operators' empty septic tanks and absorption pits from residential, commercial and industrial sites. In theory the disposal of the septage should take place at the two official facilities operated by the NWC: the Bevin Avenue facility located in Montego Bay (Western Jamaica) and the Greenwich Treatment Plant a primary sewage treatment plant (STP) in Kingston.

The Bevin Avenue Plant operates six days a week from Monday to Saturday from 8:30 am to 4:00 pm. The facility consists of a secondary treatment STP. To use the plant, cesspool operators have to purchase 'waste dumping coupon booklets' One coupon costs nine hundred and fifty dollars (J$950). The coupon contains information on the name of the hauler. The coupon is handed in at the security office at the entrance of the plant. The office retains the original copy of the coupon. Once the coupon is handed in the hauler is allow to enter the facility to discharge. Each discharge should be tested for its grease content. Loads containing high grease levels are not allowed to off load. Approximately, 415,000 United States gallons (around 1,600 cubic meters) of septage is off loaded at the facility daily.

At the Greenwich facility approximately 750 loads of septage or one million US gallons (3,800 cubic meters) is offloaded at the plant each month. The system of coupons is similar to what obtains at the Bevin Avenue plant. However, the actual treatment of the septage is significantly compromised because of the non-operation of the sedimentation tanks and digesters at this facility. In reality, very little treatment takes place with the exception of removal of some grit. The untreated septage flows directly into the Kingston Harbour, one of the country's most valuable national assets.

More recently the Can Cara Disposal Site has been approved by NEPA as a regional treatment and disposal site. The facility, an activated sludge plant, will handle a maximum of eight trucks (estimated 12,000 US gallons) daily.

There are two 'unofficial' disposal sites located in the parish of Clarendon which are used by cesspool operators to dispose of septage. The genesis of these disposal sites appears to have come out of a need to find an 'environmentally acceptable' method of disposing of septage. Both operators had previously been offloading septage into sewage treatment ponds in the area, one operated by the NWC and the other by the HEART Academy. However, this practice

was discontinued because the offloading appeared to have adversely affected the operation of the sewage waste stabilization ponds. Both operators consulted the Clarendon Health Department and received approval to build sealed ponds to dispose of the septage. Notably, NEPA did not license or permit either facility and the ponds appeared not to have been designed according to standard good engineering practice.

One of the septage disposal sites is located in Osborne Store. No method of record keeping was observed at the site. Although built as facultative waste stabilization ponds the consultant observed the first pond was basically anoxic at the time of the visit.

The other disposal site in Clarendon is located on a five acre property in Comfort. The owner said that the site was basically used to support his own operation and is occasionally used by other operators. There were no records on the site but it was estimated that 120 loads 36,000 US gallons (136 cubic meters) were offloaded each month.

The situation of the ponds in Clarendon clearly demonstrates the dilemma of septage management in Jamaica. On the negative side it shows the lack of an adequate regulatory and monitoring framework and suitable treatment and disposal facilities. On the positive side it shows that the private sector is willing to invest in disposal facilities to support their business operations. The irony of the situation is that these two 'unofficial sites' may be less deleterious to the environment in their present operating scenario than the official septage disposal site at Greenwich. Furthermore, while there is anecdotal information about illegal disposal of septage in the country, there are no official records documenting the issue

None of the septage facilities in Jamaica treat nor have the design capacity to treat the estimated 1.9 million cubic meters of septage generated annually. The challenge to the country is to provide the enabling environment which will allow the development of the sector based on sound technical options for treatment and disposal of septage in an appropriate an effective institutional, legislative and enforcement framework.

Anaerobic digestion is one of the proven methods to treat septage producing a stabilized sludge and methane as valuable byproducts. The Scientific Research Council with the support of the Ministry of Commerce and Technology is currently conducting a preliminary feasibility study on "The Commercial Production of Biogas from Aerobic Sludge and Septage".

The study, which views waste as a resource, is being supported by the European Union through GTZ and CREDP. The project is examining using the methane to generate electricity and supply the grid. The key stakeholders are involved in the process; NWC, NSWMA, Jamaica Public Services Company (JPSCo) and Petroleum Corporation of Jamaica (PCJ).

The intention is to locate such treatment facilities strategically throughout the island. If the results of the study are favorable this may resolve the issue of treatment of the septage, although the issue of disposal of the biosolids would still need to be resolved. Fortunately, the anaerobic process produce less and more stable solids that aerobic processes. The matter for

characterization of the septage and biosolids and the need for applied research to see the appropriateness for agricultural application will be necessary.

In addition to the SRC initiative, a local firm WAYMAY Limited, through its Water & Waste Environmental Solutions Division has written to the MOH expressing an interest in constructing a waste treatment facility to treat septage in the Kingston and St. Andrew area. The proposal also includes the use of anaerobic technology and the generation of electricity to supply the grid.

Uncontrolled and indiscriminate dumping of faecal sludge (FS) removed from on-site systems is commonplace in many regions of Jamaica. Such mismanagement creates the potential for human health risks through human contact with untreated FS and the potential for drinking water contamination. In the parish of St. Elizabeth no FS treatment facilities exist and the distance to existing facilities outside the parish renders hauling cost-prohibitive. When the sludge from on-site sanitation systems is emptied, there is general uncertainty as to its ultimate disposal (Fernandes 2005).

The physical characteristics of fecal sludge vary significantly due to, among other factors, climate, tank emptying technology and pattern, storage duration (months to years), performance of tank, additional components of FS such as grease, kitchen/solid waste, and potential groundwater intrusion (Montangero and Strauss, 2002 as cited by Fernandez, 2005). Faecal sludge is a highly variable, organic material with considerable levels of grease, grit, hair and debris. In addition to its variable nature, FS tends to foam upon agitation, resists settling and dewatering and serves as a host for many disease-causing viruses, bacteria and parasites (US EPA, 1999).

It is clear that FS removed from systems in the country is not being hauled to either of the existing plants, as the distance is cost-prohibitive (Van Hoven 2004). The remaining wastewater treatment plants on the island, particularly those in St. Elizabeth and surrounding parishes, are not designed to accept additional waste.

Were these plants operating to standards, the possibility of updating them to handle FS as influents would be considered. From an initial review of the publicly-owned plants in the country, however, it appears that none are operating to standards and it would not be feasible to upgrade the systems to accept more solids.

In addition to the limits of existing wastewater treatment plant infrastructure, faecal sludge, unlike sewage sludge, is rarely contaminated with toxic chemical compounds and is considered a type of "organic waste". From a sustainability standpoint, therefore, it could be argued that as an organic waste it should not be added to a sludge with potentially high chemical contamination, as such a process would render it unsuitable for reuse (Klingel et al., 2001).

Very little data surrounding faecal sludge quality, in particular total suspended solids (TSS) concentration, in Jamaica are available. However, in 2004, faecal sludge samples were taken at

7 different locations throughout western Jamaica (Stewart, 2004). The results indicated a range in TSS concentration from 228 mg/L to 24,350 mg/L.

CONDITION OF WASTEWATER TREATMENT INFRASTRUCTURE

Over the past several years, there has been significant improvement in wastewater treatment infrastructure, with new systems recently completed in Negril, Ocho Rios, Montego Bay, Soapberry (serving parts of Kingston and St. Andrew and St. Catherine). However, many of the plants across the island are old, extending up to 30 years and currently use older inefficient technologies and operate beyond their lifespan and their design capacity. In addition, the original designs for some plants do not allow them to generate effluent for discharge that complies with the revised Sewage Effluent Standard. However, in most cases, plants are not even meeting the approved standards that were set according to their original design specifications. Coupled with this is the fact that most of these plants are mechanical, using the aerobic process for treatment, and subject to frequent mechanical failure and also are energy intensive. Plants are being overloaded. This occurs in urban centres when housing stocks are increased and their wastewater flows are connected to the existing wastewater treatment plants without commensurate increase in their capacity to accommodate such loads.

Important equipment for the proper functioning of a significant number of sewage treatment plants is either missing or not functioning properly. This is particularly so for the various pumps and motors used at the plants. There is little effort to replace or repair vital components responsible for the effective functioning of plants. Also, there seems to be no adequate maintenance programmes in place for some equipment. In addition, most plants lack a documented operational and maintenance programmes; some operators are working based on what they are told and their own experience.

NEPA reports that there are instances where the sewer systems have overflowed because of siltation and breakage due to the age of pipes.

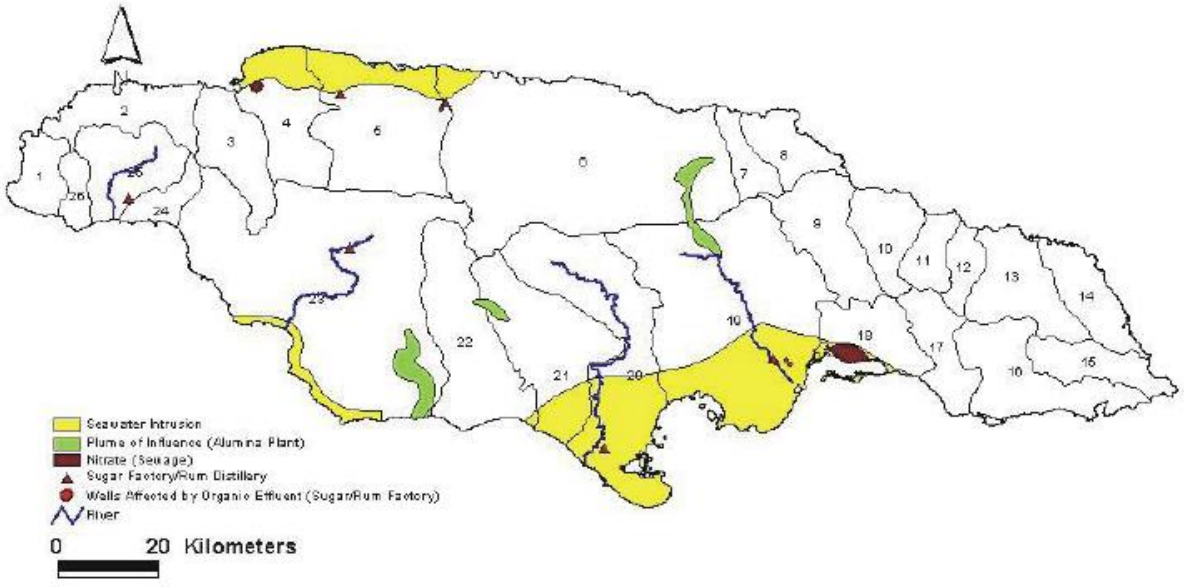
6. POLLUTION PROBLEMS AND THEIR COST

POLLUTION IN RIVERS, LAKES, MANGROVES AND COASTAL AREAS (THERMAL AND NUTRIENT POLLUTION)

Water is becoming scarce not only because of increased demand, but also because of higher pollution levels and habitat degradation. Global freshwater resources are threatened by various factors, including: overexploitation, poor management, watershed degradation and pollution. The Water Resources Authority reports that about 10 per cent of the island's water resources has been lost as a result of pollution, saline intrusion (from overexploitation) and watershed degradation.

Ground and surface waters in Jamaica are generally of a high quality. However man's influence affects the quality of the water resources. The main sources of water pollution in Jamaica are: inadequate sewage disposal, soil erosion and agricultural and industrial discharges. Surface water is more susceptible to contamination and is used to transport waste from industrial complexes and human settlements.

Figure 6: Known Water Pollution Problems



Source: Water Resources Authority

Generally, surface water quality is poor around and downstream of industrial and population centres. The nutrient-rich industrial and sewage effluent encourages the growth of algae and other plants, and increases faecal coliform levels. This is evident in the Black River which is contaminated by the discharge of dunder from Appleton sugar factory and distillery. Groundwater near soak-away pits may also have high coliform levels. For example, several supply wells in the Liguanea Plain that supplied water for Kingston have been abandoned due

to nutrient (nitrate and phosphate) contamination, which results from seepages from sewage soak-away pits (Figure 6).

According to NEPA, in 2010 the percentage of rivers meeting the BOD and nutrient standard was 79 per cent and 72 per cent respectively (Table 31). During the period 2008-2010, there was a general improvement in these water quality indicators.

Table 31: Environmental Indicators and Trends 2008-2010

	2008	2009	2010
Percentage of fresh water (river) sites meeting BOD standards	76%	82%	79%
Percentage of fresh water (river) sites meeting nutrient standards	55%	59%	72%
Source: NEPA, State of the Environment 2010			

Three sets of standards, each measuring specific parameters, are used to assess the quality and suitability of different types of Jamaica's freshwater resources. In the case of ambient waters (rivers, lakes and ponds), the parameters measured are: calcium, chloride, magnesium, nitrate, phosphate, pH, potassium, silica, sodium, sulphate, hardness, biochemical oxygen demand, conductivity, and total dissolved solids (TDS). Based on these criteria, the surface and ground water resources are presently of excellent quality throughout the country. Less than 10 per cent of the island's water resources have been contaminated. In the areas of contamination there are drinking water use restrictions and strategies are in place to improve water quality and prevent further contamination.

During the period 2007-2010, 36 per cent of river sites sampled showed deterioration with respect to faecal coliform concentration when compared to the period 2003-2006. Table 32 shows the comparisons for faecal coliform and three other key parameters. Figure 7 shows the change in water quality (as determined by faecal coliform level) during the period 2007-2010 when compared with 2003-2006 at fresh water (river) sites across the island.

There are two specific areas that are worth mentioning with respect to water quality: Kingston Harbour and Hunts Bay. These are described below.

Kingston Harbour is a major industrial center and commercial port. According to NEPA (NEPA 2011) Kingston Harbour receives pollution from different sources, including wastewater treatment facilities, industrial facilities, power plants, construction works (urban expansion, harbour works), habitat modification (dredging, filling and clearing of mangroves), urban runoff, agricultural and horticultural runoff, construction runoff and landfills. Pollution entering the Harbour is mainly in the form of liquid waste coming from gullies, ships, rivers, sewage treatment plants, industrial outfalls and solid waste from poorly managed or illegal waste

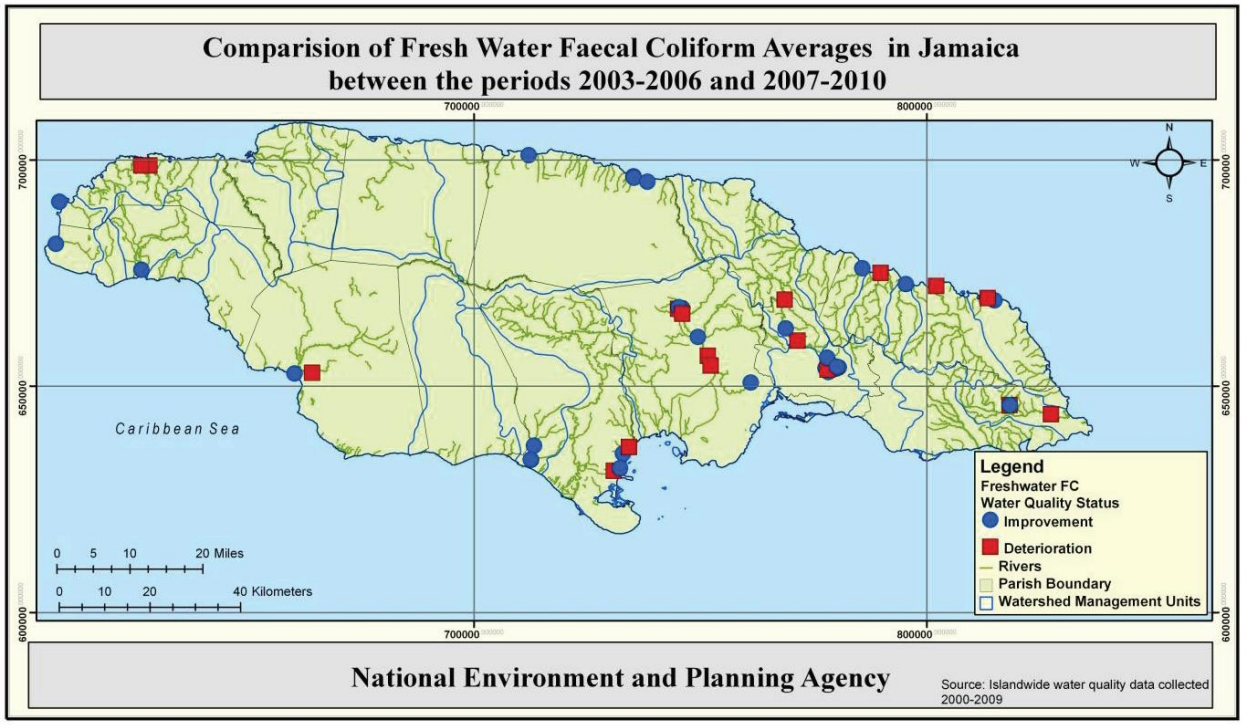
dumps as well as gullies. Poorly or untreated sewage is by far the most serious source of pollution affecting the Harbour.

Before 2007, both Western and Greenwich sewage treatment plants (with an estimated volume of 5.3 MGD and 10.5 MGD, respectively) were discharging their effluent into the Harbour. Western Sewage was functioning as a primary treatment facility, while Greenwich was overloaded and frequently inoperative. The pollutant concentrations at the outfall of the Greenwich and Western sewage treatment plants rendered these two areas as the most significant point sources of pollution to the Harbour. In a study conducted in 1993 by SENTAR Consultants Ltd. (1993), sewage contributed to approximately 37 per cent of biochemical oxygen demand, 65 per cent nitrogen and 75 per cent phosphorus.

In 2007, Soapberry STP was commissioned and sewage from the Greenwich and Western treatment plants are redirected to the Soapberry Plant. At Soapberry, sewage is treated in a lagoon treatment system. The implementation of the plant led to the many communities that were previously served by sewage soak away pits to become connected to a sewer system that now channels waste water from the KMA to this new treatment facility. Treatment of sewage by the Soapberry STP is expected to considerably improve the water quality of Kingston Harbour over time, by reducing the high bacterial, nutrient and organic loading.

Hunts Bay has traditionally been a major shrimp fishery. The fisherfolk located on the Causeway fish in Hunts Bay, as well as further out to sea. Hunts Bay has a licensed fishing beach with 17 boats in use. The Causeway Fishing Beach, though unlicensed, is the largest fishing beach in the Harbour rim and has 103 boats in use (Environmental Solutions Ltd 2004). The main resources for the fisherfolk on the Causeway Beach and in Hunts Bay are snapper and shrimp. Hunts Bay and Kingston Harbour have both been recognized as dying ecological systems resulting from continued pollution loading over the years, and the fisheries have been further compromised by overfishing. Anecdotal information over the years has indicated that the shrimp fishery in the Bay has steadily declined and fisherfolk have indicated that fish and shrimp have almost disappeared from the Harbour (Environmental Solutions Ltd. 2004).

Figure 7: Comparison of Freshwater Faecal Coliform Averages in Jamaica between the periods 2003-2006 and 2007-2010



There has been a complete loss of benthic macrofauna in the central areas of Hunts Bay and the Upper Basin. The only animal groups found in these areas are meiofauna with a dominance of nematodes (90-100 per cent) in this assemblage. The sediment macrofauna have totally disappeared from the deeper basins within the Harbour as well as in Hunts Bay.

Table 32: Number of River Sites Showing Deteriorating Water Quality for 2007- 2010 Compared with 2003-2006 and the Number of Sites Meeting the Standards in 2010

Parameter	No. of sites	No. of sites meeting standards in 2010	Standard	No. of sites showing deterioration *	% of sites showing deterioration *
Nitrate	52	38	0.10 - 7.5 mg/L	25	48%
Phosphate	50	36	0.01 - 0.8 mg/L	23	46%
Biochemical Oxygen Demand (BOD)	52	43	0.80 - 1.7 mg/L	52	43%
Faecal Coliform	47	...	...	17	36%

* Sites with an increase in parameter concentrations compared with 2003-2006
Source: NEPA

Hunts Bay is a shallow basin of an area of 10.10 km^2 with depth ranges from 0.31 m to 4.57 m (Goodbody, 1970; Wade, 1976; Ranston, 1998 in Webber 2003). The Bay is subjected to considerable salinity fluctuations due to fresh water runoff from the Rio Cobre, Ferry and Duhaney Rivers and from the Sandy Gully and is now only connected to the Kingston Harbour by a 213.36 m opening since the construction of the Causeway Bridge in 1969 (Webber 2003).

Fresh water enters the Harbour at Hunts Bay from two main rivers, the Rio Cobre and the Duhaney rivers, and by a drainage scheme, the Sandy Gully, as well as via several intermittent streams (Webber, 2003). The most important source of fresh water is the Rio Cobre, which has a mean discharge rate of approximately 6.2 m^3/s but during flash floods, peak flow may rise to 283 m^3/s (Government of Jamaica, 1968; Wade, 1976 in Webber 2003).

The discharge rate of the Duhaney River is fairly uniform (2.83 m^3/s) but is less than half that of the Rio Cobre while Sandy Gully discharge over a one-year period was approximately 61,317 million liters or 1.9 m^3/s (Government of Jamaica, 1968; Wade, 1976 cited in Webber 2003). When there is significant land runoff, water also enters the Harbour along its northern shore via several gullies. The flow rate of these gullies on the north shore was 1.7 m^3/s or 54,504 million liters per year (Webber, 2003). Webber et al (2003) clearly show that the concentration of pollutants in Hunts Bay have increased considerably over the last twenty years. Webber et al (2003) further show that the eutrophication of Kingston Harbour can only be reversed by control of the domestic and industrial waste presently released into it. Even with such waste being diverted, the slow flushing time of the Harbour makes that a difficult task (Webber 2003). It is important therefore that adverse impacts on these surface water systems be minimized to prevent further degradation of the water quality.

Treatment of sewage by Soapberry WWTP will considerably improve the water quality of the Rio Cobre and Hunts Bay. The water quality in these water bodies is presently quite stressed with high bacterial, nutrient and organic loading. In the long term this should contribute to the reduction of the effects of eutrophication and a restoring of some of the ecological attributes of the Bay.

Information presented in an Environmental Impact Assessment (EIA) for Soapberry (Environmental Solutions, 2004) indicates that data generated for the surface water systems show considerable organic contamination and high bacterial loading (Table 33).

Dissolved oxygen levels were good at Stations S1 and S3 ranging from 5.9 to 7.8. The dissolved oxygen levels at the mouth of the Duhaney River were however quite low. The waters at all three stations sampled were slightly alkaline. BOD for surface waters in excess of 2.0 mg/l indicates elevated organic loading, which is a cause for concern. BOD levels were elevated at all three stations ranging between 3 and 12 mg/L. High BOD levels are a direct consequence of the high concentration of oxygen demanding species in the surface waters. Faecal coliform is used as an indicator of the possible presence of pathogenic organisms. The generally accepted limit for faecal coliform in surface waters is 200 MPN/100 mL. A guideline of 450 MPN/100 mL

is used for one-off samples. This limit was significantly exceeded at two stations, where levels were in excess of 1,100 MPN/100 mL.

Table 33: Water quality sample stations				
Parameter	**Samples/Station Location**			**NEPA Marine Standards**
	S1	**S2**	**S3**	
	Duhaney River at the mouth	**Hunts Bay – South**	**Rio Cobre at its mouth**	
pH	7.8	8.7	8.3	8.0-8.44
Salinity (ppt)	4	9.1	2.2	-
Dissolved Oxygen (mg/L)	2.8	7.8	5.9	4.5-6.8
BOD (mg/L)	3	12	10	0.57-1.16
Nitrate (mg/L)	1.2	0.1	3.8	0.001-0.081
TSS (mg/L)	5	16	31.3	-
Phosphate (mg/L)	0.2	0.2	0.3	0.001-0.055
Oil & Grease (mg/L)	2	0.5	0.7	-
Total Coliform (MPN/100ml)	>2400.0	93	>2400.0	48-256
Faecal Coliform (MPN/100ml)	1100	23	1100	<2-13
Source: Environmental Solutions, 2004				

One of the big problems that causes pollution of water is the large number of housing developments that are being implemented. In the period 1999 to 2009 a total of 2,160 applications were received (Figure 8). These housing developments are using small wastewater plants that do not necessarily meet the discharge standards that have been set prior to their approval. Developers installed sewage plants without any consideration to the operation and maintenance. Therefore, after several years the plants become inoperative. Figure 8 presents the geographical distribution of these development applications and Figure 9 the number of development applications per year during the period 1997 to 2008.

Figure 8: Development Applications Assessed by WRA (1999 – 2009)

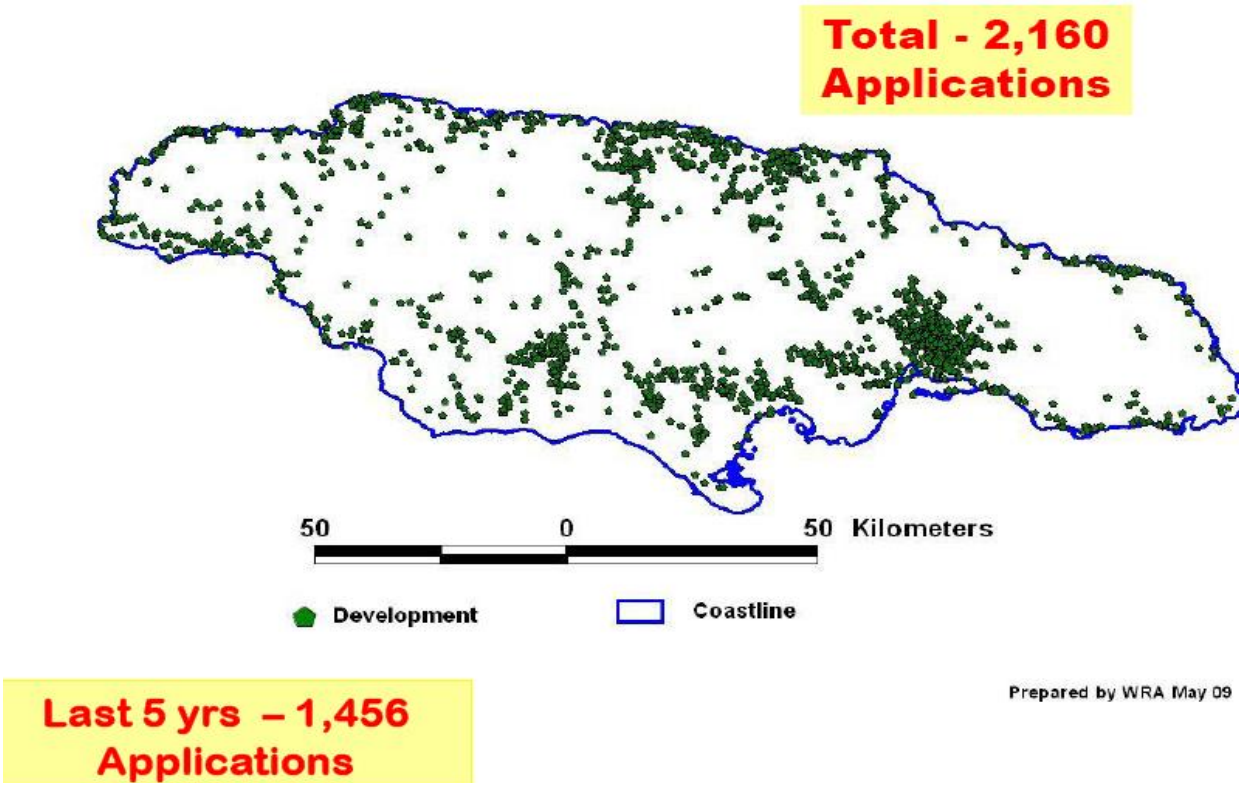
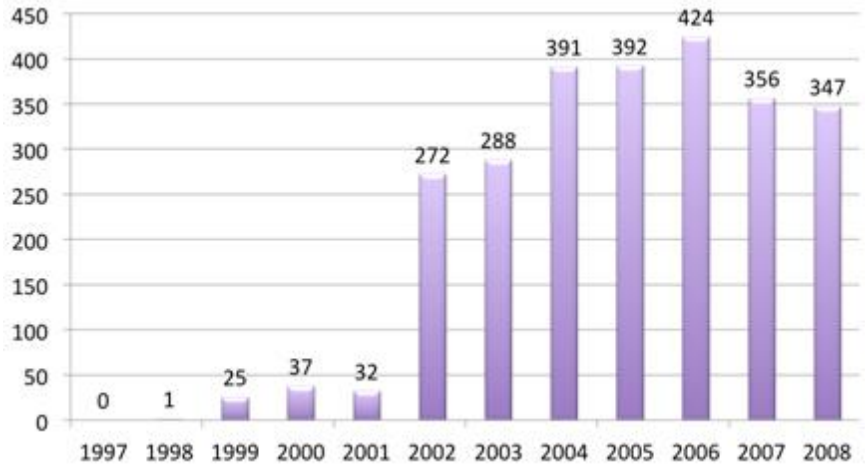


Figure 9: Environmental Permit and Licensing System
(Rolled out in 1997)
Number of Development Submissions Received by
Water Resources Authority 1997 – 2008



ENVIRONMENTAL DETERIORATION SUCH AS TOXIC ALGAE BLOOMS AND DESTRUCTION OF CORAL REEFS

Poor water quality from land-based sources of pollution leads to the degradation of coral reefs. Sediment from land-clearing and high levels of nutrients from agricultural areas and sewage outflows are often carried in the runoff. Increased nutrients lead to poor water quality and as well as eutrophication, which enhances algal growth on reefs. Sedimentation can lead to smothering of corals and interfere with their ability to feed and reproduce. Pesticides, which are known to affect coral reproduction and growth, as well as petroleum products, are also often transported and they pollute the marine environment, threatening coral reef health (NEPA 2011).

In Jamaica the coastal waters have been progressively deteriorating for a number of years. Ecological observations on the increasing abundance and species diversity of algae around Jamaica in the 1990s suggested that eutrophication had become a general phenomenon in the previous decade. Eutrophication had been so serious that many reefs which formerly had more than 95 per cent live coral cover were then more than 95 per cent algae covered. Overgrowth of reef corals and "good" sand-producing algae by "bad" fleshy algae took place at different times in different places, suggesting that local nutrient sources played a key role. Coral reefs near Kingston were affected in the 1950s and 1960s, reefs near Montego Bay and Ocho Rios are thought to have been impacted in the 1970s, the area from Rio Bueno to Runaway Bay was affected in the 1980s, and Negril and parts of Western Jamaica were affected in the early 1990s (Goreau 1992). Algae overgrowth spread outward from source areas in expanding rings which were initially focused around local sources, but which have since begun to merge along much of the coastline. Along most of the south and north coasts, eutrophication had become a persistent regional phenomenon. In addition, nutrient inputs caused permanent planktonic algae blooms, turning formerly clear blue waters dark, turbid and green. Only the least developed and populated areas had coral reefs in good condition, with algae cover around 20 per cent or less. Even in the Port Antonio area, eutrophication was visible in all populated bays but absent off un-populated shores. Similar patterns were seen in Western Jamaica (Goreau 1994).

Nutrients enter the Jamaican coastal zone from streams and from submarine springs supplied by groundwater seepage. Measurements around 1980 found nitrate levels in Discovery Bay in the range of 5 to 10 micromoles per liter. By the late 1980s these increased to approximately 10 to 15 micromoles per liter, and ecological replacement of corals by weedy algae was nearly complete. Samples analyzed for nitrogen and phosphorus showed that the source of nitrogen was from freshwater and the concentrations were sufficiently high that they exceeded critical levels down to a depth of 100 feet on the outer reef slope. Similar nutrient values were found all along western St. Ann from Rio Bueno to Dunns River. Because of the much larger sewage discharges from highly developed areas near Ocho Rios, Montego Bay and the South Coast, those areas had considerably higher values. While the main source of nitrogen was from subsurface drainage from the interior of the watershed, it appears that the growth of

population and tourism along the shore in the 1980s provided local phosphorus inputs which had been previously lacking, causing rapid eutrophication (Goreau 1994).

Negril, located at the western tip of the island, has had explosive tourism development and population growth in the last two to three decades. Analyses made in 1992 by Wade showed high values of nutrients in the range of 10 to 20 times the acceptable levels. In the early 1990s, the reefs of Negril were subjected to unprecedented algae overgrowth, with the result that the coverage of algae on the bottom equalled or exceeded that of corals. These values suggest that nutrient concentrations need to be reduced by 90 to 95 per cent or more to allow ecosystem recovery (Goreau 1994).

The Port Antonio region was also found with high concentrations of nitrates. This occurred to such an extent that, in the 1990s, it was recommended that the measured inputs to the coastal zone be diluted by a factor of between 2 and 45 times before their nitrate contents are sufficiently low (Goreau 1994).

The fact that eutrophication has followed the course of coastal development and increasing resident and visitor populations, along with their releases of inadequately-treated sewage, suggests that excessive algae growth has been fertilized by increasing nutrient inputs rather than being due to destruction of corals by hurricanes, which took place at the same time at all sites, or due to overfishing, which had removed most of the top predatory fish and reached unsustainable catch/effort ratios more than 20 years ago (Aiken 1991 cited in Goreau, 1994).

In 2010, mean percentage cover for hard corals ranged from a low of 1.4 per cent in the Oracabessa Bay Fish Sanctuary (now known as the Oracabessa Bay Special Fishery Conservation Area), to a high of 30.6 per cent within the Palisadoes/Port Royal Protected Area (NEPA - Reef Status and Trends 2010). In contrast, fleshy algae composition ranged from 0.6 per cent to 81.6 per cent, with the Oracabessa Bay Fish Sanctuary site recording both the lowest coral coverage and the lowest algal coverage. Of 22 sites assessed, only Drapers and Drunkenman's Cay recorded coral cover of at least 20 per cent while eight sites had less than 10 per cent. Since 2007, the coral reef system appears stable, with no drastic change in annual average coral cover. Hard coral coverage in 2010 was 13.3 per cent compared to 13.2 per cent in 2009 and 13.7 per cent the previous year.

HUMAN SHELLFISH AND REEF FISH POISONING

The potentially toxic dinoflagellate species *Alexandrium minutum* was found for the first time in Jamaica in 1994. This dinoflagellate which produces potent neurotoxins responsible for paralytic shellfish poisoning (PSP) in humans in many parts of the world, as well as mass mortality of various marine flora and fauna, was identified in water samples collected during an extensive bloom of the species in the brackish to saline water body of Hunts Bay in August 1994. The highest cell concentration was 4.6×10^5 cells/liter, a concentration which far exceeds acceptable concentrations ($<10^3$ cells/liter) of PSP-toxin-producing *A. minutum* in several countries, including Spain and Denmark. No human PSP symptoms were reported during the

bloom; however it was accompanied by a large kill of small pelagic fish extending across a third of the Bay.

Since then, smaller blooms of *A. minutum* have occurred with the most recent in February and April 2004. Hunts Bay is an important fishing, shrimping and to some extent oyster/mussel collection area and provides an important source of livelihood and food for many fisherfolk in nearby fishing communities as well as an important source of food for members of other communities. Although there are no known records of human illness due to PSP in Jamaica, the occurrence and blooming in Jamaican waters of this potentially toxic dinoflagellate, is great cause for concern (Ranston 2007).

In 1990, 17 persons in a community in St. Ann suffered from gastrointestinal disturbance-discomfort, nausea, vomiting and dizziness presumably the result of ingestion of a single Ciguatoxin-infected barracuda fish (Coleman 1990). A similar case occurred in April 2006, when there were reports of 19 persons from Enfield, St. Mary being poisoned, also allegedly from eating barracuda fish, and subsequently hospitalized at the Annotto Bay Hospital (Thompson 2006).

OUTBREAKS OF WATER- AND FOOD-BORNE ILLNESSES RELATED TO BAD SANITATION

In 2009, a Jamaica Burden of Illness study was conducted by the Ministry of Health, in collaboration with the Caribbean Epidemiology Centre (CAREC) and the Pan-American Health Organization (PAHO). The study revealed that 6.1 per cent of the 1,920 people interviewed reported having an episode of diarrhoea within the previous month. Diarrhoea is a principal symptom of food-borne infections. Approximately 50 per cent of the respondents who reported having had diarrhoea attributed their diarrhoea to food and/or drink consumed. Only one third of those who suffered diarrhoea sought help from a health care provider. Of the number that sought care only one person reported submitting a stool sample.

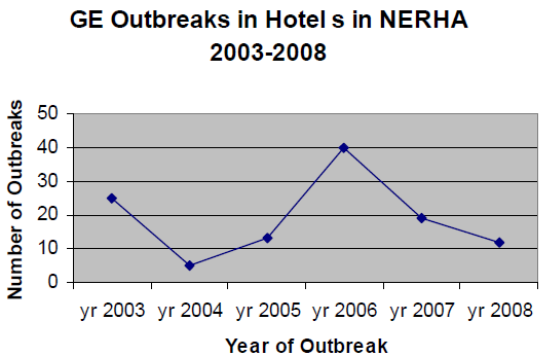
Tourism is an important earner of foreign exchange in Jamaica; hence, the protection of visitors' health is very important. A study of travellers to Jamaica in 1996 to 1997 found that travellers' diarrhoea (TD) affected almost 25 per cent of visitors. Jamaica's Ministry of Health initiated a programme for the prevention and control of TD aimed at reducing attack rates from 25.0 per cent to 12.0 per cent over a five-year period through environmental health and food safety standards of hotels. The study examined the food safety systems in Jamaican hotels.

There were 12 TD outbreaks in 2008 compared to 2007 in which there were 19 outbreaks. Eight (8) outbreaks were reported in the parish of St. Ann, affecting over 60 guests and staff cumulatively. The majority of outbreaks occurred in the month of August. Four (4) outbreaks were reported in the parish of St. Mary, affecting over 150 guests and staff cumulatively. The

March outbreak in St. Mary led to the closure of one hotel. All outbreaks were investigated within 24 hours of reporting.

The increased vigilance of the tourism and health authorities, through periodic, routine and compliance inspections, quick response to outbreaks, and improved overall sanitation at the properties may have had an impact on this decline. The monitoring activities were complimented by functional Health and Safety Committees in most of the properties (which the team was instrumental in developing). Meetings with environmental staff and hotel nurses in the properties as well as HACCP [10] training for hospitality workers offered by the region enhanced capacity of the staff on the properties to improve sanitation.

Figure 10: GE Outbreaks in Hotels in NERHA, 2003 – 2008



Cholera is another important water-borne disease and is closely associated with small crustaceans called copepods. It is critical to address a deteriorated environment to prevent the establishment of cholera in Jamaican waters because *V. cholerae*, an environmental autochthonous (indigenous) inhabitant of brackish, estuarine, and marine ecosystems, represents an important agent of disease that can be dramatically influenced by environmental changes. A correlation has been observed between the incidence of cholera and presence of increased numbers of blue-green algae in the water (Cockburn TA, 1960).

Cholera can result from ingesting enough of these copepods while bathing or swimming or by drinking untreated water from ponds, rivers and lakes of cholera-endemic countries. The number in a glass of water of 150-200 milliliters would be enough to cause cholera, i.e., trigger an infection or even an epidemic.

Therefore, it appears that improperly functioning STPs are creating optimal conditions for development and survival of vibrio cholera in the environment and in the food chain and sources of drinking water. Serious and continued action to improve the STP effluent should be taken for protecting public health and also protecting the environment which later will result in preventing the development and survival of the cholera vibrio.

As indicated by the graph in Figure 10 the steady decline in the number of reported gastroenterology (GE) cases (above endemic levels) in hotels continued since the peak in 2006. Response to outbreaks took on a multidisciplinary approach involving Public Health Inspectors, Public Health Nurses, Food Safety Coordinators, Epidemiologists, Surveillances Officers and other professionals.

[10] Hazard Analysis & Critical Control Points

The high load of faecal coliform is a result of low or non-existent free residual chlorine and other physical conditions of the effluent such as high TSS. High TSS or turbidity is known to reduce disinfection efficiency (Mark W. Lechevallier et al 1981).

However, the lack of residual chlorine in wastewater may not only be a result of low dosages of chlorine, but also due to the presence of organic matter (BOD_5) in the effluent. Total organic carbon has been found to interfere with maintenance of a free chlorine residual by creating a chlorine demand. Chlorine accomplishes BOD reduction by oxidation of organic compounds present in wastewaters. In the USA in the 1920s and 1930s and thereafter the chlorination of sewage was in use for purposes of protecting water supplies, bathing beaches and shellfish breeding grounds situated at sewer outfalls. Chlorination was reported to reduce the BOD of sewage as well as to control odours. Therefore chlorine added to water first reacts with organic matter, before it starts its disinfection process. Effluents with high BOD therefore prevent the bactericidal action of chlorine and increase the demand for this element.

VECTOR-BORNE DISEASES (CHIKUNGUNYA, DENGUE, MALARIA, LEPTOSPIROSIS ETC.)

Improper management of solid and liquid wastes can contribute to a range of vector-borne diseases such as chikungunya, dengue, malaria (spread by mosquitoes) and leptospirosis (spread by rodents). The high content of nitrates and phosphates in wastewater (raw, partially treated and treated) causes massive growth of vegetation mats in gullies and streams, converting them into mosquito breeding sites and increasing the incidence of mosquito-norne diseases. Also, flooding caused by the presence of these mats eliminates natural breeding sites of rodents forcing them to migrate to surrounding homes in search of food, potentially causing leptospirosis.

Table 34 presents trends in select diseases between 1997 and 2007 in Jamaica.

Table 34: Water and Sanitation Related Diseases – Number of Cases

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Dengue Fever	16	1509	23	25	14	103	70	48	27	71	1521
Malaria Imported	4	3	5	7	6	7	9	141	88	8	8
Malaria (Locally Acquired)	0	0	0	0	0	0	0	0	0	185	191
Leptospirosis	-	-	-	-	-	-	99	153	328	204	255
Food-Borne Illness	93	29	12	289	9	32	5	28	33	18	25
Source: PAHO, Health in the Americas 2012											

Chikungunya Chikungunya is spread to humans by the bite of infected *Aedes aegypti* mosquitoes. The *Aedes aegypti* mosquito, which spreads the dengue virus also, is very well

domesticated – preferring to breed in containers within the household and the immediate surroundings. The female mosquito is the carrier of the virus and it bites at all hours of the day, taking a blood meal for the maturation of its eggs during which is transmits the viruses from person to person.

While the Caribbean region is familiar with dengue and malaria, the Chikungunya virus first appeared in the region towards the end of 2013 and by the end of 2014, every Caribbean Community (CARICOM) country had recorded cases of the virus caused by the aedes aegypti mosquito that causes a dengue-like sickness. The Caribbean Public Health Agency (CARPHA) reported an estimate in excess of 600,000 cases in total, most of those being from the bigger countries like the Dominican Republic and Haiti with 37 deaths in total (Caribbean 360 2014). PAHO reports that Jamaica's incidence in 2014 was less than 100 cases per 100,000 persons (Robles 2014).

Dengue Dengue is transmitted by the *Aedes aegypti* mosquito and on an annual basis, there are approximately 70 confirmed cases of dengue. A dengue fever outbreak occurred in 2007, and since then, although the number of cases has been on the decline, dengue has become endemic. In 2008 a total of 92 suspected cases were reported by all parishes. Approximately 3 suspected cases are now reported weekly island-wide, indicating a virtual return to endemic levels. The threat of another outbreak of dengue fever still looms, however, as the virus is still in circulation in the Caribbean and Latin American Region, with several countries having outbreaks from time to time.

It is important to note that Jamaica has had all four serotypes of dengue circulating and as such, the population is more susceptible to the more severe forms of dengue: dengue haemorrhagic fever (DHF) and dengue shock syndrome (DSS). DHF has been confirmed in Jamaica. In 1995, there were 11 confirmed cases and in 2008, there were 92 confirmed cases. Figure 11 presents the trend of dengue cases from 1997 to 2008.

Figure 11: Reported Dengue Fever cases in Jamaica 1999 - 2008

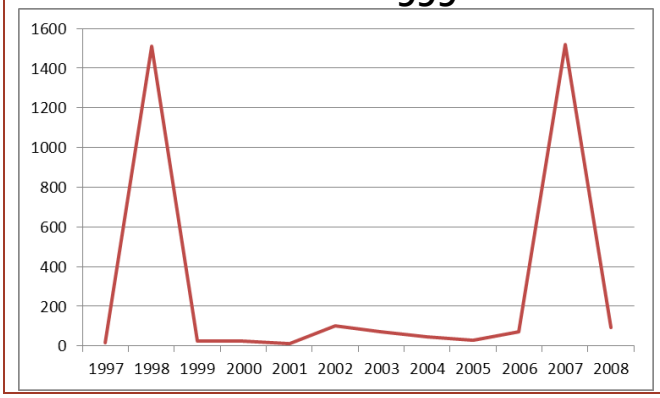
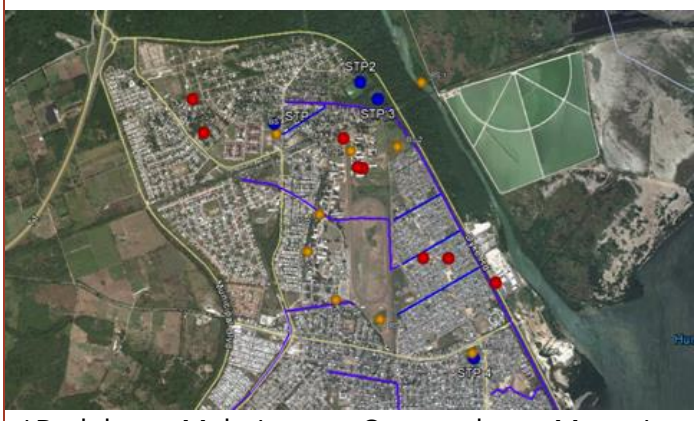


Figure 12: Spatial Distribution of Malaria Cases in Kingston

Dengue and chiungunya are related to sanitation, especially in septic tanks and sewer lines. It is important to mention this, because in the past the *Aedes aegypti* mosquitoes' natural habitat was related to only clean and stagnant water. Studies conducted in Puerto Rico and Peru by the US Centers for Disease Control and Prevention (CDC) have reported the discovery of dengue-carrying mosquitoes that can actually harbour the dengue virus underground, in septic tank and sewer systems.

Malaria Malaria is another mosquito-transmitted disease transmitted by the bite of an infected female *Anopheles* mosquito**.** In November 2006, locally transmitted malaria was detected in a section of Kingston (Figure 12). Having had the re-introduction of malaria into Jamaica in November 2006, a total of 377 cases of *Plasmodium falciparum* malaria were diagnosed by 2008. In 2008 there were a five confirmed cases of locally transmitted *Plasmodium falciparum* malaria – all residing in St. Catherine. Three of these cases were asymptomatic and were identified through active fever surveillance in the communities. The majority of the cases were close to gullies or drains found with massive vegetation which is a product of highly polluted waters that include wastewater discharges. This relationship was examined in Portmore (Figure 13).

Figure 13: Malaria, Mosquito Breeding Sites and WWTPs in Portmore*

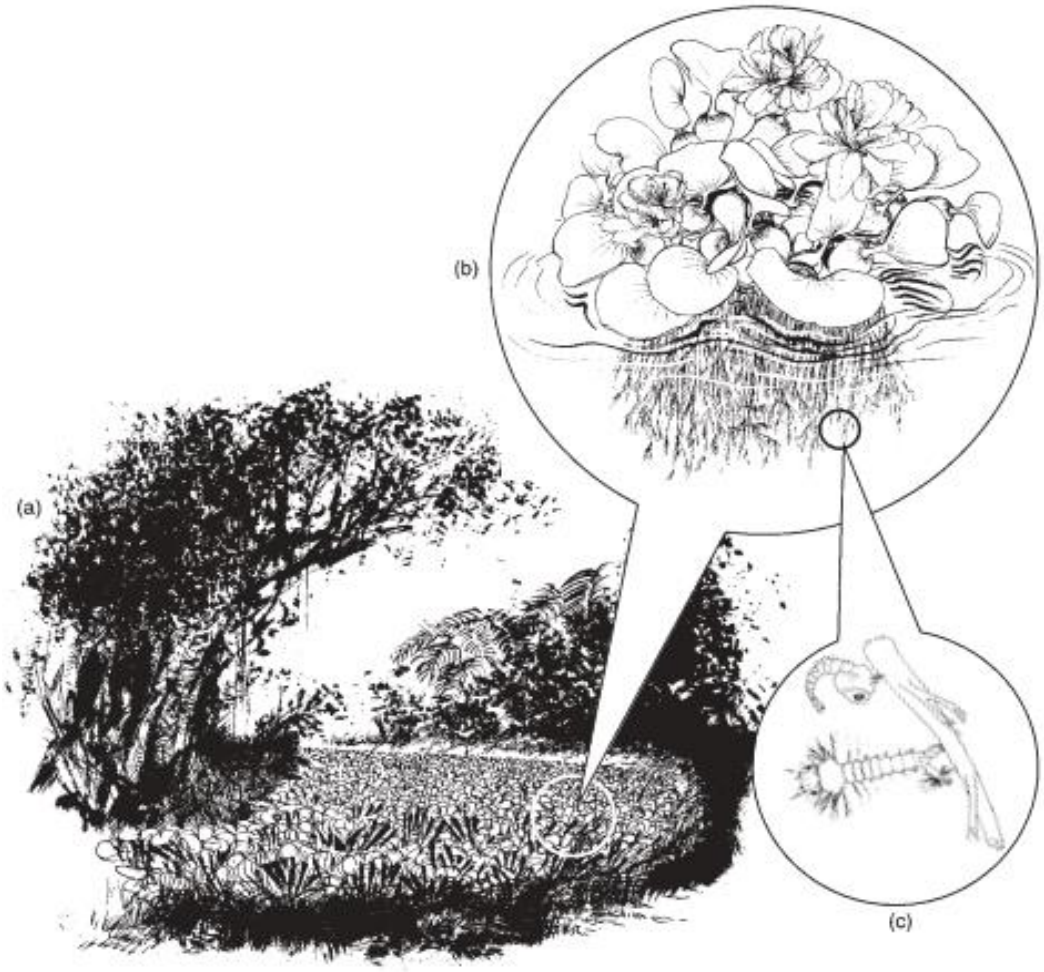


*Red dots = Malaria case, Orange dots = Mosquito breeding site, Blue dot= Wastewater Plant

There were two confirmed imported cases of malaria in early 2008: a case of *P. falciparum* diagnosed on January 9, 2008; and a case of *P. vivax* diagnosed on January 16, 2008. In response to this outbreak, several parishes updated information on their Anopheles breeding sites but these still have not been mapped.

The organic contributions of carbon, nitrogen and phosphorous create optimum conditions for eutrophication and mosquito breeding sites. Eutrophication may occur in slow movement waters in which plants such as water hyacinths may grow. The correlation of breeding of mosquitoes to hyacinth growths is an established and recognized fact (Figure 14). The plant blocks sunlight from reaching native aquatic plants, starving the water of oxygen and thus killing fish and other organisms. It has been found that these plants harbour mosquito larvae and otherwise protect them from fish and other forms of life that feed on the larvae. In areas where malaria is a hazard, the removal of water hyacinth plants is one of the accepted control measures for controlling the breeding of anopheline mosquitoes.

Figure 14: A canal in which the water surface is covered with floating mats of water hyacinth (a). On the right (b), the water hyacinth in more detail. Mansonia larvae and pupae are attached to the roots, from which they obtain oxygen for breathing (c).



Source: Spira 1981.

Moreover, in treating bodies of water where mosquito breeding is associated with hyacinth growths, a larger amount of the larvicide is required and the result of the treatment is not as effective. Thus the cost factor is increased by hyacinth growths not only because of the material cost of the larvicide, but also because of the labour time element and the frequent periodic treatment necessary for adequate control.

Leptospirosis As mentioned previously, domestic wastewater discharges damage ecosystems as a result of its organic and nutrient content, promoting proliferation of algae and other aquatic plants and causing oxygen depletion. The high content of nitrates and phosphates causes massive growth of vegetation mats in gullies and streams, reducing the hydraulic capacity of these water bodies and causing flooding. Rodents displaced by such flooding often migrate to surrounding homes in search of food, potentially causing leptospirosis.

As a consequence of flooding, there were approximately 253 confirmed cases of leptospirosis in 2007, (Table 35) compared to 205 in 2006 and 332 in 2005 after the passage of Hurricane Wilma. The majority (44.3 per cent) of cases were reported from the South East Region Health Authority, with St. Catherine (20.6 per cent) and Kingston and St. Andrew (18.6 per cent) being the big contributors. The Southern Region Health Authority had the next greatest proportion of cases (24.1 per cent). The number of confirmed leptospirosis cases increased in the last quarter of 2007 as expected from prior years and after heavy rains of Hurricane Dean and October. There were 26 suspected leptospirosis deaths of which nine (34.6 per cent) were confirmed. In the outbreak of 2005, there were 12 confirmed deaths out of 55 suspected deaths.

Table 35: Confirmed and Suspected Leptospirosis Cases Reported, Weeks 1 – 52, 2007

Parish/Region	Confirmed n (%)	Suspected n (%)
KSA	47 (18.6)	576 (33.6)
St. Thomas	13 (5.1)	86 (5.0)
St. Catherine	52 (20.6)	264 (15.4)
Clarendon	23 (9.1)	104 (6.1)
Manchester	9 (3.6)	63 (3.7)
St. Elizabeth	29 (11.5)	97 (5.7)
Westmoreland	10 (4.0)	17 (1.0)
Hanover	2 (0.8)	5 (0.3)
St. James	15 (5.9)	98 (5.7)
Trelawny	7 (2.8)	20 (1.2)
St. Ann	21 (8.3)	103 (6.0)
St. Mary	13 (5.1)	95 (5.5)
Portland	5 (2.0)	21 (1.2)
Unknown	7 (2.8)	164 (9.6)
TOTAL	**253 (100.0)**	**1,713 (100.0)**
Source: Ministry of Health		

With hurricanes being projected to increase in frequency and intensity, it is expected that there will also be an increase in the transmission of leptospirosis.

There are several other disease vectors in Jamaica. Culex mosquitoes are the implicated vector of the West Nile virus in the Caribbean region and are present in abundance in Jamaica. There are also several species of the genus *Simulium* (blackfly) which is the vector in the transmission of Onchoceriasis (river blindness).

DETERIORATION OF BATHING AND RECREATIONAL AREAS

The beaches in Jamaica are considered to be one of the most dynamic coastal environments. Approximately 30-49 per cent of the coastline of Jamaica is characterized as sandy beach. Sandy beaches are important to society because of their economic and social value. In spite of this, the special ecological features and unique biodiversity that are characteristic of sandy beaches are often undervalued.

As mentioned previously, over the past 10-20 years, marine pollution has increased. Deterioration in coastal water quality has not only made beaches unsuitable for swimming, but has also damaged ecological systems. Jamaica's coastal waters receive pollution from a number of sources, including wastewater treatment facilities and industrial facilities, among others. Poorly or untreated sewage is discharged directly into the sea or into rivers and streams that reach the coast. The number of sites monitored by NEPA increased significantly during 2009-2010. Over 200 coastal water quality stations have been established and are presently monitored by NEPA (NEPA, 2010). The readings at these sites are compared with national standards to determine the quality of the water in that area.

An assessment of marine water quality indicators across the island indicates that most of the coastal area is under threat and is not fully meeting all the established standards for various parameters (see Table 36). Values are highest in areas near coastal townships and within the plume of waterways, gullies and rivers.

An assessment of the profile for phosphates in marine waters across the island indicates that most of the coastal area is affected by phosphate pollution. When the average values are compared to the marine standards for this parameter a clear pattern emerged for data collected since 1990. As with other water quality indicators, with few exceptions, phosphate values are highest in areas near coastal townships and within the plume of waterways, gullies and rivers.

In Negril, there are two main rivers (North and South Negril River) emptying into the coastal area. The South Negril River receives effluent from the National Water Commission's ponds, and often shows high levels of phosphates. A similar scenario is evident around the Dutch Canal (Westmoreland) which receives cane wash effluent from the Frome Sugar Factory and agricultural runoff from nearby sugarcane lands. Most of the phosphate pollution to the Lucea

Harbour is from domestic sources and a small amount can be attributed to small farming in the hinterland. The data also show that the Great and Montego Rivers in St. James as well as the Martha Brae in Trelawny are delivering large quantities of phosphate into the marine environment. Additionally, the level of phosphate pollution around the town of Falmouth in Trelawny is high. The absence of sewage treatment solutions and the effluent from activities at the municipal market, which flows directly into the sea, have contributed to the high nutrient levels in this area. The Ocho Rios (St. Ann) area is seeing increased levels of phosphates due to the inflow of fresh water into the coastal environment, and also to poor domestic sanitation practices. The low flushing of the Ocho Rios Bay area has exacerbated the problem. The trend is constant across the northern coastal area, which has seen extensive development over the last decade.

Table 36: Number of Marine Sites Showing Deteriorating Water Quality for 2007 - 2010 Compared with 2003-2006 and the Number of Sites Meeting the Standards in 2010

Parameter	No. of sites	No. of Sites meeting Standards (2010)	Standard	No. of sites showing deterioration*	% of sites showing deterioration
Nitrate	52	31	0.0443 - 0.359 mg/L	33	63%
Phosphate	49	28	0.001 - 0.055 mg/L	24	46%
Biochemical Oxygen Demand	54	43	0.57-1.16 mg/L	21	38%
Faecal Coliform	50	35	<2-13 MPN/100mL	22	44%

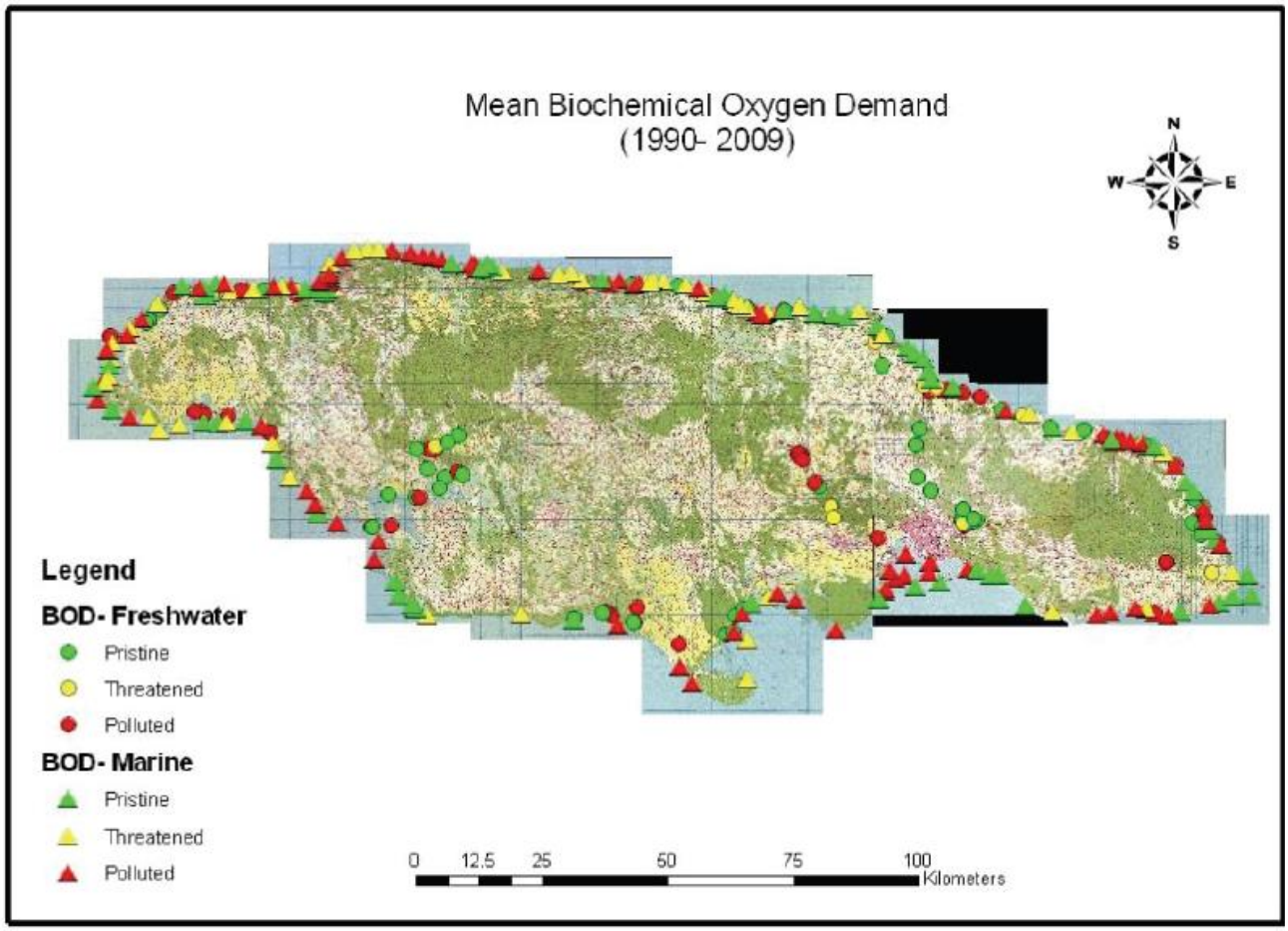
Percentage of sites with an increase in parameter concentrations compared with 2003-2006
Source: NEPA

Similar to phosphates, the introduction of nitrates from anthropogenic sources into the marine environment disturbs the nutrient balance in aquatic systems resulting in the over-production of plant material. Data from all the marine sites Ocho Rios Bay and Kingston Harbour show that a significant portion of Jamaica's coastal area is threatened by nitrogen pollution, and is showing signs of stress. In the Negril area, Montego Bay (and Bogue Lagoon) and the Lucea Harbour all testing sites exhibit similar results.

Another water quality indicator is dissolved oxygen, which is a measure of the gaseous oxygen present in solution. Dissolved oxygen is essential for promoting aquatic life, and adequate amounts are necessary for good water quality. In most cases, a minimum level of oxygen is required to sustain life; below this level, generally taken to be 4 mg/l, organisms will experience difficulty breathing and will eventually die if the level persists or decreases.

Biochemical oxygen demand (BOD) is a standard measure of the amount of organic matter in a system.Hence high BOD is indicative of pollution inflow from various sources, including processing facilities, sewage treatment plants, animal husbandry and abattoirs. The absence of waste treatment facilities in many residential and commercial areas compounds the problem of coastal pollution. Figure 15 shows the spatial distribution of mean BOD across the island in both freshwater and coastal water.

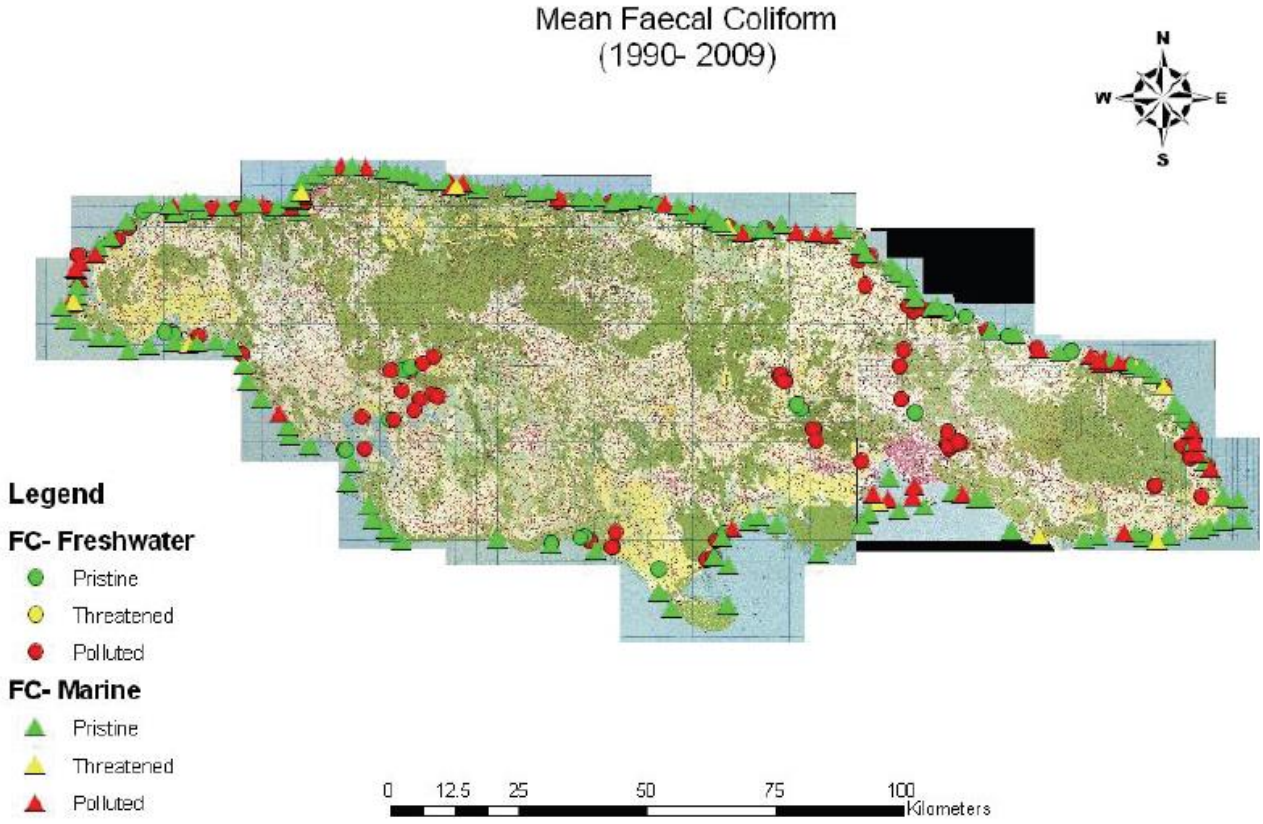
Figure 15: Map of Jamaica Showing Mean BOD (1991 – 2009) in Freshwater and in Coastal/Marine Water



Source:NEPA

The potential for faecal matter to enter coastal areas is very high. The absence of centralized or formal sewage treatment systems especially in rural areas is a major contributor to this problem. Coastal areas which receive large and consistent inflow of faecal matter include Hunts Bay and Kinston Harbour, the Black River in St. Elizabeth and the Carbaritta and South Negril Rivers in Westmoreland. Figure 16 shows the spatial distribution of mean faecal coliform across the island in both freshwater and coastal water.

Figure 16: Map of Jamaica showing Mean Faecal Coliform (1991 – 2009) in Freshwater and in Coastal/Marine Water



SOCIAL IMPACT DUE TO DETERIORATION OF THE ENVIRONMENT

Social impacts can be defined as the consequences to people of any proposed action that changes the way they live, work, relate to one another, organize themselves and function as individuals and members of society. This definition includes social-psychological changes, for example to people's values, attitudes and perceptions of themselves and their community and environment. Indeed, some social impact assessment (SIA) practitioners consider social impacts to be only 'as experienced' (e.g. stress, disruption, hunger) and differentiate these from the causal processes (e.g. over-crowding, infrastructure pressure, poverty).

The key characteristics and variables that are often correlated with adverse social impacts of development include:

- demographic change, e.g. size and composition of resident population, influx of temporary work force or new recreational users (disrupts the cohesion of a small, stable community)
- economic change, e.g. new patterns of employment/ income, real estate speculation (marginalizes long term, older residents)
- environmental change, e.g. alterations to land use, natural habitat and hydrological regime (loss of subsistence or livelihood in resource dependent community)
- institutional change, e.g. in the structure of local government or traditional leadership, zoning by-laws or land tenure (reduced access or loss of control leads to disempowerment or impoverishment of the established population)

The main types of social impact that occur as a result of bad sanitation practices and environmental degradation can be grouped into five overlapping categories:

- *lifestyle impacts* – on the way people behave and relate to family, friends and cohorts on a day-to-day basis
- *cultural impacts* – on shared customs, obligations, values, language, religious belief and other elements which make a social or ethnic group distinct
- *community impacts* – on infrastructure, services, voluntary organizations, activity networks and cohesion
- *amenity/quality of life impacts* – on sense of place, aesthetics and heritage, perception of belonging, security and livability, and aspirations for the future
- *health impacts* – on mental, physical and social well-being, although these aspects are also the subject of health impact assessments.

In the case of health, improper wastewater management impacts on each determinant of health. These determinants explain why some persons are healthy and others are not. Determinants of health have an impact on both individual and population health. Each determinant of health is important in its own right; however, they interact to forcefully influence health and well-being across people's lifespan.

Although the determinants of health can be described in many ways, this paper uses the twelve major determinants (Public Health Agency Canada 2003) of health proposed by the Public Health Agency of Canada, as follows: 1) income and social status, 2) social support networks, 3) education and literacy, 4) employment / working conditions, 5) social environments, 6) physical environments, 7) personal health practices and coping skills, 8) healthy child development, 9) biology and genetic endowment, 10) health services, 11) gender and 12) culture.

Income and Social Status

Health status improves at each step up the income and social hierarchy. High income determines living conditions such as safe housing and ability to buy sufficient good food. The healthiest populations are those in societies which are prosperous and have an equitable distribution of wealth. Public health researchers and epidemiologists have long known that

social status – wealth, educational attainment, occupational prestige and occupational status – is related to health and well-being.

Social Support Networks

A social support network is made up of friends, family and peers. It can play an important role in times of stress. A social support network is something people can develop when they are not under stress, providing the comfort of knowing that friends are there if they need them. Pollution of water bodies and beaches and mosquito breeding sites hinder the establishment and development of social networks, by forcing people to stay indoors.

Education and Literacy

Health status improves with level of education and at the same time health improves education. Investment in health makes investment in education more effective. In order for the inversion in education be effective, first it is necessary that the person be alive and have good health. Sick children cannot learn because of several reasons. There is evidence showing that sick children cannot learn new elements and new things and that they can present behaviour problems, etc. Different studies on return investments in human capital as a function of age where investment is done have concluded this to be higher during early years than in later years, i.e., investments in health should be at infancy.

Education is closely tied to socioeconomic status, and effective education for children and lifelong learning for adults are key contributors to health and prosperity for individuals and for the country. Education contributes to health and prosperity by equipping people with knowledge and skills for problem solving, and helps to provide a sense of control and mastery over life circumstances. It increases opportunities for job and income security as well as job satisfaction. Furthermore, education improves people's ability to access and understand information to help keep them healthy.

Employment / Working Conditions

Unemployment, underemployment, and stressful or unsafe work are associated with poorer health. People who have more control over their work circumstances and fewer stress-related demands of the job are healthier and often live longer than those in more stressful or riskier work and activities.

Social Environments

The importance of social support also extends to the broader community. Civic vitality refers to the strength of social networks within a community, region or country. It is reflected in the institutions, organizations and informal giving practices that people create to share resources and build attachments with others. The array of values and norms of a society influences in varying ways the health and well-being of individuals and populations.

Physical Environments

The physical environment is an important determinant of health. At certain levels of exposure, contaminants in our air, water, food and soil can cause a variety of adverse health effects,

including cancer, birth defects, respiratory illness and gastrointestinal ailments. In the built environment, factors related to housing, indoor air quality, and the design of communities and transportation systems can significantly influence our physical and psychological well-being.

Personal Health Practices and Coping Skills

Personal health practices and coping skills are those actions by which individuals can prevent diseases and promote self-care, cope with challenges, develop self-reliance, solve problems and make choices that enhance health.

Definitions of lifestyle include not only individual choices, but also the influence of social, economic and environmental factors on the decisions people make about their health. There is a growing recognition that personal "life choices" are greatly influenced by the socioeconomic environments in which people live, learn, work and play. These influences impact lifestyle choice through at least five areas: personal life skills, stress, culture, social relationships and belonging, and a sense of control. Interventions that support the creation of supportive environments will enhance the capacity of individuals to make healthy lifestyle choices in a world where many choices are possible.

Healthy Child Development

New evidence on the effects of early experiences on brain development, school readiness and health in later life has sparked a growing consensus about early child development as a powerful determinant of health in its own right. At the same time, we have been learning more about how all of the other determinants of health affect the physical, social, mental, emotional and spiritual development of children and youth. For example, a young person's development is greatly affected by his or her housing and neighborhood, family income and level of parents' education, access to nutritious foods and physical recreation, genetic makeup and access to dental and medical care.

Biology and Genetic Endowment

The basic biology and organic make-up of the human body are a fundamental determinant of health. Genetic endowment provides an inherited predisposition to a wide range of individual responses that affect health status. Although socioeconomic and environmental factors are important determinants of overall health, in some circumstances genetic endowment appears to predispose certain individuals to particular diseases or health problems. Pollutants not removed in wastewater treatment plants enter water bodies and the food chain. These pollutants cause different genotoxic, neurotoxic and teratogenic effects in persons based on their genetic make-up.

Health Services

Health services, particularly those designed to maintain and promote health, to prevent disease, and to restore health and function contribute to population health. The health services continuum of care includes treatment and secondary prevention. Diseases caused by improper wastewater management impose a burden on the health services.

Gender

Gender refers to the array of society-determined roles, personality traits, attitudes, behaviours, values, relative power and influence that society ascribes to the two sexes on a differential basis. "Gendered" norms influence the health system's practices and priorities. Many health issues are a function of gender-based social status or roles. Illnesses caused by improper wastewater management impose a greater burden on women, because women are usually the health care providers in the family. Time devoted to health care can prevent them from being involved in educational or productive tasks.

Culture

Some persons or groups may face additional health risks due to a socioeconomic environment, which is largely determined by dominant cultural values that contribute to the perpetuation of conditions such as marginalization, stigmatization, loss or devaluation of language and culture and lack of access to culturally appropriate health care and services.

ECONOMIC IMPACT DUE TO DETERIORATION OF THE ENVIRONMENT

There are many lost opportunities in tourism, fisheries, and health due to the deterioration of the environment. Deterioration of the environment due to bad wastewater management practices has different economic impacts due to bad health; polluted drinking water sources and food; polluted rivers, streams, mangroves and beaches and destruction of coral reefs and seagrass beds. Coral reefs, seagrass beds and mangroves provide critical habitat during different stages of the life cycle of fish and other marine animals. Therefore, pollution and sedimentation that affect these ecosystems will also affect fisheries.

It is important to underline the impact on tourism due to pollution of the coastal zone, especially beaches. The beaches in Jamaica are considered to be one of the most dynamic coastal environments. As stated above, approximately 30-49 per cent of the coastline of Jamaica is characterized as sandy beach. Less than 1 per cent of this is designated as public and fishing beach areas. The rest of the developed beaches are confined to hotels and other tourist attractions. In Jamaica there are:

- 87 public bathing beaches (18 of which are commercial/recreational beaches)
- 121 fishing beaches
- 61 hotel/resort beaches
- 275 beaches associated with guest houses and villas

No information was found on the economic impact of environmental deterioration in Jamaica. However, the foreseen economic impact from deterioration of the environment as a consequence of deficient waste management can be grouped on the areas of health, tourism and food safety.

As mentioned previously, poor sanitation can increase the cases of diarrhoea, dengue and malaria and this has an impact on human capital development. What people can achieve contributes to human capital development. In this regard, Theodore Schultz formulated his theory about development – where to achieve development, human as well as fixed capital should be considered. The possibility and capability of human beings to produce and contribute is called human capital. The two most important ingredients to achieve this are health and education. Schultz produced his ideas of human capital in the 1960s to explain the advantage of investing in health and education, in order to improve agricultural production. He demonstrated that human capital production in the USA economy was higher than that based on physical capital (i.e., a new plant or machine).

For Schultz, the concept of human capital implies investing in people. He argues that education, training and health investments open opportunities and options that would normally not be available to many individuals. He compares the acquisition, knowledge and skills to the "acquisition of production means". Workers should not be at mercy of others. To the contrary, they can control the increase of their own productivity and income. He defends that income difference among persons is related to differences in education and health.

In the past, the belief was that fixed capital investment was the most important contributor for the future growth of a country. But, Schultz has demonstrated this is wrong — investment in human capital contributes up to 65 per cent to the economic growth of a country. When we talk about poverty, or how to improve the situation of one country, we shall never forget human capital, because it contributes to the growth of wealth in a country.

For example, in some classical studies in Central America, in populations dedicated to agriculture, correction of anemia has shown that productivity increases greatly. Iron deficiency and anemia reduce the capacity of individuals and of the entire population causing serious economic consequences and obstacles for national development. Inversely, anemic treatment can increase national productivity by 20 per cent. Overall, the most poor and the less educated are more vulnerable and disproportionately affected by iron deficiency. These vulnerable groups benefit most from anemia treatment.

Health status can influence poverty itself but, contrarily, health can contribute to the productivity or wealth of a country. It is obvious that ill persons cannot contribute; their productivity is relatively low. Health is an element that impacts in well-being and contributes to economic growth in four ways: 1) reduces production losses by workers infirmity; 2) allows the use of natural resources that, due to diseases, were totally or practically inaccessible; 3) increases school enrollment of children and allows them to learn better; and 4) liberates, for other uses, resources needed to treat infirmity in other ways.

Ill health has been shown to have an impact on the tourism industry. Some examples from other countries are described below.

- In Mexico, the number of foreign visitors declined by 11.4 per cent in 2009 due to an AH1N1 (commonly known as swine flu) epidemic.

- In Rio de Janeiro, Brazil, cancellation of 45 per cent of room reservations occurred after a dengue outbreak was announced in the media.
- In French Reunion, a severe outbreak of chikungunya led to a decline in international tourist arrivals of up to 40 per cent.
- In southern Mozambique, there was a 44 per cent cancellation of rooms after a malaria outbreak was announced.
- Cook Islands lost tourism estimated US$3 million due to a dengue epidemic.
- In Malaysia and Thailand it has been estimated that a dengue outbreak would result in a 4 per cent decline in tourists from non-endemic countries.

Regarding the impact on tourism, a deteriorated environment will not be attractive to tourists who will look for other destinations. Beaches provide not only an important escape but also a crucial source of tourism revenue for beach communities. The paradox that beautiful locations attract tourists, who subsequently degrade the location leading to its abandonment as a desirable location has been widely noted.

Dyson (2010) has prepared an extensive discussion on the links between beach pollution and tourism. The following information is extracted from her paper. Many studies have found that clean beaches are one of, if not the, most important factor to tourist beach selection and enjoyment. Tourists associate the presence of wastes along the coasts with polluted beaches and poor water quality, and hence littered beaches are a major deterrent to tourism. In Wales, for all 19 beaches studied, 'clean litter-free sand' and 'clean water' were the first and second most important factors in beach selection (Tudor 2006). These results have been mirrored for beaches with a wide variety of characteristics in (Tunstall and Penning-Roswell, 1998), South Africa (Balance *et al*., 2000) and Brazil (Santos et al., 2005).

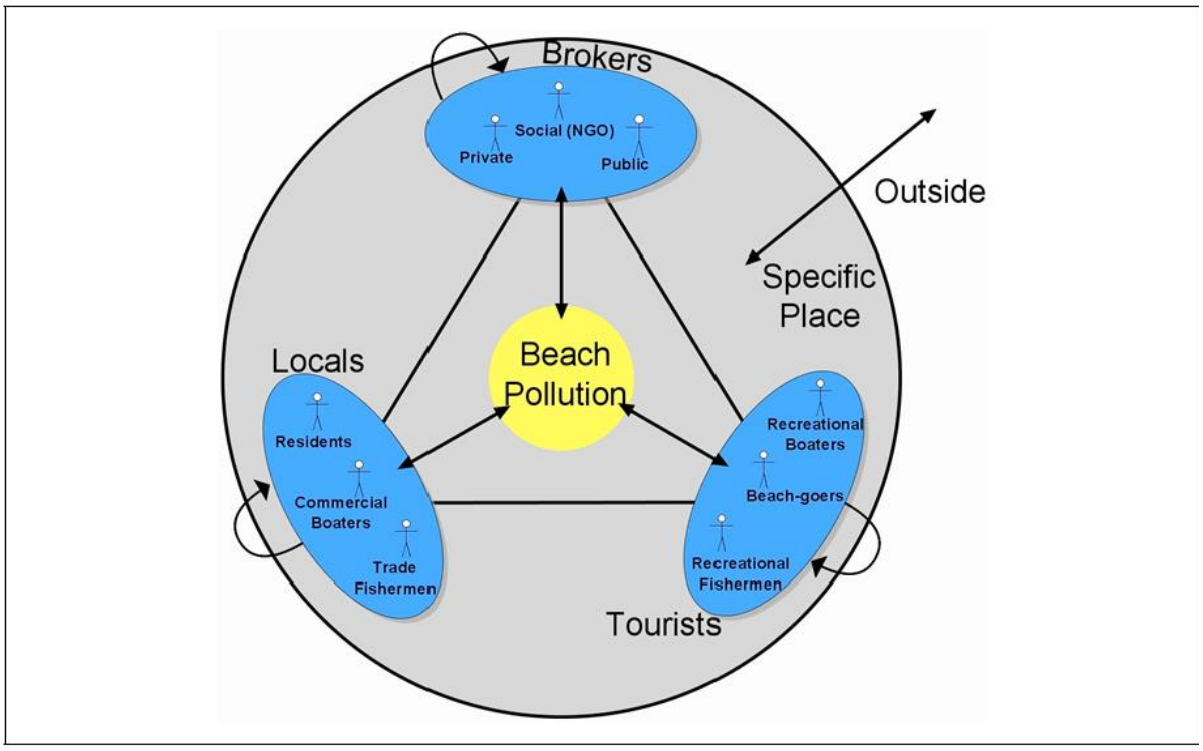
In South Africa, 85 per cent of out-of-town tourists and local tourists would avoid visiting beaches with more than 2 items of litter per square metre, and 97 per cent of visitors would avoid visiting if the beach had more than 10 large items per square metre (Balance *et al*., 2000). As a result, areas that are dependent on tourism can face serious hardship due to beach litter pollution. It should also be noted that local tourists, even more so than out-of-town tourists, are very sensitive to information about beach degradation (Tunstall and Penning-Roswell, 1998).

The effects of these aesthetic preferences include "a loss of tourist days producing damage to the leisure and tourism infrastructure; damage to commercial activities, *e.g*. fisheries, dependent on tourism; and damage to the resort image" (Tudor and Williams, 2006). Furthermore, if the media reports on a marine debris wash-up event, beaches that are not affected by the event will also see reduced visitation numbers and lost revenue (Ofiara and Brown, 1999).

The Broker-Local-Tourist (BLT) model is used as a basic framework in an attempt to explore the interactions between tourism and beach pollution (Figure 17). Miller and Auyong's BLT model classifies the components of a tourism system into three groups. *Brokers* are those who

are professionally involved in the tourism industry and consist of *private sector brokers*, those who belong to the tourism industry, *public sector brokers* who regulate, legislate, and plan for tourism, and *social movement brokers* (or NGO brokers), who address tourism issues from outside the government and industry (Miller *et al*., 1999). Brokers are neither uniformly for or against tourism, and broker-broker conflicts are very common (Miller *et al*., 1999).

Figure 17: The Place-based Tourism Model



Notes: The place-based tourism model, which depicts the interactions between brokers, locals, tourists and the central element, here beach pollution, in the context of a specific place, in this case a beach.

Public and private brokers, such as municipal beaches or beach resorts, are often required to remove beach litter frequently to continue attracting tourists. This results in much higher maintenance costs, as beach cleaning is quite expensive. In South Africa, cleaning costs for the Cape Metropolitan area for 1994-5 was R3.5 million, which is very expensive when compared to the value of these beaches (Ballance *et al*., 2000). These efforts have since increased in scope and cost. Publicly owned community beaches and local and national parks – all the responsibility of public brokers – are also subject to increased maintenance costs which the community must pay for.

When marine debris and beach litter cause tourists to avoid private brokers, as mentioned above, it negatively impacts the economy of tourism dependent communities. As a result, local businesses are often harmed, even if they are not directly involved in the tourism industry

(Ofiara and Brown, 1999). This phenomenon is known as the 'multiplier effect' (Ofiara and Brown, 1999).

Local fishermen who rely on populations of near-shore fish for their livelihood are very vulnerable to events which harm fish stocks (Gregory, 1999, Ofiara and Brown, 1999; Ivar do Sul and Costa, 2007). Fisheries can be harmed through "outright mortality, loss of fish habitat and spawning grounds, and decreases in recruitment and gain in weight" (Ofiara and Brown, 1999). Ghost fishing caused by local fishermen's discarded nets can also cause high mortality of commercially valuable species. In Korea, 200 kg of king crab was found in derelict nets in one harbour (Cho, 2005). Harmed fish stocks will result in fishermen catching fewer fish, resulting in decreased incomes and possibly economic hardship.

An example of lost economic opportunities in Jamaica is the Hunts Bay fishery described previously in this report, in which pollution of the Bay has resulted in the loss of livelihoods of fisherfolk who depend on the Bay.

Shellfish fisheries may need to be completely shut down if a health hazard is suspected. Furthermore, locals who own boats, even if they are not fishermen, are subject to the hazards of marine debris as described in the brokers section (Gregory, 1999). Similarly, locals who enjoy dining on locally caught fish, especially shellfish, are faced with safety issues if, sewage contaminates local waters or the marine debris contains medical waste (Ofiara and Brown, 1999). This can in turn reduce the prices that locals are willing to pay for local seafood, further depressing local economies (Ofiara and Brown, 1999).

It is also possible that locals and tourists will find that the devaluation of the beach goes beyond any lost community income or reduced enjoyment of beach facilities. The existence value – the pleasure derived from knowing something exists – along with the other intangible benefits of a clean beach is something that no study has yet examined. When marine debris and beach litter make beaches unpalatable, tourists are harmed because their beach experiences are less enjoyable. This is especially true when beach litter is sewage derived, or is perceived to be sewage derived even if it is not (Tunstall, 1998). Even at urban beaches, the illusion of being in and interacting with a 'natural' litter free environment is very important (Tunstall, 1998). The reactions people have to high levels of beach litter can be very strong.

This loss of enjoyment derived from the beach experience can be approximated using willingness to pay studies. These studies determine the amount a consumer, or in this case a tourist, would be willing to spend to increase the quality of the beach they are visiting. Estimates of this willingness to pay range quite a bit, and are often tied to tourists' incomes and other factors, but one estimate put the value of a linear foot of clean beach at US$14/year (Cho, 2005).

The impacts on beachgoers can also be more physical – 30 per cent of beach users surveyed had suffered problems caused by beach litter, mostly from cutting themselves on glass and other sharp materials (Santos *et al.*, 2005). The incidence of human diseases, along with

general public health, has also been tied to beach litter and marine debris. These matters affect both tourists and locals.

Recreational fishers, like local fishermen, are affected when fish stocks suffer due to marine debris (Ofiara and Brown, 1999). Fewer fish in the water means fewer fish caught per hour or per trip, greatly reducing the pleasure of fishing (Ofiara and Brown, 1999). Faced with this situation, some recreational fishermen either reduce the number of trips they take, or stop fishing in the affected location (Ofiara and Brown, 1999). If they choose to fish in alternate locations, they may face increased travel costs (Ofiara and Brown, 1999). Recreational fishermen will also reduce the number of fishing trips they take if the quality of fish is negatively impacted (Ofiara and Brown, 1999).

Jamaica has recognized the importance of valuating its natural capital to guide effective environmental and natural resource management. In 2009, NEPA undertook an Economic Valuation of Protected Areas project which looked at valuing the ecosystem services and biodiversity of three protected areas, examining their economic, social and communal values. Between 1998 and 2003, seven economic valuation studies were carried out on selected ecosystems in Jamaica. These are presented in Table 37.

Table 37: Seven Ecosystem Economic Valuation Studies in Jamaica

Case Study	Study Site	Ecosystem Services	Policy Relevance	Reference
Socioeconomic assessment of fishing and tourism association with Montego Bay Marine Park	Montego Bay	Tourism and Fisheries	Asses the level of social dependence upon Montego bay Marine Park (e.g. volume of reef tourism, hotel use; fisheries revenue). Results can inform policies and justify Investment of the Park.	Bruce and Gustavson (1998)
Financial analysis of reef – associated fisheries and tourism; avoided damages from shoreline protection	Montego Bay	Tourism, fisheries, shoreline protection	The high valued associated with the park (NPV US$ 381M, 10% discount rate) can be used to justify grater investment in management. Many jobs and business in Montego Bay rely on the health of the park.	Gustavson (1998)
Value of many ecosystem services provided by Portland Bight; include scenario of future tourism	Portland Bight	Fisheries, forestry, tourism, carbon fixation, coastal protection, biodiversity	Study estimates US$40 to $53 M/yr. value from services associated with Portland Bight Protected Area. Result could justify greater investment in the reserve.	Cesar at al. (2000)

Table 37: Seven Ecosystem Economic Valuation Studies in Jamaica				
Case Study	**Study Site**	**Ecosystem Services**	**Policy Relevance**	**Reference**
Financial analysis of reef – associated fisheries and tourism; avoided damages from shoreline protection	Ocho Rios	Fisheries, tourism, shoreline, protection, biodiversity	Estimated value of ecosystem services provided by the Ocho Rios Marine Park is US$245 M/yr. The study also estimated losses to the tourism sector if ecosystem quality degrades farther. Management interventions are needed to avoid financial losses in the future.	Environment Management Unit (2001)
Current value of Jamaica's reef fishery and estimated losses from lack of management over 25 year.	Discovery Bay	Fisheries	Estimates US$1.3 M in lost revenues from reef fisheries due to poor management over 25 years. Argues for implementing enforcing strong fisheries regulations.	Sary et al. (2003)
Source: NEPA 2011				

7. NATIONAL CAPACITY

EXISTING LEGISLATIVE FRAMEWORK

As noted earlier in this report, Jamaica there are at least fifty existing statues which relate in one way or another to environmental management and protection. The existing legislation is widespread and fragmented. With regards to wastewater management the most important statues are:

- The Natural Resources Conservation Authority (NRCA) Act, 1991 and regulations:
  - Permit and Licence Regulations (1997)
  - Wastewater and Sludge Regulations (2013)
- The Public Health Act 1974, amended in 1985
- The National Water Commission Act, 1963, amended in 1965, 1973 and 1980
- The Water Resources Act, 1995

The NRCA Act has significant powers related to the management of the environment, and specifically for the regulation of effluent discharges, Sections 9(4) and 12. The National Environment and Planning Agency has the mandate for environmental management in Jamaica, which it executes on behalf of the NRCA. The NRCA is empowered by the NRCA Act.

Section 12 of the NRCA Act indicates that a license is needed for the discharge of wastewater into the environment and also for the alteration, reconstruction and construction of wastewater treatment facilities. Effective January 1, 1997, the Permit and Licence Regulations were promulgated and required that a permit be obtained from the NRCA for the construction and operation of a new wastewater treatment facility and that a licence be obtained for the discharge of trade and sewage effluent. NEPA processes permit applications for new wastewater treatment facilities and licence applications for the discharge of effluent. The organization is also involved in enforcement and public education.

There are established standards for sewage and trade effluent quality and meeting the standards is a condition of every licence granted by the Authority (NRCA) through NEPA. It should be noted that there are currently two standards for sewage effluent: for some existing facilities (defined as facilities in operation prior to 1997) and those for new facilities (licensed after 1996). The NRCA standards equal or exceed (i.e. are more stringent than) the standards established in Annex III of the LBS Protocol for discharges into Class I waters (see Table 38).

Table 38: Comparison of Effluent Standards for Jamaica and LPS Protocol

Parameter	NRCA Standard for Pre-1997 Facilities	NRCA Standard for Post-1997 Facilities	LBS Protocol Standard for Class I Waters
BOD_5	20 mg/L	20 mg/L	30 mg/L
Total suspended solids	30 mg/L	20 mg/L	30 mg/L
Faecal coliform	1,000 MPN/100mL	200 MPN/100mL	200 MPN/100mL
pH	6-9	6-9	5-10
Sources: NEPA[11], UNEP - LBS Protocol			

[11] Available from NEPA website: http://www.nepa.gov.jm/standards/sewage_effluent_standards.pdf

The conditions of the licence usually require that there is self-monitoring at a specified frequency to ensure that standards are being met. An Environmental Monitoring and Management Plan is usually requested of the entity that has been granted the licence. NEPA conducts post-approval compliance monitoring to ensure that conditions are being met. Samples of effluent are also analyzed by the NEPA laboratory. Standard conditions included in sewage treatment facility permits and licences include the need for standby generators and standby pumps where there are mechanical plants, as well as contingency plans in case of malfunction of the plant.

In 1997 the then NRCA initiated the Section 17 Programme to work with some of the existing major generators of effluent. The Programme initially targeted those entities that discharged wastewater into the Kingston Harbour but has since expanded to include all sugar factories and distilleries, the bauxite/alumina plants, the coffee pulperies as well as other establishments known to generate sewage and trade effluent. This was a voluntary compliance programme for entities which operated prior to January 1997. As of the start of the 1999/2000 fiscal year, these entities were eventually incorporated into the licensing system for existing entities.

In 2013, Jamaica took the milestone step of promulgating the NRCA Wastewater and Sludge Regulations for the practice of safe environmental sanitation (ecosan) and protection of public health and is a significant development in the Government of Jamaica's attempts to address water pollution. The regulations provide the regime for regulating the construction, modification and operation of wastewater treatment facilities and the discharge of sewage and trade effluent. They establish strict pathogen and heavy metal content limits for treated domestic sewage sludge (called National Treated Sewage Sludge/Biosolids Standard) that is suitable for land application. The regulations are designed to encourage the land application of biosolids and biosolids-derived products in a manner that protects the public health and maintains or improves environmental quality.

The regulations apply to all wastewater treatment facilities and are implemented through the granting of Licenses under the NRCA (Permit and Licenses) Regulations which make provisions for wastewater discharge fees. The wastewater regulations require that the entity discharging effluent pay a calculated rate fee for that discharge whether the effluent is in or out of compliance with the effluent standards. The aim is to encourage the polluter to fix the problem rather than to pay the penalty.

The regulations include the standard for pathogens using an indicator of faecal coliforms of less than 1,000 MPN/g of treated sludge and the absence of Salmonella and establish metals ceiling concentrations, annual loading rates and cumulative loading rates for metals in treated sewage sludge when applied to agricultural land. Also, the regulations include licence requirements for sludge treatment and sewage sludge disposal and the requisite forms.

They are based on the approach of self-monitoring by the generator, the performance of an auditing function by NEPA, the polluter pays principle, economic incentives for development of environmentally sound alternative uses for sludge and effluents and progressively severe penalties. The regulations are complemented by 10 schedules which provide the standards for sewage and trade effluent, including standards for use of discharges for irrigation, landfilling of sludge and water quality, as well as forms and reporting stipulations.

The Public Health Act allows for the Minister of Health to make regulations in relation to air, soil and water pollution in Section 14. It also allows the Local Board of Health to make regulations for the sanitary collection and disposal of garbage and other waste matter in Section 7(p).

The National Water Commission Act of 1980 gives the NWC responsibility for public water supply systems and public sewerage and sewage treatment. The National Water Commission has developed various regulations under the National Water Commission Act, mainly concerned with setting and collection of tariffs for water supply and sewerage services.

Since the completion of the new central sewerage systems in Negril, Montego Bay and Ocho Rios by the NWC, there still exists the problem of connection to the system by those entities that generate wastewater. This presents a challenge to the NWC as there is no legislation binding the wastewater generator to connect to the sewerage system. There is an updated policy whereby facilities located within 100 m of the NWC sewerage network are required to pay a sewerage charge whether they opt to connect to the system or not.

The Water Resources Act was established to provide for the establishment of the Water Resources Authority whose responsibility is to regulate, control and conserve water resources.

EXISTING POLICY FRAMEWORK

The Jamaica National Environmental Action Plan (JaNEAP) is the country's main environmental management policy instrument, and its stated purpose is "to document the major environmental problems facing the country and to formulate the appropriate policy framework, institutional arrangements, legal instruments, strategies, programmes and projects to address and mitigate these problems". First developed in 1995 by the Natural Resources Conservation Authority (NRCA)[12] and the Planning Institute of Jamaica (PIOJ), the JaNEAP covers a three-year period, each successive JaNEAP represents a comprehensive update of the actions outlined in the previous plan and is consistent with new policy priorities of the Government. This document is significant because it explicitly recognizes the need to pursue the goal of sustainable development and the role that the polluter pays principle must play in order to achieve that goal. It includes the Government's commitment to have in place

[12] The National Environment and Planning Agency , established in 2001, is an amalgamation of the Natural Resources Conservation Authority, the Town Planning Department and the Land Development and Utilization Commission

standards for trade effluent, sewage effluent, ambient water quality, potable water quality, irrigation water quality and recreational water quality (pool and beaches).

The Jamaica Water Sector Policy (1999) articulates the Government's objectives in the provision of urban and rural water and sewerage. In the area of the services provided to consumers, the Government commits to:

- Ensure the availability of minimum necessary quantities of potable water and minimum standards of sanitation service to all in a cost effective and efficient manner, with due regard to health and environmental considerations and at a price customers can afford
- Ensure minimum standards/levels of service for the public supply of potable water. For municipal/urban households and other urban consumers, this will include potable water available 24 hours per day
- Focus the provision of water and sewerage services on meeting the needs of areas targeted by the National Industrial Policy so as to have the maximum impact on growth and development
- Provide for expansion of the sewerage network in areas with high population densities having regard to health and environmental considerations
- Ensure improvements in sewage treatment and disposal, to protect the environment
- Control and reduce the production of industrial effluents, and ensure that such effluents are adequately treated, to avoid contamination of existing water resources.

Within the Water Sector Policy, there are strategies focused and designed for water pollution prevention and control including:

- Maintenance of ecosystem integrity through the protection of aquatic resources from negative impacts caused by development and natural processes
- Protection of public health against disease vectors and from pathogens
- Ensuring sustainable water use and ecosystem protection on a long-term basis
- Implementing the polluter pays principle.

The 1999 policy outlines specific roles and responsibilities of key institutions in the water, wastewater, drainage and irrigation sectors. The principal actor is the Water Resources Authority, which has had responsibility for regulation, control and management of the nation's water resources since April 1996.

The revised draft Water Sector Policy, Strategy and Action Plan (2004) outlines the sewering of all major towns by 2020 and the rehabilitation of existing non-compliant facilities to achieve compliance with national environmental standards as key objectives.

The Draft Jamaica National Sanitation Policy (2005) presents a situation analysis which provides background information on sanitation at the local and national levels. The institutional framework for sanitation is outlined, including the role of non-governmental organizations (NGOs) and community-based organizations (CBOs) and highlights the importance of stakeholders in the improvement of sanitation. Additionally, the inter-linkages

with other existing policies which can complement the sanitation policy are elucidated. These include the water sector policy, poverty eradication policy, health policy, solid waste management policy and the social housing policy.

The vision of the policy is to ensure that "Every Jamaican understands what proper sanitation and hygiene means and has the means to be able to practice proper sanitation". The main objectives are:

- Acceptable water supply and sewage and excreta disposal systems available in homes, schools and public places
- Sustained education on sanitation, hygiene and solid waste management for the general public, new parents and early childhood, primary and secondary students
- Sanitation facilities mandatory where food is prepared and sold and at public entertainment venues/functions
- All communities with a safe and reliable solid waste management system in place.

The policy includes strategies that are synthesized to improve environmental sanitation and wastewater disposal. They are dependent upon local political, institutional and economic conditions and include:

- Health issues as key rationale
- Streamlining the institutional and policy framework
- Waste minimization, reuse and recycling
- Promotion of local solutions
- Encouraging the involvement of all stakeholders
- Regulation and monitoring
- Population targeting
- Sanitation solutions appropriate for specific locations
- Recognition of dimensions of gender and poverty
- Financial issues – funding for infrastructure and cost recovery

The document outlines existing laws, policies and guidelines to achieve the vision and goals and proposes new legislation required. Importantly, it outlines the monitoring and evaluation system and responsibility of the various ministries for effecting the goals and objectives.

Other policies that have been drafted and support improved sanitation include the Health Policy (Ministry of Health), the Squatter Management Policy (Ministry of Water, Land, Environment & Climate Change), and the Social Housing Policy (Ministry of Transport, Works and Housing). Also, the NWC has a development manual which outlines requirements for wastewater management on the island and the types of systems deemed appropriate.

EXISTING INSTITUTIONAL FRAMEWORK

The agencies that play a significant role in wastewater management are: National Environment and Planning Agency, Environment Health Unit of the Ministry of Health, National Water Commission and Water Resources Authority. The Ministry of Water, Land, Environment and Climate Change has recently established a Sanitation Committee.

The Ministry of Water, Land, Environment and Climate Change has responsibility to develop and implement environmental management policies. Also, the Ministry focuses on development and implementation of policies for the management of water supplies, wastewater treatment/disposal systems and housing developments; implementation of programmes to provide potable water to all communities in Jamaica; implementation of programmes to provide for the safe collection, conveyance, treatment and disposal of sewage; and ensuring that all housing developments meet required standards for sanitation.

The Ministry of Health has responsibility to develop and implement health policies and legislation to promote appropriate sanitation practices; establish and monitor health indicators for sanitation; enforce public health laws; provide public education on sanitation and hygiene; and promote good hygiene practices. In the area of water quality standards, the World Health Organization guidelines and the Interim Jamaica guidelines will continue to apply, and to be monitored by the parish Public Health Departments and the Environmental Health Unit of the Ministry of Health. These organizations monitor effluent standards for permissible limits on discharge of treated sewage, as well as ambient water quality guidelines for recreational waters. This responsibility for monitoring and enforcing compliance with these standards is shared with NEPA. In addition to their role as regulators, the Ministry of Health operates the sewage treatment plants associated with their hospitals and health care facilities.

The National Environment and Planning Agency establishes planning requirements and develops and enforces environmental management standards; establishes and enforces legal standards for effluent disposal; ensures, through regulatory instruments or otherwise, that housing developments are not sited in vulnerable areas; ensures that planning requirements for housing developments meet required standards for density and sanitation facilities (water supply and sewage disposal).

The Local Authorities, including Parish Councils, provide properly maintained public sanitary conveniences (especially in urban centres); prohibit/penalize urination and defecation in areas that are not designated for that purpose; and work as work as partners with communities to establish acceptable water supply and excreta disposal systems.

The National Water Commission, the largest owner of sewage treatment plants in the country, has indicated that it is discouraging the use of package plants and promoting the use of sewage treatment ponds where applicable. There is a preference for low technology facilities so that the maintenance costs can be reduced.

The Scientific Research Council (SRC) provides information and advice on design and implementation of environmentally friendly wastewater management systems such as anaerobic technology systems and biodigesters. Services include measuring, analyzing and characterizing the types of wastewater produced at a given source and determining the methods for treating it to reduce pollution. The experts conduct feasibility studies and offer consultancy for waste problems. The Scientific Research Council is the sole provider of anaerobic technology in Jamaica. The SRC provides technical support to the National Water Commission, communities, schools, farmers and housing developers in commissioning and maintaining waste treatment systems.

The Jamaica Wastewater Operators Association (JWOA) is a professional body for wastewater plant operators. The association, which was formally registered in 2002, provides a framework for establishing the first wastewater operators' certification programme in Jamaica. The Association was formed to act as an oversight and lobby group. It is expected to set stringent codes by which its members, operators and owners of industrial and sewage treatment facilities, are bound to abide. However, the organization is now inactive.

The National Housing Trust (NHT) usually operates sewage treatment plants associated with government housing projects but eventually hands these plants over to the NWC. Increasingly the NWC has indicated that it must agree to any proposed sewage treatment facilities that they are eventually expected to take over.

The Urban Development Corporation (UDC) operates a number of small sewage treatment plants across the island.

Local involvement in wastewater management has improved significantly over the past five years with the establishment of a North Coast Wastewater District by the NWC. It has also seen the strong involvement of environmental non-governmental organizations and community-based organizations.

There is increasing collaboration between regulatory agencies such as NEPA, MOH/EHU/Public Health Department and WRA. An extensive monitoring programme has been in place for NEPA and as of 2009 has seen results of several enforcement actions taking place.

8. SURVEILLANCE AND ENFORCEMENT CAPACITY

Examining the adequacy of surveillance capacity to support wastewater effluent and ambient environmental quality monitoring will help to assess compliance with LBS Protocol Annex III parameters.

In the past four years, implementation of environmental policies and legislation was affected by the country's economic situation which was as a result of the global economic crisis. Partially, as a result of obligations under the multilateral loan agreement with the International Monetary Fund (IMF), the Government cut expenditure in a range of areas, including environmental management, which consequently limited the quantity and quality of resources available to agencies carrying out the mandate for environment and planning.

As a result, a number of functions, including monitoring and enforcement, were affected due to strict restrictions imposed on the staffing and travelling budget. The enforcement arm of NEPA, which was identified as a major area that needed additional staff to enforce environmental legislation and to carry out routine and post-development monitoring, was clearly affected. Up to financial year 2009/2010, the enforcement arm of the Agency had a total of 18 enforcement officers to carry out monitoring activities for well over one thousand developments.

The regulatory and compliance arm of the Government continues to face several challenges in enforcing environmental legislation. Some of these challenges include the need for better coordination and communication between and amongst certain agencies in addressing enforcement issues. Inadequate monitoring and limited enforcement options by regulatory agencies continue to allow plants to operate and emit pollution at undesirable levels.

Owners/operators of most plants do not conduct any form of monitoring in order to assess the performance of their plants. Effluent quality for most plants is known only when compliance monitoring by regulatory agencies or special studies is done. This lack of monitoring is evident from an examination of the NRCA Section 17 Programme Pollution Control Programme that indicates that little or no monitoring reports are being submitted by owners/operators of plants without environmental licences.

Most plants are staffed by operators who lack the necessary technical knowledge. Many plants are simply being run mechanically but are not operating properly. Some plants are in fairly good working condition but are producing effluent of poor quality, most likely as a result of poor operation.

The main entity with responsibility for regulating sewage systems is the Environmental Health Unit (EHU) in the Ministry of Health. The EHU approaches its mandate utilising an inter-agency strategy and coordinates with NEPA and the WRA in approving designs/systems. NEPA is the Competent Authority to issue Permits (to build) and Licences (to discharge) into the environment while the WRA prepares and supplies Technical Notes outlining the level of sewage treatment requirements for particular areas, based on the hydrogeology of the area (Smith 2013).

The Environmental Health Unit's activities are regulatory in nature and in reality, the Unit constitutes a regulatory agency that makes recommendations on water and wastewater systems, through a systematic appraisal of engineering plans submitted to support the application of subdivision and development projects, including tourists resorts, and developments in the industrial and agricultural sectors. The legal basis for this mandate is enshrined in the Public Health Act, the Town and Country Planning Act and the Local Improvements Act wherein the Parish Council is required to consult and receive the advice and recommendations on all sewage treatment systems dealing with the treatment of wastewater from the Medical Officer (Health)/Local Health Department (Smith 2013).

In addition, the Public Health Act through the Public Health (Nuisance) Regulations gives the Minister of Health, and in extension the Medical Officers (Health), authority to take action where any existing or potential situation is likely to endanger the health and well-being of the population (Smith 2013).

The EHU approves any of the following four general types of on-site systems for sites based on the treatment level desired (primary, secondary or tertiary):

i. dry excreta management systems (dry conservancy)
ii. soil absorptive methods
iii. liquid discharge treatment facilities (frequently package plants, ponds or constructed wetland systems) and
iv. evaporation and/or transpiration systems with no liquid discharge.

The choice of sewage treatment options lies with the developer or homeowner and is constrained by the nature of the project, the topography and hydrogeology of the proposed building site and prudent environmental public and environment health concerns. The general preference is for developments to connect to existing central or community sewerage systems to reduce the impact on the environment. In cases where no central or community sewerage system exists or where such systems are not able to accommodate additional sewage flow, due to lack of capacity, high pollution loads or other reasons, or where a reasonable time for the formal connection to such systems has elapsed, on-site treatment must be considered as the alternative option.

Applications for on-site sewage treatment systems are routed through the application processes of NEPA and/or the Parish Council, depending on the nature and scale of the sewerage system. The Parish Councils await the outcome of NEPA's process before making a decision on the application before them. No approval will be given for connecting to an existing central system that does not meet the discharge standards set by NEPA or if the central treatment plant meets the discharge standards but does not have extra capacity (Smith 2013).

The Environmental Health Unit is guided, in most cases, by the Water Resources Authority Technical Note which recommends the level of treatment (primary, secondary or tertiary)

required. Proponents are therefore required to obtain and submit the WRA's Technical Note along with other documents (Smith 2013).

NEPA regulates sewage treatment systems under the NRCA Act and associated regulations as follows:

1. The Natural Resources Conservation Authority Act (1991) section 4(1) gives the NRCA the power to take the necessary steps for the effective management of the physical environment of Jamaica so as to ensure the conservation, protection and proper use of its natural resources among other things.
2. The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order, 1996 requires that effective January 1, 1997, a permit be obtained for the construction and operation of certain types of projects. Sewage treatment plants require environmental permits in accordance with this Order.
3. The Natural Resources Conservation (Permits and Licences) Regulations, 1996 and The Natural Resources Conservation (Permits and Licences) (Amendment) Regulations, 2004 require completed Permit Application, Licence Application and Project Information Forms to be submitted to NEPA in accordance with this regulation for the construction and operation of prescribed activities and the discharge of effluent. Also, an environmental impact assessment may also be requested by NEPA for the proposed activities.

Effluent disposed via dry gully or other surface water source(s) from on-site or central treatment systems must meet the NRCA Act sewage effluent standards.

9. MANPOWER CAPACITY

There are adequate technicians and professional available in the wastewater sector. However, a certification regime for wastewater operators is lacking. This has caused persons without adequate training to be engaged sometimes and this can cause problems with the effective operation of the treatment plants. Additionally, many professionals trained in sanitation opt to work in other sectors.

The Environmental Health Unit does not believe that there are sufficient Public Health Officers to adequately fulfil the mandate of the MOH. Another perspective has been proffered by the Executive Director of NEPA who believes that the operations of the Public Health Inspectors cannot remain as it was originally conceptualized many decades ago. He believes that, due to the changes in development, a risk-based approach to public health should be taken. He suggests that if this is done, the cadre of Public Health Inspectors will be adequate.

Several attempts have been made to analyze capacities in human resources for general economic development and also in regard to sanitation and public health. However, they do not necessarily relate to the achievement of national goals / MDGs on sanitation.

There is a lack of opportunities for specialized training locally in some critical areas of sanitation and limited specialized associated skills. This, in turn, affects the efficient operations of certain health facilities such as landfills and wastewater treatment plants. Most sewage treatment plants are equipped with operators who lack the necessary technical knowledge. Most sites have no documented operating and maintenance procedures. Some operators are working only on the basis of their own experience.

Several assessments[13] have revealed that the low level of performance of Jamaica's wastewater sector has been linked to improper plant designs; old technology; overloading; lack of maintenance; and improper operations. A detailed examination of the situation indicates that operational and maintenance issues are the most predominant reasons for the low level of performance. The significant operational and maintenance issues are: plants in a state of disrepair; limited self-monitoring; overloaded plants; limited technical capacity of the staff; inadequately trained staff; absence of documented standard operational procedures; lack of proper equipment; and poor maintenance.

The country has access to appropriate technology for the disposal of excreta and solid waste. The main problem is the lack of resources (human and financial) to implement the technologies. The Government should promote providing sanitation training to technical personnel in service provider agencies, national and local governments, as well as by encouraging professional development within employees' career path. Also, GOJ should

[13] NEPA's monitoring programme along with special study by the Scientific Research Council indicates that poor operating practices and inadequate maintenance at sewage treatment plants are very evident. The Jamaica Wastewater Operators Association presents a similar situation in its status report on Wastewater Treatment Plants, 2003. The JWOA study looked at 14 plants, highlighting the conclusions of the plant operators on the facilities they operate.

promote programmes to update technical, administrative and operational skills with respect to sanitation.

The National Water Commission received some US$19 million in grant funding from the European Union (EU) to undertake an institutional strengthening project, which was aimed at improving its capacity to supply water, especially to rural communities. The project, which was undertaken over a 20-month period, ended in February 2008. The specific purpose of the project was to strengthen the capacity of the NWC, as the principal water/sewage utility in the island. The initiative fell under the then Ministry of Water and Housing's mandate to "achieve universal access to potable water by 2010 and the implementation of central wastewater services in most major towns by 2020." In order to achieve "greater operational efficiency", the project included the establishment of operations manuals and procedures, an asset management plan, management of supplies in rural areas in the context of community involvement and the implementation of a system of benchmarking for the operations of the NWC.

The project, undertaken by the Austrian-based SETEC Engineering Company, was implemented in two phases. The first phase took place over a four-month period, during which tendering and other preparatory installations were done, while the second phase, extended over 16 months, involved improvements to the pipe networks and training of NWC staff.

The 2012 Kingston Metropolitan Area Water Supply Improvement Programme, comprising four components, is being funded by the Inter-American Development Bank (IDB). This series of projects being funded by the IDB include the US$138 million Kingston Metropolitan Programme for which the IDB is providing loan funds to the value of US$133 million.

As part of this programme, the National Water Commission (NWC) is to spend US$18.4 million to implement the 26 Facilities Project which seeks to provide improved water supply to residents in keeping with the Commission's targets and the nation's Vision 2030 goals (Linton 2014). The project involves the rehabilitation and improvement of 26 water supply facilities in the Corporate Area, which have over the years, lost their efficiency or have become inadequate to meet the demands being placed on them by a growing population in the Kingston Metropolitan Area.

The broad objective of the KMA programme is to improve efficiency, quality and sustainability of the potable water services provided in the Kingston Metropolitan Area, and to increase access in selected urban centres of the island. Specifically, the programme will optimize water infrastructure performance, reduce non-revenue water levels and strengthen NWC's performance in terms of operation and maintenance practices.

One component deals with the institutional strengthening of the NWC at a cost of US$3.5 million to enable better service delivery. This component will target the change management process required to facilitate the shift of the operational culture of the NWC to assure adequate corporate planning and improved performance of all its employees.

Not only is there a need for upgraded education in public health, but there is also the need for an increased number of qualified practitioners both locally and regionally. In some Caribbean countries, governments have been unable to recruit sufficient numbers of adequately qualified personnel. Consequently, they have been forced to operate an apprenticeship system in which unqualified officers carry out limited public health duties.

There is a Basic Course in Water Works and Sewage Plant Operations and Maintenance directed at persons employed in the water and wastewater industries such as plant operators and public health inspectors. This course was introduced in 1987 at the College of Arts, Science and Technology, now the University of Technology, Jamaica (UTech) to address the need to provide training to persons employed in the water and wastewater sectors in the Caribbean region. However, this course takes place only when at least 15 persons register for the course.

Since its inception, the course has been conducted in the summer months of July to early August. The course has previously received support from the Pan American Health Organization, the Ministry of Health and the National Water Commission, through the sponsorship of participants. This course has also attracted overseas participants from institutions such as the Caribbean Health Institute and the Caribbean Basin Water Management Programme. The course is offered in collaboration with the Ministry of Health. The course is geared towards service personnel engaged in water and sewage plant operations, who have had little or no formal training in this specialized area. Participants are provided with the basic skills and knowledge that will enable them to function more efficiently in their jobs.

Changing environmental conditions including industrialization, intensive agriculture and demographic shifts have heightened the need for advanced educational preparation to deal with these complexities. The transformation of the economic structure in recent years and the emergence of new technologies have generated changes in production and consumption patterns with the consequential increase in environmental and health risks. Internationally, there is a growing trend towards baccalaureate education as the first level of professional preparation. Relevant courses related to wastewater management are: Pollution Control, Solid Waste Management, Wastewater Management, Water Technology and Liquid Waste Management.

UTech offers a Bachelor of Health Sciences in Environmental Health. Traditionally the training in public health inspection was in response to adverse prevailing health conditions. Current basic training in this discipline was developed and managed by the Ministry of Health as a three-year diploma programme incorporating two years of didactics and one year of internship. UTech also offers a Bachelors Degree in Chemical Engineering which includes a wastewater treatment course.

The University of the West Indies (UWI), Mona and St. Augustine campuses offer courses in water and wastewater management. The St. Augustine campus offers both a Bachelors and a Masters degree in Civil/Environmental Engineering. The Masters programme in Urban and

Regional Planning offered at the St. Augustine campus also offers a course in wastewater management. Both UTech and UWI offer Bachelors and Masters degrees and doctoral studies in Public Health. Public health personnel cannot practice without being licensed with the Council for Professionals Supplementary to Medicine.

10. FINANCING

The three main government entities involved in wastewater management are the NWC, NEPA and Ministry of Health.

In recent years, the NWC has been incurring losses. Currently, it comes close to covering its operating costs, but does not generate any surplus which could be used to finance investment. The practice has been for the NWC to rely on the Government to finance new infrastructure. However, competing demands on the Government budget mean that this source has not been adequate to provide for the water and wastewater infrastructure needs of the country. In spite of numerous interventions by GOJ to make NWC more self-sufficient, the desired results have not been achieved for a number of reasons, including:

- Absence of timely and adequate tariff adjustments
- An increase in the area served by the NWC and hence demand for the service consequent on NWC taking over Parish Council systems
- Insufficiency of capital to upgrade facilities taken over from Parish Councils
- The generally poor state of NWC's infrastructure, which will require significant investment to rehabilitate.

The NWC plans to spend US$600M over the next five years on an initiative for the consolidation of wastewater facilities which includes:

- Rehabilitating existing WWTPs to ensure that plant effluents meet NEPA standards
- Installing trunk sewers to allow retiring of old plants
- Maximizing use of existing WWT facilities (e.g. Soapberry)
- Replacing old sewers (e.g. in downtown Kingston)

As noted above, the Government's recent reduction of NEPA's budget has reduced the quantity and quality of resources available to carry out its mandate.

The MOH has been progressively losing its capacity for environmental health surveillance, both in terms of staff and laboratory equipment, to such a degree that only 3 per cent of the water quality parameters recommended by WHO are monitored with adequate frequency. It is estimated that Jamaica has been short of its required public health officer cadre by about 40 per cent.

The National Public Health Laboratory's (NPHL's) Environmental Health Laboratory is short of personnel and equipment. Since the failure of the Perkin Elmer 5000 Atomic Absorption and the Perkin Elmer Gas Chromatography Analyzers in 1999, environmental monitoring of heavy metals and organic pollutants ceased to be a feature of environmental health programmes. The significance of this loss cannot be overstated, as the scope of analysis by this public health partner leaves critical gaps in environmental health programmes. With the ever increasing demand for establishment owners to carry out their own monitoring at their own cost and the responsibility of MOH for managing these risks to public health, the NPHL, as the country's central laboratory, has both a responsibility and the ability to provide a viable heavy metals and organic pollutants analysis programme.

Several recent events occurring in environmental health, have brought to the fore the need once again to invest in instruments to detect heavy metals and organic pollutants. These are described below.

- The deadline for the implementation of essential aspects of the US' Food Safety and Modernization Act (FSMA) has raised great alarm in the commerce industry. Several of these aspects relate directly to the National Public Health Laboratory, namely, (1) a proper food surveillance system (not just limited to microbiological assessment), (2) hazards assessments of facilities that "…identify and evaluate known or reasonably foreseeable hazards that may be associated with the facility" (FSMA) (3) traceability in the event of illness from foods and (4) food tests for export should be done by accredited laboratories. Aspects (1) and (2) require the Ministry to be able to competently and comprehensively assess risks related to food establishments as well as to investigate illnesses to root causes.
- Assistance rendered by the National Public Health Laboratory (Environmental Health Section) to the Standards and Regulations Branch of the MOH has revealed that there are significant gaps in the monitoring of the safe use of hazardous chemicals once they enter the country. These risks cannot be identified outside of a proper environmental health audit and exposures determined should either be eliminated or monitored. One recent example of this issue was the recent leakage of cyanide at the gold mine in Pennant, Clarendon. A site visit after the "crisis" revealed an industry need of a proper system of management, which would have prevented the importation of such an acutely toxic substance. Many questions still loom about the MOH's management of this hazard.
- The drafting of at least two key pieces of legislation which will require this assessment capacity to be in place: the Drinking Water Regulations (Ministry of Health) and the Occupational Health and Safety Regulations (Ministry of Labour). Both of these regulations have direct implications for the NPHL as monitoring is a direct public health issue or at least will require the competence of environmental health professionals.

These and other developments have set the stage of the central laboratory to act to fill the need that currently exists and which is likely to be enlarged in the near future.

The NPHL/EHL asserts that its role in facilitating "a healthy and stable population" and a "healthy natural environment" is to competently and comprehensively conduct environmental analysis to identify risks to public health, compliance with standards and causes of illness. To this end, it is critical to acquire instruments established as the world standard in providing these services, specifically an Atomic Absorption Spectrophotometer (AAS) and a Gas Chromatography/Mass Spectrophotometer analyzer.

Arguments put forward to date restricting EHL's involvement in this area of analysis are summarized as follows:

1. The EHL is duplicating the role of NEPA and other agencies
2. The capital cost is prohibitive

3. The service cost will not be sustainable as the budget will not be able to manage it

The EHL has been unable to locate documentation for these arguments, so it is difficult to identify the justification on which they are built. None of these arguments, however, are sufficient to exclude the MOH from its duty to protect public health, and value is to be gained by establishments from having a comprehensively assessed and monitored safe operating environment.

The scope of the NRCA Act, or the policy framework that governs NEPA's operations, does not speak to health impact assessments, environmental risk assessments, food safety, industrial hygiene, environmental epidemiology or occupational health and safety, all of which are related to the environment, but directly apply to public health and safety. Other agencies directly involved in these issues are the Bureau of Standards, the Veterinary Services Division (Ministry of Agriculture - MOA) and Food Storage and Infestation (MOA) among others. Each of these institutions has a role, but all of them combined do not constitute a satisfactory environmental public health programme.

With the current demand to meet not just local, but international standards, as well as the emphasis on environmental monitoring and assessment within individual establishments, the demand for analysis directly related to health and safety currently exists and will increase as the country's development increases. If we anticipate the nation achieving its goal of economic growth then we can also anticipate the need for the systems to be in place to sustain it. The National Food Safety Policy, the pending Drinking Water Regulations and the pending Occupational Health Regulations covering industrial hygiene for major industries are all regulations that are necessary for development and are drivers for increased demand of environmental analysis services.

11. BEST PRACTICES AND INNOVATIVE TECHNOLOGICAL TREATMENT SOLUTIONS

There are several existing and potentially viable best practices and innovative technological treatment solutions in the water, wastewater and sanitation arena. Some examples that address Jamaica's domestic wastewater system needs are described below.

1. The **Access to Information Act, 2002** which came into effect in 2003. The Act gives a general right of access to official government information which would otherwise be inaccessible. Further, under the Act, certain information will not be subject to disclosure in order to protect essential public interests and private rights. The Act aims to reinforce fundamental democratic principles vital to:
    - improved, more transparent government
    - greater accountability of government to its people
    - increased public influence on and participation in national decision making and increased knowledge of the functions of government.

    The Act therefore, signals a ground breaking departure from an age-old culture of secrecy surrounding government and its day-to-day activities and facilitates access by Jamaicans to information related to government plans and reports and data related to sanitation and wastewater management.

2. Draft **National Sanitation Policy**. The development of the draft National Sanitation Policy is an important first step towards effective management of the sector. The Policy's vision statement is that "Every Jamaican understands what proper sanitation and hygiene means and has the means to be able to practice proper sanitation." There are several goals:
    - Goal #1: Acceptable water supply and sewage and excreta disposal systems available in homes, schools and public places (based on established national standards)
    - Goal #2: Sustained education on sanitation and hygiene for the general public, new parents (ante natal) and early childhood, primary and secondary students
    - Goal #3: Sanitation facilities are mandatory where food is prepared and sold and at public entertainment venues/functions
    - Goal #4: All communities with a suitable, safe and reliable solid waste management system

3. The **Jamaica Water Sector Policy** (1999). Integration of the water and wastewater management can be beneficial. While focus is usually on the provision of potable water, a revised draft Water Sector Policy, Strategy and Action Plan (2004) was created which places an emphasis on wastewater. The plan stipulates the sewering of all major towns by 2020 and the rehabilitation of existing non-compliant facilities to achieve compliance with national environmental standards as key objectives.

4. **Developers' responsibilities**. In Jamaica, developers are now asked to be responsible for the construction and maintenance of sewage treatment plants for new residential developments.

5. **Draft sewage sludge regulations**. Jamaica is one of the few countries in the Wider Caribbean Region (WCR) to develop draft sewage sludge regulations. This example can be defined as a best practice as it relates to sewage sludge regulations.

6. **Formal school curriculum**. In Jamaica, environmental issues, including sanitation, are integrated into the formal school curricula, beginning in primary schools.

7. **Jamaica's "k factor"** A charge applied to the water bill (the "k factor") is to be applied soon to water treatment projects. The k factor is an Office of Utilities Regulation (OUR) monitored facility, which allows the NWC to use a pre-determined percentage on customers' bills to implement non-revenue water reduction, sewerage and other specifically approved operational efficiency projects. The k factor funds are later repaid to customers as an X-Factor on their bills (JIS 2013).

8. **Use of reed beds** for tertiary treatment. Reed beds use common reed plants to dewater solids in a confined area and are used at Round Hill Resort in Hanover.

9. **Water reuse** for golf courses as practiced by several hotels.

10. **Water recycling projects.** There is a water recycling project at Denbigh 4-H.

11. **Recycled Water for electricity generation at Bogue**. JPSCo is using the effluent from the NWC Bogue sewage treatment plant, for cooling and other purposes in the electricity generation process.

12. **Recycling in bauxite/alumina industry**. The recycling of industrial effluent by four bauxite/alumina companies operating in Jamaica is a good example of wastewater reuse and recycling. This practice has resulted in cost savings to the companies as well as protection of water and land resources.

13. **Water use efficiency in hotels**. Water conservation and efficiency activities have institutionalized "best practices" in the tourism industry in Jamaica. These measures contribute to cost savings as well as reduced water, energy and chemical use.

14. **Environmental Impact Assessments.** EIAs are required of certain developments, including hotels, and are an important tool for improving project design to reduce potential environmental impacts.

15. **The Tourism Enhancement Fund**. The Tourism Enhancement Act, 2004 provided the legal basis for the ministry responsible for tourism to establish a mechanism for the

collection of a fee from incoming airline and cruise passengers to be paid into a dedicated Tourism Enhancement Fund. The Fund, established in 2005, accords the highest priority to projects falling within the following classifications:

- Heritage tourism - built and natural
- Resort enhancement (product development, beautification)
- Community tourism
- Sports and entertainment
- Environmental management
- Culture

16. **Environmental Certification.** Within the tourism sector, EarthCheck, Green Globe and Blue Flag are three environmental certification programmes which are internationally known and accepted. EarthCheck and Green Globe certification indicates that a hotel has met standards related to sustainability policy, energy consumption, potable water consumption, solid waste production, social commitment, resource conservation and cleaning chemicals used. Blue Flag certification indicates that beaches and marinas have met criteria dealing with water quality, environmental education and information, environmental management, and safety and other services. Currently, there are 15 hotels with EarthCheck or Green Globe certification and 8 beaches and one marina which are Blue Flag certified.

12. CURRENT KNOWLEDGE, ATTITUDES, BEHAVIOURS AND PRACTICES

A Knowledge, Attitudes and Practices (KAP) survey is a representative study of a specific population to collect information on what is known, believed and done in relation to a particular topic — in this case, wastewater management in the Wider Caribbean.

Information in this section was recovered from the document Wastewater Management in the Wider Caribbean Region: Knowledge, Attitudes and Practice Study (UNEP, 2010), from interviews with NEPA staff and from personal experience. The information to be presented here will help us to answer the question "Why are we where we are?"

In Jamaica, approximately 20 per cent of urban sewage is treated before disposal; the percentage is even lower in rural communities. Sewage is disposed of mainly through septic tanks and pit latrines, many of which do not comply with minimum technical specifications or are not adequately maintained. Indeed, as a result of rapidly expanding populations, poorly planned development, and inadequate or poorly designed and malfunctioning sewage treatment facilities, untreated sewage is often discharged into rivers and bays. This practice has serious repercussions to human health, marine life and ecosystem services, and the already fragile economies. There is thus an urgent need to increase wastewater management, which is presently far below required levels.

While Jamaica increasingly recognizes the importance of improving wastewater management, obstacles exist to meeting the obligations of the LBS Protocol and taking such steps necessary to address the problems. The 2010 State of the Environment Report (NEPA 2011) indicates that significant financial constraints exist and that there is a lack of adequate, affordable financing available for investments in wastewater management. Smaller communities, in particular, often find it difficult to obtain affordable financing improving wastewater infrastructure.

In addition to financial constraints, other substantial barriers exist: inadequate national policies, laws and regulations; limited enforcement of existing laws and regulations; poor communication and collaboration between various sectors and agencies which contributes to a fragmented approach to wastewater management; and limited awareness, knowledge and understanding of appropriate, alternative and low cost wastewater treatment technologies. Other limitations in technical capacity (e.g. in developing project proposals, operating and maintaining treatment systems, and monitoring and analyzing wastewater discharges and impacts) constrain progress in effectively managing wastewater.

In summary, Jamaica suffers from the "Environmental Arrogance Syndrome" in all levels of government and civil society due to our level of "environmental ignorance" which is a result of the scarce information, analysis and research in the area of wastewater management and its impact on the environment.

The following points summarize the key issues:

1. The level of awareness about wastewater management concepts, issues and technologies is low.

2. The strength of attitudes towards implementing proper wastewater practices is medium.
3. The level of focus on wastewater compared with water is low.
4. The likelihood that decentralized natural treatment systems (e.g. ecological sanitation, constructed wetlands, sand filters) would be accepted as options for domestic wastewater treatment is low.
5. The extent of people's awareness of the impact of current methods of disposal on health and the environment is medium.
6. People are inadequately aware of the link between sewage, poor sanitation and health problems such as diarrhoeal diseases, malnutrition, vector diseases, human capital, etc.
7. Senior management officials in government/decision makers have a fairly comprehensive knowledge of wastewater management issues and can link these with other areas of socioeconomic development.
8. Politicians have a lack of comprehensive knowledge of wastewater management issues and cannot link these with other areas of socioeconomic development.
9. Wastewater operators are inadequately aware of proper operations and maintenance techniques.
10. National, local and sectoral education and public awareness programmes and campaigns for wastewater management or for environmental management (which includes wastewater management) are fairly adequate.

13. INFORMATION COLLECTION AND SHARING

This section describes the capacity of countries in the region to collect and share information related to wastewater management and the avenues used for communicating this information within the sector and with the general public.

In order to facilitate informed physical planning and land management, the Office of the Prime Minister has continued to work towards the establishment of the National Spatial Data Infrastructure (NSDI). A fundamental component of an NSDI is the existence of a geospatial clearing house/portal that provides access to spatial information.

In 2008, a national geospatial metadata portal was created to serve as the single point of contact for anyone wishing to know which geospatial data sets are available for the island (Ministry of Housing, Environment and Water 2011). This is supported by a network of 13 high precision GPS base stations used to collect positioning data (X and Y coordinates). The portal currently has data from five organizations, available to the public for viewing. At that time, the Government aimed to have at least twenty government agencies publishing their metadata records via the portal by the end of 2010.

The Water Resources Authority is responsible for the management, protection, controlled allocation and utilization of the water resources of Jamaica. The WRA maintains a hydrological database and provides data, information and technical assistance to governments and non-governmental institutions. The major activities of the WRA include: hydrologic data collection, compilation, and analysis; water resources investigation, assessment, and planning; water resources allocation; and environmental monitoring and impact assessment. The WRA routinely monitors river flows at 133 gauging stations, and groundwater at 1,802 sites across the island.

The Authority has a database of quality-checked data, stored in computerized format dating back to the 1950s. Projects, such as the Rio Cobre Dam Reconstruction, benefitted greatly from the use of this database. Rational water allocation was formally facilitated by the issuing of licenses for groundwater abstraction.

In theory, the Water Resources Authority is the repository of information on water and wastewater management generated by other agencies such as NEPA, NWC and MOH (Environmental Health Unit and National Environmental Health Laboratory). In practice, this system is in an inception state.

An evaluation on information collection and sharing with respect to wastewater management indicates the following:

1. No facilities exist for data collection where analysis, revision and expansion of information are conducted.
2. The quality of data analysis is poor. No attempts are made to relate it to health, social and economic issues.
3. There is a lack of periodic assessment of short-term and long-term data-collection and research needs for wastewater management.

4. Access to information related to wastewater management issues for decision making to Government officials is fair.
5. Public access to information related to wastewater management issues for decision making is fair but troublesome.
6. There is no standardized data collection, necessary for gathering comprehensive and comparable information.
7. Terminology used is fairly standardized.

There is no a national knowledge and information system/ clearing house mechanism of tools and approaches for wastewater management that are effective and appropriate to the expectations and context of the beneficiaries in the Wider Caribbean, regardless of the efforts made by the Office of the Prime Minister.

14. PRESENCE AND PARTICIPATION LEVEL OF WATER AND SANITATION ORGANIZATIONS

There are different organizations that support environmental protection and sanitation programmes. These organizations invest a large amount of funds both in technical cooperation and financing of infrastructure, as well as in raising awareness.

Several international organizations participate in the water and sanitation arena. UNEP, PAHO, UNICEF and UNDP provide technical cooperation and finance to areas of wastewater management. USAID, Inter-American Development Bank (IDB), World Bank and the Caribbean Development Bank are other international agencies with the same mandate.

Jamaican CBOs, NGOs and professional organizations are playing a lead role in building public awareness, environmental advocacy and natural resource management. However, many of these organizations lack the necessary human and financial resources on a continuous basis for long-term programme implementation. They continue to rely on international and local donors for project and organization support.

The Environmental Foundation of Jamaica (EFJ) is the country's leading source of grant funding for environmental and conservation initiatives undertaken by NGOs and CBOs. Between 2007 and 2010, the EFJ disbursed a total of approximately US$300,000 towards protection and conservation initiatives implemented by local organizations. Funded projects were in the areas of watershed and coastal zone management, biological diversity, waste and water management, community green spaces, alternative energy, ecosystem management, water harvesting, hurricane disaster mitigation, climate change, community environmental management and capacity building.

A number of professional organizations are also involved in environmental activities. These include the Jamaica Manufacturers' Association, Jamaica Hotel and Tourist Association and the Small Business Association. Increasingly, they are promoting environmental stewardship among their members.

Additionally, the Jamaica Institute of Environmental Professionals was formed in 2000 specifically to improve environmental management capacity and practices in Jamaica and is engaged in encouraging dialogue about environmental issues among different sectors of Jamaican society. Also, the Jamaica Association of Public Health Inspectors plays a leading role in environmental health issues.

Local government authorities have traditionally depended on state agencies to implement environmental programmes and to intervene in addressing environmental concerns at the local level. Through the ongoing reform process, local authorities are being strengthened to address these issues themselves. The work of the Parish Development Committees (PDCs) complement the work of the local authorities as they partner with other stakeholders across the public and private spheres. The National Association of Parish Development Committees, formed in 2007, serves to represent and promote the interests of all 13 PDCs as well as the Portmore Citizens Advisory Council. It also provides ongoing focused advocacy and policy direction. PDCs are involved in projects and programmes focused on local sustainable

development planning, disaster risk assessment and management planning, reforestation efforts, recycling efforts and waste reduction and management initiatives.

Each year, Jamaica participates in the Ocean Conservancy's International Coastal Cleanup Day. Hundreds of Jamaicans across the island collect debris from the country's beaches on that day, recording the number and type of each piece collected. This exercise results in cleaner beaches and increased awareness about the links between land-based pollution and the coastal and marine environment. The data collected are a critical component of this exercise. With knowledge about the most prevalent components of marine debris, elected officials can make informed policy decisions and community leaders can more effectively tailor and expand recycling and other waste reduction programmes. The NGO Jamaica Environment Trust plays an important role in the organization of this event.

In Jamaica, environmental issues, including sanitation, are integrated into the formal school curricula, beginning in primary schools.

15. CLIMATE CHANGE IMPACTS

The objective of this section is to determine if there is an impact on the sanitation infrastructure by the effects of climate change, if available funds will be diverted to prioritize the work emergency response in the field of sanitation or if these funds will be diverted to serve other areas outside the sector.

A warmer climate resulting from a doubling in carbon dioxide concentration in the atmosphere will lead to increased frequency of warm spells/heat waves, intense droughts, heavy rainfall events, fire and floods; higher relative humidity; rising seas; stronger storms and increased storm damage; changing landscapes; economic losses; and increased risk to wildlife.

Also, there will be an increase in the consumption of water with a rise in temperature, since the number of showers per person per day is likely to increase in many places and consequently the amount of water for laundry. This would bring an increase in the amount of greywater generated in each household.

The coastal area has been prioritized because of its low-lying state, the population concentration in this zone, the level of infrastructural development, and the range of economic activities occurring there. Therefore it is expected that sanitation infrastructure (sewer lines, latrines and septic tanks) will be affected, increasing the amount of wastewater and excreta in contact with both groundwater and the sea.

16. SUMMARY OF MAJOR FINDINGS

MAJOR FINDINGS FROM LITERATURE REVIEW

Access to Water and Wastewater Facilities

- Seventy nine per cent (79.2 per cent) of Jamaica's population is served with piped water: 57.3 per cent in dwellings, 16 per cent in yards and 5.9 per cent to standpipes. Three point six (3.6) per cent of the population still uses raw water sources and are thus more vulnerable to drought.

- In 2011, 71 per cent of households had access to water closets, with pit latrines being used by 23 per cent of households. Approximately 2.1 per cent of all households reported no toilet facilities in 2011. In 2012, the percentage of households with access to water closets increased to 73.8%. In 2007, 21.8 per cent of the population was served with sewerage (35.9 per cent urban and 4.2 per cent rural), 42.0 per cent was linked to a septic tank (46.2 per cent urban and 36.9 per cent rural) and 34.3 per cent were using a latrine (16 per cent urban and 57.2 per cent rural).

Legislative, Policy and Institutional Frameworks

- A draft Sanitation Policy has been in existence since 2005. There has been difficulty identifying the ministry that should take the lead on sanitation issues due to the cross-cutting nature of the issues.

- Jamaica has harmonized domestic effluent discharge limits with Annex III of the LBS Protocol.

- Jamaica has wastewater regulations for priority industries identified in LBS Protocol.

- An intersectoral approach to wastewater management exists but is weak. The Environmental Health Unit of the Ministry of Health is the leading agency but it does not have sufficient staff. Also there is a lack of cooperation and coordination among entities responsible for wastewater management.

- The NWC has embarked on a rehabilitation programme of existing wastewater plants as part of the IDB-funded Kingston Metropolitan Area Water Supply Improvement Programme. Approximately 26 plants will be rehabilitated.

- Manpower capacity for wastewater management is an issue. Educational opportunities for all aspects of wastewater management are limited.

- Economic constraints and lack of staff have affected the wastewater surveillance programme. The Ministry of Health has a programme that collects samples four times a year.

- Water quality surveillance and information collection and sharing are weak.

Wastewater Management Infrastructure, Technology and Practices

- Many of the sewage treatment plants across the island are old, extending up to 30 years, and currently use older inefficient technologies and operate beyond their lifespan and their design capacity.

- There are 97 wastewater treatment plants that treat domestic sewage (NWC operates 71 and other entities 26). Major urban centres such as Kingston and St. Andrew, St. James and St. Catherine account for approximately 90 per cent of the wastewater handled by the NWC. The main technology used is oxidation ditches (used in 33 plants or 34 per cent of the total) followed by pond systems (25 plants or 25.8 per cent of the total). Most of the plants are not well operated.

- Of the 165 plants monitored by the Environmental Health Unit (Ministry of Health) between January and September 2010, only 66, or 40 per cent, were in compliance with the NRCA's sewage effluent standards. Of the 65 NWC plants monitored, only 17, or 26 per cent, were compliant.

- Four sewage treatment facilities that have been built in the last 14 years with permits and licences from the NRCA/NEPA. They are: Ocho Rios sewage treatment ponds – St. Ann; Bogue sewage treatment ponds – St. James; Negril Ponds – Westmoreland and Soapberry – Kingston. These sewage treatment ponds have resulted in improved effluent quality. Of particular note is the Soapberry Treatment Ponds, the first phase of which was commissioned in 2008 to provide tertiary treatment of sewage collected from Kingston and St. Andrew and South East St. Catherine (Portmore). This is the only municipal sewage treatment plant in the English-speaking Caribbean that treats sewage to the tertiary level.

- Wastewater treatment practice is mostly by mechanical plants, which have high electricity consumption. Sixty two plants (63.9 per cent of the total) need electricity for operation. NWC uses mainly mechanical plants, using this technology in 51 (72 per cent) of its plants. Others (private and public housing developers) use oxidation ponds as the main wastewater practice.

- Industries mostly use mechanical plants. Fourteen institutions (out of a total of 21 – or 66.6 per cent) use mechanical plants, most of which are package plants.

- Hotels mostly use mechanical plants, with 27 (82 per cent of the total 33) plants using mechanical systems.

- The majority (53 per cent) of the 17 commercial institutions use mechanical plants, mainly of the Cromaglass and oxidation ditch types.

- Flatness of terrain in coastal areas leads to the use of lift stations to raise the wastewater to the level of the sewage treatment plants (STP). Many STP maintenance programmes are not up to date and as such the plants often resort to emergency discharges into streets, the sea, canals, creeks and other water bodies.

- In general, in-situ systems are always considered to cause less pollution than raw wastewater from sewerage systems. However, many of the existing septic systems are located in limestone and not functioning properly and as such only partially treat the raw sewage and grey water. This results in direct environmental impacts that can immediately contaminate any nearby water body such as creeks, rivers, sea and underground water. There have been recorded instances also that there are no soak-away or leach field and simply discharge these into the wetland or water bodies.

- Private companies provide septage service; however, they are located in only seven parishes. Septic tanks are usually cleaned only when there is a problem and private persons will call the cesspool truck to remove sludge.

- Cesspool trucks that remove sludge from private septic tanks for disposal often commingle this biological waste with waste from industrial and commercial sources with high chemical constituents and/or fats, oils and grease.

- There is no information on biosolids, but it is suspected that they are disposed of using the same procedure as septage disposal.

- Discharges from the agricultural, industrial and mining sectors contribute significantly to water pollution. Most of the industrial wastewater generated in Jamaica is from agro-based industries – breweries, coffee and sugar processing, distilleries, dairy producers and slaughterhouses.

- Wastewater reuse is practiced on a small scale and quality of reused water is good.

- Water recycling is practiced by some industries (sugar and bauxite) and by some hotels. Water conservation is practiced by many hotels.

- Hotels mainly located along the coast have a significant contribution to wastewater loads; wastewater from these hotels is treated with package plants. Cruise ships and other marine vessels' effluents are a major threat to the health of Jamaica's marine environment.

- Pollution impacts on health, environment, society and the economy have not been fully addressed. However, this is an important issue that should be assessed, especially its impact on public health and Jamaica's major foreign exchange earner, tourism.

- The impact of climate change on wastewater management has not been fully addressed.

ANALYSIS USING MATHEMATICAL MODEL

An analysis of the responses to the questionnaire using the mathematical model is summarized below and grouped according to 22 focus areas derived from the 27 issues identified in Section 2. Annex 1 describes these focus areas. Annex 2 presents the actual data used for the evaluation. Annex 3 presents the actual results from the mathematical model. Annex 4 provides a graphical representation of the results, showing which areas have a negative (red), neutral (amber) and positive environmental impact (green). Annex 5 explains the significance values used in the mathematical model.

Sanitation Coverage

- Jamaica's sanitation service (infrastructure) has a grade of 69%, meaning "neutral adequacy". Jamaica has a low percentage of the population without sanitation service. Wastewater from sewerage systems receives primary or secondary treatment and those not connected have in-situ systems in the form of septic tanks or latrines. The Soapberry Sewage Treatment Plant provides tertiary treatment and Bogue, because of its effluent reuse by JPSCo, is also considered to provide tertiary treatment.

Disposal of Treated/Untreated Wastewater

- The location of wastewater disposal or effluent discharge point has a grade of 17.5%, a "significant adverse adequacy" impact. Effluents are directly discharged either to creeks, the sea and mangroves or into groundwater via the land. Tertiary treated wastewater from Soapberry is discharged into Rio Cobre River.

Wastewater Reuse/Type of Reuse/Quality of Effluent

- The amount of wastewater reuse is 11.1%. Effluents from most plants have the potential to be reused. The type of reuse has a grade of 75%, a "neutral adequacy" impact. Wastewater reuse is practiced in industries, some hotels and institutions. The quality of effluent has a grade of 66.7%; the quality of water reused is high, except for the artificial recharge produced by septic tanks.

Industrial Wastewater Management

- The treatment of industrial wastewater has a grade of 44.8%, a "neutral adequacy" impact because industrial wastewater effluents do not meet the discharge standards.

Tourism/ Hotel Wastewater Management

- Effluent from the tourism sector has a grade of 59.3%, "neutral adequacy". Some hotels treat their wastewater with package plants and others use septic tanks. Cruise ship wastewater at Falmouth Pier is treated, reducing the threat to the health of Jamaica's marine environment.

Institutional Wastewater Management

- Institutional effluents have a grade of 57.3%, "neutral adequacy". A significant amount of hospitals, schools and other institutions have taken steps to manage wastewater appropriately.

Volume of Wastewater Discharged/Quality of Discharge

- The amount of wastewater discharged to water bodies has a grade of 10.2%, meaning that the volume of wastewater discharged into groundwater, mangroves, rivers and sea is high. The quality of effluent receives a grade of 57.3%, which signifies that quality needs to be improved.

Septage/Biosolids Management

- Septage/biosolids handling has a grade of 44.0%. Private companies operate septage service and deposit septage to special sites. In other towns where service is not available septage is disposed of improperly. There is a need for more private companies in at least 7 parishes. There was no information on biosolids, but it is suspected that they are disposed of in using the same procedure as septage disposal.

Infrastructure Condition

- Infrastructure conditions have a grade of 73.1%. The Soapberry Plant is the latest addition and Bogue has also been recently refurbished. There are major new sewer lines in Kingston. There is frequent but gradual expansion of homes, but many of these use septic tanks.

Pollution Problems and their Cost

- Pollution problems and their costs are graded as neutral adequacy with a grade of 57.6%. Pollution problems are evident in some areas and its impact on health is not reflected, except for diarrhoea cases.

National Capacity (Policy, Legislative and Institutional Frameworks)

- The level of adequacy of national capacity is graded at 54.0%. The policy framework has a level of adequacy of 71.4%, the legislative framework 55.6% and the institutional framework 54.0%. Wastewater management policies are not sufficient. Regulations for better waste management that take into account the health epidemiological profile are lacking. There is a need to increase enforcement and the institutional coordination. No forceful leading agency exists.

Surveillance and Enforcement Capacity

- Surveillance and enforcement capacity is low; the level of adequacy is 36.0%. The Environmental Health Laboratory should be certified and budget increased for acquisition of equipment, and hiring staff.

Manpower Capability

- Manpower capability adequacy is 45.0%. Adequacy of availability of staff is average (52.4%). The meeting of training needs has a negative adverse grade (16.7%). Training opportunities adequacy is low 11.1% and regional training opportunities is very low (33.3%)

Financing

- Financing has a level of adequacy of 49%. A budget in sanitation should be dedicated to wastewater treatment and management measures to facilitate smaller communities to obtain affordable financing for improving wastewater infrastructure. Affordable financing for investments in wastewater management should be made available. Cost estimates for wastewater carrying and treatment technologies should be prepared.

Best Practices and Innovative Technological Treatment Solutions

- There is a very poor level of application of best practices and technologies (25.9%). Attention should be directed to improving the following areas: policy framework, legislative framework, institutional framework, surveillance capacity, manpower strengthening, financing, and sanitation projects as community source of revenue.

Current Knowledge, Attitudes, Behaviours and Practices

- The level of adequacy of current knowledge, attitudes, behaviours and practices is average (47.2%). Priority should be given to increase: the level of awareness about wastewater management concepts, issues and technologies; the focus on wastewater compared with water; and the responsiveness of wastewater operators for proper operations and maintenance techniques; and in operations and maintenance techniques.

Information Collection and Sharing

- The adequacy of information collection and sharing is very poor (33.3%). Steps should be taken for: establishment of facilities for data collection where analysis, revision and expansion of information is conducted; the standardization of the terminology; conducting periodic assessment of short-term and long-term data collection and research needs for wastewater management; increasing access to information related to wastewater management issues for decision making to government officials; providing the public with ready access to information related to wastewater management issues for decision making; establishing a standardized data collection system, in order to gather comprehensive and comparable information; and the establishment of a national knowledge and information system/ clearing house mechanism of tools and approaches for wastewater management that are effective and appropriate to the expectations and context of the beneficiaries in the Wider Caribbean.

Organizations' Support for Wastewater Management

- Presence and participation level of water and sanitation organizations is average (55.6 %), the level of support of international UN and cooperation agencies and banks, especially IDB is high. Steps should be taken to improve the participation of: professional organizations;

media organizations; Healthy Schools programmes; environmental clubs; theatre groups and community organizations.

Climate Change Impacts

- The impact level of climate change on wastewater management is expected to be high (13.3%). The climate change effects that are expected to have a medium level of impact are higher humidity and increased risk of fire. We should increase resilience in wastewater management to address the following climate change impacts: higher temperatures; rising seas; high water tables; increased risk of drought; increased risk of flood; stronger storms and increased storm damage and increased risk of hurricanes.

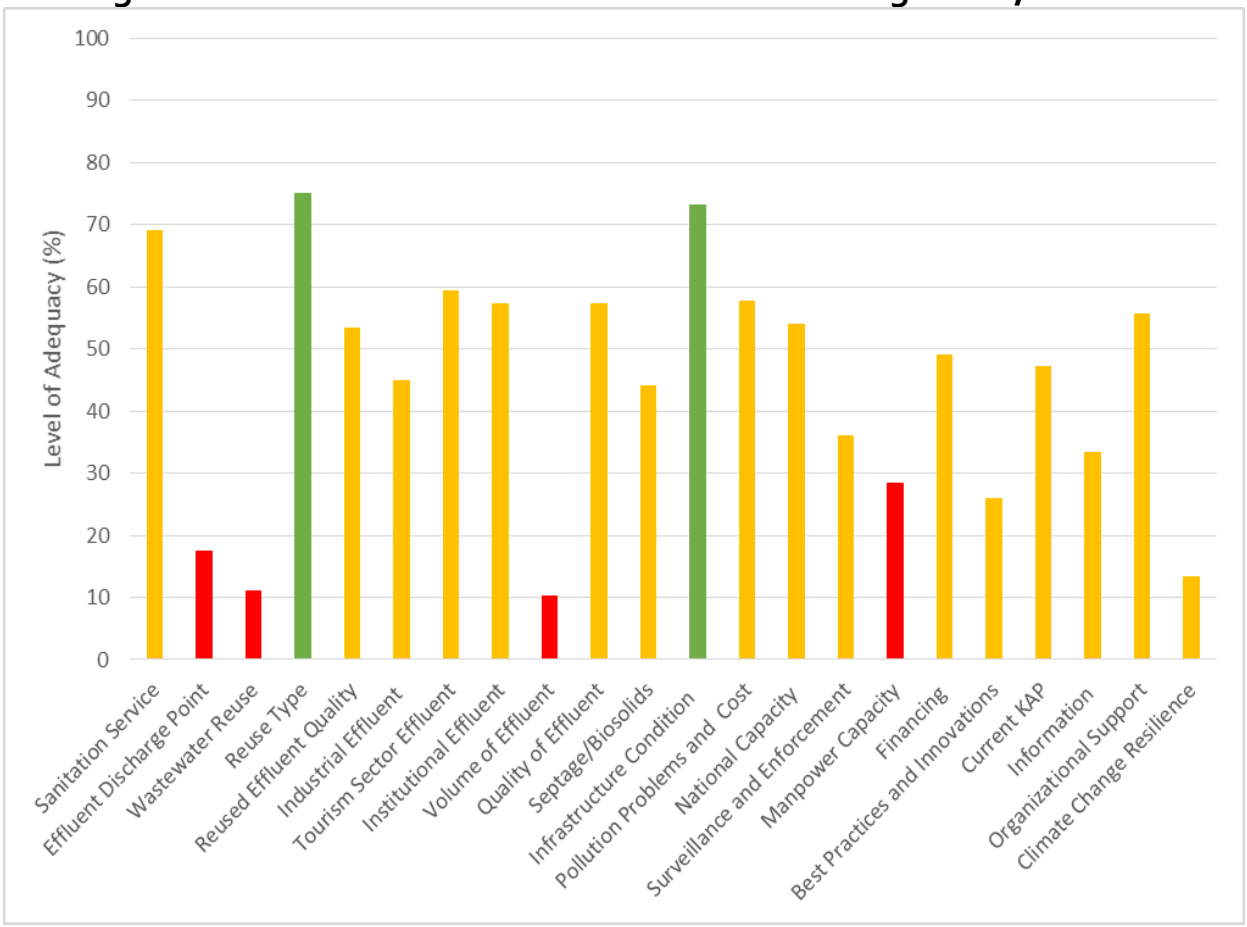
Table 39 presents a summary of the grades assigned to the issue areas from the analysis of the questionnaires. These grades can be seen as the level of adequacy of the particular wastewater issue. Figure 18 shows a graph of these results illustrating the level of adequacy using the following scale:

0 to 30 = negative adequacy impact (red)
31 to 70 = neutral adequacy (amber)
71 to 100 = positive adequacy impact (green)

Table 39: Level of Adequacy of Wastewater Issues

Issue Area	Level of Adequacy	Issue Area	Level of Adequacy
Sanitation Service	69.0	Infrastructure Condition	73.1
Effluent Discharge Point	17.5	Pollution Problems and Cost	57.6
Wastewater Reuse	11.1	National Capacity	54.0
Reuse Type	75.0	Surveillance and Enforcement	36.0
Reused Effluent Quality	53.3	Manpower Capacity	28.4
Industrial Effluent	44.8	Financing	49.0
Tourism Sector Effluent	59.3	Best Practices and Innovations	25.9
Institutional Effluent	57.3	Current KAP	47.2
Volume of Effluent	10.2	Information	33.3
Quality of Effluent	57.3	Organizational Support	55.6
Septage/Biosolids	44.0	Climate Change Resilience	13.3

Figure 18: Baseline Assessment Wastewater Management, Jamaica



17. RECOMMENDATIONS FOR ACTION

The main recommendations are presented below. These are based on the literature review and the results of the mathematical model.

National Capacity Development

1. Review and approve the Draft Sanitation Policy that was formulated through the MOH with PAHO technical cooperation taking into consideration the present epidemiological profile where chronic diseases and obesity are issues.

2. Consolidate regulations governing the sanitation sector within the Draft Sanitation Policy. Sanitation regulations exist under different laws, and their enforcement therefore falls under different ministries and agencies. Consolidate all sanitation legislation into one comprehensive act that will address all aspects of sanitation services consistent with the LBS Protocol. Both legislation and enforcement should be revised and harmonized into one instrument, with one lead ministry spearheading all matters related to sanitation. Build capacity of the lead sanitation agency – once identified – to implement the sanitation policy and enforce the sanitation act. Provide adequate resources of this lead agency to enable it to take up this role.

3. Conduct proper planning to guarantee the timely delivery of interventions in this sector, especially to identify and share responsibilities among stakeholders, reduce costs, reduce energy consumption and make the best use of available materials and human resources. Strategic planning is necessary to guarantee sustainability and prevent any deterioration in access to sanitation for the most vulnerable populations. Prepare a 20-year sanitation development plan to determine the minimum needs for sewage treatment and secure land for expansion

4. Strengthen the human resources capabilities both in terms of number and qualifications of the Environmental Health Unit and NEPA. To implement the proposed interventions and solutions, the capacity of both need to be strengthen with a focus on building technical capacity, acquiring key equipment and developing an operational budget sufficient to properly carry out sanitation surveillance and enforcement.

5. Expand the analytical capacity of NEPA and Environmental Health Laboratory to carry out chemical organic analysis and analysis of pesticides, pharmaceutical waste and heavy metals.

6. Support the review, socialization and use of the Manual for Minimum Requirements for Waste Water Treatment Systems and Excreta Management in Jamaica.

7. Build capacity and provide resources to develop land use policy.

8. Build leadership capacity at the community level to integrate and implement improvement of sanitation in villages

9. Build community capacity and skills to maintain or improve the standards of sanitation facilities for each household.

Enabling Environment

10. Tighten control of construction activities in urban areas, densely populated villages and coastal regions.

11. Place more attention on sanitation. Sanitation continues to remain a neglected portfolio. Progress in sanitation should be accelerated and will require a concerted effort at national and local levels to accelerate the progress.

12. Provide a supporting environment for the sanitation sector. Good sanitation is achievable if supported by the right set of policies, targeted technical assistance, institutional capacity, adequate funding, and strong political commitment and community engagement.

13. Give attention to increased treatment and reuse of municipal wastewater.

Financing

14. Secure funding and identify new revenue/funding sources for sewerage expansion efforts. Improve income generation capacity of the sanitation sector and increase benefits with respect to costs by including chronic diseases and vector borne disease in benefits and not only diarrhoeal diseases.

15. Provide technical (and financial) support at the community level for those households adopting pit latrines as an improved sanitation facility, taking into consideration local conditions (for example, sandy soil and high water table).

Wastewater Infrastructure and Technology

16. Expand piped sewerage systems in urban centers to those households that presently use septic tanks. Use of small diameter sewerage systems should be considered taking advantage of the septic tanks. A cost benefit analysis of this intervention will be needed to justify the upfront investment.

17. Place priority on reducing the high risk of pollution from septic tanks located above limestone areas.

18. Provide amenities to prevent open defecation, which still continues in some areas of the country, mostly in rural areas and slums.

19. Explore, identify and adapt relevant technology for disposal and treatment of sewage. Use of mechanical plants imposes a big burden on the country's energy sector.

20. Fund research on wastewater treatment, biomass production and electricity generation. It is reported that the sewage managed by NWC could produce electricity to satisfy 46 per cent of Jamaica's electricity demand.

21. Facilitate the construction of basic improved sanitation facilities for the poorest households, based on joint efforts with the community.

22. Attention should be given to solve the incomplete treatment of industrial effluent due to technology and capacity shortfalls by implementing and enforcing the effluent regulations to prevent contamination of water bodies from industrial effluents, with specific emphasis on enforcing penalties for violations.

23. Promote the creation of septic haulers and sludge disposal sites in different areas of the island.

24. Explore, identify and adapt relevant technology for disposal and treatment of sewage.

25. Conduct a review of sanitation facilities and investigate use of alternative, cost-effective systems.

Information Collection and Communication

26. Develop a database system to facilitate evidence-based planning and interventions for sanitation services and programmes. The database shall be built on the resources available among agencies that support sanitation projects.

27. Ensure the availability of detailed information on which households have an improved sanitation system and which do not. This shall include a detailed data system based on cadastral maps which would give authorities insight into where action has to be taken to improve the level of sanitation coverage in the country. It also shall include all information pertinent to the sanitation sector such as overview of ongoing sanitation projects and villages / households in need of technical or financial assistance.

28. Disseminate technical assistance and information on how to determine the size of the leach pit amongst the general public. Partnering with communities, people will learn how to properly build a latrine and that, in the future, other families will develop the capacity to build and maintain their own.

29. Conduct public awareness campaigns about good sanitation practices. A sanitation education campaign should be strengthened to change the perception of the low priority afforded by households to improved sanitation. The public awareness campaign and training should be innovative and appealing to the public. It shall promote the need for proper sanitation and explain the associated health and financial benefits.

The campaign should be addressed to different stakeholders to raise support to address wastewater management issues. It should disseminate information on the standards of sanitation and good sanitation practices to the general public, professionals, teachers and health workers. It also shall target and train the community (leaders, heads of households, women, youth, etc.).

Surveillance, Monitoring and Enforcement

30. NEPA and MOH, through its Environmental Health Laboratory, the Environmental Health Unit and the Regional Health Authorities shall implement joint efforts to improve surveillance of wastewater discharges and water bodies.

31. Use the information from the most recent census to identify, delineate and preserve catchment areas for the major water sources.

32. Public Health Officers, who are legally mandated to inspect building plans to ensure they include properly designed septic systems, shall supervise that every construction activity in urban and rural areas have a building permit from the parish Health Authorities.

33. Implement more control on the design and quality of septic tanks through adequate monitoring.

34. Improve enforcement towards constructing functional treatment systems, proper maintenance and desludging of septic tanks. The lack of proper maintenance and desludging of septic tanks result in direct environmental impacts that can immediately contaminate any nearby water body such as creeks, rivers, the sea and underground water.

Research

35. Carry out studies related to the impact on health and environment of bad wastewater management.

36. Carry out an evaluation on how climate change will impact on wastewater management. The information available does not fully address this problem.

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ANNEX 1 DEFINITION OF OBJECTIVES FOR AREAS OF FOCUS

1. Sanitation Coverage

The objective is to present information regarding the type of sanitation used for carrying, treating and disposing the excreta and wastewater generated. This includes:

- the type and coverage of excreta disposal systems used
- the total population served with Wastewater Treatment Plants
- the percentage of population receiving primary, secondary and tertiary treatment
- the percentage of WWTPs meeting discharge limits

2. Disposal of Treated/Untreated Wastewater

The objective is to find out where wastewater is disposed and the perceived level of environmental impact. This includes determining the impact of wastewater reuse. It is believed that wastewater discharges into the sea or mangroves have the greatest impact on the LBS Protocol. Reuse of wastewater has the least impact, because in the case of irrigation, wastewater receives additional treatment.

3. Wastewater Reuse

The objective is to find out the degree of treatment before reuse and the level of reuse in each case. In many countries wastewater is reused unintentionally.

4. Type of Reuse

The objective is to find out where ad for what purpose water is reused and the level of reuse. Effluent from septic tanks disposed of into the ground by the use of trenches or percolation pits, are ways of unintentional artificial recharge.

5. Quality of Effluent

The objective is to find out the quality of the effluent for each type of reuse.

6. Industrial Wastewater Management

The objective is to determine existing industries in the country that are considered a priority in the LBS Protocol, the industrial wastewater management practices and level of discharges. This also seeks to determine the level of effluent compliance and if there is surveillance and enforcement.

7. Tourism/Hotel Wastewater Management

Tourism plays an important role in the economy of Caribbean countries. If wastewater produced by the tourism industry is not managed properly, tourism will become environmentally unsustainable and tourists will migrate to cleaner locations. The objective is to find out hotel wastewater management practices and level of discharges as well as the level of effluent compliance and how proper surveillance and enforcement is conducted.

8. Institutional Wastewater Management

Hospitals and schools can be important sources of infectious and other liquid wastes. Commercial centres and other types of institutions, many of which manage their own wastewater management systems, are also important sources of pollution. Thus, the objective is to determine institutional wastewater management practices and level of discharges as well as the level of effluent compliance and how proper surveillance and enforcement is conducted.

9. Volume of Water Discharged

The objective is to estimate the pollution load in different water bodies. Therefore information on the amount of wastewater discharged in different water bodies is needed. In case that information is not available, then a qualitative answer is obtained, i.e. level of discharge.

10. Quality of discharge

This question is the complement of Focus Area #9. Here the objective is to find out the level of treatment before discharge. Water bodies receive different quality levels (raw, primary, secondary and tertiary).

11. Septage/Biosolids Management

Sludge from septic tanks (septage) and sludge produced in WWTPs (raw and digested) are important sources of pollution that is frequently ignored. The objective is to assess the level of adequacy of septage and biosolids management, in terms of treatment, place of disposal and amounts generated.

12. Condition of wastewater treatment infrastructure

The objective is to get information on the physical condition, age and obsolescence of wastewater sewerage and WWTPs.

13. Pollution Problems and their Cost

The objective is to assess the types of problems and the costs associated with not addressing them, such as poor health and disease, loss of business, resources, recreational, and other pertinent areas.

14. National Capacity

The objective is to identify national planning issues pertaining to policy, legal and regulatory frameworks, government institutions, information management systems, and education to enable national compliance with Annex III of the LBS Protocol of the Cartagena Convention as well as political will.

15. Surveillance and Enforcement Capacity

It is impossible to know how good or bad a wastewater management programme is without a diagnostic. Adequate laboratory capacity along with adequate of surveillance capacity is of utmost importance to support wastewater effluent and ambient environmental quality monitoring to assess compliance with LBS Protocol Annex III parameters. To close the cycle, another important element is enforcement. The objective is to assess these issues.

16. Manpower Capacity
The objective of this is to acquire information on training requirements and actual training offered at the national and regional levels.

17. Financing
The objective is to determine the level of financing of wastewater management to assess compliance with LBS Protocol Annex III.

18. Best Practices and Innovative Technological Treatment Solutions
The objective is to identify existing and potentially viable approaches to addressing domestic wastewater system needs and evaluate and develop recommendations based on criteria such as local conditions, effectiveness, availability, cost-effectiveness, and stakeholder acceptability.

19. Current Knowledge, Attitudes, Behaviours and Practices
A KAP survey is a representative study of a specific population to collect information on what is known, believed and done in relation to a particular topic. The objective is to conduct a brief KAP survey related to wastewater management in the Wider Caribbean.

20. Information Collection and Sharing
The objective is to examine the capacity of countries in the region to collect and share information related to wastewater management and the avenues used for communicating this information within the sector and with the general public.

21. Water and Sanitation Diaspora Organizations
There are different organizations that support environmental protection and sanitation programmes. These organizations invest a good amount of funds both in technical cooperation and financing of infrastructure, as wells as in the creation of awareness. The objective is to determine the various organizations involved and their degree of support wastewater management.

22. Climate Change Impacts
With global warming, human well-being will be affected by droughts and higher temperatures either directly or indirectly. Pathogen loading of streams and poor sanitation could possibly result from lack of potable water. Storage of water during droughts in drums provides suitable habitats for mosquitoes and so augments the transmission of vector-borne diseases such as dengue fever and malaria, which are likely to increase with predicted higher temperatures. Increased pesticide use for vector control will also have an impact on water bodies and the food chain.

Increased temperatures are also associated with increased episodes of diarrhoeal diseases, sea food poisoning and increases in dangerous pollutants. Threats from higher temperatures may cause greater contact between food and pest species. Warmer seas contribute to toxic algae

bloom and increased cases of human shell-fish and reef-fish poisoning. Incidents of high temperature morbidity and mortality are projected to increase and so the use of pharmaceuticals which will end up in water bodies.

Thus, the objective is to assess the level of discussion about of how climate change is going to affect compliance with the LBS Protocol.

ANNEX 2 DATA USED FOR EVALUATION

Mathematical Model Jamaica

2. Overview of Wastewater Treatment Management

2a. Domestic Wastewater Treatment Systems

1	**Level Sanitation service**		**Adequacy of service/treatment**		
		%	Poor	Medium	High
1A	Sewerage System	21.8		X	
1B	Septic Tank (on-site treatment)	42		X	
1C	Latrine	34.3		X	
1D	Open defecation	1.5	X		
1E	% Population connected to a WWTP	20		X	
1F	% Population Primary Treatment	0.1	X		
1G	% Population Secondary Treatment	18.7		X	
1H	% Population Tertiary Treatment	12.8			X
1I	% Meeting Discharge Standards	8		X	
2	**Disposal of treated/untreated wastewater**		**Impact**		
		%	Low	Medium	High
2A	River	16.8		X	
2B	Lake	1.3	X		
2C	Sea	1.8			X
2D	Underground	42		X	
2E	Reused	1	X		
2F	Other (specify):				

2b. Wastewater Reuse

3	**Wastewater Reuse**		**Level of reuse**		
		Yes = 1	Low	Medium	High
3A	Treatment and Reuse	1	X		
3B	Treatment and No Reuse	1			X
3C	No Treatment and Reuse	1	X		
4	**Type of Reuse**		**Level of Reuse**		
		Yes = 1 No = 0	Low	Medium	High
4A	Irrigation Unrestricted Root and Leaf Crops, high and low growing crops	0			
4B	Irrigation Restricted Labour Intensive and highly mechanized	0			
4C	Lawns/Parks	1	X		
4D	Golf Courses	1		X	

4E	Cricket Grounds/Football Fields	**0**			
4F	Industrial	**1**			**X**
4G	Aquaculture	**0**			
4H	Artificial Recharge (Septic Tank effluents)	**1**			**X**
4I	Surface reservoirs	**0**			
4J	Other (specify)				
5	**Quality of Effluent**		Level Quality of Effluent		
			Low	Medium	High
5A	Unrestricted Root and Leaf Crops, high and low growing crops	**0**			
5B	Restricted Labour Intensive and highly mechanized	**0**			
5C	Lawns/Parks	**1**			**X**
5D	Cricket Grounds/Football Fields	**1**			**X**
5E	Cricket Grounds	**0**			
5F	Industrial	**1**			
5G	Aquaculture	**0**			
5H	Artificial Recharge	**1**	**X**		
5I	Surface reservoirs	**0**			
5J	Other (specify)	0			

2c. Industrial Effluent Discharges										
6	Type of Industries	Priority Industries*								
		a	b	c	d	e	f	g	h	i
	Presence of priority industry	1	1	1	1	1	0	0	1	1
6A	% of untreated wastewater sent to a WWTP	low	low	low	low	low			low	high
6B	% untreated wastewater discharged directly into water bodies	high	low	low	low	low			low	low
6C	% treated before discharged into water bodies	low	high	high	high	high			high	high
6D	% untreated before discharged into municipal sewers	low	mod	mod	mod	low			low	low
6E	% of industrial wastewater that is treated together with municipal wastewater	low	high	mod	high	low			low	low
6F	Level of effluent compliance	low	mod	high	high	mod			low	high
6G	Are there sampling and reporting requirements.	low	high	high	high	high			high	high
6H	Is there enforcement? Level of enforcement.	low	low	low	low	low			low	low

*a = Agricultural; b= Chemical; c= Extractive Industries and Mining; d = Food Processing Operations; e = Manufacture of Liquor and Soft Drinks; f = Oil Refineries; g = Pulp and Paper Factories; h = Sugar Factories and Distilleries; i = Intensive Animal Rearing Operations

2d. Tourism /Hotel Sector Wastewater Management						
7	Tourism /Hotel Sector Wastewater Management	Existence		Presence Level of Discharges		
		Yes = 1	%	Low	Average	High
7A	Are tourism and hotel facilities connected to a central sewerage system? (% connected)	1			X	
7B	Is the wastewater in the central sewerage system treated before it is discharged? (% treated)	1			X	
7C	Do tourism and hotel facilities not connected to a central sewerage system treat their wastewater before discharge? (% of facilities that treat)	1				X
7D	Is treated wastewater in tourism and hotel facilities reused? (% reused)	1			X	
7E	Do tourism and hotel facilities discharge treated wastewater into water bodies? (% that discharge into water bodies)	1		X		
7F	Do tourism and hotel facilities discharge untreated wastewater into water bodies? (% that discharge into water bodies)	1		X		
7G	Level of effluent compliance	1				X
7H	Is there sampling and reporting?	1			X	
7I	Is there enforcement? (Level of enforcement)	1			X	
			0			

2e. Commercial and institutions not connected to sewerage situation						
8	Institutional Effluent Discharges	Existence		Connection Level/Adequacy		
		Yes = 1	%	Low	Average	High
8A	Hospitals (% connected to sewerage)	1			X	
8B	Schools (% connected to sewerage)	1		X		
8C	Camps (% connected to sewerage)	1		X		
8D	Other (specify): (% connected to sewerage)	1		X		
8E	Do institutions discharge treated wastewater into water bodies? Level of discharge?	1				X
8F	Do institutional WWTPs exist in commercial and other institutions? Presence level?	1				X
8G	Is treated wastewater in institutions reused? (% reused)	1		X		
8H	Level of effluent compliance	1			X	
8I	Is there sampling and reporting requirement?	1		X		
8J	Is there enforcement? (Level of enforcement)	1		X		

0

2f. Pollution Load of sewage discharged into water bodies (Quantity and Quality)					
9	**Amount of water Discharged**	**Yes= 1**	**Low**	**Medium**	**High**
		No = 0			

9A	Do you know the total amount of sewage discharged into water bodies?	**1**			
9B	How much in MGD?	**59.764**			
		How Much	Level of discharge		
	Is water being discharged to:		Low	Medium	High
9C	Creeks	**11.97**		**X**	
9D	Rivers,	**38.52**			**X**
9E	Natural or constructed reservoirs	**0**			
9F	Mangroves	**3.89**	**X**		
9G	Coastal waters	**5.38**	**X**		
9H	Outfalls	**1**	**X**		
9I	Underground Injection (**Septic Tanks)**	**115.14**			**X**
10	Quality of discharge	Yes = 1	**Level of Treatment**		
	Is water being discharged to:	No = 0	**Prim**	**Second**	**Tart**
10A	Creeks	**11.97**	**X**	**X**	**X**
10B	Rivers,	**38.52**	**X**	**X**	**X**
10C	Natural or constructed reservoirs	**0**			
10D	Mangroves	**3.89**	**X**	**X**	**X**
10E	Coastal waters	**5.38**		**X**	
10F	Outfalls	**1**	**X**		
10G	Underground	**115.14**	**X**	**X**	

2g. Septage/Biosolids Management					
11	Septage/Biosolids Management		Adequacy of Treatment/Disposal		
		Yes = 1	Low	Medium	High
11A	Does septage receive treatment?	**1**	**X**		
11B	Adequacy of septage disposal?		**X**		
	Where is disposed?				
11C	Treatment plants? Quantity?	**1**		**X**	
11D	Landfills/dumpsites? Quantity?	**1**	**X**		
11E	Land? Quantity?	**1**	**X**		
11F	Water Body? Quantity?	**1**	**X**		
11G	Do biosolids receive treatment?	**1**		**X**	
11H	Adequacy of biosolids disposal?	**1**		**X**	
	Where are disposed of?				
11I	Landfills/dumpsites? Quantity?	**1**	**X**		
11J	Reused? Quantity?	**1**	**X**		
11K	Land? Quantity?	**1**	**X**		
11L	Water Body? Quantity?	**1**	**X**		

11M	Amount of Septage produced (m3/year)	**1**			**X**
11N	Amount of Biosolids produced (m3/year)	**1**		**X**	

2h. Condition of wastewater management infrastructure				
12	Infrastructure Condition	Low	Medium	High
12A	How adequate is your sanitation WWTP infrastructure?		**X**	
12B	How adequate is your sanitation pipe network infrastructure?		**X**	
	Age of Infrastructure (YEARS)	**<10**	**10 - 20**	**>20**
12C	Age of sewerage systems. What percentage of your total sewerage systems are	**20**	**33**	**47**
12D	Age of WWTPs. What percentage of your WWTPs are	**40**	**20**	**40**
	Deterioration of Infrastructure			
12E	Degree of deterioration of sewer lines	**X**		
12F	Degree of deterioration of WWTPs	**X**		
12G	Are technologies used old or obsolete?		**X**	

3. Pollution Problems and Their Cost				
13	**Pollution Problems and Their Cost**	Very Little	Some	A Great Deal
13A	Level of pollution in rivers, lakes, mangroves and coastal areas (increase in thermal pollution in addition to nutrient pollution)		**X**	
13B	Level of environmental deterioration such as toxic algae bloom and destruction of coral reefs			**X**
13C	Level of deterioration and impact in residential areas		**X**	
13D	Level of deterioration and impact in commercial areas		**X**	
13E	Level of deterioration of bathing and recreational areas		**X**	
13F	Level of Social impact due to deterioration of the environment		**X**	
13G	Level of Economic impact due to deterioration of the environment		**X**	
13H	Number of cases of human shellfish and reef fish poisoning during last year.		**X**	
13I	Number of outbreaks (water and food) related to bad sanitation during the last year.			**X**
13J	Number of vector borne diseases (Dengue, malaria, yellow fever, etc.) in the last year.		**X**	
13K	Lost Opportunities due to deterioration of the environment			**X**

4. National Capacity					
14	**Policy framework**		Level of Adequacy		
		Yes = 1 No = 0	Low	Moderate	High
14A	Has the country highlighted domestic wastewater/ sewage as a priority pollutant in national objectives/ sustainable development planning?	**1**			**X**
14B	Are there strategies associated with the development of this sector?	**1**		**X**	
14C	Is there performance indicators associated with the development of this sector?	**1**		**X**	
14D	Are there targets associated with the development of this sector?	**1**		**X**	
14E	Are there national policies in wastewater management, including a National Plan of Action?	**1**		**X**	
14F	Do main cities have a Plan for wastewater management?	**1**		**X**	
14G	Do national policies allow for private sector participation in sewerage services in the absence of adequate public facilities island-wide?	**1**		**X**	
15	**Legislative framework**		Level of Adequacy		
	Which of the following Laws and Regulations exist in the country?	Yes = 1 No = 0	Low	Moderate	High
15A	Environmental Act	**1**		**X**	
15B	Public Health Act	**1**			**X**
15C	Environmental health Act	**1**			**X**
15D	Environmental Impact Assessment	**1**			**X**
15E	Marine protected areas	**1**			**X**
15F	Ambient Water Standards	**1**			**X**
15G	Discharge Limits	**1**			**X**
15H	Marine Pollution Control Act	**1**			**X**
15I	Design Standards for Wastewater Plants	**0**			
15J	Design for On-site Treatment Systems	**1**		**X**	
15K	Regulations on biosolids Management	**0**			
15L	Storm water runoff	**0**			
15M	Irrigation Standards	**1**			**X**
15N	Urban Wastewater management	**0**			
15O	Agricultural pollutants standards	**1**	**X**		
15P	Pesticides environmental management	**1**		**X**	
15Q	Regulation of industry types	**0**			
15R	National Zoning Policy	**1**		**X**	

15S	Building Code	**1**			**X**
15T	Public Information e.g. boil water advisories	**1**			**X**
15U	National Wastewater Management Strategy	**1**		**X**	
15V	Are legislative instruments adequate for wastewater pollution control? Level of Fusion?	**0**			
15W	Do legislative instruments for wastewater pollution overlap? Level of overlap?	**1**		**X**	
15X	Level of enforcement of existing laws and regulations?		**X**		
16	**Institutional framework**		Level of Adequacy		
		Yes = 1	Low	Moderate	High
16A	Is there a designated/ lead national authority for wastewater management?	**0**			
16B	Is there a water resource management authority?	**1**		**X**	
16C	Is there a public service regulatory commission?	**1**	**X**		
16D	Is there an intersectorial approach for wastewater management?	**1**		**X**	
16E	Is there an interdisciplinary approach?	**1**		**X**	
	Level of communication and collaboration between various sectors and agencies:				
16F	Water	**1**		**X**	
16G	Sanitation	**1**		**X**	
16H	Health	**1**		**X**	
16I	Environment	**1**		**X**	
16J	Tourism	**1**	**X**		
16K	Industry	**1**	**X**		
16L	Agriculture and Livestock	**0**			
16M	Social development	**0**			
16N	Planning	**1**	**X**		
16O	Finance	**1**	**X**		
16P	Labour	**0**			
16Q	Food	**0**			
16R	Developers	**1**		**X**	
16S	How adequate are the current institutional arrangements for wastewater management at the community, local and national levels?			**X**	
16T	Is there a Regional Intersectorial/interdisciplinary approach?	**1**		**X**	
16U	Do responsibilities overlap among various agencies with respect to wastewater management? Level of overlap?	**1**		**X**	
16V	Is there a fragmented approach in the institutional framework with respect to wastewater management? Level of fragmentation?	**0**			

16W	Is your Water Authority: 1: a government department, 2: a statutory authority, or 3: a public company?				

5. Surveillance and Enforcement Capacity					
17	Surveillance and Enforcement Capacity		Level of Adequacy		
		Yes = 1	Low	Average	High
17A	Is there a wastewater discharge surveillance programme? How adequate is coverage and frequency of monitoring?	**1**	**X**		
17B	Is there a natural water surveillance programme? How adequate is coverage and frequency of monitoring?	**1**	**X**		
17C	Are there qualified personnel for surveillance? Is the quantity of personnel adequate?	**1**	**X**		
17D	Is enforcement of regulations applied? How adequate is the level of enforcement?	**1**	**X**		
17E	Is there equipment and supplies for wastewater and natural water sampling? Is it sufficient?	**1**	**X**		
17F	Are there standardized methods for wastewater and natural water sampling? Are they adequate?	**1**			**X**
17G	Are there laboratory facilities available? Is their capacity adequate?	**1**	**X**		
17H	Are the Laboratories certified?	**0**			
17I	Can Chemical and biological supplies be acquired locally? Is their availability adequate?	**1**		**X**	
17J	Can laboratory equipment be repaired and maintained locally? Is availability of these services adequate?	**0**			
17K	Are there standard Methods for reporting?	**1**		**X**	
17L	How adequate is the budget for surveillance and enforcement?		**X**		
17M	Are Operational Parameters measured in WWTP? How adequately are they measured?	**1**	**X**		
	Laboratory Parameters and Capability Parameters	Yes = 1 No = 0	# Samples Required	# Samples Analyzed	
17N	Total Suspended Solids	**1**			**Low**
17O	Biochemical Oxygen Demand (BOD_5)	**1**			**Low**
17P	Chemical oxygen Demand	**1**			**Low**
17Q	pH	**1**			**Low**
17R	Fats, Oil and Grease	**1**			**Low**
17S	Total Nitrogen	**1**			**Low**
17T	Total Phosphorous	**1**			**Low**
17U	Faecal Coliform	**1**			**Low**
17V	*E. coli* (freshwater) and	**1**			**Low**

17W	Enterococci (saline water)	**1**			**Low**
17X	Heavy metals	**1**			**Low**
17Y	Pesticides	**1**			**Low**

6. Manpower Capacity					
18	**Availability of Staff for Wastewater Management**				
			Adequacy Level		
		Yes=1 No = 0	Low	Medium	High
18A	Planning Capacity for WWTP	1		**X**	
18B	Managerial capacity	**1**	**X**		
18C	Developing project proposals	**1**	**X**		
18D	Design and Construction capacity	**1**		**X**	
18E	Operation and maintenance Capacity	**1**	**X**		
18F	Surveillance Capacity	**1**		**X**	
18G	Sampling and reporting capacity	**1**		**X**	
19	***Are there national/regional training needs for existing or new staff in the following areas of wastewater management?***				
		Yes=1	Urgency Level		
		No = 0	Low	Medium	High
19A	Planning Capacity for WWTP	**1**		**X**	
19B	Managerial capacity	**1**	**X**		
19C	Developing project proposals	**1**	**X**		
19D	Design and Construction capacity	**1**		**X**	
19E	Operation and maintenance Capacity	**1**	**X**		
19F	Surveillance Capacity	**1**		**X**	
20	***Are the following types of national/regional training available in the area of wastewater management?***				
		Yes=1	Level of Adequacy		
		No = 0	Low	Medium	High
20A	Basic operator certification	**1**		**X**	
20B	Technical	**0**			
20C	BSc	**0**			
20D	Specialization	**0**			
20E	MSc	**0**			
20F	PhD	**0**			
21	***Is national/regional training available for the following areas concerning wastewater?***				
		Yes=1	Level of Adequacy		
		No = 0	Low	Medium	High
21A	Management,	**0**			

21B	Administration,	**0**			
21C	Accounting	**0**			
21D	Engineering	**1**		**X**	
21E	Technician	**1**		**X**	
21F	Operators	**1**		**X**	
21G	Human Resources	**0**			

7. Financing

22	Financial Issues				
22A	What are the Primary Source of Funding for Water and Wastewater Projects				
			Level of Adequacy		
		Yes = 1 No = 0	Low	Medium	High
22B	Is the polluter pays principle applied	**1**		**X**	
	Indicate which of the following sources fund wastewater management.				
22C	User fees	**1**		**X**	
22D	Taxes	**0**			
22E	Grants	**1**		**X**	
22F	Loans	**1**			**X**
22G	Private investments (e.g. Hotels, developers)	**1**		**X**	
22H	Is there a budget in sanitation dedicated to wastewater treatment management for capital improvements? (adequacy of budget)	**1**		**X**	
22I	Is there a budget in sanitation dedicated to wastewater treatment management for operations and maintenance? (adequacy of budget)	**1**	**X**		
22J	Do smaller communities have access to affordable financing for improving wastewater infrastructure? (adequacy of access)	**0**			
22K	Is financing available for investments in wastewater management affordable?	**1**	**X**		
22L	What is the per capita investment into wastewater management projects? < $60 = not very adequate; $60-$120 = Somewhat adequate; > $120 = Very adequate			**X**	
22M	How adequate is spending on the wastewater sector compared with other sectors? (E.g. water, health)		**X**		
22N	Is there a sewer tariff for cost recovery? (adequacy of the tariff)	**1**		**X**	
22O	How adequate are the funds from all available sources for the operations or service delivery cost of the utilities?		**X**		

22P	To what extent are public authorities assisted by other stakeholders (community groups, private development companies etc.) in wastewater management**?**			**X**	
22Q	How adequate are the rates for biosolids disposal?	**1**		**X**	
22R	Are there standard cost estimates in your country for estimating wastewater network, treatment plant capital improvements and reviewing new technologies?	**0**			

8. Best practices and Innovative technological treatment solutions					
23	**Best Practices and Innovative technological Treatment solutions**	Existence Yes=1	Level of Application		
		No = 0	Low	Medium	High
23A	Policy framework	**0**			
23B	Legislative framework	**1**		**X**	
23C	Institutional framework	**0**			
23D	Surveillance capacity	**0**			
23E	Manpower	**0**			
23F	Financing	**0**			
23G	Wastewater treatment technology*	**1**		**X**	
23H	Sanitation projects as Community source of revenue	**0**			
23I	Other (Specify)water conservation	**1**			**X**

9. Current knowledge, attitudes, behaviors and practices				
24	Current knowledge, attitudes, behaviors and practices	Level of Adequacy		
		Low	Medium	High
24A	How is the Level of awareness about wastewater management concepts, issues and technologies in the general public?	**X**		
24B	How is the Level of awareness about wastewater management concepts, issues and technologies in government/Boards of Trustees etc.?	**X**		
24C	How are the Attitudes towards implementing proper wastewater practices?		**X**	
24D	Level of focus of wastewater compared with water	**X**		
24E	How likely is it that decentralized natural treatment systems (e.g. ecological sanitation, constructed wetlands, sand filters) would be accepted as options for domestic wastewater treatment?	**X**		
24F	How likely are people to be aware of the impact of current methods of disposal on health and environment?		**X**	

24G	How likely are people to be aware of the link between sewage, poor sanitation and health problems such as diarrheal diseases, malnutrition, vector diseases, human capital, etc.?	**X**		
24H	How likely is it that senior management officials in government/decision makers have a comprehensive knowledge of wastewater management issues and can link these with other areas of socio-economic development?		**X**	
24I	How likely is it that officials and politicians have a comprehensive knowledge of wastewater management issues and can link these with other areas of socio- economic development?	**X**		
24J	How likely is it that wastewater managers are aware of proper operations and maintenance techniques?	**X**		
24K	How likely is it that wastewater operators are aware of proper operations and maintenance techniques?		**X**	
24L	How likely is it that national, local and sectoral education and public awareness programmes and campaigns exist for wastewater management or for environmental management (which includes wastewater management)?		**X**	

10. Information Collection and Sharing					
25	Information Collection and Sharing	Yes = 1	Level of Adequacy		
		No = 0	Low	Medium	High
25A	Do you have facilities for data collection where analysis, revision and expansion of information are conducted?	**0**			
25B	How is the quality of data analysis?	**1**	**X**		
25C	Are there periodic assessments of short-term and long-term data-collection and research needs for wastewater management?	**1**	**X**		
25D	Is there access to information related to wastewater management issues for decision making to Government Officials?	**1**		**X**	
25E	Is there public access to information related to wastewater management issues for decision making?	**1**		**X**	
25F	Is there an Standardize Data Collection, in order to gather comprehensive and comparable information,	**0**			
25G	Is the terminology standardized?	**1**		**X**	

25H	Existence of national knowledge and information system/ clearing house mechanism of tools and approaches for wastewater management that are effective and appropriate to the expectations and context of the beneficiaries in the Wider Caribbean.	**0**			

11. Presence and Participation Level of Water and Sanitation Organizations					
26	Organizations that provide support for wastewater management	Yes=1	Level of Support		
		No=0	Low	Medium	High
26A	UN	**3**		**X**	
26B	NGOs		**X**		
26C	International Cooperation Agencies	**1**	**X**		
26D	IDB	**1**			**X**
26E	World Bank	**1**	**X**		
26F	Sub regional banks	**0**			
26G	Professional Organizations	**3**		**X**	
26H	Media organization	**0**			
26I	Healthy Schools	**1**		**X**	
26J	Eco clubs	**0**		**X**	
26K	Theatre groups	**0**			
26L	Community organizations	**1**	**X**		

12. Climate change impacts					
27	Climate Change Impact		Level of Impact Expected		
		Yes = 1 No=0	Low	Medium	High
27A	Higher temperatures	**1**		**X**	
27B	Higher Humidity	**1**	**X**		
27C	Rising seas	**1**			**X**
27D	High Water Tables	**1**			**X**
27E	Increased risk of drought	**1**			**X**
27F	Increased risk of fire	**1**		**X**	
27G	Increased risk of flood	**1**			**X**
27H	Stronger storms and increased storm damage	**1**			**X**
27I	Increased Risk of Hurricanes	**1**			**X**
27J	Higher infrastructure flows	**1**			**X**

Mathematical Model Jamaica

2. Overview of Wastewater Treatment Management

2a. Domestic Wastewater Treatment Systems

1	Level Sanitation service	Grade	Weight						
1A	Sewerage System	2	1	21.8	0.060	66.7	4.0	4.0	
1B	Septic Tank (on-site treatment)	2	2	84.0	0.233	66.7	15.5	15.5	
1C	Latrine	2	3	102.9	0.285	66.7	19.0	19.0	
1D	Open defecation	1	-3	-4.5	-0.012	33.3	-0.4	-0.4	
1E	% Population connected to a WWTP	2	2	40.0	0.111	66.7	7.4	7.4	
1F	% Population Primary Treatment	1	1	0.1	0.000	33.3	0.0	0.0	
1G	% Population Secondary Treatment	2	2	37.4	0.104	66.7	6.9	6.9	
1H	% Population Tertiary Treatment	3	3	38.4	0.106	100.0	10.6	10.6	
1I	% Meeting Discharge Standards	2	4	32.0	0.089	66.7	5.9	5.9	
				361.1				69.0	69.0
2	Disposal of treated/untreated wastewater	Grade	Weight						
2A	River	2	-1	-16.8	-0.25	66.7	-16.4	-16.4	
2B	Lake (Mangrove)	1	-1	-1.3	-0.02	33.3	-0.6	-0.6	
2C	Sea	3	-3	-5.4	-0.08	100.0	-7.9	-7.9	
2D	Underground	2	1	42.0	0.61	66.7	40.9	40.9	
2E	Reused	1	3	3.0	0.04	33.3	1.5	1.5	
2F	Other (specify):	0	0	0.0	0.00	No Data	0.0	0.0	17.5
				68.5				17.5	

2b. Wastewater Reuse

3	**Wastewater Reuse**	Grade	Weight						
3A	Treatment and Reuse	1	3	3.0	0.50	33.3	16.7	16.7	
3B	Treatment and No Reuse	3	-1	-1.0	-0.17	100.0	-16.7	-16.7	
3C	No Treatment and Reuse	1	-2	-2.0	-0.33	33.3	-11.1	-11.1	
			0	6				-11.1	11.1

4	**Type of Reuse**	Grade	Weight						
4A	Irrigation Unrestricted Root and Leaf Crops, high and low growing crops	0	1	0.0	0.0	Not Applicable	0.0	0.0	

4B	Irrigation Restricted Labour Intensive and highly mechanized	0	1	0.0	0.0	Not Applicable	0.0	0.0	
4C	Lawns/Parks	1	1	1.0	0.3	33.3	8.3	8.3	
4D	Golf Courses	2	1	1.0	0.3	66.7	16.7	16.7	
4E	Cricket Grounds/Football Fields	0	1	0.0	0.0	Not Applicable	0.0	0.0	
4F	Industrial	3	1	1.0	0.3	100.0	25.0	25.0	
4G	Aquaculture	0	1	0.0	0.0	Not Applicable	0.0	0.0	
4H	Artificial Recharge (Septic Tank effluents)	3	1	1.0	0.3	100.0	25.0	25.0	
4I	Surface reservoirs	0	1	0.0	0.0	Not Applicable	0.0	0.0	
4J	Other (specify)	0	1	0.0	0.0	No Data	0.0	0.0	
				4				75.0	75.0

5	**Quality of Effluent**	Grade	Weight						
5A	Unrestricted Root and Leaf Crops, high and low growing crops	0	1	0.0	0.0	Not Applicable	0.0	0.0	
5B	Restricted Labour Intensive and highly mechanized	0	1	0.0	0.0	Not Applicable	0.0	0.0	
5C	Lawns/Parks	3	1	1.0	0.2	100.0	20.0	20.0	
5D	Cricket Grounds/Football Fields	3	1	1.0	0.2	100.0	20.0	20.0	
5E	Cricket Grounds	0	1	0.0	0.0	Not Applicable	0.0	0.0	
5F	Industrial	0	1	1.0	0.2	No Grading	0.0	0.0	
5G	Aquaculture	0	1	0.0	0.0	Not Applicable	0.0	0.0	
5H	Artificial Recharge	1	2	2.0	0.4	33.3	13.3	13.3	
5I	Surface reservoirs	0	1	0.0	0.0	Not Applicable	0.0	0.0	
5J	Other (specify)	0	1	0.0	0.0	Not Applicable	0.0	0.0	
				5				53.3	53.3

2c. Industrial Effluent Discharges						
6	Type of Industries					
	Presence of priority industry	Grade	Weight			
6A	% of untreated wastewater sent to a WWTP	1.3	1	0.05	42.9	2.1
6B	% untreated wastewater discharged directly into water bodies	1.3	-3	-0.15	42.9	-6.4
6C	% treated before discharged into water bodies	2.7	3	0.15	90.5	13.6
6D	% untreated before discharged into municipal sewers	1.4	-1	-0.05	47.6	-2.4
6E	% of industrial wastewater that is treated together with municipal wastewater	1.7	3	0.15	57.1	8.6
6F	Level of effluent compliance	2.1	3	0.15	71.4	10.7
6G	Are there sampling and reporting requirements.	2.7	3	0.15	90.5	13.6
6H	Is there enforcement? Level of enforcement.	1.0	3	0.15	33.3	5.0
a = Agricultural; b= Chemical; c= Extractive Industries and Mining; d = Food Processing Operations; e = Manufacture of Liquor and Soft Drinks; f = Oil Refineries; g = Pulp and Paper Factories; h = Sugar Factories and Distilleries; i = Intensive Animal Rearing Operations			20.0			44.8
				44.8		

2d. Tourism /Hotel Sector Wastewater Management								
7	Tourism /Hotel Sector Wastewater Management	Grade	Weight					
7A	Are tourism and hotel facilities connected to a central sewerage system? (% connected)	2	2	2	0.07	66.7	4.9	4.9
7B	Is the wastewater in the central sewerage system treated before it is discharged? (% treated)	2	3	3	0.11	66.7	7.4	7.4
7C	Do tourism and hotel facilities not connected to a central sewerage system treat their wastewater before discharge? (% of facilities that treat)	3	3	3	0.11	100.0	11.1	11.1
7D	Is treated wastewater in tourism and hotel facilities reused? (% reused)	2	4	4	0.15	66.7	9.9	9.9
7E	Do tourism and hotel facilities discharge treated wastewater into water bodies? (% that discharge into water bodies)	1	3	3	0.11	33.3	3.7	3.7
7F	Do tourism and hotel facilities discharge untreated wastewater into water bodies? (% that discharge into water bodies)	1	-3	-3	-0.11	33.3	-3.7	-3.7
7G	Level of effluent compliance	3	3	3	0.11	100.0	11.1	11.1
7H	Is there sampling and reporting?	2	3	3	0.11	66.7	7.4	7.4
7I	Is there enforcement? (Level of enforcement)	2	3	3	0.11	66.7	7.4	7.4
				27			59.3	59.3

2e. Commercial and institutions not connected to sewerage situation									
8	Institutional Effluent Discharges	Grade	Weight						
8A	Hospitals (% connected to sewerage)	2	3	3	0.120	66.7	8.0	8.0	
8B	Schools (% connected to sewerage)	1	2	2	0.080	33.3	2.7	2.7	
8C	Camps (% connected to sewerage)	1	1	1	0.040	33.3	1.3	1.3	
8D	Other (specify): (% connected to sewerage)	1	1	1	0.040	33.3	1.3	1.3	
8E	Do institutions discharge treated wastewater into water bodies? Level of discharge?	3	3	3	0.120	100.0	12.0	12.0	
8F	Do institutional WWTPs exist in commercial and other institutions? Presence level?	3	3	3	0.120	100.0	12.0	12.0	
8G	Is treated wastewater in institutions reused? (% reused)	1	3	3	0.120	33.3	4.0	4.0	
8H	Level of effluent compliance	2	3	3	0.120	66.7	8.0	8.0	
8I	Is there sampling and reporting requirement?	1	3	3	0.120	33.3	4.0	4.0	
8J	Is there enforcement? (Level of enforcement)	1	3	3	0.120	33.3	4.0	4.0	
				25				57.3	57.3

2f. Pollution Load of sewage discharged into water bodies (Quantity and Quality)									
9	**Amount of water Discharged**	Grade	Weight						
9A	Do you know the total amount of sewage discharged into water bodies?								
9B	What is the total population of your country?								
	Is water being discharged to:								
9C	Creeks	2	3	35.9	0.084	66.7	5.6	5.6	
9D	Rivers,	3	3	115.6	0.269	100.0	26.9	26.9	
9E	Natural or constructed reservoirs	0	4	0.0	0.000	Not Applicable	0.0	0.0	
9F	Mangroves	1	4	15.6	0.036	33.3	1.2	1.2	
9G	Coastal waters	1	5	26.9	0.063	33.3	2.1	2.1	
9H	Outfalls	1	5	5.0	0.012	33.3	0.4	0.4	
9I	Underground Injection (**Septic Tanks**)	3	2	230.3	0.537	100.0	53.7	53.7	
				429.2				10.2	

10	Quality of discharge								
	Is water being discharged to:	Grade	Weight						
10A	Creeks	2	3	35.91	0.084	66.7	5.6	5.6	
10B	Rivers,	2	3	115.56	0.269	66.7	17.9	17.9	
10C	Natural or constructed reservoirs	0	4	0	0.000	Not Applicable	0.0	0.0	

10D	Mangroves	2	4	15.56	0.036	66.7	2.4	2.4	
10E	Coastal waters	2	5	26.9	0.063	66.7	4.2	4.2	
10F	Outfalls	1	5	5	0.012	33.3	0.4	0.4	
10G	Underground	1.5	2	230.28	0.537	50.0	26.8	26.8	
				429.21	1.0			57.3	57.3

2g. Septage/Biosolids Management									
11	Septage/Biosolids Management								
		Grade	Weight						
11A	Does septage receive treatment?	1	3	3	0.075	33.3	2.5	2.5	
11B	Adequacy of septage disposal?	1	4	4	0.10	33	3.3	3.3	
	Where is disposed?							0.0	
11C	Treatment plants? Quantity?	2	4	4	0.100	66.7	6.7	6.7	
11D	Landfills/dumpsites? Quantity?	1	3	3	0.075	33.3	2.5	2.5	
11E	Land? Quantity?	1	2	2	0.050	33.3	1.7	1.7	
11F	Water Body? Quantity?	1	-3	-3	-0.075	33.3	-2.5	-2.5	
11G	Do biosolids receive treatment?	2	3	3	0.075	66.7	5.0	5.0	
11H	Adequacy of biosolids disposal?	2	4	4	0.10	66.7	6.7	6.7	
	Where are disposed of?							0.0	
11I	Landfills/dumpsites? Quantity?	1	4	4	0.100	33.3	3.3	3.3	
11J	Reused? Quantity?	1	3	3	0.075	33.3	2.5	2.5	
11K	Land? Quantity?	1	2	2	0.050	33.3	1.7	1.7	
11L	Water body? Quantity?	1	-3	-3	-0.075	33.3	-2.5	-2.5	
11M	Amount of Septage produced (m3/year)	3	-1	-1	-0.025	100.0	-2.5	-2.5	
11N	Amount of Biosolids produced (m3/year)	2	-1	-1	-0.025	66.7	-1.7	-1.7	
				40				44.0	44.0

2h. Condition of wastewater management infrastructure									
12	Infrastructure Condition	Grade	Weight						
12A	How adequate is your sanitation WWTP infrastructure?	2	2	2	0.222	66.7	14.8	14.8	
12B	How adequate is your sanitation pipe network infrastructure?	2	2	2	0.222	66.7	14.8	14.8	
	Age of Infrastructure (YEARS)								
12C	Age of sewerage systems. What percentage of your total sewerage systems are	57.7	1	1	0.111	57.7	6.4	6.4	
12D	Age of WWTPs. What percentage of your WWTPs are	66.7	1	1	0.111	66.7	7.4	7.4	
	Deterioration of Infrastructure								
12E	Degree of deterioration of sewer lines	3	1	1	0.111	100.0	11.1	11.1	
12F	Degree of deterioration of WWTPs	3	1	1	0.111	100.0	11.1	11.1	

12G	Are technologies used old or obsolete?	2	1	1	0.111	66.7	7.4	7.4	
				9	1.000			73.1	73.1

3. Pollution Problems and Their Cost									
13	**Pollution Problems and Their Cost**	Grade	Weight						
13A	Level of pollution in rivers, lakes, mangroves and coastal areas (increase in thermal pollution in addition to nutrient pollution)	2	1	1	0.1	66.7	6.1	6.1	
13B	Level of environmental deterioration such as toxic algae bloom and destruction of coral reefs	1	1	1	0.1	33.3	3.0	3.0	
13C	Level of deterioration and impact in residential areas	2	1	1	0.1	66.7	6.1	6.1	
13D	Level of deterioration and impact in commercial areas	2	1	1	0.1	66.7	6.1	6.1	
13E	Level of deterioration of bathing and recreational areas	2	1	1	0.1	66.7	6.1	6.1	
13F	Level of Social impact due to deterioration of the environment	2	1	1	0.1	66.7	6.1	6.1	
13G	Level of Economic impact due to deterioration of the environment	2	1	1	0.1	66.7	6.1	6.1	
13H	Number of cases of human shellfish and reef fish poisoning during last year.	2	1	1	0.1	66.7	6.1	6.1	
13I	Number of outbreaks (water and food) related to bad sanitation during the last year.	1	1	1	0.1	33.3	3.0	3.0	
13J	Number of vector borne diseases (Dengue, malaria, yellow fever, etc.) in the last year.	2	1	1	0.1	66.7	6.1	6.1	
13K	Lost Opportunities due to deterioration of the environment	1	1	1	0.1	33.3	3.0	3.0	
			11	11				57.6	57.6

4. National Capacity									
14	**Policy framework**								
		Grade	Weight						
14A	Has the country highlighted domestic wastewater/ sewage as a priority pollutant in national objectives/ sustainable development planning?	3	1	1	0.14	100.0	14.3	14.3	
14B	Are there strategies associated with the development of this sector?	2	1	1	0.14	66.7	9.5	9.5	
14C	Are there performance indicators associated with the development of this sector?	2	1	1	0.14	66.7	9.5	9.5	
14D	Are there targets associated with the development of this sector?	2	1	1	0.14	66.7	9.5	9.5	
14E	Are there national policies in wastewater management, including a National Plan of Action?	2	1	1	0.14	66.7	9.5	9.5	

14F	Do main cities have a Plan for wastewater management?	2	1	1	0.14	66.7	9.5	9.5	
14G	Do national policies allow for private sector participation in sewerage services in the absence of adequate public facilities island-wide?	2	1	1	0.14	66.7	9.5	9.5	
			7	7	1.0			71.4	
15	**Legislative framework**								
	Which of the following Laws and Regulations exist in the country?	Grade	Weight						
15A	Environmental Act	2	1	1	0.04	66.7	2.8	2.8	
15B	Public Health Act	3	1	1	0.04	100.0	4.2	4.2	
15C	Environmental health Act	3	1	1	0.04	100.0	4.2	4.2	
15D	Environmental Impact Assessment	3	1	1	0.04	100.0	4.2	4.2	
15E	Marine protected areas	3	1	1	0.04	100.0	4.2	4.2	
15F	Ambient Water Standards	3	1	1	0.04	100.0	4.2	4.2	
15G	Discharge Limits	3	1	1	0.04	100.0	4.2	4.2	
15H	Marine Pollution Control Act	3	1	1	0.04	100.0	4.2	4.2	
15I	Design Standards for Wastewater Plants	0	1	0	0.00	Absent	0.0	0.0	
15J	Design for On-site Treatment Systems	2	1	1	0.04	66.7	2.8	2.8	
15K	Regulations on biosolids Management	0	1	0	0.00	Absent	0.0	0.0	
15L	Storm water runoff	0	1	0	0.00	Absent	0.0	0.0	
15M	Irrigation Standards	3	1	1	0.04	100.0	4.2	4.2	
15N	Urban Wastewater management	0	1	0	0.00	Absent	0.0	0.0	
15O	Agricultural pollutants standards	1	1	1	0.04	33.3	1.4	1.4	
15P	Pesticides environmental management	2	1	1	0.04	66.7	2.8	2.8	
15Q	Regulation of industry types	0	1	0	0.00	Absent	0.0	0.0	
15R	National Zoning Policy	2	1	1	0.04	66.7	2.8	2.8	
15S	Building Code	3	1	1	0.04	100.0	4.2	4.2	
15T	Public Information e.g. boil water advisories	3	1	1	0.04	100.0	4.2	4.2	
15U	National Wastewater Management Strategy	2	1	1	0.04	66.7	2.8	2.8	
15V	Are legislative instruments adequate for wastewater pollution control?	0	1	0	0.00	Absent	0.0	0.0	
15W	Do legislative instruments for wastewater pollution overlap? Level of overlap?	2	-1	-1	-0.04	66.7	-2.8	-2.8	
15X	Level of enforcement of existing laws and regulations?	1	1	1	0.04	33	1.4	1.4	
		44	24	16	0.67			55.6	
16	**Institutional framework**	Grade	Weight						
16A	Is there a designated/ lead national authority for wastewater management?	0	1	0	0.000	Absent	0.0	0.0	
16B	Is there a water resource management authority?	2	1	1	0.050	66.7	3.3	3.3	

16C	Is there a public service regulatory commission?	1	1	1	0.050	33.3	1.7	1.7	
16D	Is there an intersectorial approach for wastewater management?	2	1	1	0.050	66.7	3.3	3.3	
16E	Is there an interdisciplinary approach?	2	1	1	0.050	66.7	3.3	3.3	
	Level of communication and collaboration between various sectors and agencies:								
16F	Water	2	1	1	0.050	66.7	3.3	3.3	
16G	Sanitation	2	1	1	0.050	66.7	3.3	3.3	
16H	Health	2	1	1	0.050	66.7	3.3	3.3	
16I	Environment	2	1	1	0.050	66.7	3.3	3.3	
16J	Tourism	1	1	1	0.050	33.3	1.7	1.7	
16K	Industry	1	1	1	0.050	33.3	1.7	1.7	
16L	Agriculture and Livestock	0	1	0	0.000	Absent	0.0	0.0	
16M	Social development	0	1	0	0.000	Absent	0.0	0.0	
16N	Planning	1	1	1	0.050	33.3	1.7	1.7	
16O	Finance	1	1	1	0.050	33.3	1.7	1.7	
16P	Labour	0	1	0	0.000	Absent	0.0	0.0	
16Q	Food	0	1	0	0.000	Absent	0.0	0.0	
16R	Developers	2	1	1	0.050	66.7	3.3	3.3	
16S	How adequate are the current institutional arrangements for wastewater management at the community, local and national levels?	2	1	0	0.000	No Data	0.0	0.0	
16T	Is there a Regional Intersectorial/interdisciplinary approach?	2	1	1	0.050	66.7	3.3	3.3	
16U	Do responsibilities overlap among various agencies with respect to wastewater management? Level of overlap?	2	-1	-1	-0.050	66.7	-3.3	-3.3	
16V	Is there a fragmented approach in the institutional framework with respect to wastewater management? Level of fragmentation?	0	-1	0	0.000	Absent	0.0	0.0	
16W	Is your Water Authority: 1: a government department, 2: a statutory authority, or 3: a public company?	0		0	0.000	Null	0.0	0.0	
		27	20		0.650			35.0	54.0

5. Surveillance and Enforcement Capacity									
17	Surveillance and Enforcement Capacity		Grade	Weight					
17A	Is there a wastewater discharge surveillance programme? How adequate is coverage and frequency of monitoring?		1	1	1	0.040	33.3	1.3	

17B	Is there a natural water surveillance programme? How adequate is coverage and frequency of monitoring?		1	1	1	0.040	33.3	1.3	
17C	Are there qualified personnel for surveillance? Is the quantity of personnel adequate?		1	1	1	0.040	33.3	1.3	
17D	Is enforcement of regulations applied? How adequate is the level of enforcement?		1	1	1	0.040	33.3	1.3	
17E	Is there equipment and supplies for wastewater and natural water sampling? Is it sufficient?		1	1	1	0.040	33.3	1.3	
17F	Are there standardized methods for wastewater and natural water sampling? Are they adequate?		3	1	1	0.040	100.0	4.0	
17G	Are there laboratory facilities available? Is their capacity adequate?		1	1	1	0.040	33.3	1.3	
17H	Are the Laboratories certified?		0	1	0	0.000	Absent	0.0	
17I	Can Chemical and biological supplies be acquired locally? Is their availability adequate?		2	1	1	0.040	66.7	2.7	
17J	Can laboratory equipment be repaired and maintained locally? Is availability of these services adequate?		0	1	0	0.000	Absent	0.0	
17K	Are there standard Methods for reporting?		2	1	1	0.040	66.7	2.7	
17L	How adequate is the budget for surveillance and enforcement?		1	1	1	0.040	33	1.3	
17M	Are Operational Parameters measured in WWTP? How adequately are they measured?		1	1	1	0.040	33.3	1.3	
	Laboratory Parameters and Capability Parameters	% Analyzed	Grade						
17N	Total Suspended Solids	1.00		1	1	0.040	33.3	1.333	
17O	Biochemical Oxygen Demand (BOD_5)	1.00		1	1	0.040	33.3	1.333	
17P	Chemical oxygen Demand	1.00		1	1	0.040	33.3	1.333	
17Q	pH	1.00		1	1	0.040	33.3	1.333	
17R	Fats, Oil and Grease	1.00		1	1	0.040	33.3	1.333	
17S	Total Nitrogen	1.00		1	1	0.040	33.3	1.333	
17T	Total Phosphorous	1.00		1	1	0.040	33.3	1.333	
17U	Faecal Coliform	1.00		1	1	0.040	33.3	1.333	
17V	*E. coli* (freshwater) and	1.00		1	1	0.040	33.3	1.333	
17W	Enterococci (saline water)	1.00		1	1	0.040	33.3	1.333	
17X	Heavy metals	1.00		1	1	0.040	33.3	1.333	
17Y	Pesticides			1	1	0.040	33.3	1.33	

		1.00						3	
				25	23	0.920		36.0	

6. Manpower Capacity									
18	**Availability of Staff for Wastewater Management**	Grade	Weight						
18A	Planning Capacity for WWTP	2	1	1	0.143	66.7	9.5		
18B	Managerial capacity	1	1	1	0.143	33.3	4.8		
18C	Developing project proposals	1	1	1	0.143	33.3	4.8		
18D	Design and Construction capacity	2	1	1	0.143	66.7	9.5		
18E	Operation and maintenance Capacity	1	1	1	0.143	33.3	4.8		
18F	Surveillance Capacity	2	1	1	0.143	66.7	9.5		
18G	Sampling and reporting capacity	2	1	1	0.143	66.7	9.5		
		9	7	7	1.0		52.4		
19	***Are there national/regional training needs for existing or new staff in the following areas of wastewater management?***								
		Grade	Weight						
19A	Planning Capacity for WWTP	2	1	1	0.167	66.7	11.1		
19B	Managerial capacity	3	1	1	0.167	100.0	16.7		
19C	Developing project proposals	3	1	1	0.167	100.0	16.7		
19D	Design and Construction capacity	2	1	1	0.167	66.7	11.1		
19E	Operation and maintenance Capacity	3	1	1	0.167	100.0	16.7		
19F	Surveillance Capacity	2	1	1	0.167	66.7	11.1		
		15	6	6			16.7		
20	***Are the following types of national/regional training available in the area of wastewater management?***								
		Grade	Weight						
20A	Basic operator certification	2	1	1	0.167	66.7	11.1		
20B	Technical	0	1	0	0.000	Absent	0.0		
20C	BSc	0	1	0	0.000	Absent	0.0		
20D	Specialization	0	1	0	0.000	Absent	0.0		
20E	MSc	0	1	0	0.000	Absent	0.0		
20F	PhD	0	1	0	0.000	Absent	0.0		
		2	6				11.1		
21	***Is national/regional training available for the following areas concerning wastewater?***								
		Grade	Weight						
21A	Management,	0	1	0	0.000	Absent	0.0		
21B	Administration,	0	1	0	0.000	Absent	0.0		
21C	Accounting	0	1	0	0.000	Absent	0.0		
21D	Engineering	2	1	1	0.167	66.7	11.1		
21E	Technician	2	1	1	0.167	66.7	11.1		

21F	Operators	2	1	1	0.167	66.7	11.1		
21G	Human Resources	0	1	0	0.000	Absent	0.0		28.4
		6	6				33.3		
7. Financing									
22	Financial Issues								
22A	What are the Primary Source of Funding for Water and Wastewater Projects								
		Grade	Weight						
22B	Is the polluter pays principle applied	2	1	1	0.059	66.7	3.9		
	Indicate which of the following sources fund wastewater management.								
22C	User fees	2	1	1	0.059	66.7	3.9		
22D	Taxes	0	1	0	0.000	Absent	0.0		
22E	Grants	2	1	1	0.059	66.7	3.9		
22F	Loans	3	1	1	0.059	100.0	5.9		
22G	Private investments (e.g. Hotels, developers)	2	1	1	0.059	66.7	3.9		
22H	Is there a budget in sanitation dedicated to wastewater treatment management for capital improvements? (adequacy of budget)	2	1	1	0.059	66.7	3.9		
22I	Is there a budget in sanitation dedicated to wastewater treatment management for operations and maintenance? (adequacy of budget)	1	1	1	0.059	33.3	2.0		
22J	Do smaller communities have access to affordable financing for improving wastewater infrastructure? (adequacy of access)	0	1	0	0.000	Absent	0.0		
22K	Is financing available for investments in wastewater management affordable?	1	1	1	0.059	33.3	2.0		
22L	What is the per capita investment into wastewater management projects? < $60 = not very adequate; $60-$120 = Somewhat adequate; > $120 = Very adequate	2	1	1	0.059	67	3.9		
22M	How adequate is spending on the wastewater sector compared with other sectors? (E.g. water, health)	1	1	1	0.059	33	2.0		
22N	Is there a sewer tariff for cost recovery? (adequacy of the tariff)	2	1	1	0.059	66.7	3.9		
22O	How adequate are the funds from all available sources for the operations or service delivery cost of the utilities?	1	1	1	0.059	33	2.0		
22P	To what extent are public authorities assisted by other stakeholders (community groups, private development companies etc.) in wastewater management**?**	2	1	1	0.059	67	3.9		
22Q	How adequate are the rates for biosolids disposal?	2	1	1	0.059	67	3.9		

22R	Are there standard cost estimates in your country for estimating wastewater network, treatment plant capital improvements and reviewing new technologies?	0	1	0	0.000	Absent	0.0		
		25	17		0.8		49.0		49.0

8. Best practices and Innovative technological treatment solutions									
23	**Best Practices and Innovative technological Treatment solutions**	Grade	Weight						
23A	Policy framework	0	1	0	0.00	Absent	0.0		
23B	Legislative framework	2	1	1	0.11	66.7	7.4		
23C	Institutional framework	0	1	0	0.00	Absent	0.0		
23D	Surveillance capacity	0	1	0	0.00	Absent	0.0		
23E	Manpower	0	1	0	0.00	Absent	0.0		
23F	Financing	0	1	0	0.00	Absent	0.0		
23G	Wastewater treatment technology*	2	1	1	0.11	66.7	7.4		
23H	Sanitation projects as Community source of revenue	0	1	0	0.00	Absent	0.0		
23I	Other (Specify)water conservation	3	1	1	0.11	100.0	11.1		
		7	9				25.9		25.9

9. Current knowledge, attitudes, behaviors and practices									
24	Current knowledge, attitudes, behaviors and practices	Grade	Weight						
24A	How is the Level of awareness about wastewater management concepts, issues and technologies in the general public?	1	1	1	0.083	33	2.8		
24B	How is the Level of awareness about wastewater management concepts, issues and technologies in government/Boards of Trustees etc.?	1	1	1	0.083	33	2.8		
24C	How are the Attitudes towards implementing proper wastewater practices?	2	1	1	0.083	67	5.6		
24D	Level of focus of wastewater compared with water	1	1	1	0.083	33	2.8		
24E	How likely is it that decentralized natural treatment systems (e.g. ecological sanitation, constructed wetlands, sand filters) would be accepted as options for domestic wastewater treatment?	1	1	1	0.083	33	2.8		
24F	How likely are people to be aware of the impact of current methods of disposal on health and environment?	2	1	1	0.083	67	5.6		

24G	How likely are people to be aware of the link between sewage, poor sanitation and health problems such as diarrheal diseases, malnutrition, vector diseases, human capital, etc.?	1	1	1	0.083	33	2.8		
24H	How likely is it that senior management official in government/decision makers have a comprehensive knowledge of wastewater management issues and can link these with other areas of socio-economic development?	2	1	1	0.083	67	5.6		
24I	How likely is it that officials and politicians have a comprehensive knowledge of wastewater management issues and can link these with other areas of socio- economic development?	1	1	1	0.083	33	2.8		
24J	How likely is it that wastewater managers are aware of proper operations and maintenance techniques?	1	1	1	0.083	33	2.8		
24K	How likely is it that wastewater operators are aware of proper operations and maintenance techniques?	2	1	1	0.083	67	5.6		
24L	How likely it is that national, local and sectoral education and public awareness programmes and campaigns exist for wastewater management or for environmental management (which includes wastewater management)?	2	1	1	0.083	67	5.6		
		16	12	12	1.0		47.2		47.2

10. Information Collection and Sharing									
25	Information Collection and Sharing	Grade	Weight						
25A	Do you have facilities for data collection where analysis, revision and expansion of information are conducted?	0	1	0	0.000	Absent	0.0		
25B	How is the quality of data analysis?	1	1	1	0.125	33.3	4.2		
25C	Are there periodic assessments of short-term and long-term data-collection and research needs for wastewater management?	1	1	1	0.125	33.3	4.2		
25D	Is there access to information related to wastewater management issues for decision making to Government Officials?	2	1	1	0.125	66.7	8.3		
25E	Is there public access to information related to wastewater management issues for decision making?	2	1	1	0.125	66.7	8.3		
25F	Is there an Standardize Data Collection, in order to gather comprehensive and comparable information,	0	1	0	0.000	Absent	0.0		
25G	Is the terminology standardized?	2	1	1	0.125	66.7	8.3		

25H	Existence of national knowledge and information system/ clearing house mechanism of tools and approaches for wastewater management that are effective and appropriate to the expectations and context of the beneficiaries in the Wider Caribbean.	0	1	#VALUE!	#VALUE!	No Grading	0.0		
		8	8				33.3		33.3

11. Presence and Participation Level of Water and Sanitation Organizations									
26	Organizations that provide support for wastewater management	Grade	Weight						
26A	UN	2	1	3	0.3	66.7	16.7		
26B	NGOs	1	1	0	0.0	No Data	0.0		
26C	International Cooperation Agencies	1	1	1	0.1	33.3	2.8		
26D	IDB	3	1	1	0.1	100.0	8.3		
26E	World Bank	1	1	1	0.1	33.3	2.8		
26F	Sub regional banks	0	1	0	0.0	Absent	0.0		
26G	Professional Organizations	2	1	3	0.3	66.7	16.7		
26H	Media organization	0	1	0	0.0	Absent	0.0		
26I	Healthy Schools	2	1	1	0.1	66.7	5.6		
26J	Eco clubs	2	1	0	0.0	Absent	0.0		
26K	Theatre groups	0	1	0	0.0	Absent	0.0		
26L	Community organizations	1	1	1	0.1	33.3	2.8		
		15	12	11	0.9		55.6		55.6

12. Climate change impacts									
27	Climate Change Impact	Grade	Weight						
27A	Higher temperatures	2	1	1	0.1	66.7	6.7		
27B	Higher Humidity	1	1	1	0.1	33.3	3.3		
27C	Rising seas	3	1	1	0.1	100.0	10.0		
27D	High Water Tables	3	1	1	0.1	100.0	10.0		
27E	Increased risk of drought	3	1	1	0.1	100.0	10.0		
27F	Increased risk of fire	2	1	1	0.1	66.7	6.7		
27G	Increased risk of flood	3	1	1	0.1	100.0	10.0		
27H	Stronger storms and increased storm damage	3	1	1	0.1	100.0	10.0		
27I	Increased Risk of Hurricanes	3	1	1	0.1	100.0	10.0		
27J	Higher infrastructure flows	3	1	1	0.1	100.0	10.0		13.3

ANNEX 4 SUMMARY OF GRADING OF ANSWERS (DNA OF WASTEWATER MANAGEMENT, JAMAICA)

1A	Sewerage System	66.7	10C	Natural or constructed reservoirs	Not Applicable
1B	Septic Tank (on-site treatment)	66.7	10D	Mangroves	66.7
1C	Latrine	66.7	10E	Coastal waters	66.7
1D	Other (specify):	-33.3	10F	Outfalls	33.3
1E	% Population connected to a WWTP	66.7	10G	Underground	50.0
1F	% Population Primary Treatment	33.3	11A	Does septage receive treatment?	33.3
1G	% Population Secondary Treatment	66.7	11B	Adequacy of septage disposal?	33.3
1H	% Population Tertiary Treatment	100.0	11C	Treatment plants? Quantity?	66.7
1I	% Meeting Discharge Standards	66.7	11D	Landfills/dumpsites? Quantity?	33.3
2A	River	66.7	11E	Land? Quantity?	33.3
2B	Lake	33.3	11F	Water Body? Quantity?	-33.3
2C	Sea	100.0	11G	Do biosolids receive treatment?	66.7
2D	Underground	66.7	11H	Adequacy of biosolids disposal?	66.7
2E	Reused	33.3	11I	Landfills/dumpsites? Quantity?	33.3
3A	Treatment and Reuse	33.3	11J	Reused? Quantity?	33.3
3B	Treatment and No Reuse	-100.0	11K	Land? Quantity?	33.3
3C	No Treatment and Reuse	-33.3	11L	Water Bodies? Quantity?	-33.3
4A	Irrigation Unrestricted Root and Leaf Crops	Not Applicable	11M	Amount of Septage produced (m3/year)	-100.0
4B	Irrig Restric Labour Intensive and highly mechanized	Not Applicable	11N	Amount of Biosolids produced (m3/year)	-66.7
4C	Lawns/Parks	33.3	12A	How adequate is your sanitation WWTP infrastructure?	66.7
4D	Golf Courses	66.7	12B	Adequate sewerage infrastructure	66.7
4E	Cricket Grounds/Football Fields	Not Applicable	12C	Age of sewerage systems	57.7
4F	Industrial	100.0	12D	Age of WWTPs	66.7
4G	Aquaculture	Not Applicable	12E	Degree of deterioration of sewer lines	100.0
4H	Artificial Recharge (Septic Tank effluents)	100.0	12F	Degree of deterioration of WWTPs	100.0
4I	Surface reservoirs	Not Applicable	12G	Are technologies used old or obsolete?	66.7
4J	Other (specify)	No Data	13A	Level of pollution in rivers, lakes, etc	66.7
5A	Unrestricted Root and Leaf Crops	Not Applicable	13B	Level of environmental deterioration	33.3
5B	Restricted Labour Intensive and highly mechanized	Not Applicable	13C	Level of deterioration and impact in residential areas	66.7
5C	Lawns/Parks	100.0	13D	Level of deterioration and impact in commercial areas	66.7
5D	Cricket Grounds/Football Fields	100.0	13E	Level of deterioration of bathing and recreational areas	66.7
5E	Cricket Grounds	Not Applicable	13F	Level of Social impact	66.7
5F	Industrial	No Grading	13G	Level of Economic impact due to deterioration env	66.7
5G	Aquaculture	Not Applicable	13H	# cases human shellfish and reef fish poisoning	66.7
5H	Artificial Recharge	33.3	13I	# outbreaks (water and food) related to bad sanitation	33.3
5I	Surface reservoirs	Not Applicable	13J	# vector borne diseases (Dengue, malaria, etc.)	66.7
5J	Other (specify)	Not Applicable	13K	Lost Opportunities due to deterioration of the envir	33.3
6A	% of untreated wastewater sent to a WWTP	42.9	14A	WW highlighted priority pollutant national objectives	100.0
6B	% untreated WW discharged directly into water bodies	-42.9	14B	Existence strategies associated w dev of this sector	66.7
6C	% treated WW before discharged into water bodies	90.5	14C	Existence performance indicators	66.7
6D	% untreated before discharged into municipal sewers	-47.6	14D	Existence targets associated with the dev sector	66.7
6E	% of industrial WW treated with municipal wastewater	57.1	14E	Existence national policies in WW mngmnt/Nat Plan	66.7
6F	Level of effluent compliance	71.4	14F	Existence WW mngmnt Plan main cities	66.7
6G	Are there sampling and reporting requirements.	90.5	14G	Private sector participation National Policies	66.7
6H	Is there enforcement? Level of enforcement.	33.3	15A	Environmental Act	66.7
7A	Hotel connection to central sewerage	66.7	15B	Public Health Act	100.0
7B	Treatment of WW central sewerage before discharge	66.7	15C	Environmental health Act	100.0
7C	Treatment of Hotel WW not connected to sewerage	100.0	15D	Environmental Impact Assessment	100.0
7D	Reuse treated wastewater in tourism and hotel	66.7	15E	Marine protected areas	100
7E	Hotel treated wastewater discharge into water bodies	33.3	15F	Ambient Water Standards	100
7F	Hotel raw wastewater discharge into water bodies	-33.3	15G	Discharge Limits	100
7G	Level of effluent compliance	100.0	15H	Marine Pollution Control Act	100
7H	Is there sampling and reporting?	66.7	15I	Design Standards for Wastewater Plants	Absent
7I	Is there enforcement? (Level of enforcement)	66.7	15J	Design for On-site Treatment Systems	67
8A	Hospitals (% connected to sewerage)	66.7	15K	Regulations on biosolids Management	Absent
8B	Schools (% connected to sewerage)	33.3	15L	Storm water runoff	Absent
8C	Camps (% connected to sewerage)	33.3	15M	Irrigation Standards	100
8D	Other (specify): (% connected to sewerage)	33.3	15N	Urban Wastewater management	Absent
8E	Institutions treated wastewater discharge into water bodies	100.0	15O	Agricultural pollutants stnadrds	33.3
8F	Existence institutional WWTPs commercial and other institutions	100.0	15P	Pesticides environmental management	66.7
8G	Is treated wastewater in institutions reused? (% reused)	33.3	15Q	Regulation of industry types	Absent
8H	Level of effluent compliance	66.7	15R	National Zoning Policy	67
8I	Is there sampling and reporting requirement?	33.3	15S	Building Code	100
8J	Is there enforcement? (Level of enforcement)	33.3	15T	Public Information e.g. boil water advisories	100.0
9C	Creeks	-66.7	15U	National Wastewater Management Strategy	66.7
9D	Rivers,	-100.0	15V	Legislative instruments wastewater pollution control	Absent
9E	Natural or constructed reservoirs	Not Applicable	15W	Overlapping legislative instruments for WW	-66.7
9F	Mangroves	-33.3	15X	Level enforcement of existing laws and reg?	33.3
9G	Coastal waters	-33.3	16A	Existence lead national authority for WW	Absent
9H	Outfalls	-33.3	16B	Is there a water resource mngment authority?	66.7
9I	Underground Injection (Septic Tanks)	100.0	16C	Is there pub service regulatory commission?	33.3
10A	Creeks	66.7			
10B	Rivers,	66.7			

Not Applicable	16D	Intersectorial approach for WW management	66.7	22B	Is the polluter pays principle applied	66.7
66.7	16E	Is there an interdisciplinary approach?	66.7	22C	User fees	66.7
66.7	16F	Water	66.7	22D	Taxes	Absent
33.3	16G	Sanitation	66.7	22E	Grants	66.7
50.0	16H	Health	66.7	22F	Loans	100.0
33.3	16I	Environment	66.7	22G	Private investments (e.g. Hotels, developers)	66.7
33.3	16J	Tourism	33.3	22H	Budget in sanitation for capital improvements	66.7
66.7	16K	Industry	33.3	22I	Budget in sanitation for WW treatment O&M	33.3
33.3	16L	Agriculture and Livestock	Absent	22J	Access to financing smaller communities	Absent
33.3	16M	Social development	Absent	22K	Affordability of financing available WW	33.3
-33.3	16N	Planning	33.3	22L	Per capita investment wastewater projects	66.7
66.7	16O	Finance	33.3	22M	Spending compared with other sectors	33.3
66.7	16P	Labour	Absent	22N	Adequacy sewer tariff for cost recovery	66.7
33.3	16Q	Food	Absent	22O	Funds for the operations or service delivery	33.3
33.3	16R	Developers	66.7	22P	Extent of assistance by stakeholders	66.7
33.3	16S	Institutional arrangements for WW mngmnt	No Data	22Q	How are the rates for biosolids disposal?	66.7
-33.3	16T	Regional Intersecto/interdisciplina approach	66.7	22R	Existence cost estimates for WW technol	Absent
-100.0	16U	Responsibil overlap among various agencies	-66.7	23A	Policy framework	Absent
-66.7	16V	Level fragmented approach for WW mngmnt	Absent	23B	Legislative framework	66.7
66.7	16W	Water Authority a government department	Null	23C	Institutional framework	Absent
66.7	17A	Wastewater discharge surveillance programme	33.3	23D	Surveillance capacity	Absent
57.7	17B	Natural water surveillance programme	33.3	23E	Manpower	Absent
66.7	17C	Qualified personnel for surveillance	33.3	23F	Financing	Absent
100.0	17D	Application enforcement regulations	33.3	23G	Wastewater treatment technology*	66.7
100.0	17E	Equipment and supplies for surveillance	33.3	23H	Sanitation proj as Community source revenue	Absent
66.7	17F	Standardized methods	100.0	23I	Other (Specify)water conservation	100.0
66.7	17G	Availability laboratory facilities	33.3	24A	Level awareness wastewater general public	33.3
33.3	17H	Are the Laboratories certified?	Absent	24B	Level awareness WW government/Boards	33.3
66.7	17I	Availability Chemical and biological supplies locally	66.7	24C	Attitudes towards proper WW practices	66.7
66.7	17J	Llaboratory equipment repaired and maintained locally	Absent	24D	Level of focus of WW compared with water	33.3
66.7	17K	Are there standard Methods for reporting?	66.7	24E	Likely decentrlzd nat treat syst be accepted	33.3
66.7	17L	Adequacy budget for surveillance and enforcement?	33.3	24F	Awareness impact disp on health and env	66.7
66.7	17M	Are Operational Parameters measured in WWTP	33.3	24G	Awareness link between sewage and health	33.3
66.7	17N	Total Suspended Solids	33.3	24H	Sr Officials Knowledge link WW mngmnt & SE Dev.	66.7
33.3	17O	Biochemical Oxygen Demand (BOD_5)	33.3	24I	Politicians knowledge link WW mngmnt & SE Dev.	33.3
66.7	17P	Chemical oxygen Demand	33.3	24J	Awareness WW managers proper O&M	33.3
33.3	17Q	pH	33.3	24I	Awareness WW operators proper O&M	66.7
100.0	17R	Fats, Oil and Grease	33.3	24K	Existence educ and public awareness programmes	66.7
66.7	17S	Total Nitrogen	33.3	25A	Facilities data collection and analysis	Absent
66.7	17T	Total Phosporous	33.3	25B	How is the quality of data analysis?	33.3
66.7	17U	Faecal Coliform	33.3	25C	Existence periodic assess of data- collection and res	33.3
66.7	17V	*E. coli* (freshwater) and	33.3	25D	Access to information to Government Officials	66.7
66.7	17W	Enterococci (saline water)	33.3	25E	Public access to information	66.7
66.7	17X	Heavy metals	33.3	25F	Standardize Data Collection	Absent
66.7	17Y	Pesticides	33.3	25G	Standardized terminology	66.7
100.0	18A	Planning Capacity for WWTP	66.7	25H	Existence clearing house mechanism	Absent
100.0	18B	Managerial capacity	33.3	26A	UN	66.7
100.0	18C	Developing project proposals	33.3	26B	NGOs	33.3
100	18D	Design and Construction capacity	66.7	26C	International Cooperation Agencies	33.3
100	18E	Operation and maintenance Capacity	33.3	26D	IDB	***100.0***
100	18F	Surveillance Capacity	66.7	26E	World Bank	33.3
100	18G	Sampling and reporting capacity	66.7	26F	Sub regional banks	Absent
Absent	19A	Planning Capacity for WWTP	66.7	26G	Professional Organizations	66.7
67	19B	Managerial capacity	100.0	26H	Media organization	Absent
Absent	19C	Developing project proposals	100.0	26I	Healthy Schools	66.7
Absent	19D	Design and Construction capacity	66.7	26J	Eco clubs	Absent
100	19E	Operation and maintenance Capacity	100.0	26K	Theatre groups	Absent
Absent	19F	Surveillance Capacity	66.7	26L	Community organizations	33.3
33.3	20A	Basic operator certification	66.7	27A	Higher temperatures	33.3
66.7	20B	Technical	Absent	27B	Higher Humidity	66.7
Absent	20C	BSc	Absent	27C	Rising seas	0.0
67	20D	Specialization	Absent	27D	High Water Tables	0.0
100	20E	MSc	Absent	27E	Increased risk of drought	0.0
100.0	20F	PhD	Absent	27F	Increased risk of fire	33.3
66.7	21A	Management,	Absent	27G	Increased risk of flood	0.0
Absent	21B	Administration,	Absent	27H	Stronger storms and increased storm damage	0.0
-66.7	21C	Accounting	Absent	27I	Increased Risk of Hurricanes	0.0
33.3	21D	Engineering	66.7	27J	Higher infrastructure flows	0.0
Absent	21E	Technician	66.7			
66.7	21F	Operators	66.7			
33.3	21G	Human Resources	Absent			

Summary of Answers		
Type of Answer	**Number**	**%**
Responded	**228**	80.3
Absent	**38**	13.4
No Data	**3**	1.1
Not Applicable	**12**	4.2
No Grading	**2**	0.7
Null	**1**	0.4
Total Questions	**284**	

ANNEX 5 EXPLANATION OF SIGNIFICANCE VALUES USED IN MATHEMATICAL MODEL

The following tables present an explanation of each one of the significance values that were used in the mathematical model to assess each feature.

	1. Sanitation Coverage		
	Level Sanitation service	Value	Description
1A	Sewerage	1	The values assigned to the level of adequacy are related to the potential of wastewater reaching a surface water body. Open defecation is considered the worst form of sanitation and was given a value of -3, sewerage a value of 1, septic tank effluents a value of 2, because it is discharged underground and soil serves as treatment process. Latrines were given a value of 3, because the liquid waste is minimal.
1B	Septic Tank (on-site treatment)	2	
1C	Latrine	3	
1D	None	-3	
1E	% Population connected to a WWTP	2	1E is rewarded with a 2
1F	% Population Primary Treatment	1	For 1F,1G and 1H, the values assigned represent the level of adequacy of treatment, being tertiary treatment with the highest level of significance
1G	% Population Secondary Treatment	2	
1H	% Population Tertiary Treatment	3	
1I	% Meeting Discharge Standards	4	1I is rewarded with a 4 value
	2. Overview of Wastewater Treatment Management		
2	**Disposal of treated/untreated wastewater**	Value	Description
2A	River treated	-1	Values assigned represent the level of impact to water bodies and to the LBS Protocol. Discharging to the sea has the highest negative value (-3), and reuse has the highest positive value (3).
2B	River untreated	-1	
2C	Lake treated	2	
2D	Lake untreated	-1	
2E	Sea treated	3	
2F	Sea untreated	-3	
2G	Underground treated	3	
2H	Reused treated	3	
2I	Underground untreated	-1	
2J	Other (specify):	0	
3	**Wastewater Reuse**	Value	Description
3A	Treatment and Reuse	3	Values assigned represent the degree of suitability for protecting the environment and health. Reuse in occasions can be seen as a tertiary level or quaternary treatment.
3B	Treatment and No Reuse	-1	
3C	No Treatment and Reuse	-2	

4	**Type of Reuse**	Value	Description
4A	Irrigation Unrestricted Root and Leaf Crops, high and low growing crops	1	A significance value of 1 is assigned to all. However you can assign a different value. This will automatically be updated in the model.
4B	Irrigation Restricted Labour Intensive and highly mechanized	1	
4C	Lawns/Parks	1	
4D	Golf Courses	1	
4E	Cricket Grounds	1	
4F	Industrial	1	
4G	Aquaculture	1	
4H	Artificial Recharge (Septic Tank effluents)	1	
4I	Surface reservoirs	1	
5	**Quality of Effluent**	Value	Description
5A	Unrestricted Root and Leaf Crops, high and low growing crops	1	A significance value of 1 is assigned to all. However you can assign a different value. This will automatically be updated in the model.
5B	Restricted Labour Intensive and highly mechanized	1	
5C	Lawns/Parks	1	
5D	Golf Courses	1	
5E	Cricket Grounds	1	
5F	Industrial	1	
5G	Aquaculture	1	
5H	Artificial Recharge	2	
5I	Surface reservoirs	1	
6	Industrial Effluent Discharges	Value	Description
6A	Agricultural Non-Point Sources	-1	A significance value of 1 is assigned to all. However you can assign a different value. This will automatically be updated in the model.
6B	Chemical Industries	-1	
6C	Extractive Industries and Mining	-1	
6D	Food Processing Operations	-1	
6E	Manufacture of Liquor and Soft Drinks	-1	
6F	Oil Refineries	-1	
6G	Pulp and Paper Factories	-1	
6H	Sugar Factories and Distilleries	-1	
6I	Intensive Animal Rearing Operations **(shrimp and fish farms)**	-1	
6J	Do industries discharge raw wastewater directly into water bodies?	-3	Values are assigned according to the potential level of pollution. Raw industrial discharges into water bodies are assigned a value of -3. Treated industrial discharges or industrial discharges mixed with municipal wastewater and treated, receive a value of 3 (very adequate). Pretreatment of industrial discharges into sewerage receive a value of 2.
6K	Do industries treat effluents before discharge into water bodies?	3	
6L	Do industries pretreat effluents before discharge into municipal sewers?	2	
6M	Do industrial wastewaters are treated together with municipal wastewater?	3	
6N	Level of effluent compliance (%)	3	A significance value of 3 is assigned to all. However you can assign a different value. This will automatically be updated in the model.
6O	Is there surveillance? Level of surveillance?	3	
6P	Is there enforcement? Level of enforcement?	3	

7	Tourism /Hotel Sector Wastewater Management	Value	Description
7A	Are tourism and hotel facilities connected to a central sewerage system?	2	Values are assigned according to the potential level of pollution. 7A is assigned a value of 2, because being connected to a sewerage system does not ensure that the wastewater will be treated before discharge. 7B through 7D are assigned a value of 3 (adequate). Treated hotel wastewater but not reused is penalized with a -3 value. There is no reason for a hotel not to reuse its wastewater.
7B	Is the wastewater in the central sewerage system treated before its discharge?	3	
7C	Do tourism and hotel facilities not connected to a central sewerage system treat their wastewater before discharge?	3	
7D	Is treated wastewater in tourism and hotel facilities reused?	3	
7E	Do tourism and hotel facilities discharge into water bodies?	-3	
7F	Level of effluent compliance (%)	3	A significance value of 3 is assigned to all. However you can assign a different value. This will automatically be updated in the model.
7G	Is there surveillance? Level of surveillance?	3	
7H	Is there enforcement? Level of enforcement?	3	
8	Commercial and Institutional Effluent Discharges	Value	Description
8A	Hospital	-3	Values are assigned according to the potential level of pollution. Hospitals are considered as high polluters where infectious, chemical, heavy metals and radioactive material can be present, and that can be a public health and environmental problem. Hence a value of -3 is given to 8A. 8b, 8c and 8D are given a value of -1.
8B	Schools	-1	
8C	Camps	-1	
8D	Other	-1	
8E	Do institutions discharge raw wastewater into water bodies? Level of discharge?	-3	Values are assigned according to the potential level of pollution. 8E is given a value of -3, because its pollution potential. 8D and 8e are given a value of 3 (adequate)
8F	Existence of institutional WWTPs in commercial and other institutions? Presence level?	3	
8G	Is treated wastewater in institutions reused?	3	
8H	Level of effluent compliance (%)	3	A significance value of 3 is assigned to all. However you can assign a different value. This will automatically be updated in the model.
8I	Is there surveillance? Level of surveillance?	3	
8J	Is there enforcement? Level of enforcement?	3	

9	Amount of Water Discharged	Value	Description
9A	Do you know the amount of sewage discharged into water bodies?		
9B	How much in MGD?	3	A value of 3 is given (as a bonus) for knowing the load of pollution.
	Is water being discharged to:		
9C	Creeks	-1	Values assigned represent the level of impact to water bodies and to the LBS Protocol. Discharging to the sea has the highest negative value (-3).
9D	Rivers,	-1	
9E	Natural or constructed reservoirs	-2	
9F	Mangroves	-2	
9G	Coastal waters	-3	
9H	Outfalls	-3	
9I	Underground Injection (**Septic Tanks)**	2	

10	Quality of discharge	Value	Description
	Is water being discharged to:		

10A	Creeks	1	A significance value of 1 is assigned to all. However you can assign a different value. This will automatically be updated in the model.
10B	Rivers,	1	
10C	Natural or constructed reservoirs	1	
10D	Mangroves	1	
10E	Coastal waters	1	
10F	Outfalls	1	
10G	Underground	1	
11	Septage/Biosolids Management	Value	Description
11A	Does septage receive treatment? Adequacy?	3	A significance value of 3 is assigned for treatment and a value of 4 for safe disposal
11B	Adequacy of septage disposal?	4	
	Where is disposed?		
11C	Treatment plants? Quantity?	4	A value of 4 is given for disposing of septage in a treatment plant and a value of -3 if it is discharged into a waterbody.
11D	Landfills/dumpsites? Quantity?	3	
11E	Land? Quantity?	2	
11F	Water Body? Quantity?	-3	
11G	Do biosolids receive treatment? Adequacy?	3	A significance value of 3 is assigned for treatment and a value of 4 for safe disposal
11H	Adequacy of biosolids disposal?	4	
	Where are disposed of?		
11I	Landfills/dumpsites? Quantity?	4	A value of 4 is given for disposing of septage in a treatment plant and a value of -3 if it is discharged into a waterbody.
11J	Reused? Quantity?	3	
11K	Land? Quantity?	2	
11L	Water Body? Quantity?	-3	
11M	Amount of Septage produced (m3/year)	-1	The amount of septage and biosolids is penalized by a value of -1
11N	Amount of Biosolids produced (m3/year)	-1	
12	Infrastructure Condition	Value	Description
12A	Is sanitation infrastructure adequate?	1	A significance value of 1 is assigned to all. However you can assign a different value. This will automatically be updated in the model.
12B	How old are the sewerage systems? 0-10yrs= High; 10-20=Medium; >20 = Low	-1	
12C	How old are the WWTP? 0-10yrs= High; 10-20=Medium; >20 = Low	-1	
12D	Degree of deterioration of sewer lines (leakage, tears, insufficient capacity of collectors, obstructions, illegal interconnections, storm water runoff, operational problems of pumping stations among others)	-1	
12E	Degree of deterioration of WWTPs (leakage, tears, insufficient capacity of collectors, obstructions, illegal interconnections, storm water runoff, operational problems of pumping stations among others)	-1	
12F	Are technologies used old/obsolete?	-1	

3. Pollution Problems and their Cost

13	**Pollution Problems and Their Cost**	Value	Description
13A	Level of pollution in rivers, lakes, mangroves and coastal areas (increase in thermal pollution in addition to nutrient pollution)	1	A significance value of 1 is assigned to all. However you can assign a different value. This will automatically be updated in the model.
13B	Level of environmental deterioration such as toxic algae bloom and destruction of coral reefs	1	
13C	Level of cases of human shellfish and reef fish poisoning	1	
13D	Number of outbreaks (water and food) related to bad sanitation during the last year	1	
13E	Level of vector borne diseases (Dengue, malaria, yellow fever, etc.)	1	
13F	Level of deterioration of bathing and recreational areas	1	
13G	Level of Social impact due to deterioration of the environment	1	
13H	Level of Economic impact due to deterioration of the environment	1	
13I	Lost Opportunities due to deterioration of the environment	1	

4. National Capacity

14	**Policy framework**	Value	Description
14A	Has the country highlighted domestic wastewater/ sewage as a priority pollutant in national objectives/ sustainable development planning?	1	A significance value of 1 is assigned to all. However you can assign a different value. This will automatically be updated in the model.
14B	Are there strategies, indicators and targets associated with the development of this sector?	1	
14C	Are there national policies in wastewater management, including a National Plan of Action?	1	
14D	Do main cities have a Plan for wastewater management?	1	
14E	Do national policies allow for private sector participation in sewerage services in the absence of adequate public facilities island-wide? What is the extent?	1	

15	**Legislative framework**	Value	Description
15A	Environmental Act	1	A significance value of 1 is assigned to all. However you can assign a different value. This will automatically be updated in the model.
15B	Public Health Act	1	
15C	Environmental health Act	1	
15D	Environmental Impact Assessment	1	
15E	Marine protected areas	1	
15F	Ambient Water Standards	1	
15G	Discharge Limits	1	
15H	Marine Pollution Control Act	1	
15I	Design Standards for Wastewater Plants	1	
15J	Design for On-site Treatment Systems	1	
15K	Regulations on Septage/biosolids Management	1	
15L	Storm water runoff	1	
15M	Irrigation Standards	1	
15N	Urban Wastewater management	1	
15O	Agricultural pollutants	1	
15P	Pesticides environmental management	1	
15Q	Regulation of industry types	1	
15R	National Zoning Policy	1	
15S	Building Code	1	
15T	Public Information	1	
15U	Are legislative instruments for water pollution control fusion? Level of fusion?	1	
15V	Do legislative instruments for water pollution overlap? Level of overlap?	1	
15W	Level of enforcement of existing laws and regulations?	1	
16	**Institutional framework**	Value	Description
16A	Is there a designated/ lead national authority for wastewater management?	1	A significance value of 1 is assigned to all. However you can assign a different value. This will automatically be updated in the model.
16B	Is there a water resource management authority?	1	
16C	Is there a public service regulatory commission?	1	
16D	Is there an intersectorial approach for wastewater management?	1	
16E	Is there an interdisciplinary approach?	1	
16F	Level of communication and collaboration between various sectors and agencies:	1	
		1	
16G	Water	1	
16H	Sanitation	1	
16I	Health	1	
16J	Environment	1	
16K	Tourism	1	
16L	Industry	1	
16M	Agriculture and Livestock	1	

16N	Social development	1	
16O	Planning	1	
16P	Finance	1	
16Q	Labour	1	
16R	Food	1	
16S	How adequate are the current institutional arrangements for wastewater management at the community, local and national levels?	1	
16T	Do responsibilities overlap among various agencies with respect to wastewater management? Level of overlap?	1	
16U	Is there a fragmented approach in the institutional framework with respect to wastewater management? Level of fragmentation?	1	
16V	Is there a Regional Intersectorial/interdisciplinary approach?	1	

5. Surveillance and Enforcement Capacity			
17	Surveillance and Enforcement Capacity	Value	Description
17A	Is there a wastewater discharge surveillance programme? How is Coverage and frequency of monitoring?	1	A significance value of 1 is assigned to all. However you can assign a different value. This will automatically be updated in the model.
17B	Is there a natural water surveillance programme? How is Coverage and frequency of monitoring?	1	
17C	Is there a qualified personnel for surveillance? Is the quantity of qualified personnel adequate?	1	
17D	Is enforcement of regulations applied? What is the level of enforcement?	1	
17E	Is there equipment and supplies for wastewater and natural water sampling? Is it sufficient?	1	
17F	Are there standardized methods for wastewater and natural water sampling	1	
17G	Are there laboratory facilities available? Are there enough?	1	
17H	Are the Laboratories certified?	1	
17I	Can Chemical and biological supplies be acquired locally?	1	
17J	Can laboratory equipment be repaired and maintained locally?	1	
17K	Are there standard Methods for reporting?	1	
17L	Budget Adequacy	1	
17M	Are Operational Parameters measured in WWTP? Adequacy?	1	
	Laboratory Parameters Capability Parameters analyzed		
17N	Total Suspended Solids	1	
17O	Biochemical Oxygen Demand (BOD_5)	1	
17P	Chemical oxygen Demand	1	
17Q	pH	1	
17R	Fats, Oil and Grease	1	
17S	Total Nitrogen	1	
17T	Total Phosphorous	1	
17U	Faecal Coliform	1	
17V	*E. coli* (freshwater) and	1	

17X	Enterococci (saline water)	1	
17Y	Heavy metals	1	
17Z	Pesticides	1	

6. Manpower Capacity			
	Availability of Staff for Wastewater Management	Weight	Description
18A	Planning Capacity for WWTP	1	A significance value of 1 is assigned to all. However you can assign a different value. This will automatically be updated in the model.
18B	Managerial capacity	1	
18C	Developing project proposals	1	
18D	Design and Construction capacity	1	
18E	Operation and maintenance Capacity	1	
18F	Surveillance Capacity	1	
19	**National/Regional Training Needs for Wastewater Management**	Weight	Description
19A	Planning Capacity for WWTP	1	A significance value of 1 is assigned to all. However you can assign a different value. This will automatically be updated in the model.
19B	Managerial capacity	1	
19C	Developing project proposals	1	
19D	Design and Construction capacity	1	
19E	Operation and maintenance Capacity	1	
19F	Surveillance Capacity	1	
20	**National/Regional Training Opportunities for Wastewater Management**	Weight	Description
20A	Basic operator certification	1	A significance value of 1 is assigned to all. However you can assign a different value. This will automatically be updated in the model.
20B	Technical	1	
20C	BSc	1	
20D	Specialization	1	
20E	MSc	1	
20F	PhD	1	
21	**National/Regional Training Areas for Wastewater**	Weight	Description
21A	Management,	1	A significance value of 1 is assigned to all. However you can assign a different value. This will automatically be updated in the model.
21B	Administration,	1	
21C	Accounting	1	
21D	Engineering	1	
21E	Technician	1	
21F	Operators	1	

7. Financing

22	Financial Issues	Value	Description
22A	What are the Primary Source of Funding for Water and Wastewater Projects		
22B	Is the polluter pays principle applied	1	A significance value of 1 is assigned to all. However you can assign a different value. This will automatically be updated in the model.
	What economic Instruments are applied?	1	
22C	User fees	1	
22D	Taxes	1	
22E	Grants	1	
22F	Loans	1	
22G	Private investments	1	
22H	Is there a budget in sanitation dedicated to wastewater treatment management?	1	
22I	Do smaller communities obtain affordable financing for improving wastewater infrastructure?	1	
22J	Is financing available for investments in wastewater management affordable?	1	
22K	Investment per capita into wastewater management projects < $60 = Low; $60-$120 = Medium; > $120 = High	1	
22L	How is spending on the wastewater sector, compared with other sectors?	1	
22M	Is there a sewer tariff for cost recovery? Adequacy?	1	
22N	What is the adequacy of funds generated from central government, donors, bank loans or grants and revenue from tariffs, for the operations or service delivery cost of the utilities?	1	
22O	To what extents are public authorities assisted by other stakeholders including community groups, private development companies etc. in wastewater management**?**	1	
22P	Are Rates for septage disposal adequate?	1	
22Q	Are there Cost Estimates for wastewater carrying and treatment technologies?	1	

8. Best Practices and Innovative Technological Treatment Solutions

23	**Best Practices and Innovative technological Treatment solutions**	Value	Description
23A	Policy framework	1	A significance value of 1 is assigned to all. However you can assign a different value. This will automatically be updated in the model.
23B	Legislative framework	1	
23C	Institutional framework	1	
23D	Surveillance capacity	1	
23E	Manpower	1	
23F	Financing	1	
23G	Wastewater treatment technology*	1	
23H	Sanitation projects as Community source of revenue	1	
23I	Other (Specify)water conservation	1	

9. Current Knowledge, Attitudes, Behaviours and Practices

24	Current knowledge, attitudes, behaviors and practices	Value	Description
24A	How is the Level of awareness about wastewater management concepts, issues and technologies?	1	A significance value of 1 is assigned to all. However you can assign a different value. This will automatically be updated in the model.
24B	How are the Attitudes towards implementing proper wastewater practices?	1	
24C	Level of focus of wastewater compared with water	1	
24D	How likely is it that decentralized natural treatment systems (e.g. ecological sanitation, constructed wetlands, sand filters) would be accepted as options for domestic wastewater treatment?	1	
24E	To what extent are people aware of the impact of current methods of disposal on health and environment?	1	
24F	Are people aware of the link between sewage, poor sanitation and health problems such as diarrheal diseases, malnutrition, vector diseases, human capital, etc.?	1	
24G	Do senior management officials in government/decision makers have a comprehensive knowledge of wastewater management issues and can link these with other areas of socio-economic development?	1	
24H	Do officials in politicians have a comprehensive knowledge of wastewater management issues and can link these with other areas of socio-economic development?	1	
24I	Are wastewater operators aware of proper operations and maintenance techniques?	1	
24J	Do national, local and sectoral education and public awareness programmes and campaigns exist for wastewater management or for environmental management (which includes wastewater management)?	1	

10. Information Collection and Sharing

25	Information Collection and Sharing	Value	Description
25A	Do you have facilities for data collection where analysis, revision and expansion of information are conducted?	1	A significance value of 1 is assigned to all. However you can assign a different value. This will automatically be updated in the model.
25B	How is the quality of data analysis?	1	
25C	Existence of periodic assessment of short-term and long-term data-collection and research needs for wastewater management.	1	
25D	Is there access to information related to wastewater management issues for decision making to Government Officials?	1	
25E	Is there public access to information related to wastewater management issues for decision making?	1	
25F	Is there an Standardize Data Collection, in order to gather comprehensive and comparable information,	1	
25G	Is the terminology standardized?	1	
25H	Existence of national knowledge and information system/ clearing house mechanism of tools and approaches for wastewater management that are effective and appropriate to the expectations and context of the beneficiaries in the Wider Caribbean.	1	

11. Presence and Participation Level of Water and Sanitation Organizations

26	Organizations support for wastewater management	Value	Description
26A	UN	1	A significance value of 1 is

26B	NGOs	1	assigned to all. However you can assign a different value. This will automatically be updated in the model.
26C	International Cooperation Agencies	1	
26D	IDB	1	
26E	World Bank	1	
26F	Sub regional banks	1	
26G	Professional Organizations	1	
26H	Media organization	1	
26I	Healthy Schools	1	
26J	Eco clubs	1	
26K	Theatre groups	1	
26L	Community organizations	1	

12. Climate Change Impacts

27	Climate Change Impact	Value	Description
27A	Higher temperatures	1	A significance value of 1 is assigned to all. However you can assign a different value. This will automatically be updated in the model.
27B	Higher Humidity	1	
27C	Rising seas	1	
27D	High Water Tables	1	
27E	Increased risk of drought	1	
27F	Increased risk of fire	1	
27G	Increased risk of flood	1	
27H	Stronger storms and increased storm damage	1	
27I	Increased Risk of Hurricanes	1	