GREEN PAPER ON THE

2020 WATER PROTECTION AND LAND USE ZONING POLICY

MINISTRY OF Energy & Water Resources
UTILISING OUR NATURAL RESOURCES

BWA
BARBADOS WATER AUTHORITY

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DOCUMENT PREPARATION

This Green Paper was prepared as a consultative document under the guidance of the Ministry of Energy and Water Resources as Chair of a Technical Working Group comprising: the Ministry of Health and Wellness, the Ministry of Agriculture and Food Security, the Ministry of the Environment and National Beautification, the Environmental Protection Department, the Barbados Water Authority, the Coastal Zone Management Unit and with assistance from the Government's Special Envoy for Climate Change, Energy, Water and the Environment.

SUBMITTED FOR DISCUSSION:

- New groundwater protection zoning regulations.
- Sewering densely populated sites in the new Zone A areas.
- Discouragement of the use of absorption or “suck” wells alone as the primary means of domestic wastewater treatment and disposal.
- Use of proven technologies to remove contaminants from drinking water, where necessary.
- Establishing a new Water Resources Agency.

CONTENTS

ACRONYMS

Acronym	Definition
BFS	Belle Feasibility Study
BOD	Biological Oxygen Demand
IWRM	Integrated Water Resource Management
MGD	million gallons per Day
MIGD	millions of imperial gallons per day
NRCA	Non-Recharge Contributing Area
PSW	Public Supply Well
RCA	Recharge Contributing Area
RO	Reverse Osmosis
UN	United Nations
USEPA	United States Environmental Protection Agency
WHO	World Health Organisation
WRA	Water Resources Agency

EXECUTIVE SUMMARY

The following paper describes the existing groundwater protection zoning policy, outlines its strengths and shortcomings and proposes a new integrated approach to protection of all of the island's water resources, including coastal waters. The existing policy was created over 50 years ago, at a time of much less freshwater demand, a less densely populated island with most of its population concentrated on the south and west coasts, limited use of persistent hazardous chemicals, and in the absence of modern water and wastewater treatment technologies. Although progressive at the time, the existing policy is no longer adequate. It restricts development over large swathes of land and over the years there has been encroachment in some Zone 1 areas.

The existing policy is ineffective against persistent chemical pollutants and only focuses on protecting groundwater to the detriment of coastal waters.

The new proposed water protection and land use policy is guided, inter alia, by the following principles:

(i) prevention is better than cure,
(ii) systematic approaches are more effective than ad hoc, and
(iii) policy should be guided by the best science.

It is recognised that all of Barbados may be considered a "coastal zone" and that it is an economic and environmental imperative to not only protect drinking water supplies, but also our coral reefs. In this context, persistent pollutants (e.g. nitrates) become primary pollutants of concern and the new policy will seek to address both agriculture and sewage, which are the main sources of nitrate pollution.

An integrated approach which addresses sources of pollution, uses the best technology and practices, strengthens capacity and creates the appropriate regulatory and legislative structure is proposed.

Several studies have been conducted since the old policy was established in 1962. The recommendations contained in this paper are as a result of the latest scientific information and modelling, and were previously approved in 2011.

It is being proposed that the existing Zones 1 – 5 be replaced by new Zones A – E as outlined below:

- Zone A – a **strict exclusion zone**, smaller in area than the existing Zone 1, with no new developments and restricted agriculture.
- Zone B – a **pathogen management zone**, with stricter rules for sewage treatment and disposal.
- Zone C – a **chemical management zone**, with restrictions on chemicals storage, use and disposal. Regulations for nutrient removal (nitrates and phosphates) from wastewater that recognises potential impacts on nearshore ecosystems.
- Zone D – a **recharge controlling zone,** that encompasses the limestone area, with continued standards for wastewater treatment.
- Zone E – a **non-recharge contributing area** that primarily consists of areas that

do not contribute to the recharge of aquifers (i.e. Scotland District). Again, there will be minimum standards for wastewater discharge with the objective of protecting coastal water quality.

If approved, the new policy will result in, inter alia:

- Stricter control of chemical usage and disposal (including agrochemicals).
- Sewering of communities around the Belle public supply well, which supplies almost one-third of the island's drinking water.
- Reduction in the use of suck wells as the primary method of domestic wastewater disposal.
- Require developers of new developments to provide the means of protecting ground water and coastal waters whether by sewage treatment, wetlands, or other acceptable means as deemed appropriate.

SECTION 1:

WHAT IS THE CURRENT SITUATION?

THE CURRENT SITUATION

For the last half of a century, Barbados has attempted to control groundwater quality (the source of our drinking water) by dividing the island into 5 zones, heavily restricting activity in Zone 1 around the public supply wells (PSW), with fewer restrictions in zones further away from the PSWs and hence closer to the coast. This narrowly focused approach:

- failed to provide any protection to coastal waters from land-based sources of marine pollution,
- relied solely on a predicted minimum time of travel to control biological contamination of the groundwater close to the PSWs, in geology that is heterogenous and likely to have unpredictable conduit flow, and
- was ineffective in the control of chemical contamination of the groundwater.

This paper seeks to replace the current ground-water protection system with an integrated approach to water resource management.

INTEGRATED WATER RESOURCES MANAGEMENT

Integrated Water Resources Management (IWRM) promotes the coordinated development and management of water, land and related resources for the benefit of the island and its communities. A strategic approach is central to an effective IWRM for Barbados. This critical need is increased with ongoing climate change and its impacts on freshwater resources, leading to more frequent periods of both drought and flooding, posing significant problems for maintaining a steady freshwater supply for drinking, farming and industry, as well as increased damage due to flood events

While the initial focus of this paper was on ground-water policy, it immediately became evident that complementary work was needed with respect to storm-water, wastewater and coastal zone management. The whole of Barbados can be regarded as a coastal zone, with direct hydraulic connectivity between the freshwater aquifers and the nearshore (See Figure 1 on next page); implying that any water and associated contaminants that soak into the ground eventually reach the sea (See Figure 2 on next page).

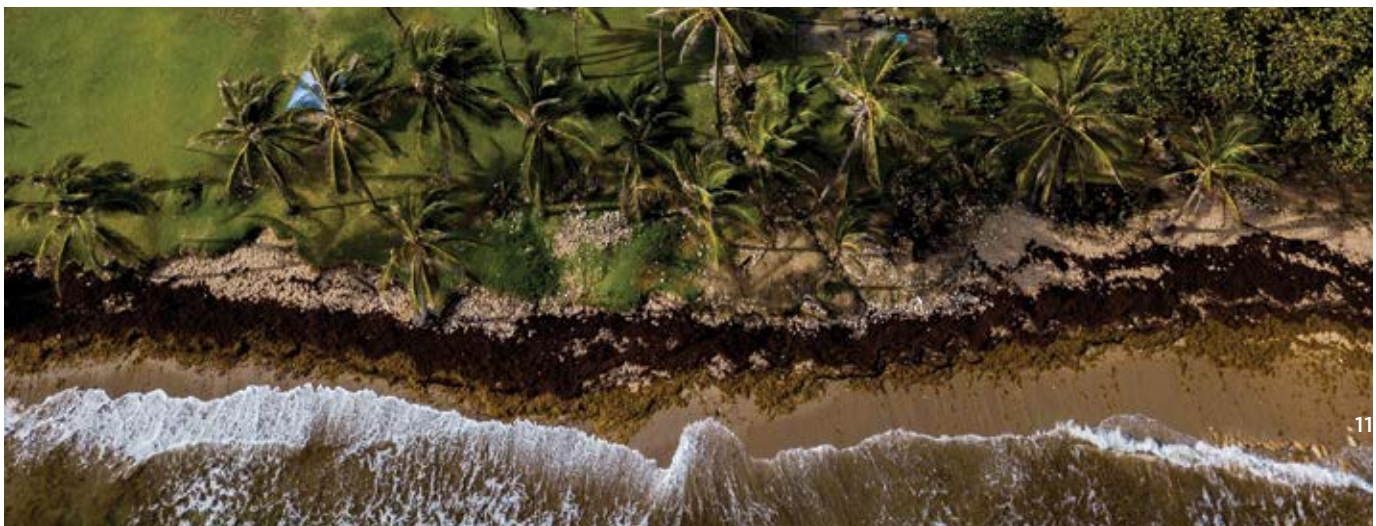


FIGURE 1: A SIMPLIFIED HYDROGEOLOGICAL PROFILE

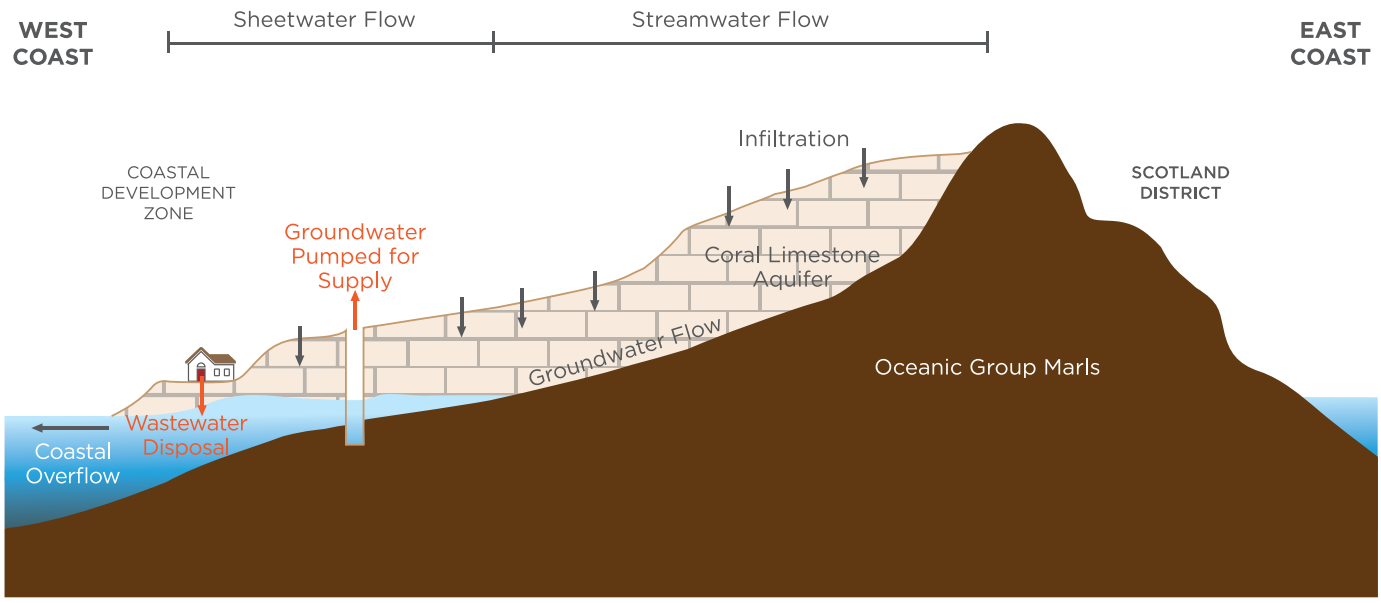
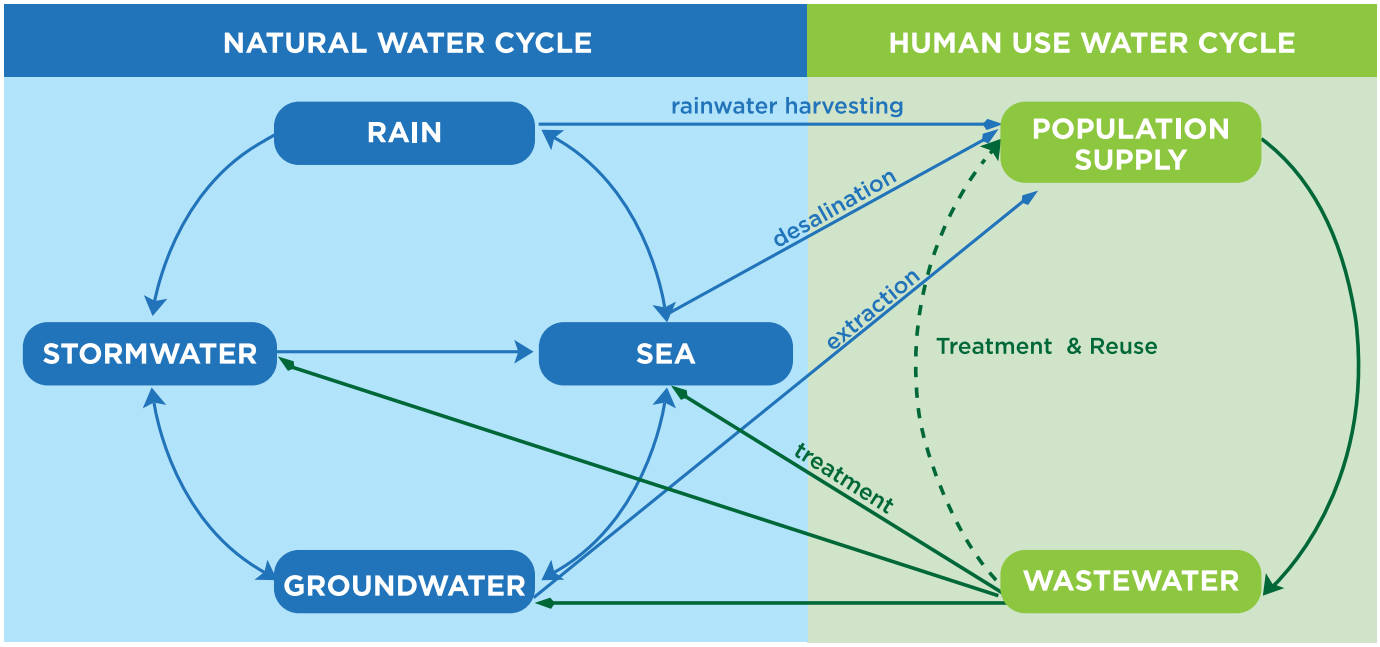


FIGURE 2: THE WATER CYCLE.



BACKGROUND TO THE EXISTING LAND USE AND WATER ZONING POLICY

In the early 1940s, British Union Oil Company was interested in the geology of Barbados and funded groundwater research studies which were conducted by a British geologist - Alfred Senn from 1943-47. Senn produced a Report in 1946 which included:

- an assessment of the geology of Barbados;
- a detailed examination of the development of water services and the overall distribution network; and
- the movement of groundwater on the island.

In 1946, the population of Barbados was estimated to be in the region of 192,000 persons and the water consumption was around 4.2 million imperial gallons per day (MIGD) or 21.2 imperial gallons (~ 96 litres) per day per person, as compared to today's population of 300,000 whose consumption is around 35.5 MIGD, or 118 imperial gallons (~ 536 litres) per day per person. According to Senn, less than 20% of the population had water piped into their homes in 1946.

It should be noted that tourism was non-existent in 1946 and most houses had dry pit toilets as a means of disposal of their waste. Standpipes were very popular and places such as the plantations had private water wells from where they took their water supply.

Senn identified functioning and abandoned suck wells[1] as potential dangers to the groundwater and pointed to a danger from discharges of untreated waste entering the fissures of the coral.

Underground Water Control Act – 1951

The work undertaken by Senn influenced the development of an Underground Water Control Act – 1951. This Act, which was administered by the Water Board and chaired by the Chief Agricultural Officer, was established with a mandate to issue water abstraction licenses and advise the Government on water resources matters.

In 1961, Government obtained assistance from a UN program for Technical Assistance to undertake a 2-year study aimed at locating new groundwater wells and to recommend ways for their protection from pollution. The UN commissioned a hydrologist called Tullström to undertake the appropriate study.

Tullström Study

In Barbados, at the time of this study in 1961, there was a population of around 235,000 persons consuming some 13.2 MIGD or 56 imperial gallons (~ 255 litres) per day per person of groundwater from seven (7) water wells and two (2) spring sources. Approximately 35% of the population had water piped into their homes while most houses still had dry pit toilets and standpipes were still popular. Tourism was now in its formative years.

Risks Identified by Tullström

Tullström identified the following as imperilments to the water supply:

1) The presence of densely populated villages near to pumping wells.

[1] A suck well is a local term for an absorption well, usually dug in an attempt to reach a fissure (suck) in the limestone, to allow for rapid infiltration of the water into the ground.

2) The observation of large numbers of remains of dead animals and rubbish in suck wells when being cleaned.
3) A proliferation of dry pits which were unprotected against heavy rainfall and inflow.
4) The abandonment of old water supply sources: Harrison's and Cole's Cave, Jack-in-the-Box Gully and Porey Spring, due to surface pollution.

In an effort to reduce the risks of contamination of the groundwater supply, Tullström recommended the establishment of five (5) groundwater protection zones amongst other considerations. The Zoning Policy which emerged was as follows:

Zone 1

It is the most restrictive of all the zones, with an estimated travel time of 300 days for a molecule of water, moving from the boundary of the zone, to reach the well. The Water Board felt uncomfortable with a 200-day travel time (originally recommended) and adopted a 300-day travel time instead. This zone advocated:

- The prohibition of building development around existing and future wells.
- There shall be no new buildings in Zone 1.
- Existing buildings shall continue to use existing disposal systems.
- No new water connections shall be provided.

Zone 2

This zone has an estimated travel time of 600 days and prescribed that:

- No soak-away pits shall exceed 20 ft. in depth.
- Separate soak-away pits shall be provided for sewage and domestic wastewater (bath, kitchen waste etc.)
- Sewage disposal by dry pit permitted.
- No rainwater shall be permitted in sewage pits.
- No petrol stations shall be permitted.

Zone 3

This zone adopted the same restrictions as set out in Zone 2 with the exception that:

- No soak-away pits shall exceed 40 ft. in depth.
- Petrol stations shall be enclosed in a leak-proof reservoir built to the satisfaction of the Water Board.

Zone 4

- There shall be no special restrictions on the system of wastewater and sewage disposal employed.
- Petrol stations shall be enclosed in a leak-proof reservoir built to the satisfaction of the Water Board.

Zone 5

- There shall be no special restrictions on the system of wastewater and sewage disposal employed.

Additionally, Tullström recommended:

(i) The development of a sewerage system for the Belle area.

(ii) Bacterial analyses of all wells and tap water were to be performed regularly.

(iii) Chemical analyses of all water sources to be performed once or twice annually.

(iv) Chlorination of water supply to be undertaken.

(v) Biological Oxygen Demand[2] (BOD5) testing of the water supply to be done annually especially in the wet season.

This led to the development of the current existing zones as described in Table 1 below:

TABLE 1: BREAKDOWN OF THE EXISTING ZONES BY PARISH

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
Parish	Area (km2)	Area (km2)	Area (km2)	Area (km2)	Area (km2)
Ch. Ch.	0.4	0.4	10.0	6.5	43.2
St Andrew	2.5	2.9	-	2.3	24.7
St. George	5.2	3.9	9.8	26.0	-
St. James	6.2	6.1	6.7	11.6	4.2
St. John	4.4	4.1	2.9	15.6	4.7
St. Joseph	0.8	2.5	-	9.5	13.5
St. Lucy	0.7	11.2	6.3	7.4	9.7
St. Michael	5.9	10.5	4.5	4.5	12.8
St. Peter	7.0	3.7	2.3	15.0	3.3
St. Philip	3.7	8.2	21.3	12.6	14.2
St. Thomas	2.5	2.4	5.3	23.0	0.7
Total	39.3	55.9	69.1	137	131
Percentage	9	13	16	32	30

Michael White Report

Michael White, a Jamaican hydrogeologist who worked as part of the Belle Feasibility Study, June 2002, in his Report entitled: "Review of Barbados Groundwater Protection Zone System", recommended that: "the existing Public Supply Wells Zoning Policy be accepted as being ineffective, outdated and in need of revision and/or replacement. However, its repeal must of necessity await approval of a suitable replacement policy".

White further opined that the Zoning Policy did not address contamination by stable inorganic contaminants such as nitrates that did not degrade with time, nor did it provide a 100% protection from bacteriological contamination. He went on to point out however that the level of bacteriological contamination would have been significantly higher if the Zoning Policy was not in place and housing densities were higher in close proximity to the supply wells.

[2] BOD_5 measures the amount of oxygen required for the biological decomposition of the pollutants present in the water, over a 5 -day period.

Current Threats to Groundwater

The groundwater protection system, developed by Tullström over 50 years ago, has come under increased pressure due to limited physical space and the demands for economic growth. There is now an increased number of properties erected in Zone 1 areas without planning permission: e.g. Belle, Hampton, Ashton Hall. This situation has contributed to elevated levels of nitrates in the groundwater, bordering on and sometimes exceeding the latest World Health Organisation (WHO) Guidelines for Drinking Water Quality (50mg/l) as nitrate ion (11 mg/l) as nitrogen[3], at some sources.

Additionally, chemicals from agricultural activities are entering the groundwater supply system resulting in high levels of nitrates. Another contributor to the negative trend is the scourge of illegal dumping and the presence of abandoned quarries where old vehicles, stoves, fridges and other potential pollutants are dumped in and around the Zone 1 areas.

Objectives of the 2010 Study

This situation underpinned the need to undertake the study entitled "Comprehensive Review and Overhaul of the Groundwater Protection Zoning Policy and System of Barbados" which was undertaken by consulting firm Burnside and commenced in 2010.

The objectives of this study were to:

(i) Review the existing groundwater protection policy and system developments to determine if the system is sustainable for the long-term protection of the groundwater resources.

(ii) Develop a sustainable groundwater protection system capable of providing effective protection against emerging threats, while taking advantage of technological advances in the water supply sector.

(iii) The preparation of a Draft Groundwater Protection Act for Barbados that will ensure the sustainability of the public water supply for residents and visitors to Barbados.

Importance of the Study

Barbados is one of the world's most densely populated countries and is almost entirely dependent on groundwater for its freshwater supply. With a current population density of 616 persons per square kilometre and renewable water resources estimated at 390 m^3 per capita per year, Barbados has been classified by the United Nations as a water scarce country. Countries falling short of 1,000 m^3 per capita of renewable water resources per capita per year are designated as water scarce.

The island was challenged to develop a groundwater protection scheme that gave maximum physical, biological and chemical protection to the limited water resources without negatively impacting or hampering national development. However, due to limited physical space and low rainfall, Barbados found difficulty in maintaining its traditional protection barriers between an ever-expanding urban corridor and the land area required to protect the groundwater resources.

[3] The US Environmental Protection Agency maximum contaminant level goal for nitrates in drinking water is 10 mg/l NO_3_Nd.

In Barbados droughts are becoming more frequent and a one-in-fifteen-year drought can result in a deficit of approximately seven MIGD to Barbados' water supply.

Pollution of the limited available groundwater resources could therefore result in a reduction of the available freshwater resources, and an increase in the number of persons without access to safe and affordable drinking water. There must also be adequate consideration for the protection of the marine environment from pollutants, not only nitrates, but other pollutants such as artificial sweeteners, caffeine, biocides (including herbicides), polymer precursors, personal hygiene products, and degradation products from detergents and nicotine, along with chemicals used for many other purposes.

Some of the project activities were therefore intended to address the Millennium Development Goal[4] of ensuring environmental sustainability with regards to reversing the loss of environmental resources and provision of safe drinking water. Under the current policy at the time, some persons residing on Zone 1 lands were denied access to water supply services and as a result, lived in sub-standard conditions. Identification and adoption of new technologies, water protection and management policies, may allow for these persons to be provided with water services and contribute to improving their living and health conditions as well as possibly "free-up" some of the restricted lands for other uses including housing. Conversely, it is also recognised that squatting remains illegal and should not be encouraged.

THE CONSEQUENCES OF ILLEGALLY CONSTRUCTED HOMES IN ZONE 1 AREAS

Social

The Barbados Habitat III Report (2015) states that 0.2% of Barbados' population is presently living illegally in dwelling units constructed in Zone 1 areas and communities. These communities, especially in the Belle represent a significant threat to the national development of the island. The threats stem from the construction of illegal structures and the associated activities therein.

The presence of such a community in a Zone 1 area pose a substantial threat to the groundwater resources due to restricted activities such as animal rearing, the construction of suck wells, vehicle repairs and inadequate sanitary facilities, which are all potential sources of water contamination.

The effects of dwelling units illegally erected in these communities have been seen from various perspectives; the most common one being the deplorable environmental conditions. To this end, the World Bank Thematic Group on Services to the Urban Poor described slums as unplanned and under-served neighbourhoods typically settled by squatters.

Where such communities exist, the layout is never prepared, and developments are not subject to any control. In cases where the layout is agreed upon by the squatters themselves, such layout does not conform to the standards and laws of

[4] The original 8 Millennium Development Goals were replaced in 2016 with more ambitious UN Sustainable Development Goals as part of the 2030 agenda for sustainable development..

the Town and Country Development Planning Office. The absence of meaningful development control in these cases invariably leads to haphazard or uncoordinated development consequently therefore characterises slum formation, and as a result presents significant public health risk.

Another effect is the absence of municipal services and infrastructure like roads, water supply, sanitation and waste collection. Within these neighbourhoods, waste generated is thrown indiscriminately into drainage channels, gullies and other clandestine areas resulting in blockages which might eventually result in the flooding and erosion of the area. This situation also leads to the breeding of flies, rodents, mosquitoes and other vermin. The lack of basic municipal facilities further exposes residents to disease, crime and natural disasters.

Since residents of these settlements lack legal titles, they usually suffer from the problem of uncertainty in tenure. They live daily with the perpetual fear of eviction and demolition by authority; as a result, there is no incentive to spend on housing improvements; hence they live in houses constructed with substandard materials.

The social impacts of squatting in Barbados are mainly three-fold:

(i) First, the lack of social amenities and public facilities that characterize squatter settlements encourage theft of public services and often promote socially deviant behaviour. This is evident in the high incidence of stolen electricity and water supply in many squatter communities.

(ii) Second, squatter settlements are often characterized by threats of eviction, which undermine personal security. Moreover, squatters generally lack protection from disasters like fire and floods that destroy property on a regular basis.

(iii) Third, due to lack of planning, squatters try to utilise their entire plots for housing, leaving no room for provision of access roads and other social services like playgrounds for children. Moreover, in case of emergency situations within the settlements, responses by police, fire services and health service providers are hampered by lack of road access.

Health

Five health-related problems arising from these illegally erected dwelling units can be identified:

(i) First, air-borne diseases like acute respiratory infections are common due to over-crowding and poor ventilation.

(ii) Second, outbreaks of water-borne diseases like typhoid and gastroenteritis, have been shown to be very prevalent because of the absence of proper water supply systems, sewage and waste disposal systems in some other jurisdictions.

(iii) Third, foul-smelling garbage and smells from unsanitary animal keeping affect squatter communities, especially children.

(iv) Fourth, unreliable collection of waste often results in the prevalence of rats,

cockroaches and mosquitoes, all of which may result in a health hazard, especially to children.

(v) Finally, the implications of all the above, is that squatter settlements are a potential health hazard not only to their inhabitants, but also to the public at large that interfaces with many of these people on a daily basis.

Unfortunately, it is not always easy or possible to remove these communities once they have been established. It is therefore incumbent upon government to regulate their expansion (draw a proverbial line in the sand), curb restricted activities, and if the decision is made not to remove existing squatters, to provide remedial public services such as water supply, wastewater treatment and garbage removal.

Although the provision of municipal services may be seen by some as promoting or rewarding deviant behaviour, it must be borne in mind that if left unaddressed, the social and health effects can be must costlier.

Belle Feasibility Study

The Belle Feasibility Study (BFS) which was undertaken in the year 2002 by Stantec also informed the outcome of the Zoning Study later conducted by Burnside. The objectives of the BFS were to:

(i) Evaluate the environmental conditions within the Belle area with special attention to the protection of the groundwater.

(ii) Conduct a feasibility study of the alternative for improving the environmental conditions of the Belle.

The Study pointed out that the Belle Pumping Station Well is the main water supply source for the country. It provides a yield of 11.5 MIGD (52,000 m^3/day) which is approximately one-third of the country's daily water demand. This volume ought to be reduced in times of drought because of rising salinity levels. The original design yield was 5 MIGD a day. However, over time it has more than doubled the yield. It is instructive to note that the existing zone boundaries at the Belle were established based on the 5 MIGD yield[5].

In addition, Waterford Well with a yield of 1.5 MIGD (6,800 m^3/day) has also experienced water quality problems with respect to nitrates and bacteria. The nitrate levels in the wells have become a problem with the USEPA standard of 10 mg (NO_3_N)/L being exceeded; on occasions going as high as 15.6 mg/L at Waterford, and 17.3 mg/L at the Belle. The main sources of the nitrates are fertilizers, human and animal waste.

Stantec stated that although the micro-biological contamination levels were not normally a major problem, it was still a problem as the chlorination process was not always effective. There were a number of illegal and unregulated dwellings in the area. The number of dwellings was increasing, and this needed to be arrested. The sewage from the soakaway pits of these dwellings flows along the ground and directly into the gully system and contributes to the nitrate and bacteria levels at both the Belle and Waterford Wells.

[5] The travel time of a water molecule from the zone boundary to the public supply well is a function of, inter alia, the rate of abstraction at the well. The greater the abstraction rate, the shorter the travel time.

The study recommended that if the rate of illegal dwellings were to continue at pace, then consideration would have to be given to sewering of the Belle and/or treatment of the water using one of, or a combination of, the following options which are detailed in Appendix 2:

(i) sewering the Belle area and its environs at an estimated capital cost of US$7.4m (in 2002);

(ii) partially treating the Belle water by way of a reverse osmosis plant (15,000m^3/day) at an estimated capital cost of US$18.6m (in 2002); and

(iii) treating the full capacity of the Belle water by reverse osmosis (52,000m^3/day) estimated at US$40m (in 2002).

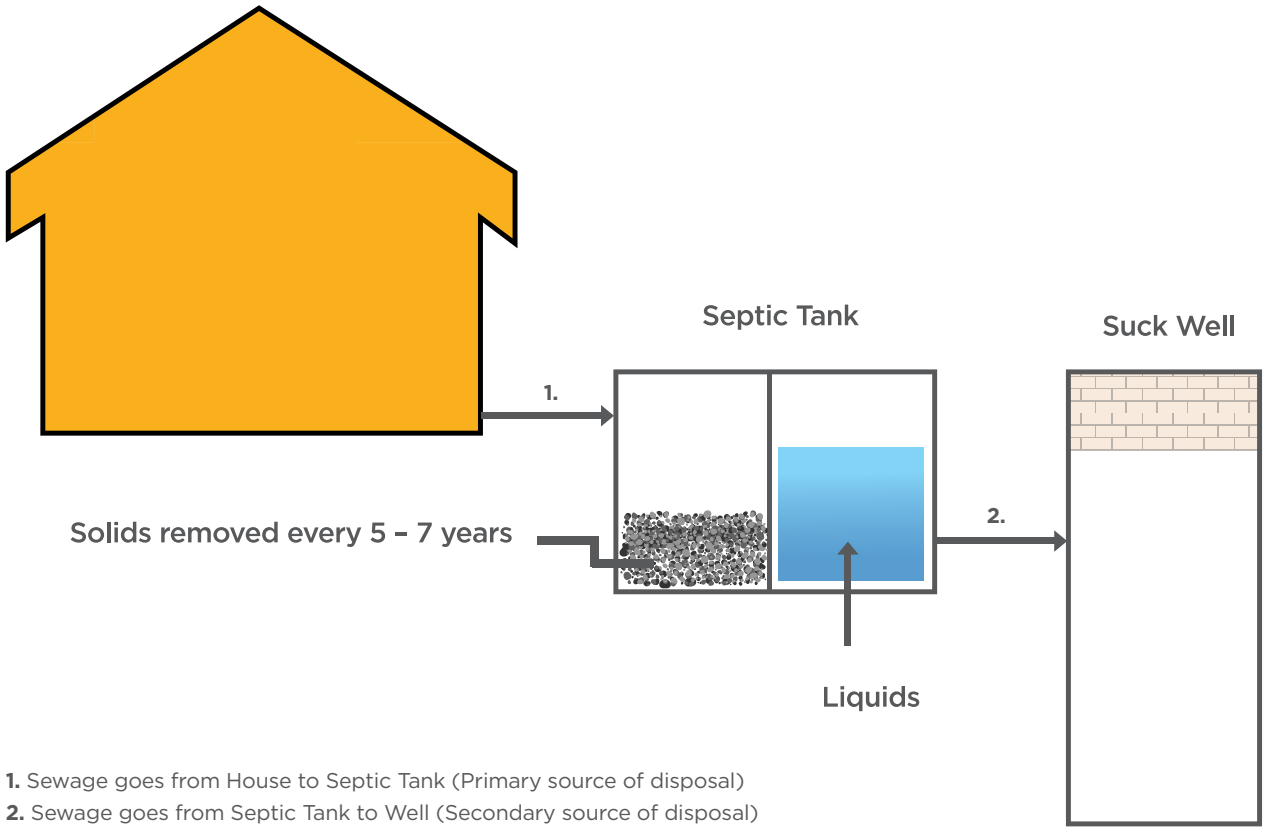
Use of Suck Wells in Revised Zoning System

The Consultant recommended the elimination of the suck well as the primary source of sewage treatment/disposal from properties. This recommendation implied that a septic tank or some other effective treatment processing system would have to be introduced as the primary source of sewage treatment, while the suck well would become the secondary source of disposal (see Figure 3 below).

The septic tank would remove some of the solids as well as some of the bacteriological loadings from the effluent entering the disposal system. The solids would break down biologically inside the tank. After five (5) to seven (7) years of continuous use, the decomposed solids would have to be physically removed and disposed of as septage.

The advantage of introducing a septic tank or a better/equivalent technology would be a reduction of the solids, bacteriological and chemical loading that currently goes directly into the suck well and into the groundwater.

FIGURE 3: SEPTIC TANK AS PRIMARY SOURCE OF DISPOSAL



1. Sewage goes from House to Septic Tank (Primary source of disposal)
2. Sewage goes from Septic Tank to Well (Secondary source of disposal)

Potential Sewerage Service Area

The Belle Feasibility study identified the following areas that should be sewered in the Licorish Village/Belle Tenantry:

- Licorish Village, My Lord's Hill
- 1st, 2nd and 3rd Avenue, Licorish Village, My Lord's Hill
- Belle Road #1, My Lord's Hill
- Odessa McClean Avenue
- Odessa McClean Drive
- Odessa McClean Road
- Thompson's Land, Licorish Village
- Belmont Primary School

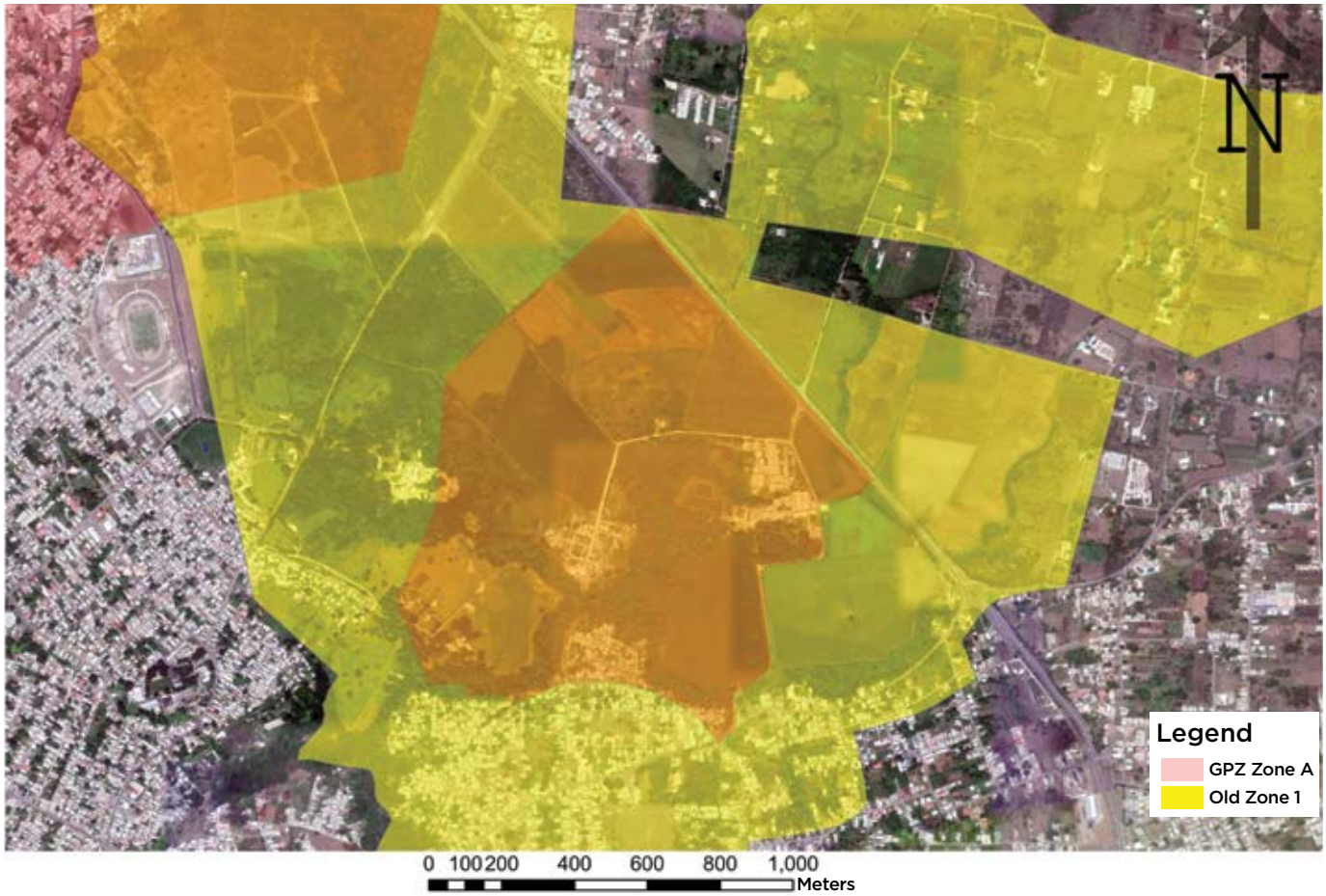
The limits of the area are shown on Figure 4. The area within the limits is 23.7 hectares (~ 59 acres). The population within the Study area in 2002 was 1,580 and the number of pupils and staff in Belmont School was taken as 350. The total population would be serviced on the basis of natural drainage. Although the collection system being considered is intended to serve the Licorish/Belle Study Area, it would be prudent to look also at the surrounding areas as evidenced in Figures 4 and 5.

Investigation of the ground contours showed that most of the Ivy, the area adjacent to, and the Community College could be sewered by gravity towards the west for a future connection to the Greater Bridgetown collection system, or other suitable disposal system.

The installation of a sewerage system for the Belle area was proposed on the grounds of improving public health, and the adverse effects of doing nothing included the continuation of health-related problems among the area residents. The Socio-Economic Study implied that doing nothing is not acceptable. Further, the nitrate and bacteria loadings, originating from this area, would continue to reach the Belle Well and negatively impact the groundwater quality.

FIGURE 5: EXISTING WATER ZONES AND DWELLING UNITS IN AND AROUND THE BELLE AREA AERIAL FOOTAGE - MARCH 2020

OLD ZONE ONE IN THE BELLE AND SURROUNDING AREAS



Comprehensive Review and Overhaul of the Groundwater Protection Zoning Policy and System of Barbados

R.J. Burnside International Ltd., (Burnside), was subsequently awarded a contract to undertake a "Comprehensive Review and Overhaul of the Groundwater Protection Zoning Policy and System of Barbados".

After thorough review by a select technical committee, a number of recommendations based on the results of the Study were submitted for the consideration of the Cabinet. Subsequently, on April 14 2011, the Cabinet agreed[6] to implement a number of the recommendations of the committee which delineated five (5) zones as A through E with the concomitant obligations and regulations respective to each. These new zones will be discussed in the next section: What Are We Proposing?

[6] The Cabinet's decision of April 14, 2011 is attached as Appendix I.

SECTION 2:
WHAT ARE WE PROPOSING?

NEW POLICY DIRECTION FOR WATER PROTECTION AND LAND USE

Guiding Principles for Policy

Reaction to the proposed changes in the groundwater protection zoning policy in the Burnside Report has resulted in this Green Paper recommending a new approach, a new philosophy towards the management of water resources. Central to that philosophy is the recognition that virtually all of the rainwater that falls on this island eventually reaches the coast, as either surface water flow or groundwater flow, carrying with it entrained solids, dissolved chemicals and microorganisms that can be detrimental to public health and to the environment. The whole of Barbados can and should therefore be regarded as a coastal zone.

It is also recognised that our beaches and reefs are perhaps our greatest physical asset. Therefore, it is prudent to develop a groundwater protection policy that not only seeks to protect drinking water quality, but also seeks to protect the coastal zone. The current policy does not. The following are suggested principles that will guide a new integrated approach and the scientific/technical axioms to which the new policy should abide:

(i) Access to freshwater should not be a constraint to national development. Therefore, the new water protection and land use policy should seek to maximise the economic value of both land and water resources.

(ii) Prevention is better than cure. Therefore, the policy should first seek to prevent pollution (chemical and biological) from entering the groundwater (e.g. restrictions on further population encroachment and hazardous chemicals usage), rather than relying solely on removing the contaminants at a water treatment plant (WTP) or a wastewater treatment plant (WWTP).

(iii) Integrated, synergistic approaches are better than ad hoc, potentially antagonistic approaches. Therefore, the policy should seek to address all major sources of water pollution (e.g. agricultural, industrial, domestic) using all the appropriate means (e.g. legal, institutional, technical, economic, social).

(iv) The polluter pays. Therefore, the policy should seek to use legal and economic instruments that force the polluter (waste generator) to bear some, if not all, of the costs of treatment/remediation. However, it is recognised that supply source environment, and eco-systems benefit all Barbadians and visitors, and therefore some of the costs of implementing this policy should be borne nationally.

(v) Policymakers (the Cabinet) should be informed by the best available data. Therefore, the policy should seek to create systematic provision of:

[7] minus evapotranspiration and the two major wastewater outfalls – Bridgetown and South Coast.

- Timely and accurate raw and treated freshwater and coastal water quality data.
- Storm water and wastewater flow (volumes).
- Enforcement and compliance data.
- Economic data.

(vi) Conflicts of interest should be avoided. Therefore, the policy should seek to separate regulatory and operational responsibilities by removing regulatory responsibility from the Barbados Water Authority and creating a Water Resources Agency (WRA) to take on this function. The policy should also focus on collaboration and partnerships amongst agencies in the overall sustainable management of the water resources.

(vii) Water should be fit for its intended purpose. Therefore, the policy should seek to categorise water uses (e.g. direct potable versus non-potable) and create/ legislate appropriate water quality standards for each proposed category of end use.

Suggested Scientific/Technical Guidance

(i) Hydrogeologically, the whole of Barbados including the Scotland District, should be treated as a "coastal zone"; i.e. any persistent contaminant released on land, or into the ground, is likely to reach the coast. Therefore, the policy should seek to protect all waters (fresh, brackish and saline).

(ii) Using travel time to protect groundwater is effective against biological pathogens when travel times are predictable.

(iii) Using travel times is ineffective against persistent chemicals (e.g. nitrates). The number of different persistent chemicals being used in Barbados has increased exponentially over the last 50 years.

(iv) Travel time decreases with increased abstraction rates. Abstraction rates have doubled at the Belle PSWs)since the original groundwater policy was implemented in 1964.

(v) Nitrogen is one of the primary chemical contaminants of concern both for
` groundwater and coastal waters. Agriculture (~50%) and sewage (~50%) are the primary sources of nitrogen in our groundwater.

(vi) Nitrogen flux to the coast is primarily through groundwater (85%), with surface water also contributing (15%).

(vii) Conventional sewage treatment (on-site septic tanks, or communal primary or secondary treatment) does not remove enough nitrogen of complex persistent organic chemicals to protect either drinking water or coral reefs. The government will conduct further research to identify low-cost wastewater treatment solutions for both high and low-density developments, which are appropriate for our culture and hydrogeology. Government will also establish and implement a comprehensive wastewater treatment

master plan to ensure continuous evolution of wastewater treatment.

(viii) There is already considerable encroachment in the existing Zone 1 areas, particularly at the Belle and Hampton. Even if existing settlements within the new Zone A's are sewered, no further encroachment should be allowed.

(ix) Housing density (pollutant load) is likely to increase in the proposed Zone B areas. Mandatory requirements for sewerage systems to be installed for new developments (particularly in Zone B) over a to-be-determined threshold density may necessitate the incorporation of a financial mechanism, which can be used for the maintenance, upkeep and service of communal wastewater systems. This may place a greater onus on the developers and /or owners association of new housing developments after their construction.

Policy Vision Statement

An integrated knowledge-based system that ensures a safe, affordable and abundant potable water supply to support domestic, agricultural, commercial and industrial development without adversely impacting the development, use or quality of marine resources and eco-systems.

Policy Aim

The 2020 Water Protection And Land Use Zoning Policy aims to protect public supply wells from above-ground sources of pollution and coastal waters from land-based sources of marine pollution through an integrated mix of legislative, technical, economic and social interventions.

Policy Objectives

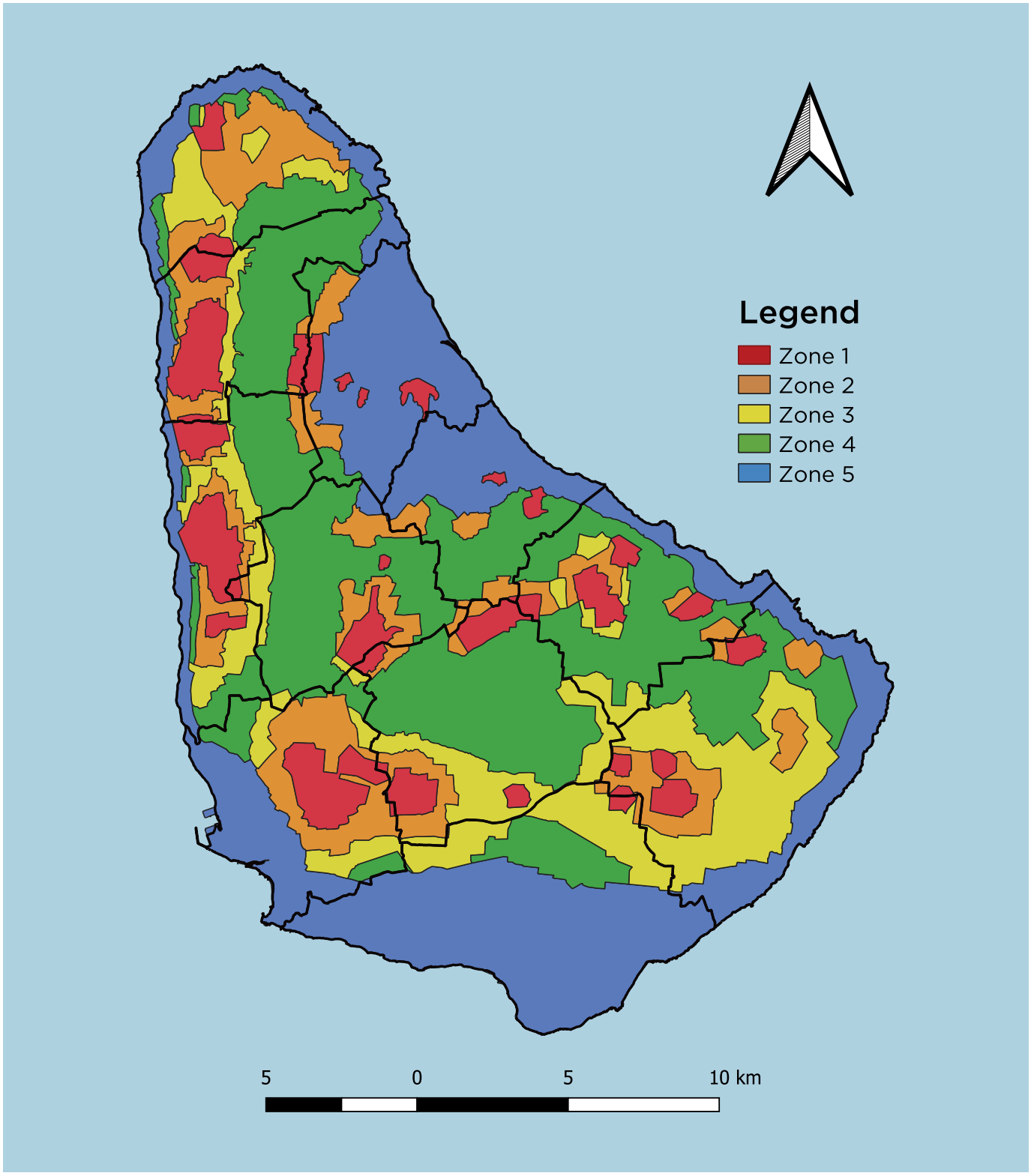
The objectives of the 2020 Water Protection And Land Use Zoning Policy are to:

(i) Prevent groundwater, storm water and coastal water contamination.

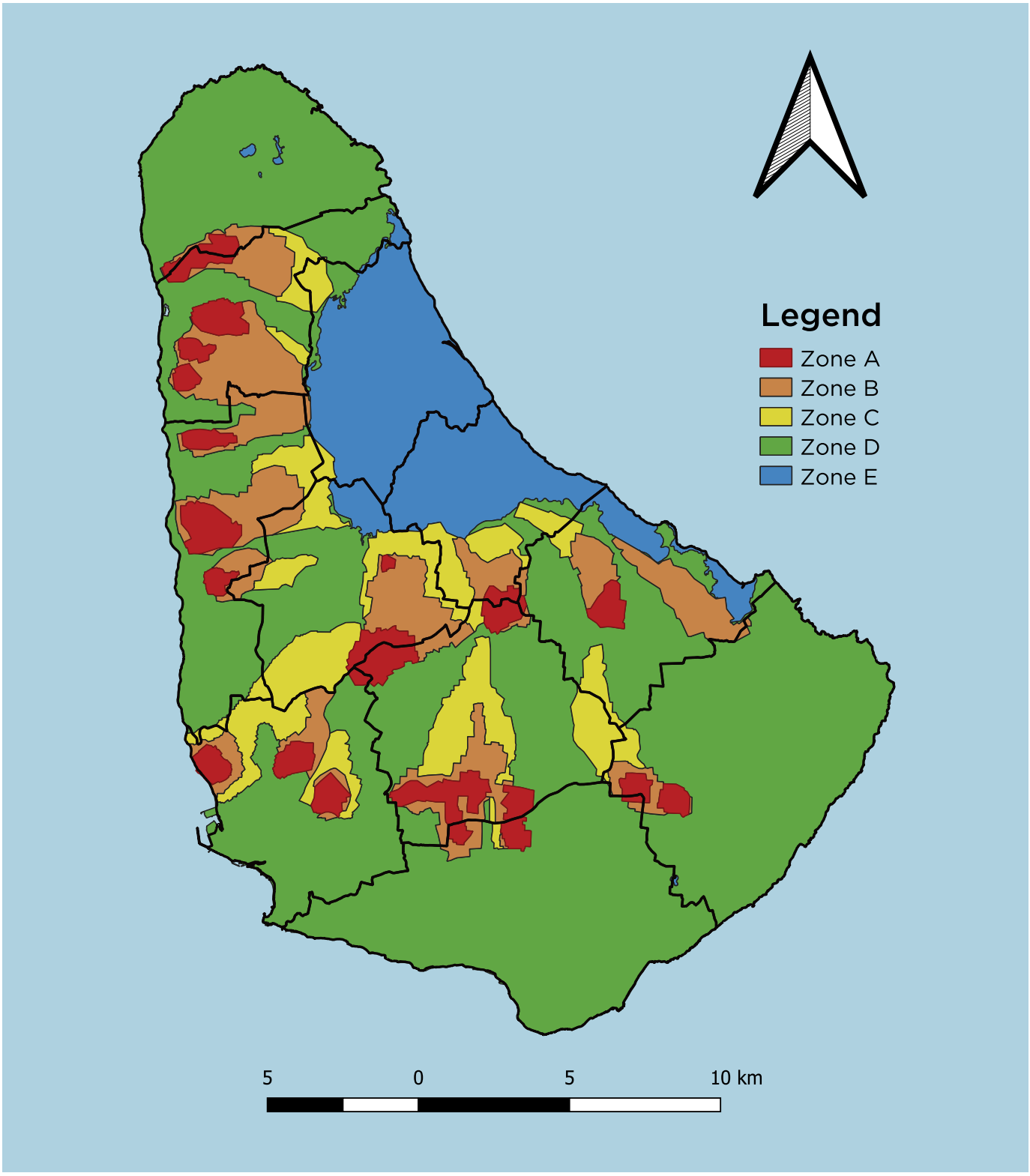
(ii) Use the most cost-effective water and wastewater treatment technologies that meet the appropriate standards.

(iii) Provide policymakers with sufficient information to allow informed, evidence-based decision making.

MAP #1 EXISTING WATER ZONES



MAP #2 NEW WATER ZONES



DELINEATION OF THE PROPOSED PROTECTION ZONES

The proposed protection zones (Zones A – E) (see Map 2) were developed from groundwater modelling, which was recognized as the most accurate method of delineation of these zones. The zones as delineated represent the areas within the aquifer that contribute water to the wells within a certain time frame. Based on the time frame from a point within the aquifer to the well, time travel capture zones were developed for the protection well and these capture zones in turn were used to delineate the protection zones. New, additional Zone A areas may become necessary to facilitate work already in progress by the Barbados Water Authority, such as is taking place at Groves St. Philip, where a new source of groundwater for potable supply has already been commissioned.

The premise of the proposed protection system is to reduce the source of the threats in the case of chemicals. The provisions of the new system will serve to reduce the chemical input to the aquifer. Under the existing zoning system even with large areas associated with Zone 1, chemicals are still being used near to the wells. The current proposal seeks to limit the use of chemicals (including agrochemicals) especially in close proximity to the wells and in this manner enhance the protection provided.

Modelling indicates that groundwater has a relatively short residence time within our unconfined aquifers. Therefore, in addition to still using time of travel, the new policy also recommends more attention to other water protection strategies, for example, restricting land-use activities as appropriate (including intensive agriculture/animal husbandry) and the use of best management practices. This integrated approach is preferred rather than relying on degradation and attenuation of contaminants which are all time dependent.

It is to be noted that residence time within the aquifers in Barbados is insufficient to allow for the decay of some persistent chemicals of concern, and hence protection from these chemicals was focused on removal of the source of contamination rather than on treatment. In the case of ubiquitous chemicals like nitrates, the new policy recognises than an integrated approach combining restrictions on development in some areas, changes in farming practices and the use of treatment technologies to remove/reuse nitrates from water and wastewater will be required.

RECOMMENDATIONS FOR THE PROPOSED WATER PROTECTION AND LAND USE ZONING POLICY

The recommendations for the proposed water protection and land use Zoning Policy are as follows:

Zone A - Exclusion Zone

(i) There will be extension from the proposed 200 metre exclusion zone to a 200-day time-of-travel based on average

die-off times for bacteria travelling in groundwater.

(ii) Agriculture Class-Two will be the only type of agricultural activity permitted within the zone. This will include horticulture, fruit growing, seed growing and the use of land for market gardens, nursery grounds, woodland or forestry with enforceable best management practices being adopted. These practices will be enforced by the Ministry of Agriculture.

(iii) Low environmental impact development such as solar PV and wind farms may be allowable under specific permitting conditions.

Zone B - Pathogen Management Zone

(i) This zone will have a 300-day time-of-travel.

(ii) The main method of protection offered in this zone will be the elimination of significant sources of pathogens.

(iii) Existing land users will be asked to adopt best management practices; however, a phased-in approach for these practices will be applied.

(iv) Government will determine which areas will have to be sewered.

Zone C - Chemical Management Zone

(i) This zone will be a chemical management zone with a two-year time of travel to justify the proposed restrictions.

(ii) There will be provision of nutrient removal systems in the sensitive areas to protect public water supply sources. The provision will be aimed at protecting the public water supply sources; as well as controlling nutrient-rich groundwater contamination of the marine ecosystem.

(iii) Storage and handling of fuel and fuel products will be restricted in Zone C and areas downstream of the public supply wells or outside of the catchment areas for the wells.

(iv) There will be a clear definition of the qualities and quantities of chemicals which can be stored in Zone C to provide a threshold level with the relevant criteria.

(v) Storage of chemicals over a stipulated amount will require a special permit dependant on the nature of the chemicals.

Zone D - Recharge Contributing Area

The remainder of the recharge area for an aquifer on the island is designated as Zone D or the Recharge Contributing Area (RCA). Regulations regarding wastewater disposal will apply in this area as well as across the entire island. This allows for the designation of additional sensitive areas where the regulatory body may ask that water resources be treated as if the sensitive area were a part of any of the aforementioned protection zones.

Zone E - Non-Recharge Contributing Area

The areas of the island outside of a protection zone and outside of the recharge area for the aquifer are included in this final zone which is also referred to as the Non-Recharge Contributing Area (NRCA).

The area is mainly the Scotland District and Panhandle. Wastewater disposal in the NRCA will be controlled by the existing standards for waste disposal.

Suck Wells

(i) Suck-wells will be discouraged as the primary means of sewage treatment island-wide.

(ii) An appropriate form of sewage treatment will be used in conjunction with suck-wells.

(iii) The mechanisms announced in the 2020 Budget will be put in place to help householders acquire and install water saving devices.

(iv) Options such as septic tanks or other technologies that allow for better removal of nutrients will be encouraged for new construction and Government will collaborate with the financial sector to provide financing solutions.

Scrap Yards and Vehicle Shops

(i) Scrap yards and vehicle shop operations will be controlled by the issuance of permits, monitoring and certification of their operators and operations.

Summary of Restricted land use in Zone C

(i) The following activities will be restricted in Zone C and no new activities from the following list allowed in Zone B:

Cemeteries; Funeral homes; Crematoria; Landfills; Motor Vehicle Service Stations and Chemical Manufacturing.

Spill Response Plan

(i) Oil well operators and transporters of oils and chemicals will be required to develop a spill response and management plan.

(ii) The existing National Oil Spill Response Plan will be strengthened in the necessary areas.

Dry Cleaners

(i) All dry cleaner operators must be certified by the Environmental Protection Department.

(ii) There must be a management plan for disposal of dry-cleaning chemicals.

Gasoline Retailers

(i) In relation to gasoline retailers/operators, existing gasoline operators/retailers will be required to comply with the latest best management practices and mandated to follow the adequate handling and storage protocol.

(ii) The practices of gasoline retailers must remain in keeping with the Storage of Petroleum Act Cap 172[8].

(iii) Gasoline retailers must have permits.

[8] The Storage of Petroleum Act Cap 172 is an Act to consolidate and amend the law relating to the storage and importation of petroleum and will need to be amended to compensate for the new proposed Land Use zoning terminology.

Criteria for Provision of Sewer Systems

(i) The implementation of the sewerage systems will be based on priorities determined through vulnerability studies, water protection objectives and public health.

Operations and Maintenance of Sewerage System

(i) Mechanisms will be implemented to ensure proper operation and maintenance of sewerage systems.

(ii) Low cost systems as an alternative to septic tanks will be investigated for use.

Proposed Regulated Activities

In order to allow for the protection of the groundwater resource, it is the industry standard to focus on protection rather than remediating the groundwater after it has been contaminated. The following activities (Table 7) would need to be regulated within the zones outlined above in order to prevent the occurrence of contamination from known or potential sources.

TABLE 2: PROPOSED REGULATED ACTIVITIES

Zone	Restricted Land Use/ Activity
Zone A Pathogen Exclusion	All
Zone B Pathogen Management	Sewage lagoons or any surface storage of chemicals.
	Sewage treatment via suck wells.
	Land application of manure based fertilizer.
	Storage or disposal of manure.
	Activities that generate animal waste, manure or other pathogenic contaminants.
	Waste disposal from meat or meat products facility.
	Waste disposal from sugar factories, rum plants, or other manufacturing/industrial facilities.
	Zoos, animal sanctuaries and other facilities for the intensive housing of animals.
	Landfills.

TABLE 2: PROPOSED REGULATED ACTIVITIES CONTD.

Zone C Chemical Management	Storage and handling of dry cleaning products
	Chemical Manufacturing and storage
	Recycling of scrap metals, automobiles, appliances and machinery.
301 day to 730 day TOT	Use of chemical based fertilizers on land.
	Use of Agro Chemicals on land.
	Storage of significant volume of fertilizers or other agricultural chemicals
	Storage of significant volume of household, industrial or other domestic chemicals
	Use of pesticides or other household chemicals on land
	Cemeteries or Crematoria
	Landfills
	Sewage treatment via suck wells
Zone D Recharge Contributing areas	Sewage treatment via suck wells
	Location of potential threat activities in the vicinity of "sensitive areas."
Zone E Non-Recharge Contributing areas	Location of potential threat activities in the vicinity of "sensitive areas."

Economic Impact

One of the economic implications of the proposals is associated with the lands that will be released (~ 16 sq. km or 4% of the land area of the island) from the previous designation of Zone 1, and made available for the development process; (see Table 8 on page 37).

Within the existing policy, lands within Zone 1 are not open to development; the proposal would however remove some portions of these lands from the most stringent restrictions and make them potentially available for development. It should be noted that relevant development guidelines for sewage treatment, drainage and chemical handling will need to be observed to

TABLE 3: COMPARISON BETWEEN LAND AREA OF EXISTING VS PROPOSED ZONES

EXISTING ZONES			PROPOSED ZONES			
ZONE	AREA (SQ KM)	% OF IS-LAND	ZONE	AREA (SQ KM)	% OF ISLAND	%(+) OR %(-)
1	39.3	9	A	23	5	-4
2	55.9	13	B	46	11	-2
3	69.1	16	C	41	9	-7
4	137	32	D	268	61	29
5	131.3	30	E	55	12	-18

ensure that no greater harm occurs to the aquifer from the development of these released lands. It is recommended that development should be undertaken in a manner that is consistent with the vision for growth provided in the Physical Development Plan (2013) and the amended plan (2017). The release of lands from Zone 1 may make additional lands available to the development process; whether these lands are actually developed, remains a function of land use planning considerations under the Physical Development Plan and the development review process for water, wastewater and environmental impacts of each development.

The minimum standards for wastewater disposal in the new policy would result in an increased cost for house building. Consideration may be given to offering rebates to homeowners who implement the minimum standards; however, this would then become a cost to the Government. Additionally, Government may choose to assist low income earners in new homes with the cost of including systems that meet the new minimum standards.

There would be a cost for the establishment and operation of the Water Resources Agency. The economic implications associated with this are the costs to support salaries for the staff and funding for regulatory and investigative functions. Some revenue will be generated through the licensing system associated with some regulated water uses.

Legal Considerations

For the successful implementation of a policy as far-reaching as the new water protection and land use Zoning Policy being proposed, the Ministry of Energy and Water Resources is keenly aware of the need to address and enforce new legislation and regulations.

There has been consideration of a full comprehensive approach to legislation to cover all the regulatory aspects of the new 2020 Water Protection And Land Use Zoning Policy. This will include roles and responsibilities as presently encapsulated in legislation and those which are envisioned for the new Water Resources Agency.

Presently, the matter of zoning is spoken to in the Physical Development Plan (2013) as well as the Draft Physical Development Plan (2017) but the outline of its applicability does not allow for the enforcement that is required. Therefore, any new Water Protection And Land Use Zoning Policy will require a new suite of legislation which speaks to the roles and responsibilities of the newly conceptualised Water Resources Agency[9] and which bequeaths to this agency the full gamut of responsibilities for its successful operation, including penalties for infractions.

To be thorough in the application of responsibilities it may be necessary to develop, inter alia, the following legislation:

- Water Resources Agency Act.
- Water Protection Act.
- Water Reuse Act and Regulations.
- Environmental Management Act.
- Chemicals Management Act.

In line with the need to modernise existing legislation the following pieces of legislation may need to be amended:

- Barbados Water Authority Act, Cap. 274A.
- Pesticides Control Act, Cap. 395.
- Health Services Act, Cap. 44.
- Planning and Development Act 2019.
- The Highways Act, Cap 289.
- The Prevention of Floods Act, Cap 235
- The Storage of Petroleum Act Cap 172

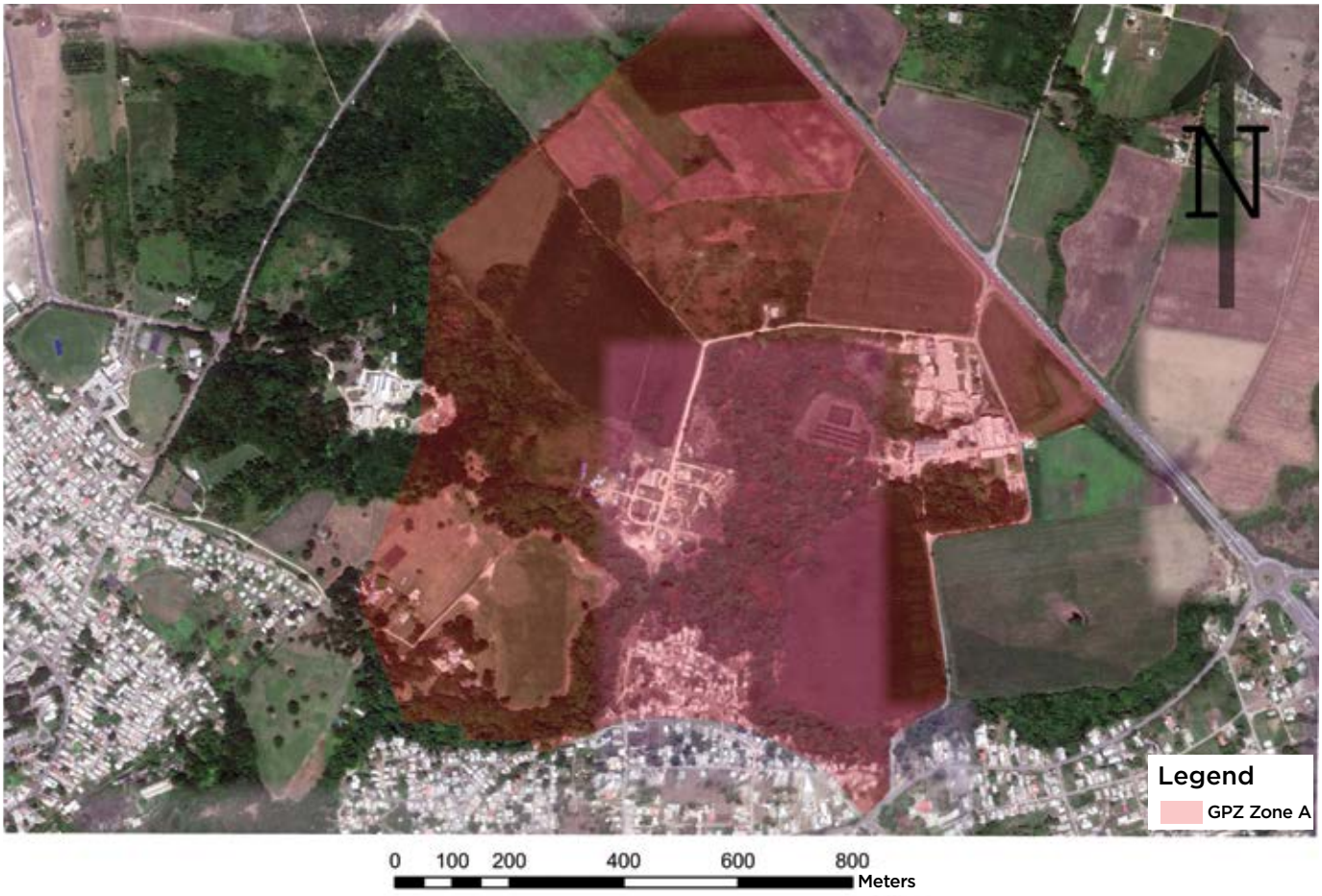
It is recognised that virtually every aspect of Barbados' development can potentially be affected by the safety of potable water made available through the public distribution systems. The Ministry of Health and Wellness has responsibility for managing risks within the water supply systems of Barbados and should maintain responsibility for developing, implementing and enforcing a regulatory framework for protecting the public's health from water-borne risks and hazards.

The development, setting, monitoring and enforcement of drinking water standards should be a shared responsibility of a technical committee designated to oversee drinking water quality with the lead agency being the Ministry of Health and Wellness. This committee should include, inter alia, the Environmental Protection Department, the Barbados Water Authority, the Water Resources Agency, the Coastal Zone Management Unit and the Barbados National Standards Institution.

[9] All roles and responsibilities for the organisations necessary to bring this Water Protection and Land Use Zoning Policy are delineated in Table 8 in Section 3.

TECHNICAL OPTIONS CONSIDERED FOR THE BELLE

PROPOSED WATER ZONES IN AND AROUND THE BELLE



The Belle has benefitted from a detailed analysis of the technical options available for dealing with environmental public health risks. The results of this analysis are shown below in Tables 2-6. Similar analyses and recommendations may be required for the other proposed Zone A areas.

TABLE 4: OPTION #1 FULL REVERSE OSMOSIS TREATMENT WITHOUT SEWERING

Options for Treating Groundwater	Requirements	Advantages	Disadvantages
Full Reverse Osmosis Treatment Without Sewering.	Treating the full capacity (100%) or 52,000 m^3/day of existing source. **Requirements:** Pre-treatment. Environmental Impact Assessment Study. Detailed Designs.	Reduction in the nitrate levels. Barrier against any sudden increase in nitrates. Ability to accommodate increased development in the areas closer to the water well. Improved living conditions for existing residents, multiple contaminant removal.	High Capital Cost. 15% loss of yield. May be damaged by hydrocarbons. RO will remove bacteria and viruses but may need an additional barrier like UV treatment. Membrane fouling and scaling, lower water recovery, operational complexity, energy demands, waste disposal.

TABLE 5: OPTION #2: FULL REVERSE OSMOSIS TREATMENT ALONG WITH SEWERING

Options for Treating Groundwater	Requirements	Advantages	Disadvantages
Full Reverse Osmosis Treatment along with sewering.	Treating the full capacity (100%) or 52,000 m^3/day of existing source. **Requirements:** Pre-treatment. Detailed Designs. Environmental Impact Assessment Study.	Reduction in the level of nitrates that would reach the groundwater.	Higher Capital Cost. 15% loss of yield. May be damaged by hydrocarbons. RO will remove bacteria and viruses but may need additional barrier like UV treatment. Membrane fouling and scaling, lower water recovery, operational complexity, energy demands, waste disposal.

TABLE 6: OPTION #3: PARTIAL REVERSE OSMOSIS TREATMENT WITHOUT SEWERING

Options for Treating Groundwater	Requirements	Advantages	Disadvantages
Partial Reverse Osmosis Treatment without sewering.	Partial Treatment (~28%) or 15,000 m^3/ day of existing source and blending it with the remaining 37,000 m3/day. Detailed Designs. Pre-treatment required. Environmental Impact Assessment Study.	Reduction in the level of nitrates that would reach the groundwater.	High Capital Cost. 15% loss of treated water (4% overall yield loss). May be damaged by hydrocarbons. RO will remove bacteria and viruses but may need additional barrier like UV treatment. Membrane fouling and scaling, lower water recovery, operational complexity, energy demands, waste disposal.

TABLE 7: OPTION #4: PARTIAL REVERSE OSMOSIS TREATMENT ALONG WITH SEWERING

Options for Treating Groundwater	Requirements	Advantages	Disadvantages
Partial Reverse Osmosis Treatment along With Sewering.	Partial Treatment (~28%) or 15,000 m^3/ day of existing source and blending it with the remaining 37, 000 m^3/ day. **Requirements:** Detailed Designs. Pre-treatment required. Environmental Impact Assessment Study.	Reduction in the level of nitrates that would reach the groundwater.	Higher Capital Cost. 15% loss of treated water (4% overall yield loss). May be damaged by hydrocarbons. RO will remove bacteria and viruses but may need additional barrier like UV treatment. Membrane fouling and scaling, lower water recovery, operational complexity, energy demands, waste disposal.

TABLE 8: ADDITIONAL OPTIONS:

Options for Treating Groundwater	Requirements	Advantages	Disadvantages
Sewering with no water treatment.	Environmental Impact Assessment Study Detailed Designs.	Reduction in the level of nitrates that would reach the groundwater.	Risk of sewers leaking into the groundwater system.
Full Electro-dialysis treatment without sewering.	Pre-treatment. Detailed design. Environmental Impact Assessment Study.	Multiple contaminant removal, higher water recovery (less waste) than desalination, unaffected by silica.	Energy demands, operational complexity, waste disposal.
Full Ion Exchange Treatment without sewering.	Pre treatment Detailed design Environmental Impact Assessment Study	Nitrate selective resins, common application, multiple contaminant removal	Potential for nitrate peaking, high chemical use (salt), brine waste disposal, potential for disinfection by-product formation.
Do Nothing Option.			

SECTION 3: INSTITUTIONAL ASSESSMENT, IMPLEMENTATION SCHEDULE

Integrated Institutional Policy Implementation Strategy

The implementation and enforcement of the new Water Protection And Land Use Zoning Policy, including the recommended water and waste-water treatment options, will involve multiple agencies to be successful. Coordination of the development and enforcement of drinking water standards and the need to strengthen institutional capacity through the creation of the Water Resources Agency has already been alluded to. The following table (Table 9) describes some of the expected responsibilities of relevant existing and proposed agencies but does not address potential capacity constraints.

RESPONSIBILITIES OF RELEVANT AGENCIES

TABLE 8: RESPONSIBILITIES OF RELEVANT AGENCIES

Agency	Responsibilities	Remarks
Town and Country Development Planning Office	• Review and approval of development applications. • Enforcement of physical development plan and zoning systems development restrictions. • Education of developers on zoning restrictions.	Revised draft PDP already incorporates new groundwater protection zones.
Water Resources Agency	• Enforcement of zoning regulations. • Assessment of effectiveness of zoning system. • Evaluation of impact of new development projects on groundwater. • Review, amend, delineate and map groundwater protection zones and regulations. • Long-term monitoring of groundwater quality. • Groundwater vulnerability and risk assessment and mapping. • Monitoring of groundwater levels and groundwater use. • Administering the groundwater abstraction licensing scheme and approval of water impoundment and augmentation options. • Water resources assessment. • Monitoring surface water and preparing water budgets • Plan and evaluate water reuse strategies. • Research and identification of new sources of water.	The agency is expected to take over the management of water resources from the BWA as well as enforce the groundwater protection system. This will address the conflict of BWA being a service provider and regulator.

Environmental Protection Department	• Development and enforcement of waste disposal standards. • Chemical use and storage management and control. • Review, approval and licensing of wastewater treatment and disposal systems. • Monitoring and review of effectiveness of water and wastewater treatment plants. • Monitoring beach water quality.	Legislatively, the regulation and approval of package wastewater treatment plants, and development of drinking water standards currently rests with the BWA.
Ministry of Agriculture and Food Security	• Development, implementation, monitoring and control of best management practices (BMP) for agricultural chemical applications, irrigation, animal husbandry and animal waste disposal practices. • Training of Farmers in BMPs, analytical services and administering the Pesticides Control Board and unit.	
Ministry of Health and Wellness	• Establishment of a water and sanitation surveillance framework with specific responsibility for the management of public health issues relevant to water and waste disposal. • Development and enforcement of public health sanitary standards for public and private water production, processing, supply, transport, storage and distribution systems. • Plan and evaluate water reuse strategies. • Develop, implement and enforce amendments to the Health Services Act to include water quality regulations.	Legislatively, the regulation and approval of package wastewater treatment plants, and development of drinking water standards currently rests with the BWA.

	• Implement amendments to the Health Services Waste Disposal Regulations to manage public health hazards associated with wastewater treatment and disposal systems and wastewater reuse. • Develop and implement relevant interventions and communication protocols for public health risks and emergency situations associated with water quality and waste disposal. • Monitor and report on new, existing and emerging waterborne disease trends in the population. • Monitor the quality of drinking water.	
Barbados Water Authority	• Monitoring of raw feed water and product water quality at the wells under the responsibility of the BWA • Provision of water and sewerage services.	Revised draft PDP already incorporates new groundwater protection zones.
Ministry of Public Works and Transport (Including the Drainage Unit)	• Control and management of storm water.	
Coastal Zone Management Unit	• Monitoring the quality of marine eco-systems. • Development and implementation of coastal zone management.	

Table 8 blends both existing and proposed roles and responsibilities. It is recognised that there will need to be further analysis to identify inefficient overlaps and gaps.

RECOMMENDED PHASING OF THE PROGRAMME OF ACTIVITIES

Several actions have been recommended in this Paper that have institutional, legal, economic, environmental and social implications. It is suggested that these actions be phased as follows to allow for effective implementation:

Phase 1 (Year 0 to Year 2)

Institutional:

- Create the Water Resources Agency; strengthen the Pesticides Control Unit; the Government Analytical Services and the Ministry of Health and Wellness surveillance program. Costs are not estimated.

Legal and Policy:

- Approve the new Water Protection And Land Use Zoning Policy and create new and revised legislation, as required, including "triggers" for compulsory sewering of developments and a licensing/permitting system for wastewater treatment plants.

Social:

- Implement a public awareness program to sensitise the population to the vulnerability of drinking water and coastal waters to pollution. Implement special awareness/education/incentives programs for farmers. Estimated annual costs: BDS$1,000,000.

Technical:

- Sewer the Belle and surrounding areas (estimated capital cost of US$ 22.3M[10]) .
- Monitor raw water quality at the Belle (ex-ante and ex post sewering) (estimated annual cost: BDS$100,000).
- Conduct pilot trials with communal wetlands (estimated cost: BDS$0.5M).

Phase 2 (Year 3 – 5)

Continue social programs.

Technical:

- Sewer other areas with high housing density and groundwater vulnerability. Capital costs not estimated.
- Install partial RO treatment at the Belle (estimated capital cost: US$55.3 M), if raw water data ex post sewering in Phase 1 merits such action.
- Install partial/full RO treatment at other public supply wells, as dictated by water quality data.

[10] Using a 5% compounding factor on the estimates provided by Stantec in 2002.

SECTION 4: CONCLUSIONS AND RECOMMENDATIONS

FINAL RECOMMENDATIONS FOR CONSIDERATION AND DISCUSSION

The following is a summary of the key recommendations:

- Barbados implements the new water protection and land use zoning regulations.

- The Chief Parliamentary Counsel prepares the Barbados Water Authority (Amendment) Bill, 2020 and the Barbados Water Authority (Water Zones) Order, 2020 to bring the new water zones into effect, noting that these new zones are reflected in the Draft Amended 2017 Physical Development Plan. Comments on this legislation were received from the Chief Town Planner, the General Manager of the Barbados Water Authority, the Director of the EPD and the Chief Environmental Health Officer.

- Along with the 2020 Water Protection And Land Use Zoning Policy, it is further recommended that in Phase 1, the Belle and the densely populated environs (e.g. Ivy and Licorish Village) are sewered. In Phase 2, other developments in at risk areas should be sewered. Furthermore, in Phase 2, after monitoring the nitrate levels in the groundwater at the Belle and determining the effectiveness of the sewerage system and changes in agricultural practices in lowering the nitrate levels, it may be necessary for a partial reverse osmosis plant to be installed at the Belle.

- There will be a need for regulations prohibiting the use of suck wells only as the primary form of wastewater treatment. Further research into low cost treatment technologies for individual and communal/municipal systems along with the creation of facilitative financial mechanisms will be necessary.

- It is acknowledged that the installation of a reverse osmosis (RO) treatment plant at the Belle, if necessary, after sewering the existing properties in the area, will result in the loss of approximately 15% of the water that is treated. Under the partial RO treatment option, ~28% of the abstracted water would be treated, resulting in losses of approximately 4% (2,200 m^3/day or ~0.5 MIGD) of the overall flow. Building the sewerage system for the Belle, before potentially installing a RO system, would also provide a means of disposal for the RO effluent, which would be fed into the Belle sewerage system, which itself would be connected to an upgraded Bridgetown system. Regulated wastewater reuse will be encouraged.

- A Water Resources Agency will be created to regulate water resources management; the Pesticides Control Unit is strengthened, and the analytical capacity of the Government Analytical Services increased. Furthermore, the surveillance capacity of the Ministry

of Health and Wellness and the Environmental Protection Department should be increased and a general public awareness program on water pollution prevention devised and launched by the Government Information Service.

- A comprehensive educational and economic incentives/penalties program for farmers to promote eco-friendly practices, particularly pertaining to the application of agrochemicals, should be devised and launched by the Ministry of Agriculture and Food Security.

- There should be strict enforcement of the policy of no further housing development in Zone A.

- In Zones B, C, D and E there should be the implementation of strict regulations and enforcement of laws for new and existing housing developments. These will include the following:

  (i) New developments that anticipate high housing density with high wastewater flows (e.g. > 45 m^3/day) should be mandated to have a sewerage system installed, and meet operational standards specified in a licensing and permitting system administered by the EPD. Provision should also be made for a transportation mechanism to remove the treated effluent for proper disposal, if required.

  (ii) New developments with sewerage systems should have the plans for these systems reviewed by the EPD in collaboration with the TCPDO and should have the installed systems licensed and permitted by the EPD.

  (iii) New developments where it is not anticipated that there will be a high housing density, should be obligated to install individual disposal systems such as septic tanks with additional treatment as specified by the EPD, if required.

  (iv) Existing developments with high housing density should also be sewered. This should be the responsibility of the government. The Belle community would be the first priority, followed by the development in Ashton Hall and Hampton.

  (v) The enforcement of these additional regulations should be managed by the EPD, Water Resources Agency and Ministry of Health and Wellness.

- It is to be noted that additional consideration should be given to the institutional structure and regulatory framework best suited for efficient enforcement, and the specific roles which the supporting agencies will play.

- New and amended legislation will have to be drafted which may include the following:

- Water Resources Agency Act
- Water Protection Act
- Water Reuse Act and Regulation
- Environmental Management Act
- Chemicals Management Act
- Storage of Petroleum Act

In conclusion, Barbados has benefitted from a deserved reputation for having a safe drinking water supply. However, increased housing densities including encroachment into Zone 1 areas, changes in agricultural practices and industrialisation have impacted groundwater, stormwater and coastal water quality. A policy that seeks to protect public supply wells from sources of contamination continues to be justified. However, the groundwater protection policy, developed in the 1960's, could be made both more effective and efficient by placing more emphasis on an integrated approach, that seeks to also protect coastal water quality. This Green Paper has sought to outline such an approach and is submitted for public consideration.


APPENDICES

APPPENDIX 1: CABINET'S DECISION

The Cabinet of Barbados in relation to the Comprehensive Review and Overhaul of the Groundwater Protection Zoning Policy and System of Barbados' Study agreed, among other things:

(i) That any revised Groundwater Protection Zoning Policy should be located within the framework of an 'Integrated Water Resources Management and Protection Policy', which would afford protection to the marine ecosystem;

(ii) To the following definitions and conditions to delineate the new zones for the island:

Zone A – Exclusion Zone

(a) An exclusive zone which should be delineated by a 90-day time-of-travel based on die-off time for bacteria travelling in ground water from the outer boundary of the zone to the well. This would allow agencies which undertake sampling for water quality, for example, the Barbados Water Authority (BWA), the Environmental Protection Department (EPD), Ministries of Health and Agriculture, at stations, (in the case of the BWA, every 30 days) to use this time as an early warning system to track pollutants in the ground water.

(b) Only activities associated with the development of water resource development should be permitted in this zone. Any existing housing that legally exists within the zone should be permitted to remain and allowed to improve its amenities.

Zone B – Pathogen Management Zone

(a) A Pathogen Management Zone to be referred to as Zone B should be established and delineated by a 91 – 300-day time-of-travel. This represents the criteria that were used to define the current Zone 1 boundaries. The aim of the Pathogen Management Zone is to provide protection to the aquifer from pathogenic (bacteria and other microscopic pathogens) sources. The main method of protection offered through this zone is the elimination of sources of pathogen from it.

(b) That population growth in this zone should be managed through land use planning legislation.

(c) The criteria established by the EPD of 10,000 Imperial Gallons per day (IGPD) (37,000 litres) should be adopted as the minimum flow rate requiring a communal sewage system in a new development.

(d) This responsibility for operating communal sewage systems should be placed in hands of private operating agencies under the EPD's oversight.

(e) Support "grandfathering" existing land uses but require existing land users to adopt best management practices to be implemented over a defined phase-in period.

Zone C – Chemical Management Zone

(a) A Chemical management zone referred to as Zone C should be established and delineated by 301-730 day time-of-travel. This zone should focus on the management and regulation of chemicals that would pose a threat to the aquifer.

(b) There should be provision of nutrient removal systems in the sensitive areas to protect public water supply sources. The provision should not be limited to protecting the public water supply ources. It should also be targeted at controlling nutrient rich groundwater flows to the marine ecosystem.

(c) Storage and handling of fuel and fuel products should be banned in Zone C and be restricted to areas downstream of the public supply wells or outside of the catchment areas for the wells.

(d) The provision for persons acquiring permits for storage of chemicals on their property over a stipulated amount. Permits should be based on how the chemicals would be controlled.

Zone D – Recharge Controlling Zone

(a) The remainder of the recharge area in the limestone aquifer on the island is designated as Zone D or the Recharge Contributing Area (RCA). This is similar to the current Zones 4 and 5 areas under the existing Zoning Policy.

(b) Regulations regarding wastewater disposal are applicable in this area as well as across the entire island.

(c) The proposal allows for the designation of additional sensitive areas where a regulatory body may ask that water resources be treated as if the sensitive areas were a part of any of the aforementioned protection zones.

Zone E – Non-Re-charge Contributing Area(Scotland District)

(a) The areas of the island outside of a protection zone and outside of the recharge area for the aquifer are included in this final zone which is also referred to as the Non-Recharge Contributing Area (NRCA).

(b) The NRCA comprises the areas where impermeable rock occurs at the surface and is mainly confined to the Scotland District and Panhandle.

(c) It is proposed that wastewater disposal in the NRCA be controlled by standards for waste disposal developed for the entire island.

(iii) Agreed to the abandonment of suck wells being used as the primary means of sewage treatment island wide. Appropriate forms of sewage treatment, to be outlined in detail, should be used ahead of suck wells;

(iv) Agreed to the provision of a mechanism that allows householders and operators of wastewater treatment facilities to immigrate to other systems ahead of the suck wells;

(v) Agreed to the control of scrap yards and vehicle shops operations through the issuance of permits, monitoring and certification of their operators and operations;

(vi) Agreed to the restriction of the following activities in Zone C while instituting a ban in Zone B:

(a) Cemeteries
(b) Funeral homes
(c) Crematoria
(d) Landfills
(e) Motor Vehicle Service Stations
(f) Chemical Manufacturing

(vii) Agreed that oil well operators and transporters of oils and chemicals develop a spill response and management plan;

(viii) Agreed that the National Oil Spill Response Plan be developed/ strengthened and a management plan for disposal of dry-cleaning chemicals be developed and/or strengthened;

(ix) Agreed that gasoline retailers/operators should be:

(a) Required to comply with the latest best management practices; and

(b) Mandated to follow the adequate handling and storage protocols; and

(x) Noted that legislative change was necessary to change the Zones.

APPENDIX 2:

Cost Comparisons and Indicative Sewering Costs

COMPARISON OF COSTS OF REVERSE OSMOSIS TREATMENT OPTIONS
2002 USD

	52,000 m3/ day RO Plant without Sewering	52,000 m3/day RO Plant with Sewering	15,000 m3/ day RO Plant without Sewering	15,000 m3/day RO Plant with Sewering
Capital Cost	183,800,000	217,800,000	85,800,000	120,075,834
Annual Equivalent Capital Cost	9,190,000	10,890,000	4,290,000	6,005,629
Ave Annual O&M	7,776,000	9,148,000	3,630,000	4,700,675
Total Annual Equivalent Cost	200,766,000	237,838,000	93,800.000	130,782,120

CONSTRUCTION COST FOR SEWERING THE BELLE
2002 USD

Sewerage System Phases 1, 2, 3 and Connection to Bridgetown System. (2002)	Reverse Osmosis Plant Treating 15,000 m3/day (2002)
$10,221,420 USD	$25,338,000 USD

The **2020 Water Protection and Land Use Zoning Policy** was produced by the **Ministry of Energy and Water Resources** in collaboration with the **Barbados Water Authority**.

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