The Official Gazette

PUBLISHED BY AUTHORITY

VOL. CLVII No. 5

Part A BRIDGETOWN, BARBADOS, 13TH JANUARY, 2022

Contents

S.I. 2022 No. 3: Coastal Zone Management Plan and Coastal Zone Management Area (Boundaries) Order, 2022.

S.I. 2022 No. 4: Declaration of Approved Small Business (Hopewell Distillery Inc.) Order, 2022.

Printed and Published by
the Barbados Government Printing Department

BARBADOS

The Official Gazette Part A 13th January, 2022

Statutory Instrument

S.I. 2022 No. 3

Coastal Zone Management Act

CAP. 394

COASTAL ZONE MANAGEMENT PLAN AND COASTAL ZONE MANAGEMENT AREA (BOUNDARIES) ORDER, 2022

The Minister, in exercise of the powers conferred on him by section 7(2) of the *Coastal Zone Management Act*, makes the following Order:

1. This Order may be cited as the *Coastal Zone Management Plan and Coastal Zone Management Area (Boundaries) Order, 2022*.

2. The boundaries in respect of the areas of land and sea set out in the *First Schedule* and shown on the maps set out in the *Second* and *Third Schedules* shall constitute the Coastal Zone Management Area for Barbados.

3. The Coastal Zone Management Plan set out in the *Fourth Schedule* shall constitute the Coastal Zone Management Plan for Barbados.

FIRST SCHEDULE

(Paragraph 2)

Coastal Zone Management Area (Boundaries) Order, 2022
(S.I. 2022-)

Boundaries of the Coastal Zone Management Area

Sub-Area 1

All that area of land and sea, being areas of the coastline in the parish of Christ Church and the parish of St. Philip which are shown as sub-area 1 on the map of the coastal zone management area.

Land areas of coast

All that land ABUTTING and BOUNDING along the coastline, commencing at Barbados Grid co-ordinate point 33129.503482, 60518.520431, inclusive of all the co-ordinate points thereafter, to a point ending at the Barbados Grid co-ordinate point 44712.967883, 71624.779617.

Maritime Boundary

All the seas located in the area commencing at Barbados Grid co-ordinate point 32864.62016, 57899.92681, inclusive of all the co-ordinate points thereafter, to a point ending at Barbados Grid co-ordinate point 47945.701498, 71754.0295.

Sub-Area 2

All that area of land and sea, being areas of the coastline in the parish of St. Philip and the parish of St. John which are shown as sub-area 2 on the map of the coastal zone management area.

First Schedule - (Cont'd)

Land areas of coast

All that land ABUTTING and BOUNDING along the coastline, commencing at Barbados Grid co-ordinate point 44734.998336, 71667.600097, inclusive of all the co-ordinate points thereafter, to a point ending at Barbados Grid co-ordinate point 40799.531863, 75127.281083.

Maritime Boundary

All the seas located in the area commencing at Barbados Grid co-ordinate point 47930.573177, 71801.685915, inclusive of all the co-ordinate points thereafter, to a point ending at Barbados Grid co-ordinate point 40926.157156, 77296.958047.

Sub-Area 3

All that area of land and sea, being areas of the coastline in the parish of St. John, the parish of St. Joseph and the parish of St. Andrew which are shown as sub-area 3 on the map in the coastal zone management area.

Land area of coast

All that land ABUTTING and BOUNDING along the coastline, commencing at Barbados Grid co-ordinate point 40754.0022, 751750.235395, inclusive of all the co-ordinate points thereafter, to a point ending at Barbados Grid co-ordinate point 28662.592588, 863603.615127.

Maritime Boundary

All the seas located in the area commencing at Barbados Grid co-ordinate point 40881.573487, 77319.592013, inclusive of all the co-ordinate points thereafter, to a point ending at Barbados Grid co-ordinate point 31852.147394, 86835.210388.

First Schedule - (Cont'd)

Sub-Area 4

All that area of land and sea, being areas of the coastline in the parish of St. Lucy and the parish of St. Peter which are shown as sub-area 4 in the map in the coastal zone management area.

Land area of coast

All that land ABUTTING and BOUNDING along the coastline, commencing at Barbados Grid co-ordinate point 28678.053245, 86350.876819, inclusive of all the co-ordinate points thereafter, to a point ending at Barbados Grid co-ordinate point 24098.469851, 91856.662786.

Maritime Boundary

All the seas located in the area commencing at Barbados Grid co-ordinate point, 31832.570536, 86881.218503, inclusive of all the co-ordinate points thereafter, to a point ending at Barbados Grid co-ordinate point 24057.530483, 94574.807276.

Sub-Area 5

All that area of land and sea, being areas of the coastline in the parish of St. Lucy which are shown as sub-area 5 on the map of the coastal zone management area.

Land area of coast

All that land ABUTTING and BOUNDING along the coastline, commencing at Barbados Grid co-ordinate point 23910.264583, 91943.71278, inclusive of all the co-ordinate points thereafter, ending at Barbados Grid co-ordinate point 23954.897194, 91969.649927.

First Schedule - (Cont'd)

Maritime Boundary

All the seas located in the area commencing at Barbados Grid co-ordinate point, 24007.856403, 94580.506907, inclusive of all the co-ordinate points thereafter, to a point ending at Barbados Grid co-ordinate point 18052.19739, 87088.588052.

Sub-Area 6

All that area of land and sea, being areas of the coastline in the parish of St. James, the parish of St. Peter and the parish of St. Lucy which are shown as sub-area 6 on the map of the coastal zone management area.

Land area of coast

All that land ABUTTING and BOUNDING along the coastline, commencing at Barbados Grid co-ordinate point 20293.030215, 87168.966263, inclusive of all the co-ordinate points thereafter, to a point ending at Barbados Grid co-ordinate point 21586.528259, 70365.813537.

Maritime Boundary

All the seas located in the area commencing at Barbados Grid co-ordinate point 18058.464113, 87038.982325, inclusive of all the co-ordinate points thereafter, to a point ending at Barbados Grid co-ordinate point 19830.527507, 70220.083007.

Sub-Area 7

All that area of land and sea, being areas of the coastline in the parish of St. Michael which are shown as sub-area 7 on the map in the coastal zone management plan.

First Schedule - (Concl'd)

Land area of coast

All that land ABUTTING and BOUNDING along the coastline, commencing at Barbados Grid co-ordinate point 21613.008845, 70324.044431, inclusive of all the co-ordinate points thereafter, to a point ending at Barbados Grid co-ordinate point 25583.011639, 64689.704868.

Maritime Boundary

All the seas located in the area commencing at Barbados Grid co-ordinate point, 19826.927279, 70170.212792, inclusive of all the co-ordinate points thereafter, to a point ending at Barbados Grid co-ordinate point 21700.759024, 62696.68106.

Sub-Area 8

All that area of land and sea, in the parish of Christ Church which are shown as sub-area 8 on the map of the coastal zone management area.

Land area of coast

All that land ABUTTING and BOUNDING along the coastline, commencing at Barbados Grid co-ordinate point 25585.421779, 64640.510748, inclusive of all the co-ordinate points thereafter, to a point ending at Barbados Grid co-ordinate point 33080.407326, 60512.566061.

Maritime Boundary

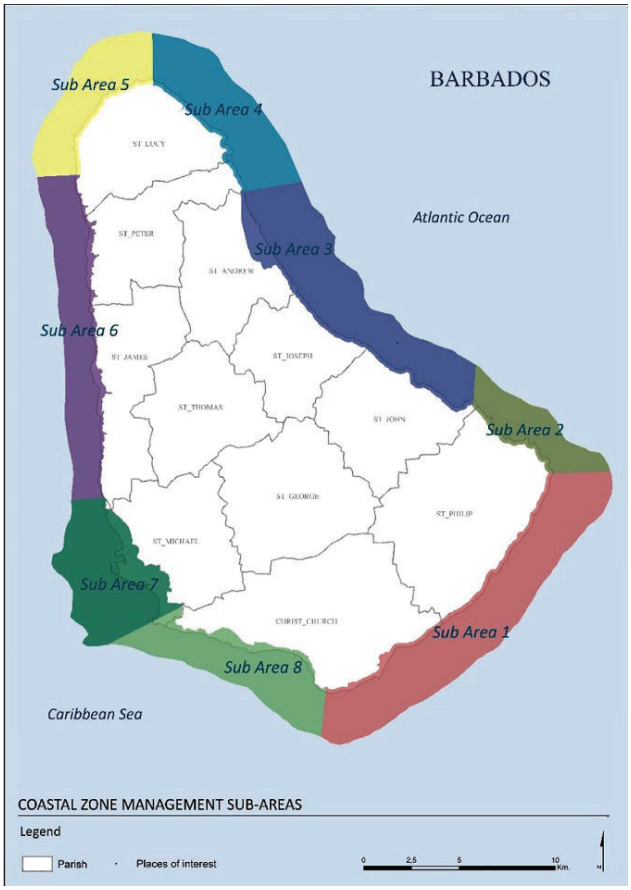
All the seas located in the area commencing at Barbados Grid co-ordinate point, 21750.52305, 62701.533047, inclusive of all the co-ordinate points thereafter, to a point ending at Barbados Grid co-ordinate point 32818.210158, 57918.53088.

SECOND SCHEDULE

(Paragraph 2)

Coastal Zone Management Area (Boundaries) Order, 2022
(S.I. 2022-)

Map of the Coastal Zone Management Area

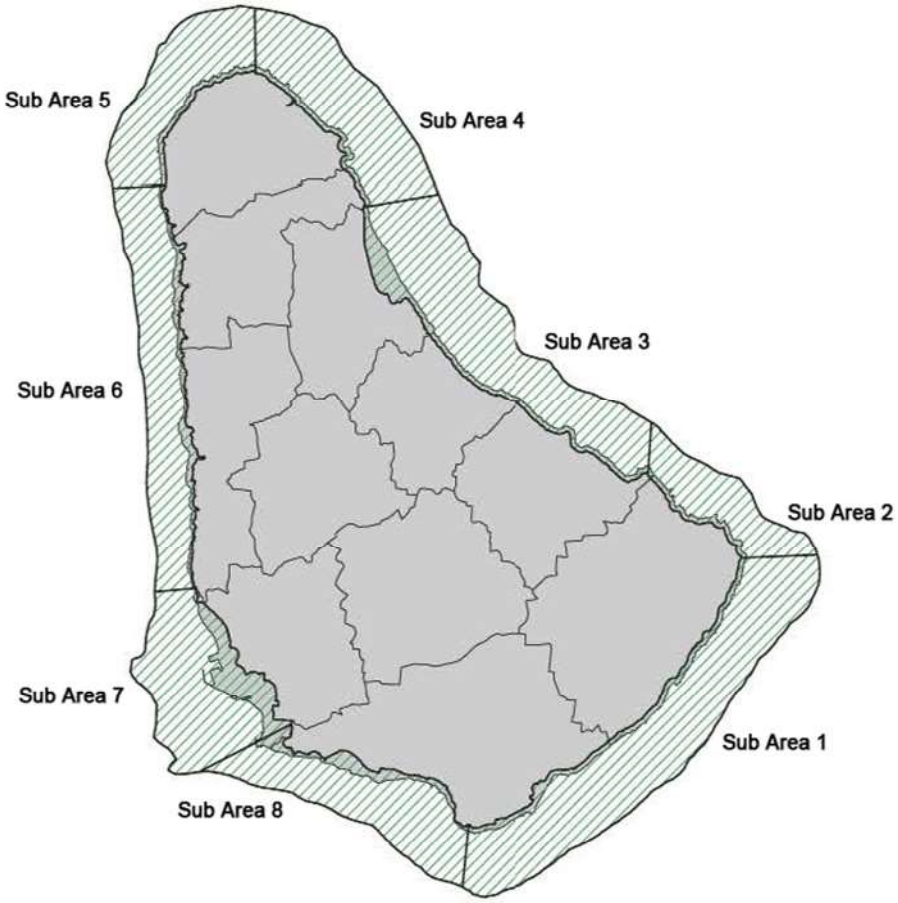


THIRD SCHEDULE

(Paragraph 2)

Coastal Zone Management Area (Boundaries) Order, 2022
(S.I. 2022-)

Map of the Coastal Zone Management Area



INTEGRATED COASTAL ZONE MANAGEMENT: THE BARBADOS CZM PLAN (2020 to 2030)

PLANNING TO DELIVER RISK RESILIENCE

COASTAL ZONE MANAGEMENT UNIT

FOREWORD (OCTOBER 2021)

FOREWORD

Our coast has immense value and is integral to the lives of Barbadians. All of its 97 kilometres (60 miles) are beautiful, diverse and productive. Barbados' coast has a special national heritage that comprises a range of different natural features which include cliffs, mangrove swamps, tide pools, beaches and low lying coral rock platforms. However, few people appreciate the incredible opportunities that it offers to improve the well-being of current and future generations. Our coast provides:

- **Goods and services** essential to meeting basic needs and improving the quality of life of all Barbadians. It provides food, a place to live, work and relax, and a gateway to the world via the Bridgetown Port.
- **Economic opportunities** for improving Barbados' development prospects, including tourism, fishing and a range of recreational business-related opportunities.

Maintaining the diversity, health and productivity of our coast is central to realising and sustaining these economic and social benefits. Doing so requires an understanding of the wider coastal system. Our coast is:

- **A complex natural system.** Many interactions take place there. It is the meeting place of the land and sea – where freshwater and seawater mix; the venue for high energy and change - where tides, currents, winds and waves shape and reshape the shoreline and the backdrop for rich landforms and resources (living and non-living) such as coral reefs, beaches, sand dunes, mangroves, seagrasses, wetlands, rocky headlands and rivers. The coast also nurtures diverse life-forms including turtles, marine mammals, fish, seabirds and a range of coastal plants, all of which make up varied ecosystems. It is therefore rich in natural resources.
- **A natural heritage, which must be carefully managed**. It is a public asset that supports a variety of human activities and is subject to intense and growing demands. However, coastal resources are finite, and vulnerable to over-use, degradation and importantly, climate change. Ongoing coastal erosion and sea level rise all make implementation and preservation of lateral beach access challenging. In fact, the coast can also be an unforgiving place, where inappropriate planning decisions can expose human life and property to high risks. In spite of this, it nonetheless offers enormous opportunities for future development in Barbados.

According to historical records, global average sea surface temperature has increased by 1 degree Celsius since the 1850s as indicated by the Intergovernmental Panel on Climate Change (IPCC). Small Island Developing States (SIDS) such as Barbados are therefore likely to be impacted by factors including coastal erosion, flooding, tidal variations and tropical storms/hurricanes that are exacerbated by climate change. The growing population and economic development will simply create more pressure on land use and the natural resources along the coastal zones. We therefore need to protect the natural assets for the benefit of our coastal communities and in order to achieve economic prosperity in the future.

Coastal management in Barbados has undergone a significant evolution over the past 35 years placing the island at the forefront of ICZM related best practice across the Caribbean, and contributing to a thriving coastal tourism industry that continues to remain at the core of the country's economy. Despite this, a more modern coastal management delivery model is now required if Barbadians are to realise and sustain goods and services and development opportunities that the coast provides. The Government of Barbados (GOB) is committed to adopting a new strategy in order to better implement a climate and disaster risk resilient related ICZM approach which places an improved emphasis on adaptation strategies that provides the optimum response to factors that are exacerbated by climate change. This new delivery model seeks to introduce improved coastal risk understanding and procedures into infrastructure and non-structural adaptation measures that are designed to increase resilience to climate induced coastal hazards whilst embracing ICZM principles and lessons from international best practice.

Implementing risk resilient ICZM is not a simple task, but given the potential, it is a task well worth undertaking. To achieve this, and through implementation of this Plan, there is a concerted effort, through public organisations in tandem with civil society, to promote the following:

- **A more co-ordinated and integrated coastal management approach.** The various human uses of coastal resources are inter-dependent. These uses affect each other and the overall benefits that can be gained from the coast. Co-ordinated and integrated management is needed to ensure that the positive benefits of different human uses are realised in the interests of all Barbadians. Our coast should therefore be managed in a holistic way as a **system,** not as a range of distinct sectors.
- **More efficient, effective and co-operative governance**, based on partnerships between Government, civil society and the private sector. Current legal and institutional arrangements for coastal management are complicated and fragmented. Risk resilient ICZM capacity needs to be built to achieve the development potential of the coast. Proactive guidance is needed to promote a visionary, practical and focused management process that fosters self-regulation and shared responsibility for our special coastal heritage.

The above shall facilitate implementation of this updated ten-year ICZM Plan (2020 - 2030), which represents a mandatory requirement under the Coastal Zone Management Act (currently under revision). There are two (2) Volumes to the Plan:

- Volume 1: Integrated Coastal Zone Management – The Barbados Policy Framework (2020 to 2030);
- Volume 2: Integrated Coastal Zone Management – The Barbados ICZM Plan (2020 to 2030).

It should be emphasised that these two Volumes have been developed in consultation with all stakeholders to enhance understanding about the risks associated with climate change and development pressures around the coastal zones in Barbados. The Plan takes into consideration existing studies that focus on coastal hazards relating to overtopping, sea level rise, cliff stability and flooding along the Barbadian shoreline. Presently, the Ministry of Maritime Affairs and the Blue Economy (MMABE), through the Coastal Zone Management Unit (CZMU) intervenes in association with other partners during extreme events and executes various coastal management efforts to combat such hazards.

This updated Plan provides the guidance that was previously lacking with regards to appropriate long-term ecosystem-based interventions that may be combined with the existing strategies to deal effectively with known coastal hazards. Such measures will help to build coastal resilience and capacity within developmental planning decision making within the newly defined coastal zone management area (CZMA) whilst in addition seeking to reduce future coastal risks and encouraging sustainable coastal economic development for communities by supporting the promotion of healthy coastal ecosystems.

The Plan is therefore an important milestone for Barbados. It will provide not only a framework for all coastal management initiatives but also an opportunity for stakeholders to become more aware of the seriousness of climate change and the developments affecting our nation. The clock is ticking and the race has begun. As one of the world's smallest nations, and through implementation of this Plan, we are tackling climate change and all of its issues head on.

EXECUTIVE SUMMARY (OCTOBER 2021)

EXECUTIVE SUMMARY

INTRODUCTION

Our coast has immense value to the people of Barbados. It is beautiful, productive and is of special national heritage value. People appreciate the incredible opportunities that our coast offers to improve the well-being of current and future generations. However, in the context of disaster risks and climate change, management of the coastal environment is a complex task, involving many organizations and individuals and requiring action at local, national and global scales.

In 1998, Barbados produced their first Integrated Coastal Zone Management (ICZM) Plan that provided the policy framework and detailed recommendations for conservation and management of coastal resources of the Caribbean and Atlantic coasts. This updated Final ICZM Plan (2020-2030) modernises the original 1998 document by incorporating Climate Change Adaptation (CCA) and Disaster Risk Management (DRM) as key elements of a future more resilient national coastal planning process. The updated ICZM Plan and CZM Act constitute the foundations for the sustainable use and promotion of climate resilient development within the defined Coastal Zone Management Area (CZMA).

With reference to the CZM Act, this defines the implementation process of the ICZM Plan and the functions and competencies of the Coastal Zone Management Unit (CZMU). These include the oversight of the ICZM Plan implementation and the advisory role to statutory authorities on the policies to be exercised within the CZMA.

According to the CZM Act, Cap.394, the Final ICZM Plan is to be approved by the Minister after the conduct of a public enquiry. This was undertaken during the period June 8-July 14, 2021 and included the organization of a National Launch Event and eight participatory meetings that were attended by more than 120 attendees/participants from public institutions, the private sector, academia, non-government associations and the general public. Thus, the Final ICZM Plan considers/incorporates the comments and suggestions raised by stakeholders during participatory meetings and written comments received during the public enquiry process.

Geographical scope

The CZMA defines the area where ICZM implementation related principles, policies and actions apply as articulated within the Final ICZM Plan. It extends around the entire coastline of Barbados, with inland and offshore limits of variable widths.

The updated delimitation of the CZMA is based on a multi-criteria analysis methodology that integrated the spatial distribution of coastal resources whilst incorporating DRM and CCA related approaches. Coastal resources (defined by the CZM Act) include coastal ecosystems such as beaches and coral reefs, geological formations, landscape values, coastal infrastructures and cultural resources. DRM is considered to embrace natural hazards including storm surge, coastal erosion, tsunami and cliff collapse, and latest sea level rise projections as recently provided by the Intergovernmental Panel of Climate Change (IPCC).

The CZMA is divided into eight different Sub Areas that reflect specific Barbadian coast characteristics and risk exposure variances, based on an improved understanding of coastal hazards, risks, vulnerabilities and exposures[1].

The Final ICZM Plan (2020 to 2030) consists of two volumes as follows:

- VOLUME 1: ICZM – THE BARBADOS POLICY FRAMEWORK: describes guiding principles and Government policy outcomes; and
- VOLUME 2: ICZM – THE BARBADOS ICZM PLAN: provides specific guidance to achieve climate and disaster risk compatible development in the CZMA.



Figure 1. Sub Areas of the CZMA.

ICZM - The Barbados Policy Framework (Volume 1)

This Volume describes guiding principles and policy outcomes and goals, governance arrangements and evaluation indicators to support the successful delivery of risk resilient ICZM in Barbados. It defines the ICZM Vision which reflects the coast's contribution to our society along with/in addition to the Key Principles to guide the way forward. Six Policy Outcomes are designed to help demonstrate how the Vision shall be achieved as follows:

POLICY OUTCOMES
Policy Outcome 1 - Sustainable socioeconomic development is achieved
Policy Outcome 2 - Coastal resources are protected and effectively managed
Policy Outcome 3 - Climate and disaster risk adaptive capacity is strengthened
Policy Outcome 4 - ICZM is delivered through a coordinated governance arrangement
Policy Outcome 5 - Capacity for ICZM delivery is strengthened for all relevant sectors

Each Policy Outcome shall be developed through a set of Policy Goals (17 in total) which are supported by management guidelines and supporting actions as proposed in more detail within Volume 2 of the Final ICZM Plan.

[1] "Sub Areas" remain unaltered as per the original CZM Plan (1998/9) based on an improved understanding of Legal and administrative framework; physical and human characteristics.

ICZM – The Barbados ICZM Plan (Volume 2)

This Volume provides detailed guidance for the management of coastal resources, their use, development and regulation at both national and more localised Sub Area levels. The guidelines proposed are based on detailed analytical studies undertaken over the past 20 years in tandem with information presented within the National Coastal Risk Resilience Platform (NCRIPP).

The ICZM Plan is structured into five separate parts:

- PART A: SETTING THE SCENE FOR RISK RESILIENT ICZM: presents the Plan and describes the main characteristics of the Barbadian coast.
- PART B: MOVING ICZM FORWARD BASED ON PRIORITIES: summarizes the policy framework and how guidance and recommendations are designed to achieve the defined policies and goals.
- PART C: NATIONAL GUIDANCE: provides guidance on key themes that are relevant to support decision-making within the CZMA. For each key theme, the ICZM Plan provides management guidance on the following aspects and defines actions of national relevance:

KEY THEMES	ASPECTS	Nº OF NATIONAL ACTIONS PROPOSED
DRM and CCA	• Planning and implementing DRM and CCA strategies within the CZMA. • Ensuring financial sustainability for DRM and CCA.	7
Beach Management	• Beach Management Planning • Beach Risk Management Framework. • Guidance for the approval of commercial applications. • Public access to the beach. • Monitoring.	6
Development Planning and Setbacks*	• Establishment and application of setbacks (including 30 m, flood inundation, climate change, cliff and landscape setbacks). • Coordination with national policies.	13
Compliance with Environmental and Social Safeguards*	• Towards an efficient Environmental and Social Impact Assessment (ESIA) implementation. • ESIA in the CZMA.	4
Construction and Maintenance of Coastal Structures	• Mainstreaming DRM and CCA into the design of coastal structures. • Monitoring of coastal structures. • Maintenance of coastal structures. • Managing emergency maintenance works.	11
Emerging Issues	• Regulatory implications of new issues.	10
Biodiversity Conservation and Coastal Habitat Restoration	• Monitoring biodiversity.	9
Non-living resource exploration and exploitation	• Land based quarries for aggregate extraction. • Nearshore aggregate extraction. • Offshore resources.	6
Research	• 2020-2030 Coastal Research Agenda. • Data management, access and dissemination.	7
Public Awareness and Stakeholder Participation	• Effective consultation. • Types of consultation. • Draft Guidelines for Consultation.	6

Implementation of setbacks and related ESIA procedures within the CZMA is one of the key elements defined in the Final ICZM Plan. Setbacks refer to areas where specific conditions or provisions for development are imposed. The Final ICZM Plan defines setback guidance for four new categories which complement those already outlined in the Physical Development Plan (PDP) (2017), namely flood inundation, cliff collapse, climate change adaptation and landscape setbacks. A factsheet on setbacks and ESIA has been produced separately to support outreach messaging.

- PART D: SUB-AREA GUIDANCE: defines more localised actions of relevance to each Sub-Area, tabulating issues and identifying likely implementation pathways. Recommended lead and supporting agencies are highlighted in addition to indicative delivery timeframes and links to supporting government policies. This part also presents a series of Sub Area description and localised setbacks maps for each Sub Area.

SUB AREA	MAIN THEMES ADDRESSED	Nº OF SUB-AREA ACTIONS PROPOSED
Sub Area 1: South Point to Kitridge Point	• Biodiversity and landscape resources for eco-tourism and residential uses. • Relevant cliff collapse and coastal erosion risk.	20
Sub Area 2: Kitridge Point to Consett Point	• Rural character and fisheries are compatible with planned development. • Low levels of coastal risks.	9
Sub Area 3: Consett Point to The Choyce	• Landscape and natural values for recreation. • Different coastal hazards at specific locations.	14
Sub Area 4: The Choyce to North Point	• Wilderness character and geological interest. • Risks due to cliff collapse.	6
Sub Area 5: North Point to Maycock´s Bay	• Wilderness character and geological interest. • Risks due to cliff collapse.	8
Sub Area 6: Maycock´s Bay to Batt´s Rock	• Intense tourism activities and environmental degradation. • Coastal erosion and flooding.	9
Sub Area 7: Batt´s Rock to Needham´s Point	• Coexistence of urban and port activities with environmental values. • Importance of natural and recreational areas for climate change adaptation.	9
Sub Area 8: Needham´s Point to South Point	• Residential development and local fisheries to support small scale tourism. • Storm surge and cliff collapse.	13

- PART E: IMPLEMENTATION: defines the key requirements needed to support implementation of the ICZM Plan with sections included on information needs and data management; education, training and public outreach; institutional and capacity requirements; evaluation and monitoring procedures and considerations needed to secure sustainable ICZM plan implementation in the coming years.

A considerable amount is being done to promote ICZM in Barbados. The vision, strategic objectives, policies and actions described in this document will guide its implementation along the coast of Barbados. Putting these ideas into practice will require co-operation and collaboration within Government as well as between the public and private sectors, non-governmental organizations and individuals who regulate, use and value the coast.

The most critical requirement for success, however, is the support and interests of the institutions and citizens of Barbados.

INDEX
(OCTOBER 2021)

INDEX

FOREWORD 1

EXECUTIVE SUMMARY 1
INTRODUCTION 1
ICZM - The Barbados Policy Framework (Volume 1) 1
ICZM – The Barbados ICZM Plan (Volume 2) 2

PART A: SETTING THE SCENE FOR RISK RESILIENT ICZM 1
A1. INTRODUCTION 1
A1.1. Purpose and Structure of the Plan 1
A1.2. Geographic Scope of the Plan 2
A1.3. Vision Statement 6
A1.4. Legal and institutional framework for risk-resilient ICZM in Barbados 6
A1.5. Relationship of the ICZM Plan to other plans 12
A2. CHARACTERISTICS OF THE CZMA 14
A2.1. The natural environment 14
A2.2. People and economy 23
A2.3. Risks in the CZMA 26

PART B: CREATING AN ADAPTIVE PATHWAY 47
B1. IDENTIFYING PATHWAY PRIORITIES 47
B2. ISSUES IDENTIFICATION AND ASSESSMENT 48
B3. NATIONAL MANAGEMENT PRIORITIES 50
B4. USING POLICY OUTCOMES TO SUPPORT THE ADAPTIVE PATHWAY 51

PART C: NATIONAL GUIDANCE 52
C1. DISASTER RISK MANAGEMENT AND CLIMATE CHANGE ADAPTATION 99
C1.1. Current status 99
C1.2. Implications 100
C1.3. Management guidance 101
C1.4. Action brief 103
C2. BEACH MANAGEMENT 104
C2.1. Current status 104
C2.2. Implications 105
C2.3. Management guidance 105
C2.4. Action brief 113
C3. DEVELOPMENT PLANNING AND SETBACKS 114
C3.1. Current status 114
C3.2. Implications 115
C3.3. Management guidance 116
C3.4. Action brief 121
C4. COMPLIANCE WITH ENVIRONMENTAL AND SOCIAL SAFEGUARDS 122
C4.1. Current status 122
C4.2. Implications 124
C4.3. Management guidance 124
C4.4. Action brief 126
C5. CONSTRUCTION AND MAINTENANCE OF COASTAL STRUCTURES 127
C5.1. Current status 127
C5.2. Implications 128
C5.3. Management guidance 128
C5.4. Action brief 133
C6. EMERGING ISSUES 134
C6.1. Current status 134
C6.2. Implications 138
C6.3. Management guidance 138
C6.4. Action brief 139
C7. BIODIVERSITY CONSERVATION AND COASTAL HABITAT RESTORATION 140
C7.1. Current status 140
C7.2. Implications 144
C7.3. Management guidance 144
C7.4. Action brief 149
C8. NON-LIVING RESOURCE EXPLORATION AND EXPLOITATION 151
C8.1. Current status 151
C8.2. Implications 152
C8.3. Management guidance 153
C8.4. Action brief 155
C9. RESEARCH 156
C9.1. Current status 156
C9.2. Implications 156
C9.3. Management guidance 157
C9.4. Action brief 160
C10. PUBLIC AWARENESS AND STAKEHOLDER PARTICIPATION 161
C10.1. Current status 161
C10.2. Implications 161
C10.3. Management guidance 162
C10.4. Action brief 164

PART D: SUB-AREAS ACTION BRIEFS 165
D1. INTRODUCTION 165
SUB-AREA 1: SOUTH POINT TO KITRIDGE POINT 166
Main themes 166
Sub-Area description and context 166
Development Planning and Setbacks at Sub-Area scale 167
Action brief 168
SUB-AREA 2: KITRIDGE POINT TO CONSETT POINT 190
Main themes 190
Sub-Area description and context 190
Main issues and strategic objectives 190
Development Planning and Setbacks at Sub-Area scale 190
Action brief 191
SUB-AREA 3: CONSETT POINT TO THE CHOYCE 200
Main themes 200
Sub-Area description and context 200
Main issues and strategic objectives 201
Development Planning and Setbacks at Sub-Area scale 201
Action brief 202
SUB-AREA 4: THE CHOYCE TO NORTH POINT 219
Main themes 219
Sub-Area description and context 219
Main issues and strategic objectives 219
Development Planning and Setbacks at Sub-Area scale 220
Action brief 221
SUB-AREA 5: NORTH POINT TO MAYCOCK´S BAY 234
Main themes 234
Sub-Area description and context 234
Main issues and strategic objectives 234
Development Planning and Setbacks at Sub-Area scale 235
Action brief 236
SUB-AREA 6: MAYCOCK´S BAY TO BATT´S ROCK 248
Main themes 248
Sub-Area description and context 248
Main issues and strategic objectives 248
Development Planning and Setbacks at Sub-Area scale 248
Action brief 249
SUB-AREA 7: BATT´S ROCK TO NEEDHAM´S POINT 260
Main themes 260
Sub-Area description and context 260
Main issues and strategic objectives 260
Development Planning and Setbacks at Sub-Area scale 260
Action brief 261
SUB-AREA 8: NEEDHAM´S POINT TO SOUTH POINT 274
Main themes 274
Sub-Area description and context 274
Main issues and strategic objectives 274
Development Planning and Setbacks at Sub-Area scale 275
Action brief 276

PART E: IMPLEMENTATION PROCEDURES 287
E1. ENABLING ACTIONS AND PRIORITIES 287
E1.1. Enabling Actions 287
E1.2. Action Priorities 288
E2. ROAD MAP FOR IMPLEMENTATION 290
E3. INFORMATION NEEDS AND DATA MANAGEMENT 295
E3.1. Overview 295
E3.2. Streamlining and targeting data collection Programmes 295
E3.3. Oceanographic and Coastal Engineering Data Collection 295
E3.4. Socio-economic Data Collection 296
E3.5. Geotechnical and Seismic Data Collection 296
E3.6. Systems Required to Update the CZMA Inland Limits 296
E3.7. Creating Guidelines and State of the Coast Reports 297
E4. EDUCATION, TRAINING AND PUBLIC OUTREACH NEEDS 298
E4.1. Education and Training Needs 298
E4.2. South-South Cooperation (SSC) 299
E4.3. Public Outreach Needs 300
E4.4. Communication 300
E5. INSTITUTIONAL AND CAPACITY REQUIREMENTS 301
E5.1. Government Responsibility and Authority for ICZM 301
E5.2. CZMU Restructuring 301
E6. EVALUATION AND MONITORING PROCEDURES 305
E6.1. Performance Management and Evaluation 305
E6.2. Integrated Monitoring Programmes 305
E7. FINANCIAL CONSIDERATIONS 306
E7.1. Overview 306
E7.2. Current Macro-economic Situation 306
E7.3. Possible Financing Mechanisms 307
E7.4. Summary of Recommended Options 311
APPENDIX A. REVIEW OF FUNDING AND FINANCE OPTIONS FOR RISK RESILIENT ICZM IN BARBADOS 312

BIBLIOGRAPHY 315

ANNEX 1. LIMITS OF THE COASTAL ZONE MANAGEMENT AREA A.1

ANNEX 2. BASELINE STUDIES AND RISK ASSESSMENTS DEVELOPED BY THE CZMU A.28

ANNEX 3. CLIMATE CHANGE TRENDS AND PROJECTIONS A.29

ANNEX 5. SAMPLE VULNERABILITY MAP A.38

ANNEX 6. SOCIAL IMPACT ASSESSMENT AND GENDER ANALYSIS A.39

ANNEX 7. DRAFT TERMS OF REFERENCE CLIMATE RISK AND VULNERABILITY

ASSESSMENTS A.41

ANNEX 8. STANDARD FORMS FOR COASTAL RESEARCH A.43

ANNEX 9. BASIC SOCIOECONOMIC ASSESSMENTS TO SUPPORT COASTAL DEVELOPMENT PLANNING A.47
- A9.1. Introduction A.47
- A9.2. What is a Socio-economic Assessment? A.47
- A9.3. Recommended Approach A.49
- A9.4. Work plan: A.51

ANNEX 10. COASTAL CLIFF CLASSIFICATION, SETBACK AND RISK FROM GSI STUDY A.54
- A10.1. Maps: coastal cliff classification, setback and risk. A.54
- A10.2. Guidelines for development A.55

ANNEX 11. TIERED APPROACH TOWARDS ADDRESSING EMERGING ISSUES IN THE CZMA A.57

ACRONYMS
(OCTOBER 2021)

ACRONYMS

AAL	Average Annual Loss
AWS	Automated Weather Stations
BADMMC	Barbados Agricultural Development and Marketing Corporation
BBMP	Barbados Beach Management Plan
BMS	Barbados Meteorological Service
BNSI	Barbados National Standards Institute
BPI	Barbados Port Inc.
BRA	Barbados Revenue Authority
BSS	Barbados Statistical Service
BTA	Barbados Tourism Authority
BWA	Barbados Water Authority
CANARI	Caribbean Natural Resources Institute
CAST	Caribbean Alliance for Sustainable Tourism
CBA	Cost Benefit Analysis
CBEI	Centre for the Blue Economy and Innovation
CBMP	Carlisle Bay Marine Park
CCA	Climate Change Adaptation
CCTV	Closed Circuit Television
CDEMA	Caribbean Disaster Emergency Management Agency
CEA	Cost Effectiveness Analysis
CRMP	Coastal Risk Management Programme
CRVA	Climate risk vulnerability assessment
CSR	Corporate Social Responsibility
CTP	Chief Town Planner
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Area
CZMU	Coastal Zone Management Unit
DEM	Department of Emergency Management
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EbA	Ecosystem-based Adaptation
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EPA	Environmental Protection Area
EPD	Environmental Protection Department
ESIA	Environmental and Social Impact Assessment
EWS	Early Warning Systems
FPMR	Folkestone Park and Marine Reserve
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GMC	Global Circulation Models
GMSL	Global Mean Sea Level
GOB	Government of Barbados
GSI	Geological Survey Investigation
HWM	High Water Mark
ICZM	Integrated Coastal Zone Management
IDB	Inter-American Development Bank
IDD	Disaster Deficit Index
IOC	International Oceanographic Commission
IODE	International Oceanographic Data and Information Exchange
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
LEC	Loss Exceedance Curves
LVIA	Landscape and Visual Impact Assessment
MAP	Marine Protected Area
MCA	Multi Criteria Analysis
MENB	Ministry of Environment and Natural Beautification
MFEI	Ministry of Finance, Economic Affairs and Investment
MMA	Marine Managed/Management Area
MMABE	Ministry of Maritime Affairs and the Blue Economy

MNES	Matters of National Environmental Significance
MoU	Memorandum of Understanding
MPA	Marine Protected Area
MSP	Marine Spatial Planning
MTI	Ministry of Tourism & International Transport
MTWM	Ministry of Transport, Works and Maintenance
NAP	National Programmes of Action
NbS	Nature based Solutions
NCC	National Conservation Commission
NCCC	National Climate Change Committee
NCRIPP	National Coastal Risk Resilience Platform
NDC	Nationally Determined Contribution
NGO	Non- Governmental Organisation
NHCA	National Heritage Conservation Area
NHD	National Heritage Department
NOAA	National Oceanic and Atmospheric Administration
NOP	National Ocean Policy
NRD	Natural Resources Department
OBPS-R	Ocean Best Practices System Repository
ODSBP	Ocean Data Standards and Best Practices
OECS	Organisation of Eastern Caribbean States
OPM	Office of the Prime Minister
PADO	Professional Association of Dive Operators
PDP	Physical Development Plan
PES	Payments for Environmental Services
PIU	Public Investment Unit
PPP	Public Private Partnership
R2R	Ridge-to-Reef
R2RP	Ridge-to-Reef Programm
RCM	Regional Circulation Models
RCP	Representative Concentration Pathway
SANDS	Shoreline and Nearshore Data Systems
SAP	Strategic Action Plan
SCU	Soil Conservation Unit
SDGs	Sustainable Development Goals
SIA	Social Impact Assessment
SLR	Sea Level Rise
SSC	South-South Cooperation
SWOT	Strengths, Weaknesses, Opportunities and Threats
TCDPO	Town and Country Development Planning Office
ToR	Terms of Reference
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNESCO	United Nations Educational, Scientific and Cultural Organization
UWI	University of West Indies
WHO	World Health Organization
WTTC	World Travel & Tourism Council
ZoI	Zone of Influence

PART A
SETTING THE SCENE FOR RISK RESILIENT ICZM (OCTOBER 2021)

PART A: SETTING THE SCENE FOR RISK RESILIENT ICZM

A1. INTRODUCTION

Coastal management is of critical importance to the people, economy and environment of Barbados. The coastal resources and ecosystems, distributed along 97 km of shoreline, provide both opportunities for enjoyment in addition to offering tremendous benefits for the economy and employment opportunities for all Barbadians. The tourism sector for example, which is mainly based around beach and marine activities (including man-made attractions and natural assets), accounted directly for 13% of the total GDP in 2017 whilst its indirect contribution is estimated at 40% of total GDP (WTTC, 2018). Despite this, most economic activities that rely on the coast (including tourism, urban development and fisheries and new emerging sectors), all exert significant pressures on valuable coastal resources and ecosystem services. Additionally, as the country's population continues to grow, the demand that this places on coastal resources increases considerably.

Barbados currently finds itself confronted with the reality of facing global climate change and adapting to the increased risks that this brings. The coast in particular is becoming more exposed to tropical storms and hurricanes whilst being increasingly susceptible to beach and cliff erosion either from specific short-term events or from long-term coastal processes. Regional projections, for example, suggest that climate change is increasing the disaster risk profile of Barbados, especially when embracing issues such as the effects of sea-level rise (SLR).

The complexity of coastal processes, the development of new and competing land use activities, the existence of diverse stakeholder interests and new emerging issues (including climate change), all now require a comprehensive and integrated approach towards managing the coastal zone in Barbados. In tandem with this, there is a global acceptance that Integrated Coastal Zone Management (ICZM) and Disaster Risk Management (DRM) in coastal areas are totally entwined and they constitute an integrated approach that should be adhered to in order to ensure the sustainable and resilient management of the coast.

ICZM IN BARBADOS

Harnessing and sustaining the development potential of the coast will require a significant change in thinking about how to plan and manage land use development processes. To facilitate this change, proactive ICZM planning (that is supported by latest knowledge on climate change) needs to be better inculcated into new guidelines, legislation, regulations and advisories to help improve awareness to the public, private and civil society sectors to support the achievement of long-term climate compatible development within the coastal zone.

To date, the Government of Barbados (GOB) through the Coastal Zone Management Unit (CZMU) has made significant advances in ICZM, including tangible achievements in coastal erosion control, coastal resource conservation, institutional strengthening and capacity building. Guidance up to now to support the management of coastal uses, development and regulation along the coast of Barbados, has been addressed within the original ICZM Plan and Policy Framework (Halcrow 1998a, 1998b and 1998c). However, the emerging challenges facing Barbados, including climate change and DRM, require a new way of thinking, culminating in an update to these 1998 plans and policies (i.e.: this revised Volume 2 Plan).

This updated ICZM Plan (2020) adopts an integrated DRM and Climate Change Adaptation (CCA) approach towards supporting effective coastal planning. This is achieved by incorporating the latest results from an Inter-American Bank (IDB) funded programme named the "Coastal Risk Assessment and Management Program (CRMP)" and a supporting tool entitled the "National Coastal Risk Information and Planning Platform (NCRIPP)" which was undertaken and developed by the CZMU between 2011 and 2020. The CRMP has supported the analysis of current and future key issues facing coastal management delivery in Barbados by collecting new scientific information in addition to gathering stakeholder concerns, observations and views. Through the CRMP, new information is now available to help re-position policy goals and priorities and from this, updates to management guidelines and implementation procedures undertaken to support public agencies and private individuals and to help with ICZM Plan implementation. Two separate volumes have been produced that legally comprise the ICZM Plan:

- Volume 1: ICZM – The Barbados Policy Framework (IHCantabria, 2020), that describes ICZM policy outcomes and goals.
- Volume 2: ICZM – The Barbados ICZM Plan (this document), that provides detailed guidance on general themes relevant for activities within the Coastal Zone Management Area (CZMA) at the national and Sub-Area level, to support and advise on how all sectors and the wider society in Barbados can achieve climate and disaster risk compatible development.

Coupled with the proposed revisions to the CZM Act (2020), foundations are set for the sustainable use and promotion of climate-resilient development within the legally defined CZMA of Barbados. This work is also cognisant of the recently endorsed Roofs to Reefs Programme (R2RP[1]), which is the national development programme for the next decade and presents an overarching organising framework for coordination across government to support sustainable development and resilience, whilst helping to operationalise the PDP (2017). It also seeks to support delivery of an Ecosystem based Adaptation (EbA) approach for Barbados that (where suitable) embraces the implementation of Nature based Solutions (NbS) into the process.

A1.1. Purpose and Structure of the Plan

PURPOSE OF THE ICZM PLAN

The purpose of this Plan is to provide detailed guidance for the management of coastal resources, uses, development and regulation along the coast of Barbados that embraces current and future climate and disaster related risks.

Volume 2 (of the ICZM Plan) contains five separate Parts as follows:

- PART A: SETTING THE SCENE FOR RISK RESILIENT ICZM: introduction to the Plan and its vision, and description of the characteristics of the coast, based on the last existing baseline and risk assessment studies performed by the Government of Barbados (GOB).

[1] The R2RP is also outlined in the recently updated Barbados NDC, submitted to UNFCCC in 2021

- PART B: IDENTIFICATION OF PRIORITIES: identification of issues and challenges and definition of future policy goals for ICZM.
- PART C: NATIONAL GUIDANCE: guidance on general themes that are relevant to support decision making within the defined CZMA. These include sub-sections on the current status of the specific theme, implications, management guidance and supporting actions at a national scale.
- PART D: SUB-AREA GUIDANCE: action brief for each Sub-Area of the Barbados CZMA, tabulating issues and likely implementation pathways highlighting recommended lead (and supporting) agencies, timeframes and links to relevant government policy as appropriate.
- PART E: IMPLEMENTATION: this includes sub-sections on information needs and data management; education, training and public outreach; institutional and capacity requirements; evaluation and monitoring procedures plus importantly, the financial budgets and considerations needed to secure sustainable ICZM plan implementation in the coming years.

A1.2. Geographic Scope of the Plan

The Coastal Zone Management Area and the Zone of Influence

The principle of "Island System Management", which recognizes the need for the management of terrestrial and coastal resources together, as well as the International Union for Conservation of Nature (IUCN) initiative entitled "Reef to Ridge", is relevant for the protection of natural resources and environmental awareness. This is key as Barbados's unique coastal character is influenced and shaped by prevailing coastal processes. Two different geographical areas fall within this ICZM Plan (Figure A.1.):

- The **CZMA**, a core area where human activities can directly impact upon coastal resources or where land is exposed directly to coastal hazards. The CZMA represents the geographical scope of this ICZM Plan.
- The **Zone of Influence** (ZoI) represents the surrounding space to the core area (both inland and offshore), where activities or events could indirectly affect the integrity of coastal resources identified within the core area.



Figure A.1. Updated CZMA and ZoI.

As stated within the Planning and Development Act (2019), any new development proposal identified within the CZMA shall have regard to the provisions and guidelines set out in the ICZM Plan. That means that the CZMU will advise all statutory authorities on all relevant policies, regulations and advisories that may apply within the CZMA. With regard to the ZoI, the role of the CZMU will be to consider actions and to raise awareness to both public and private sectors, civil society and the citizens of Barbados of the implications and impacts of any proposed activity or future development. This can specifically include any impacts anticipated from strategic and national plans or developments proposals submitted (see Part C, Section C5). Through specific coordination and collaboration mechanisms, the CZMU shall continue to be involved towards supporting and contributing to existing collaborative partnerships and forums that may exist both now or in the future (see Sections 1.4 and 1.5) that may help develop joint initiatives to promote the conservation and sustainable exploitation of coastal resources within the defined core CZMA or ZoI.

A1.2.1. The Coastal Zone Management Area

THE CZMA

The CZMA constitutes the geographic limits of this ICZM Plan, updating the inland and offshore limits originally established within 1998 ICZM Plans for the Atlantic and Caribbean Seas (Halcrow 1998). The delineation of the CZMA is based on a sound technical and scientific analysis of the coastal zone.

The first step undertaken to re-define the CZMA was to analyse international definitions of similar "zones" adopted. The analysis deduced that any precise delimitation of a coastal area should be based on the specific characteristics of any specific country and the respective inland and offshore limits that are influenced by the climate or disaster related hazards of relevance to that nation. The methodology applied a spatial multi-criterion analysis (MCA) approach that adopted criteria to answer two key coastal issues facing the GOB, namely: (a) the effective management and sustainable use of coastal resources and (b) hazards and associated coastal risks derived from a changing climate. Specific criteria and variables are selected that consider and embrace Islands Systems Management (ISM). Each coastal resource (defined under the CZM Act) and climate/disaster related hazard (McCue, 2018) were analysed through the adoption of the following principles:

- *Guarantee the continuation of physical and environmental processes*. That is, to secure the natural functioning of dynamic coastal processes and protect sensitive coastal ecosystems.
- *Guarantee the continuation of sustainable socio-economic activities*. This focuses on ensuring the economic activity impacts consider the importance of sustainable coastal resource management.
- *Guarantee coherence in governance mechanisms*. This principle calls for the need for institutional coordination and harmonization of governance mechanisms including plans, policies, regulations and laws.
- *Mainstreaming coastal risk understanding into coastal planning*. This addresses the prevention and/or reduction of the effects of coastal hazards by ensuring their consideration within all sector strategies.
- *Mainstreaming adaptation to climate change strategies into coastal planning*. This focuses on integrating adaptation strategies into ongoing policy and planning processes, such as the Physical Development Plan (PDP 2017) or other sectoral strategies or relevance.

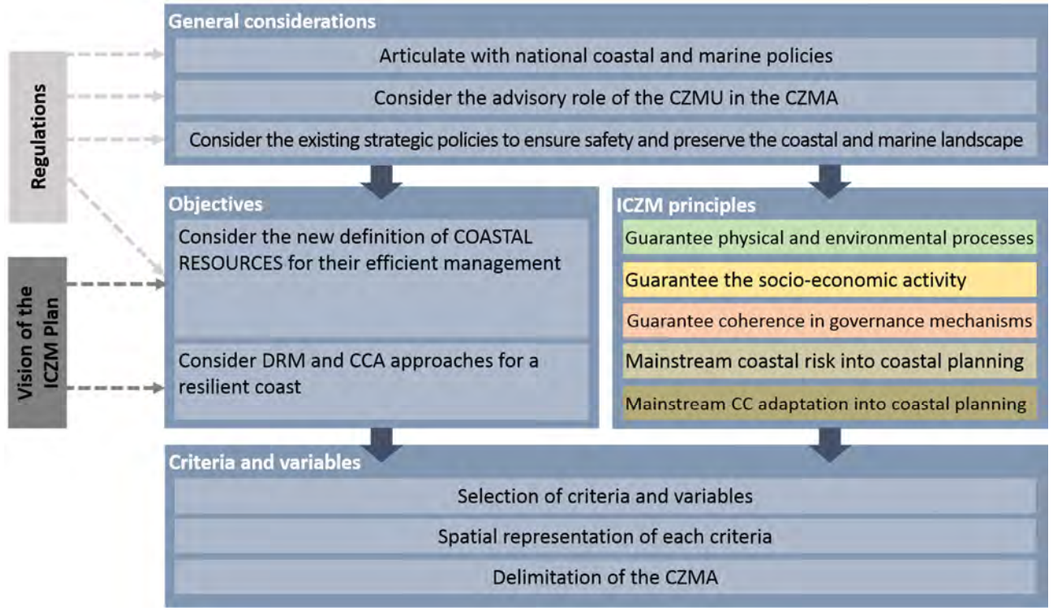


Figure A.2. Conceptual framework for the definition of the CZMA.

By adhering to these considerations and principles, Table A.1 and Table A.2 present the set of spatial criteria used to delineate the limits of the CZMA.

CATEGORY	CRITERIA FOR EACH COASTAL RESOURCE
BEACHES	Initiation of sediment transport (calculated as -10 m bathymetric contour).
	Storm surge flooding area (T= 100-years).
	Areas of adjacent auxiliary facilities directly related to beaches (including beach access, adjacent recreational areas and lifeguard facilities).
	Areas of the current mapped resource defined by the competent agency.
SAND DUNES	Total extension of the primary dune.
	Areas of the current mapped resource defined by the competent agency.
SURF ZONE	Wave shoaling and surf zone (calculated as -140 m bathymetric contour), including sand reserves.
	Beach areas.
COASTAL CLIFFS AND CAVES	Initiation of sediment transport (calculated as -10 m bathymetric contour).
	Inland boundary of the recommended setback - cliff collapse (T=100-years).
WETLANDS	Connection area between wetland and coastal waters.
	Areas defined as a wetland by the competent agency.
CORAL REEFS	Limit depth related to shallow-water coral reef ecosystems presence estimated as the -150 metres bathymetric contour).
	Areas of the current mapped resource defined by the component agency.
ALGAL AND SEAGRASS BEDS	Areas of the current mapped resource defined by the competent agency.
PLACES OF ENVIRONMENTAL INTEREST	Total extension of the planned and current marine reserves.
	Areas with endangered and protected species, including turtle nesting sites, mangroves, Walkers Quarry restoration area and coastal woodlands.

Category	Criteria for Each Coastal resource
	Areas of the current mapped resource defined by the competent agency.
Places of landscape interest	Coastal areas of outstanding aesthetic value, including (i) the wave shoaling and surf zone (calculated as the -140m bathymetric contour), and (ii) coastal landscape protection areas defined under the PDP (2017) and the CZMU, and the National Park landscape (200m buffer from the coastline).
	Coastal rural areas of medium aesthetic value (100 m buffer from the coastline) in rural areas defined by the (PDP).
Places of geological interest	Areas with coastal and marine geological and geomorphological formations of outstanding value.
Cultural resources	Lighthouses.
	Historic locations including HARP gun, screw dock, old coastal forts, selected archaeological areas and monuments and prehistoric sites.
	Include historic architecture – UNESCO sites.
	Fishing landing sites.
	Underwater Cultural Heritage.
	Areas of the current mapped resource defined by the competent agency.
Coastal infrastructure	Initiation of sediment transport (calculated as the -10m bathymetric contour).
	The area occupied by coastal infrastructures, including port and marina areas, coastal defences, outfall and intakes and defence areas.
	Include coastal infrastructures related to socio-economic activities: fishing landing sites and reef fishing sites; power generating plants, etc.
	Areas of the current mapped resource defined by competent agency: marine and port restricted areas.
Existing regulations	Minimum 30m setback distance established by PDP (2017).

Table A.1. Criteria for the delimitation of the CZMA addressing coastal resources.

Category	DRM/CCA Criteria
Hazardous areas - NCRIPP	Storm surge flooding area (T=100-years).
	Areas affected by coastal erosion.
	Tsunami flooding area (T=100-years).
	Setback recommendation for cliff erosion collapse (T=100-years).
Hazardous areas – IPCC SLR scenario	Estimated flooding area (storm-surge and tsunami) considering the SLR projection as the principal effect of climate change considering RCP 8.5 in the year 2100 (IPCC,2019)
T: return period. RCP: Representative Concentration Pathways defined as a greenhouse gas (GHG) concentration trajectory adopted by the IPCC.	

Table A.2. Criteria for the delimitation of the CZMA addressing DRM and CCA.

The new CZMA (Figure A.3) extends around the entire coastline of Barbados, with landward and seaward limits of variable widths defined as follows:

- **Landward Limit:** the landward limit embraces the above criteria. It includes key terrestrial coastal habitats such as beaches, cliffs, wetland, and mangroves, areas of importance for endangered species, places of environmental and geological interest, areas of outstanding landscape value, cultural resources linked to the coast, coastal infrastructures; and those areas exposed to coastal hazards (storm surge, tsunami, coastal erosion and cliff collapse), considering long-term scenarios of SLR. It is defined by specific coordinate points (longitude, latitude) each being 50m apart.
- **Seaward Limit:** this contains key marine resources and habitats (coral reefs, algae and seagrass beds, etc.); protected and restricted marine areas; areas of outstanding seascape value; and the surf zone where active sediment transportation influences beach profile shape (i.e.: the nearshore "closure depth" contour).



Figure A.3. The Coastal Zone Management Area.

A1.2.2. Sub-Areas of the CZMA

The CZMA consists of a series of "Sub-Areas", as originally defined within the 1998 ICZM Plan, that reflect specific Barbadian coastal characteristics and risk exposure variances. These were based on the legal and administrative framework, physical (mainly coastal geology), geomorphological and human (mainly land use patterns) characteristics. They continue to embrace these criteria set in 1998, but importantly, have now been updated to better reflect the improved understanding of coastal hazards, vulnerabilities and climate/disaster risks that have more recently been studied, monitored and witnessed since 1998 to the present day.

Eight Sub-Areas (five of them are located in the Atlantic coast (Sub-Areas 1, 2, 3, 4 and 5) and the other three are located in the Caribbean coast (Sub-Areas 6, 7 and 8)) are discussed below and displayed in Figure A.4:

- *Sub-Area 1: South Point to Kitridge Point*. This covers the south east coast and comprises lengths of cliff top lands interspersed with pocket beaches at Harrismith, Peat Bay and Bottom Bay. Other widely used beaches occur at Crane and Foul Bay. Residential development continues in addition to tourism- related and commercial activities. The nearshore environment includes the presence of Cobblers Reef. It also commands high landscape value. Beach and cliff erosion are the most significant risks experienced in this Sub-Area.
- *Sub-Area 2: Kitridge Point to Consett Point.* The land use in this Sub-Area is characterised by small-scale agricultural holdings and the settlements of Sealy Hill, Whitehaven and Bayfield. The developments trends show that there is increasing interest in tourism-related activities. Due to the topography of the Sub-Area, it experiences reduced direct coastal risks related to climate change (i.e.: storm surges, coastal flood inundations, etc.).
- *Sub-Area 3: Consett Point to the Choyce*. This Sub-Area covers most of the coastline of the Barbados National Park. There is significant topographic variance within Sub-Area 3 when compared to the other Sub-Areas. It consists of sloping areas between the main escarpment and the coast, displaying significant erosion in parts. With low population density, the economic activities are diverse though include eco-tourism, agriculture and fisheries, and sand extraction. The Sub-Area commands high potential for community focused tourism development and low-key recreational activities. Regarding coastal risks, storm surge inundation may prove a future issue due to its shallow topographic slope gradients. There are several areas where land slippage occurs such as Consett Bay and Glenburnie, St. John. The Sub-Area also contains remaining remnants of the train line.
- *Sub-Area 4: The Choyce to North Point*. North Point lies to the north of the island at the boundary between the Caribbean and Atlantic coasts. This coastline is exposed to high swell waves and winds, often displaying a barren cliff-top landscape. Apart from the main settlement of Rockfield, there is limited built development. Locations such as River Bay and Pico Tenerife are popular for recreational uses such as cliff walks and hiking, picnics, etc. Beach erosion and cliff collapse, however, are coastal risks that are most pertinent within this Sub-Area.
- *Sub-Area 5: North Point to Maycocks Bay*. Being mainly undeveloped, the landscape within this Sub-Area is dominated by cliff top related coastal vegetation. The main coastal risks relate to geotechnical instability issues that includes cliff collapse.
- *Sub-Area 6: Maycocks Bay to Batt´s Rock*. This Sub-Area extends along the leeward west coast of the island. Tourism development/infrastructure occurs immediately adjacent to the coast. This is associated with residential areas that include the commercial centres of Speightstown and Holetown. Folkestone Marine Park falls within this Sub-Area reflecting the importance of coral reef habitats in the Sub-Area. Storm surge related hazard events (wind and swell waves) are the most common coastal hazards within this Sub-Area.
- *Sub-Area 7: Batt´s Rock to Needham´s Point*. This Sub-Area is predominantly south-west facing. The footprint of Bridgetown and associated port dominates the land use. It supports the highest population density anywhere in the island. The Sub-Area contains the Historic Bridgetown and its Garrison, a World Heritage Site. The key coastal embayment feature is the sheltered area of Carlisle Bay whose southern boundary (Needham´s Point) in included within a proposed Marine Protected Area (MPA). The low-lying topography and shallow coastal hinterland slope that occurs within the Sub-Area means that storm surge, swell events and potentially tsunami hazards are most relevant.
- *Sub-Area 8: Needham´s Point to South Point.* This Sub-Area extends along the south coast of the island and includes Oistins Bay. It is principally a residential area although there are also sections immediately adjacent to the coast that have more of a tourism focus. The regional centre of Oistins is an important focal settlement for fisheries-related activities. Graeme Hall Mangrove Wetland, a Ramsar site, is located in this sub-area. It contains two species of mangroves, red and white mangroves. Due to the shallow coastal hinterland slope (especially adjacent to Needham's Point), the Sub-Area is exposed to medium level risks that are associated with storm surges whose impacts may be exacerbated by SLR.

Part D of this ICZM Plan describes in more detail other key characteristics relating to the natural and socio-economic setting, developmental opportunities and constraints of these Sub-Areas.



Figure A.4. Sub-Areas of the CZMA.

A1.3. Vision Statement

A series of visioning and issue identification workshops, were held during 2018 and 2019, involving over 200 participants from more than 30 organizations. These events, under the guidance of the CZMU, provided the foundation from which the national vision was developed[2].

VISION

"A coast and marine area to be proud of, which is valued, appreciated and safeguarded as places to live, work, use and relax; places where economic activity and the use of resources are sustainable, hazard resilient and adaptive to climate change, and where the natural environment is protected and enhanced to keep its essential and unique place in the Barbadian heritage and economy."

The vision seeks to provide a clear statement of intent for the ICZM Policy Framework (Vol. 1). It expresses the GOB's intention to enhance the capacity of current and future generations to realise their human potential within the context of maintaining diverse, healthy and productive coastal resources and ecosystems.

A1.4. Legal and institutional framework for risk-resilient ICZM in Barbados

A1.4.1. New and Existing Legislation, Regulations and Government Policy relevant to ICZM

Many elements of GOB policy and legislation are relevant to activities taking place in and around the coast. The primary legislative instruments, of relevant to ICZM in Barbados, are the following:

- proposed revisions to the CZM Act (2020) to help update and supersede the existing CZM Act (Cap. 394A 1998)[3];
- Planning and Development Act (2019);
- Marine Pollution Control Act (1998);
- Fisheries Act (Cap. 391) L.R.O 1995;
- Barbados Territorial Waters Act (Cap. 386) L.R.O. 2002;
- Marine Areas (Preservation and Enhancement) (Barbados Marine Reserve Regulations) 1981 and other provisions within the current CZM Act that currently pertain to management of restricted areas by the National Conservation Commission (NCC) of the Ministry of the Environment and National Beautification (MENB).

The proposed revisions to the CZM Act (2020), if considered, will create the essential foundation for the implementation of risk resilient ICZM in Barbados as it mandates the CZMU to prepare an ICZM Plan and an order delimiting a CZMA. This Plan, by convention in Barbados, includes the elucidation of an ICZM Policy Framework

[2] The vision of the ICZM Plan embraces the original version established in 1998 though, for completeness, was reviewed for possible alteration following a national process of consultation with interested and affected parties during 2018 and 2019

[3] This draft legislative Bill update has been produced though no formal consultation has been carried out to date.

(Volume 1) that is in keeping with other national policies. Provision for describing the boundaries of the CZMA is also included in the proposed revisions to the CZM Act (2020). Whilst it will not provide details of the plan, nor exact boundaries of the CZMA, these aspects are included in the ICZM Plan (see Annex 1) and referred to within the revised CZM Act. The Plan will come into force after the receipt of Ministerial approval (see Part E). The CZM Act will include a legal requirement to review the ICZM Plan every 10 years. Figure A.1 shows the key steps in implementing the Plan.

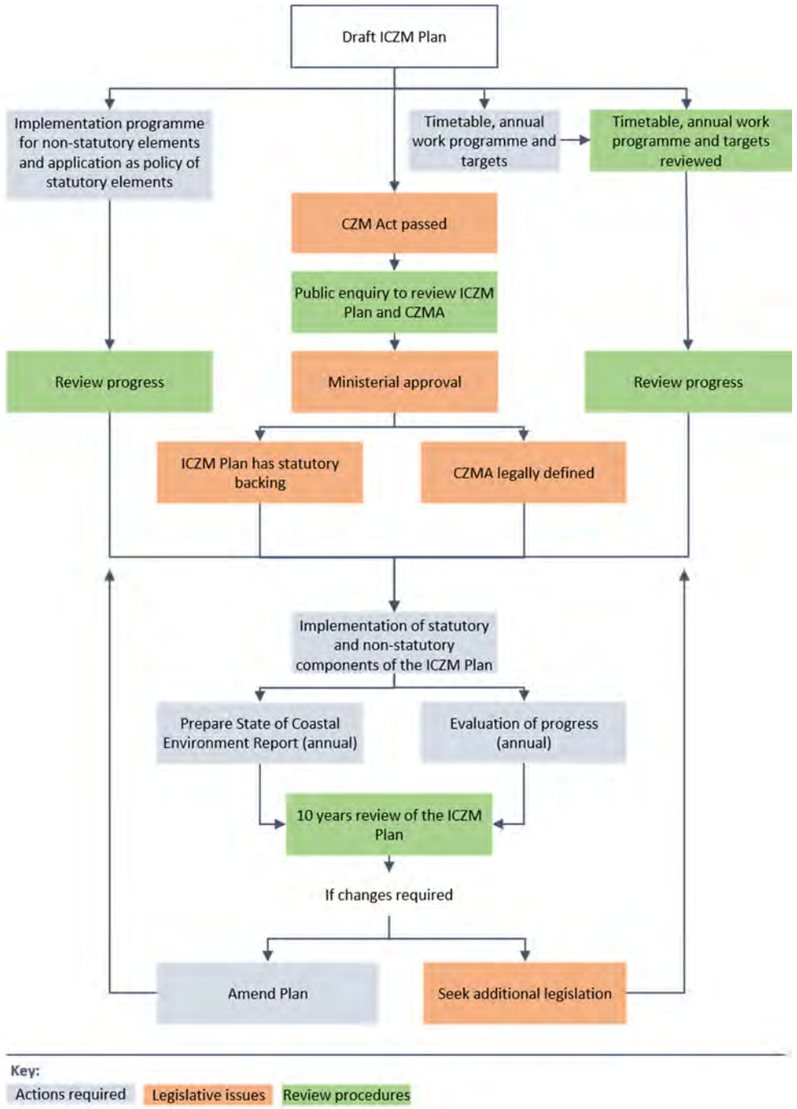


Figure A.5. Key stages in the Barbados ICZM process. (Source: adapted for Halcrow, 1998a).

To support implementation of this ICZM Plan, a series of National Guidance advisories are prepared (see Part C), ranging from coastal engineering, beach management and new emerging issues facing the CZMA of Barbados. In addition to this, and at the core of this ICZM Plan (and replicated within the proposed revisions to the CZM Act (2020)), is that public outreach and engagement remains a pivotal aspect to ensure successful implementation of this ICZM Plan. In addition to the gathering of social data to inform coastal resource management decision making, the importance of message communication (outreach) is vital. To this end, Part C focuses specifically on stakeholder delivery support (see National Guidance C.10).

In addition, a new set of draft regulations are being prepared to accompany the proposed revisions to the CZM Act (2020) as follows:

- Regulation 1: Coastal Zone Management Regulations 2020;
- Regulation 2: Special Marine Areas (Preservation and Enhancement) Regulations, 2020
- Regulation 3: Draft Aquarium Trade Regulations, 2020
- Regulation 4: Coral and Coastal Organisms Protection Regulations 2020

The proposed revisions to the CZM Act (2020) shall declare and affirm the right of the public to access, use and enjoy the beaches of Barbados and to secure the interest of the public by partially altering the common law doctrine of accretion. Within the revised CZM Act, the public right to beaches will be subject to any other law related to environmental management and in particular beach protection and to public safety, health, order and the regulation of trade. The Crown, acting through the Director of the CZMU (see draft Regulation 1 above), shall continue to have the right and authority to construct groynes, breakwaters, and sediment trapping devices or any other structures which are specifically designed to cause accretion of land or to prevent erosion of land.

Table A.3 shows the Government agencies undertaking primary risk resilient ICZM functions.

PRIMARY OR SECONDARY ICZM FUNCTION	AGENCY RESPONSIBLE	KEY PARTNER IMPLEMENTATION AGENCIES	LEGISLATION	FUTURE DELIVERY OF RISK RESILIENT ICZM – LIKELY ACTIONS
Primary Function 1: Preparation and revision of Coastal Management Plans: • Inventory of coastal resources (data collection, etc.) • Coastal management strategies • Standards of new development • Allocation of resources between competing use • Coordination with other development plans • Stakeholder engagement	CZMU *(Ministry of Maritime Affairs and the Blue Economy)*	TCDPO; Ministry of Finance, Economic Affairs and Investment; Environmental Protection Department; Drainage Division; Fisheries Division; Department of Emergency Management National Conservation Commission Natural Resources Department, (Energy Division)	Proposed revisions to the CZM Act (2020)	Undertake a new status of coastal resources exercise as part of the "State of the Coast" reporting strategy. In addition, important that new hazard risk profile findings are presented into this updated CZM Plan as well as being reflected and inculcated into a new set of national applicable monitoring and evaluation indicators (M&E) that will help to demonstrate institutional and GOB progress against the SDG13 and the Sendai Framework. Tsunami and storm surge hazard mitigation measures, articulated within the updated ICZM Plans, need to be embraced within future developmental policy and planning decision making (applications) that consider evacuation routes/setback guidance (i.e.: new standards, etc.).
Primary Function 2: Control of development in Coastal Zone Management Area: • Environmental and Social impact assessment • Inspection • Consultation to Town & Country Planning Office • Compliance and enforcement • Review design of any coastal projects • Data collection on stakeholders • Stakeholder engagement	TCDPO, CZMU	Environmental Protection Department Drainage Division Soil Conservation Unit Fisheries Division Barbados Water Authority Ministry of Finance, Economic Affairs and Investment; National Conservation Commission Natural Resources Department, (Energy Division) Natural Heritage Department) All government Departments linked to any aspect of developmental control within the defined CZMA.	Planning and Development Act (2019) Proposed revisions to the CZM Act (2020) Tourism Development Act (2002)	Planning system is currently not specifically climate-resilient. Impetus for GOB to adopt through advisories and protocols, designed and prepared by key agencies (e.g.: DEM and CZMU) are required. There is a need to implement Standard Operating Procedures (SoPs), building codes (not formalised) etc. to advise on climate-resilient adaptation measures for existing and future infrastructure (with advisories for retrofitting where suitable). The development or expansion of any activity in the CZMA and of any facilities associated with them will continue to need and involve CZMU supervision through the development control process and some will trigger an environmental impact assessment (EIA). CZMU needs to play an enhanced role in the planning development control arena with total support from TCDPO. Need to setup complimentary "Standing Committees" on specific topics, similar to the approach adopted by DEM whereby sector-specific sub DRM teams are chaired by specific sectors. CZMU to consider ways of improving two-way communication between themselves and relevant stakeholders so that an early understanding of any large development project that may be attracted to Barbados is considering climate resiliency into early design ideas.
Primary Function 3: Beach erosion and accretion control (coastal maintenance): • Monitoring programs, sampling measurement and data collection • Database building Stakeholder engagement	CZMU Ministry of Transport, Works and Maintenance	Ministry of Tourism and International Transport Barbados Tourism Investments Inc. Department of Emergency Management Barbados Meteorological Service The Research and Planning Unit Barbados Statistical Service National Conservation Commission	Proposed revisions to the CZM Act (2020)	Need to set up a series of "transition hand over" phases (advisories) to other organisations to take responsibility for management and maintenance of structures/assets etc. Where possible, there is a need to reduce the cost of outsourcing skills to private companies with regards to core activities that may be undertaken by the CZMU such as maintenance of coastal assets, setting up new databases etc.
Primary Function 4: Research and its regulation: • Internal research programs • Approval and monitoring of external programs through stakeholder engagement • Compliance and enforcement • Supporting data collection programmes	CZMU and Fisheries Division	Ministry of Finance, Economic Affairs and Investment Environmental Protection Department The Research and Planning Unit Barbados Statistical Service National Conservation Commission Natural Resources Department, (Energy Division) Natural Heritage Department) Barbados Agricultural Development and Marketing Corporation	Proposed revisions to the CZM Act (2020) Fisheries Act (2004)	Create an implementable policy on Knowledge Management (KM) so that all key information developed (via various consultancies) are used for improved implementation of the ICZM Plan for GOB especially regarding monitoring and evaluation and compliance/enforcement-related issues. Create clear "conditions of sale" as well as "information sharing" policies on the coastal related data is required. CZMU could potentially add "marine climate services" to their technical portfolio to help the Barbados Meteorological Service (BMS).
Primary Function 5: Coastal Resources protection and monitoring: • Monitoring and data collection (sampling, etc.) • Coral reef/ wetland/mangrove/seagrass database creation • Setting and enforcing protection standards • State of the Coast Reporting • Education and Outreach • Stakeholder engagement	CZMU Fisheries Division	Ministry of Finance, Economic Affairs and Investment Environmental Protection Department Drainage Division Fisheries Division Barbados Water Authority Ministry of Tourism and International Transport Sanitation Service Authority Ministry of Transport and Works UWI Department of Emergency Management	Proposed revisions to the CZM Act (2020)	Creation of an outreach strategy that clearly communicates agency mandates and roles with regard to reef conservation. This should dilute any confusion over responsibilities and delivery expectations linked to various statures, regulations and laws (i.e.: the proposed revisions to the CZM Act (2020), NCC Act and Fisheries Act, etc.). There is also no formal reporting system currently in place to capture coral reef health statistics as part of a "State of the Coast" reporting system. There is a need

PRIMARY OR SECONDARY ICZM FUNCTION	AGENCY RESPONSIBLE	KEY PARTNER IMPLEMENTATION AGENCIES	LEGISLATION	FUTURE DELIVERY OF RISK RESILIENT ICZM – LIKELY ACTIONS
		Barbados Coast Guard Barbados Statistical Service National Conservation Commission Natural Resources Department, (Energy Division) Natural Heritage Department Royal Barbados Police Force Barbados Agricultural Development and Marketing Corporation		to formalise a new reporting function to assess progress against a nationally agreed set of bio-indicators as well as SDG 14.
Primary Function 6: Marine water quality testing: • Monitoring and data collection programs • Sampling and analysis • Database building • State of the Coast Reporting • Interpretation and assessment of results and trends • Identification of critical water quality characteristics for specific environments • Establishment of appropriate standards (both ambient and point of discharge) • Enforcement of water quality standards through stakeholder engagement	EPD CZMU	Government Analytical Services Drainage Division Soil Conservation Unit Fisheries Division Barbados Water Authority Ministry of Tourism and International Transport Sanitation Service Authority Ministry of Transport and Works Barbados Statistical Service National Conservation Commission	Marine Pollution Control Act (1998)	There is no formal reporting system currently in place to capture environmental statistics or "state of the coast" information. There is a need to formalise a new reporting function progress against a nationally agreed set of bio-indicators (for wetlands, mangroves, seagrasses as well as coral reefs) in addition to SDG 13 and 14 national reporting support.
Primary Function 7: Coastal Engineering and Shoreline Management: • Monitoring and data collection • Coastal construction and maintenance • New materials for beach recharge • Enforcement of prohibition, conditions of approval where permitted • Support to promote ecosystem-based adaptation techniques • Stakeholder engagement	TCDPO CZMU	Drainage Division Soil Conservation Unit Sanitation Service Authority Ministry of Transport and Works Department of Emergency Management Barbados Meteorological Service National Conservation Commission	Planning and Development Act (2019) Proposed revisions to the CZM Act (2020)	A national Coastal Engineering Guide ("How to Guide") needs to be prepared that embraces the new NCRIPP data with a summary "White Paper" disseminated to all GOB Ministries and new developers (including TCDPO as an annex to the existing EIA ToR Guideline). New technical guidance on (for example) flood retention basins, flood conveyance and ecosystem-based adaptation advisories and practices and use of quarried sands for beach recharge should be developed that consider new engineering support advice within the Coastal Zone Management Area. Importantly, no building regulations are enshrined in law at present, where these do exist they are in need of update to become climate resilient (to better embrace latest climate model predictions of precipitation rates for better calculate culvert diameters for roads). Internally, infrastructure specifications do already exist (written by MTW) for roads and culvert designs. These need to be better communicated to contractors as required to embrace the more recent climate predictions and risk analysis work recently carried out by CZMU through the NCRIPP project.
Primary Function 8: Development and management of marine parks, reserves and beach accesses: • Identification of potential marine reserves and parks • Establishment and operation • Beach Management Standard setting (ISO13009) through stakeholder engagement • Data collection on beach users	NCC	CZMU TCDPO Ministry of Finance, Economic Affairs and Investment Environmental Protection Department Drainage Division Soil Conservation Unit Fisheries Division Ministry of Tourism and International Transport Barbados Tourism Investments Inc. Department of Emergency Management Barbados Meteorological Service Barbados Tourism Investment Inc. (BTI) Barbados Tourism Authority Barbados Hotel and Tourism Association	Proposed revisions to the CZM Act (2020) Planning and Development Act (2019) National Conservation Commission Act	Creation of a new International Standard for Beaches (ISO13009), with NCC as the lead implementer, under the management of the Barbados Standards Bureau. The service provided by CZMU would be as supporting coordinator. The new Special Marine Areas Regulations (2020),once endorsed, may be used to help identify and manage new marine reserves/parks etc.
Supporting Function 1: Coordination and enforcement: • Ensuring that primary coastal management functions are carried out through stakeholder engagement • Ensuring that all coastal management functions are coordinated through stakeholder engagement	CZMU TCDPO	CZMU Government Analytical Services Ministry of Finance, Economic Affairs and Investment Environmental Protection Department Drainage Division Soil Conservation Unit	Proposed revisions to the CZM Act (2020) Marine Pollution Control Act (1998)	The CZMU should consider multi-disciplinary approaches (whereby actions are delivered by others) though CZMU may spearhead the action if required to promote the need. Improving public outreach of CZMU to the public is important and should continue to be improved upon coupled with improve education to all sectors of society on risk resilient ICZM measures.

Primary or Secondary ICZM Function	Agency Responsible	Key Partner Implementation Agencies	Legislation	Future Delivery of Risk Resilient ICZM – likely actions
Supporting Function 2: Provision of legislation and regulations: • Identify needs for legislation and regulations • Timely drafting and submission to Parliament of the Minister for consideration	Chief Parliamentary Counsel Solicitor General's Chambers	Fisheries Division Barbados Water Authority Ministry of Tourism and International Transport Barbados Tourism Investments Inc. Sanitation Service Authority Ministry of Transport and Works Department of Emergency Management Barbados Meteorological Service Barbados Coast Guard The Research and Planning Unit Barbados Statistical Service National Conservation Commission Natural Resources Department, (Energy Division) Natural Heritage Department) Barbados Police Force Royal Barbados Police Force Customs Division, Barbados Agricultural Development and Marketing Corporation Barbados Tourism Investment Inc. (BTI) Barbados Tourism Authority Barbados Hotel and Tourism Association	N/A	Proposed revisions to the CZM Act (2020) encourage improved enforcement powers to the CZMU to help remove poor coastal designed structures. This should help to climate proof the current planning system and to help with regulatory enforcement. Recommend new specific M&E guidance or models are set up to comply with the latest Sendai Framework Priorities/Targets/Indicators. Support and encourage CDEMA to develop a consistent approach to determine this approach for Caribbean Nations.

Table A.3. Government agencies undertaking primary risk resilient ICZM functions.

A1.4.2. The legal and institutional framework for physical planning in the CZMA

The CZMU is one of several agencies within the Ministry of Maritime Affairs and the Blue Economy (MMABE) with responsibility for supporting GOB, providing advice on physical planning within the defined CZMA. The CZMU remains as the national focal agency for ICZM and coastal planning advisories in Barbados. It is responsible for undertaking, in conjunction with others, a series of primary and secondary functions for risk resilient ICZM (see Table A.3) and in liaison with others concerning all other (non-primary) ICZM functions that are not embraced under the proposed revisions to the CZM Act (2020). It therefore works in partnership with other agencies of government and acts as the key development advisors to the Town and Country Development Planning Office (TCDPO) who have the authority for granting planning permission for all developments in Barbados and hence within the CZMA to help implement the ICZM Plan.

The TCDPO is responsible for enforcing the Land Boundaries Act (1980) and the more recent Planning and Development Act (PDA 2019[4]) as it relates to all lands within the limits of the territorial waters of Barbados, including the newly defined limits of the CZMA. The PDA (2019) underpins the approach that applies to this ICZM Plan, as well as the wider process of developmental planning in Barbados.

Importantly for ICZM delivery, the PDA (2019) expresses the requirement for public participation towards achieving the purposes of the Act which was a requirement that was absent from the original Town and Country Planning Act (Cap. 240). The new PDA (2019) is delivered through a range of internal administrative Sections. This importantly provides for a Planning and Development Board (the "Board") whose requirements pertaining to the operation and members of that Board are definitively expressed within the PDA (2019). This includes matters pertaining to stakeholder engagement and public participation. The Board is a body corporate with perpetual succession and a common seal and is responsible for the implementation of the policies framed by the Minister. This is relevant to the ICZM Plans implementation as the CZMU's role and responsibility (as a key member of this Board) will be to specifically to advise the TCDPO on the granting of permissions for development within the CZMA. In addition, it shall ensure that all relevant supporting agencies undertake their roles to implement the policies and adopt the guidelines set out within the ICZM Plan.

Supporting agencies (with specific reference to physical planning in the CZMA) that are important in delivering aspects of ICZM (primary or secondary functions) include the following:

- Environmental Protection Department (EPD) implementing the Marine Pollution Control Act 392A (1998) to address water quality matters on land and at sea[5];
- Drainage Division (within the Ministry of Transport, Works and Water Resources - MTWM) on matters relating to the effective management, monitoring and enforcement of drainage structures as necessary relative to the Prevention of Floods Act (1951) and the Highway Act;
- Soil Conservation Unit (through the Soil Conservation Scotland District Act (1998) on matters regarding the stability of land within the Scotland District area;
- Fisheries Division on matters regarding fisheries and aquaculture/mariculture projects,
- Barbados Water Authority on groundwater and water supply matters, under the Underground Water Control Act (1953) and the Barbados Water Authority Act (1980);

[4] Anticipated to be a Statutory Instrument in 2020

[5] With respect to the Marine Pollution Control Act (1998), the draft subsidiary legislation required to facilitate full implementation of the Act, was drafted but has not been reviewed by the Chief Parliamentary Counsel for approval. On the other hand, the Environmental Management Act is not yet enshrined in law. However, elements of the Act are being implemented nationally by EPD though it has no legal authority to enforce or prosecute any known offenders and instead the EPD's regulatory authority remains bound by the Health Services Act (1969).

- Ministry of Tourism and International Transport on coastal tourism-related issues;
- Barbados Tourism Investments Inc. on matters that help identify investment opportunities and service providers;
- Sanitation Service Authority on matters relating to the Mangrove Pond Beautification Programme and to ensure refuse collection and street cleaning within the CZMA;
- Ministry of Transport, Works and Maintenance (MTWM) on matters relating to sustainable transport and infrastructure works strategy.

Supporting Committees (in addition to the Planning and Development Board) that help implement physical planning related activities include the Barbados Hotel and Tourism Association committees that exist on various topics including conservation and beach management.

A1.4.3. The legal and institutional framework for Disaster and Climate Risks

To support disaster and climate mainstreaming, the approach presented within this updated ICZM Plan seeks to complement the ongoing R2RP and to help inculcate CCA and DRM within longer-term adaptation action planning in the country. Key paradigm shifts in governance arrangements, though this ICZM Plan, seek to better embrace aspects of risk identification, prevention and mitigation and financial risk management for preparedness and response and recovery under the CZMU's mandate (under the legislative powers set within the proposed revisions to the CZM Act (2020)).

Key stakeholders to support implementation include (amongst others) the following:

- Department of Emergency Management (DEM) - seeks to implement the Emergency Management Act (2006) and the Emergency Powers Act, Cap. 161 (2006-20) to help promote and institutionalize the practice of appropriate preventative and mitigation measures for all possible hazards, as well as the development and maintenance of effective national and sectoral warning, response and recovery plans.
- Barbados Meteorological Service (BMS)[6] - responsible for monitoring marine conditions in the country (within the context of meteorological data forecasting needs) and maintaining a database of weather data including stream flow data valuable for use in flood mapping and early warning system implementation.
- Barbados Coast Guard - represents the maritime division of the Barbados Defence Force with responsibilities for patrolling Barbados' territorial waters as well as drug interdiction and humanitarian and life-saving exercises.
- The Public Investment Unit (PIU)[7] - provides assistance, advice and guidance to line ministries, which have direct responsibility for project planning and implementation, including advice on DRM (ex-ante services).
- The Research and Planning Unit - provides expert policy and technical advice based on a sound framework for economic and social planning (including DRM) through the conduct of economic and social research, policy analysis, rational economic and social planning, technical cooperation, coordination and the compilation and analysis of statistical information.
- Barbados Statistical Service (BSS) – is mandated (under the Statistics Act) to collect, compile, analyse, abstract and publish reliable and timely information relating to the social, economic and general activities or conditions of the inhabitants of Barbados. BSS works with DEM to assist on damage assessment work after natural disaster events. BSS also relies heavily on CZMU to provide specific data to support this plus also baseline maps of the coast (LiDAR, etc.).

Existing committees and their respective roles include the Cabinet approved multi-stakeholder National Climate Change Committee (NCCC). This was recently transformed into the Climate Change Unit (CCU) and was tasked with producing the 2nd National Communication on Climate Change (2018). In addition, the Technical Standing Committee on Coastal Hazards is a scientific Standing Committee comprising of representatives from both GOB and private sector all working on DRM initiatives to reduce the impact of hazards along the coast, such as tsunamis, storm surge, winter swells, erosion, sea-level rise and oil spills. There may be a future need for all stakeholders, under the advisory of the CZMU, to support in the production and subsequent Summary Reports and/or "White Paper" publications plus other supporting actions as identified in Table A.3 that include functions including (amongst others) capacity support enforcement support and future regulation recommendations, etc.

A1.4.4. The legal and institutional framework for coastal resource protection

Coastal resources are given special attention including greater emphasis on wetlands, mangroves and seagrass beds (amongst others) within the proposed revisions to the CZM Act (2020) to ensure their consideration (in tandem with coral reefs) is granted with reference to how they may be affected/ impacted by CCA/DRM. Attention is also given to all non-living resources (both of land and on the seabed) including minerals/nodules and offshore aggregates in tandem with living resources associated with the shoreline, water column, and marine areas of Barbados[8].

The CZMU Director has a key role to notify all relevant agencies of the need to consult CZMU if they are seeking to undertake any activities, or make decisions, that may affect coastal resource health and integrity. The legal requirement to consult, contained in Section 33(3) of the existing CZM Act (1998), and retained within the proposed revisions to the CZM Act (2020) therefore represents an important legal tool to help deliver this approach (with support from a range of organisations – see Table A.3). A new routine process for communicating research findings is to commence to assess the status of coastal resources, in the form of an annual "State of the Coast" report. This is a requirement set out within this ICZM Plan and linked to revised legislation such as the proposed revisions to the CZM Act (2020). This shall be supplemented with publications (including "White Papers" as appropriate) to help clarify the range of roles that coastal resources play in Barbadian society.

Supporting organisations with specific reference to the protection of coastal resources within the CZMA, whom are important in partnering to produce the "State of the Coast" reports include the following:

[6] Within the Ministry of Agriculture and Food Security.
[7] Within the Ministry of Finance and Economic Affairs.

[8] This includes beaches, shore cliffs, seascapes and other resources of aesthetic value, coral reefs, coral rubble, algal beds, seagrass beds, sand dunes, mangroves, other wetlands and other ecosystems found along the shore together with the flora and fauna found in these areas.

- Environmental Protection Department (EPD) - implement the Marine Pollution Control Act 392A (1998) to address water quality matters on land and at sea[9];
- National Conservation Commission (within the MENB) - mandated (under the National Conservation Commission Act 1982) to carry out a number of functions related to the provision of services to the public and the protection and enhancement of the marine and terrestrial environment as well as regulatory functions as described in its Act. NCC also represents an important and integral agency towards the delivery of beach management related activities in Barbados.
- Natural Resources Department (NRD), (Energy Division) - located within the Prime Minister's Office (PMO), their role is to support the promotion and development of all local natural resources (on-shore and within the Barbados EEZ), in an economically and environmentally sustainable manner.
- Natural Heritage Department (NHD) - works with the NCC (the enforcers of regulations) to implement the Marine Areas (Preservation and Enhancement Act – 1976) and the Marine Areas (Preservation and Enhancement – Barbados Marine Reserve Regulations - 1981) to promote the conservation of special and unique biomes through effective management of a network of terrestrial and MPAs.
- Fisheries Division - responsible for implementing the Fisheries Act (1993). They provide support on fisheries planning and management (including sports fisheries) with the Fisheries Resource Management Section (of this Division) and provide scientific information for planning and implementing measures for fishery management and development, including catch and effort statistics; biological, social and economic information, fisheries management measures and aquaculture and mariculture services. Under the Fisheries Act (1993), Fisheries Regulations (1998) are (or can be) made on all aspects of fisheries and related activities, including limiting catches and protecting species such as coral shells, ornamental fish, lobsters, conchs and sea-eggs. The Act also requires licensing of vessels and fishermen and makes provisions for resource management plans ("fisheries schemes").
- Soil Conservation Unit - implement the Soil Conservation (Scotland District) Act (1998) which includes interventions to implement the extensive re-vegetation of the Scotland District with a large variety of vegetation including fruit trees.
- Barbados Coastal Guard and Police Force - responsible for patrolling Barbados' territorial waters as well as drug interdiction and humanitarian and life-saving exercises. They support CZMU with regards to local enforcement of the Shipping (Watersports) Regulations (2004) and beach byelaws (set by NCC authority) plus also the adherence to speed controls within marine protected areas (e.g.: Folkestone Marine Park and Carlisle Bay Marine Park).
- Barbados Agricultural Development and Marketing Corporation (BADMC) - established by a legislative act (Cap. 254) in 1993 and help with undertaking water quality monitoring of groundwater for irrigation purposes.
- Barbados Port – within MMABE (who have responsibility for the Barbados Port Inc), a private company exists of which the Government of Barbados holds 100 percent shares.
- Maritime Division (MMABE) - responsible for advising the Minister on program-related policy formulations and implementation and the management of the legislative/regulatory, supervisory and monitoring framework, including relevant international conventions that govern matters relating to shipping, seafaring, and safety at sea and the prevention of marine pollution.

Existing committees and their respective roles include the National Oil Spill Response Committee (chaired by the EPD) who coordinate activities including oil spill response and clean up technique training.

A1.5. Relationship of the ICZM Plan to other plans

The updated PDP (2017) is the primary planning instrument within Barbados for establishing the use of land, and the environment and conservation policies that will apply within these designations. Other plans support the PDP by providing national guidance on specific elements of natural resource management and development. Those most relevant are listed below:

- The ICZM Plan (this document plus Volume 1 ICZM Policy Framework);
- Storm-water management Plan Update (2021);
- Green Paper on Water Protection and Land Use Zoning Policy (2020);
- Second NDC (2021)
- Barbados National Strategic Policy (BNSP 2005-2025)
- Draft National Climate Change Policy Framework (NCCPF) (2012);
- Country Document for Disaster Risk Reduction (DEM 2014);
- Tourism Master Plan (2014-2023);
- The Environmental Management Plan (1998);
- Barbados Growth and Development Strategy (2013 – 2020)
- Barbados Oil Spill Contingency Plan (2013);
- Fisheries Management Plan (2004 to 2006);
- Barbados National Biodiversity Strategic Action Plan (2002)

The PDP integrates the ICZM Plan, along with other policy and planning documents, for example, the ground-water protection policy etc. As stated within the updated PDP (2017), the ICZM Plan conforms with the *Natural Heritage System* approach and in return, all decisions on coastal development, conservation, and management in the CZMA are to be informed by the latest technical data and analysis available to the CZMU. The ICZM Plan will also compliment and support the implementation of PDP policies for Open Spaces that occur within the CZMA (Section 2.2.2 – Natural Heritage System: Coastal Zone Management sub-section).

Reflecting this synergistic approach, Section 4.4 of the PDP (OS3 – Coastal Landscape Protection) defines the limits of Coastal Landscape Protection Zones from Salt Cave Point to Consett Bay (south and east coasts) plus from

[9] The Environmental Management Act is not yet enshrined in law. However, elements of the Act are being implemented nationally by EPD though it has no legal authority to enforce or prosecute any known offenders and instead the EPD's regulatory authority remains bound by the Health Services Act (1969),

Archers Bay to Maycocks Bay (north-west coast) whereby the CZMA boundary defines the inland limits. In addition, Section 4.8 of the PDP (2017) refers to "Shore Access Points" and the importance of maintaining access to the sea for emergency vehicles and maintenance vehicles for coastal structures. In a similar vein, the objectives of the Barbados National Park are adopted to guide the coastal management programme for the stretch of coast falling within the proposed National Park (see Section 4.2.8 of the updated PDP 2017). Part C of this ICZM Plan provides additional information and guidance on this matter. Maintaining these links is important during any review of these related plans and policies (see Figure A.6). The Planning and Development Board (as set out within the PDA (2019)) shall assist with this process[10].

Consistency of approach, in line with the updated PDP (2017) and the PDA (2019)[11] (Sections 1.4 and C5.1 of this ICZM Plan), remains paramount throughout the effective life of this ICZM Plan. These also provide the opportunities to support delivery of an improved environmental impact assessment (EIA) process for the country. This opportunity is supported through existing planning processes with the Director of the CZMU currently identified (within the PDA 2019) as a key member of the Planning and Development Board which is an obligatory channel of cooperation and communication relating primarily to physical development and planning.

Links between the different legal provisions are subsequently essential to ensure ICZM delivery and success as all aspects of ICZM in Barbados involve aspects of environmental management. Consequently, in addition to the proposed revisions to the CZM Act (2020) (see Section 1.5), the PDA (2019) and the Marine Pollution Act (1998), the entire legal framework is important to the implementation of the ICZM Plan. New legislation is being prepared in the form of the Open Beaches Bill (2019) with provisions to help facilitate ICZM delivery. Pending developments to formalise a "Sustainable Ocean Based Economy (SOBE)[12]" for Barbados shall also require close integration with this ICZM Plan and supporting sectoral strategies within the coming years.

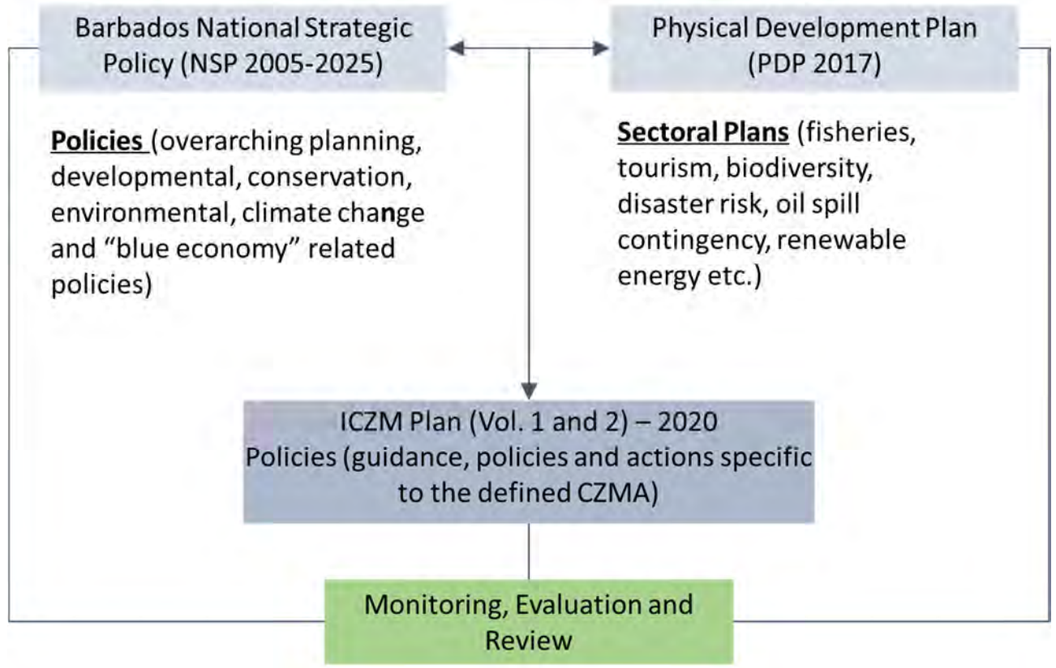


Figure A.6. Links between key planning documents which support this ICZM Plan.

[10] The Planning and Development Board is a body corporate with perpetual succession and a common seal. The Board is responsible for the implementation of the policies framed by the Minister.

[11] Accepted by both Houses of Parliament by January 2019. Currently it underpins the approach that applies to ICZM as well as the process of national physical planning and development. It is anticipated that this legislative instrument will be effected as a Statutory Instrument.

[12] Also termed as the "Blue Economy".

A2. CHARACTERISTICS OF THE CZMA

This section describes the characteristics of the CZMA, including the natural environment, the people and economy and the risks derived from natural and anthropogenic processes. The information provided has been extracted from the numerous baseline studies and risk assessments developed by the CZMU during last years (see Annex 2), mostly within the CRMP (IDB funded programme – undertaken by Baird 2015-2018). These baseline studies have been integrated within the NCRIPP, which is a software tool to provide planners and other government groups with a manner to assess and mitigate risk.

A2.1. The natural environment

A2.1.1. Physical environment

Climate

Barbados is the most easterly of the islands of the Lesser Antilles, located at 13º 4' North latitude and 59º 37' longitude, which determines the island climate.

The climate is tropical and oceanic, hot and humid all year round, with an average and homogeneous (without severe seasonal or daily changes) temperature of 26.8 ºC. The island enjoys two weather seasons: the wet season, which coincides with the Atlantic hurricane season (from June to November), and the dry season, with an average rainfall range of 39 mm per month. During the wet season, most of the rainfall is derived from tropical waves that lead to downpours or thunderstorms with monthly average rainfall ranges from 160/170 mm.

Geology and geomorphology

The coastline length of Barbados is about 114 km of which approximately 59 km are coralline limestone cliffs (Golder, 2016), mainly located along the southeast, east and north coasts (Figure A.7). Approximately 86% of the land area is capped by coralline limestone rocks, overlying uplifted sea-bed sediments and weak/poorly consolidated Tertiary rocks of Eocene.

Cliffs have been classified into five main types (Golder, 2017; Figure A.8 and Figure A.32) based on rock strength, type, modes of failure and geological composition. Total lengths of each type classified around the island are:

- Type A - about 11 km.
- Type B - about 19 km.
- Type C - about 19 km.
- Type D - about 5 km.
- Type E - about 6 km.

Coralline cliffs exist around the majority of the coastline of Barbados, except for Scotland District. According to Golder (2017), between the predominant cliff areas along the west and south coasts (Sub-Areas 6, 7 and 8, Figure A.7), about 21 km length of the coastline consists of calcareous beach sand. Moreover, along the east part of the island, approximately 13 km of primary silica (quartz) sand beaches occur at or near the base of the exposed sloping Tertiary sediments/weak rocks of the Scotland District.

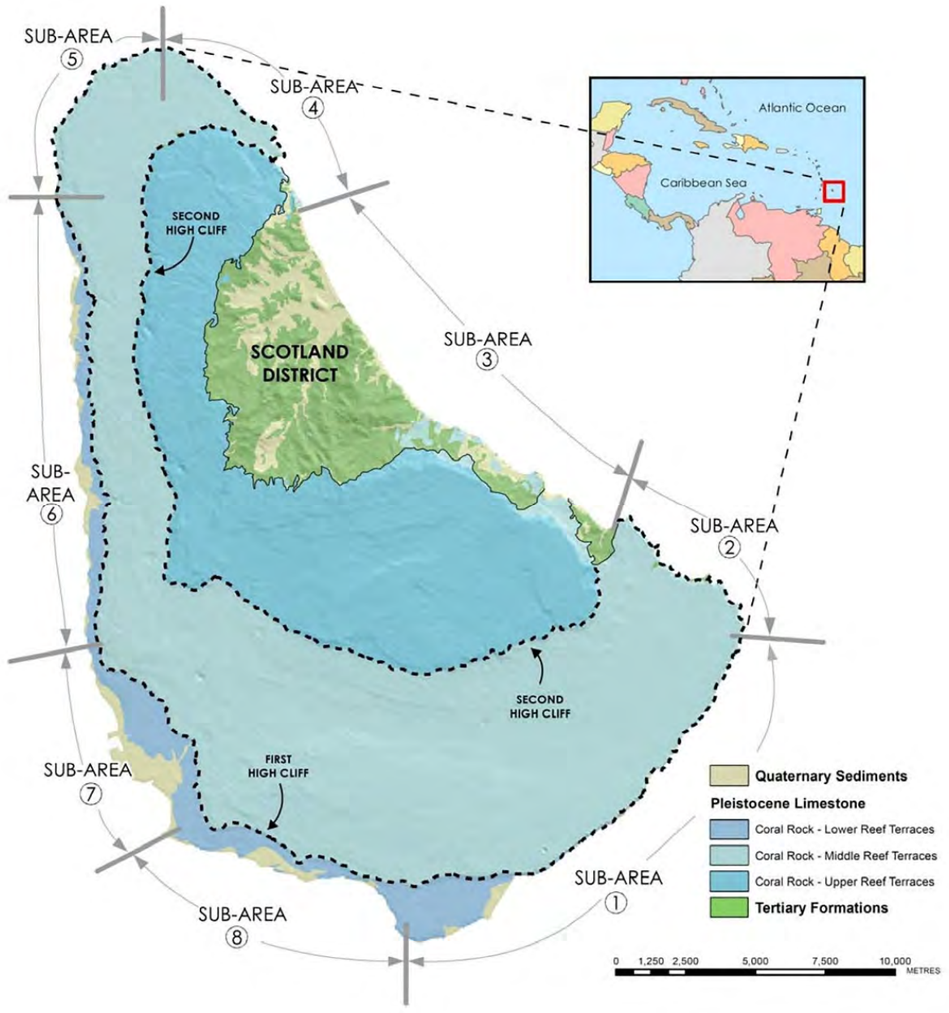


Figure A.7. Sub-areas of the Geotechnical Surveys Investigation developed by Golder Associates (Source: Golder, 2017).

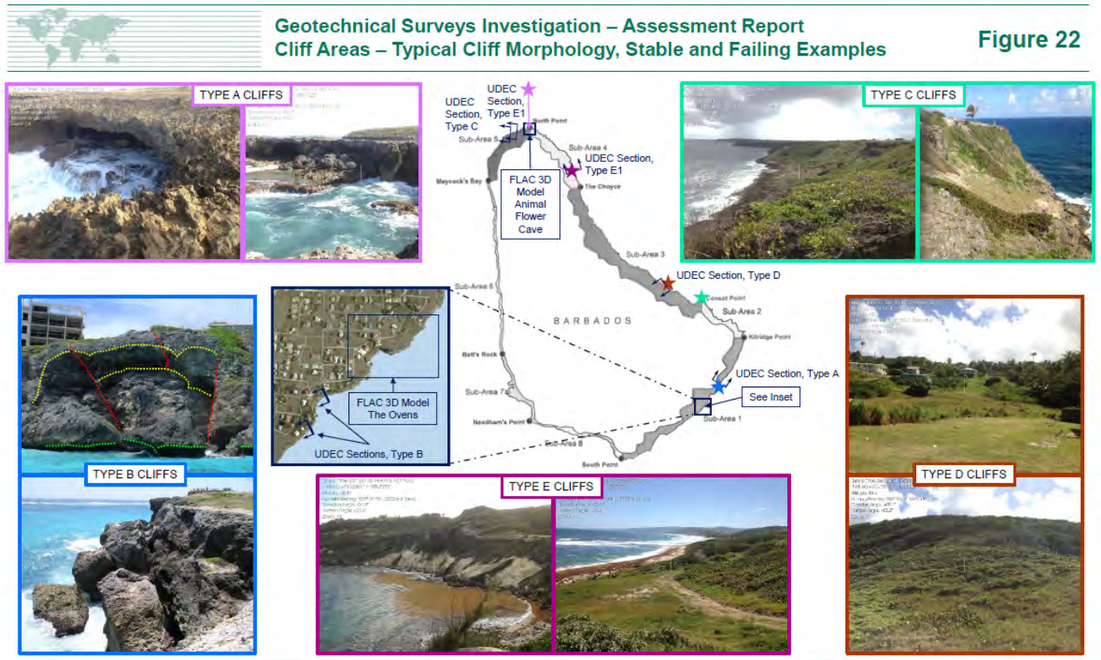


Figure A.8. Examples of the five types of cliffs (Golder, 2017).

Nearshore dynamics

Nearshore dynamics in Barbados relate to the interface between the sea and the land. These dynamics are complex systems that evolve in time and produce changes between them. The more important nearshore dynamics for the ICZM of Barbados are sea level, current circulation, waves, sediment transport, and coastal stability.

Sea level

Sea level movement is composed of two different processes: the rise of sea level due to astronomical tides and the rise of sea level due to atmospheric surges.

Barbados, as in the majority of the Caribbean Sea, presents mixed semidiurnal tides, this magnitude is well-know and it is possible to be predicted accurately. Commonly this magnitude is calculated by subtracting the astronomical tide from the instrumental register of sea level in areas protected of the short waves, as bays or behind breakwaters in ports.

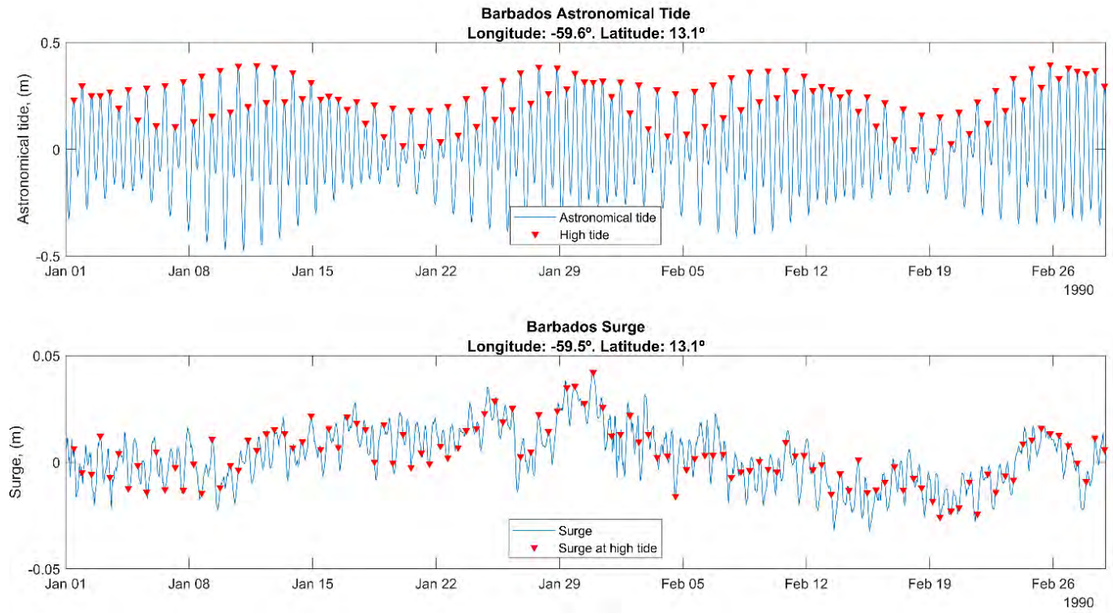


Figure A.9. Astronomical tide and atmospheric surge obtained from reanalysis databases.

Two tide gauges are in place to record sea level in Barbados notably one at Port St Charles and another one at Bridgetown Port.

Current circulation

Barbados is subject to both south and north equatorial currents. The north equatorial current flows east to west at a latitude of 10° to 20°. Moreover, the influence of the Orinoco and Amazon Rivers are also influencing the pattern of currents around the island. As a result, the dominant oceanographic currents in Barbados are from the southeast towards the northwest but the important variability of these processes usually needs the use of numerical modeling to obtain specific results in nearshore scales. Barbados has carried out an important effort in the study of nearshore current circulation during the last years as part of the CRMP. Consequently, Barbados implemented, calibrated and validated an island-wide model to perform the downscaling of the regional currents to local scale using several intermediate numerical domains.

Waves

Wind-generated waves at the sea surface play a major role in many engineering and environmental issues, both within the offshore and shoreline areas, providing a significant contribution to coastal sea level extremes and subsequent flooding. They are also a key factor in determining rates of coastal erosion and sediment budgets. At the open sea, they represent a major hazard for any offshore operation or structure or to maritime transportation and shipping activity. Therefore, changes in wave climate are of central importance for almost all aspects of coastal and offshore activities.

Barbados is effected primarily by waves generated by the following:

- NE Trade Winds;
- North Atlantic Ocean Swells;
- Hurricane and Storm Activity.

Figure A.18 illustrates these three mechanisms of wave generation and their relative direction of approach to the island.



Figure A.10. Wave Generation Mechanisms for Barbados. (Source: Baird and Associates, 2003).

Long period swells originate from storm activity in the North Atlantic and propagate to the shoreline of Barbados. These waves impact in first instance the north-east and east coasts but also, due to their long periods (12 seconds and greater), tend to wrap around westerly affecting the west coast, and easterly affecting the complete east coast and in last instance the south coast of the island.

The North East trade winds result from the pressure gradient that exists due to rising air at the equator. These trade winds that blow within the vicinity of Barbados cause locally generated seas.

Hurricanes and storms form over tropical waters (between 8° and 20° latitude) in areas of high humidity, light winds, and warm sea surface temperatures (typically 26.5°C or greater). These conditions usually prevail in the summer and early fall months of the tropical North Atlantic and North Pacific Oceans and for this reason, hurricane 'season' in the northern hemisphere runs from June through November. These systems typically form east of Barbados and travel west, generally passing north of the island.

Over 30 years of wave data has been collected in Barbados. Much of the older data are either not available, have inadequate documentation, use older technologies, and/or are very limited in duration. The more consistent and reliable data generally commence in the late 1990s. Wave data provides one of the primary driving forces in the CRMP as well as also being an important part of the development carried out in the NCRIPP.

More recently, new data measurements from CRMP are used to calibrate and validate island-wide modeling to obtain a comprehensive reanalysis of the wave climate in Barbados. Figure A.19 presents the location of the instruments used during the Nearshore Wave Study (NWS) and the island-wide domain used for the regional downscaling. As a result, NWS concludes that the model would compare well during some periods and then poorly during another period when the offshore waves were similar. The conclusion was that currents were playing a large role in the wave transformations into the more sheltered areas (such as the SW coast).

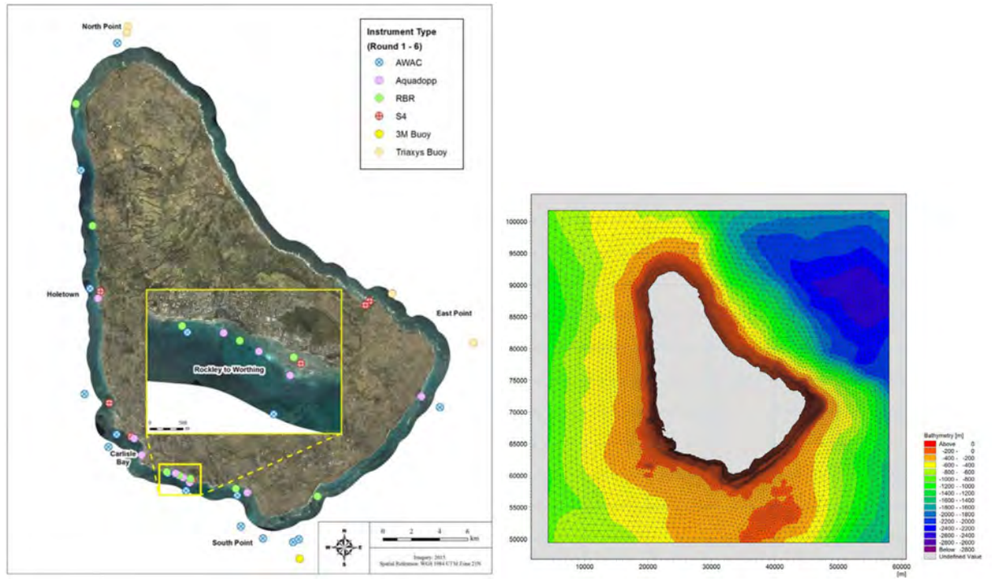


Figure A.11. Location of Wave Measurement Equipment during NWS and Nearshore Wave Model Domain (Source: Baird, 2016).

Sediment transport and coastal stability

Sediment transport and coastal stability are important issues related to the physical environment of the coast of Barbados because of the important use of the beaches on the island. Sediment transport is a complex process in which many factors are involved such as currents, waves, reefs, sediment availability, sand supply, man-made structures.

To enhance the understanding of these processes, a numerical model was developed as part of the CRMP to adopt an integrated sediment budget approach that incorporates the balance between beach building and beach eroding parameters on a multi-decadal scale to assess the impact of SLR. Key sediment budget components for a typical beach in Barbados include: 1) carbonate sediment supply from local underwater habitats such as corals, 2) profile response to storm events (driven by cross-shore sand transport) under different sea levels, and 3) alongshore sediment supply as a result of the gradient in longshore sediment transport (reach-based difference between incoming and outgoing alongshore transport).

Longitudinal transports were calculated and results confirm some of the previous works carried out in local scales like the predominance of a longitudinal transport from Bottom Bay to North Point at the Atlantic coast. However, at the south part of Bottom Bay, the net annual longitudinal transport goes to the south-west until it reaches Carlisle Bay where longitudinal transports in both directions are significantly balanced. As an example, longitudinal sediment transport patterns at 2m depth is presented in Figure A.12.

The sediment budget model indicated that the most sensitive locations to SLR are those where beaches are unable to migrate landward during SLR by an existing hard barrier at the back of the beach. As a result, the beach becomes narrower and steeper and loses its ability to preserve a reservoir of sand for temporary storm loss. Furthermore, beach overtopping or over-washing events would increase resulting in sand (and water) being washed across roads or properties behind the beach. Beaches on the southwest and west coasts of Barbados are susceptible to coastal squeeze (e.g. Sandhurst Main, Drill Hall, the southern reach of Carlisle Bay, Fitts Village, Folkestone and Heywoods South) due to the manmade structures along the densely populated shoreline. North Point is also susceptible to coastal squeeze, due to the steep rocky coastal cliff located at the back of the beach.

The findings from the CRMP "Shoreline Change Study" (Baird, 2015c) declared that the majority of the eroding coast (natural) shoreline is located between Sandy Lane and the Cement Plant on the west coast (Sub-Area 6). The only segments of accreting coast (natural or engineered) are located north and south of the Port in Bridgetown (Figure A.13). The majority of the southwest coast is classified as being a stable (engineered) coast, whereas the entire north shore is a more natural coastal cliff. The Scotland District coast is a dynamically stable area including coastal cliffs to the south. The east and southeast coasts feature coastal cliffs with isolated pocket beaches that are generally stable.

When aggregated for the entire island, some important trends for the coast of Barbados emerge. First, 8% of the coastline is eroding, while only 2% features an accretion rate. The coastal cliffs represent 48% of the island, while 8% of the coast is classified as artificial coast. The northern half of the Scotland District features the only coast classified as dynamically stable (natural) but it is a large segment and represents 9% of the shoreline of the island.



Figure A.12. Sediment transport patterns around the coast of Barbados (Source: Baird, 2016).

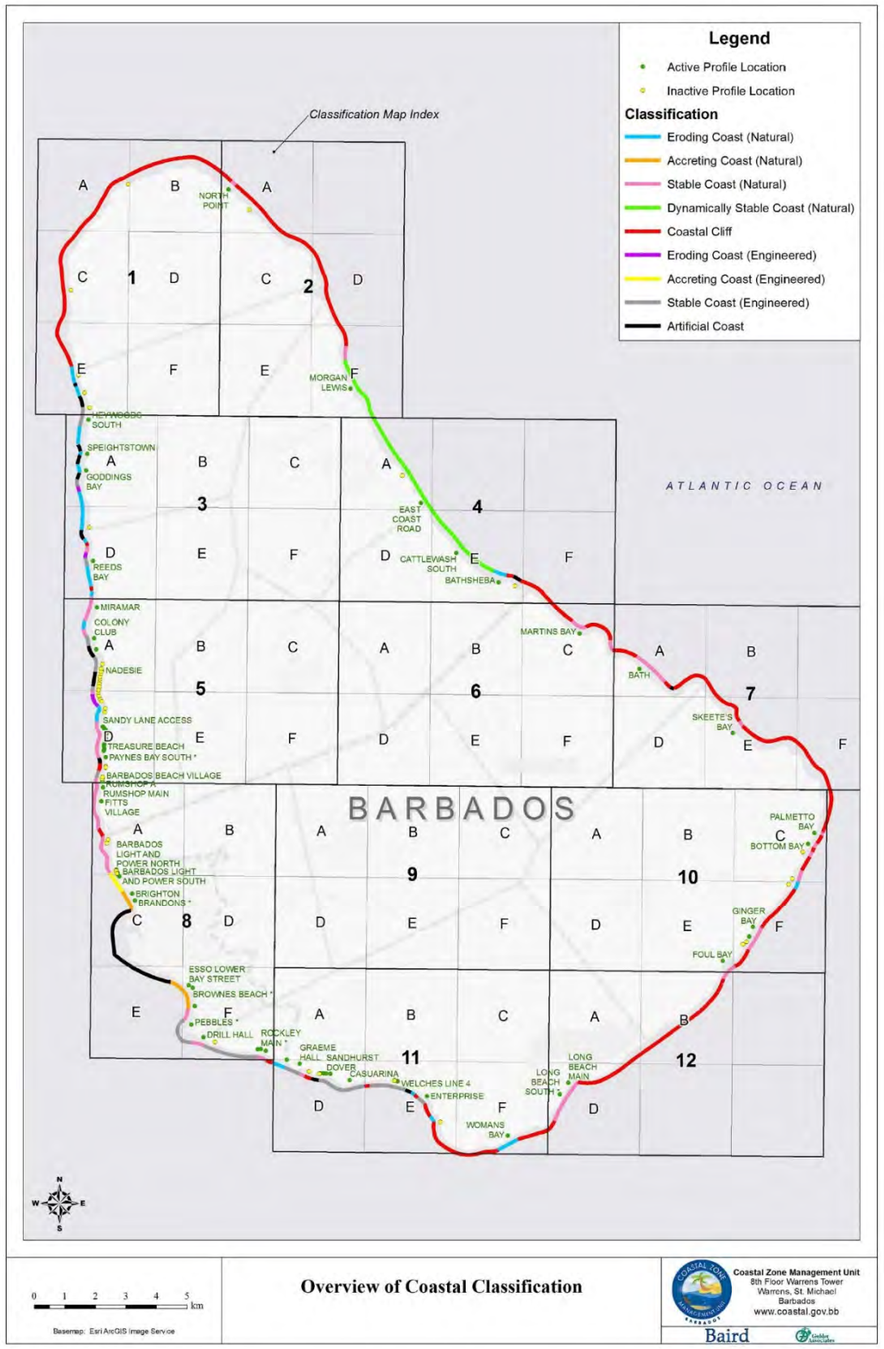


Figure A.13. Overview coastal classification due to their coastal stability (Baird, 2015).

Water quality

The quality of the marine water is fundamental to the maintenance and functioning of the coastal ecosystems as well as human health. According to the ICZM Plan for the Caribbean Coast (Halcrow, 1998b), in Barbados, terrestrial discharges are the main source of pollutants in the marine environment and the main transport mechanisms are surface water runoff, groundwater discharge and direct discharge or dumping.

A review of historical data shows that poor water quality has been characteristic of the south and west coasts of Barbados due to nutrients, which are identified as being a key stressor affecting the health of the coral reefs (Baird, 2015b). During the 1992/93 sampling program nutrient (nitrate and phosphate) and bacteria levels already exceeded threshold levels on most of the west and southwest coasts. On the other hand, the Atlantic coastal area showed low levels of contaminants in both terrestrial and coastal waters (Halcrow, 1998a), and therefore, a better quality than the Caribbean area of Barbados.

Agricultural practices and residential wastewater disposal are identified as a significant source of nutrient contamination in both surface waters and groundwater (Baird, 2015b). It is important to note that surface water discharges depend on seasonal rainfall, but groundwater discharges are continuous and generates the largest nitrogen lead to coastal waters. This study also indicates that removal of wastewater inputs and improved agricultural practices could reduce groundwater nitrogen loads by approximately 60%. This would significantly improve nearshore water quality, not only with respect to nutrients, but also by reducing other contaminants associated with residential and agricultural wastewater.

A2.1.2. Biological environment

Coastal habitats

A2.1.2.1. Terrestrial Ecology

The natural vegetation of the coast in the Plan area has been severely impacted by development activities taking place during the previous three or four decades. Mangroves and littoral vegetation were the two coastal vegetation communities that were important along these shores, however only one major wetland remains, which is the Graeme Hall Swamp. The swamp is the largest body of inland water in Barbados and includes a brackish lake, a freshwater marsh and the only remaining large area of mangrove forest. Apart from this, there are only small, discrete patches of coastal wetlands, generally at the seaward end of gullies. Development has also modified the littoral vegetation communities such that those sites remaining have a low species diversity.

In certain locations, ponding of surface and groundwater has created lagoons. Reads Bay Hole, Lord's Hole, heron Bay Hole and Cobblers Hole are some examples. These sites tore some of the surface runoff however they also tend to collect garbage and can be unsightly and smell as a result of decomposing matter and associated bacterial action. The use of aeration systems to alleviate these issues has been proposed at a number of sites and a successful pilot project using such a system was deployed at the Holetown "Hole" in 1994. It operated successfully for nine months until being washed out following a heavy rainfall event.

A2.1.2.2. Marine Ecology

Geophysical surveys conducted in 1992 and 1993 (Delcan, 1994a) identified eleven unique seabed surface sediment types of the west and south coasts using side scan sonar data. These were:

- Fringing reefs
- Sand/rubble patch reefs
- Sand with bedforms/Isolated corals, sponges, soft corals
- Rubble with isolated corals, sponges and soft corals
- Sand/rubble with patch reefs (high relief)
- Sand
- Continuous patch or bank reefs
- Silt covered sand /rubble
- Sand in deep water
- Relic Reef and Rubbles
- Dredge/Rubble piles

The main offshore features in the Plan area are the submerged bank barrier reefs, at depths of 14 -45m which extend as virtually unbroken features, parallel to the west coast. They continue albeit as more fragmented reefs, off the south coast. Fringing reefs occur immediately adjacent to the west coast and as relic reefs along the south coasts interspersed with areas of rubble and patch reefs of soft corals. The total area covered by the submerged bank reefs is estimated to be approximately 1.4km2 (Delcan, 1994a).

Historic data and the Feasibility Studies conducted in the early 1990's have revealed that the west coast fringing reefs are in poor health and that the patch reefs along the south-west coast have deteriorated significantly between 1987-92. The bank reefs were reported to be in good health in the early 1990's, although there are reports of localized over-exploitation of fish and corals, of physical damage at popular dive sites, and of sediment related damage off the Holetown "Hole" (Hunte & Allard, 1994; Delcan, 1995f). Seagrass communities occur at eleven locations on the south-west coast and three locations on the west coast but they are generally sparse and occur in small patches. The most extensive beds are off St. Lawrence and Welches (Delcan, 1994e).

Hawksbill and leatherback turtle nest on Barbados beaches with the main nesting sites of the hawksbill on the west and south coasts (Horrocks and Scott, 1991). The most important nesting sites on the island for this species are between Hilton and Coconut Court hotels on the south west tip of the island. Their main foraging areas are the bank reefs along the west coast, and on the south coast patch reefs.

Barbados shows a rich biodiversity of coastal habitats and ocean life. Nevertheless, habitat loss is an on-going challenge to biodiversity conservation in Barbados. During colonial times, substantial vegetation was cleared for agricultural purposes, building materials and firewood. More recently, vegetation loss has resulted primarily from land clearing to facilitate residential development, the largely ad-hoc urbanization process and the construction of tourism sector developments, such as hotel and golf course facilities.

Some of the natural coastal habitats present in Barbados are: Beaches, sand-dunes and sandy bushlands, sea cliffs and sea rocks, gullies, coastal wetlands, tidepools and coral reefs.

Beaches, sand dunes and sandy bushlands

Beaches are characterized by xerophytic (a plant that needs very little water) and halophytic vegetation (a salt tolerant plant that grows in soil of waters of high salinity), although windward and leeward dunes show some specific differences. According to the Barbados National Biodiversity Strategy and Action Plan (BNBSAP, 2002), within the beaches on the windward coast the sandy bush-lands, sometimes referred to as dry thorn scrub communities with cacti and other prickly shrubs, often appear to be a further development of the *Coccoloba* association of the dunes. The leeward beaches are relatively narrow and, where they have not been cleared for coastal development, are backed by trees and shrubby undergrowth.

On the other hand, there are some pebble beaches, characterized by pebbles, boulders and a reef flat extended from the beach seaward for several meters. These pebble beaches are found at Cattlewash, Edgewater, Glenburnie, 3 Boys Rocks and Tent Bay (St. Joseph), which were described in the study of Lewis (1960) and this information has been no update since then.

Sea Cliffs and Sea Rocks

Sea cliffs with sparse plant life is restricted to halophytes species which occur within rock crevices. At the tops of these cliffs, grasses and shrubs are usually abundant.

It is important to note the presence of three rare cliff species: *Heliotropium microphyllum* (lesser Antillean endemic) found only at River Bay, St Lucy; *Strumpfia maritima* (Caribbean-wide sp), which is found only near Gemswick to Foul Bay, and Barbados Cinnamon found at Pico Teneriffe, the only location on island where it has been found.

Gullies

The gullies are landforms created by running water, eroding sharply into soil, typically on a hillside. They are predominant features in the island, running in all directions from the higher elevations to the sea. Today, these gullies tend to have a large and mature collection of native ferns, climbers, shrubs and trees in Barbados (BNBSAP, 2002).

Coastal wetlands

Mangroves communities mainly compose the scrub vegetation in the coastal Barbados swamps. The largest mangrove area in Barbados, and last remaining significant natural mangrove estuary, is located at the Graeme Hall Swamp (30 ha) that includes both natural and man-made water bodies (BNBSAP, 2002), with the largest remaining area of red mangroves (*Rhizophora mangle*) and white mangroves (*Laguncularia racemosa*).

The mangrove forests of Barbados also include the species *Conocarpus erectus*, which is limited to Chancery Lane (Carrington, 1991).

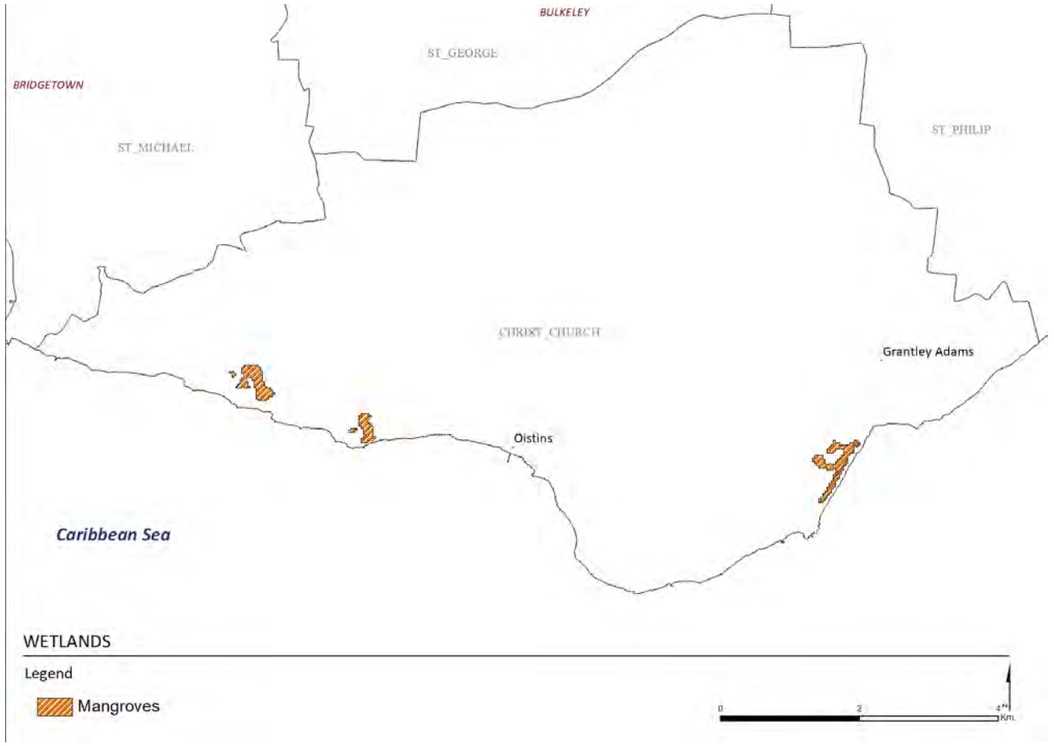


Figure A.14. Mangrove's distribution in Barbados (Source: CZMU).

Another wetland coastal habitat are the seagrass beds. Four species of seagrasses have been reported for Barbados: *Thalassia testudinum*, *Syrungodium filiforme*, *Halodule wrightii* and *Halophila* sp (Delcan, 1994; Vermeer, 1997).

Tidepools

Tidepools are present along the north, east and south-east coast of Barbados. Tidepools act as nursery habitat (Mahon and Mahon, 1994) and recruitment issue (Halcrow, 1998b) for some reef fish.

Coral reefs

The coral reefs are a great ecological value of Barbados (Figure A.15). This habitat provides shelter, feeding and breeding grounds, recruitment sites and nursery grounds for multiple marine organisms. Moreover, coral reefs show several socio-economic impacts such as their medicinal properties, the associated white sand that act as source of beach nourishment, recreational and educational values to both visitors and locals, and the climate services provided for coastline protection from erosion. The majority of wave attenuation on fringing reefs is due to wave breaking on the reef crest (approximately 80 to 90%), while the live coral canopy on the reef flat accounts for an additional 10 to 20% of the wave attenuation (Baird, 2015). Despite their importance, more than 70% of coral reefs in the Caribbean are under immediate threat from anthropogenic stressors and climate change (Jackson et al., 2014).

According to the BNBSAP (2002), the total area covered by the bank reefs in Barbados is estimated at 4.9 km^2, while the fringing reefs cover 1.4 km^2. The fringing reefs generally have three distinct zones: back reef, reef flat, and the spur and groove zone, while the bank reefs are characterized by a narrow crest and steep landward and seaward slopes.



Figure A.15. Distribution of coral reefs in Barbados (Source: CZMU).

Endangered species

The major threats to biodiversity in Barbados are habitat loss and fragmentation, but also a long history of alien species introduction (BNBSAP, 2002). Some of these introduced species are the mongoose (*Herpestes javanicus*), cane toad (*Bufo marinus*) and wild sage (*Lantana*).

The Lesser Antilles has approximately 2100 species of indigenous plants, but only about 700 of these indigenous plants are hosted by Barbados. According to Cohall (2014), the intense cultivation of sugar led to the disappearance of many indigenous plants. Nevertheless, Barbados preserves two endemic species: broom weed (*Phyllanhus andersonii)* and *Metastelma barabdense*. Broom weed is found in several gullies, but *Metastelma barabdense* has not been seen for, at least, 20 years.

The IUCN Red List of Threatened Species lists eight critically endangered species of fauna in Barbados: The Atlantic Goliath Grouper (*Epinephelus itajara*), Elkhorn Coral (*Acropora palmata*), Eskimo Curlew (*Numenius borealis*), Hawksbill Turtle (*Eretmochelys imbricata*), Smalltooth Sawfish (*Pristis pectinata*), Staghorn Coral (*Acropora cervicornis*) and Warsaw Grouper (*Epinephelus nigritus*).

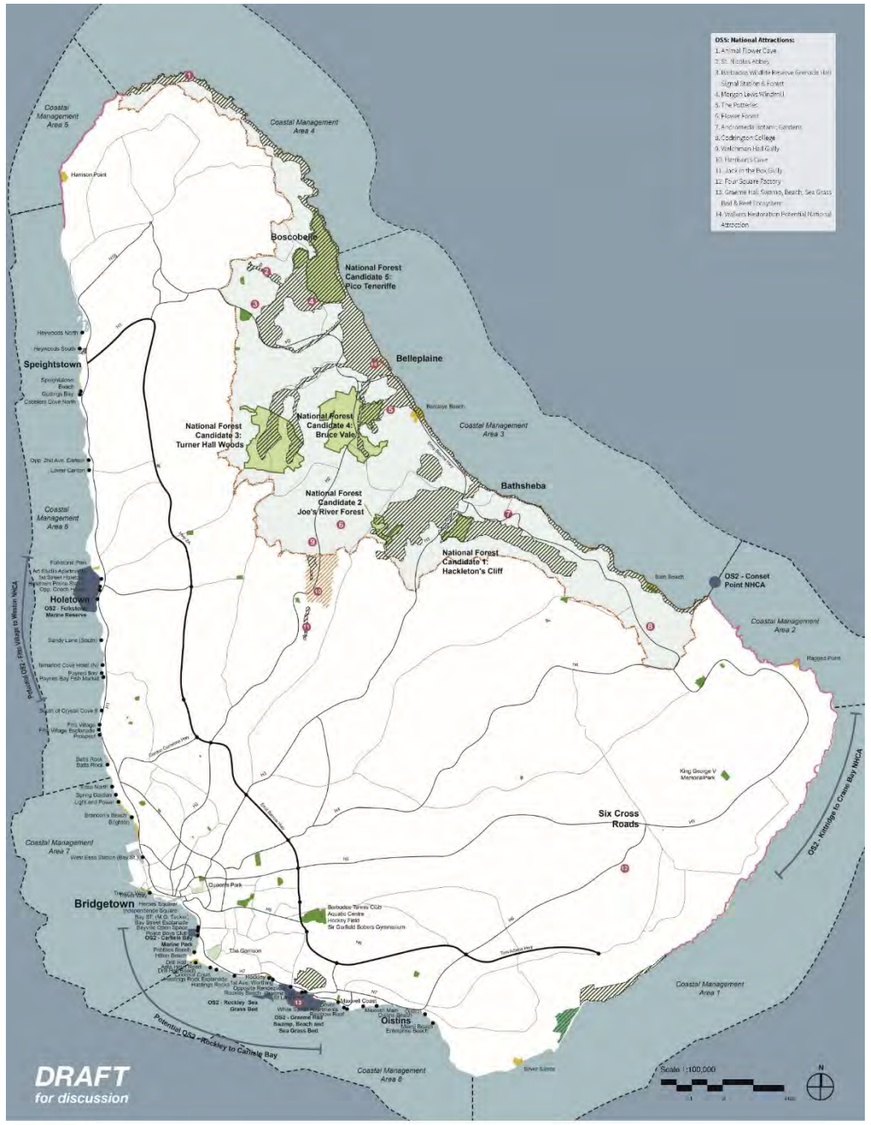
On the other hand, the Barbados leaf-toed gecko (*Phyllodactylus pulcher*), a species unique to the island, was declared extinct until a small colony was rediscovered in 2011. It lives in limestone coastal cliff habitats only and hence is a critical coastal habitat. Both endemic reptiles - *Phyllodactylus pulcher* and *Tetracheilostoma carlae,* are also listed as Critically Endangered on the IUCN Red List. Nowadays, the estimated number of adult Barbados leaf-toed geckos remaining in the wild is less than 200.

Natural protected areas

Barbados shows different types of natural protected areas: National Park, Natural Heritage Conservation Areas (features and locations that are important to the natural heritage of the island) and Coastal Landscape Protection Zones (coastal areas with a natural character and unique physical attributes), as well as a variety of coastal/beach parks and open spaces (see annex

Figure A.16).

The National Park (Scotland District; Figure A.17) is the base of the Barbados System of Parks. It encompasses a wide range of land use activities, from forestry and conservation to tourism, settlements, sugar production and other extraction activities. The National Park is an IUCN Category 5 Protected Landscape/Seascape. Therefore, the aim of this protected area is to preserve and sustain important landscapes/seascapes and the associated nature conservation and other values created by interactions with humans through traditional management practice.



Map 15
Barbados System of Parks and Open Spaces
February, 2017
Barbados Physical Development Plan Amendment

Legend

OS1: Barbados National Park IUCN Category 5:
- Protected Landscape / Seaside (Source: PDP, 2003)

OS2 - Natural Heritage Conservation Area (Source: PDP, 2003)
- Land
- Marine
- Harrison's Cave Zone of Special Environmental Control
- Chancery Lane Natural Heritage Area

OS3 - Coastal Landscape Protection Zone (Source: USI, 2016)

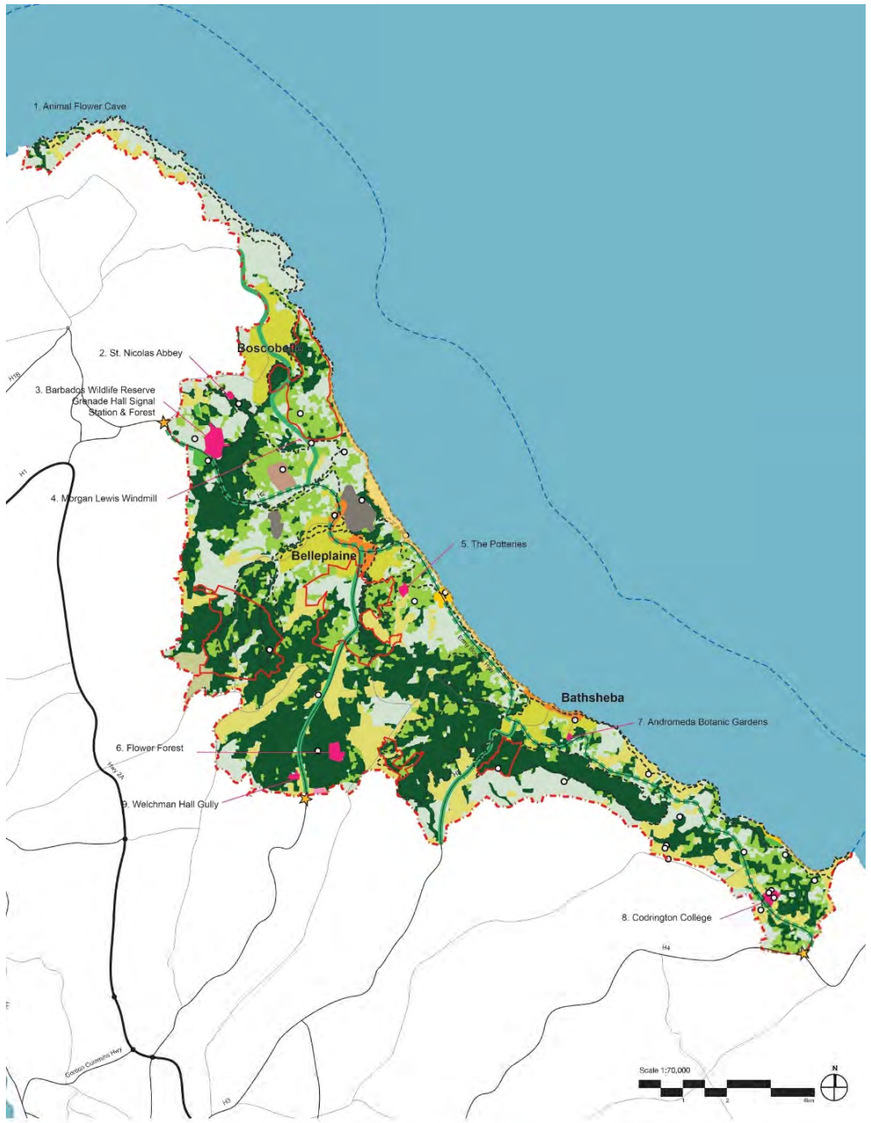
OS4 - Public Parks and Open Spaces (Source: PDP, 2003)
- Historic Urban Park
- Coastal / Beach Park
- Recreational Park

OS5 - National Attractions (Source PDP, 2003)

OS6 - Barbados National Forest Candidate Site (Source: PDP, 2003)

OS7 - Shore Access Points (Source: PDP, 2003)

Figure A.16. System of Parks and Open spaces in Barbados. (Source: PDP, 2017).



Map 16
National Park Plan
February, 2017
Barbados Physical Development Plan Amendment

Figure A.17. Settlement Structure Map. (Source: Barbados Physical Development Plan Amendment 2017)

The Natural Heritage Conservation Areas are sensitive or unique ecosystems, both within and outside of the National Park, which require protection from development and intensive recreational development. According to the PDP (2017), there are two categories of Natural Heritage Conservation Areas: land and marine.

The Land Natural Heritage Conservation areas include the following:

- Graeme Hall Swamp and Beach;
- Heywoods Mangrove Swamp;
- Chancery Lane Swamp;
- Harrison Cave Special Study Area;
- Welchman Hall Gully;
- Jack in the Box Gully;

Heritage Conservation Areas of the Natural Park (all of the coastal beaches, dunes and cliffs) include the following:

- Morgan Lewis;
- Walkers Beach and St. Lucy Cliffs;
- Hackleton's Cliff and Woods;
- Turners Hall Woods;
- Cattlewash Woods;
- Joe's River Forest;
- Boscobelle Woods;
- Long Pond and Green Pond;
- The Green River, Joe's River, Bruce Vale River systems;
- The Savannahs complex; and
- Chalky Mount.

The Marine Natural Heritage Conservation Areas (OS2) include the following:

- Graeme Hall Beach, Drill Hall Beach, Sea Grass Bed and Reef Ecosystem;
- Carlisle Bay Marine Management Area;
- Rockley Breakwater;
- Kitridge to Crane Bay;
- Consett Point; and
- Folkestone Marine (the first marine protected area in Barbados - 1981).

In addition, two coastal landscape protection zones are designated in Barbados. These zones extend from Salt Cave Point to Consett Bay (along the southeast and east coasts) and from Archers Bay to Maycock's Bay (along the northwest coast). Both designations contain significant habitat and contribute to the appearance and function of the coastal areas of Barbados (Barbados Physical Development Plan, 2017).

A2.2. People and economy

A2.2.1. Demography

Barbados is one of the world's most densely populated islands in the world with approximately 660 persons per square km. With a surface of 439 km^2, the island's population is about 293.000 (index mundi, 2018), with a median age of 39 years. According to 2010 census, ethnic groups constitute the following percentages of Barbadian population: 92.68%: black; 3.49%: white; 2.67%: mixed; 0.99%: East India 0.05%: Chinese; 0.03: Arab; and 0.09%: other.

Population densities showed in Figure A.18 evidence high values at the coast, mainly around four coastal community cores -Speightstown, Holetown, Bridgetown, and Oistins, with densities over 3000 people per square km. Moreover, the entire urban corridor proposed in Draft PDP (2017), located along the west, south and south-east coast, concentrates most of the population of the island.

On the other hand, the interior areas present the lowest densities, under 1000 people per square kilometer. Densities under 1500 people per square km occur along the east coast, where National Park is located and where the wildest character of the Barbadian coast is still preserved.

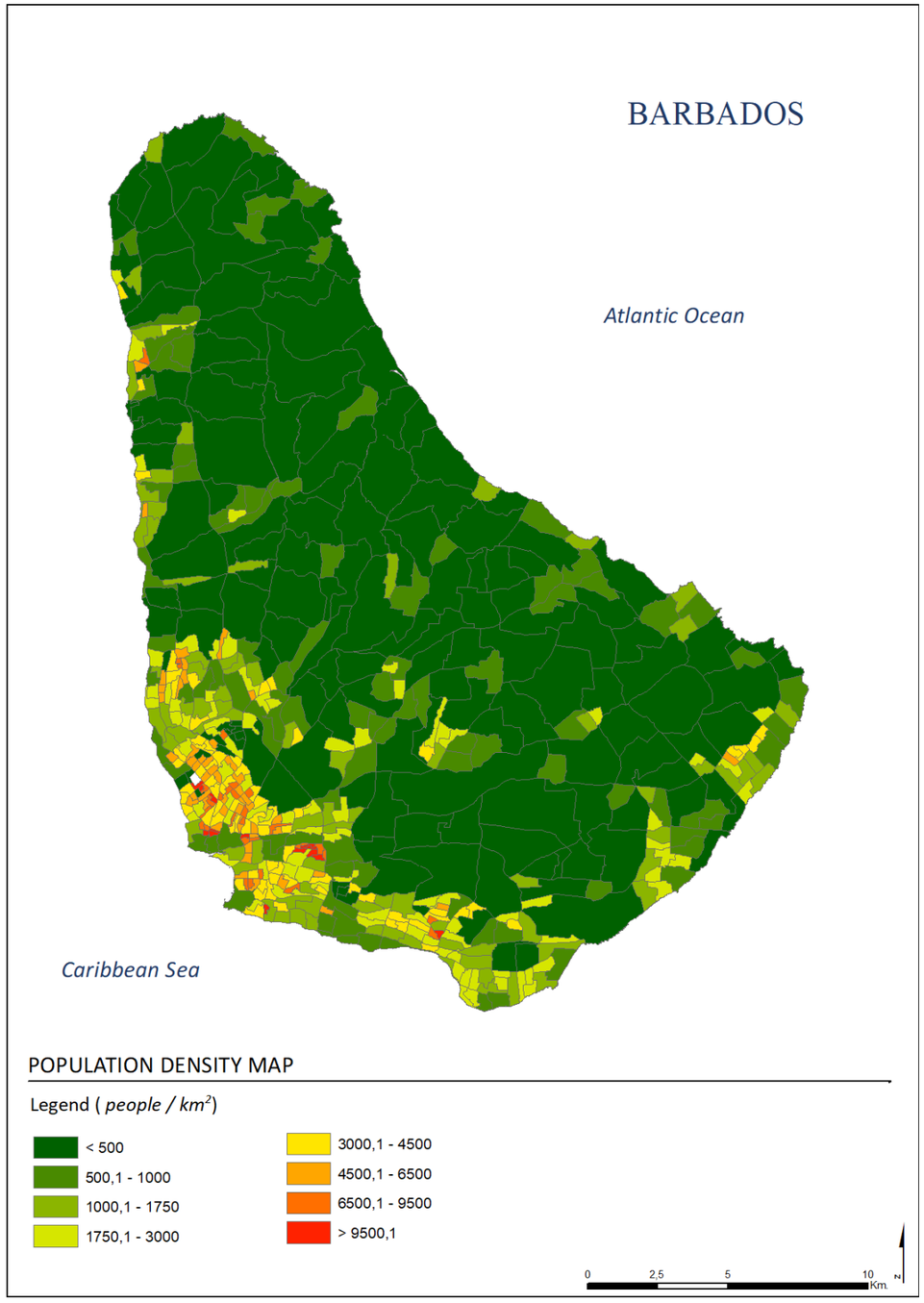


Figure A.18. Population density map of Barbados.

A2.2.2. Land-use

The Barbados Revenue Authority (BRA) define the usage of the 121940 parcels of land that are included in the BRA Tax Database. It is important to note that the BRA data represents the number of properties but does not provide an indication of the size of these properties or total area. While it does show the development of infrastructure types in Barbados.

It is important to note that over 25% of the population and much of the infrastructures lie within a risk zone about 2 km of the flood plain in coastal line. Accordingly, the west and south coasts have always been the preferred site for settlement in the Caribbean area because of the calm waters, natural harbors and gentle slopes (ICMPCCB, 1999). Consequently, there is no agricultural land in these coastal areas. On the other hand, within the Atlantic coast, there are also differences along the coast. The southeast is predominantly residential, while the east coast has little built development, with large areas of important natural and heritage resources. On the north and northwest coasts, the land use is predominantly agricultural (ICMPACB, 1998).

In recent times, although much of the landscape have been transformed from natural ecosystems into agricultural ecosystems (NBSAP, 2002), the land under agricultural production is declining through the demand for land for settlements and tourism development (hotels and golf areas).

A2.2.3. Economic Activities

Barbados's economy is largely service driven with the sector accounting for 88.7% of GDP and 75% of employment with visitor expenditures constituting over 22% of GDP. Within the services sector, tourism alone accounts for 17.5% of GDP and more than 12% of direct employment while wholesale and retail are the next biggest component of the services sector, accounting for nearly 10% of GDP. The offshore financial services and international business industry is another important source of foreign exchange. Notably, 95% of the country's industry is located on the coast or in coastal areas.

Coastal economy related activities in Barbados are primarily located in the west-coast of the island, with two main areas of concentration.

The region with the highest concentration of activities is located in the Bridgetown-Christ Church area in the Southwest and mainly related to the coastal tourism industry (Figure A.28). In Bridgetown, the port plays an important role as the main entry point for both cruise passengers and sea borne trade. The other region with a higher concentration of Blue activities is located in the north part of the west-coast, between Speightstown and Holetown. Again, the coastal tourism industry represents the main activity.

Cruise tourism has a large footprint on the island, contributing 54% of the 1.3 million tourists who visited the country in 2015. While the total number of cruise passengers arriving in the Bridgetown port has increased in recent years, the average amount of money they are spending is declining.

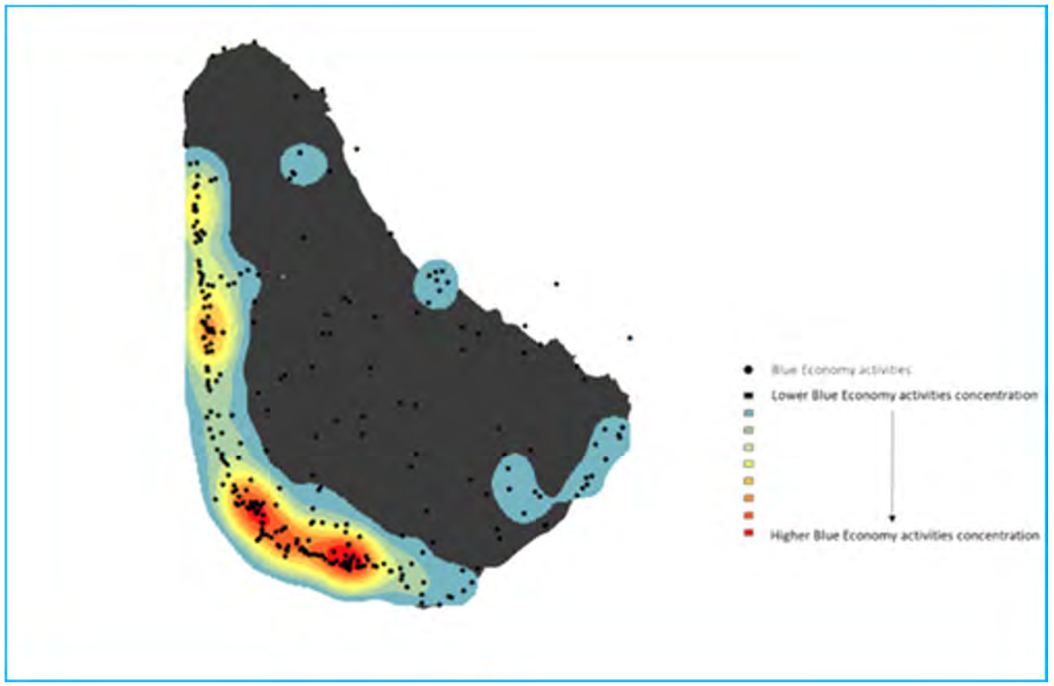


Figure A.19. Highest concentrations of Blue Economy activities in Barbados[24]

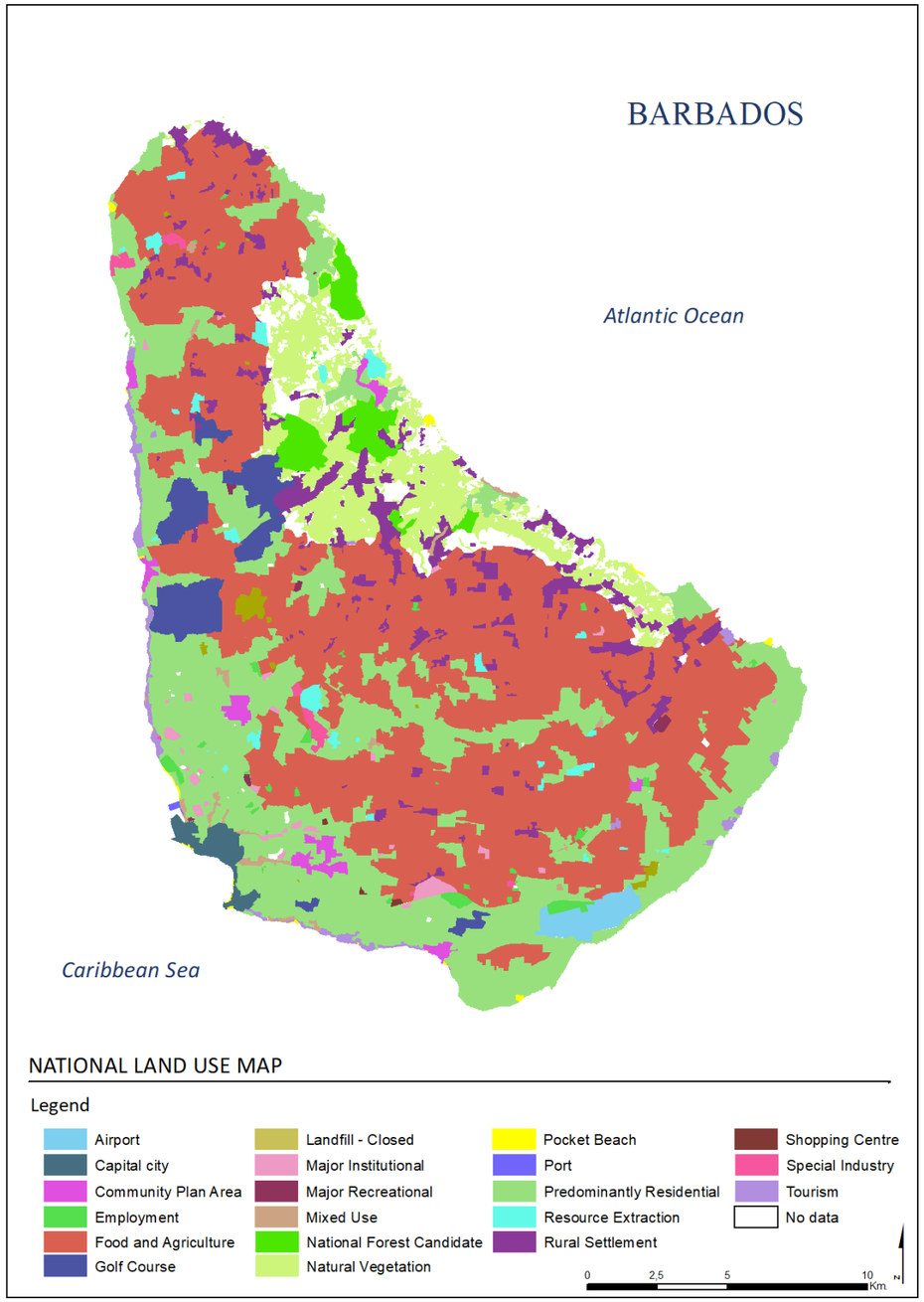


Figure A.20. Land use Map.

A2.3. Risks in the CZMA

The NCRIPP, being a key component of the CRMP, was a multiphase project that involved investigation of hazards, vulnerability and risk for assets and inhabitants in Barbados. The first phase of the project focused on analysing the following hazards:

- hurricane winds;
- storm surge;
- rainfall-induced flooding;
- coastal erosion;
- earthquakes;
- landslides;
- tsunamis and
- oil spills at sea.

Climate change was examined as part of this study and was not considered as a separate and distinct hazard on its own but is certainly a contributing factor to some of the above hazards. The second phase of the project involved assessing the vulnerability of assets to the above hazards. Vulnerability was classified on both exposure to the hazards, as well as susceptibility to the hazard. The third phase of the project involved calculating financial damage resulting from the assessed hazards. Risk was computed for multiple hazards at various return periods for a range of assets.

This section presents a summary of the studies conducted. The text presented has been extracted from the Final Hazard Report (Baird, 2017), Final Vulnerability Report (Baird, 2017b), Revised Draft Risk Report (Baird, 2018b) and the Hazard Risk Atlas (Baird, 2018). These reports include the most updated information on disaster risk management in Barbados.

A more detailed description is provided for those hazards and related risks that are considered "core issues" for the CZMU: storm surge, coastal erosion (beach and cliff), and tsunami.

A2.3.1. NCRIPP Hazard assessment

This section presents the major results of the NCRIPP Hazard Assessment, the first phase in the overall assessment of hazards, vulnerability and risk for assets and inhabitants in Barbados. The NCRIPP study examines natural hazards (hurricane winds, storm surge, shoreline erosion, rainfall-induced flooding, tsunamis, landslides and seismic hazards) and one anthropogenic hazard (marine oil spills). The effects of climate change are also considered (where appropriate) to define hazards both in the present day and in the future.

Desktop studies and numerical modelling were performed to estimate these hazards. Details on the methodology used and results obtained were presented in the Final Hazard Report and a series of hazard maps. Hazards relating to coastal processes, which are core issues for the CZMU, are also presented in the Sub-Areas maps (Part D).

Climate change impacts on hazards

A summary of climate trends is presented in Annex 3 and is based on the report titled "Historical Trends and Future Climate Change: Barbados" prepared by the Climate Studies Group at the University of West Indies (UWI) in Mona, Jamaica., completed for the NCRIPP study.

Air temperatures, rainfall, hurricane winds, and sea levels are the climate parameters considered, including regional trends and variability in Barbados. Finally, the climate parameters are discussed in terms of their effects on the following NCRIPP-defined hazards:

- Wind/hurricanes
- Landslides
- Storm surge
- Tsunamis
- Coastal erosion
- Coastal and inland flooding

Other hazards considered in the NCRIPP that were not deemed to be significantly impacted by climate change, included earthquakes, and oil spills. That is not to say that some minor linkage to these hazards is not theoretically possible, but climate change does not contribute in a definable manner, considering the overall accuracy and uncertainty in defining these hazards.

A brief summary of the findings, as included in the NCRIPP report, is provided in Annex 3, where GCM refers to general climate models while RCM refers to regional climate models. Input to the various GCMs and RCMs include various "scenarios" with respect to global economic activity, population growth, energy usage and greenhouse emissions. The table presented in Annex 3 was produced before the publication of the Special Report on the Ocean and Cryosphere in a Changing Climate, in September 2019. In this report, the sea level rise projections indicate higher values than previous IPCC reports. Major conclusions from this report related to SLR are presented after Table A.4.

Sea level rise projections – IPCC 2019.

Sea level continues to rise at an increasing rate. SLR by 2100 is projected to be faster under all scenarios, including those compatible with achieving the long-term temperature goal set out in the Paris Agreement. Table A.4 presents the projected Global Mean Sea Level (GMSL) for RCP 2.6 and 8.5. RCP -Representative Concentration Pathway- is a greenhouse gas concentration (not emissions) trajectory adopted by the IPCC. Four pathways were used for climate modelling and research for the IPCC Fifth Assessment Report (AR5) in 2014. The pathways describe different climate futures, all of which are considered possible depending on the volume of greenhouse gases (GHG) emitted in the years to come.

RCP	Increase in meters relative to (1986-2005), central values and the 5%-95% *Likely range (66%-100%)*	
	2081- 2100	2100
2.6	0.39 (0.26–0.53)	0.43 (0.29–0.59)
8.5	0.71 (0.51–0.92)	0.84 m (0.61–1.10)

Table A.4. GMSL projections for RCPs 2.6 and 8.5. Source: IPCC 2019.

Mean sea level rise projections are higher by 0.1 m compared to the IPCC Fifth Assessment Report AR5 under RCP8.5 in 2100, and the likely range extends beyond 1 m in 2100 due to a larger projected ice loss from the Antarctic Ice Sheet (medium confidence).

Extreme sea level events that are historically rare (once per century in the recent past) are projected to occur frequently (at least once per year) at many locations by 2050 in all RCP scenarios, especially in tropical regions (high confidence). The increasing frequency of high-water levels can have severe impacts in many locations depending on exposure (high confidence).

Hurricane winds

Barbados is located at the south-eastern edge of the Atlantic hurricane region and has an overall low frequency of close tracking hurricane intensity events. It is more common that severe storms, which may have damaging winds, high rainfall and cause coastal impacts, to be below hurricane strength in the vicinity of Barbados.

Between 1979 and 2015, 27 Category 2 (or stronger) hurricanes tracked within 500 km of Barbados. NCRIPP study focused on defining the long-term wind hazard from CAT 2+ events, including defining the regional scale spatial and temporal wind characteristics that will drive associated wave and storm surge impacts.

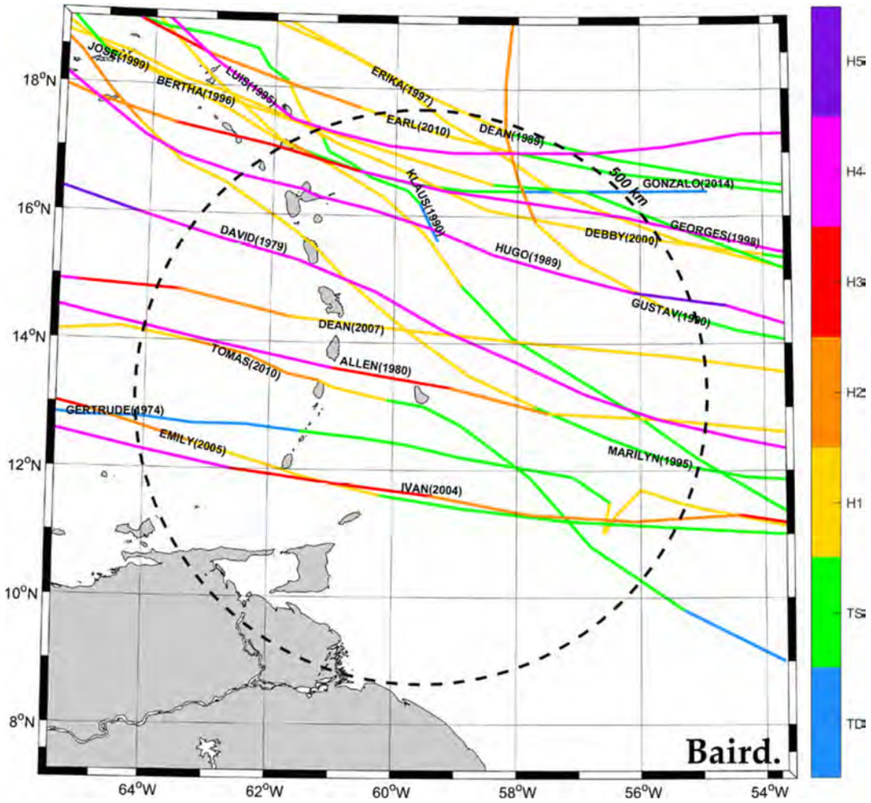


Figure A.21. Track / Intensity Plot for 19 Selected Events within 500 km (Best Track data set). (Source: Baird, 2017).

Table A.5 presents the resulting recommended wind speeds, obtained by Monte Carlo analyses. Therefore, this information has been used in other NCRIPP studies to produce long-term records of hurricane wind fields. The 1,000-year event data set produced provides a large random assessment of hurricane tracks and intensities. This large data set reduces the spatial banding that can occur in short data sets and evens out the "chance" of some regions from encountering or missing strong storms due to the relatively short duration of the reliable track data sets.

	Return Period (years)		
	20	50	100
10 min wind speed (10 m)	23.7 m/s	29.4 m/s	<33.1 m/s
3 sec gust wind speed (10 m)	33.9 m/s	42 m/s	47.3 m/s

Table A.5. Recommended hurricane wind values from Monte Carlo analysis.

Storm surge

Storm surge is a significant natural hazard to coastal regions in Barbados. It is a type of coastal flooding caused by the passage of tropical storms and hurricanes or distant swell events. The increase in water levels at the shoreline is caused by the combination of low atmospheric pressure, which tends to raise the water surface, and strong winds which cause a build-up of water on the coast. The magnitude of the storm surge and extent of the coastal flooding is related to the:

- Storm intensity, track position, and forward speed;
- Pressure setup;
- Wave processes and wave setup;
- Tidal elevation; and,
- Wave runup and overtopping at the shoreline.

The purpose of the hurricane surge assessment is to develop the associated wave, surge and flood levels for each of the synthetic hurricane events. An example of the maximum wave runup elevation for the 25-year hurricane event is shown in Figure A.22, for Profile 28. For this storm, the maximum significant wave height at the toe of the beach slope is 1.3 m, and the wave runup elevation (for an infinite slope) is 4.0 m above datum. The flow depth on the beach crest is 0.27 m (at an elevation of 3.27 m). From the beach crest to some distance inland, overtopping water will partially drain back towards the sea. This distance is estimated to be 30 m based on the profile. The overtopping rate 30 m from beach crest is also estimated to be 10 L/s/m, and 16% of the waves are estimated to overtop the beach crest. The elevations shown on the hazard maps are the flow depth on the crest when overtopping occurs, and the wave runup level when no overtopping occurs.

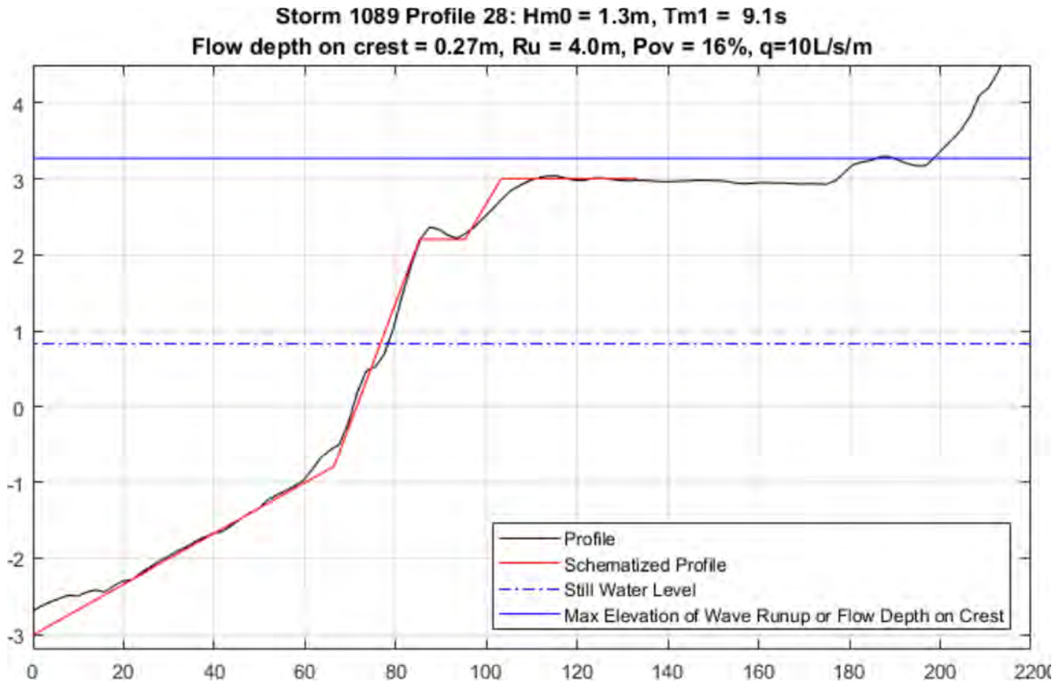


Figure A.22. Example of Maximum Wave Runup Elevation and Overtopping Rate. (Source: Baird, 2017).

Two sea level rise scenarios were assessed using the wave runup and overtopping methods. In the first scenario, a sea level rise of 0.3 m was considered. For depth-limited wave conditions, this scenario resulted in wave heights approximately 20% larger at the toe of the beach slope or structure and overtopping rates considerably larger. The overtopping rates were calculated for the 198 profiles at MHHW as the base condition (+0.6 m datum), and for a sea level rise scenario of +0.3 m (+0.9 datum). Please see Annex 4 for further details.

Wave hazards at the crests of coastal cliffs

Wave impacts against coastal cliffs may send significant volumes of water upward as spray (often carried by its own momentum or the wind tens of metres inland). In some cases, the force of the up-rushing water may entrain rock from the seabed or cliff face, creating a more serious hazard. Spray may cause additional hazards such as reduced driving visibility and deterioration of building materials. A building setback is recommended around all coastal cliffs but given the very site-specific nature of the hazard the setback needs to be evaluated on a case by case basis.

In Barbados, the northeast coast fits this description and there is evidence of large boulders being deposited at the top of cliffs during severe storms. While the southeast coast does have vertical cliffs the spray, overtopping tends to be lower as the water depths are shallower at the base of the cliff and the barrier reef limits wave heights at the shoreline.



Figure A.23. Overtopping and spray near Animal Flow Cave. Source: (Source: Baird, 2017).

Shoreline erosion – Beaches

Erosion hazards around Barbados is classified according to two primary types of shorelines: beaches experience variable erosion trends in response to storms and long-term trends in the sediment patterns, while cliffs experience much slower erosion in addition to sudden cliff collapse.

Shoreline fluctuations are naturally occurring processes that, in and of themselves, are not hazards, and only become hazards when human activities and development encroach within the shoreline. In some instances, these human activities may accelerate the severity of the resulting hazards. Over the short-term, beach environments, impacted by flood and erosion processes, may undergo alternating periods of erosion and accretion as they attempt to achieve a dynamic equilibrium with the forces acting upon them. Over the long term, beaches experiencing a positive sediment budget (i.e., more sand and gravel incoming than outgoing) are generally accreting shore forms while those experiencing a negative sediment budget are eroding. Future sea level rise is expected to cause shoreline recession as resulting greater depths would allow more wave energy to reach the shoreline. As such, the depiction and evaluation of the hazard susceptibility of beaches in Barbados should be dependent on information and understanding of short-term fluctuations as well as long-term beach sediment budget including potential sea level rise impacts. Please see Annex 4 for further details.

Shoreline erosion - cliffs

Three components of marine energy affect the recession of the various cliffs around the island. These are (in order of impact damage):

(1) wave climate associated with regular close-by or directly shoreline-impacting CAT1-3 and further away CAT 4 and CAT 5 Hurricanes and surges;

(2) wave conditions associated with the regular Northeast Trade Winds, and

(3) extreme wave conditions associated with periodic, but rare earthquake-induced seismicity-related tsunami events combined with direct shoreline impacting CAT4-5 Hurricane events.

Cliff Erosion Rates

Stability-driven recession rates differ for each of the cliff types due to significant differences in their morphology and failure behaviour. The total setbacks computed for the various cliff types around Barbados completed under the CRMP include a component that addresses recession rates. This rate is based on historical erosion rates derived from aerial photograph comparisons.

Five cases have been evaluated – 10-year, 25-year, 50-year, 100-years and ultimately 500 years. These estimates are made for each of the Type A, B, C, D and Type E cliffs (see Annex 4 for further details).

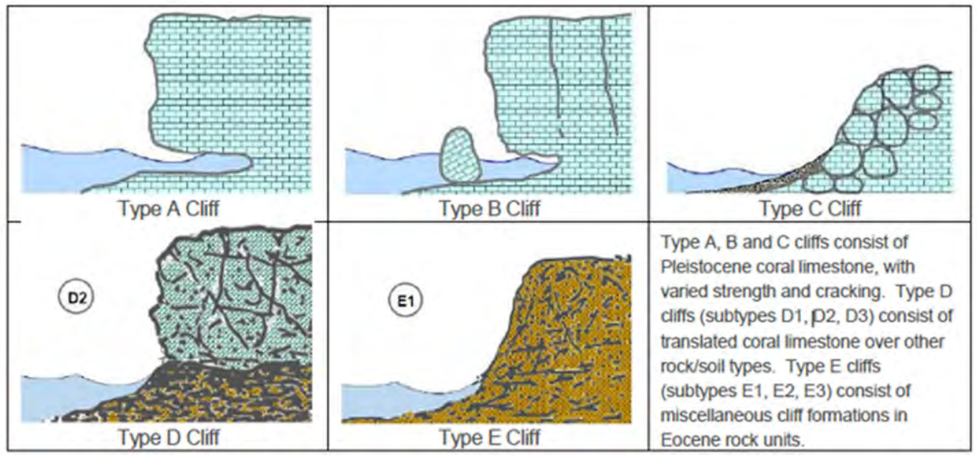


Figure A.24. Cliff types. (Source: Baird, 2017).

Rainfall induced flooding

Predicting rainfall induced flooding in Barbados is a significant task as it requires both broad scale long term rainfall data, and detailed information that covers the entire country. The NCRIPP hazard assessment defines the island wide flooding hazard through available data sources, two numerical models, and no scope or schedule to measure rainfall/runoff and supplement significantly limited calibration data.

The impact of climate change on precipitation intensity and depth on a small scale is still uncertain. A previous climate change analysis described in a previous study by Baird (Baird, 2017) indicated that maximum precipitation intensity in Barbados could decrease by 70 percent or increase by 45 percent. The large error bars and uncertainty are due to limitations in the current state of climate modelling capabilities. Since Barbados is a relatively small and isolated island, the climate models are unable to capture changes in sub-daily precipitation patterns with an appropriate resolution. Although there is uncertainty in whether the rainfall intensity will significantly decrease or increase, simulations were completed to better define what the worst-case scenario (in terms of climate changed induced variation in rainfall intensity) may be. It was not necessary to repeat the lower return period events as the current 50-year return period event would become a 10-year return period event if rainfall intensity increases by 45 percent.

Rainfall induced hazards have some overlap with the storm surge flood hazard. During a tropical system (that may cause rainfall induced flooding), there may also be storm surge, including wave overtopping for beach berms. Many strong rainfall events in Barbados are associated with tropical events that have minimal storm surge. However, it is likely that the more severe storm surge from strong hurricanes that would include significant rainfall. When combining rain induced flood risk and coastal storm surge events, only specific coastal regions experience significant impact this way (e.g.: the Constitution River)[13].

The model results from the 100-year return period precipitation induced flooding event on the Western Plateau were compared to previous flooding studies in Holetown Lagoon (Baird, 2017). As an example, Figure A.25 illustrates the flood extent after a 100-year return period event.



Figure A.25. 100-year return period precipitation event in Holetown.

Earthquake

The Caribbean region is a tectonically diverse region. It is marked by the intersection of four major lithospheric tectonic plates (North America, South America, Cocos, and Nazca) with the Caribbean plate. It includes deep oceanic trenches and associated Benioff zones of shallow and deep earthquakes, active volcanoes, fault-bounded

[13] Considering the joint probability of rainfall and storm surge flood events was only considered by Baird through basic assumptions only.

submarine marine extensional basins, and seismically-active transform faults in northern South America, Hispaniola and Cuba (Benz et al. 2011). This tectonic diversity has resulted in a history of frequent moderate to large earthquakes, tsunami and volcanic eruptions. The location of Barbados east of the region of deeper subduction results in an absence of volcanic activity, and a lower rate of historic earthquake occurrence when compared to the volcanic islands farther west.

In the absence of the time and resources to undertake a major revision of the Salazar et al. (2013) analysis for the NCRIPP hazard, Golder considers that the Salazar et al. (2013) seismic source model, which is at present the best-available for Barbados. Accordingly, Golder has directly used the results of this model to develop earthquake ground motions for NCRIPP.

Results of Golder analysis show that the higher levels of earthquake shaking occur along the eastern coast of Barbados, particularly on the younger sediments and reclaimed land in and surrounding Bridgetown, and in parts of the Scotland District. The distribution and variation of near-surface site soil conditions in Barbados are key factors that influence ground surface earthquake shaking.

Landslide

Landslide hazard assessments have been undertaken within the Scotland District. The majority of the Barbados land area is capped by coralline limestone (of Quaternary age), however in the Scotland District, the older (Tertiary age) ancient sea-bed sediments outcrop and are exposed at surface in many places. These sediments are prone to landslides and the geology in this area, while variable, is dominated by poorly consolidated clayey sediments and weak clayey rocks (mudstones, shales, etc.) interspersed with more competent, more consolidated sandy sediments, sandstones and siltstones. The susceptibility to landslides for each of the eleven geologic units present in the Scotland District are considered as part of this assessment.

Maps showing the distribution of risk classification in the Scotland District for each of the hazards considered as part of the stability analyses have been developed to support the landslide hazard assessment of Component 2 of the NCRIPP. The results estimated slope risk classification zones for each of the four (4) hazards considered (i.e., 50 Year Erosion condition, Fully Saturated condition, Seismic (1 in 475 year) condition, and Seismic (1 in 2,475 year) condition) are presented on a series of four maps.

The results also indicated that the seismic (1 in 2,475 year) condition represents the highest risk to the slopes in the Scotland District, while the 50 Year Erosion condition represents the lowest risk to the slopes in the Scotland District.

Tsunami

Barbados is susceptible to tsunami waves originating from far-field, near-field and local (< 300 km distant) sources. Near-field sources originate from within the Caribbean Sea region, and far-field sources from areas outside the Caribbean Sea and the western Caribbean Sea. Major far-field sources of tsunamis include tectonic faulting events along the eastern margin of the Atlantic Ocean, volcanic flank collapses from volcanic islands in the Atlantic Ocean, and continental shelf landslides off the western coasts of Europe and Africa.

Numerical modelling was carried out to estimate the extent of inundation and run-up around the island of Barbados for tsunami events with a return period of approximately 100-years. Larger events were also considered to provide context with respect to potential inundation for these more extreme events; however, hazard maps were only produced for the 100-year tsunami events. Data generated from the seismic hazard assessment were used to define the 100-year return period. The 1839 and 1843 earthquakes were used to support the hazard mapping given the proximity of these historical events to Barbados and recognizing that the frequency of occurrence is the same order of magnitude.

Tsunami hazard maps were generated around the island of Barbados using the 1839 and 1843 earthquake events as these are considered a conservative representation of the 100-year return period event. The maximum inundation generated by the fourteen simulations was used to define the inland extent of the hazard maps. A map showing a typical plot of maximum elevations and inundation around the island is shown in Figure A.26. The image also shows the detailed mesh resolution defined along shore and inland in order to predict inundation. Higher waves were observed around the north end of the island and north of the port in Bridgetown where values of 0.9 m were predicted by the model. The rest of the island was impacted by levels less than 0.9 m.

Climate change impacts are depicted in the hazard maps through simulations at a higher water level, representing a high tide (0.6 m) plus 25 cm of sea level rise. We have not considered possible changes to the shore protection or natural beach berm heights that may accompany such a change in sea level.

In general, very little inundation occurred for the 100-year tsunami, although it is important to note that this does not imply that Barbados is not at risk of larger tsunami events. To illustrate this, an extreme seismic event was simulated to provide some context on the potentially destructive nature of tsunamis. Using a coarse mesh, a tsunami generated by a (hypothetical) 8.53 magnitude earthquake approximately 200 km immediately east of Barbados was simulated using the MIKE21 model. The results showed predicted wave heights of approximately 9 m along the east coast of Barbados and 7 m around Bridgetown.

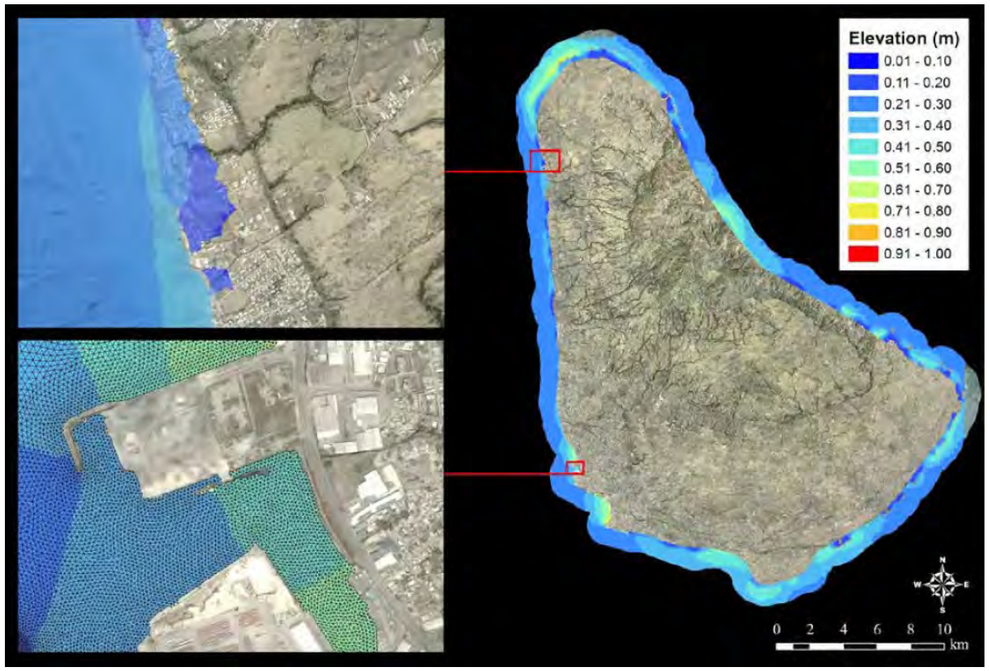


Figure A.26. Example of maximum elevations and inundation around Barbados (1839 Event). (Source: Baird, 2017).

A2.3.2. NCRIPP vulnerability assessment

The hazard assessment defined the spatial extent and severity of hazards (exposure), while the vulnerability assessment documents the assets and looks at two factors: exposure and susceptibility. Exposure implies that an asset is located where a hazard exists, and susceptibility implies that the hazard can have an adverse impact of the asset. Both exposure and susceptibility are required for an asset to be vulnerable.

A wide range of assets have been catalogued from data obtained from the CZMU, previous phases of CRMP, other government agencies, and field data collection. These assets included the housing stock, tourism plant, critical facilities, physical infrastructure, community resources, and environmental resources.

The primary economic sectors in Barbados were identified through a range of sources, and these were mapped spatially through land use listed for each property parcel from the BRA. A social vulnerability assessment was also performed, which used different techniques to quantify and map socially vulnerable populations in Barbados at the enumeration district level.

Vulnerability mapping was undertaken by grouping similar hazards (water, earth, wind and oil) and similar assets. Water included rainfall flooding, storm surge, tsunami and coastal erosion. Earth included landslides and seismic hazards.

Susceptibility of assets was derived based on a scoring system that was generally qualitative in nature but translated relative susceptibility into a numeric score. Susceptibility was also specific to hazard groups due to the varied nature of the hazards being considered. For example, a concrete house might be better in a wind event; however, a wood frame house may sustain less damage in a seismic event. Combinations of hazards and assets each had a susceptibility defined.

A final analysis was undertaken to examine regions that had higher hazard vulnerability and increased levels of social vulnerability. These areas were described as having compounded vulnerability and would be some of the most at-risk areas in the event of a hazard event.

In summary, the main outputs from the NCRIPP vulnerability study are as follows:

- A spatial database of assets in Barbados.
- Valuation of many of these assets.
- An evaluation of susceptibility of these assets.
- An evaluation of vulnerability of all the catalogued assets in Barbados.
- Vulnerability maps organized by classes of similar assets and groups of hazards. These maps may include up to 65 tiles to cover all of Barbados at 1:5000, although only regions with active hazards and assets were included in the map sets (see sample maps in Annex 5).

Identification, location and financial valuation of assets in Barbados

Six groups of assets have been identified, located and assessed to conduct the vulnerability analysis and the further risk analysis: housing, tourism plants, critical infrastructure, physical infrastructure, community resources and environmental resources. Each group is presented below. The complete description, data sources and valuation figures are presented within the Final Vulnerability report (Baird, 2017b).

Housing stock: the housing stock assessment aims to better understand factors related to the quality of the home.



Figure A.27. Roof Types from Field Survey. Clockwise from top left: Hip, Flat, Lean-to, and Gable. (Source: Baird, 2017b).

Tourism plant: consists only of primary tourism operations such as restaurants, hotels and resorts but does not include the support industries. There is some complication due to the fact that many rental properties may be classified as residential, instead of being classified as part of the tourism plant. These rentals may be widely spread in Barbados and are generally absorbed into the housing stock statistics.

Critical facilities: consist of facilities that will be instrumental during and after a natural disaster. These assets are:

- Emergency shelters: often located in schools or churches and are inspected every two years under the direction of the Ministry of Education, Science, Technology and Innovation. These inspections outline the integrity of the structures and whether the shelters are intended for use during (category 1) or also after an event (category 2).
- Emergency services: include hospitals, fire stations and police stations.
- Barbados Defence Force (used for exposure assessment, not for vulnerability).
- Ports and landing facilities are especially important on a small island such as Barbados that relies heavily on imported food and goods. These facilities take on an even greater importance in the aftermath of a natural disaster as they provide gateways for aid and supplies to enter the country for relief and rebuilding efforts. Grantley Adams International Airport (GAIA), the Barbados Port Inc. (BPI), and Port St Charles are the three primary ports and landing facilities. These three locations maintain a staff of customs and immigration officers where personnel and goods may legally enter Barbados. In addition, during emergency situations, there are several other locations which may be used as temporary ports of entry including the Careenage, the Barbados Coast Guard Base, the Shallow Draught, Port Ferdinand, Oistins and Consett Bay.

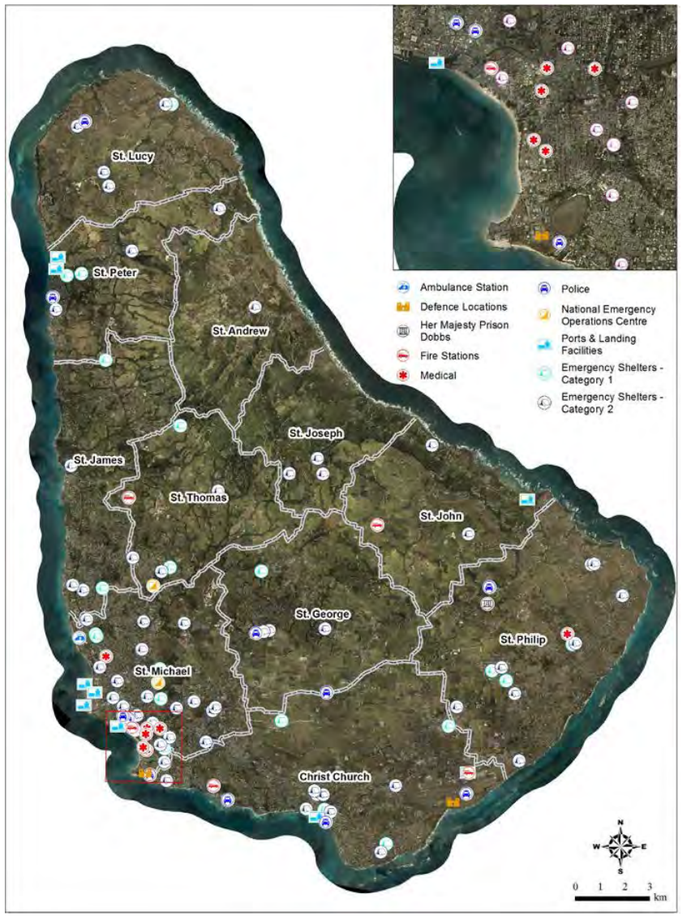


Figure A.28. Critical facilities. (Source: Baird, 2017b).

Physical infrastructure: damage to physical infrastructure is more readily defined in terms of what impacts it may have on emergency services or recovery operations after a disaster. Physical infrastructure catalogued included:

- Roads and bridges.
- Telecommunications.
- Power Generation and Distribution.
- Water and Sewer.
- Surface Drainage.
- Landfill and Recycling.
- National Monuments.

Community resources:

- Schools, Churches, Post Offices, Libraries, Community Centres and Banks
- Homes for the Aged & Children's Homes
- Public Buildings (located on property owned by the government)

Environmental resources: described in section A.2.1.2.

Once the assets are identified and located, asset classes have been developed for two purposes: to assist in determining values and (later) risks; and to allow more efficient plotting of vulnerability.

Asset classification is more aligned with similar asset properties and susceptibility, rather than exposure. The comments and results of valuation of each asset category can be found in the report Final Vulnerability Report (Baird, 2017b).

Social vulnerability

Societal conditions and exposure to natural hazards influence the vulnerability of communities and places. The most vulnerable people are likely to be those whose needs are not sufficiently considered in the planning of local response and relief organizations (Flanaganet al, 2011).

Therefore, identifying and overlaying the several social characteristics that influence social vulnerability in the Barbadian context, offers an indication within the context of the NCRIPP, of where the highest levels of social vulnerability might occur on the island.

The methodology used to develop the Social Vulnerability Index (SVI) for the NCRIPP is based on five demographic categories; Socioeconomic, Gender, Age, Special Needs and Property Type, comprising eight key census variables:

The Socioeconomic category was calculated using two variables:

1. Unemployment rate - The unemployment rate is the number of unemployed persons divided by the total labour force in an Enumeration District (ED)
2. Persons per household - Average number of persons who live within a household in an ED

Gender was determined by the following variable:

3. The percentage of women - The ratio of women to men in an ED

The Age category was calculated by two variables:

4. The percentage of children - The ratio of children to adults in an ED
5. The ratio of retired persons - the number of persons retired in relation to the total population in an ED

The Special Needs category was determined by the following variables:

6. The mobile impairment rate - the ratio of persons who are immobile divided by the total number of persons within an ED
7. The rate of disability - the number of persons with a disability divided by the total number of persons within an ED

The Property category was based on:

8. The ratio of wooden properties - the number of 100 percent wooden structures divided by the total number of structures within an ED

. These variables were ranked from highest to lowest across all (ED) in Barbados. In a second approach to identifying social vulnerability, a count or flag was provided of the number of individual variables with percentile ranks of 0.75 or higher for each of the five themes and for the ED overall, as number of mobility impaired people in a district, among many others. As a third method to view social vulnerability, a bidirectional matrix was used to simultaneously assess the results of the SVI and Vulnerability Flags approaches. Ranking was classified into three subgroups: low, medium, and high.

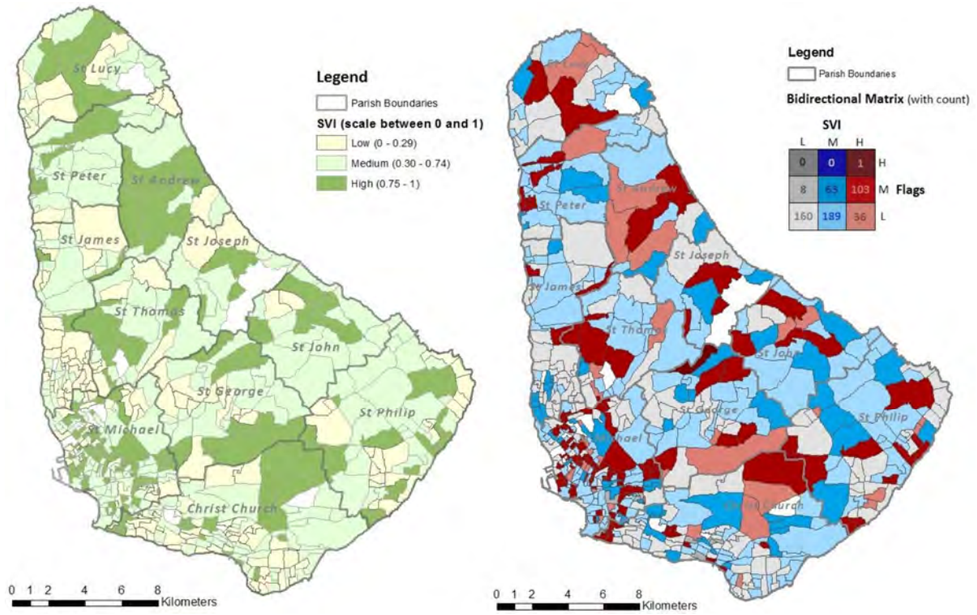


Figure A.29. Left: Social Vulnerability Index by Enumeration District. Right: Bidirectional Vulnerability by Enumeration District. (Source: Baird, 2017b).

The SVI provides an opportunity to build resilience by implementing targeted vulnerability reduction and risk mitigation programs directed at the most vulnerable geographic areas. At the same time, it demonstrates the need for island wide efforts focused on, *inter alia*:

- increasing wide-based public awareness on disaster planning and preparedness;
- increasing support for community-based disaster management groups;
- establishing early warning systems, with an emphasis on the needs of especially vulnerable groups – children, the elderly and the physically or intellectually challenged;
- enforcing standards for housing stock on the island; and
- engagement with the insurance sector to encourage the development of affordable plans for low to medium income households to aid in the recovery and rebuilding phase.

It is important to note that this analysis only considers statistics aggregated over the enumeration district and does not consider smaller regions within an enumeration district that may be more vulnerable.

Social vulnerability is most pronounced in the face of a disaster, when socially vulnerable populations are faced with hazard exposure and hazard vulnerability. The social and hazard vulnerability compound to create some of the most difficult and dangerous circumstances. For example, there may be compounding vulnerabilities if a socially vulnerable population is vulnerable to storm surge in a coastal region. Compounding vulnerability (social and hazard) is discussed further in Section Areas of Special Consideration.

Economic Sectors

Mapping of employment type to land parcel definition is the ability to spatially assess what types of employment are occurring in different areas of Barbados. This allows spatial assessment of exposure and vulnerability for different employment sectors in response to a hazard event.

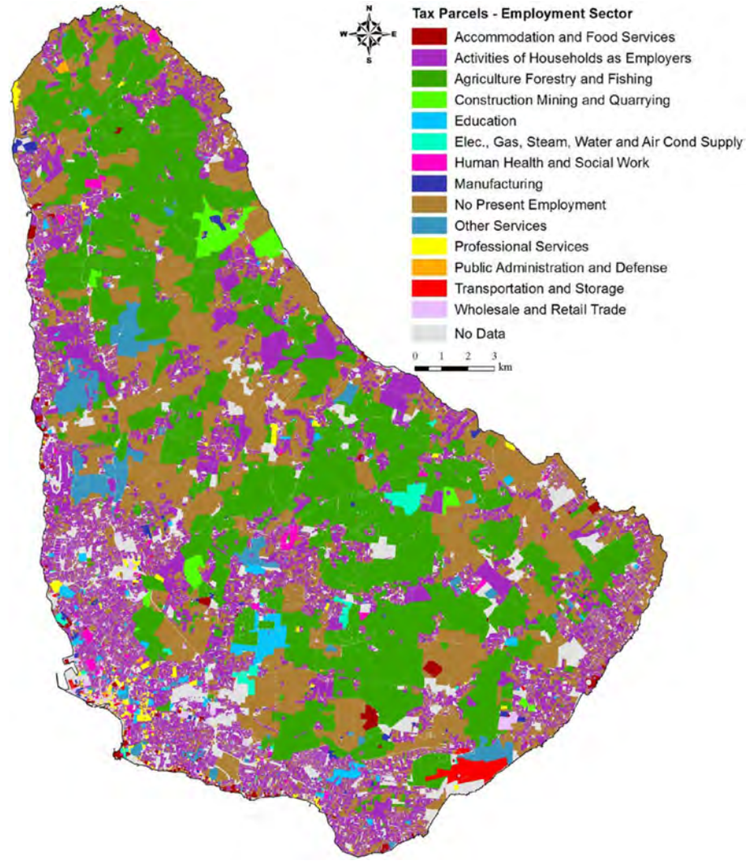


Figure A.30. Mapping of employment sectors in Barbados. (Source: Baird, 2017b).

It is important to consider that all employment sectors have vulnerability related to their reliance on employees. If employees do not have a home, or are not able to travel to work, then economic productivity will be severely impacted. This means that housing stock and many other assets can all impact a wide range of economic sectors.

Vulnerability mapping and scoring system for vulnerability assessment

Vulnerability is a combination of exposure to one or more hazards, as well as being susceptible to hazard related damage. For example, a road may become exposed to water and wind hazards; however, the road would have little susceptibility to damage from winds. Conversely, water may erode and damage the road. It is therefore important to undertake vulnerability mapping based on either an individual hazard, or on the basis of a group of similar hazards. For the NCRIPP study, we have grouped hazards into four categories:

- Wind: This only includes the wind hazard.
- Water: This includes tsunami inundation, rainfall induced flooding, storm surge and coastal erosion.
- Earth: This includes seismic events (ground accelerations but not tsunamis) and landslides.
- Oil Spill: This only includes the oil spill hazard (limited to nearshore waters and shoreline only).

Determining the vulnerability of assets was undertaken using a scoring system, some of which was data-driven and some of which was more subjective. The scoring system was developed so that each asset is scored separately for different groups of hazards (wind, oil, earth and water). Exposure and susceptibility for each hazard/group are combined to obtain the vulnerability scoring. Vulnerability maps present the results of the vulnerability analyses (see sample maps in Annex 5).

Areas of Special Consideration

Areas of special consideration consist of regions that have increased social vulnerability and increased hazard vulnerability.

It is important to consider that there is significant variability within an enumeration district, both in terms of hazard vulnerability and social vulnerability. Therefore, the areas of special consideration demonstrate regions that are likely to require special consideration, but the results are not definitive. It would have been misleading to only identify very specific locations because there is not the data to support very specific conclusions. The maps presented in this section highlight: the top 5% range (blue); the 5% to 10% range (purple); and the 10% to 20% range (red). Areas of special consideration are most likely in the blue zone but may also occur in other regions.

The compounded vulnerability of SVI and water hazards is presented in Figure A.31. Areas of special consideration in these plots consist of areas with increased vulnerability and those areas that are more prone to flooding, such as some regions near Holetown, regions along the south coast, and some isolated inland areas.

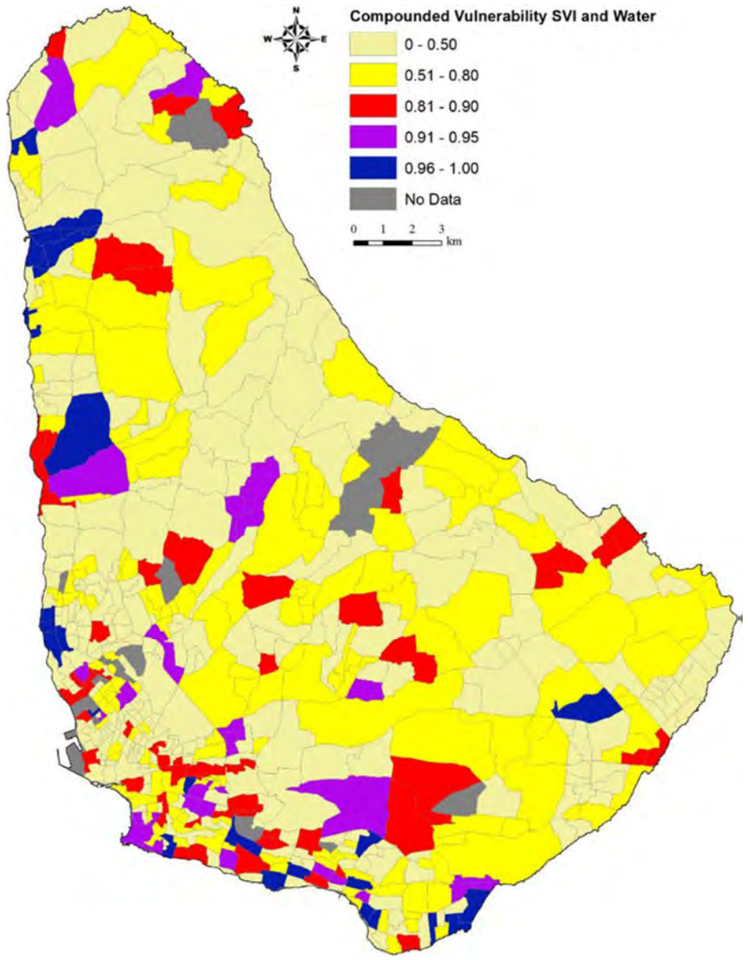


Figure A.31. Compounded Vulnerability: Social Vulnerability and Water Vulnerability. (Source: Baird, 2017b)

The earth hazards (landslide and seismic) are combined with the SVI and are presented in Figure A.32, using the same colour scheme as the water hazards. The regions of greatest compounded vulnerability create a more distinct pattern, with higher vulnerability levels in the Scotland District due to landslide threat. Some other localized regions are also present along the coast where weaker soils result in height ground accelerations during an earthquake.

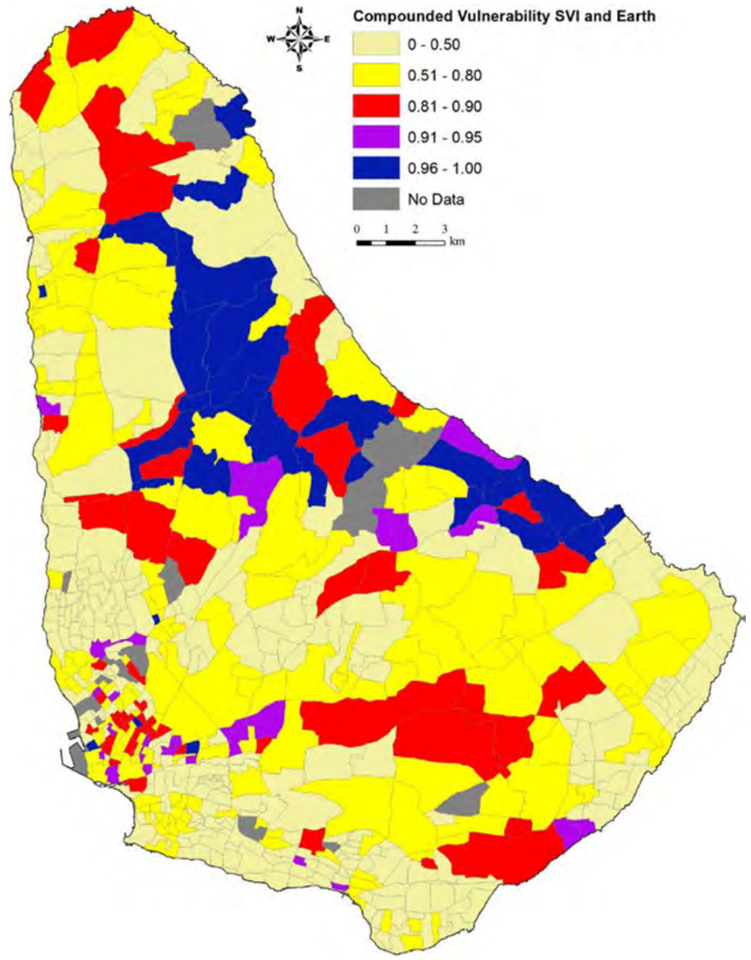


Figure A.32. Compounded Vulnerability: Social Vulnerability and Earth Vulnerability. (Source: Baird, 2017b)

The compounded vulnerability of SVI and Wind are shown in Figure A.33. Because the wind hazard is consistent throughout Barbados, the resulting map is really a combination of SVI and the housing stock's wind susceptibility (primarily about structure type and condition). The results are not as well clustered as some of the other results; a fairly random pattern appears to exist. With the variability in housing stock within an enumeration district, the compounded SVI and wind vulnerability may be less reliable compared to some of the other indicators.

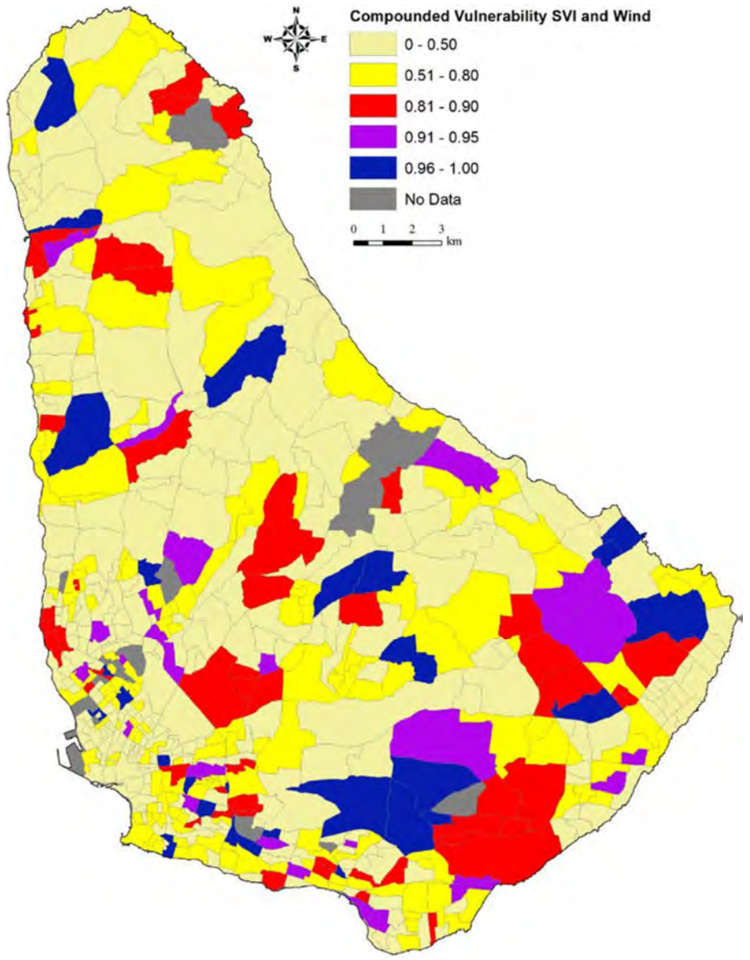


Figure A.33. Compounded Vulnerability: Social Vulnerability and Wind Vulnerability. (Source: Baird, 2017b)

A2.3.3. NCRIPP risk assessment

Based on the hazard and vulnerability assessments, the final phase of the NCRIPP study involved calculating financial damage (referred to as risk in this study) resulting from the assessed hazards. Risk is computed for multiple hazards at various return periods for a range of assets. Most of the damage values were based on buildings, which were classified based on the 2015 LiDAR Study and supporting data from the Barbados Revenue Authority and the 2010 Barbados Census.

Some of the hazards were found, as expected, to be very severe, while others are of much less concern. The hazards with the largest risk were found to be flooding due to storm surge and flooding due to rainfall. An overview of the risks is outlined in order from largest to smallest as follows:

- Seismic risk was ranked as the highest financial value of any of the hazards; however, this was assessed for a much higher return period than other hazards. Seismic was assessed as per the values prescribed in the building code of 475 years (10% chance of occurring in 50 years) and 2,475 years (2% in 50 years). The total risk values of BBD 18 billion and BBD 30 billion were determined for these two events.
- Flooding due to storm surge has a large influence on residential, commercial and tourism assets, with totals damages in the range of BBD 3 billion for the 100-year condition. Some of the largest damages are in the Bridgetown area, although with limited information on the urban drainage in this region, we believe the risk in this area is likely overestimated.
- The risk of flooding due to rainfall for the 100-year event is estimated to be approximately BBD 900 million. This includes slightly more damage in the commercial sector rather than residential buildings, with the greatest damages in Bridgetown.
- Winds during a hurricane at the 100-year level are estimated to cause BBD 1.7 billion in damage, with about 60% of that damage being to residential buildings.
- Risk due to the 100-year tsunami is estimated at BBD 31 million, which is located primarily in the vicinity of the Careenage. With a future sea level rise of 25 cm, the damage increases and is approximately BBD 80 million. These are very likely conservative estimates based on some of the assumptions in the hazard analyses.
- Risk due to landslides in the Scotland District is estimated at BBD 21 million for the 100-year event. Such an event could happen at many different locations in the Scotland District and the specific location could significantly vary this number. Damage to infrastructure such as roads is not considered in these values.
- Risk due to coastal cliff collapse is cumulative with collapses occurring in numerous locations rather than as a single large event. The cumulative damage over a 50-year period is estimated to be in the range of BBD 7 million, which increases to BBD 18 million over the next 100 years (expressed as 2017 values).
- The oil spill hazard was demonstrated through oil spill modelling and industry statistics to have minimal risk, with annual risk values in the order of a few thousand dollars. This does not imply that no spill will ever happen, but suggests that with industry standard practices and preparedness in place, no further mitigation and preparedness efforts are required for oil spills.

The Hazard Report (Baird, 2017) showed that a Sea Level Rise (SLR) of 25 cm had only limited impact on storm surge, but more impact on tsunami inundation. The date by which 25 cm of SLR has occurred varies greatly with different studies, but a typical range is approximately 30 to 60 years from today.

The most common return periods for the hazards analyzed were in the range of 50 to 100 years; these data have been compiled for the relevant hazards and are plotted below. This plot (Figure A.34) shows the large disparity in the risk for some of the hazards, as well as the difference between the 100-year and the 50-year events. The large difference for the two return periods for wind is evident, while the more similar return period results for storm surge is also shown.

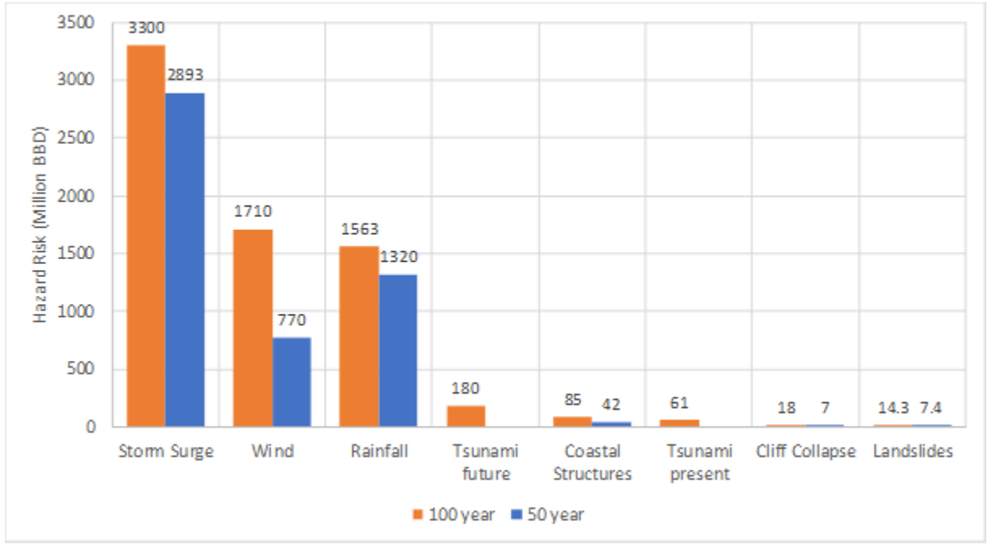


Figure A.34. Hazard Risk (Million BBD). (Source: Baird, 2018).

The annual expected damage is derived from the damage associated with various return period events and the annual probability of occurrence. This process has been completed for the time span of the 10-year event to the 100-year event, with the results plotted below. These expected damage values are intended for comparisons between hazards, rather than for any sort of budgeting purposes as there is considerable estimation in defining the shape of some of these curves.

Seismic damages are not depicted in this figure due to the different return periods that were assessed.

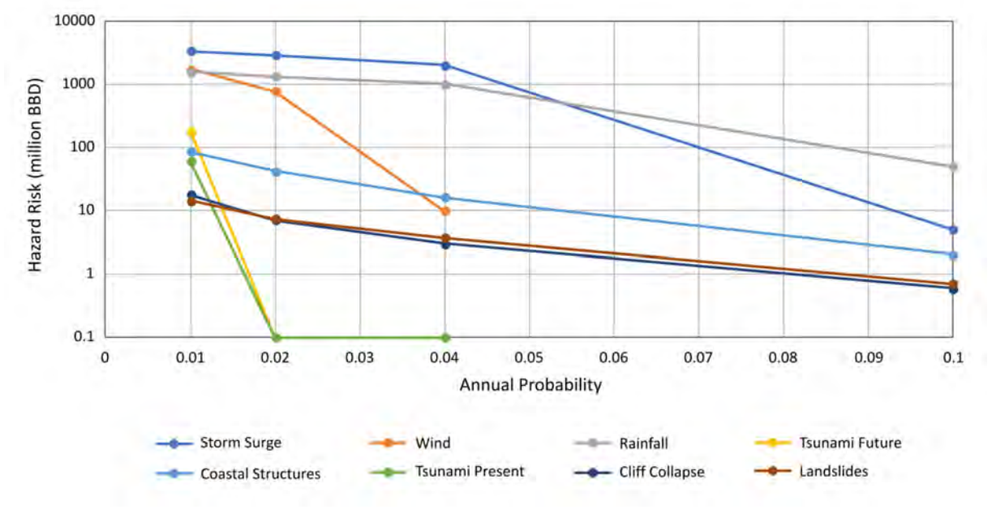


Figure A.35. National maximum probable loss by hazard. (Source: Baird, 2018)

Wind risk

The potential for severe wind damage in Barbados is high; this was strongly demonstrated through the extreme hurricane damage in the northern Caribbean during the 2017 hurricane season.

Risk from the wind hazard was assessed for Barbados based on the exposure to the hazard, and the susceptibility of various assets to wind damage. The wind hazard was derived based on statistical analysis of hurricanes and tropical storms and a Monte Carlo analysis of thousands of hypothetical storm tracks. The wind exposure in the vicinity of Barbados is essentially equal throughout the area; all regions of Barbados are thus assumed to have the same design wind speeds (see Table A.6), regardless of proximity to the coast or local land profile. Localized adjustments to winds are applied based on surface roughness such as trees, and buildings, which is obtained from the LiDAR survey (Baird, 2015c). The vulnerability to wind damage was based on statistical information describing the building parameters, which introduced spatially varying vulnerability to the wind hazard.

Return period	3 sec Gust Speed (m/s)
20	34
50	42
100	47

Table A.6. Design wind speeds. (Source: Baird, 2018)

Asset values were obtained from the Barbados Revenue Authority tax parcel database. These improved values (structure values) were available for most properties and were the primary source of information for asset valuation.

Structural properties considered in the wind damage assessment included roof shape, roof covering, structure size/height, building material (e.g. wood/masonry) and various other parameters. The FEMA HAZUS software was used to describe the expected losses due to wind.

Damage was assessed for all structures in Barbados, and catalogued as damage to either a residential or commercial structure.

Content losses are not considered for wind damages, since for the typical damage levels that are expected (up to the 100-year event), content damage is limited.

Mapping of wind losses is presented based as the sum of the loss for each hectare (100 m by 100 m) throughout Barbados.

Figure A.36 presents the residential and commercial wind damage. The Hazard Risk Atlas (Baird 2018) includes values of wind damage on tiles of 65 maps for residential and commercial buildings (note that commercial includes all non-residential buildings), as well as for the tourism plant (selected tiles only).

Residential Wind Damage: In a 100-year event, damage is widespread throughout Barbados, and closely follows the distribution of the housing stock. Residential housing stock totals approximately BBD 29 billion, and damage estimates are approximately BBD 1.0 billion, or about 3.6% of the total residential value. Losses at the 50-year level were significantly less, which shows the sensitivity of the damage to wind speeds. Note that content losses were not included in these estimates and that rebuilding value is typically in the order of 50% higher than the damage estimate.

Commercial Wind Damage: In a 100-year event, commercial damage is estimated to be approximately BBD 660 million, which represents just over 5% of the commercial structure value in Barbados. Content losses are not included in this estimate. Damage is clustered in St. Michael, as well as along the south and west coast, largely due to tourism assets. Damage throughout the remainder of Barbados is scattered, although increased damage occurs in isolated locations. Some localized higher damage occurs in Newton Industrial Park, Warrens, Wildey, Belleville, Bridgetown and the Port.

Tourism Wind Damage: Wind damage to the tourism sector is a subset of the commercial sector and was computed at BBD 270 million for the 100-year wind event. This represents about 8% of the total tourism asset value (BBD 3.3 billion). Damage is much more localized in specific areas along the coast, including the southwest coast, Carlisle Bay and St. James (Paynes Bay through Heron Bay). Additional losses are noted on the east coast close to Crane. Damage that can be linked to specific structures must consider that structure-specific susceptibility information was not available for these analyses.

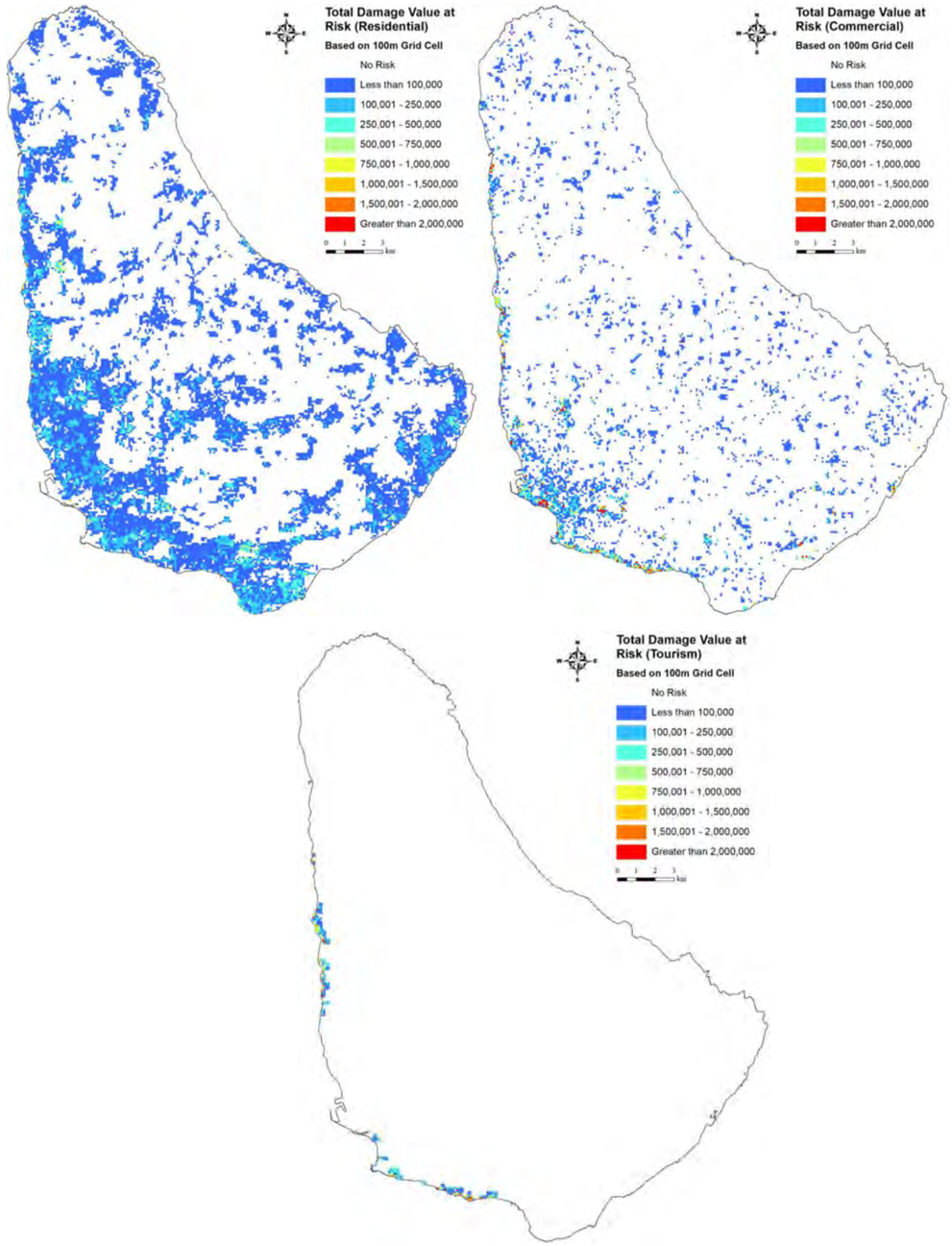


Figure A.36. Map of Wind Risk from 100-year Event (Residential on upper left, Commercial on upper right, Tourism on bottom). (Source: Baird, 2018b).

Storm surge risk

Storm surge typically occurs in Barbados during a tropical storm or hurricane, and includes the processes of pressure setup (due to low pressure in a storm), wind setup (from onshore winds), wave setup (associated with large onshore waves) and wave runup as the waves impact the shore or structures. Storm surge was assessed through the simulation of hundreds of hypothetical storm events using a Monte Carlo approach. Coupled numerical models of waves and storm surge defined the conditions close to the shore, while profile models were used to assess runup and overtopping along the shore. Storm surge can be very localized and a strong event on one coast may occur while other coasts see little impact. As a result, the runup and overtopping estimates vary significantly from site to site, and the impacts are highly variable depending on shoreline topography.

Approximately 250 profiles were defined around Barbados to define the storm surge exposure. Where runup did not exceed the beach or cliff face, the exposure region is very close to the shore and typically has little to no impact since structures are generally further landward. In instances where the runup exceeds the beach elevation, inland inundation will occur and in extreme cases waves may impact buildings.

Damage to buildings was assessed based building footprints that were defined from the recent LiDAR study (Baird, 2015c). The Improved values for the properties were obtained from the Barbados Revenue Authority, while information on the building susceptibility was defined from information obtained from the 2010 Barbados Census. Census data were available at the enumeration district level and provided statistical guidance on building construction and other parameters. Buildings were defined as having a first-floor elevation of above or below 0.6 m, which impacted their flood susceptibility.

Building-specific flood damage was estimated as the percentage of structure loss versus water depth. These data were derived from U.S. estimates and applied for different types of structures. Loss data are summed by one hectare parcels and are limited to coastal areas where this type of flooding is expected. Assets are group into residential and non-residential categories, and are also presented separately for the building stock. Losses for building contents and vehicles are also considered, in addition to loss of life.

Residential Surge Damage: Damages due to storm surge are greatest along the developed SW through west coasts and sum to about BBD 650 million for the 100-year event, or close to BBD one billion if a 50% content loss assumption is applied. The majority of these losses are within the parishes of St. James and Christ Church, accounting for about two-thirds of this value. Losses on the other coasts are minimal in comparison. Bridgetown also has significant damage, although these are generally more commercial than residential properties.

Commercial Surge Damage: Commercial damage from storm surge at the 100-year level totals about BBD 1.1 billion in structure damage, with content damage doubling this value to a total of BBD 2.3 billion. Close to half of this damage occurs in the central Bridgetown area, in the vicinity of the Careenage through Fontabelle to the shallow draught harbour. The storm surge flooding hazard, particularly close to the port, was identified as likely being conservative in terms of its extent and depth due to the lack of details regarding urban drainage in the area.

Tourism Surge Damage: The risk to tourism structures in Barbados due to storm surge primarily occurs along the SW and west coasts in the parishes of St. Peter, St. James and Christ Church. The majority of commercial flood damage in the Bridgetown area is not associated with tourism, but general commercial assets instead. The total structure damage to the tourism sector is estimated at BBD 870 million, plus content losses that are estimated at an additional 100% for commercial assets (tourism is a subset of commercial).

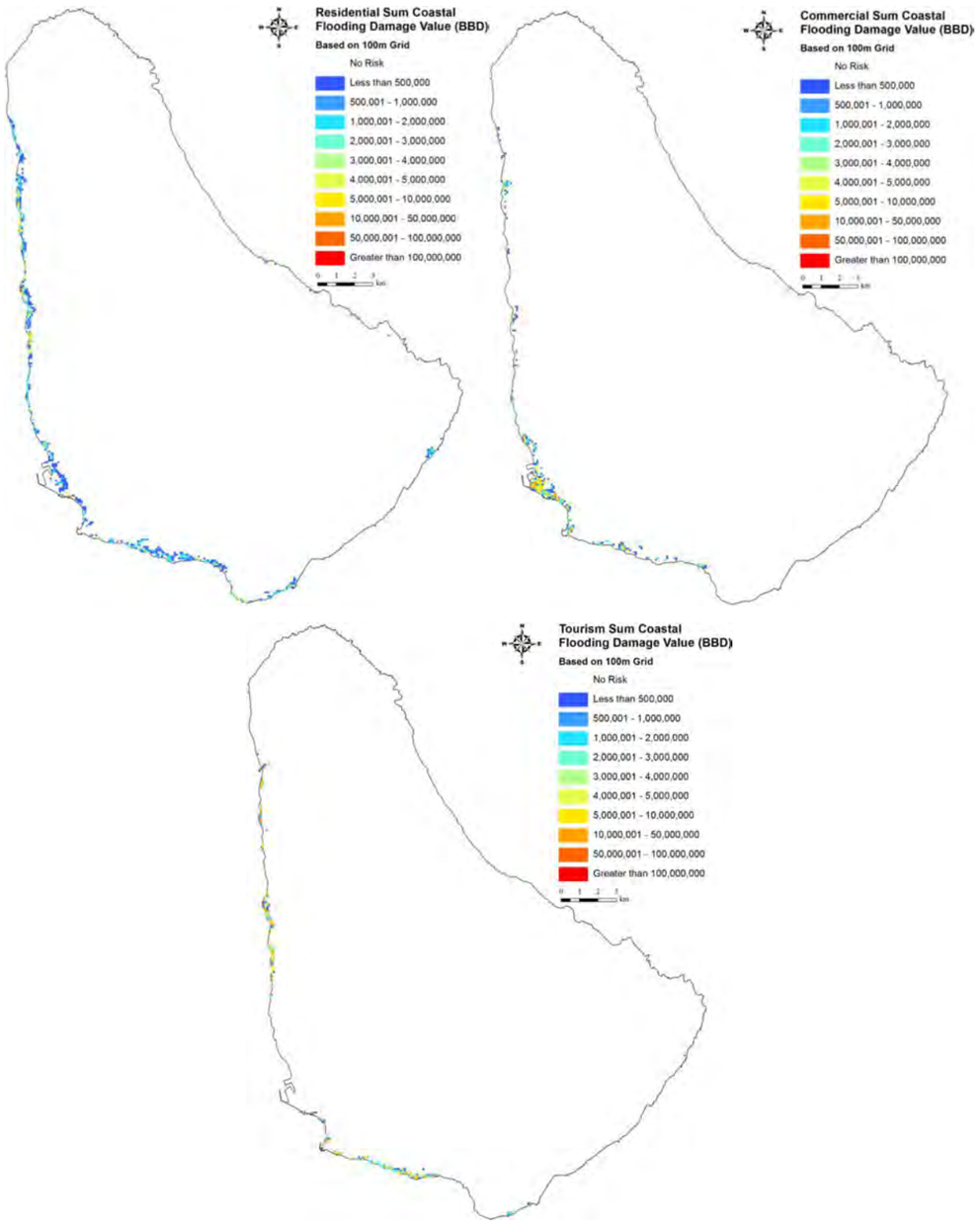


Figure A.37. Map of Storm Surge Risk from 100-year Event (Residential on upper left, Commercial on upper right, Tourism on bottom). (Source: Baird, 2018b).

Coastal erosion - beaches risk

Coastal erosion risk relates to beach damage or damage to coastal structures, or erosion of coastal cliffs. These processes are all inter-related in that they are caused by a combination of short- and long-term degradation due to wave attack; they also have significant differences.

Beach erosion and cliff collapse are cumulative process that happen over a period of many years, although for both processes event-based losses will occur.

Beach erosion is different to other hazards as the beach will accrete and erode in response to varying wave conditions, including major storms. Assigning beach damage immediately after an event may not be appropriate since some natural recovery of the beaches occurs. Therefore, only long-term erosion of beaches can be assigned a numerical damage value; however, this is a continuing loss value each year based on long term trends, rather than being associated with a specific event.

Estimates of long-term beach erosion were undertaken through statistical analyses completed on the surveyed beach profiles from CZMU's long term monitoring program. Estimates of long-term trends were developed for each station, and broader estimates by coastline were developed. These results are shown in Table A.7. Table A.7 also provides the change in value under different beach width scenarios. The annual value change represents the losses/gains per year as a result of long-term trends in the beach width. These long-term trends are based on the last 10 to 30 years (depending on the site) of beach survey data.

Coast	Long term beach change (m/yr)	Beach length (km)	Annual Area Change	Without SLR	With SLR (3mm/yr)
West	-0.08	16	-1298	-3.2	-4.1
Southeast	-0.05	6	-317	-0.2	-0.3
Northeast	-0.18	9	-1586	-1.3	-1.4
Southwest	0.16	8.5	1366	3.8	3.3
Carlisle Bay & Brandons	1.23	2	2468	10.1	9.9

Table A.7. Estimation of long-term term beach erosion. (Source: Baird, 2018).

Beach values were derived by examining the total contribution of beaches to tourism in Barbados, in addition to other uses that provide value. This value was distributed to the beaches based on the approximate beach width and relative use level on the beach. Beach values and associated losses are not based on specific site issues such as the adjacent property values, but are based on general trends.

The annual erosion damage to the beaches (considering beach loss only, not structures) is in the order of BBD 3.2 million along the west coast, and 1.3 million along the northeast coast. The southwest coast and the region of Carlisle Bay and Brandons are accreting and therefore (technically) increasing in value.

A SLR of about 3 mm/yr will cause a recession of about 24 mm per year on an 8:1 sloped beach, resulting in additional total losses of about BBD 2 million per year. It is important to consider that these losses are not evenly distributed in Barbados; west coast damages increase by an addition BBD 1 million per year. Gains on the southwest coast are slightly reduced if SLR is considered. The southwest coast erosion/accretion is often linked to shoreline restoration works and is not spatially consistent. There may be some sections of beaches on the SW coast that are eroding and do not follow the general trend; localized erosion maybe an ongoing trend. Also gains in one

location (e.g. Carlisle Bay) are not directly transferrable to losses in other locations, such as the west coast where erosional losses are higher.

Figure A.38 presents the change in beach value (in BBD) if beach width decreases 2 m. Sub-Area maps also present this information at local scale.

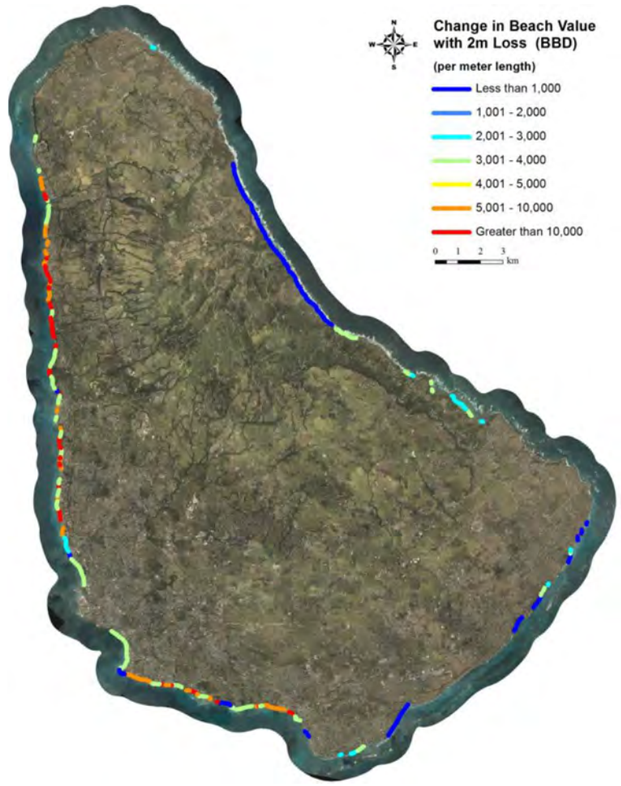


Figure A.38. Change in Annual Beach Value for 2 m Reduction in Beach Width. (Source: Baird, 2018b).

Damage to coastal structures was also assessed based on very limited information (no field studies or inspections were completed). The lengths of different types of structures was determined based on aerial imagery and structure values were estimated based on Baird's local knowledge of structures and construction costs. An estimate of the structure conditions was also applied in a statistical manner (percentage of robust, acceptable and poor condition) in addition to an estimate of the damage level from different storm events. From this an estimate of the financial risk to various structures was developed; however, it needs to be emphasized that all these data are based on statistical estimates and local knowledge. No site inspections were completed and consequently specific structures at risk were not identified.

Coastal cliff collapse may be associated with a specific wave event, or a cliff may be seriously weakened in an event and fail in the weeks, months or years that follow. However, cliff damage is generally more cumulative than occurring during a specific event. The frequency of coastal cliff collapse is estimated by assessing the historical failures of different classes of cliffs, and then determining what percent of the cliff length may be expected to fail over different time periods. The different cliff classifications were established to reflect the integrity of the rock, the shape of the cliff and the likely failure mechanisms.

		50-year Setback		50 year Losses					
Cliff Type	Length of Coast (m)	Number of Buildings	Value of Buildings (M BBD)	Expected Loss of Cliff (m)	Cliff Loss	Developed Frontage	Loss of Structure Probability	Number of Buildings	Value of Buildings (M BBD)
A	10900	47	190.9	50	0.46%	26%	0.12%	0.06	0.2
B	18800	119	263.5	400	2.13%	38%	0.81%	0.96	2.1
C	19700	160	346.8	150	0.76%	49%	0.37%	0.59	1.3
D	5300	43	7.74	50	0.94%	49%	0.46%	0.20	0.0
E	600	13	5.4	60	10.00%	130%	13.00%	1.7	0.7
Total	**55300**	**382**	**814.34**	**710**	**1.28%**	**41%**	**0.92%**	**3.5**	**BBD 4.38**

Table A.8. Cliff losses by cliff type. (Source: Baird, 2018).

Cliff failures are difficult to predict for any specific location; the probability of a cliff failure is assessed in a uniform manner along the length of the cliff. There are two aspects to understanding structure risk at a cliff. First there is the probability of having cliff failure occur somewhere along the coast. There is also then a probability that the failure will be fronting a structure that is close enough to a cliff to cause damage.

Cliff failures that intersect with or are close to a structure are assumed to result in complete loss of the building. There are 382 structures that lie within the 50-year setback that was established during this study, and our estimate of the expected building losses over the next 50 years is 3.5 structures. These are most likely to occur along type E and type B cliffs. The value of the building loss over the next 50 years (in today's dollars) is BBD 4.4 million. Loss of life and content loss is a possibility, but depends on whether there are any warning signs that permit evacuation to occur.

Structures that are threatened by cliff collapse are almost exclusively residential structures. There are very few other types of structures such as the Crane Hotel (which has a specially engineered foundation) and some structures at the Arawak Cement Plant.

Rainfall flooding risk

Flooding due to rainfall is common in Barbados and can occur throughout many parts of the island. Flooding from rainfall could be due to a widespread tropical depression/storm, a hurricane, or even localized downpours. Rainfall estimates for Barbados relied on data from 1971 with recent updates by the Caribbean Institute for Meteorology and Hydrology (Baird, 2017). The CIMH data provided revised intensity-duration-frequency (IDF) curves for Barbados, which were modified to represent different rainfall intensities over Barbados.

Hydrological modelling used a combination of the SWAT model (which considered soil type, and infiltration and built upon previous modelling efforts in Barbados) and the MIKE21FM model for simulating the spatial extent of the flooding in some of the broad flat areas. Numerical modelling of flooding did not include urban drainage features such as ditches and culverts; it represents overland flow that would be indicative of flooding when the local drainage was overwhelmed. The numerical model did not include the effects of building and walls on how flood water will travel. Therefore, the results of these simulations should be considered with the knowledge that this study does not represent the definitive flooding study for all of Barbados.

Census data were available at the enumeration district level and provided statistical guidance on building construction and other parameters. The census data were applied to the LiDAR-derived building definitions and an estimate of the first-floor elevation (above or below 0.6 m) impacted their flood susceptibility.

Building-specific flood damage was estimated as the percentage of structure loss versus water depth. These data were derived from U.S. estimates and applied for different types of structures. Assets are grouped into residential and non-residential categories and are also presented separately for the building stock. Losses for building contents and vehicles are also considered, in addition to loss of life.

Residential Rainfall Flooding Damage: Residential risk is generally more present along the coasts where flatter land is present and where there is typically a higher housing density. Some pockets of higher risk occur in regions such as Speightstown, Holetown, Six Roads and scattered pockets throughout St. Michael and Christ Church. When assessing losses at the sub-parish level (20 regions described in the Risk Report (Baird, 2018), two thirds of the damage occurred in Central Bridgetown, Christ Church West, and St. James (urban). Residential damage is estimated at BBD 370 million, plus 50% to include damage to contents (total is BBD 550 million).

Commercial Rainfall Flooding Damage: Commercial damage associated with the 100-year event is most prevalent in the Bridgetown area, where flooding issues and commercial properties intersect. Regions of Fontabelle, Cheapside and along the Careenage/Constitution River are some of the more damaged regions. In other parts of Barbados, there are only small isolated regions where commercial damage is expected to occur at higher levels, including Speightstown, Holetown, Spring Garden, Worthing and a few other regions. The total commercial damage is estimated to be about BBD 500 million for the 100-year event. If content losses are included, this estimate doubles to about BBD 1 billion.

Tourism Rainfall Flooding Damage: Damages to the tourism sector arising from the 100-year rainfall event are similar in character to the commercial damages, except there is much less damage in the central Bridgetown area. Other regions, such as Speightstown and Holetown, show significant damage, along with the south end of Carlisle Bay, and Worthing to St. Lawrence Gap. The losses are typically very close to the shore since these are the regions that are most commonly defined as tourism. Tourism damage, which is a subset of commercial damage, is estimated to total BBD 145 million in a 100-year event. One half of this occurs in St. James while Bridgetown, Christ Church and St. Philip complete all but 1% of the damage that is outside these four regions. The total damage, if content losses are included, would double the damage estimate to almost BBD 300 million.

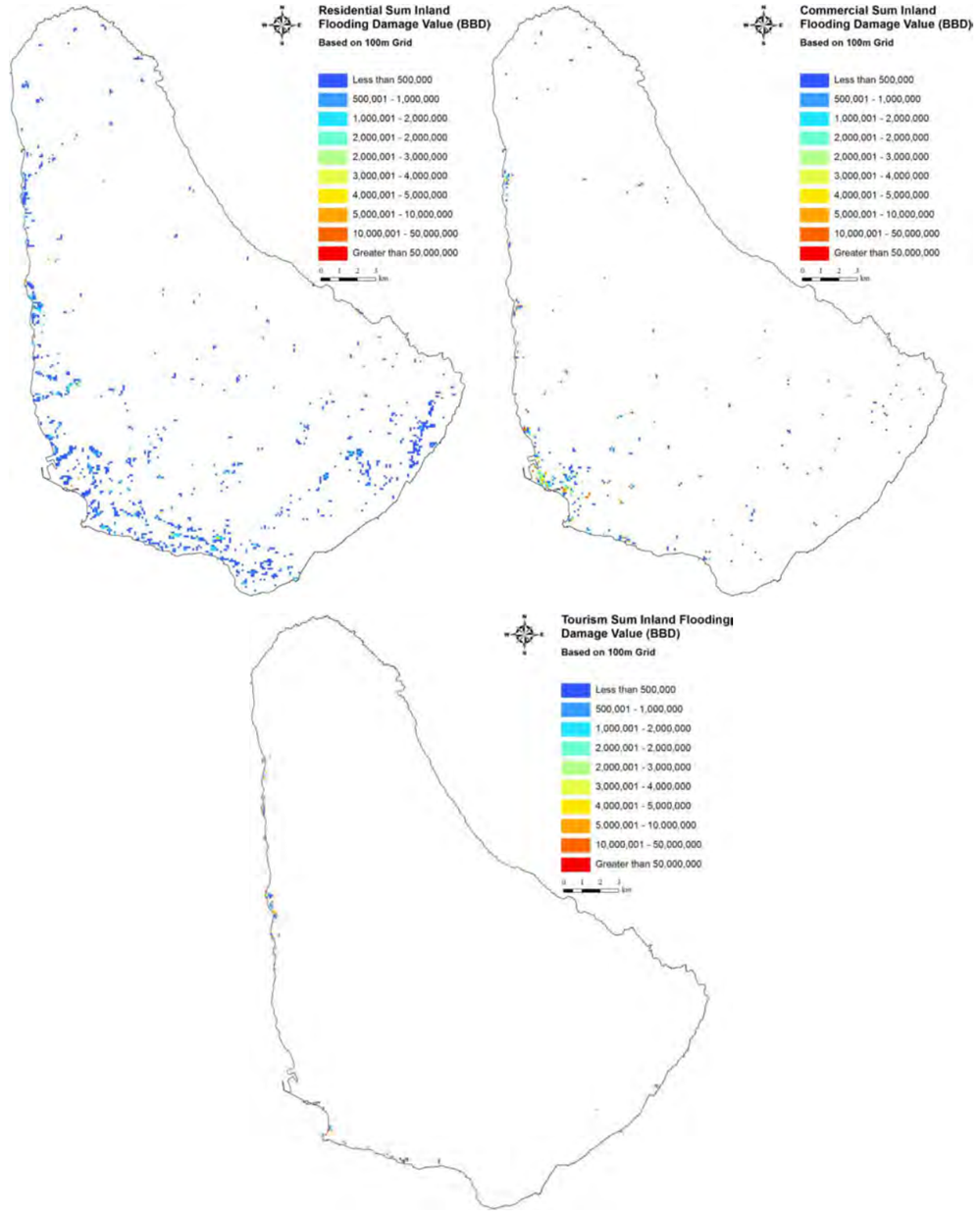


Figure A.39. Map of Rainfall Flooding Risk from 100-year Event (Residential on upper left, Commercial on upper right, Tourism on bottom). (Source: Baird, 2018b).

Seismic risk

Seismic hazards for this study were developed by Golder Associates based on the results of existing studies such as Bozzani et al. (2011) (a regional study for the Eastern Caribbean) and ground motions estimates for Barbados by Salazar et al. (2013). Ground accelerations are then modified according to the geological site class and soil amplification factors specified in the 2015 International Building Code for the 475 and 2,475 year return period events. Note that the return periods assessed for the seismic hazard are in alignment with building code approaches to new construction, and are much greater than the return periods examined for other hazards in the NCRIPP.

Seismic conditions and damage are evaluated based on the Peak Ground Acceleration (PGA) modified by site class; each structure in Barbados is as signed a PGA value that is associated with the 475 and 2475 return period events. Note that the return periods assessed for the seismic hazard are in alignment with building code approaches to new construction, and are much greater than the return periods examined for other hazards in the NCRIPP.

Barbados and its immediate vicinity have a limited history of seismic activity. This results in uncertainty in the overall ground acceleration values, as well as uncertainty in the ability of typical Barbadian structures to withstand seismic motion. As a result, the overall damage levels have significant uncertainty.

Damage levels due to seismic hazard were determined based on the probability of five damage states, ranging from “none” (no damage to structure) to “complete” (100% damaged), for a given building type and peak ground acceleration (PGA) value from the HAZUS technical manual. Six different types of structures were considered: Wood 1 to 2 story, Concrete 1 to 3 story, Concrete 4 to 7 story, Masonry 1 to 2 story, Masonry 3+ stories, and Chattel. Expected damages are assigned to each structure based on an estimate of the number of stories in the building, and a probabilistic approach based on the types of buildings in the enumeration district.

The damage levels in Barbados are extreme from these higher return period events. Losses are significantly influenced by the assumed level of code adherence in Barbados. Mapping is undertaken based on a low code adherence, although this may be somewhat conservative. Losses are still extreme for high code adherence. Including content loss increases the damages by 60% to 70%. The total structure value in Barbados (based on BRA “improved value” estimates) is BBD 42 billion. This suggests that a 475-year seismic event would involve structure losses at BBD 21 billion, or BBD 34 billion if contents a reconsidered. Reconstruction costs are estimated to be 50% higher than the improved value in the BRA database (plus content replacement).

Residential Seismic Damage: The total residential structure value in Barbados (based on BRA “improved value” estimates) is BBD 29 billion. A total residential structure damage value of just over BBD 10 billion is expected in a 475-year seismic event, which is approximately one third of the structure value. Reconstruction costs are estimated to be 50% higher than the improved value in the BRA database (plus content replacement).

The damages are generally distributed in a manner that is consistent with the residential development density, although regions with higher structure values (e.g. coastal St. James) have higher monetary damage than some regions of central St. Michael.

Differences in building type (wood versus concrete) may also contribute to the patterns in the seismic risk maps. For example, southern St. James has a much higher proportion of concrete structures than northern St. Michael, which is consistent with damage calculations.

Commercial Seismic Damage: Mapping of commercial seismic losses is highly linked to the location of the more valuable commercial assets. For example, there are regions in central Bridgetown and in the Warrens area where higher losses are observed. The more developed west and southwest coasts also show higher losses. Grantley Adams Airport shows as a region of higher loss, but this is based on averaged building properties and no seismic specific building inspections. Expected damages are in the range of BBD 7.2 billion, which is approximately 57% of the commercial building stock. Tourism is expected to have similar overall losses to other commercial assets.

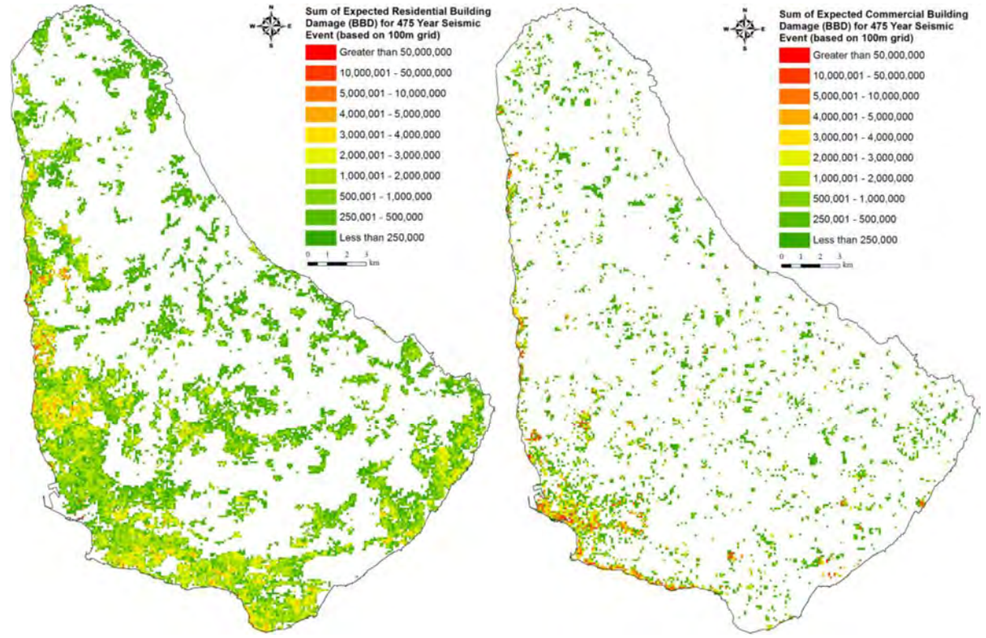


Figure A.40. Map of Damages due to 475-year Seismic Event (residential on left; commercial on right). (Source: Baird, 2018b).

Landslide risk

Landslide risk in Barbados is generally limited to the Scotland District, which contains very different soil types to the remainder of Barbados. As Barbados was gradually pushed up from the ocean floor, a coral cap developed, that was subsequently pushed above sea level. In the highest parts of Barbados, this coral cap has crumbed away, leaving behind the clays of the Scotland District which underlay the coral cap. These clays, with varied characteristics, form the hills and valleys which can be prone to landslides.

Landslide hazards were evaluated based on soil properties and slope angles, using topographic information from the 2015 LiDAR study (Baird, 2015c). Defining slope risk is not a precise science since it depends on accurate depiction of soil characteristics and definition of these characteristics through depth. Slope stability is classified as low, medium and high, based on local slope angle and soil properties associated with different regions.

Historical landslide information was also assessed, and an estimate of the area associated with different return period events was developed. The largest of known historical events was used as guidance in estimating the 100-year event, in which an estimated 2% of the Scotland District may fail. There are significant uncertainties in these estimates; however, they provide general guidance for assessing overall risk and are presented in Table A.9.

Return Period	Approx. Failure Area	Annual Exceedance Probability	Chance of Failure at Any Location for Medium & High Risk Regions	
			Areal Probability	**Annual Probability**
100 year	1.2 km^2 (2% of 60)	0.01	0.027	0.00027
25 year	0.3 km^2 (0.5% of 60)	0.04	0.007	0.00028
5 year	0.03 km^2 (0.05% of 60)	0.2	0.0007	0.00014

Table A.9. Chance of failure at any location for medium and high risk regions. (Source: Baird, 2018).

The risk to structures in the Scotland District is based on having building assets in medium or high risk areas; buildings in areas listed as "low" were not considered in the risk assessment. Each building that is medium or high risk is then assigned a spatial probability of being part of a particular X-year landslide event.

The total value of structures in the Scotland District is approximately BBD 1.0 billion based on the BRA database that documents the improved value. Just over half of these structures by value (BBD 528 million) were found to be located in medium to high risk areas. The results of the risk (see Table A.10) analyses show that in a 100-year event, approximately 1.4% of the buildings could be lost, for a value of BBD 14 million. Residential buildings and possible landslide damage amount to about 90% of the risk in the Scotland District. If a 100-year slide impacted a more or less developed area, the damages could be minimal, or could be many times higher than the predicted value.

	Value in Million BBD		
	All Structures	**Residential**	**Commercial**
Total Structure Value	1,024	901	123
At Risk Value	528	465	63
5 Year Event Loss	0.37	.33	.04
25 Year Event Loss	3.7	3.3	0.4
100 Year Event Loss	14.3	12.6	1.7
Average Annual Risk	0.68	0.60	0.08
Cumulative Risk 50 Years	34	29.9	4.1

Table A.10. Landslide risks (in Million BBD). (Source: Baird, 2018).

In addition to the landslide risk listed in this table, there are also losses that occur on a regular basis as a result of gradual ground creep, which can result in cracking of foundations and damage to building stability. These ongoing damages are not included in the above statistics, which are more focused on larger events.

Residential building damage: Residential structures make up the vast majority of structures in the Scotland District and account for about 95% of the expected losses over the next 50 years. Some of the more populated areas are located in flatter regions that are less prone to landslides, and therefore do not contribute to the damage totals. The regions of Belleplaine and Lakes are examples of regions where some houses are in more expose d locations, while other houses are much less exposed. Overall, the expected damages are distributed in small pockets throughout the Scotland District and largely follow the roads and settlements. Few areas are considered low hazard exposure and thus low risk.

Commercial building damage: Landslide related damage to commercial (anything that is non-residential) is limited in the Scotland District due to the fact that only 6% of structures reclassified as non-residential. The expected losses over the next 50 years are estimated at about BBD 1.8 million, which is only about 5% of the total losses when considering all structures. Some of the more valuable non-residential assets are located in flatter re ions of the Scotland District (close to the coast). The following maps show only scattered pockets where damages are expected.

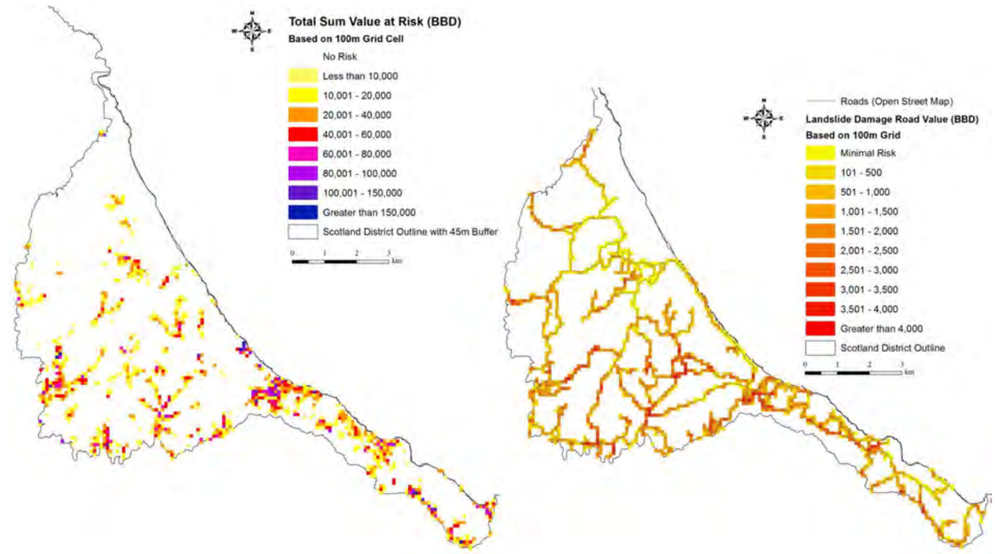


Figure A.41. Maps of Landslide Risk in Scotland District: right: structures; left: roads. (Source: Baird, 2018b).

Tsunami risk

There are a number of challenges in defining the tsunami risk, primarily related to uncertainties in the location, type and overall geometry of the generating mechanism. The Caribbean is a tectonically diverse environment, with many plate boundaries, some of which are transverse and others close to Barbados are subduction faults. There are also volcanic cones that could collapse and/or explode and the potential for submarine landslides. All of these are possible events and some of these would constitute events that may occur on the scale of 10,000 years or longer, while others are much more frequent. Many of the processes that are associated with volcanic activity along the lesser Antilles are far enough away and directed towards the west, such that their direct impact on Barbados would be limited. As a result of these factors, tsunami hazards in Barbados are minimal at the 100-year level, which is supported by the limited historical data for tsunami damage.

The most probable tsunami threats in the vicinity of Barbados at the 100-year level involve a subduction earthquake, similar to those that occurred in 1839 and 1843 to the east of Martinique. These events caused some damage in the northern Lesser Antilles and only limited impacts in Barbados. There is the potential for a large subduction event directly east of Barbados, although there is no historic evidence of such events, suggesting that these events would be well beyond the 100-year event.

The 100-year event in Barbados was simulated with various tsunamis similar to the 1839 and 1843 events. The overall dimensions of the seafloor movement were varied in numerous simulations, along with the orientation and position. There are so few strong historical seismic events recorded in the region that defining specific parameters for an expected 100-year event is close to impossible.

Seafloor displacements were supplied to the MIKE21 Flexible Mesh hydrodynamic model and the propagation and runup of the tsunami around Barbados was simulated. The tsunami waves were typically less than 0.5 to 1 m in height, and only in selected areas did the tsunami waves overtop the beach crest to cause flooding. The model results were also found to be quite varied around Barbados, with higher runup in some areas and much less in other areas. Sensitivity analyses were completed for a range of similar events (in magnitude, not in position and orientation) and one of the more damaging events was selected to represent the 100-year tsunami event. With this selected approach, the damages listed below are believed to be conservative.

Residential Tsunami Damage: Residential damages from a 100-year tsunami event in Barbados are limited to only a few selected areas. These areas are best characterized as regions that are generally much more protected, and therefore have lower beach berms protecting the land. The regions of Brighton (Spring Garden) and Oistins are two such areas. Damages were calculated using the same approach as storm surge, and are estimated at BBD 6 million, plus content damage for a total of BBD 9 million.

Commercial Tsunami Damage: Commercial damages from a 100-year tsunami are mostly in the region of Bridgetown, where tsunami waves enter the Careenage and spill into the downtown area. The total structure damages are estimated at BBD 83 million, although 70% of these damages are associated with three of the one-hectare grid cells. This suggests that much of the losses are in a very specific area, and therefore the reliability of these numbers is dependent on whether the damaged buildings are properly represented. The highly localized damage suggests that further investigation may be required to gain confidence in these values.

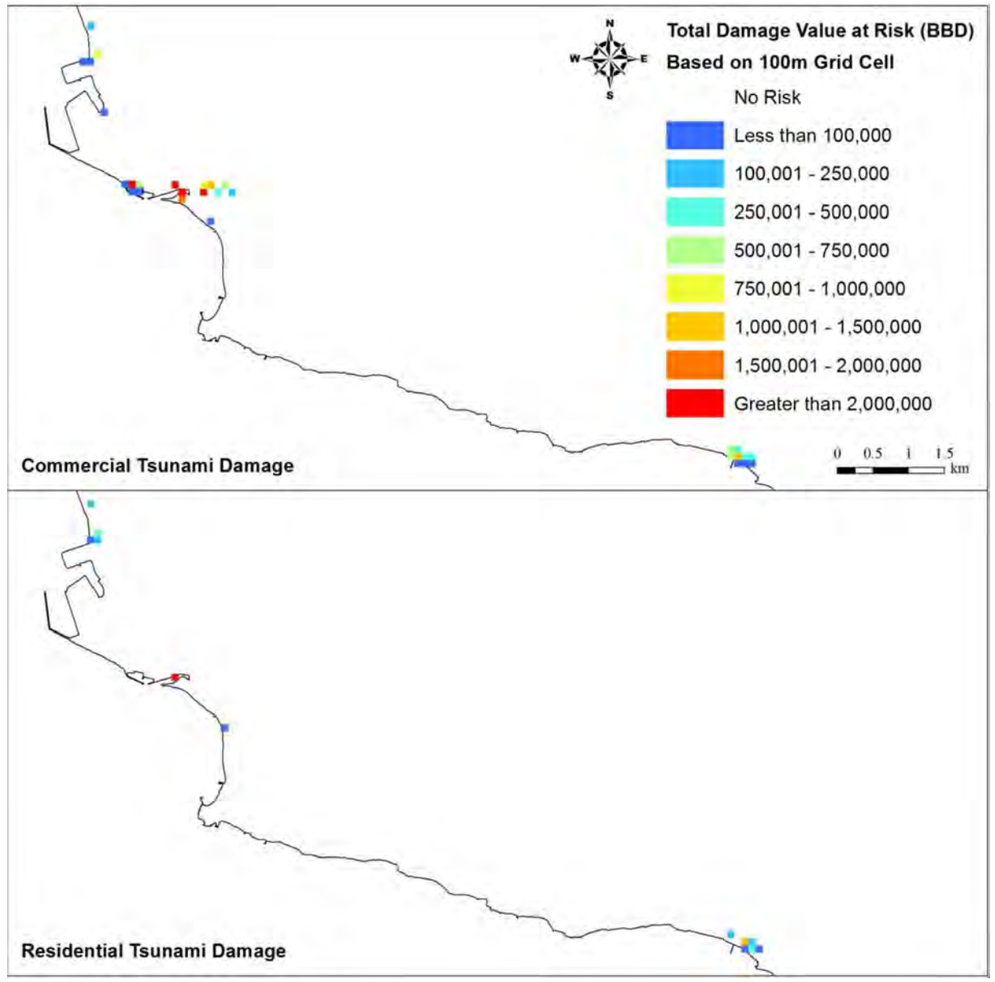


Figure A.42. Map of Damages from 100-year Tsunami Hazard (Source: Baird, 2018b).

Marine Oil Spill Risk

Oil spill risk is low in Barbados. Offshore spills, that could impact upon fishery or tourism sectors at an island-wide scale, are extremely rare (annual risk estimated at 1 in 100,000) and as a result the financial risk is negligible. There is the potential for spills in the region of Oistins, where transfer of light processed products takes place. Spills from this type of operation could impact on the south coast, but typically disperse and evaporate quickly; a shoreline clean-up is rarely required for these types of spills.

There is potential for spills to occur in the vicinity of the port; however, these are typically isolated near their source and escaping oil is blown towards the west due to the prevailing winds. Risks are small and can be mitigated through industry standard response and containment procedures. There is the potential to have port delays in the event of a spill; however, there are many port delays that occur on a regular basis and attempting to define a

specific event and the associated damage is not useful when considered in the broader context of everyday operations.

Marine oil spills were found to be small enough in frequency, size and risk that mapping of oil spill risk was not undertaken for this project.

Application of the NCRIPP Risk Results

The results from the NCRIPP risk study provide valuable insight into the relative magnitudes of the risks, as well as the shape of the curves and the potential differences between less common (e.g. 100-year) and more common (e.g. 10 year) events. It also provides insight into the spatial distribution of the hazards, vulnerability and risk. These types of information will be beneficial to Barbados in establishing overall priorities in terms of which hazards warrant more planning attention, and in what regions. With some hazards having annual average damage values one or two orders of magnitude higher than other hazards, decisions on where to direct effort should be apparent.

The NCRIPP platform also provides the ability to carry out a series of analyses that could be applied to risk mitigation, emergency preparedness, or other applications. The NCRIPP platform will provide the user the ability to examine scenarios that may involve a single building, a selected region, or could be applied country-wide. Typical applications would involve making changes to the hazard exposure, or making changes to the susceptibility of assets. There are also possible uses for emergency preparedness. These types of applications could rely on the existing mapping, or could make use of the user-driven functions of the NCRIPP. Examples of these applications are provided below.

Hazard Mitigation

The NCRIPP system and maps, along with historical knowledge of hazard exposure, may lead to interests in reducing risk in some areas. Hazard reduction is one manner in which the risk can be reduced, and the NCRIPP system could be used to examine the impacts of various alternatives. Hazard exposure mitigation potential is outlined below for the different groups of hazards.

- Water Hazards: Risk values due to storm surge, rainfall flooding, and tsunamis are all computed in a similar manner, with damage largely dependent on depth of flooding. Changing the exposure could involve rerouting of flood water (regionally or locally), installing barriers of some type, reducing wave heights (and therefore overtopping), improving storm drainage, or various other alterations.
- Earth Hazards: These consist of landslide and seismic hazards, and there are limited manners in which these hazard exposures could be reduced. For seismic hazards, there is nothing that can be done to reduce exposure, other than to be selective in where development occurs (although this makes minimal difference). Similarly, for landslides, the best way to impact exposure is through site selection. Some schemes to stabilize soils may be proposed, and the effectiveness would need to be translated into a change in the slope risk rating (low, medium or high).
- Wind Hazards: These hazards are unlikely to be mitigated through changing exposure; the manner in which wind hazard are mitigated is through susceptibility (likely some structural alteration).
- To assess mitigation options, the NCRIPP system would be used to complete a “before and after” assessment of the mitigation. The system would first be queried using the region of interest for the existing hazard conditions and a summary of the risk results would be produced by the system. The alteration to the hazard level would then be applied, perhaps through a revised flood depth or a change in the wave impact zone. The NCRIPP system would then produce a revised risk summary. Comparisons of these scenarios would be undertaken outside of the system, perhaps in excel or some other system that would allow the user to present the results in the most effective manner.

Exposure Mitigation

Exposure mitigation is a continuous process that requires constant monitoring. It might be better considered as part of site selection for a new development in a region where hazards are present. In this case, one assumes that the hazard is not being varied, but the position of the asset could be adjusted in some meaningful manner. This would be more likely to be applicable on a larger property, as spatial differences on a small property may not be possible to assess within the resolution of the analysis.

The NCRIPP system would be assessed with an existing, or perhaps multiple proposed scenarios and the risk would be computed for one or a suite of hazards. Structures would be assigned using a shape-file for each of the scenarios being tested, and the appropriate information would need to be supplied with each building (first floor elevation, wall type, roof type, etc.). The require parameters will be provided in the NCRIPP documentation.

The results from this type of assessment would be (among other data) the annual average damage, which is a good overall risk indicator that might be used in site assessment. Other factors would also need to be considered in a broader cost/benefit analysis to understand if one scenario was preferred over another.

Emergency Preparation

The NCRIPP system is not intended as a system that would be used for decision making during an emergency. However, the information provided by the system could be used for emergency preparedness including:

- In preparing for emergencies, there are items such as shelters and/or other supplies that should be allocated according to the expected need. Emergency response regions could be developed, perhaps centred close to public facilities or expected distribution centres. If polygons were developed to surround the relief centres, the risk could be summed in these regions and boundaries could be adjusted or stocked appropriately for the anticipated need.
- Planning routes for evacuation or emergency response: The NCRIPP will provide information on what regions may require evacuation (or may be impacted). It will also provide general guidance on what roads may be exposed so that plans can be made to follow less impacted routes. The NCRIPP does not do this automatically, but provides the information for use by emergency response staff. However, the NCRIPP is not a real time system and other information would also be expected to be used, especially during an emergency as the hazard data is statistical in nature and only provides an estimate for specific events that were simulated, not a forecast of a potential future event.
- Identifying regions of compounded risk: During the vulnerability phase, a social vulnerability index was developed. This index provides an indication of what regions may require proportionally more assistance before and/or after a disaster. Regions with higher risk (financial) and higher vulnerability could be identified through the existing maps, or a platform user with GIS skills could examine the combined occurrence of higher risk and higher social vulnerability.

Use of the NCRIPP Risk Results for the ICZM Plan

The results of the NCRIPP constitute the basis for a longer strategy for DRM and CCA in Barbados aimed at reducing disaster risks, that is, the likelihood of loss of life, injury, or destruction and damage from a disaster in a period of time (UNISDR, 2015).

The objective of an ICZM Plan is complementary and embraced to the objective of a DRM plan, as the hazards, vulnerability and risks in the coastal area are closely related to the management of coastal resources. In this sense, this ICZM Plan mainstreams the results of the NCRIPP into the main guidance provided:

- Delimitation of the CZMA has been designed including hazards related to coastal processes:
    - Storm surge inundation area for a 100-years return period.
    - Tsunami inundation area for a 100-years return period.
- Definition of setbacks based on hazardous areas, including:
    - Delimitation of inundation setback based on inundation areas due to storm surge and tsunami with 100-years return period.
- Identification of priority Actions (Part C and D) to be performed by the CZMU and key actors as DEM and CDEMA for DRM and CCA.

PART B
CREATING AN ADAPTIVE PATHWAY
(OCTOBER 2021)

PART B: CREATING AN ADAPTIVE PATHWAY

B1. IDENTIFYING PATHWAY PRIORITIES

The previous section (Part A) has identified, in detail, the baseline environmental, climatic conditions and risks that the Barbados coast is experiencing. The knowledge and findings presented convey a clear understanding that climate change is impacting significantly on the health of coastal resources. Linked to this, future climate change projection modelling suggests that there will be an increased frequency of extreme meteorological and oceanographic phenomena (i.e.: sea-level rise, storm surge inundation and erosion, etc.) that shall increase exposure of built and natural assets to coastal hazards within the CZMA. This highlights the fact that change is inevitable in the future and hence, an adaptive management approach for the coast will be required.

Adaptation involves managing changing levels of residual risk, including minimising or reducing it where possible. It also involves a process for articulating strengths and opportunities which may be achieved over time to enable people and communities to adjust to changing climatic conditions and to minimise (or reduce) the risks of natural hazards to themselves and to their property. It is in this context that the "journey" of adaptation needs to pursue a defined roadmap that is carefully aligned with the ICZM Policy Framework (see Volume 1 for details). The end destination of this journey is a place where Barbadian coastal stakeholders (public and private sector, civil society and local communities) are able to adapt to climate change and disaster impacts.

Figure B.1 presents a cyclical approach towards setting "Adaptive Pathways". This demonstrates the importance of adopting an iterative process that involves a range of steps, namely problem and issue identification (step 1), plan preparation (step 2), plan adoption (step 3), plan implementation (step 4) and plan evaluation (step 5). This Part B focuses on undertaking a critical step in ICZM Plan preparation (step 2) which involves the participatory and inclusive identification of issues. From this step, proposed actions can be established within the ICZM Plan that address national and local concerns along with future opportunities that may fall within the CZMA. Step 1 is therefore necessary in order to suggest changes in existing policies or priorities should any identified issues change over time.

This Part B presents stakeholder derived information and issues which subsequently may be used to promote meaningful Policy Outcomes and Goals presented in detail within the Volume 1: ICZM Policy Framework 2020-2030 and supporting ICZM Plan (Volume 2) which supports the creation of an "Adaptive Pathway" for Barbados's CZMA.

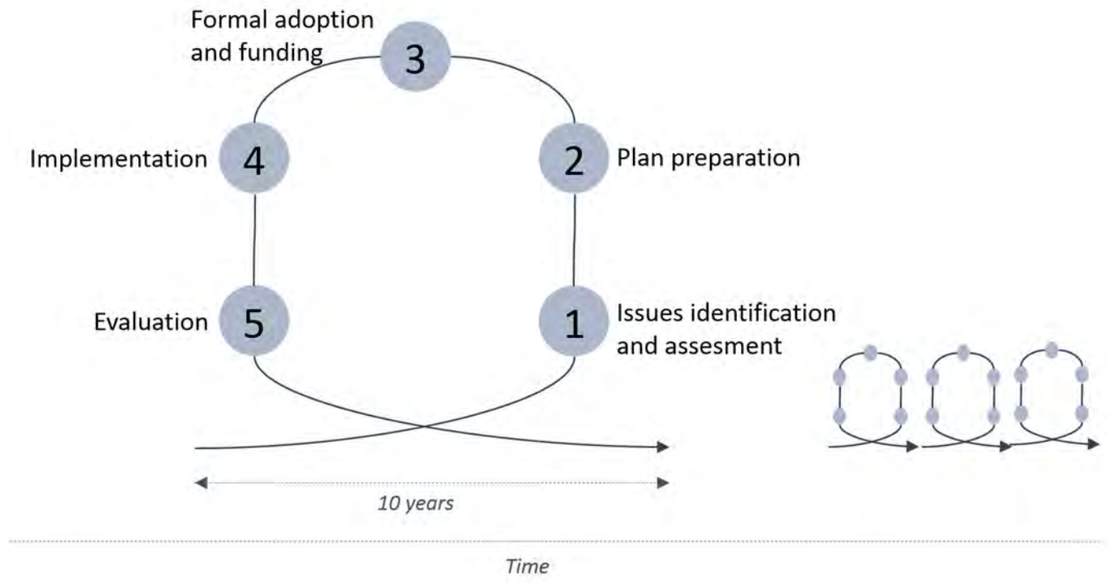


Figure B.1. Adaptive Pathway for ICZM in Barbados.

B2. ISSUES IDENTIFICATION AND ASSESSMENT

A key task when designing an "Adaptive Pathway" for ICZM relates to *issue identification and assessment* (see step 1 in Figure B.1). This assessment (or often referred to as an "issues analysis") is adopted to help formulate the framework and subsequent details of this ICZM Plan. It is presented as a "Strengths, Weaknesses, Opportunities and Threats (SWOT)" approach in Table B.1. The preliminary working phase of the SWOT uses four "theme" headers to help categorise a long list of issues and observations that have been determined through the analytical phase of this Plans' preparation. These broad "Themes" are presented as follows (using 4 separate colours):

THEME 1: Coastal resource management issues
THEME 2: Socio-economic developmental issues
THEME 3: ICZM capacity, legislative, governance and knowledge framework related issues
THEME 4: Climate and disaster risk related issues

Table B.1 lists a series of colour coded issues and findings under the above four theme headers. Strategic observations and requirements from this preliminary SWOT task, that are deemed to require future management priority attention (see Section B3), are presented ***as bold italic text*** for later consideration.

STRENGTHS	WEAKNESSES
- A diverse range of coastal "typologies" and resources in existence. - A rich biodiversity of coastal habitats. - A diverse array of commercial and non-commercial fish stocks remains within Barbadian waters. - Endemic species exist. - Research and monitoring of sea turtles ongoing. - A network of Natural Protected Areas now exists as defined by the PDP (2017). - Commitments and signatories to some key International commitments, treaties and conventions to protect the wider environment of Barbados.	- Loss of beach width due to construction on the shoreline in the Caribbean coast. - Lack of previous experience in Barbados in ecosystem-based solutions. - ***Biodiversity conservation-related challenges*** (Habitat loss and fragmentation and alien species introduction) continues with limited regulatory enforcement powers/penalties etc… being enforced. - ***Research and monitoring*** of coastal resources (including all living/non-living coastal resources) remain weak (nationally and regionally). - Limited regulation or advisories exist for the management of **non-living resource exploitation and exploration** (i.e.: individual-level sand extraction from beaches and dunes continues on more rural beaches along the Atlantic coast). - Poor water quality on the south and west coasts derived from land derived nutrients, which is a key stressor for living coastal habitats (such as coral reefs). - Critically endangered species of fauna still exist.
- Historically strong beach tourism product in existence (pre-COVID 19) though less so on eco-tourism. - Potential for more community-focused tourism on the Atlantic coast. - Cultural heritage opportunities exist within the CZMA.	- Poorly communicated and implemented ***national beach management plan*** (with no international standard in place) to support (and market) the beach tourism product (NCC responsibility). - ***Developmental planning and setback*** related issues continue to be observed. These relate to (for example) tourism facilities that block **lateral access to the coast.** Challenges over "access" to the sea still exist. - Conflicts continue to exist between different sectoral groups (minimal integrated strategies to mainstream DRM/CCA set up within GOB) often due to limited stakeholder participation. - Limited enforcement of recommended setback lines and no "set back" land available to facilitate increased ***developmental setback planning*** (historic building lines, etc.). - Loss of beach width in part due to construction of buildings and coastal structures.
- Specific ICZM agency is in existence (CZMU) whose mandate is to deliver implement ICZM. The CZMU also performs a range of advisory roles with regard to coastal conservation plus development applications and permitting. - Existence of an active international donor community in supporting (funding) ICZM initiatives, including climate change adaptation and the Blue Economy. - Key stakeholders related to environmental management and DRM willing to participate in the ICZM process. - Existing ***Research*** establishments (UWI) already established in the country and are undertaking relevant ICZM related research programmes (directly or via partner institutions).	- Limited ICZM policy enforcement capabilities within CZMU whose regulatory role regarding coastal developments is advisory only. - Formalised coordinated governance arrangements on ICZM related issues are lacking. - ***Environmental and social safeguards*** not addressed in a comprehensive manner within the permitting system (especially social impacts of developments). - The impact of the CZMU's recommendations remain tempered by other mitigating factors (e.g. national investment and economic opportunities, etc.) - Lack of environmental awareness on the part of developers (minimal outreach programmes designed to rectify this). - No formal cross-sectoral capacity development programme for ICZM/CCA and DRM currently exists in the public sector. - Civil society does not feel empowered to work with GOB to support ICZM as ***public participation and awareness*** of coastal issues remain weak.
- Relatively low exposure to hurricanes. - The existence of disaster focused agencies within Barbados namely DEM and CDEMA. - Risk assessments performed to date consider present development scenarios. - CZMU has robust experience in managing ***coastal structures construction and maintenance*** projects. - Ongoing preparedness strategies for tsunami risk are being produced.	- Adaptive capacity for ***disaster risk management and climate change adaptation*** remains weak. - Absence of approved Building Code for Barbados. - Risk resilient management standards or procedures are in place for construction purposes only, but not specifically for coastal developments (nor do they align with national socio-economic policies or plans). - Coastal hazard related emergency procedures are lacking to support ***coastal structures construction and maintenance***, disaster event preparedness, response and recovery related actions. - ***Research*** on assessing the vulnerability of certain social groups within the CZMA is not accurately measured or determined.

OPPORTUNITIES	THREATS
- Strengthened regulations in Natural Protected Areas exist via the PDP (2017) to help support future multi-sector policy and plan setting. - Establishment of setbacks based on DRM approaches. - Opportunities for ***coastal habitat rehabilitation and restoration*** may be enhanced through the adoption of nature-based solutions (NbS).	- Severe threats to coastal resources and landscape exist due to continuing rapid physical development and unplanned ***emerging issues***. - No formal guidelines exist that may help protect the living and ***non-living resource exploitation and exploration*** and to regulate/manage such activities within the defined CZMA (loss of 20-50% of sand volumes by 2100 if no mitigation measures are implemented).
- Promotion of the creation and adoption of a new ISO13009 ***Beach Management*** Standard. - The promotion of sustainable tourism based on natural heritage principles and assets found within the CZMA remains untapped. - New tourism opportunities: overwater bungalows, jetties (***Emerging Issues***) must be aligned to the PDP (2017) and be in line with the new Planning and Development Act (2019). - Potential to advance and deliver coastal adaptation techniques within the designs and plans of current and future coastal development. - Encouragement of new and emerging sustainable opportunities that support continued effort to develop green and blue economies - Preservation of port infrastructure/existing buildings (as a programme) could be undertaken to retain the maximum amount of port functionality..	- New ***emerging issues*** (creating to new recreational, societal and community preferences etc.) are becoming apparent. - Loss of recreational areas for Barbadians close to the coastline. - Increased shipping activities may impact on coastal and marine environments if Blue Economy strategies for Barbados are not aligned with the ICZM Plan and supporting legislation. - Increasing population density. - HWM definition is dated and the methodology to measure it remains undefined in Barbados in order to help support implementation of setback distances set through the PDP or ICZM Plan.
- Capacity building on ICZM for key stakeholders could be improved through initiation of a new training programme. - Improvement of coordination mechanisms among stakeholders may link well with new MMABE strategies for Blue Economy implementation (data collection, storage, analysis and monitoring systems etc.). The pending National Ocean Policy (NOP) for Barbados may help link with ICZM Policy to encourage improved collaboration of sectors for implementation. - Potential for a new ICZM performance management, evaluation and reporting system could be set up by adapting existing systems in place within GOB. - Simple mechanisms may be introduced to improve knowledge of the needs and aspirations of communities working and living in the CZMA. - Promotion of health and wellbeing could be easily improved upon through effective outreach.	- Limited implementation of ICZM policies due to the lack of a current legal mandate to enforce the ICZM Plan. - Engagement and outreach strategies to coastal communities currently have minimal impact on changing lifestyles or mind-sets. - Confusion over the purpose of the ICZM Plan and its implementation once a Blue Economy strategy is formally defined and endorsed via MMABE. The GOB must improve clarification on this matter as a priority. - Improvements to existing education and outreach are reliant on clear messaging and societal interest in ICZM issues. - Health and wellbeing are highly influenced by regulations and policies that may influence and protect access to the coast/beach.
- Implementation of DRM/CCA impact considerations and measures may be better assessed through the current EIA approach by forcing the production of a Climate Risk Vulnerability Assessment (CRVA) as part of the development planning procedure. - Procedures for enabling risk transfer (within the public, private and civil society sectors) remains a key possibility.	- Storm surge flooding of low-lying areas due to tropical storms likely to increase with climate change. - 25% of the population and much of the infrastructures lie within a zone about 2 km away from the flood plain on the coast.

Table B.1. ICZM SWOT analysis

B3. NATIONAL MANAGEMENT PRIORITIES

From the ***bold italic text*** identified within Table B.1 above, a series of ten (10) national management priority titles are presented which shall set the framework for delivering the "Adaptive Pathway" required for the successful implementation of this ICZM Plan (see Table B.2). A series of sub-topics are also included to capture the various elements that fall within each national management priority topic. These are listed to help justify the relevance (see Part A2) in addition to the importance of the 10 national management priority titles selected (as implied from the SWOT analysis presented in Table B.1.).

These priority titles are then used to create a set of National Guidance descriptions and action briefs as detailed in Part C of this ICZM Plan. These are also used to help guide the more local delivery of ICZM, defined as a series of Sub-Area specific recommended actions (in Part D).

It should be noted that whilst the majority of these priorities are mostly sectoral in nature, the inclusion of "Emerging Issues", "Compliance with Environmental and Social Safeguards" and "Public Awareness and Stakeholder Participation" as national management priorities are both multi-dimensional, non-sectoral and importantly cross-cutting at this juncture. The reason for these being included (and written as specific Guidance in Part C) is that the previous 1998 ICZM plan was deemed as being too rigid and prescriptive in terms of GOB being able to address any new societal and developmental "issue" that might arise.

The new "Adaptive Pathway" approach adopted within this ICZM Plan provides the flexibility required to better consider and manage new trends, demands or broader compliance requirements on environmental and social safeguards that may face GOB in the coming years. For this reason, these three topics allow decision makers to have the ability to modify ICZM policy outcomes and goals more easily (as presented within this ICZM Plan) or as required to address future issues as they arise.

NATIONAL MANAGEMENT PRIORITIES - TOPICS	SUB-TOPICS OF RELEVANCE TO SUPPORT JUSTIFICATION FOR BEING SELECTED
Disaster Risk Management and Climate Change Adaptation (DRM)	Critical infrastructure in flood risk areas Different cliff stability and collapse risks at cliff margins Sea level rise Climate change adaptation strategies Monitoring and forecasting of climate change impacts Storm surge Beach erosion Tsunami risk Vulnerability Impacts of coastal hazards Monitoring and updating risk assessments Disaster Risk Reduction measures Governance for Disaster Risk Management Financing DRM and CCA
Beach Management (BM)	Zoning and regulation of uses Beach profiling Bathing water quality Solid waste disposal Lateral access to and along the coast Tourism and recreational activities/facilities for Barbadians Beach re-nourishment
Development Planning and Setbacks (S)	Zoning and regulation of uses Collapse at cliff margins Monitoring the evolution of the coastline
	Loss of back-beach vegetation Access to the coast Governance for Disaster Risk Management
Compliance to Environmental and Social Safeguards (ESIA)	Environmental impacts of onshore/offshore activities *(see supporting text in the section above).*
Construction and Maintenance of Coastal Structures (CI)	Down drift impacts of coastal structures Different cliff stability along the coastline Beach re-nourishment Narrowing beach widths Monitoring the evolution of the coastline, including beach profiling Sediment transport Monitor wave climate and nearshore dynamics Loss of back-beach vegetation Access to the coast Recreational areas and facilities for Barbadians Offshore infrastructure
Emerging Issues (EI)	Emerging facilities *(see supporting text in the section above).*
Biodiversity Conservation and Coastal Habitat Restoration (BIO)	Different cliff stability along the coastline Narrowing beach widths Beach re-nourishment Impacts on corals Conservation of coastal habitats and decline in biodiversity Loss of back-beach vegetation Protection of endangered fish, coral, bird, reptiles and turtles and turtle nesting issues Sustainability of fishing activities
Research (R)	Beach re-nourishment Forecasting of climate change impacts Updating risk assessments
Public Awareness and Stakeholder Participation (PA)	Public outreach and involvement Public access to data *(see supporting text in section above).*
Non Living Resource Exploration and Exploitation (REE)	Sand reserves and sediment budget: offshore, dunes and beaches Beach re-nourishment Offshore infrastructure Environmental impacts of offshore oil exploitation

Table B.2. National Management Priorities and Issue sub-topics

B4. USING POLICY OUTCOMES TO SUPPORT THE ADAPTIVE PATHWAY

Table B1 above (Section B2) has identified the key ICZM issues that need to be addressed within the ICZM Plan. Section B3 (Table B2) has outlined the guidance needed towards how responses to these issues will be effectively delivered (through the adoption of national management priorities). The proposed national management priorities are designed to embrace and support the delivery of a series of ICZM Policy Outcomes[1] which collectively apply to all proposed National Guidance, presented in Part C, Sub-Area Actions presented Part D and ICZM Implementation recommendations, presented in Part E.

Policy outcomes therefore represent a core component of the "Adaptive Pathway" for Barbados. They not only align with existing international commitments that the country may already have, but they also enable efficient ICZM monitoring and delivery at both the national and international scale. A participatory approach was adopted to design the outcomes. These were discussed/validated with key stakeholders during a National Consultation Workshop held in October 2020. Based on the SWOT analysis carried out in Section B2, a series of six (6) Policy Outcomes and Goals have been produced which are discussed in more detail within Volume 1 (see below).

Outcome 1 - Sustainable socioeconomic development is achieved

Outcome 2 - Coastal resources are protected and effectively managed

Outcome 3 - Climate and disaster risk adaptive capacity is strengthened

Outcome 4 - ICZM is delivered through a coordinated governance arrangement

Outcome 5 - Capacity for ICZM delivery is strengthened for all relevant sectors

Outcome 6 - Research, understanding and knowledge outreach is increased

These Outcomes, presented in Table B.3 below, demonstrate how they relate to the 4 SWOT "Themes" used in Part B2 and the ten management priorities presented in Part B3. Some Outcomes fall specifically within a SWOT "Theme" whereas others overlap which is inevitable when trying to produce an integrated Adaptive Pathway.

THEME 1: Coastal resource management issues		**THEME 2:** Socio-economic developmental issues		**THEME 3:** ICZM capacity, legislative and governance and knowledge framework related issues				**THEME 4**: Climate and disaster risk related issues		
Outcome 2: Coastal resources are protected and effectively managed		**Outcome 6:** Research, understanding and knowledge outreach is increased		**Outcome 1:** Sustainable socioeconomic development is achieved		**Outcome 4:** ICZM is delivered through a coordinated governance arrangement		**Outcome 5:** Capacity for ICZM delivery is strengthened for all relevant sectors		**Outcome 3:** Climate and disaster risk adaptive capacity is strengthened
National Management Priorities (aligned to each Outcome as appropriate).										
REE	BIO	EI	R	S	ESIA	ESIA	BM	R	PA	DRM	CI

Table B.3. Relationship between SWOT "themes", Policy Outcomes and National Management Priorities (see Table B.2 for "codes" for each national management priority.

[1] ICZM Principles, Policy Outcomes and Goals are presented in full within the ICZM Policy Framework (Vol.1).

PART C
NATIONAL GUIDANCE
(OCTOBER 2021)

PART C: NATIONAL GUIDANCE

This Part provides guidance for risk-resilient ICZM from a national perspective to address the Policy Outcomes defined in Part B and Volume 1 of this ICZM Plan. The analysis undertaken in Part B has aided to select ten topics that deal with the national management priorities of relevance for the entire CZMA of Barbados.

Each topic provides a short introduction and a summary table where the relevant key legislation, ICZM Policy Outcomes, Goals, guiding principles[1] and the importance of its consideration. The topics current status is then described, followed by the possible national implications of not considering the specific topic and the impact this may have on delivering ***sustainable*** and ***integrated*** coastal zone management. From that, management guidance is provided on how the topic should better embrace climate and disaster resilience. Finally, actions are listed with recommendations on suitable lead organisations to take forward each proposed action, a time scale for implementation is given (short term: within 1 year; medium-term: 1-5 years; and long term: 5-10 years), and an indicator which can be used to measure progress during the life span of this ICZM Plan.

The topics and actions possess an individual code that indicates the topic and the action brief number (see Figure C.1). All suitable "Action Briefs" contain at least one action in order to periodically monitor the implementation of the proposed guidance (i.e.: an annual monitoring or summary report, etc.).

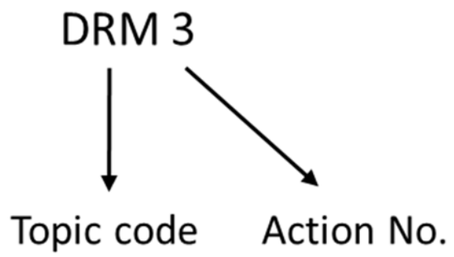


Figure C.1. Example of a National Guidance topic code and action number abbreviations.

All the guidance produced is developed to ensure consideration of key disaster risk management (DRM) "pillars". These pillars are explained as follows:

- Risk reduction: This includes all ex-ante structural (e.g. engineering) and non-structural (e.g. regulatory framework, building codes, land use planning) measures to reduce the physical impact of adverse natural and/or anthropogenic events. It is composed of actions, instruments and processes that address the following:

  i) "prevention" to cope with the reduction of the effects and impacts of hazards (natural and anthropogenic);

  ii) "mitigation" to intervene and reduce damages and losses occurring because of vulnerability, and

  iii) "adaptation" to face the impact of hazards, under the current vulnerability, not covered by the resources available (i.e. residual risk).

- Risk identification and communication: Incorporates individual and collective understanding, perceptions, social representations and evaluations (i.e. imaginary, scientific, engineering, statistical, probabilistic) of the causes and consequences of the convoluted relation of hazards (type, intensity, distance, recurrence), and vulnerability (degrees of exposure and fragility, socio-economic value of possible losses, potential negative changes to the quality of human life, and the impact on the environment and natural assets, services and functions). The communication of this assessment is intended to support education and assist political, entrepreneurial and communal decision-making processes.

- Emergency and disaster management: Plans, protocols and procedures, defined ex-ante, to be performed when risk materialization is foreseeable, imminent and materialized: observation, surveillance, alert, warning alarm systems, response, rehabilitation (immediate), reconstruction (mediate to long term) and operative continuity. They are conceived to reinforce resilience and avoid rebuilding vulnerability and must be efficient and effective in reintegrating the quality of life to the population affected as soon as possible.

- Risk financing and protection: This is an ensemble of ex-ante measures, aimed at improving the financial capacity and resilience to cope with the requirements of risk management, emergencies and the consequences of disasters through the following:

  iv) Retention: reserve funds, capacities for horizontal transfers within the fiscal budget;

  v) Transfer: contingent lines of pre-arranged credits, insurance, reinsurance, multilateral funding, capital market arrangements, and catastrophe funds.

  These instruments require an ex-ante design and strategy based upon rational definitions of "accepted" vs. "acceptable" risk, the disaster deficit index (IDD) and their support by probabilistic scenarios, models, financial engineering and metrics (e.g. Probable Maximum Loss, Average Annual Loss (AAL), Loss Exceedance Curves (LEC), etc. for various selected return periods (e.g. 50, 100, 250, 500 years).

The DRM pillars along with supporting CCA measures are most usefully analysed, not as an end-point in themselves, but as a cyclic process, with the end of one phase marking the start of another (see Figure C.2).

The main elements of this process (the four 'R's") are:

- **Risk reduction** (which includes the risk reduction pillar),
- **Response readiness** (which includes the risk identification and the emergency and disaster management pillars),
- **Response execution** (activities during the disaster) and
- **Recovery** (which includes the risk financing and protection pillar).

[1] ICZM Policy Outcomes, goals and guiding principles taken from Volume 1: Policy Framework (2020).

These 4 ‘R’s illustrate measures which public and private institutions, corporates, civil society, and communities in Barbados need to adopt in order to reduce the impact of disasters or climate change within the defined CZMA.

They also illustrate how GOB needs to react during and immediately after a disaster, followed by the steps needed to recover from such natural events after it has occurred. Timely actions during each phase of the cycle will result in greater preparedness, better warnings, reduced vulnerability and prevention of future disasters.

The four ‘R’s do not always, or generally, take place in isolation. They often overlap within the cycle with their duration greatly depending on the severity of the disaster. To this end, Part C identifies which of the four ‘R’s are most applicable to the National Guidance topic provided. Figure C.2 outlines the relationship between these “disaster cycle” phases.

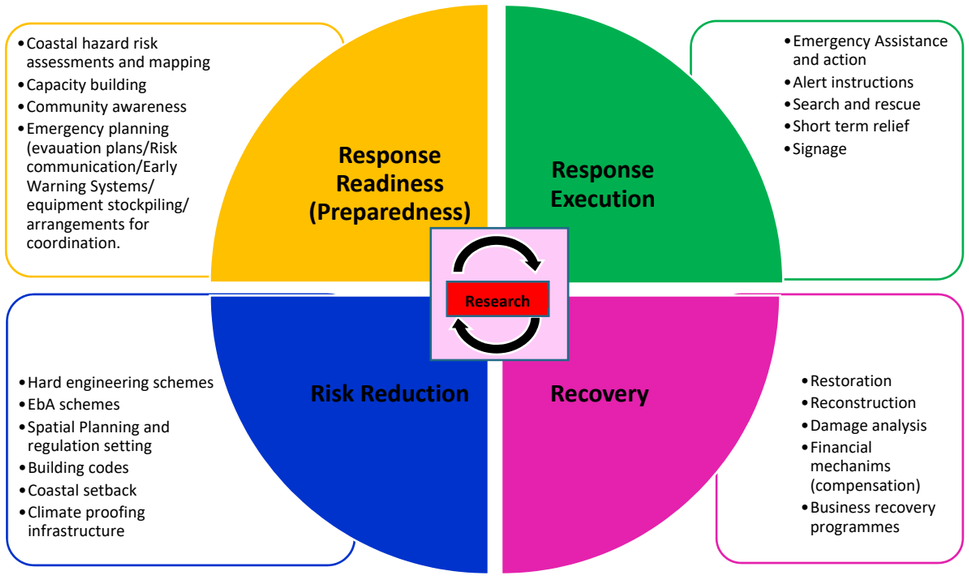


Figure C.2. Disaster cycle phases adopted within this ICZM Plan.

MANAGEMENT PRIORITIES - TOPICS	DRM/CCA "Cycle Phase"	HOW DRM AND CCA ARE ADDRESSED UNDER EACH TOPIC
Disaster Risk Management and Climate Change Adaptation (DRM)		This topic demonstrates the importance of the 4 DRM/CCA cycle "phases towards the successful delivery of risk resilient ICZM in Barbados. It also helps to set the baseline conditions for mainstreaming DRM and CCA within the policies and actions including within this ICZM Plan. It supports the importance of the 4 DRM cycle phases within the management, institutional and engagement arrangements that must be in place with other agencies whom have the mandate to perform and deliver DRM in Barbados. It also helps identify the required steps to move from disaster risk assessment (based on NCRIPP data) to a more comprehensive disaster risk management (CDM) model with associated implementation issues.
Beach Management (BM)		This topic links directly to the Prevention, Preparedness and Recovery disaster cycle "phases". This topic mainstreams DRM and CCA within the following elements: - The Barbados Beach Management Plan developed to help consider future impacts of climate change on changing beach carrying capacities. - The development of a National Beach Management Risk Framework to assess existing risks in beaches for uses (i.e.: to identify safe bathing areas or ensure the quality of bathing water) - Introduction of an ISO13009 international beach standard to help advise of risk-mitigation (beach risk assessments), preparedness (lifeguarding needs, risk signage, public rescue equipment needs and beach user engagement strategies, etc.), and response execution (beach evacuation procedures, etc.).
Development Planning and Setbacks (S)		This topic links directly to the Prevention and Preparedness disaster cycle "phases. This is because most of the setback areas defined in the ICZM Plan (and the 30m setback distance defined within the PDP 2017 for beach areas only) are based on the latest knowledge relating to coastal disaster and climate-related hazards. The ICZM Plan (in Part D) has established a range of spatial planning easements (or setbacks) that include the following: - Flood inundation setback (excluding SLR projections to 2100). - Climate change adaptation setback: (including SLR projections for 2100). - Cliff collapse setback.
Compliance to Environmental and Social Safeguards (ESIA)		The ESIA implementation process defines the studies required for future developmental applications to help define sustainable designs and sensitivities that may be used to make future development proposals more disaster and climate-resilient and to only permit (in the future) climate compatible developments within the CZMA. Future studies (if requested) must demonstrate a robust analysis of coastal risks and from this, suitable risk reduction measures are considered for each application.
Construction and Maintenance of Coastal Structures (CS)		This topic links directly to the Prevention and Recovery disaster cycle "phases". It describes how to mainstream DRM and CCA risk knowledge into the design, monitoring and maintenance of coastal structures (hard engineering and nature-based solutions). This topic also embraces the importance of managing emergency maintenance works during a recovery phase of a disaster or climate-induced event.
Emerging Issues (EI)		This topic links directly to the Prevention, Preparedness and Recovery disaster cycle "phases". It describes how policymakers need to consider DRM/CCA aspects in light of any new emerging issues that arise with respect to planning and development in the CZMA. This is important as disaster and climate-induced hazards (i.e.: hurricane or storm surge events) may have significant financial and environmental impacts associated with issues such as the siting of over-water bungalows, jetties, water parks, inflatable structures, and artificial islands etc.
Biodiversity Conservation and Coastal Habitat Restoration (BIO)		This topic links directly to the Prevention, Preparedness and Recovery disaster cycle "phases". This is because the importance of biodiversity conservation and habitat restoration both play pivotal roles in providing strong and resilient natural defences (through coral reef rehabilitation etc.) that shall help mitigate against coastal hazards in the future.
Non-living resource exploration and exploitation (REE)		This topic links directly to the Prevention and Preparedness disaster cycle "phases". This is because non-living resources (i.e.: onshore quarried sands, offshore sediment sources, fossil fuels (oil and gas) or related renewable energy resources etc.) all require clear spatial planning advisories and regulations to be set prior to any exploration and exploitation initiative is permitted. This must all include an understanding of the potential disaster and climate risks associated with any current or future planning decision reached that relates to non-living resource use. This has particular resonance for pursuing a future "Blue Economy" in Barbados.
Research (R)		This topic demonstrates the importance of the 4 DRM/CCA cycle "phases towards the successful delivery of risk resilient ICZM in Barbados. This is because Research for all 4 disaster cycle phases is required to help provide the latest knowledge and understanding to help improve mainstreaming of DRM and CCA. A key aspects proposed in this topic is to formalise a Coastal Research Agenda that seeks to embrace CCA and DRM within research programmes.
Public Awareness and Stakeholder Participation (PA)		This topic links directly to the Preparedness and Response Execution disaster cycle "phases". Effective stakeholder engagement is key to the successful implementation of this ICZM Plan. It depends on strong effective messaging and coordination amongst stakeholders. The proposed stakeholder awareness strategy is designed to focus specifically on the use of various tools and techniques to help implement risk-resilient ICZM.

Table C.1. Relationship between the Disaster Risk Management Cycle Phases and the National Management Priorities.

C1. DISASTER RISK MANAGEMENT AND CLIMATE CHANGE ADAPTATION

ICZM, DRM and CCA are all integrally linked. When combined, they constitute a robust approach to ensure that future development of the coast is both sustainable and resilient to future impacts. Responses to reduce coastal risks therefore need to be implemented within a planning framework that reflects these needs; in this context, coastal adaptation strategies are essential to allow the Barbadian economy and society to flourish.

This topic provides supporting guidance to strengthen the role of the key stakeholders (including DEM and CZMU) to deliver DRM and CCA within the defined CZMA. This is in line with Policy Goals defined to (i) adopt a DRM approach for coastal development, (ii) develop procedures for preparedness, response and recovery actions, and (iii) formalise procedures for a sustained financial resilience approach.

Table C.2 outlines the related Policy Outcomes, Goals and the importance of this topic.

Topic (code)	Disaster Risk Management and Climate Change Adaptation (DRM).
Key Legislative Instrument	Emergency Management Act (2006) Coastal Zone Management Act (CZM Act) (CAP394 - 1998) and proposed revisions to the CZM Act (2020)
Policy Outcomes	Outcome 1 - Sustainable socioeconomic development is achieved. Outcome 3 - Climate and disaster risk adaptive capacity is strengthened. Outcome 5 - Capacity for ICZM delivery is strengthened for all relevant sectors. Outcome 6 - Research, understanding and knowledge outreach is increased.
Key Policy Goals	Goal 3.1 - Adopt a risk management approach for coastal development. Goal 3.2 - Develop emergency operating procedures for preparedness, response and recovery actions. Goal 3.3 - Formalise procedures for a sustained economic and financial resilience approach.
Topic importance	Barbados, with support of this ICZM Plan, needs to better integrate the principles, objectives and actions of DRM and CCA into national policy, sectoral plans and engineering within the CZMA.
Disaster cycle phase	**Preparedness** **Response** **Prevention** **Recovery** **Research**

Table C.2. Policy outcomes, policy goals and the importance of considering this topic.

C1.1. Current status

Competences in Disaster Risk Management and Climate Change Adaptation

The Department of Emergency Management (DEM) is the government department responsible for the development, promotion and maintenance of a comprehensive National Disaster Management Programme and has the responsibility for coordinating emergency management activities in Barbados. Other key stakeholders involved in DRM and CCA are presented in Part A -Section 1.4.3.

The CZMU shall, through the proposed revisions to the CZM Act 2020, be mandated to deliver risk resilient ICZM that embraces CCA and DRM. The CZMU's jurisdiction falls within the defined CZMA and its contribution to DEM's National DRM Plan falls neatly within the ICZM Plan and provides DRM and CCA related strategies for the CZMA.

Currently, the main activities of the CZMU in DRM include (i) the participation in the Standing Committee on Coastal Hazards, aimed at promoting DRM initiatives, and (ii) increasing the resilience of Barbados to coastal hazards through the improved conservation and management of the coastal zone. New studies, particularly the CRMP 2014-2018, have helped to produce new information for CZMU towards formulating a comprehensive risk assessment with a range of supporting tools, the construction of risk-resilient coastal structures and improved institutional capacity on DRM related issues including the development of the NCRIPP. From the multiple hazards and related risks assessed under the CRMP project, storm surge, coastal erosion and tsunami risks are classified as core coastal hazards for the CZMU to embrace (McCue 2018).

The programme included the preparation of baseline studies on coastal and oceanographic processes, hazard, vulnerability and risk evaluation. The key findings are presented in Part A -Section 2.3 and Annex 4.

Conclusions extracted from the NCRIPP hazard and risk assessments

Some of the most reliable knowledge developed from the NCRIPP study relates to the spatial distribution of where a hazard is most likely to occur. Assumptions that may over (or under) estimate the impact of a hazard are applied consistently so that spatial comparisons are generally (but not always) more reliable.

The most significant coastal hazards facing Barbados now, and in the future as a consequence of climate change, are ***storm surge related flooding and coastal erosion***. Even these two hazards have levels of intensity that will influence the level of risk to be expected in any one location. Taking the hazard of storm surges, for example, a certain level of intensity is reached after which, waves are free to pass over the beach berm (or revetment/cliff) and then into the backing hinterland. Because waves approaching the shore are depth limited and storm surge events are not reported as being severe in Barbados, the differences between a 25 and 100-year return event are subsequently not statistically significant. This means that any overtopping (pooled) seawater that floods over the beach crest will reach a similar elevation for these two return period events. Damages due to storm surge are thus minimal until this overtopping threshold has been reached, after which damage occurs, though the level of damage does not change significantly as wave heights increase.

Based on hazard and vulnerability assessments undertaken by Baird (2017), the NCRIPP study calculated financial damages resulting from the various hazards assessed. Risk values for multiple hazards are assessed at various return periods for a range of assets, including for example buildings, which were classified based on the 2015 LiDAR Study, supporting data from the Barbados Revenue Authority and the 2010 Barbados Census.

An overview of the risks of concern for the CZMU is outlined in order from largest to smallest as follows:

- **Flooding** due to storm surge has a large influence on residential, commercial and tourism assets, with totals damages in the range of BBD 3 billion for the 100-year condition. Some of the greatest damage is in the Bridgetown area (Figure C.3).

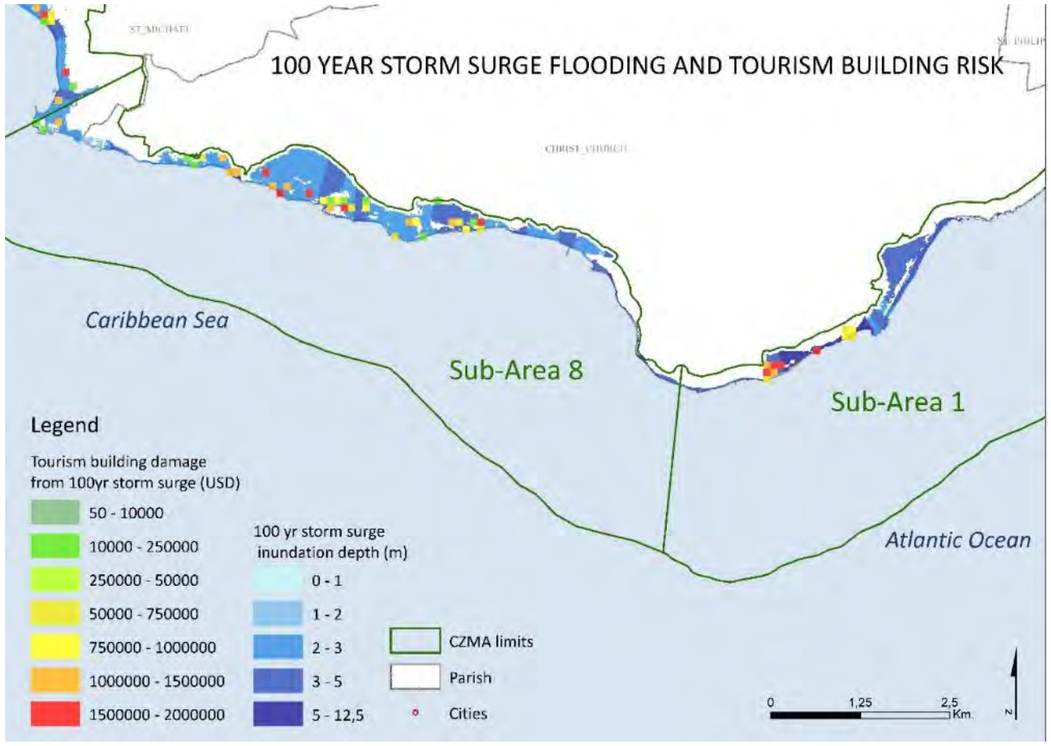


Figure C.3. Tourism Building Risk from 100 Year Storm Surge Hazard.

- Risk due to the 100-year **tsunami** is estimated at BBD 31 million, which is located primarily close to the Careenage. With a future sea-level rise of 25 cm, the damage increases and is approximately BBD 80 million. These are very likely conservative estimates based on some of the assumptions in the hazard analyses.
- Risk due to **coastal cliff collapse** is cumulative with collapses occurring in numerous locations rather than as a single large event. The cumulative damage over a 50-year period is estimated to be in the range of BBD 7 million, which increases to BBD 18 million over the next 100 years (expressed as 2017 values).
- Some other long term risk issues have also been identified. **Beach erosion** that occurs during a storm may not necessarily be followed by beach recovery in the short term and it is often an understanding of long term trends that are required in order to manage beach levels and to avoid continued damages. With beaches being such a valuable economic asset to Barbados the impacts of sea-level rise and ongoing erosion were assessed. Using basic geometry and assuming beach profiles are static, Baird (2018b) estimated that the beach asset is losing BBD 2 to 4 million every year (3 mm of sea-level rise). When considering typical erosion rates, the west coast alone is losing in the order of BBD 6 to 8 million per year. In year 10, that is 60 to 80 million in annual revenue less than today.
-

The only hazard that is significantly influenced by climate change (increasing sea levels) is storm surge. According to the last information published by the Intergovernmental Panel on Climate Change (IPCC) in the Special Report on the Ocean and Cryosphere in a Changing Climate (IPCC, 2019), SLR by 2100 is projected to be faster under all scenarios, including those compatible with achieving the long term temperature goal set out in the Paris Agreement. For 2100, SLR may increase 0.43 m under RCP 2.6, and 0.84 m under RCP 8.5 which is relative to (1986-2005) values (see Table A.1 in Part A). RCP -Representative Concentration Pathway- is a greenhouse gas concentration (not emissions) trajectory adopted by the IPCC. Four pathways were used for climate modelling, describing different climate futures, all of which are considered possible depending on the volume of greenhouse gases (GHG) emitted in the years to come.

> The information produced from this comprehensive risk focused project provides the baseline assessment necessary in order **to prepare a National DRM Plan in collaboration with key partners.** The risk assessment work undertaken creates a robust foundation for the identification of DRM and CCA policies, the identification of assets requiring a more detailed quantitative assessment and the design of site-specific risk reduction and adaptation measures. This revised ICZM Plan addresses a key part of such a future National DRM Plan.

C1.2. Implications

Historically in Barbados, the key focus for addressing disasters focused on emergency response (i.e.: post event). This approach has more recently moved towards an “ex-ante” comprehensive disaster preparedness and management model that places a greater emphasis on reducing and managing hazard conditions whilst increasing the understanding of risk exposures and vulnerabilities that will help to prevent economic and societal losses by alleviating disaster impacts.

Reducing exposure and vulnerability requires identifying and reducing the underlying drivers of risk, which are particularly related to poor economic and urban development choices and practice, degradation of the environment, poverty and inequality and climate change, which create and exacerbate conditions of hazard, exposure and vulnerability. Addressing these underlying risk drivers will reduce disaster risk, lessen the impacts of climate change and, consequently, maintain the sustainability of development (UNISDR, 2015). DRM includes strategies designed to:

- avoid the construction of new risks;
- address pre-existing risks;
- share and spread risk to prevent disaster losses being absorbed by other development outcomes and creating additional poverty;
- identify and map local capacities to cope with hazards; and
- conduct effective disaster response while reducing risks that similar disasters will re-occur.

Glossary of terms (UNISDR 2009)

Adaptation: The adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Many disaster risk reduction measures can contribute directly to better adaptation. *Comment: This definition addresses the concerns of climate change and is sourced from the secretariat of the United Nations Framework Convention on Climate Change (UNFCCC). Many disaster risk reduction measures can contribute directly to better adaptation.*

Disaster risk management: The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster. *Comment: This term is an extension of the more general term "risk management" to address the specific issue of disaster risks. Disaster risk management aims to avoid, lessen or transfer the adverse effects of hazards through activities and measures for prevention, mitigation and preparedness.*

Disaster risk reduction: The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events. *Comment: A comprehensive approach to reduce disaster risks is set out in the United Nations-endorsed Hyogo Framework for Action, adopted in 2005, whose expected outcome is "The substantial reduction of disaster losses, in lives and the social, economic and environmental assets of communities and countries.*

Mitigation: The lessening or limitation of the adverse impacts of hazards and related disasters. *Comment: The adverse impacts of hazards often cannot be prevented fully, but their scale or severity can be substantially lessened by various strategies and actions. Mitigation measures encompass engineering techniques and hazard-resistant construction as well as improved environmental policies and public awareness. It should be noted that in climate change policy, "mitigation" is defined differently, being the term used for the reduction of greenhouse gas emissions that are the source of climate change.*

Prevention: The outright avoidance of adverse impacts of hazards and related disasters. *Comment: Prevention (i.e. disaster prevention) expresses the concept and intention to completely avoid potential adverse impacts through action taken in advance. Examples include dams or embankments that eliminate flood risks and land-use regulations that do not permit any settlement in high risk. Very often the complete avoidance of losses is not feasible and the task transforms to that of mitigation. Partly for this reason, the terms prevention and mitigation are sometimes used interchangeably in casual use.*

Preparedness: The knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions. *Comment: Preparedness is based on a sound analysis of disaster risks and good linkages with early warning systems, and includes such activities as contingency planning, stockpiling of equipment and supplies, the development of arrangements for coordination, evacuation and public information, and associated training and field exercises. These must be supported by formal institutional, legal and budgetary capacities.*

C1.3. Management guidance

According to the current status and implications outlined above, management guidance is provided on the following aspects:

- Planning and implementing DRM and CCA strategies within the CZMA.
- Ensuring financial sustainability for DRM and CCA.

PLANNING AND IMPLEMENTING DRM AND CCA STRATEGIES WITHIN THE CZMA

According to UNISDR's knowledge sharing platform, Prevention Web, DRM activities are designed to increase the resilience of people, communities, society and systems to resist, absorb, accommodate, recover from and improve well-being in the face of multiple hazards. Activities for reducing and managing risks can therefore provide a way for building resilience to other risks. Although often used interchangeably with disaster risk reduction (DRR), DRM can be thought of as the implementation of DRR, since it describes the actions that aim to achieve the objective of reducing risk (UNISDR 2015).

Awareness, identification, understanding and measurement of disaster risks are all clearly fundamental underpinnings of DRM (UNISDR, 2015b). In this regard, the results of the NCRIPP provide risk information to inform a range of activities to reduce risk (such as storm surge protection), that is, to move from DRR to DRM within the CZMA. As identified in the UNISDR (2015) glossary of terms presented earlier, DRM involves activities related to:

- **Prevention/Mitigation,** often less costly than disaster relief and response. For instance, relocating exposed people and assets away from a known hazard area.
- **Adaptation** –. Adaptation options may include a wide range of actions that can be categorized as structural, institutional, or social for instance, constructing coastal or flood defences, planting trees to stabilize slopes and implementing strict land use and building construction codes.
- **Preparedness:** For instance, installing early warning systems, identifying evacuation routes and preparing emergency supplies.
- **Response:** The provision of assistance or intervention during or immediately after a disaster to meet the life preservation and basic subsistence needs of those people affected. It can be of an immediate, short-term, or protracted duration.
- **Recovery:** Any decision and/or action taken after a disaster with a view to restoring or improving the pre-disaster living conditions of the stricken community, while encouraging and facilitating necessary adjustments to reduce disaster risk. Recovery (rehabilitation and reconstruction) affords an opportunity to develop and apply DRR measures.
- **Transfer:** The process of formally or informally shifting the financial consequences of particular risks from one party to another whereby a household, community, enterprise or state authority will obtain resources from the other party after a disaster occurs, in exchange for ongoing or compensatory social or financial benefits provided to that other party. For instance, insurance.

Implementation of these activities and measures is rarely carried out in isolation and often includes a number of associated activities as follows:

- Identification and measuring disaster risk;
- Education and knowledge development;
- Informing people about their risk (awareness raising);
- Incorporating DRM into national planning and investment;
- Strengthening institutional and legislative arrangements;
- Providing financial protection for people and businesses at risk (finance and contingency planning);
- Integrating DRM across multiple sectors, including health, environment, etc.

The DEM Country Document for Disaster Risk Reduction (2014) represents the only publication to highlight the nexus between DRM, Climate Change and Sustainable Development within the national and international context. Most recently, the document was used by DEM to inform the revision of the disaster management section in the upcoming updated version of the Barbados' Growth and Development Strategy.

In spite of this document, Barbados still does not currently possess a formal and up to date national DRM policy, strategy or plan. To this end, prevention and mitigation activities within the Barbados CZMA should be carefully articulated by a new "National DRM and CCA Plan" led by DEM and in collaboration with CZMU for the CZMA, and other relevant agencies. Transfer and preparedness activities should be developed specifically by the competent national agency (i.e.: DEM), in collaboration with the CZMU for the CZMA if required for the provision of risk information from the NCRIPP.

The National DRM and CCA Plan represents a critical tool to support the delivery of CCA within the defined CZMA. It needs to be carefully planned at the national level so that it is compliant with national developmental and conservation policies and supporting legislation. Any CCA and DRM measures should be articulated into the proposed national DRM Plan that considers the latest climate change scenarios and incorporates up to date available technical and scientific information, mostly derived from NCRIPP. The DRM and CCA Plan should also incorporate the views and needs of coastal stakeholders, including institutions, private developers and communities. Measures to be included for the coast also need to build on existing DEM initiatives that are targeted to reduce the impact of coastal hazards on vulnerable communities, critical infrastructure and coastal resources.

Table C.3 presents examples of strategies for risk reduction measures for Barbados, potentially to be included within the new national DRM and CCA Plan:

DRM Cycle	Approach	measure	Addressed risk component	Role of CZMU
Mitigation and Prevention → National DRM Plan prepared by DEM supported by CZMU	Engineering-based	Seawalls and sea revetments	H	Promotion, design and implementation in collaboration with TCDPO.
		Breakwaters		
		Movable barriers and closure dams		
		Land claim		
	Nature-based	Managed realignment	H	Promotion, design and implementation in collaboration with TCDPO and NCC.
		Beach nourishment		
		Artificial sand dunes and dune restoration		
		Living shorelines		
		Wetland restoration		
Preparedness → DEM activities supported by CZMU	Coastal planning and architectural	Building standards	V	Promotion, design and implementation in collaboration with TCDPO and DEM.
		Flood proofing		
		Coastal setbacks	Ep	
	Risk mapping and assessment	Hazard, vulnerability and risk	V	Updating and dissemination.
	Social and institutional capacity	Raising awareness	Et and V	Promotion, design and implementation in collaboration with DEM.
		Capacity building		
		Education		
	Emergency planning	Early warning systems	Et	CZMU support to DEM as requested.
		Evacuation planning		

Table C.3. Examples of risk reduction measures (H: hazard, Ep: permanent exposure, Et: temporary exposure, V: vulnerability). Source: adapted from Aguirre et al, 2018.

The proposed new Barbados DRM and CCA Plan should be developed in parallel with a tailored training program for staffs within the CZMU, DEM and relevant agencies to help enable the implementation and future update of the proposed DRM and CCA Plan. Ahead of this, the following recommended policies apply:

a) **All development applications with the CZMA shall be reviewed using the information from the NCRIPP to identify the potential risk and possible mitigation measures**
b) **Applicants shall incorporate the risk information into their proposals and provide the requisite mitigation measures**

Ensuring financial sustainability for DRM and CCA.

The implementation, monitoring and periodical update of the proposed DRM and CCA Plan requires sustainable funding mechanisms to be incorporated within it. These should be based on a range of international and national funding mechanisms that embrace both public sources and private investment opportunities. Public financing sources may include contributions from national budgets and a large number of multilateral development funds, such as the Inter-American Development Bank (IDB), Caribbean Development Bank (CDB), World Bank, Green Climate Fund (GCF) or the operational funds under UNFCCC. Sources of private financing for adaptation traditionally include a range of financial institutions, such as international banks, multinational corporations, private equity and pension funds, insurance companies, and sovereign wealth funds. Charitable foundations and social investors are also sources of private financing for adaptation (Mimura, N, 2014).

Public and financing sources typically support projects with different values of return of investment, so the comprehensive DRM and CCA Plan are likely be funded by a combination of public and private funds. Public-private partnerships are a particularly effective model for accessing financing and implementing adaptation measures (Christiansen, L., 2012). Ensuring sustainable funding requires the elaboration of a DEM initiated financial plan that identifies adequate funding sources for different adaptation options, the commitment of national public agencies and analysis of requirements for external donors and investors. In this regard, each donor its own unique set of criteria and procedures that should be well known by CZMU officers. Some criteria are fundamental for proposal eligibility as adaptation rationale and additional cost argument, sustainability of intervention, cost-effectiveness, institutional setup, result-oriented activities or environmental and social safeguards.

C1.4. Action brief

The following table presents the management guidance and goals required to support implementation through specific actions, as follows. These actions do not exclude actions already performed by the CZMU.

CODE	ACTION	LEAD ACTORS	OTHER ACTORS	RELATED ACTIONS	INDICATOR	TIME SCALE	COMMENTS
Planning and implementing DRM and CCA strategies in the CZMA							
DRM 1	Produce a specific roadmap to improve collaboration between DEM (national) and CDEMA (regional) that embraces the principles of the Sendai Framework.	DEM,	CZMU		Production of a mutually acceptable roadmap (CZMU and DEM)	Continuous, short term.	It requires the organization of continuous bilateral meeting at managerial and technical level.
DRM 2	Produce and implement a plan for continuous maintenance and improvement of NCRIPP data and risk results.	CZMU	DEM,		Brief report	Continuous, short term.	To include last available data, including updated mapping of coastal resources, met-ocean variables, climate change projections, IPCC information, etc. To include risk assessments from other projects. To generate/model updated risk assessments (including future exposure and vulnerability data).
DRM 3	Collaborate with DEM in the production of a National DRM and CCA Plan for the CZMA.	DEM	CZMU	CS 7	Technical report is agreed with DEM and CDEMA	Punctual, short term.	The Plan is to define DRR measures (see Table C3). Based on NCRIPP and other study results including tsunami evacuation related studies. Important to consider the status of existing infrastructures regarding SLR. Plan review for monitoring and update if necessary every 5 years.
DRM 4	Conduct the necessary interventions (physical and non-physical) to implement DRM measures defined in the DRM Plan.	CZMU	TCDPO	DRM 3	Annual report	Medium and long term	
DRM 5	Conduct a specific training program, delivered by CZMU and DEM staff on DRM and CCA to other sectors.	DEM	CZMU TCDPO	DRM 3	Nº of training courses Nº of staff with necessary skills	Short term	Trained CZMU staff (trained during CRMP project training work and manuals produced (McCue 2018)) should deliver the training to other institutes in tandem with DEM staff. Can be achieved through the standing committee on coastal hazards and through DEM outreach initiatives.
Ensuring financial sustainability for DRM and CCA							
DRM 6	Collaborate with the Ministry of Finance in the production of a financial plan for DRM and CCA for the CZMA.	Min of Finance	MFEI, MMABE, MENB	DRM 3	Financial Plan report is agreed with related actors	Medium term	Including financial needs based on the measures proposed in the DRM Plan, identification of potential donors, analysis of requirements to request private and public funding, and establishment of agreements for national budgets.
Monitoring							
DRM 7	Prepare and implement an indicator system to monitor DRM	DEM	CZMU		Annual monitoring report	Continuous, annual	

Table C.4. Action brief for DRM and CCA.

C2. BEACH MANAGEMENT

The beaches of Barbados are a focus for leisure and recreational use, being one of the nation's most valuable natural resources for both locals and visitors alike. Identifying, promoting and supporting opportunities for improved health and well-being for citizens and marine fauna alike (such as turtles) is at the forefront of any beach management strategy. This unique habitat provides important ecosystem services. Consequently, guidelines or standards need producing to help regulate and manage this resource for future generations whilst also ensuring any interventions are carried out in a climate resilient manner.

Topic (code)	Beach Management (BM).
Key Legislative Instrument	National Conservation Commission Act (1982 - CAP393)
Policy Outcomes	Outcome 1 - Sustainable socioeconomic development is achieved. Outcome 2 - Coastal resources are protected and effectively managed. Outcome 4 - ICZM is delivered through a coordinated governance arrangement. Outcome 5 - Capacity for ICZM delivery is strengthened for all relevant sectors. Outcome 6 - Research, understanding and knowledge outreach is increased.
Key Policy Goals	Goal 2.1 - Develop guidelines to help regulate and manage legally defined coastal resources for future generations. Goal 6.3 - Identify, promote and support opportunities for increasing the health and well-being benefits of the ocean to citizens, particularly through access to beaches and the coastal zone.
Topic importance	With growing pressure on beaches from climate change coupled with the socio-economic expectations of tourism, a risk-based approach to setting beach standards is required for the future.
Disaster cycle phase	Preparedness · Response · Prevention · Research

Table C.5. Policy outcomes, policy goals and the importance of considering this topic.

C2.1. Current status

Beaches are places of multiple anthropogenic pressures often influenced by competing human recreational preferences from a wide range of actors: environmentalists, special interest groups such as surfers, governments, NGOs, private sectors, and even the military sector. Beaches, like many other threatened resources such as coastal wetlands, therefore, require an adaptive management approach that can be adjusted to changing human and environmental needs. Beach activities along the coast of Barbados mostly take place between the backshore area (for picnics, social gatherings, barbeques, sunbathing) beyond the intertidal zone and into the nearshore for activities such as swimming, surfing, water-sport activities (motorised and non-motorised) and beach cast angling. Pressures linked to beach management in Barbados however do differ between the west coast, which is more developed, and the east coast, which remains mostly unaltered and has preserved its original character.

Beaches still remain a priority natural asset for the tourism sector that accounts for about 12.9% of the GDP and is the leading sector within the economy and employs about 26,000 persons (Clyde Mascoll, 2013). Consequential losses to beaches, and the supporting public and private infrastructure that depend on them, represent significant threats to the resilience of the economy (Barbados National Assessment Report 2010). During the last years, tourism and urban development have demonstrated a relatively unchecked growth along the Caribbean coast as well as the south, southeast and north-west areas of the island with increasing tourism development being planned for the east coast. As a result, the conflicts regarding the different beach uses and activities has increased over the last 20 years. Most recently, challenges have been faced in keeping beaches free of large volumes of sargassum around the island, though most noticeably along the south-east and Atlantic coasts.



Figure C.4. Leisure activities at Carlisle Bay Beach.

The National Conservation Commission (NCC) has the legal mandate to carry out a number of functions that relate to service provisions to enhance the public access to, use and enjoyment of coastal and land based sites. At present, NCC represents the lead agency in the delivery of beach management and clean- up related activities in Barbados. The CZMU provides support to the NCC by in its management of beaches by focusing on the management of beach access, beach erosion and accretion monitoring programmes, coral reef protection, preventing coral rubble extraction and the control of sand mining.

In recent times, the influx of sargassum seaweed onto beaches around Barbados has become a regular occurrence. The large amounts of seaweed pose a collection and disposal issue. Although there have been efforts to utilise the organic material the volumes are of such magnitude that these efforts make little inroads[2]. In fact, MMABE, as recently May, 2020, purchased a "seaweed harvester" to collect sargassum seaweed. This is to help provide the critical quantities needed for it to be economically converted into multiple uses such as the production of substrates, manufacturing of bio-composite materials, production of biofuels, the utilisation of seaweed as a soil amendment and the development of marine-based fertilisers, ocean-based compost as well as it being a catalyst for marine biotech development.

[2] Finding innovative ways to use sargassum commercially would not only stimulate a new Blue Economy sector, but also reduce the various costs associated with landfill disposal.

Under Section 5A of the National Conservation Commission Act, the NCC is to have regard to the contents of this ICZM Plan. Specific guidance for the removal of sargassum should be included as part of this plan. To this end, some general guidelines for the removal of sargassum from beaches are included in Section C2.3. with a detailed implementation plan presently being developed by the MMABE.

Tourism and resort/destination managers realise the need to act now deliver long term sustainability of the tourism product, and acknowledge with changing climates and economies, the essential need to adapt and manage the beach resource over time. Therefore, the increasing trend for sustainability in tourism requires to **carefully plan the beach-based recreational activities**. Having such a management system in place will seek to ensure **that beaches are safe and enjoyable for users** (Bajan and tourist) now and in the future.

C2.2. Implications

The implication of not developing a sustainable beach management strategy or "Standard" in Barbados may have significant economic ramifications on the tourism industry, particularly in light of the economic challenges that now face many SIDS in the Caribbean created by the 2020 COVID-19 pandemic. Incorporating climate resilience into beach management is a factor that many SIDS are starting to consider as being critical if future conservation and sustainable public use of this coastal resource is to take place. The implications of poor or dated beach management practices can result in experiencing continued anthropogenic pressures coupled with its overexploitation.

Through the management of the NCC, they have adopted some good practices during the last decade, though it is acknowledged that with additional support and guidance, new approaches and strategies may be implemented in order to:

- Resolve the current carrying capacity issues that the beaches along the Caribbean coast are facing in addition to preventing the loss of beach character along the Atlantic coast;
- Safeguard the health of the all beach users;
- Guarantee and provide public access to all beaches;
- Manage natural hazards and risks on all beaches and their potential impacts;
- Improve signage and control measures on all beaches to educate users on beach risks (natural or sport related coastal space needs such as areas for surfers, etc.).

C2.3. Management guidance

Based on the current status and implications identified above, management guidance is provided in five different thematic groups:

- Beach Management Planning;
- Beach Risk Management Framework;
- Guidance for the approval of commercial applications;
- Public access to the beach;
- Monitoring;
- Sargassum removal from Beaches.

Beach Management Planning

The management of beach-based recreational activities for local communities and tourists should be carefully planned to promote economic activities, avoid conflicts between different users and prevent impacts derived from coastal hazards. This needs to embrace user conflict assessments and supporting management strategies in the process. To this end, a Barbados Beach Management Plan (BBMP) is needed that considers beach carrying capacity, future impacts of climate change, economic trends and environmental analyses. This new BBMP shall regulate and permit specific beach uses and activities, appropriate beach infrastructure that is suitable and appropriate to support these activities, and the procedures for applications of beach commercial activities/large entertainment events etc. The BBMP will include national strategies and criteria, and site-specific provisions for beaches within each Sub-Area, including for example, how to manage heavy traffic used, regulations needed to protect Carlisle Bay Marine Park and Brandon's Beach from inflatable recreational structures, catamarans, jet-skis etc.

The BBMP shall also define provisions for the three separate beach categories that relate to and/or reflect its popularity and intensity of use (see Table C.6).

Category	Beaches	Use	Aim
Category 1 (High Activity Beaches)	Speightstown, Folkestone, Brandons, Hilton, Hastings Rocks, Rockley, Oistins, Miami Beach, Carlisle Bay, Silver Sands, Sandy beach, Pebbles, Dover, Holetown, Crane Beach, Bath Beach, Bathsheba, Barclays Park and all which are identified as coastal/beach parks in the OS2 beach/cliff sites and OS4 - Public Parks and Open Spaces defined in the PDP.	High	Prioritize the provision of high usage facilities and services in a sustainable manner.
Category 2 (Mid Use Activity Beaches)	Heywoods, Mullins, Paynes, Batt's Rock, Brighton, Pebbles, Speightstown, Drill Hall, Foul Bay, Consett Bay, Rendezvous, Tent Bay, Cave Bay, Bottom Bay, Palmetto Bay, Sam Lord's, Martin's Bay, River Bay and Maycock's Bay.	Moderate	Ensure safety and low-key access in combination with conservation and restoration of the coastal resources.
Category 3 (Low Activity Beaches)	All remaining beaches,	Low	Prioritize conservation and restoration actions in order to retain "unspoilt" character[3].

Table C.6. Beach classification and general strategy in beach management.

Beaches included in Category 1 are often exposed to high usage resulting in challenges associated with a beach's carrying capacity. This is often due to a beach's proximity to urban location/cruise visitor access and/or because of its renowned popularity. The priority within this category is to satisfy the demand of existing activities and visitor demands with a more sustainable model that controls the carrying capacity of any specific beach in order to avoid negative environmental or social impacts. It is fundamental that as part of the decision making for beaches in Category 1, that a "beach risk assessment" exercise is carried out to determine the types of control measures required such as signage or lifeguarding, as well as the extent and type of coastal infrastructure expected at the site. Table C.7 presents the management issues and recommended guidelines required for this beach category.

MANAGEMENT ISSUE	CATEGORY 1 – GUIDELINES
Master Planning	- Market demand for various activities. - Restrict carrying capacity of the beach area. - Ensure and enhance public access. - Development briefs, concept and phasing plans for each beach.
Access / circulation	- Well-defined circulation network linking facilities & centres of activity. - Restriction of cars to car-parks & access roads. - Provision of parking at the beach entrance for emergency vehicles. - Surface material depending on the use. - Associated nature trails with information. - Provision for boat accesses if appropriate in selected beaches. - Define minimum criteria to ensure public access to the beach.
Conservation	- Restricting access to areas under restoration. - Protection of critical habitats (fauna & flora). - Daily cleaning of beach and hinterland to remove sargassum and litter (non-mechanical). - Occasional removal of strandline material in line with existing guides such as the sargassum adhering to the Resource Guide produced by the Caribbean Alliance for Sustainable Tourism (CAST).
Facilities / services	- Well-designed buildings & shade structures blended with the environment. - Manned lifeguard lookouts. - Toilets facilities (including regular maintenance). - Litter bins on all beaches. - Refreshments on all beaches. - Provision of parking-lots close to the beach.
Activities	- Picnic areas located around the beach fringe in shady areas. - Bon fires to be prohibited from all beaches. - Fines for dog fouling (amount dictated by NCC as beach managers). - Beach game equipment only in flat areas and children's play areas with some suitable safety provisions on some beaches. - Camping only in designated areas. - Watersports only in designated areas.
Information	- Beach information panels in accesses (include DRM and Emergency Assembly Point). - Environmental information on beach surroundings. - Label plant species. - Information panels in associated nature beach trails. - Dissemination of DRM guidelines and good practices between stakeholders and users.
Monitoring	- Continuation of regular water quality monitoring on all beaches. - Continuation of bathing water quality profile in all Category 1 beaches. - Regular beach profile monitoring and assessment of sand nourishment needs. - Monitoring and evaluation of restoration and conservation projects. - Regular sea turtle monitoring (via the Sea Turtle Project).

Table C.7. Beach management plan for Category 1 beaches.

Category 2 beaches focus on the balance between urban development and the conservation and sustainable use of beaches, trying to avoid any negative impacts that are observed and reported on Category 1 beaches (see above). Table C.8 presents the management issues and recommended guidelines required for this beach category.

MANAGEMENT ISSUE	CATEGORY 2 – GUIDELINES
Master Planning	- Concept plans with an emphasis on the zoning of activities (recreation/fishing). - Enhancement & protection of landscape and public accesses.
Access / circulation	- Controlled pedestrian access. - Restriction of cars to car parks nearby or on-site, and access roads. - Provision for fishing boats if appropriate. - Associated nature trails with information. - Define minimum criteria to ensure public access to the beach.
Conservation	- Restoration of the landscape to safeguard biodiversity. - Regular non-mechanical cleaning of beach and hinterland to remove litter. - No removal of the strandline material in line with existing guides such as the sargassum adhering to the Resource Guide produced by the Caribbean Alliance for Sustainable Tourism (CAST). - Encourage participation in research and restoration programmes in collaboration with other institutions.
Facilities / services	- Essential buildings only (fishing facilities). - Nature-based shade structures at the backshore. - Toilets away from beaches on sites related to parks/fishing facilities. - Litter bins on some beaches (promote "take your litter home"). - Provision of parking-lots nearby to the beach. - Provision of litterbins at all car parks.
Activities	- Fishing to be given prime consideration in the planning where fishing is a traditional activity (include access, shade, seating, boat securing rings & storage space). - Barbecuing & camping only allowed in adjoining designated parks. Bon fires to be prohibited from all beaches.
Information	- Information panels in associated nature beach trails. - Make visitors aware of the resource. - Information panels are mandatory in any restoration project. - Encourage participation in research, restoration and enhance "Adopt a Beach" programmes.
Monitoring	- Regular water quality monitoring in all beaches. - Bathing water quality profile in selected beaches. - Regular beach profile monitoring in selected beaches. - Monitoring of restoration and conservation projects. - Regular sea turtle monitoring (via the Sea Turtle Project).

Table C.8. Beach management plan for Category 2 beaches.

The management for Category 3 beaches is directed towards maintained "unspoilt", "wild" or natural. Table C.9 presents the management issues and recommended guidelines required for this beach category. Issues surrounding the removal or disposal of sargassum on Category 3 beaches needs to be managed in partnership with NCC and the Sea Turtle Project. This should ensure that sargassum removal does not impact on the ecosystem "service" provided to essential habitat for fish and invertebrate species, whilst also being extremely important to particular endangered and migratory species like sea turtles and local and migratory shore birds

MANAGEMENT ISSUE	CATEGORY 3 – GUIDELINES
Master Planning	- Control of activities and where impacts have occurred promote landscape restoration.
Access / circulation	- Restriction of cars to nearby/adjacent lay-bys. - Access roads and associated nature trails with limited information. - Define minimum criteria to ensure public access to the beach.
Conservation	- Occasional litter collection by hand. - Encourage participation in research and restoration programmes in collaboration with other institutions.
Facilities / services	- No facilities.
Activities	- No provision for activities.
Information	- Small signs related to nature trails but carefully positioned to avoid visual intrusion. - Small information panels are mandatory in any restoration project.
Monitoring	- Regular water quality monitoring in selected beaches. - Bathing water quality profile in selected beaches. - Monitoring of restoration and conservation projects. - Regular sea turtle monitoring (via the Sea Turtle Project).

Table C.9. Beach Management Plan for Category 3 beaches.

NATIONAL BEACH RISK MANAGEMENT FRAMEWORK

In line with the proposed BBMP and National DRM and CCA Plan (see Section C2), the objective of developing a National Beach Management Risk Framework (ISO13009 Standard "*Tourism and related services — Requirements and recommendations for beach operation"*) is proposed to better formalise beach safety management in Barbados (under the leadership of NCC with support as requested by CZMU).

With support from the Barbados National Standards Institute (BNSI), the NCC and the CZMU may develop this to help align the BBMP to the international standard ISO13009 beach standard. This shall provide advice to current and future beach operators with the information and guidance needed to manage beaches effectively, reflecting international beach risk management principles at its core. Its value to the tourism sector includes its ability to act as a marketing focused "insurance security blanket" against liability for beach accidents on hotel property to which any hotel can use to "showcase" its sustainable beach standard credentials. In addition to general beach management, the ISO 13009 includes advisories and initial guidance on issues relating to beach safety, beach cleaning and waste removal, beach access, infrastructure, beachfront planning, stakeholder communication, beach promotion and commercial services (vendors, etc.). This in turn may help secure public funding for future improvements to surrounding beach areas (Figure C.5).

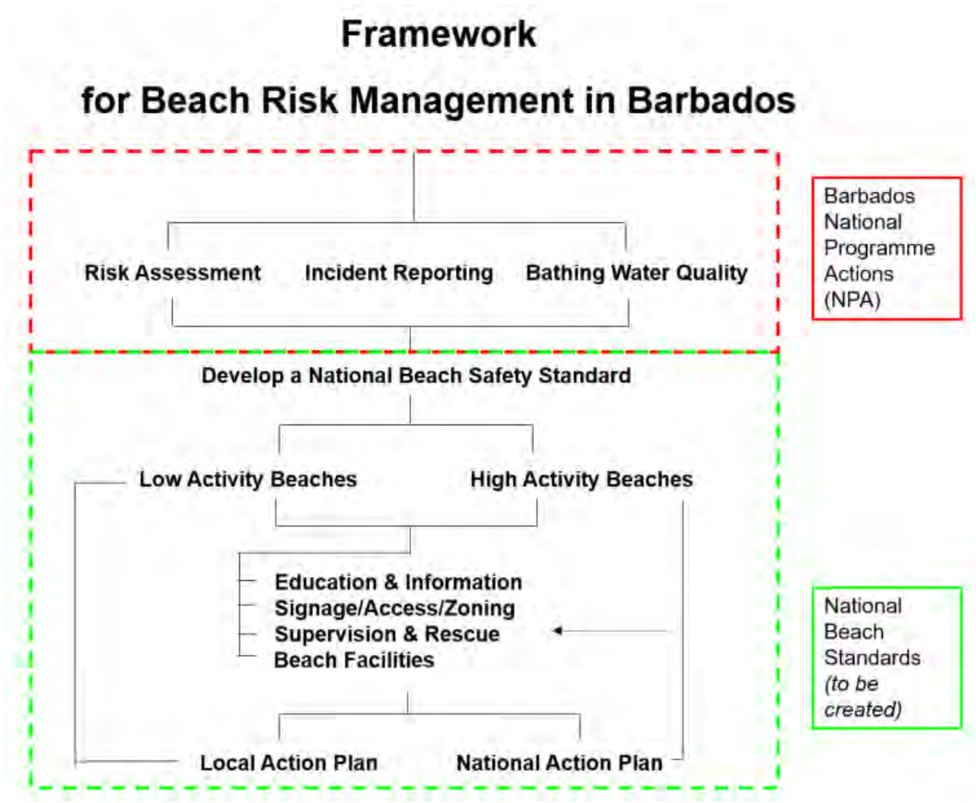


Figure C.5. Proposed Beach Risk Management Framework for Barbados.

NATIONAL PROGRAMMES OF ACTION (NPA)

The proposal to initiate the ISO13009 for Barbados will be the responsibility of NCC in tandem with BNSI and with support from CZMU as required. This is likely to involve the completion of a number of National Programmes of Action (NPAs) in order to help with national delivery as follows.

NPA 1 - National Beach Risk Assessment Programme.

The purpose of hazard and risk assessment is to assess the probability that certain events will take place and the potential adverse impact these events may have on people, property or the environment. Managing risk in the beach environment requires the systematic application of management policies, procedures and practices to the tasks of identifying, analysing, treating and monitoring risk.

The approach should use World Health Organisation (WHO) advice in relation to the assessment of hazard and risk in its guidelines for safe recreational water environments (coastal and fresh waters) to frame the risk assessment. The assessment of a beach or water body should take into account several key considerations as follows:

- The presence and nature of natural or artificial hazards;
- The severity of the hazard as related to health outcomes;

- The availability and applicability of remedial actions;
- The frequency and density of use;
- The level of development.

To establish a system of zoning for different uses or activities in the ISO13009 framework involves the following steps:

- Conduct a risk assessment to establish the need for zoning and the most appropriate methods for application;
- Consultation with relevant stakeholders;
- Establishment of a legislative framework;
- Communication with user groups.

Areas zoned for a particular use, or to exclude certain activities, can be defined by using flags, signs or buoys. Time zones can be used as an additional management tool to allow or restrict specified activities to be conducted at prescribed times.

NPA 2 - Bathing Water Quality Improvement Programme.

The BNSI, with support from NCC, CZMU and Environmental Protection Department (EPD), should be encouraged to produce a National Standard for Water Based Tourism and Guidelines for Recreational Water Quality, based on the WHO Guidelines for Safe Recreational Water Environments. The guidelines will prescribe the requirements for recreational water quality and apply to a range of public and private recreational water environments, such as coastal, estuarine waters and fresh water bodies in Barbados. The purpose of these guidelines is to establish criteria for the following:

1. Ensuring safety of users of recreational waters;
2. Types of use and methods of ensuring compliance;
3. Regulating usage of recreational waters;
4. Promoting economic and ecological sustainability of recreational waters;
5. Facilitating quality control of recreational waters.

The status of these Guidelines and National Standards will be non-statutory. Until the time these Guidelines are developed and approved, a number of actions may have to be undertaken with regards to bathing water quality management. This may include discussions to pursue a new national recreational water quality standard (or a specific review of the draft List of Prohibited Concentrations that already provides national marine water quality standards).

NPA 3 – National Building Codes and Regulations Programme.

There is a need to ensure that any future beach furniture or facilities comply with the existing or future draft Building Standards set for Barbados. The BNSI has a role to enforce the provision of the Barbados National Building Code and the Building Act to facilitate the cost-effective construction of buildings. There is, therefore, a need in NPA3 to attempt to formalize Building Standards and Regulations so that any future beach facilities are able to comply with hazard regulations and building code requirements that are important for buildings located within the defined CZMA. Specific recommended Codes of Practice[4] for completion under NP3 (in partnership with BNSI) include the following:

a) Beach Access Design Manual – a code of practice:
b) Beach Facilities (Comfort Services) Building and Design Manual – a code of practice;
c) Development Control within the CZMA – a code of practice.
d) Beach Conservation - a code of practice.
e) Establishing and regulating zones on beaches and nearshore areas – a code of practice.
f) Placement, maintenance and management of public rescue equipment – a code of practice.

NPA 4 – Communication of beach safety.

Beach safety for tourists in Barbados should use the following approaches to convey risk, health and safety information:

- En route to country i.e. airlines/cruise ship operators;
- Key country entry points i.e. airport/cruise terminals/marinas;
- Tourist hotel lobbies and main local attractions;
- Local media.

To convey the key messages of safety to the users of resort beaches it was also recommended to consider the use of practical and creative media forms, i.e. brochures, airline magazine and tourist guide advertisements, beach car park stickers, free safety gifts, television advertisements, posters, websites, mobile phone "blue-tooth" and application tools and SMS messaging services to beach users.

A suggested checklist for the contents of the local safety leaflet would contain information on the following:

- Designated swimming and activity areas;
- Specific local hazards;
- Local rescue provision e.g. position of telephones and rescue equipment;
- Location of first aid and lifeguard stations;
- What to do in an emergency i.e. 211 procedure?;
- Specific warnings about behaviour, especially alcohol and the risks of spinal injury;
- The authority of the lifeguards and beach rangers;

[4] Approaches for creating new Codes of Practice are set out within the new CZMA (Enforcement) Regulations designed to help support the proposed revisions to the CZM Act (2020)

- The responsibility of adults for children;
- An explanation of flag systems in use.

It is proposed that information signboards (or maps) should be placed at the main access points to the beach including information regarding the rescue services at the beach and recommendations for the health of the users. The signboards should have the following information as a minimum:

- Map or plan of the beach;
- Limits of the monitored bathing area;
- Flags and their meaning;
- Location of the safety, surveillance and rescue services;
- Ways of contacting the emergency services;
- Seasonal dates and time for the use for the rescue services;
- The beach operator should inform beach users if the beach (or any part of it) is closed or has restricted use.

Guidance for the approval of commercial applications/Large Entertainment Events

The NCCs jurisdiction ends at the HWM. Therefore, NCC and TCDPO need to be consulted regarding any approval of applications for various commercial activities at beaches that constitute development. These activities have to be coordinated and controlled depending on the type of activity and beach category (see Table C.6) in order to safeguard a minimum public use and to prevent conflicts between activities and beach users. For that reason, it is recommended that NCC undertaken the following activities:

- Designate maximum area percentages (land and sea to be used by commercial activities or large entertainment events) for each beach category.
- Define the list of studies or requirements for a formal application to start a commercial beach activity or large entertainment event.
- Offer and map a specific "zone" per type of activity, such as water-sports, tourism-related, bars and restaurants, sunbathing facilities, etc. to help allocate specific beach areas that are proportional to the user demand.
- For Category 1 beaches, prepare specific beach management plans in order to help in the management of these highly used beaches. This should include the procedures to be undertaken to ascertain whether a beach could/should be considered as a large entertainment event location etc.

With respect to activities allowed for each beach category, persons should be required to apply to the NCC for their approval. In order to formalize this application, the applicants should present at least the following minimum documents or requirements depending on their activities (see Table C.10).

Petition for	Example of activities	Required studies	Considerations
Use of beach public space.	Rental of beach chairs and umbrellas or other similar services.	- Current beach user and capacity-assessment - Engagement letter to remove from the beach any material related to the service under extreme events.	- Out of the service schedule, the materials will be tidied, piled up or removed in order to minimize encroachment into public areas.
Using beach public space and development/installation of small movable structures.	Snack bars, small surfing rental, small movable structures related to hotels services.	- Current beach user and capacity-assessment - Study of coastal dynamics (if sediment transport patterns are affected). - Engagement letter to remove from the beach any material or structure under extreme events.	- Will be located in the backshore of the beach close to the beach accesses. - Will be capable of being removed in less than 24-48 hours in case of an extreme event.
Using beach public space and development/installation of fixed structures.	Beach restaurants, other tourism-related structures and developments.	- Current beach user and capacity-assessment - Study of coastal dynamics (if sediment transport patterns are affected). - Insurance contract covering the risks derived under an extreme event.	- Structures will not prevent the use of the beach by the public. - CZMU will require the creation of an access to the beach.

Table C.10. Minimum requirements for beach activity application.

Minimum contents of a "current beach user and capacity assessment:

- A brief report about the current user groups (numbers/gender dis-aggregated etc.) and initial view on beach carrying capacity.
- Geo-location and mapping (fixed and moveable structures should be defined).

Minimum contents of the study of shoreline dynamics:

- Bathymetry of the area affected by the intervention.
- Marine climate, including wave and storm statistical analyses (scalar and directional).
- Equilibrium beach profile and plan-form in the area affected by the intervention.

- Study of the longshore transport capacity.
- Sediment balance and analysis of shoreline evolution before and after the intervention.
- Assessment of impacts on the coastal resources, habitats and species in the area affected by the intervention and economic activities.
- Assessment of impacts due to climate change, including at least sea level rise effects and changes in wave magnitude and direction.
- Proposal for the reduction of negative impacts during construction and exploitation/use of the intervention.
- Availability of sand and gravel resources for the intervention.
- Monitoring plan.

Guidance for Large Entertainment Event Beach Sites

Sites that fall under this category include the Hilton, Bay Street Esplanade, Carlisle Bay (Carlisle Bay Centre, Copa Cabana and northern end of Carlisle Bay near the Pierhead); Brandons Beach (near restaurant); Helipad, Hincks Street public car park, Carlisle House car park; Barbados Port Inc. Sports Club, Brighton (former visitor centre). Other potential sites would have to be considered on a case-by-case basis.

Specific guidance/action for such sites are listed below:

- The provision and availability of adequate parking;
- Temporary fencing or public exclusion structures may need to be installed 48 hours prior to the event;
- Public notification of activity and security corridor must be provided on all media platforms;
- Permission from NCC for events must be sought and the necessary beach use fees paid;
- All other related permissions for holding of such events must be sought and adhered to;
- Mandatory consultation with CZMU, EPD and DEM is a requirement for such events;
- Activities and crowds should be kept away from beach vegetation;
- Beach vegetation shall not be removed to provide expanded sand area for event;
- Adequate access for emergency personnel and vehicles;
- Speakers should face out to sea and not be turned landward;
- Solid waste management plan is a requirement;
- Public sanitary health plan is a requirement;
- No disposal of food waste or used cooking oil in back beach, beach or nearshore area post event;
- No cleaning or wash down of bar-b-que grills or cooking equipment/utensils or surfaces in back beach or beach areas post event;
- On site litter collection plan is needed and complied with during any event;
- Removal of all structures and garbage within 2 days after the event and restore the beach to original state;
- Mandatory Consultation with Sea Turtle Project is required prior to any event;
- Vehicles are strictly prohibited from extensive driving on the beach;
- Public parking is prohibited on the beach;
- Any vehicle is prohibited from parking on the beach (with the exception of emergency service vehicles).

Public Access to the Beach

Safeguarding public access to the beach is one of the most important challenges facing Barbados, especially along its Caribbean coast. The rapid urban development that has taken place over the last two decades has limited access to the shore. In an attempt to address this issue, the PDP (2017) designated a policy entitled “OS7 - Shore Access Points” in order to enhance and protect public access to beaches. These OS7 Shore Access Points are designed to ensure access for emergency and maintenance vehicles whilst where possible seeking to enhance visual connection to the sea at all times. They should also be designated under the proposed BBMP as clear “Beach Access Points” and from this, be promoted to enhance the accessibility to the beach for all citizens (see Table C.11).

Access type	Characteristics
OS7 - Shore Access Point (PDP 2017)	- Ensure access for vehicles, including emergency and maintenance vehicles. - Car-parking and signpost nearby the beach access (if possible). - Provision of parking for an emergency vehicle at the beach access. - Signposted access. - Informative panels about beach services in the entrances. - Well-design facilities.
BBMP - Beach Access Point (pending)	- Ensure pedestrian access to the beach (vehicle access if possible) - Signposted access. - Nature-based facilities.

Table C.11. Access main characteristics.

The following recommended policies should be included within a future BBMP (specific to “Beach Access Points”):

1. Existing accesses will be maintained and should be enhanced;
2. New Shore Access Points identified in the PDP community plans or Beach Access Points in the section “sub-areas action briefs” of this document should be considered as part of the development or redevelopment process;
3. Accesses should be identified by standardised signs;
4. New development will not block existing accesses. In no case will existing access be removed;
5. Where beachfront lots are being amalgamated or redeveloped, new accesses will be required as a condition of approval;
6. The Chief Town Planner will attempt, wherever possible, to secure additional accesses;
7. Subject to the analysis of the visual impact and compatibility with surrounding land uses, increases in building height may be allowed to facilitate the creation of additional public access, view corridors and/or pathways to beach areas;
8. Where possible, accesses should also provide views to the sea to enhance the visual connection with the ocean, particularly on the West Coast.

In addition to these policies, it is recommended (within the BBMP) to assign minimum criteria regarding beach access based on the popularity and category of beach. In Table C.12, (i) the beach category, (ii) the maximum distance between consecutive accesses on a beach, (iii) kind of access structure erected on the beach (if any) and minimum requirements regarding the access type are presented.

Beach category	Distance between accesses	Access structure erected on the beach (if any)	Requirements regarding access type
Category 1	1 access each 300m	Concrete or wooden boardwalks	At least one Shore Access Point.
Category 2	At least 1 access. Recommended 1 access each 300m.	Concrete or wooden boardwalks depending on maintenance cost assessments per site (high or low energy coast).	Very low maintenance gravel access paths to be determined according to community needs
Category 3	At least 1 access. Access to remain as natural as possible.	No structures.	No requirement.

Table C.12. Minimum conditions to ensure public access to the beach.

Figure C.6 shows a series of beach access points that seek to replicate the guidelines proposed.



Figure C.6. Beach access scheme proposed.

Monitoring

Aspects of beach enhancement in the form of amenity inclusion is the responsibility of NCC. Beach stabilization and enhancement is the responsibility of CZMU who determine whether shoreline stabilization techniques need to be instituted to protect or enhance the coastline for the public good. This may be through the creation of additional beach space and continual lateral access in areas where it may have been lost or become restricted as a result of long term erosion in the area. For that reason, different roles regarding integrated beach management (and monitoring of their performance) exist between a number of agencies. The CZMU monitoring programmes relates specifically to determining water quality conditions (not specifically for bathing), coral reefs and beach profiles. Table C.13 presents the main characteristics of the monitoring programmes related to the beach, including the proposed role, the spatial domain, temporal frequency and the objectives recommended for each monitoring programme.

[5] Highly dependent upon human resource capabilities within EPD.

Programme	Role of CZMU	Spatial domain	Frequency	Objectives
Bathing water quality	Supporting agency to EPD[5] (as the legal responsible agency under the Marine Pollution Act – 1998) along with support from the Best Dos Santos public health laboratory[6].	All category 1 beaches and representative selection of category 2 and 3.	At least every 30 days during the bathing season.	- Ensure standards in the legislation. - Detect uncontrolled or extraordinary pollution cases.
Beach profiling programme	Lead agency	Selected profiles in all category 1 beaches and beaches under erosion process.	- Tri-monthly. - After extreme events.	- Evaluate results of nourishments and stabilization projects. - Develop a historical database.
Beach use monitoring	Supporting role to NCC	All category 1 beaches and (where necessary) some Category 2 beaches.	Twice yearly (low and high season)	Provides a twice yearly assessment of recreational behaviour on beaches (gender disaggregated).
Restoration/ conservation projects	Collaboration with other institutions, universities and research entities.	Depending on the project.	Depending on the project.	- Evaluate the results of projects and deep in knowledge.
Sea turtle nests	Encourage collaboration on current programmes managed by the Sea Turtle Project.	Depending on the programme.	Depending on the programme.	- Awareness of citizens. - Evaluation of beach management measures focuses on sea turtle conservation.

Table C.13. Monitoring works and collaborations involved in beach management.

This information has to be accessible and visible. CZMU has to promote the dissemination of this information through the provision of access to the results of the programmes.

Guidance for the Removal of Sargassum from Beaches

When designing a program for the removal of sargassum, what is needed is to balance the importance for maintaining natural ecological processes (life-giving nourishment for beaches and seabirds), with pressures to address negative impacts on human communities and business. In this regard, Doyle, E. and J. Franks. (2015) highlight a set of key aspects to consider:

- Collection of pelagic sargassum from the sea threatens the marine organisms living within the sargassum ecosystem and can have detrimental impacts for the fisheries resources that many coastal communities depend upon for their livelihoods;
- Applying any chemicals to sargassum makes things worse, is hugely damaging to reefs and fish;
- Where capacity exists to clean beaches, it's essential to establish clear policies about where, when and how to clean beaches so as to avoid detrimental impacts such as worsened erosion from the use of machinery for beach cleaning.

[6] Analysis of beach water samples for bacteriological parameters

Accordingly, beach classification is encouraged to define different strategies for sargassum removal:

i. No Action: beaches where no action is required and where sargassum is left to allow nature to protect natural processes, as beaches on the East Coast, Cattlewash, and some North coast beaches.

ii. Low-cost environmentally friendly removal: Manual raking of the beach is encouraged as well of the use of wheelbarrows, etc. Sargassum can be manually removed from the site or placed in designated disposal/collection areas. This method is encouraged for all beaches but especially for beaches which are turtle nesting sites such as Drill Hall, Hastings, Bath, Paynes Bay, Carlisle Bay, Rockley, Dover, Richard Haynes Boardwalk, etc.

iii. Mechanical removal: The mechanical raking of high usage areas along the south and west coast. Mechanical raking does not involve the use of bob cats, skid steers, bulldozers or back hoes or their equivalent. Sargassum should be removed as soon as possible after arrival to avoid a vast accumulation. Sargassum should be placed in designated disposal sites that are exposed to the sun for drying and decomposition. The preferred option is the mechanical removal directly from the sea prior to reaching the beach.

Where removal is necessary, the following good practices should be considered (Doyle, E. and J. Franks. 2015):

- Beach cleaning should be done only in the presence of monitors who check for wildlife prior to any cleaning, and operators must respect no-go areas such as sea turtle or bird nests;
- Patience is required, and be aware that it's not necessarily desirable to clean beaches that are already facing a precarious erosion situation, that are essential habitat for sea turtle nesting or where grooming will increase wind-blown sand and worsen erosion;
- Removal of sargassum should be from and to agreed areas only, and equipment should use the same route on to and off the beach to prevent harming dunes, destroying dune vegetation and turtle or bird nests;
- There is a difference between achieving a naturally clean beach and an over-sanitized beach - constant grooming of the beach for regular maintenance or for aesthetic purposes is discouraged due to very real risks of worsened beach erosion from physical damage of machinery and unintended removal of sand;
- Least intrusive practices are preferred - hand raking is preferable to machinery, beach raking equipment with a perforated conveyor belt is preferable to heavy construction equipment, and heavy tracked equipment like road graders are prohibited. Front loaders must utilize a bucket level control indicator/float mechanism to prevent gouging of the beach;
- A mechanized beach rake can remove moderate quantities of sargassum on dry sand. When exceptional amounts occur (i.e. in excess of 3 feet deep) then removal of just the upper layers of sargassum first with a front loader, without touching sand, can be followed by mechanized beach raking in order to reduce sand loss;
- Cleaning should always occur at low tide and heavy equipment should stay on wet sand in the tidal zone. Adjust cleaning schedules to when wind and storms are less likely to immediately bring new influxes;
- Consider public safety and avoid mechanical beach cleaning in the presence of fishers or beach goers;
- In embracing the challenge of sargassum, good communications between agencies and the private sector, with the press, and with locals and visitors is essential. Make sure everyone knows where clean or less-affected beaches can be found.

C2.4. Action brief

The following set of specific actions are provided to support the achievement of management guidelines that relate to beach management.

CODE	ACTION	LEAD ACTORS	OTHER ACTORS	RELATED ACTIONS	INDICATOR	TIME SCALE	COMMENTS
Beach management planning							
BM1	Update the inventory and classification of beaches.	NCC,	CZMU	BM2	GIS Database	Continuous, Short term	The updated inventory in GIS should include polygons with information on beach category, accesses, facilities and services.
BM2	Develop and implement a Barbados Beach Management Plan (BBMP).	NCC,	CZMU Ministry of Tourism	BM1 BM3	The plan is distributed among key stakeholders	Short mid-term.	Structure of BBMP to be in close synergy with the details set out for ISO13009 for Beach Management.
National Beach Risk Management Framework							
BM3	Develop and implement a National Beach Risk Management Framework (ISO13009).	NCC, BNSI	TCDPO, DEM	BM2	Technical report	Short to mid-term.	Using the CZM Regulation (2020), a specific MoU may be set up between CZMU, BNSI and NCC to compete this task. It must include guidelines provided in this management guidance regarding each National Programme of Action (NPA1, NPA2, NPA3 and NPA4).
BM4	Development of local beach management plan by Sub-Areas.	NCC	CZMU	BM2 BM3	Technical report	Punctual, mid-term.	This local beach management plan should satisfy the guidelines of BM2 and BM3.
BM5	Organize working meetings for the coordination of each National Programmes of Action defined in the BBMP.	NCC	TCDPO	BM3	Nº of attendees Nº of meetings	Punctual, short term.	Establish agreements between actors involved in each National Programme of Action (NPA).
Management of commercial applications							
BM6	Create a Beach Access/ Enhancement Plan[7].	NCC	NCC, TCDPO CZMU	BM2 BM3	Nº new accesses Nº of accesses improved	Punctual, short term.	
BM7	Coordination meetings with NCC to ensure implementation of guidance related to commercial applications/large entertainment events.	NCC	TCDPO		Nº of attendees Nº of meetings	Punctual, short term.	To be a key part of any future ISO13009 Beach standard (or similar) to be adopted in Barbados (through Bureau of Standards etc.).
Bathing water quality							
BM8	Develop a procedure and implement bathing water profile results (as required).	EPD	CZMU	BM2 and 3	Technical report	Punctual, short term.	In collaboration with EPD. Details/actions will be dependent upon the specifics of the National Beach Management Plan plus the bathing water quality results obtained from the annual "State of the Coast" reporting approach.
BM9	Organize working meetings with EPD and Bes Dos Santos laboratory to agree on technical aspects related to BM8.	CZMU, EPD, BDS Laboratory		BM8	Nº of attendees Nº of courses	Punctual, short term.	Including the selection of representative beaches for categories 2 and 3.
Monitoring							
BM10	Creation of a Beach monitoring system	NCC	CZMU	BM1 BM3 BM10	Annual monitoring report	Continuous, annual	Includes the creation of a monitoring system, addressing beach management issues (for example: beach width, nº of beaches without public access, nº of beach works, public opinion on beach status, etc.)

Table C.14. Action brief for Beach Management.

[7] NCC did produce a beach management plan that looked at the existing conditions of the beaches. It used the Halcrow (1998) designation of beaches and identified where amenities presently exist and would be required in various forms in the future. The NCC was in the process of revising this document. The NCC Act outlines a legal pathway to the creation of beach accesses and the CZMU has used the planning process to encourage developer to create maintenance/beach accesses and to maintain existing beach accesses. This is supported by the PDP. These beach accesses serve as access points for the public, but also serve as accesses for first responders (e.g. police, ambulance, oil spill response teams, etc.) in response to emergency situations on the coast. Additionally, parking areas may also serve as staging areas for first responders.

C3. DEVELOPMENT PLANNING AND SETBACKS

A proactive approach to developmental planning in the CZMA should be undertaken to optimise sustainable socio-economic development opportunities whilst maintaining the diversity, health and productivity of coastal resources and ecosystems. If successful, this can avoid costly and inappropriate development that may impact upon current and future generations. One way to achieve this is through using easements or setbacks.

Setbacks are a key tool used by coastal planners. They refer to areas where development is restricted or where specific conditions or provisions are imposed. Provisions may also be applied to ensure the safety of structures, persons and wider communities, especially in the context of climate change. Issues including access to the coast for all Barbadians or "easements" that protect valuable and irreplaceable coastal resources (including biodiversity and landscape) are important aspects addressed through the use of setbacks.

This topic focuses on the formal establishment of coastal setbacks and their incorporation into physical development planning procedures within the CZMA.

Topic (code)	Development Planning and Setbacks (S).
Key Legislative Instrument	Planning and Development Act (2019) Proposed revisions to the CZM Act (2020)
Policy Outcomes	Outcome 2 - Coastal resources are protected and effectively managed. Outcome 3 - Climate and disaster risk adaptive capacity is strengthened. Outcome 4 - ICZM is delivered through a coordinated governance arrangement. Outcome 5 - Capacity for ICZM delivery is strengthened for all relevant sectors. Outcome 6 - Research, understanding and knowledge outreach is increased.
Key Policy Goals	Goal 1.1 - Apply risk standards to national policies. Goal 3.1 - Adopt a risk management approach for coastal development.
Topic Importance	Establish developmental related regulation in the CZMA using a risk-based approach that promotes appropriate scales of development depending on coastal risks that apply to individual lengths of coast.
Disaster Cycle Phase	Preparedness Prevention

Table C.15. Policy outcomes, policy goals and the importance of considering this topic.

C3.1. Current status

Despite coastal setbacks being used in Barbados over recent decades as a tool to support development and planning control, compliance and enforcement continues to remain a challenge. Developers often demand a more flexible approach to setback implementation by using guidelines whereas regulators (i.e.: the GOB), often require improved compliance to setback rulings to help promote climate-resilient planning and development within a defined coastal area.

The primary goal of setbacks is to protect development and coastal resources from climate or coastal-related hazards and subsequent impacts, thus lessening the likelihood of property damage or irreversible change to coastal ecosystem services (see Figure C.8). By adhering to existing regulations and plans in place, the CZMU already provides advice to Town & Country Development Planning Office (TCDPO) on new physical development[8] applications that fall within the CZMA to ensure that coastal resources are managed in an appropriate way. The CZMU currently is in possession of the latest available information on coastal hazards and risks (see Section C2) to be able to define suitable setback distances.



Figure C.7. Examples of non-compliance with 30m setback along the Caribbean coast of Barbados.

Recently, the TCDPO, who are responsible for providing permissions and permits for physical development, drafted the updated PDP (2017) and its supporting regulatory instrument entitled the Planning and Development Act (2019). Both the PDP and the new legislation articulate the strategic policies and regulations for physical planning and land development in Barbados, including recommendations for the preferred approach for applications within the CZMA. Of specific relevance, the PDP (2017) establishes a coastal setback of 30 metres from the High-Water Mark (HWM) for lands adjacent to beaches. Any new major development applications (including change of land use), that falls within this setback distance will be subject to an Environmental and Social Impact Assessment (ESIA – see Section C4 of this ICZM Plan). Other supporting technical studies may be deemed necessary by TCDPO, or as advised by supporting agencies such as CZMU or the Ministry of Public Works. Conditions of approval may be imposed, such as maintenance requirements, etc.

[8] Classes of development that require an ESIA, according to the updated PDP (Section 5: Implementation) are presented in Box C3.

Extract from the Planning and Development Act (2019)

… in the course of preparation of a draft physical development plan, the Chief Town Planner shall have regard to the policies, strategies and standards for the management and conservation of coastal resources in a Coastal Zone Management Area, established under the Coastal Zone Management Act, Cap. 394, made under a Coastal Zone Management Plan approved in accordance with that Act."

Also, according to the Planning and Development Act, and reflected within the proposed revision of the CZM Act, the Minister shall not grant planning permission for any type of development in the CZMA which is prohibited by the ICZM Plan such as beaches which are known turtle nesting sites. Areas susceptible to coastal flooding are also addressed within the PDP (2017), though no formal coastal flood inundation extents are established nor are sea-level rise projections considered under the PDP. Under this ICZM Plan, the NCRIPP provides coastal hazard related information that has been considered for the delimitation of the CZMA and setbacks.

The High-Water Mark.

For many countries worldwide, the HWM is an important cadastral boundary that separates land and sea. It is used as a baseline to facilitate CCA and DRM from which land and infrastructure development is offset to ensure the protection of property from coastal hazards such as storm surge and sea level rise. In Barbados, the HWM serves a number of purposes including being the boundary between Crown and private lands, a jurisdictional boundary for NCC whilst also being the baseline from which development setback is measured. The proposed revisions to the CZM Act define the HWM as follows:

"the line of the highest run up of waves, which is defined by the limit of the wave run up of the high tide nearest to the first or last quarter of the lunar month occurring on the third or fourth day before or after the day of a full moon".

Using this definition of HWM however is not clear and is ambiguous, that is, it may shift over time both horizontally and vertically because of a number of different natural factors as follows:

i) Due to the earth orbiting around the sun, high tides occurring on the third or fourth day before or after the day of a full moon often vary throughout a calendar year;

ii) Since Barbados has a "mixed type" tide, the sea level height recorded between these two high tides (that may occur on the third or fourth day before or after the day of a full moon) may have significant different values (see Figure C.8);

iii) Additional non-astronomical factors such as cyclones, air pressure, wind, wave height and coastal typologies may influence the highest position of wave run up and, subsequently, the position of the HWM (see also Figure C.9);

iv) Even if the vertical position of the HWM may be constant over years in a certain location, its horizontal position (the intersection of this datum with data representing the coastal morphology, such as Digital Elevation Models (DEM) may vary through time as the coastal morphology changes (winter and summer beach profiles).

Therefore, an improved and modern method to determine the position of the HWM is now required.

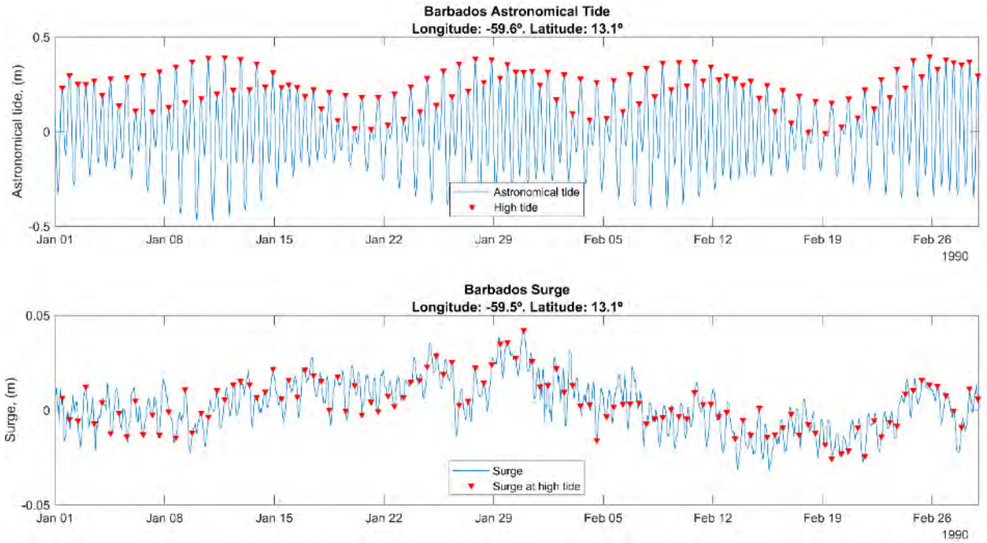


Figure C.8. Example of astronomical tide and surge values in Barbados.

C3.2. Implications

Setting restrictions to improve climate compatible physical development within the CZMA is an essential tool to better safeguard coastal resources, i.e.: turtle nesting sites, and to minimize inappropriate development within high or very high coastal risk areas. Based on improved knowledge and understanding, new development proposals spatially located within the CZMA should be designed to be cognisant of climate change implications in the mid and long term. In addition, minimum distances also have to be defined in order to safeguard access to the coast and to minimize impacts over other coastal resources such as seascape or landscape.

A change from the current reactionary management approach for this topic to one that is more proactive is now required for the whole CZMA of Barbados up to 2030 and beyond. Not adopting this change will result in setback problems that are currently witnessed along the west coast and which are being exacerbated due to the effects of the climate change, as more developed areas will become exposed to an increased frequency of coastal hazard related impacts within the same identified timeline. In fact, climate change and environmental and financial concerns in Barbados may, where situations allow, lead to a shift from a traditional 'hold-the-line' approach of coastal protection towards more flexible soft engineering options. Managed realignment[9] is one such strategy that

[9] (3) (PDF) Managed realignment: A viable long-term coastal management strategy? Available from: https://www.researchgate.net/publication/261508267_Managed_realignment_A_viable_long-term_coastal_management_strategy [accessed Aug 31 2021].

is a new measure that is being implemented around Europe and other countries worldwide. It is a relatively new soft engineering alternative aiming to provide sustainable flood risk management with added environmental and socio-economic benefits by creating space for coastal habitats to develop more dynamically. The natural adaptive capacity of coastal habitats and the delivery of ecosystem services underpin the sustainability of managed realignment. A sub-area strategy (see Part D) may be needed to better evaluate, in an integrated manner, the extent in area and the type of habitats that will be lost plus the most suitable local sites where compensatory measures might be implemented.

C3.3. Management guidance

This section provides national management guidance on the following aspects:

- Establishment and application of setbacks.
- Coordination with national policies.
- Coastal foreshore reserves.

ESTABLISHMENT AND APPLICATION OF SETBACKS.

The main intent of this national guideline is to:

- Increase and enhance setbacks for new development or re-development in sub-areas where development has traditionally been or is now encroaching on the shoreline or the beach.
- Pro-actively achieve adequate setback rules for all undeveloped areas of coast or where natural coastal features require extra protection.
- Pro-actively achieve adequate setback in low-density developed areas along both the Caribbean and Atlantic coasts.

Setback areas proposed within this national guidance are complementary to those defined in the PDP (2017) and delineated to facilitate a more flexible guideline for developers and planners for new developments. In essence, any development should only be permitted where the appropriate mitigation measures are proposed.

Various setback types (and variables) are presented as follows:

<table>
<tr><th>Setback</th><th>Distance from HWM/Toe of cliff</th><th>Objectives</th><th>Recommended Policies</th></tr>
<tr><td>Minimum 30m setback subject to ESIA (PDP, 2017)</td><td>30 m from HWM for beach front land</td><td>Ensure the safety of persons and infrastructures.
Avoid increasing flood inundation and coastal erosion risks.
Ensure public access.</td><td>- Existing development shall maintain the existing seaward building line.
- Where a structure is already in place, there shall be no seaward encroachment of the existing building line.
- All new major development or expanded development shall conform to the minimum 30 metres setback from HWM for beachfront areas.
- In exceptional cases (only in community core areas) where the 30 metres cannot be accommodated, new major developments must produce an ESIA including those studies defined in Table C.20 which minimum contents are described in Section C.5.3. The objective is to ensure that the proposed development has no negative impact on coastal dynamics and processes and that define the necessary measures to reduce coastal risks and adapt to climate change.
- The exceptional new or expanded major developments shall not be used as liveable spaces.
- Special considerations must be made for eroding beaches and those beaches where turtle nesting sites occurs.</td></tr>
<tr><td>Flood inundation setback</td><td>Variable (according to NCRIPP hazard assessment):
- Area of storm surge flooding (T= 100 years)
- Tsunami flooding area (T= 100 years)</td><td>Ensure the safety of persons and infrastructures.</td><td>- In general, all new or expanded major developments shall be located landward of flood inundation setback limits (see maps in Part D or consult to the CZMU).
- In exceptional cases where the flood inundation setback cannot be accommodated, new major developments must present an ESIA including those studies defined in Table C.20 which minimum contents are described in Section C.5.3. This includes the need for developers to consider flooding hazard (from NCRIPP) and to define robust and effective flood inundation reduction measures into the design to reduce the impact of flooding on the development.
- Specific flooding risk reduction measures shall be defined according to the characteristics of the area/parcel and type of development. Among the potential alternatives, some examples include:
▪ Raising the height of the ground floor level.
▪ Areas on the ground floor that could be used for parking and other non-liveable uses.
▪ Design and construction of adequate drainage systems.
- The CZMU shall provide developers with all up to date information on flood inundation areas.</td></tr>
<tr><td>Climate change adaptation setback</td><td>Variable (estimated using the last IPCC SLR projections)</td><td>Ensure the safety of persons and infrastructures.
Adapt to climate change and sea-level rise.</td><td>- All new or extended major developments within the Climate change adaptation setback area shall present an ESIA including those studies defined in Table C.20 which minimum contents are described in Section C.5.3.
- Major development proposers/developers are required to incorporate risk information into the design and adapt building codes to sea level rise and flooding scenarios and shall adopt site-specific climate change adaptation measures.
- The CZMU will provide developers with the latest information on sea-level rise and flooding scenarios.
- A review of the NCRIPP must be included as part of any CZMU assessment.</td></tr>
<tr><td>Cliff setback</td><td>Variable, classified into 7 setback categories (according to the GSI, Golder Associates 2017⁾:<table><tr><th>Setback category</th><th>Total setback (m)</th></tr><tr><td>i</td><td>18</td></tr><tr><td>ii</td><td>20</td></tr><tr><td>iii</td><td>25</td></tr><tr><td>iv</td><td>35</td></tr><tr><td>v</td><td>45</td></tr><tr><td>vi</td><td>55</td></tr><tr><td>vii</td><td>65</td></tr></table></td><td>Ensure the safety of persons and infrastructures.</td><td>- All new major developments shall be located behind the minimum recommended total setback limits. Any major development or structures (existing or proposed) that may encroach seaward into the total setback limit will require specific additional geotechnical evaluation to ensure that the loading from the structure(s) does not adversely affect the stability of the cliffs. All existing structures located within the total setback limits shall incur restrictions on future use depending on risk level and outcome of site specific investigations.
- Implement the recommended minimum total setback limits for all new major development in accordance with the guidelines shown on GSI Map Series 003, as provided in Annex 10. Development guidelines and requirements for development and use within the setback area are define according four coastal cliff risk classification (see Annex 10):<table><tr><th rowspan="2">Risk Class</th><th colspan="3">Usage guidelines within Total Setback Limits</th></tr><tr><th>For continued use</th><th colspan="2">For new or future development</th></tr><tr><td>Very high</td><td>NOT PERMITTED (possible only site specific assessment, movement monitoring, design and implementation</td><td>FORBIDDEN</td><td>Site specific geotechnical investigation, movement monitoring and design and implementation of engineering control measures</td></tr></table></td></tr>
</table>

<table>
<tr><th>Setback</th><th>Distance from HWM/Toe of cliff</th><th>Objectives</th><th>Recommended Policies</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><td></td><td>of engineering control measures executed)</td><td></td><td rowspan="4">required. The scope and scale of these requirements depends on the Risk Class, the type of proposed development and the nature of the site conditions. Evaluation must be carried out by a qualified geotechnical specialist with relevant experience who is a registered professional engineer. Annex 10 presents additional information on this aspect.</td></tr>
<tr><td>High
Medium</td><td>CAUTION – Site specific assessment, movement monitoring and possibly engineering control, measures required.</td><td>CONDITIONAL</td></tr>
<tr><td>Low</td><td>ALLOWED – After visual inspection</td><td>ALLOWABLE</td></tr>
</table>
</td></tr>
<tr><td>Landscape setback</td><td>Variable (according to the criteria for the definition of the CZMA):
- 100 m in rural areas
- 200 m in landscape protection areas, including OS3</td><td>Preserve the landscape as a cultural and economic resource.</td><td>- In general, all new or extended major developments within the Landscape setback area shall not be permitted if these are visible from unaltered beaches, including “secret beaches”.
- Any new or extended development within the Landscape setback area shall require specific evaluation to ensure that new structures/buildings do not adversely affect the coastal landscape.
- Any new or extended major development within the Landscape setback area shall adhere to the following requirements:
o Maximum building height shall be under vegetation height.
o All landscaping and buildings shall incorporate elements of traditional Barbadian architecture (including timber structures).
o Must maintain local vegetation and trees.
o Must have water drainage capacities of 1 sq.m per 100 sq.m of paved and built on land.
o Must provide sufficient parking for occupants and guests.</td></tr>
<tr><td>CZMA</td><td>Rest of CZMA</td><td>Preserve and effectively manage coastal resources.</td><td>For new developments, the required ESIA must include studies defined in section C5. No new developments are permitted within:
- Beaches and dunes;
- Wetlands;
- Areas adjacent to known turtle nesting sites;
- Mangrove areas;
- Geological formations of national conservation value;
- Cultural resources. OS02 Natural Heritage Conservation Areas (EIA).</td></tr>
</table>

Table C.16. Setbacks.

Flooding and landscape setbacks are calculated based on recent hazard analysis provided within the NCRIPP. *Climate change adaptation setbacks* have been calculated based on the sea level rise projections provided by the last IPCC (2019) report. These setbacks add additional easement (setback) on top of the minimum 30m setback limits as provided within the PDP (2017).



Figure C.9. Recommended policies for setbacks (easements) in a specific cliff location. Please note that the 30m setback is to be defined from the High Water Mark for beach areas only.

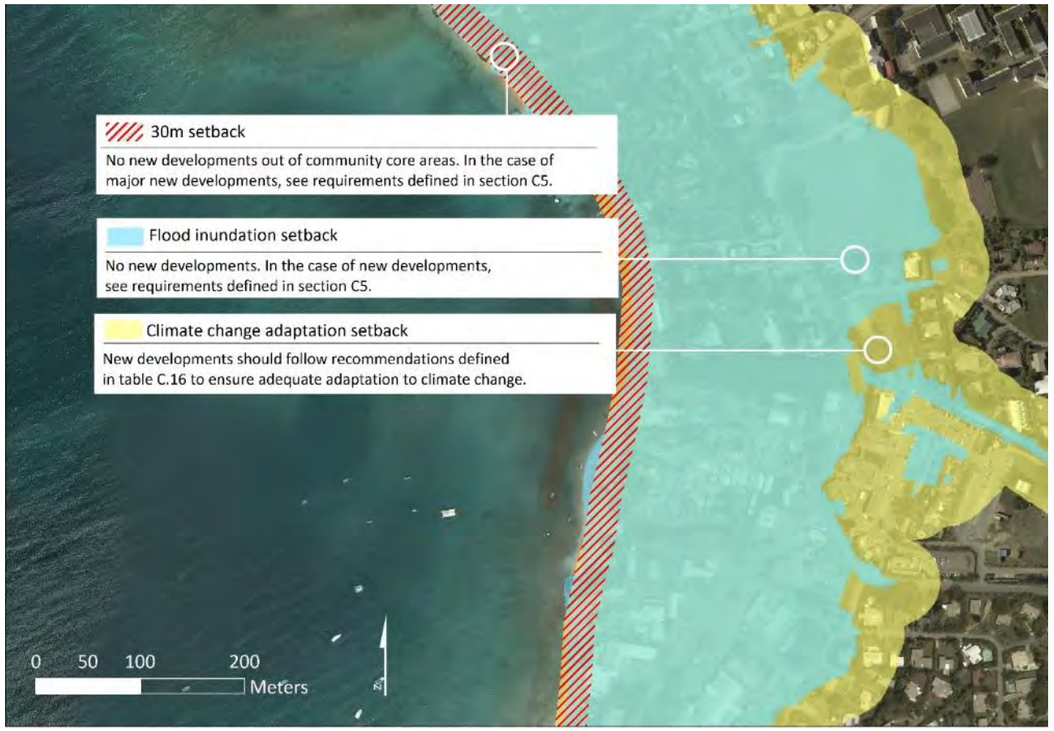
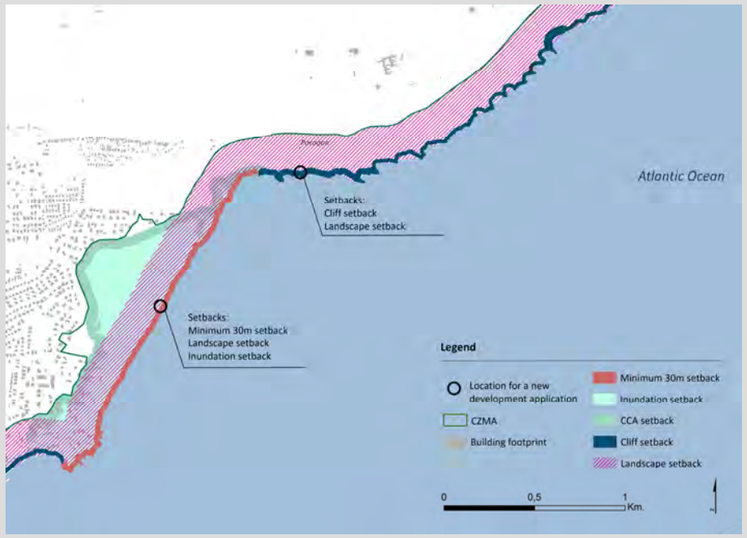


Figure C.10. Recommended policies for setbacks (easements) in a specific beach location. Please note that the 30m setback is to be defined from the High Water Mark for beach areas only

The approach to establish setback distances takes into account site-specific characteristics, establishing non-fixed distances from the coastline. Accordingly, applications for any new development must be individually evaluated considering their specific location, where a number of separate setbacks may be applicable (see **¡Error! No se encuentra el origen de la referencia.**).



Setback areas, as presented within the maps contained within Part D of this ICZM Plan and shown in the example in Figure C.11 above, will need to be integrated into the NCRIPP platform to facilitate the application review and subsequent decision based on detailed consideration of the specific location of any new development or plot sub-division. This should allow for the periodic update of setback distances based on the latest available monitoring or published information that determine coastal risks and/or the health or extent of coastal resources.

Coordination with national policies.

Climate-resilient development within the CZMA requires strong collaboration and coordination mechanisms and procedures between the TCDPO and the CZMU, together with aligned plans and regulatory instruments including the Planning and Development Act 2019 and the proposed revised CZM Act and Regulations. Importantly, matters relating to land acquisition is a constitutional matter for which specific provision is offered within national policy and law. The existing provision in the proposed revisions to the CZM Act (2020) reflects the recognition of the law and hence no action is proposed to alter or change this issue.

Coastal Foreshore Reserves

Within the CZMA, planning regulations are now established under the Planning and Development Act (2019) plus the proposed revisions to the CZM Act (2020) to encourage appropriate climate compatible developments to take place to a required resiliency standard. The Open Space policies, as set out within the PDP 2017, link neatly into the concept within this ICZM Plan for CZMU and TCDPO to help define a series of "Coastal Foreshore Reserves" around the coast of Barbados.

The purpose of Coastal Foreshore Reserves is set out below:

- Ensure that the identification of land is clearly set aside for public ownership to help deliver the PDP (2017) and ICZM Policy Framework Outcomes 2 *"Coastal resources are protected and effectively managed"* and Outcome 3 *"Climate and disaster risk adaptive capacity is strengthened"* that addresses conservation management, public access and recreation, as part of a new climate resilient coastal planning process;
- Foreshore areas shall be identified within each new development land cadastral as part of a clear "coastal foreshore reserve". This will be one aspect of a robust mitigation strategy that encourages both foreshore management and promote "open space" passive recreation.
- Ensure that the identification of coastal foreshore reserves takes into account consideration of ecological values, landscape, seascape, visual amenity and cultural heritage, public access, public recreation needs and safety to lives and property;
- Ensure that the coastal foreshore reserve is separated from adjacent development in a way that provides a clear demarcation between public and private land.

Offshore development within and beyond the core Coastal Zone Management Area (CZMA)

The marine area poses particular hazards, increased costs and the potential to impact on marine habitats and species, due to the presence of deeper water and its more remote/undeveloped location. It is recognised, however, that there may be a need to create new offshore islands beyond the CZMA due to increasing needs as defined within a future Blue Economy Plan for Barbados, for industrial needs etc. Development beyond the CZMA must always be considered in terms of the national requirements for Barbados and follow the Project of Special Nature (PSN) process as set out above.

Any proposed new island development in the core CZMA (or surrounding ZoI) should:

- Be a PSN;
- Be designed in accordance with the guidance set out in this ICZM Plan;
- Create at least 50% public coastal access;
- Be subject to a detailed EIA that takes into account the impacts of the proposed development as well as the impact from the combination of existing and proposed developments.
- Comply with the requirements of all relevant legislations and regulations linked to ICZM, Marine Spatial Plans and /or the Blue Economy;
- Be supported by appropriate survey, modelling, studies, research and design undertaken at the cost of the developer to show compliance with legislation and guidance;
- Not proceed unless there is a suitable environmental management plan, based on the EIA, and with environmental monitoring, mitigation, remediation and compensation actions taken at the cost of the developer (i.e. polluter pays principle).

C3.4. Action brief

The following table presents a series of specific actions designed to support the implementation of management guidance and goals. These actions do not exclude actions already performed by the CZMU.

CODE	ACTION	LEAD ACTORS	OTHER ACTORS	RELATED ACTIONS	INDICATOR	TIME SCALE	COMMENTS
Establishment and application of setbacks							
S1	Formally delineate the definition of HWM within statute.	CZMU	OPM	S2	HWM is established	Punctual, short term	
S2	Agree on setbacks policies and required studies (set out within this ICZM Plan) with TCPDO.	CZMU	TCDPO	S1	Cabinet endorsement of the ICZM Plan	Punctual, short term	
S3	Map setbacks distances that embrace the newly defined HWM.	CZMU		S1	Maps are published in the CZMU website	Punctual, medium term	
S4	Include setback distances within the NCRIPP platform to support the review and approval of applications/plans and official decisions.	CZMU		S3	CZMU planning officers use the platform for daily activities	Continuous, Medium term	
S5	Prepare a simple informative technical guidance (/update the Applicants Handbook to Development Planning) note describing the setback approach (including managed realignment of specific defences) to property owners and developers and the establishment of coastal foreshore reserves (as required).	CZMU	TCDPO, MTI, NCC, owners, developers	S3	Guidance note is distributed to key stakeholders	Punctual, medium term	
S6	Create a national inventory and assessment of coastal landscape /seascape values establishment of coastal foreshore reserves (as required).	CZMU	NCC	S5	National inventory is published in the CZMU website	Punctual, medium term	
S7	Disseminate setbacks (including lateral setback agreements) and recommendations through geo-viewer/website.	CZMU		S3	Setbacks are displayed in the CZMD website	Continuous, short term	
S8	Update periodically setbacks based on updated coastal risks and coastal resources information and maps.	CZMU	TCDPO, NCC		Updated setbacks included in Updated ICZM Plans	As new data is obtained long term	
Coordination with national policies.							
S9	Agree a calendar to coordinate PDP and ICZM Plan provisions/regulations/updates relating to developmental setbacks and studies required.	CZMU, TCDPO				Punctual, short term	Once the Draft ICZM Plan is approved
S10	Deliver bilateral meetings with selected staff and managers to discuss developmental planning issues and compliance aspects to the ICZM Plan.	CZMU, TCDPO			Nº of meetings and agreements achieved	Periodic, Short and medium term	
S11	Agree on existing and new setback and provisions within the CZMA (based on new monitoring related information) and publish within the annual State of the Coast reporting system.	CZMU, TCDPO			Setback provisions agreed	Punctual, medium term	
S12	Prepare supporting documentation to update the PDP (2017) regarding the definition of the CZMA, HWM and development setbacks in the CZMA.	CZMU	TCDPO		The PDP is updated accordingly	Punctual, short term	
Monitoring.							
S13	Prepare an indicator system to evaluate the success in setback implementation (linked to the CZMA (Enforcement) Regulations and the number of “coastal zone protection notices” submitted to offenders in any one year.	CZMU	TCDPO		No. of Coastal Zone Protection Notices submitted to offenders State of the Coast annual monitoring report	Annual	

Table C.17. Action brief for Development Planning and Setbacks.

C4. COMPLIANCE WITH ENVIRONMENTAL AND SOCIAL SAFEGUARDS

Anthropogenic activities exert influences on the natural environment, which can, and frequently do result in negative socio-environmental impacts. The nature, intensity and duration of these effects depend on the type of intervention and the character of the area where works are being carried out. Environmental and Social Impact Assessment (ESIA) is a process, which leads to the early identification of potential project impacts on the wider environment, and society before any physical intervention is made. In many circumstances in Barbados, an Environmental Impact Assessment (EIA) is produced, which may be supported by a separate Appendix focusing on a Social Impact Assessment (SIA) of the proposed development. No official guidance, however currently exists for the robust completion of the latter, though new draft guidance has been included in Annex 6 for consideration.

This topic guidance helps to ensure that environmental and social safeguards are adhered to in order to protect and effectively manage coastal resources into the future. Details on compliance with other environmental plans and legislation is addressed in more detail within Part A1.5.

Topic (code)	Compliance to Environmental and Social Safeguards (ESIA).
Key Legislative Instrument	Planning and Development Act (2019)
Policy Outcomes	Outcome 1 - Sustainable socioeconomic development is achieved. Outcome 2 - Coastal resources are protected and effectively managed. Outcome 3 - Climate and disaster risk adaptive capacity is strengthened. Outcome 4 - ICZM is delivered through a coordinated governance arrangement. Outcome 5 - Capacity for ICZM delivery is strengthened for all relevant sectors.
Key Policy Goals	Goal 1.1 – Apply risk resilient standards and procedures to support sustainable development within national socio-economic policies and development planning frameworks. Goal 1.2 – Encourage new and emerging sustainable opportunities within the CZMA that support the development of green and blue economies Goal 1.3 - Guidance to help deliver suitable coastal adaptation techniques. Goal 3.1: Adopt a risk management approach for coastal development. Goal 6.2 – Ensure that the needs and aspirations of communities are considered in planning, policy and decision making through active public participation.
Topic importance	Implementing suitable safeguards for the environment and social inclusion (community) issues must adhere to new legislation (Planning and Development Act 2019) whilst being cognisant to the specificities of the 8 coastal Sub-areas around Barbados.
Disaster cycle phase	**Preparedness** **Prevention**

Table C.18. Policy outcomes, policy goals and the importance of considering this topic.

C4.1. Current status

The ESIA process in Barbados is triggered by an application for development that is submitted to the TCDPO[10] that may result in environmental impacts, such as an intervention that required coral extraction/relocation, need for sand extraction, changes in water quality, impacts on fish nursery areas, etc.). The ESIA process is only required, however, for selected project classes or where it is determined that significant negative impacts are likely and to this end, the GOB has introduced guidelines for the types of developments requiring an ESIA and the related studies that are required for planning approval. Coastal engineering schemes, for example, are included in the list of projects that require this.

The ESIA process, as it is defined within the PDP (2017), is designed to ensure that any proposed major development demonstrates that its existence represents no environmental or social impact on the immediate or adjacent areas. Where this cannot be demonstrated then planning/environmental permission will not be granted. Supporting studies such as a SIA – set out in Section C4.3 below, may be requested which adheres to the requirements stated in n Section 5.3 of the PDP (2017).

A non-exclusive list of developments that are required to perform an EIA study are presented in Box C3 that is published in the PDP (Section 5.3). Other major developments (emerging new development titles etc.) not listed in Box C3 can still be required on request of the Chief Town Planner.

Box C3:

a) Special Industry including:
- *i. A chemical or petroleum manufacturing plant other than a plant for the manufacturing of pharmaceutical drugs;*
- *ii. a refinery;*
- *iii. a desalination plant;*
- *iv. an electricity generating plant;*
- *v. a cement plant or other plant for the burning of lime or bricks;*
- *vi. any other industry where the process is potentially obnoxious or dangerous to health and amenity by reason of excessive smell, fumes, smoke, dust, grift, ash, noise or vibration.*

b) Waste management facilities and waste disposal sites other than facilities for initial sorting or processing of source-separated dry recyclables.

c) Golf courses.

d) Uses within or adjacent to:
- *i. Natural Heritage Conservation Areas;*
- *ii. The National Park Forest Areas;*
- *iii. Core components of the NHS;*
- *iv. Coastal Areas.*

e) Mining operations including quarries and sand mines.

f) Applications for initial construction of, or expansions to major transportation infrastructure including highways, airports, seaport, wharves, marinas and jetties.

[10] TCDPO have the mandate to regulate and approve new and expanded major developments including those on Crown Lands and coastal and marine lands.

g) All new public roads (not private subdivision roads), and public road improvement schemes that exceed one or more of the following thresholds will require an ESIA:

i. New roads over 200 meters long;

ii. New or improved roads or junctions taking at least 10 habitable dwellings or 10 other buildings in active use;

iii. Improved roads or junctions that widen existing rights-of-way into privately owned land by at least 3 meters for a length of at least 100 meters;

iv. New or improved roads with Cultural Heritage Conservation Areas.

h) Sewage treatment facilities.

i) *Crematoria, funeral parlours or amusement parks.*

(Source: Updated PDP, Section 5: Implementation)

In addition, to ensure the protection of coastal resources and to comply with mandates provided in the PDA (2019) and the proposed revisions to the CZM Act (2020), the Director of CZMU will request, with endorsement from the Chief Town Planner, the production of an ESIA when:

(a) major development applications are proposed to be located inside the CZMA. In this case, the minimum studies requested by the CZMU as part of the ESIA are the requested studies presented in Table C.20 accordingly to its location;

(b) if a development application is proposed within the spatial limits of the defined ZoI, then the Director of the CZMU shall dictate the studies required that a developer must undertake to clearly demonstrate whether a full EIA is required or not.

ESIAs prove to be efficient tools to prevent environmental impacts and these procedures are implemented widely, however, the assessment of social impacts is less well addressed and the use of SIAs are not so extensive. This aspect is considered in more detail in Section C4.3. There are four types of impact assessment considered for use within the PDP (2017):

1. *Environmental and Social Impact Assessments (ESIA)* – these assess both the environmental and social impacts of the proposed project.

2. *Heritage Impact Assessments (HIA)*– these critically review the development proposal in terms of any impacts related to or compromising the ability to protect, restore and celebrate the cultural heritage assets on, adjacent to and within the World Heritage Conservation District also within the Buffer Zone.

3. *Agricultural Impact Assessments (AIA)* – these are aimed to critically review the development proposal in terms of any impact on the viability of food and agricultural production on site or adjacent to the proposed development.

4. *Traffic Impact Assessments (TIA)*: these consider the implications to mobility and transportation patterns as a result of the proposed development.

Where ESIAs, HIA, AIS or TIA are required, they shall be completed to the satisfaction of the Chief Town Planner, prior to approval being given. Approvals of development subject to Impact Assessments may contain certain conditions of approval to ensure that adverse impacts of such development are mitigated.

Once the developer submits the application to the TCDPO, the process continues in order to help and guide an applicant to produce an EIA that characterises the environment in the project area, predicts the nature and extent of environmental and social impacts and identifies ways in which negative impacts can be mitigated. Table C.19 outlines the key stages of this process as well as the results and the lead actor for each stage.

ACTION	LEAD ORGANISATION	RESULT
1. Submission of planning proposal.	Developer.	Triggers screening for compliance with Physical Development Plan (PDP).
2. Screening of proposal.	Chief Town Planner to give a resolution. When the project falls within the CZMA, CZMU will automatically be included (by the Chief Town Planner) to advise on screening compliance with the ICZM Plan and advice.	CZMU (advisory): - Approval without conditions. - Rejection, due to infractions of ICZM Plan. - ESIA required. Chief Town Planner: - Approval without conditions. - Rejection, due to infractions of PDP requirements. - ESIA required.
3. Scoping of the proposal. Prepare Terms of Reference for ESIA study.	Developer with approval of Chief Town Planner and CZMU.	ToR for ESIA.
4. Conduct ESIA study and submit report.	Developer submit physical report. Contents of the ESIA has to meet the terms of reference.	Environmental Impact Statement (EIS) to government, with recommendations for mitigation.
5. Review of ESIA study.	CZMU, to advise TCDPO. Chief Town Planner, to give a resolution.	CZMU (advisory): - ESIA agreement, subject to conditions relating to mitigation of impacts. - ESIA non-agreement. Chief Town Planner: - Reject project due to scale, or irreversibility of impacts, or - Ask for additional information, or - Approval, subject to conditions relating to mitigation of impacts.
6. Design of mitigation measures.	Developer.	Designs submitted to government for approval.
7. Implementation of mitigation measures.	Developer.	Functional facility with in-built mitigation.
8. Post-construction monitoring and compliance.	Developer, to submit required reports and data to TCDPO and CZMU. TCDPO and CZMU, to report reviews and site inspections.	Assessment of the success of the mitigation measures, with the opportunity to adjust as required, or to require modification if the developer has not complied as required.

Table C.19. ESIA process.

As part of the above planning approval process for projects requiring an ESIA, the TCDPO establishes a committee of relevant agencies to provide a review of and comment on the project. In advance of the ESIA, the proponent submits a Terms of Reference (TOR) document to TCDPO for approval of the scope of work to be completed in the study. Upon completion, the proponent is then required to submit the report to TCDPO, which is then circulated to the various government agencies for comment. The process also requires that the applicant conduct a public information session to present the project and its results to the public.

C4.2. Implications

The purpose of an ESIA is to ensure all stakeholders are fully informed and that decision makers consider the resulting environmental and social impacts, both negative and positive, when deciding whether to proceed with a project. Importantly, the amended PDP 2017 strengthens the role of the CZMU within the process for any major application within the CZMA. Likewise, within the new Planning and Development Act (2019), some key declarations are made. Within Clause 32 (8f), considerations of the newly formed Planning and Development Board (who review all ESIA applications and of which the Director of the CZMU is a key member) are included. It states that when determining an application, issues for the Board to take into consideration include that whenever a new planning application falls within the defined CZMA (established under the Coastal Zone Management Act, Cap. 394), the provisions set out within the ICZM Plan apply (in accordance with that Act).

Except for development within the CZMA, planning permission may be granted through a *development order* for an area of the country by the Chief Town Planner (CTP). Planning permission by a development order may be granted unconditionally or subject to specified conditions and limitations, especially if part or all of the development or use of land is within the CZMA.

> The following additional studies are required to supplement the current ESIA process when any new major development application falls within defined locations (see Table C.20).

C4.3. Management guidance

The management guidance provided is as follows:

- ESIA that better integrates social issues.
- Efficient and effective EIA implementation processes.

ESIA THAT BETTER INTEGRATES SOCIAL ISSUES.

In Barbados, the production of meaningful SIAs are not common, or if they are completed are rudimentary in nature. The implications on societal impacts of any development within the CZMA are paramount and hence critically important towards ensuring the sustainability and ultimate success of this ICZM Plan.

More robust SIAs should be introduced as part of the current ESIA process to better inform decision-making by government and the private sector on social matters associated with a major development from the early stages of a project. Equally important is the role of SIA in the ongoing management of social issues throughout the whole project cycle. As such, any social management plan that derives from an SIA is extremely important for successful ICZM delivery in Barbados.

Whilst no details are presented on the format or specific need for SIAs within the PDP (2019 – Section 5.3), the Director of the CZMU, though their advisory role on the Planning and Development Board (as initiated through the PDA 2019) can recommend the need for a development application to undertake a detailed SIA. The SIA should investigate socio-economic developmental opportunities and risks related to the execution of the project; and inform possible mitigation measures to safeguard against any risks identified, as well as other requirements to promote positive social impacts. SIAs should be conducted in a highly participatory, gender-inclusive manner engaging the communities, particularly with representatives of women and men and vulnerable groups such as children, youth, elderly, persons with disabilities (PWDs) etc. Details of what should be included within an SIA are presented in the Appendix Volume (Annex 6).

EFFICIENT AND EFFECTIVE EIA IMPLEMENTATION PROCESSES.

The PDP (2017) specifies that, the requirement for content and scope of the ESIA or other studies will be determined through pre-consultation with the TCDPO, and where required terms of reference shall be submitted early in the application process. More detailed information on the Terms of Reference can be found in the *"Applicant's Handbook and Guide to Town Planning*".

The CZMU indicate that specific studies need to be taken into account when a new development is located inside the CZMA. This document is now outdated and must be reviewed to better embrace the latest coastal risk and hazard results and studies carried out by Baird (2017). Important updates to the document that relate to the implementation of risk are now needed (see Table C.20). Improved message communication of the new setback criteria (as defined in Section C2) needs to include the definition of specific additional studies to support the production of an ESIA. A focus on an independent specific Climate Risk Vulnerability Assessment (CVRA) (see Annex 7) may be needed for a planning development should a detailed ESIA not be required.

LOCATION	REQUIRED STUDIES FOR NEW MAJOR APPLICATIONS	OBJECTIVE
Minimum 30m setback for beachfront land	- Study of shoreline dynamics. - Assessment of impacts on benthic communities (if required). - Climate risk vulnerability assessment (CRVA) and supporting proposal of risk reduction measures. - Landscape and Visual Impact Assessment (LVIA). - Site-specific coastal access plan. - Contributions towards aspects of a more detailed SIA (see Annex 6)	Identify and prevent possible impacts related to sediment transport and shore stability. Assess impacts produced over benthic communities. Take advantage of any opportunity for risk reduction in the area of study. Avoid the loss of natural landscape and views to the sea due to coastal development. Preserve and promote public access to the beach. Determine any appropriate social impacts associated within setback limits.
Flood Inundation and Climate Change adaptation setback	- High-resolution study of flood risk inundation limits associated with both the present situation and different climate change scenarios (2050, 2100). - Flooding risk reduction measures. - Adaptation of building designs and materials to flooding. - Disaster risk insurance assessments. In tsunami flood risk inundation (with support from DEM), applications should also include: - High-resolution tsunami risk assessment. - Tsunami risk reduction measures. - Tsunami evacuation plan. - Contributions towards aspects of a more detailed Social Impact Assessment (see Annex 6)	Assess possible impacts and opportunities related to flooding events, including risk reduction measures. Determine any appropriate social impacts associated with flood risk inundation limits.
Landscape setback	- Landscape and Visual Impact Assessment (LVIA), including at least: - Level of compliance with landscape recommendations as set out in the PDP (2017) - Landscape character assessment (quality, value, sensitivity, landscape units) - Visual assessment (visual receptors, visual basins) - Impact assessment (at different development stages) - Mitigation measures assessment (at different development stages) - Summary of residual impacts and significance	Avoid the loss of natural landscape and views to the sea due to coastal development. Determine any appropriate social impacts associated with visual or landscape changes.
CZMA	- Study of shoreline dynamics (as defined in Section C5) – if applicable-. - Assessment of impacts on ecosystem services including coastal risks related services. - Landscape and Visual Impact Assessment (as defined for the Landscape setback but now including seascape impacts) - Coastal access plan (as defined in Section C5). - Site-specific climate change adaptation plan. - Assessment of impacts on benthic communities (if required). - Watershed drainage assessments (if required). - Pollutant assessments (if required).	Effectively manage coastal resources
Zone of Influence (ZoI)	- Assessment of impacts on ecosystem services including coastal risks related services. - Assessment of impacts on non-living coastal resources.	Prevent impacts of developments located in the ZoI over coastal resources.

Table C.20. Required studies based on the CZMA setback designation.

C4.4. Action brief

Management guidance and goals described will be implemented through specific actions, presented in the following table. These actions do not exclude actions already performed by the CZMU.

CODE	ACTION	LEAD ACTORS	OTHER ACTORS	RELATED ACTIONS	INDICATOR	TIME SCALE	COMMENTS
Environmental and Social Impact Assessment in the CZMA. ESIA that better integrates Social Impact Assessment (SIA) in the CZMA.							
ESIA1	Coordination meetings with TCDPO to agree on new requirements to update the ESIA process to help support and improve sustainable development within the CZMA.	CZMU	TCDPO	ESIA 2	Nº of meetings Nº of attendees New additions to the ESIA process such as support guidelines for SIA production (see Annex 6).	Punctual, short term.	Include, SIA, CCA and DRM considerations into task ESIA 2.

ESIA2	Revision, update and suitable despatch of "The Applicant's Handbook and Guide to Coastal Planning in Barbados".	TCDPO	CZMU EPD, NCC	ESIA1	Updated Handbook published and uploaded onto appropriate GOB websites.	Punctual, short term. (completed after ESIA 1)	Include only requirements agreed with the Planning and Development Board. Final document is expected to better embrace details presented within the PDP (2017), the PDA (2019), new coastal set back information that embraces risk resilience measures plus potential improved SIA guidance for developers/applicants etc.
Monitoring							
ESIA3	Improved monitoring and evaluation procedures are adopted (with the endorsement of the Planning and Development Board) of current and future development applications.	TCDPO	CZMU,	ESIA1 ESIA4	Nº of compliant EIAs received Reduced Nº of "right to appeal" incidences Reduction in No, of Enforcement notices issues for non-compliant developments.	Continuous, short term.	Save and store applications may be applied.
ESIA4	Elaboration of an indicator system to assess the effects of ESIA procedures.	TCDPO PMO	CZMU	ESIA3	Annual summary report	Continuous, annual.	(Example of indicators: nº of accepted developments in the CZMA with/without presenting studies required by the CZMU under ESIA).

Table C.21. Action brief for Compliance to Environmental and Social Safeguards.

C5. CONSTRUCTION AND MAINTENANCE OF COASTAL STRUCTURES

Coastal structures include those whose purpose is for sea defence or coastal protection, water management (drainage or supply related structures) and facilities constructed at beaches (washrooms etc.). In the context of climate change, it is necessary to ensure the long-term technical, environmental and financial sustainability of these structures, in terms of functionality, effectiveness and maintenance. This national guidance is devoted to mainstreaming sustainable practices into the construction and maintenance of coastal structures and their aesthetic design as part of a national risk resilient ICZM approach for Barbados.

Topic (code)	Construction and Maintenance of Coastal Structures (CS).
Key Legislative Instrument	Coastal Zone Management Act (CAP394) (1998) Proposed revisions to the CZM Act (2020)
Policy Outcomes	Outcome 1 - Sustainable socioeconomic development is achieved. Outcome 2 - Coastal resources are protected and effectively managed. Outcome 3 - Climate and disaster risk adaptive capacity is strengthened. Outcome 4 - ICZM is delivered through a coordinated governance arrangement. Outcome 5 - Capacity for ICZM delivery is strengthened for all relevant sectors. Outcome 6 - Research, understanding and knowledge outreach is increased.
Key Policy Goals	Goal 1.3 - Guidance to help deliver suitable coastal adaptation techniques.
Topic importance	Risk resilient engineering designs, embracing nature-based solutions whether possible, require new ways of thinking (design, implementation and maintenance) that respond to current and future climate related risks that have been identified for the CZMA.
Disaster cycle phase	**Preparedness** **Recovery**

Table C.22. Policy outcomes, policy goals and the importance of considering this topic.

C5.1. Current status

Over the last 60 years, the growth of tourism and residential development has required the protection of private properties and the stabilization of beaches. Currently, there are almost 600 structures recorded within the current CZMU database (NCRIPP). These are grouped into four categories:

(i) beach facilities,

(ii) hard coastal protection structures,

(iii) nature-based measures and protection works, and

(iv) Outfall and/or seawater intake structures.

[11] Inspections of beach facilities and related infrastructure are carried out by the NCC whilst inland drainage structures are monitored by the Drainage Division and the EPD as appropriate.
[12] Designed by Halcrow Group Ltd as part of the delivery package for the original CZM Plan (1998)

Most of these structures are often originally designed without long-term consideration of climate change scenarios. With urban corridor expansion and tourism development continuing to be planned along the south and west coasts and the southeast and east coast, a new approach towards managing, monitoring and designing coastal structures is now required. This needs to better inculcate and retrofit climate resilient designs into existing and future developments that embrace nature-based designs and aesthetic appeal into future structures, where possible, whilst maintaining the natural and cultural character of the coast.

During the last two decades, the CZMU has undertaken routine monitoring inspections of coastal structures within the defined CZMA[11]. Currently, the CZMU has used a number of separate databases, as the Shoreline and Nearshore Data Systems (SANDS[12]) to specifically support structure and beach monitoring using excel and GIS databases. However, the update of these databases is not formalised and coordinated (as of 2020, no formal CZMU specific Operations Manual currently exists) and hence they are not efficiently or effectively used to collate information for use within annual reports to demonstrate structure performance or to upgrade requirements.

The TCDPO takes the advice of the CZMU and Ministry of Public Works and Maintenance (MPWM) into consideration. The TCDPO grants approvals for the construction of all coastal structures. Conditions may be imposed (as set out in Section C4 above) for the need for specific additional studies or maintenance requirements. This ICZM Plan now sets a new platform for enhanced consideration of climate change impacts when designing new coastal structures. Consequently, there is a need to define new procedures for extreme event situations or disaster emergency responses to support DEM in fulfilling their mandate as being the country's coordinator for disaster response.



Figure C.12. Recreational area on Sir Richard Haynes Boardwalk – a successful example of a climate-resilient structure that is designed to reduce flooding impacts whilst increasing the accessibility to the coast.

C5.2. Implications

Latest climate change projections provided by IPCC state that sea level rise will impact the Barbados coast within the mid and long term. Many coastal defences in Barbados are however, currently not designed with the suitable design heights that will counter the predicted sea level rise rates. It is therefore essential to re-assess the technical engineering parameters required that address future requirements to mainstream DRM and CCA understanding into coastal structure designs.

In addition, the frequency and intensity of extreme events that the Barbados coast is predicted to face in the future subsequently demands agile and effective management mechanisms to be implemented. These are needed to guarantee appropriate access points to be in place to ensure emergency repairs can be undertaken at speed (if required).

The implications of not adopting the Adaptive Pathway approach (see Part B) in Barbados is that this could expose the country to increased economic losses and damages for those sectors who rely on functioning and healthy shorelines for business continuity, especially in light of emergency situations caused by extreme events on the coast. Consequently, economic impacts to private and public businesses, developments and livelihoods, could increase especially for those on the first line of defence.

C5.3. Management guidance

According to the current status and implications as set out above, the following management guidance is provided to support on the following aspects:

- Mainstreaming DRM and CCA into the design of coastal structures.
- Monitoring of coastal structures.
- Maintenance of coastal structures.
- Managing emergency maintenance works.

MAINSTREAMING DRM AND CCA INTO THE DESIGN OF COASTAL STRUCTURES.

As stated in Part A, latest climate change projections indicate that hazards such as storm surge overtopping, coastal erosion and sea level rise around the coast of Barbados are to increase in intensity and impact. As a consequence, any new coastal structure must be designed to mitigate not only their impacts (such as increased flood and erosion risk) but also the implications of increased intensities and frequencies that may arise from these hazards in the future under different climate change scenarios that use up to date and accurate data and models.

The advisory role of the CZMU (supporting TCDPO in the approval of new coastal infrastructure related constructions within the CZMA) must now ensure that structures incorporating climate and disaster resiliency criteria and procedures into their designs.

To this end, the evaluation of each new application, that proposes the need for a coastal structure, must ensure that sufficient consideration is given to the technical engineering resilience of the proposed structure in terms of whether its design sufficiently considers hazard assessment criteria within agreed climate change scenarios set for Barbados (see proposed CRVA methodology approach in Annex 7). In addition, the structures impact in terms of environmental and financial sustainability over the long-term must be clearly assessed, ensuring that the structure pays due cognisance to its impact on neighbouring or adjacent shorelines in the future. It is proposed that to ensure climate compatible designs for future coastal structures (hard solutions, "hybrid schemes[13]" or nature based solutions, etc.), the following strengths and weaknesses of each approach are listed along with indicative support studies required:

[13] This describes a combination of nature-based and hard interventions in order to provide immediate protection solutions while at the same time also providing wider benefits. A focus on nature-based interventions often does not negate the need for physical infrastructure, as nature-based and hard interventions can often complement one other.

Adaptation Intervention	Strengths	Weaknesses	Required Studies
Hard interventions (such as sea walls, breakwaters)	▪ There is a lot of experience regarding the undertaking of these interventions. ▪ Expertise and guidance already exist. ▪ Provides protection as soon as structures are built. ▪ Detailed understanding regarding the design standards and protection that the intervention will offer.	▪ New structures required, or structures must be modified to adapt to environmental change. ▪ Has a residual life which weakens overtime. ▪ Can have negative impacts on coastal ecosystems and cause reduction in ecosystem services provided by the coastal zone. ▪ Generally, have limited wider benefits apart from storm/ erosion protection. ▪ Can experience more damage from ongoing small storm events compared to nature-based interventions.	• Feasibility study • Study of shoreline dynamics • ESIA
Hard interventions (outfalls/intake structures)			• A separate study of water quality, including water quality threshold levels and the assessment of bathing water quality (see Beach Management Guidance - C2). • ESIA
Nature-based interventions (such as coral reef or mangrove restoration)	▪ Can provide a wide range of benefits as well as shoreline protection including: fishery habitat, water quality, carbon sequestration, tourism enhancement, and recreation. ▪ If restoring or replanting ecosystems, they often get stronger and more resilient over time. ▪ Have the potential to self-recover or repair after both small and larger storm events. ▪ Has the potential to naturally adapt and keep pace with environmental change and sea level rise. ▪ Can be cheaper compared to hard interventions. ▪ Has the potential to engage the local community and stakeholders in protecting, restoring, and enhancing coastal ecosystems that support their livelihood. In the long-term, this build the adaptive capacity and resilience of coastal communities and ecosystems.	▪ There is less guidance and best practice available ▪ Hard to predict the level of protection that will be provided ▪ Can provide varying levels of protection geographically ▪ Can take longer for the ecosystem to establish. ▪ Generally required more space for implementation compared to hard interventions. ▪ Limited data to allow quantification of benefits and comparison of benefit-cost ratios. ▪ Can be more difficult to gain planning approvals for these projects.	• Feasibility study • Study of shoreline dynamics • ESIA
Hybrid intervention (combination of hard and nature-based interventions)	▪ Capitalizes on the strengths of both hard and nature-based solutions (i.e.: managed realignment, etc.). ▪ Provides opportunities for innovation. ▪ Can be used to provide wider benefits but where there is little space or there is a requirement for immediate protection. ▪ Has the potential to engage the local community and stakeholders in protecting, restoring, and enhancing coastal ecosystems that support their livelihood. In the long-term, this build the adaptive capacity and resilience of coastal communities and ecosystems.	▪ Does not provide as many wider benefits as a nature-based intervention. ▪ Requires more research for best practice examples. ▪ Can still have some negative environmental impact.	• Feasibility study • Study of shoreline dynamics and implications of managed realignment in specific sub-areas. • ESIA

Table C.23. Strengths and weaknesses of hard, nature-based, and hybrid interventions: quick guide for identification of adaptation measures and required studies. Source: adapted from Sutton-Grier et al. (2015) in 'Ecosystem-based Adaptation (EBA) & Gender Equality and Social Inclusion (GESI) mainstreaming Illustrative case studies (EGIS 2020).

Minimum contents of a feasibility study:

- Economic, technical, legal, and scheduling considerations to ascertain project success.
- A brief report about the use of coastal resources.
- Geo-location and mapping (fixed and moveable structures should be defined).

Minimum contents of a study on shoreline dynamics:

- Bathymetry of the area affected by the intervention.
- Marine climate, including wave and storm statistical analyses (scalar and directional).
- Equilibrium beach profile and plan-form in the area affected by the intervention.
- Study of the longshore transport capacity.
- Sediment balance and analysis of shoreline evolution before and after the intervention.
- Assessment of impacts on immediate and adjacent coastal resources (including baseline studies on coastal habitats and species in the area affected by the intervention and economic activities).
- Assessment of impacts due to climate change, including at least sea level rise effects and changes in wave magnitude and direction.
- Proposal for the reduction of negative impacts during construction and exploitation/use of the intervention.
- Availability of sand resources for the intervention.
- Monitoring plan.

Minimum contents of the ESIA: details are defined depending on the development's location, extended information is provided in Section C5.

Once possible adaptation options are identified, decision criteria (including the role and the importance of gender) agreed and the different methodological aspects considered, a process of selection and prioritization of adaptation measures can be initiated. The aim of this analysis is to assess the costs and benefits of each option in order to select the most relevant one.

Importantly, a number of approaches and methods to conduct a cost-benefits or cost-effectiveness analysis exist. Among available resources, the UNFCCC publication is of particular interest as it reviews all tools and process and provides a summary of approaches that can be applied to prioritize project and concepts using:

- Cost-Benefit Analysis (CBA); and/or other assessment report of alternative options;
- Cost-Effectiveness Analysis (CEA); and / or
- Multi-Criteria Analysis (MCA).

Within a project Feasibility Study, for example, the selection and prioritization of adaptation measures should include an assessment of all types of previously identified measures - nature-based, hybrid and non-structural intervention options - to achieve the wider benefits and provide long-term sustainability in addition to reducing the environmental impact. The selection and prioritization process should be rooted within the context of climate risks and vulnerabilities as defined in the ESIA process (see Section C4) to identify the opportunities and make sure that adaptation actions allow to reduce those risks. Careful consideration should also be provided on the aesthetic appeal of any defence on the local area. The production of a CRVA to support any Feasibility Study is recommended and a draft methodology for this is set out in Annex 7.

MONITORING OF COASTAL STRUCTURES

A robust and enforceable monitoring strategy for any coastal scheme (pre and post construction) should be prepared by any developer to help inform of future construction/maintenance requirements.

During annual inspections of hard structures, the following structural aspects should be considered (structure-dependent) within future construction monitoring plans:

- *Armour units & masonry including rock armour elements* - a visual inspection should be carried out on a yearly basis and/or within 3 days after any extreme or large storm event.
- *Capping and cope beams* - a visual inspection should be carried out on at least a bi-annual basis and/or within 3 days after any extreme or large storm event.
- *Grating, handrails, access ladders and stairs* - a visual inspection should be carried out on at least an annual basis and/or within 3 days after any extreme or large storm event.
- *Outfalls and manholes* - a visual inspection should be carried out on at least a 6-monthly basis. Outfalls should ideally have CCTV surveys or internal inspections (requiring entry into confined spaces) on at least an annual basis or within 3 days following a storm event where sediment appears to have been deposited (filling) outfalls in the area to ensure there is no blockages.
- *Reinforced concrete and precast concrete structures* - a visual inspection should be carried out on at least an annual basis and/or within 3 days after any extreme or large storm event. If the structure shows signs of subsidence or structural instability through issues such as cracking, an intrusive investigation may be required.
- *Steel sheet pile wall* - a visual inspection should be carried out on at least an annual basis and/or within 3 days after any extreme or large storm event. Some sediment removal may be required depending on location to allow a clear assessment of the wall. A thickness test should be carried out every five years on the sheet piles to assess corrosion.
- *Structural steel and steel framed components* - a visual inspection should be carried out on at least an annual basis and/or within 3 days after any extreme or large storm event.
- *Timber components* - a visual inspection should be carried out on at least a six-month basis.

- *Toe structure* - the toe structure can be difficult to assess as it is often buried under sediment. However, scour to the toe can cause instability within the structure and therefore should be inspected visually on an annual basis. Unless there are any other visible signs, if the toe is buried it is most likely to be in good condition as it is not exposed to the hazards. If there is excessive vegetation, the impact of the roots on the structure should be considered.

A formal Instruction Manual for the above monitoring strategy is now need to be prepared by the CZMU (and endorsed by the Planning and Development Board) with immediate effect.

Maintenance of Coastal Structures

The maintenance of coastal structures, especially in the context of climate change, is essential to avoid the deterioration of the facility and ultimately its failure to perform its designated tasks. The results of any monitoring program (as highlighted above) should be incorporated (under the responsibility of the CZMU) into a unique and updated database (NCRIPP) to facilitate access to the information. The NCRIPP database should be able to provide enough information on the coastal structure, its engineering characteristics and condition.

The maintenance of coastal protection projects and facilities should hereby be classified into three categories:

- *Built-in maintenance* - this is a preventative maintenance method adopted during the construction phase of a project. Material selection and protective techniques are important criteria reflecting on both the initial capital outlay and maintenance of a coastal protection project. Built-in maintenance methods are generally employed on projects where the design life of the project is of significant duration and the costs can be justified.
- *Routine maintenance* - this involves regular monitoring of the completed project and being pro-active in the prevention of deterioration by providing maintenance on a routine basis. Routine maintenance also includes projects such as maintenance dredging, mechanical beach cleaning (undertaken by NCC) and storm-water trash rack cleaning. Routine monitoring or inspection has been previously discussed and the results from this monitoring should feed into the routine maintenance plan. Having an adequate database is critical to this and also this can be used effectively to monitor climate change impacts on coastal protection measures and the surrounding environment.
- *Event-driven maintenance* - this involves maintenance or repair following storm events. For example, the replacement of dislodged rocks from (for example) a breakwater following a storm or the removal of sand from a boardwalk or damaged kerb (edge) stones etc. (in partnership with NCC). This action must be undertaken in addition to routine maintenance to ensure that repair of any damage or necessary maintenance is carried out immediately, rather than to address the maintenance or repair at the next programmed routine inspection. Unforeseen maintenance may occur where inappropriate planning, design or construction methods have been employed or when unforeseen events occur. When an extreme or unforeseen event damages the functionality of any critical structure that needs immediately, in order to avoid other dangers or restore basic services, emergency maintenance works procedure can be executed.

Managing Emergency Maintenance Works

Extreme weather induced events, possibly exacerbated by climate change, often cause significant damage to coastal structures and the potential to disrupt their protection functionalities and the intended services provided by critical facilities such as energy and water supply, sanitation, transportation. In order to facilitate the restoration of the expected basic functionalities and services, the CZMU and supporting agencies most notably the TCDPO, should establish specific operational procedures to enable the urgent development of emergency works. These procedures for emergency works require a more streamlined and reactionary (extraordinary) application of emergency permits and permissions for their implementation in comparison to more regular construction or maintenance permits for the construction/maintenance of new coastal structures. The procedures should therefore consider the following aspects:

- Only necessary works to restore the basic functionality or minimum services would be considered under extraordinary procedures.
- The selection of contractors to perform the necessary rehabilitation works should be streamlined and made much shorter (even immediate as part of a "call down contract" or similar arrangement than more regular applications. It is recommended that as part of such a contractual arrangement, at least three "mini bid" offers should be requested from different contractors in order to select the best price-quality offer and availability of the call down contractor.
- Only simplified ESIA procedures, if ESIA is applicable to the specific work, should be required.

The above remains in line with the current Planning and Development Act (Page 63: Emergency engineering operations) whereby it states that:

"*Nothing in this Act shall render unlawful the carrying out of any engineering operations which are urgently necessary for coastal conservation or sea defence, or in the interest of public safety or the preservation of property, provided that an application for planning permission to regularise the unauthorised development is made to the Board, pursuant to section 31, as soon as may be practicable after the necessity for the emergency works arises".*

In addition, the PDP (2017) states that:

"Where such an application is for the retrospective approval of emergency works undertaken on the seabed or shoreline for the purposes of coastal conservation or sea defence, the application shall be accompanied by a certificate issued by the Director of the Coastal Zone Management Unit verifying that the engineering operations carried out without prior planning permission were urgently necessary".

Managed Realignment

Attention to the removal of defences is gradually increasing due to the pressures posed by rising sea levels and the sustainability of maintaining defences in the future. Public and political acceptance of removing defences is still challenging in Barbados though it has been suggested that it is necessary to develop a number of demonstration projects for promoting the wider uptake of this strategy. Economic drivers and long-term planning are important to support removal of defences, but wider implications in the longer term must be carefully assessed.

Managed realignment through removal of defences is usually implemented at sites with particular characteristics, usually involving a willing landowner. Removal of defences is only likely to be implemented in Barbados at locations where:

(a) local erosion and flooding are acceptable; and

(b) risks can be managed to avoid unacceptable impacts through time.

In this regards, removal of defences is more suitable in rural or low occupation areas of the Barbadian coast and where erosion and flood risk can be contained or controlled by higher ground or existing defences further inland, which are able to provide the required level of protection without upgrading.

To maximise the potential for realising benefits and minimising detrimental impacts, the national planning processes must take careful consideration of the intended objectives of the ICZM Plan. Expectations about potential gains and losses and the associated time-frames in which these are likely to occur are also key along with appreciating the characteristics of the site and how they might affect the evolution of coastal change in the short- and long-term.

Aesthetic Design

Aesthetic appeal of landscapes for tourism is among essential intangible ecosystem services and hence of relevance within the whole CZMA of Barbados. In particular, scenery (e.g.: in Sub-Areas, 2, 3 and 4) plays an ever-increasing role in the provision of ecosystem services in coastal areas that have high conservation value and recreational appeal. There are a range of appealing types of defence design that could be selected to improve visual appearance, such as combining boulders with angled steel walls or using “outcropping” which is one method of creating a seawall that uses overlaid slabs or chunks of stone to dampen impacts on the shore while allowing water to filter back out. Rip rap similarly uses chunks of stone of various sizes to provide beach protection with a natural-looking appearance.



C5.4. Action brief

Management guidance and goals described will be implemented through specific actions, presented in Table C.24.

CODE	ACTION	LEAD ACTORS	OTHER ACTORS	RELATED ACTIONS	INDICATOR	TIME SCALE	COMMENTS
Mainstreaming DRM and CCA into the design of coastal structures.							
CS1	Produce technical "White Papers" for wide dissemination to clearly articulate recent findings for the study on shoreline dynamics, considering CCA and the national position on Managed Realignment.	CZMU	TCDPO	CS2 CS3	Technical report White Papers etc.	Punctual, short term	This includes the establishment of climate change scenarios, objective year and met-ocean variables to assess for the design of coastal structures, taking into account the type and the lifetime of the structure.
CS2	Organize bilateral working meetings with CZMU to agree on technical aspects related to CS1.	TCDPO	CZMU	CS1	Nº of attendees Nº of meetings	Punctual, short term	Contents and technical aspects to be defined under CS4 should be agreed with TCDPO to ensure alignment with PDP.
CS3	Organize training activities undertaken by CZMU staff for public sector and private sector audiences to better incorporate CCA into the design of coastal structures.	CZMU	NCC MPW	CS1	Nº of attendees Nº of courses	Punctual, short term	Beach infrastructure specific facilities will require input from NCC in partnership with CZMU
CS4	Review (in partnership with TCDPO) all current and future planning applications that request the need for new coastal structures and other construction activities within the CZMA to ensure that they are consistent with the policies and CCA requirements of the plan.	CZMU	TCDPO	CS1 CS3	Nº of applications reviewed Nº of applications in which CCA aspects are requested.	Continuous	This includes advising on minimum acceptable CCA standards for designs and constraints on construction for applications for new coastal structures in CZMA.
CS5	Support TCDPO to ensure conditions for the approval of coastal structures are incorporated in all development permits. Undertake site inspection during construction to ensure compliance.	TCDPO	CZMU	CS1 CS4	Nº of development permits reviewed	Continuous	Conditions for approval include CCA, water quality standards and other requirements.
Managing emergency maintenance works							
CS6	In partnership with DEM, support the preparation of new procedures for managing emergency maintenance works.	TCDPO	CZMU	CS3	Technical report Agreement with involved agencies	Punctual, Short term	To be developed in collaboration with related agencies.
Monitoring and maintenance of coastal structures							
CS7	Undertake assessment reports on the adequacy of existing infrastructures to projected SLR (feeding into the State of the Coast annual reporting system).	CZMU	MPW	State of the Coast Reporting	Technical report produced within 2 months prior to the publication of the annual "State of the Coast" report	Punctual, short term.	
CS8	Prepare Monitoring and Maintenance Strategy Instruction procedures/guidelines (for pre and post monitoring of coastal structures) in line with the updated ICZM Plan.	CZMU	EPD NCC DD		Technical report	Punctual, short term.	
CS9	Update the existing NCRIPP architecture to establish a comprehensive database for the inventory and assessment of coastal structures.	CZMU				Punctual, short term.	Based on existing information and inventories (SANDS, GIS and excel files).
CS10	Update the inventory and assessment database based on the results of monitoring activities.	CZMU		CS7 and CS9	Accommodate data in NCRIPP and produce annual summary	Continuous, annually	
CS11	Formalise (through a new MoU) a collaborative arrangement /agreement between CZMU, EPD, Drainage Division and NCC for ensuring the monitoring and maintenance of beach facilities, beach and storm-water facilities cleaning.	CZMU, NCC DD	EPD		Signed agreement in line with the approach set out in the CZMA (Enforcement) Regulations 2020	Punctual, short term.	This agreement is to allow the CZMU to supervise and ensure the maintenance of coastal infrastructure.

Table C.24. Action brief for the Construction and Maintenance of Coastal Structures.

C6. EMERGING ISSUES

During previous decades, government agencies in Barbados, including the CZMU, often tracked the emergence of important national and international trends by seeking input from reliable outside and internal experts and businesses that had good reasons to stay ahead of trends and by reading reports and studies produced by not-for-profit organizations. More recently however, the ability to gather, maintain, analyse, and circulate data has improved markedly. Smaller and less expensive environmental monitors have been developed and deployed, so people in state environmental agencies can quickly scan collected data for notable emerging trends and cross-reference with colleagues anywhere in the world who have similar capabilities.

Access to high-quality data will be a pivotal determinant of success in applying sustainability approaches to management of new-issues, and it is clear that GOB have deemed this a signature issue. Being able to present and embrace "emerging issues" within a flexible policy (though not necessarily within a plan) is critical for any successful ICZM approach. Delivering this is not, however, easily achievable within the previous (pre 2020) ICZM structure in Barbados. This is because rigidity of sectoral policy (outside of ICZM related matters) remains one of the main challenges that needs addressing to enable future emerging issues (or changes) to be considered which may be observational, governance related or institutional in nature. Institutional mechanisms therefore need to be able to create an adaptive yet structured space within which new/emergent issues can be addressed (if not previously foreseen).

Emerging issues with respect to planning and development in the coastal and marine areas such as managing sargassum, siting of over-water bungalows, carrying capacity for beach furniture, privatisation of part of the water, coastal transportation services and associated jetties, water parks, inflatable structures, and artificial islands, should always be analysed with respect to the implications on future developmental proposals. The following sub-sections develop this consideration further in some detail.

TOPIC (CODE)	Emerging Issues (EI).
KEY LEGISLATIVE INSTRUMENT	No one specific law (variable). Planning and Development Act (2019) and the proposed revisions to the CZM Act (2020) allow for new Regulations to be prepared to address emerging issues as required in the future. The draft CZMA (Enforcement) Regulations (2020) may prove to be an effective tool through the implementation of the new "Coastal Zone Protection Notice" which may be updated to formally identify non-compliant activities that may emerge in the future.
POLICY OUTCOMES	Outcome 1 - Sustainable socioeconomic development is achieved. Outcome 2 - Coastal resources are protected and effectively managed. Outcome 4 - ICZM is delivered through a coordinated governance arrangement. Outcome 6 - Research, understanding and knowledge outreach is increased.
KEY POLICY GOALS	Goal 1.2 - Emerging opportunities for green and blue economy.
TOPIC IMPORTANCE	Changing social preferences, economic demands and natural phenomena all require flexible management systems to be in place to ensure that new paradigms and emerging issues are correctly addressed and managed in a timely manner.
DISASTER CYCLE PHASE	Preparedness Response Prevention

Table C.25. Policy outcomes, policy goals and the importance of considering this topic.

C6.1. Current status

Examples of specific "emerging issues" that require specific focus as they are immediately pertinent to the Barbados coastal situation are set out below:

COASTAL TRANSPORTATION SERVICES AND ASSOCIATED JETTIES

Transport is a demand-driven industry. Indirect impacts of climate change on tourism/land transport in Barbados are often related to the connectivity of settlements and economic/tourist centres i.e. to the coastal resorts/beaches along the north-west coast at Speightstown, Holetown south to Bridgetown and, Oistins on the South coast. This connectivity is under increased risk of disruption due to the gridlock commonly experienced along the coastal road network coupled with the flooding that is being more frequently observed and recorded following extreme precipitation events.

These disruptions, in addition to human losses and asset and infrastructural damages also present challenges to the smooth operation of a road-based transportation industry to service all sectors, including tourism. Regarding tourism, the connectivity between the major beach resorts, mostly located along the south and west coasts and Grantley Adams International Airport, faces much higher disruption risk in light of climate change. Similarly, low bulk cargo distribution from centres such as Speightstown to Bridgetown Port and on to the major urban centre of the island are also likely to be impacted upon by climate change. For these reasons the development of formalized water-taxi and ferry services is now being considered between the north, north-west, west, and south of the island with possible landing sites at Speightstown, Holetown, Bridgetown and Oistins, to supplement the more ad-hoc private water taxi arrangement that is in existence at present.

No formal guidelines exist in Barbados for the sustainable and climate resilient construction of jetties, pontoons or supporting coastal/marine transportation services. This remains an activity that the GOB needs to formalize in partnership with the MPW. Jetties need to be designed to meet the requirements of the appropriate design codes and standards, to adhere sound engineering principles and to be fit for purpose. Jetties should be of sound construction, preferably made of non-combustible materials, and be of sufficient strength to withstand normal berthing forces. Importantly, their design must consider the outcomes of specific CRVA carried out as part of the ESIA process (see Section C4 and Annex 7).

New formal National Guidelines (supported by a backing legal/regulatory framework if required) needs to be produced that will assist in what design of jetty or pontoon related structures should be allowed within the Barbados CZMA (core area). These will need to be prepared with due cognisance of existing regulations and legislations of relevant government agencies; and best practices and standards for the activity plus consideration of Blue Economy related policies and approaches. It must also consider the implications of their location near sensitive coastal habitats (i.e.: coral reefs, seagrass beds, etc.).

It is presupposed that these Guidelines, when produced, would be supported by a National Policy or new Regulation that limits the construction of these structures to only suitable locations and that embrace agreed climate resilient designs (see Section C5). It is recommended that the Guideline takes into account the following:

- General siting considerations;

- The civil and structural design requirements for the jetty taking into the location, natural phenomena such as the weather and tidal/marine considerations;
- Impact protection for the approach of the vessel to the jetty. Consideration needs to be given to protection of the jetty from impact from the vessel and vice versa. A major accident could result if contact between the vessel and jetty resulted in damage to the vessel and loss of containment of a hazardous substance or if significant damage occurred to the jetty structure vessel anchorage/mooring requirements at the jetty.
- The design needs to take into account the requirements for anchorage and mooring at low and high tides, and when the vessel is full and empty ship to shore transfer.
- In addition to the correct design of the jetty installation, the facility should also be subjected to an adequate maintenance and inspection programme designed to ensure that the integrity of the facility is maintained during operation.

Additional consideration should be given (within the Guidelines) to the precautions that should be taken at jetties since there may be a number of different 'authorities' which may have a controlling influence. These include the harbour operator, the jetty operator and the master of the ship. There should be a clear definition of the roles and responsibilities of all parties concerned. In addition, consideration may be needed in respect of other jetties in the vicinity and the impact on management arrangements in the case of interaction arising from domino effects, communication links, etc. In the immediate term, the following recommended policies apply:

ALL COASTAL TRANSPORTATION INCLUDING JETTIES SHALL BE SUBJECT TO THE ESIA PROCESS.

USE OF 4X4 VEHICLES ON COASTAL HABITATS

Specific emerging issues that require attention may include the need for new specific to restrict activities such as driving on beaches, dunes or other coastal resources or specific habitats are at risk of being impacted on. Currently driving on some beaches and specific coastal areas is permitted for the haulage of vessels. New formal Guidelines however need to be produced to better communicate formal regulatory needs to better manage this activity within the defined CZMA in Barbados. These will need to be prepared with due cognisance of existing regulations and legislations of relevant government agencies; and best practices and standards for the activity; consideration of local community requests and transport related policies and approaches of relevance. In the immediate term, the following recommended policies apply:

NO VEHICLES ARE ALLOWED TO DRIVE ON BEACH AREAS EXCEPT IN EMERGENCY SCENARIOS AND AT DESIGNATED WATERCRAFT HAUL-OUT POINTS.

OVER WATER BUNGALOWS AND OTHER BUILDINGS

Overwater structures are constructed, in the main, to support the tourism or service sectors (restaurants, etc.) and are usually located close to the shore, allowing easy access to the building, service or "feature". Where there are several structures, these are often grouped together with one common deck connecting them to the shore.

Recently, TCDPO have received numerous applications for the construction of overwater structures and overwater restaurants, "cabanas", villas and bars. These structures are often located within the intertidal and nearshore areas of the defined CZMA mostly out to the circa -10m bathymetric contour. Proponents have repeatedly expressed the desire for developments of this nature to appeal to the high-end, high-income tourist simultaneously offering the exclusivity of an overwater villa/cabana. In response to these proposals, CZMU[14] have often advised the TCDPO that any future application must include the following issues within an ESIA before any future planning permit is granted:

- Addressing issues of waste-solid and liquid waste and its disposal;
- Construction in sensitive areas leading to destruction of habitat and sedimentation onto coral reefs, etc.;
- Potential hazards to navigation and marine life (turtles and finfish);
- Impacts to the aesthetic value of the coast;
- Lack of access to the seafront and seabed to the general public;
- Potential for expanding the property greater than the actual size;
- Safety issues;
- Placement of structures in areas vulnerable to natural hazards;
- Consideration for the effects and impacts of climate change.

Whilst the tourism industry in Barbados remains a pillar of the economy and the ability to offer the exclusivity of an overwater structure may be an asset to certain developments, CZMU and TCDPO also recognize that developments of this nature should be conducted in a prudent and regulated manner. To this end, work has started to develop Guidelines for the Construction and Operation of Overwater Structures.

New formal Guidelines therefore need to be produced that will assist regulators and developers in determining where, how and what type of structure can be allowed in Barbados. These guidelines will need to be prepared with due cognisance of the existing regulations and legislations of relevant government agencies; best practices and standards for the activity; and consideration of communities whilst still being economically viable for the proponent.

To this end, the following definition is proposed for adoption and to support implementation of this ICZM Plan:

- "Overwater Structures" – any structure suitable for use as a restaurant, bar, dive shop or dwelling for commercial purposes and the enjoyment by tourists, which extends in any part beyond the shoreline of any public water or publicly–owned water body and includes pontoons and "floatels";

[14] The CZMU intends to provide the best available guidance on these matters given the information from recent and future studies undertaken (or planned).

- "Suitable for use as a dwelling" – any structure which is used for temporary residence purposes by one or more persons, or which contains kitchen, bathroom, shower, or toilet facilities.

In the immediate term, the following recommended policies apply:

ALL DEVELOPMENT PROPOSALS FOR THE ERECTION OF STRUCTURES WITHIN THE NEARSHORE AREA INCLUDING OVERWATER BUNGALOWS SHALL BE SUBJECT TO THE ESIA PROCESS.

USE OF QUARRIED SANDS[15] FOR BEACH RECHARGE AND OFFSHORE ISLANDS

Recently, TCDPO have received numerous applications for coastal tourism related developments to make use of terrestrial sources of sand as opposed to offshore/marine sands. Proponents have repeatedly expressed the desire for quarried sands of acceptable sedimentological standards and criteria to be used on beaches. For example, the testing quarried sands at Lears and Black Bess Quarries has occurred over the past few years for use as an alternative to marine sands for beach recharge. However, it is evident that this type of "sand" does become hard and compact over time, resulting in ponding of water on the beach due to the compaction culminating in the death of benthic organisms within the nearshore. Beach enhancement schemes at Dover, for example, in addition to others have been implemented with no formal guidance standard for their usage, application, and post placement monitoring criteria in addition to guidance on sand cleaning expectations prior to placement.

New formal Guidelines therefore need to be produced that will assist regulators and developers in determining whether land based quarried sands could be used on Barbados' beaches as an alternative to marine sources. These guidelines will need to be prepared with due cognisance of existing regulations and legislations of relevant government agencies; and building codes/best practices and standards for similar activities plus consideration of communities, road transport consequences etc.

The Guidelines should be supported by a national Policy (or Regulation) that limits the quarried beach sands to only those areas that meet the following criteria:

- placement guidelines,
- on site storage of sands prior to beach placement,
- timings and approach to beach placement,
- cleaning approaches and,
- whether the petrology of the quarried sands is of a required standard (with the sediments being predominantly from coralline limestone-derived soils, etc.).

Guidance specific to sediment compaction tests using accredited laboratories will also need to be prepared. In the immediate term, the following recommended policies apply:

THOROUGH SEDIMENTOLOGICAL STUDIES AND SHORT TERM TRIALS ARE REQUIRED TO JUSTIFY THE TYPE AND PLACEMENT OF QUARRIED SANDS BEFORE BEING ACCEPTED FOR BEACH NOURISHMENT AND ENHANCEMENT

[15] Quarried sands in this instance are defined as sand of predetermined sediment gradation made from the grinding process of lime stone (coralline materials) in a rock quarry.

CARRYING CAPACITY OF BEACHES

Issues pertaining to the carrying capacity of beaches have already been addressed as part of the Risk Assessment tasks within the recommended ISO13009 Beach Standard for Barbados (see Section C2). Whilst the adoption of such an ISO standard falls within the remit of the BNSI, the NCC needs to consider and approach BNSI to advise them that its implementation is necessary for Barbados. There is also value in the NCC and the Ministry of Tourism collaborating on this matter to agree on an appropriate methodology for determining beach carrying capacity and to then apply it to some of the more popular beaches and hotel frontages so that a developer may have an appreciation for the potential expectation of their available beach space. Harmonization will also be needed with the NCC through their parent legislation on issues pertaining to beach carrying capacity aspects. This is because current law makes specific reference to the ICZM Plan (in Section 5A) and the need for improved delivery modalities that are linked to beach management and emerging issues thereof such as inflatable recreational structures/beach carrying capacity/beach safety and risk assessments/beach standard setting.

WATER PARKS AND USE OF INFLATABLE STRUCTURES

An improved definition of "water-sports" is necessary within the Shipping and Watersports Regulations 2004 in Barbados. This currently includes the terms "jet-skis" and "high-speed vessels" but does not include none powered activities such as paddle boarding. There is also a need for new prescriptive and non-prescriptive policies pertaining to water parks and individual inflatable structures also known as 'icebergs' in the sea. Consequently, the preparation of a specific Green or White Paper on this issue is urgently required for Cabinet approval. These will prove useful planning tools that can support the creation of new policy or for updating existing or planned Regulations. These papers and notes importantly relate only to standards and should speak to the performance of required systems, but not to specific technologies or practices. As these structures cause significant social impacts, in the immediate term, the following recommended policies apply:

THE CONSTRUCTION OF WATER PARKS AND INFLATABLE STRUCTURES SHALL BE SUBJECT TO THE ESIA PROCESS WHICH INCLUDES PUBLIC CONSULTATION WITH NEIGHBOURING PROPERTIES AND OTHER STAKEHOLDERS SUCH AS BEACH USERS.

ARTIFICIAL OFFSHORE ISLANDS

The concept of artificial offshore islands is currently in "vogue" from an international perspective to help support the concept of a "Blue Economy" though these vary in type and scale quite considerably as constructing an artificial offshore island depends on a number of factors, but most notably, location. By definition, an artificial offshore island or man-made island is one that has been constructed by people rather than formed by natural means. Artificial islands may vary in size from small islets reclaimed solely to support a single pillar of a building or structure, to those that support entire communities and cities. For the purposes of this ICZM Plan for Barbados, they may be categorised as follows:

a) Artificial Dredged Islands – where sand, land or marine sourced, is pumped to the bottom of the seabed which is used to construct the base of the island. These are often constructed at significant scales to accommodate infrastructure or support new communities. Exemplars include a number of artificial islands such as Dubai's famous Palm Island and "The World" islands. These are only viable where seabed geology is resilient enough for building such islands.

b) Artificial Floating Vegetated Islands (AFIs) – these are human-made floating structures, small in scale when compared to "artificial dredged islands" that are capable of supporting aquatic vegetation, that rise and fall with fluctuating water levels. They can serve to support various functions such as water purification through absorption, habitat for fish and birds, act as wave breaks or simply be constructed for seascape improvement.

c) Floating Islands – these are often constructed using man made materials, platforms, etc. instead of using dredged material. No physical connection to the seabed is made apart from anchoring systems to allow natural tidal flows to continue unabated underneath them. Links, chains or floating pontoons are often used to construct these islands and in general, they cause a far lower environmental impact. Internationally, these are being considered especially by the tourism sector in some low lying SIDS such as in the Maldives and in the Pacific in order to reduce footprint impacts on seabed biodiversity, marine habitats and associated wildlife.

No formal strategy for artificial islands currently exists. In spite of this, the challenges surrounding the construction of any artificial island fundamentally link to the need for these structures to be environmentally, socially and financially sustainable in the long term. Planning decisions for locating future artificial islands, including any of the three types highlighted above, must be carefully considered through the current planning system and through the pending national marine spatial planning process to help determine optimal locations for such constructions. In the immediate term, the current ESIA process in Barbados (see Part C4) needs to be adhered to robustly to ensure that before any artificial island construction application is taken forward, the applicant must demonstrate no net impacts through the collection of baseline data and information to support any application. The following recommended policies apply:

ALL PROPOSALS FOR ARTIFICIAL OFFSHORE ISLANDS SHALL INCLUDE AN ESIA, WHERE THE FOLLOWING ISSUES SHALL BE INCLUDED BUT NOT LIMITED TO:

- **WATER DEPTH**
- **WAVE HEIGHT RANGES**
- **TIDAL RANGE**
- **CURRENT SPEEDS**
- **FOUNDATION CONDITIONS**
- **EARTHQUAKE AND TSUNAMI RISK**
- **SOURCE OF MATERIALS**
- **PROXIMITY TO IMPORTANT HABITATS (CORAL REEF ETC.)**
- **PROXIMITY TO SHIPPING LANES**
- **PROXIMITY TO EXISTING PIPELINES AND CABLES**
- **PROXIMITY TO FISHING GROUNDS AND FISH NURSERY AREAS**
- **COASTAL AND OFFSHORE VISTA AMENITY CONSIDERATIONS**
- **CHANGES IN CURRENTS THAT CAN IMPACT THE COASTLINE**
- **RENEWABLE ENERGY CONSIDERATION FOR SELF-CONTAINED ELECTRICITY GENERATION.**

MANAGING SARGASSUM

Since circa 2011, mega-algal blooms in the mid-Atlantic have resulted in increasing volumes of seaweed (and other macro algae, but particularly sargassum) washing up on Caribbean shorelines (Smetacek, Zingone and Green, 2013, Milledge and Harvey 2016). Sargassum piles up on beaches and then begin to rot. They also sink and smother seagrass meadows and coral reefs and can contribute to beach erosion. The situation became so bad in 2018 that Barbados declared a national emergency (Langin, 2018). Stranded sargassum on tourist beaches have a major negative impact on industry whilst the CZMU have had sargassum fouling experience of their oceanographic buoys. The economic costs of sargassum being stranded have not been documented as yet.

ALL MANAGEMENT ISSUES PERTAINING TO SARGASSUM RELATED CLEAN-UP OPERATIONS REMAIN THE RESPONSIBILITY OF THE NATIONAL CONSERVATION COMMISSION (NCC).

C6.2. Implications

The lack of established new guidance focusing on the efficient management of emerging issues is a key and urgent task for Barbados to address. It is needed to better define minimum requirements and maximum occupation of the private services in order to safeguard public fundamental rights (access to the coast, beach and seawater room at beaches, safeguard longitudinal connectivity of beaches for pedestrians, etc. and limit the pressures that coastal resources support.

Moreover, the treatment of this topic has to provide the CZMU with flexible and sensible guidance in order to respond to new emerging issues in the future.

C6.3. Management guidance

According to the current status and implications as set out above, the following section provides national management guidance as follows.

The regulatory implications of new issues are best informed and guided by the early warning of the existence of these issues through a robust ICZM focused surveillance program and by equally robust sustainability assessments and analytics. However, once an emerging issue has been identified, an initial assessment is required, to categorize it in such a way as to determine whether specific existing or new regulatory oversight is necessary and, if so, which regulatory agencies in Barbados should be engaged. One first task is to ensure that the legal framework for a National Policy Position Paper on a specific emerging issue is requested especially for new emerging issues that currently lie outside of any developmental control measure.

Given that emerging issues, whether proceeding from societal or natural factors, will probably cut across social, economic, technologic, and environmental risk assessment and management, multiple regulatory agencies often will need to collaborate. It is likely that an increased technical presence within the staffs of existing regulatory agencies may be required, coupled with the design of new "issue" screening assessments, tools, and formal sustainability assessments that may need to be further automated to meet the rapid throughput that new-issue management on the coast will require.

Given the global nature of many existing environmental and sustainability issues and the likelihood that new emerging issues will have international implications, new-issue identification approaches are required that promote regulatory convergence and synergies among countries in the Caribbean region who may be attempting to address newly identified issues jointly. To this end, the sharing of sustainability tools and approaches could foster such congruent approaches.

It is proposed that a **National Policy Position Paper** is prepared to provide the direction for any specific emerging issue. This Position Paper shall initiate a new "triggering mechanism" that would be linked to national policy and regulation (to better adapt, regulate and manage the emerging issue in question. This triggering mechanism[16] is likely to be an iterative process and will change in approach as more thought and attention is given to it, though it could be defined using the principles of "process change management"[17]. Specific topics to include within the Policy Position Paper include:

- Clear description of the proposal inclusive of the relevant diagrams and photos;
- Site description for the proposal to determine the impacts of the proposed development.

The Planning and Development Board may prove important here as any advisory or decision to further study an emerging issue must be based on the collective view of its members to determine whether specific regulations, standards and/or procedures pertaining to the emerging issue (be it coastal or marine related) is required. Annex 11 outlines a proposed tiered approach towards addressing future emerging issues pertaining to the CZMA.

In essence, any future policies on emerging issues should always be dealt with by adhering to the ESIA process.

[16] In the first instance, the tabling of an issue by the Planning and Development Board, which is set up under the Planning and Development Act (2019), represents the initial "trigger" to produce a Position Paper if this is unanimously agreed by Board members.

[17] https://status.net/articles/change-management-principles/

C6.4. Action brief

Management guidance and goals described will be implemented through specific actions, presented in the following table.

CODE	ACTION	LEAD ACTORS	OTHER ACTORS	RELATED ACTIONS	INDICATOR	TIME SCALE	COMMENTS
EI1	Devise a National Policy Position Paper on Coastal transportation services and associated jetties.	TCDPO	CZMU, MTI, NCC,	EI2-EI6	Publication of the National Position Paper	Punctual, short term	Green or White Paper details to adhere to national legislative formats, details and requirements. This must consider the location of sensitive habitats in any future Policy Position Paper.
EI2	Devise a National Policy Position Paper on Use of 4x4 Vehicles on coastal habitats to support updates to new amended legislation.	NCC	TCDPO, MTI, CZMU,	EI1-EI6	Publication of the National Position Paper	Punctual, short term	Green or White Paper details to adhere to national legislative formats, details and requirements.
EI3	Devise a National Policy Position Paper on Over Water Bungalows and other buildings.	TCDPO	CZMU, MTI, NCC,	EI1-EI6	Publication of the National Position Paper	Punctual, medium term	Green or White Paper details to adhere to national legislative formats, details and requirements.
EI4	Devise a National Policy Position Paper on Use of Quarried Sands for Beach Recharge.	CZMU	TCDPO, MTI, NCC,	EI1-EI6	Publication of the National Position Paper	Continuous, medium term	Green or White Paper details to adhere to national legislative formats, details and requirements.
EI5	Devise a National Policy Position Paper on Carrying Capacity of beaches based on the National Beach Management Plan.	NCC	TCDPO, MTI, BNSI, CZMU,	BM2, BM3, EI1-EI6	Publication of the National Position Paper	Punctual, medium term	Needs to link to the details agreed within the ISO 13009 Beach Standard (see Beach Management Guidance). BHTA and NCC involvement is required along with the Caribbean Tourism Organisation as carrying capacity has never been developed or explored for Barbados
EI6	Devise a National Policy Position Paper on Water Parks and use of inflatable structures.	TCDPO	CZMU, MTI, NCC, Ministry of Housing, property owners, developers	EI1-EI5	Publication of the National Position Paper	Punctual, medium term	Green or White Paper details to adhere to national legislative formats, details and requirements
EI7	Agree on analysing and applying approaches (screening tools) to identify possible emerging challenges and from this, shortlist those emerging issues of immediate importance.	TCDPO	CZMU			Punctual, medium term	The rate at which future challenges are likely to approach and their increasing complexity will afford less and less time in which to assess them and, if necessary, to devise strategies to address them. A set of screening tools that can be implemented rapidly is essential. It is important to avoid rapidly approaching challenges from becoming historical events before they can be adequately assessed
EI8	Automate existing screening approaches, tools, and formal sustainability assessments for the rapid analysis that responses to new issues will require.	TCDPO	CZMU			Punctual, medium term	
EI9	Create a searchable database of valuable lessons learned (identify, track, and address unintended consequences of an emerging issue).	TCDPO	CZMU			Continuous, short term	

Table C.26. Action brief for Emerging Issues.

C7. BIODIVERSITY CONSERVATION AND COASTAL HABITAT RESTORATION

Coastal resources of Barbados are recognised to be under severe threat from overexploitation and from pollution discharges associated with intensive urbanisation, especially along the west and south coast corridors. They are also known to be additionally affected by climatic and extreme weather events that give rise to increases in sea surface temperature, coral bleaching, ocean acidification, sea level rise and erosion. For example, the last remaining local mangrove estuary, the Graeme Hall Swamp, is under threat from reduced salinity and contaminated storm water run-off. Likewise, seagrass cover in the St. Lawrence lagoon has nearly disappeared due to periodic scouring, siltation, eutrophication and threats from invasive species.

Preserving the health of Barbados' coastal habitats therefore remains a continuous national priority and focus. By achieving this, it will help to ensure sustainable use and development of fisheries, marine assets, resources, minerals and species for sustainable recreation and the livelihoods of those that make a living from the sea.

Perhaps of most significance is the decline of specific coastal habitats, especially coral reef cover in Barbados. This is attributed to a range of factors deteriorating coastal water quality, sewage contamination, overfishing, and which is currently being compounded by Lionfish (*Pterois volitans*) invasions. In addition, the accelerated decline of coral reefs has removed natural coastal protection and has reduced the replenishment of sand, leading to significant beach erosion, particularly along the west coast. As a consequence, many beaches are narrower than in years past.

Strong planning and management frameworks are therefore essential to safeguard what biodiversity (coastal and marine) remains but at the same time, there is also an important role for appropriate habitat restoration. This is an approach that is becoming an important part of national biodiversity conservation efforts, particularly for coastal habitats and resources which are under considerable pressure and where restoration and rehabilitation is required. To support this concept, the GOB ratified the Convention of Biodiversity Development (CBD) on December 10, 1993 and is, therefore, responsible for ensuring that the provisions of that Convention are complied with in accordance with the particular conditions within the country and with the available financial, technical and other resources.

There is considerable scope in Barbados for coastal and marine habitat restoration through the development of clear regulation to prevent damage and advisory guidance on how to improve biodiversity conservation which can help to better mainstream nature based solutions and Ecosystem based Adaptation (EbA) related approaches thus increasing resilience to climate change and disasters.

TOPIC (CODE)	Biodiversity Conservation and Coastal Habitat Restoration (BIO).
KEY LEGISLATIVE INSTRUMENT	Marine Pollution Prevention Act (1998), the Coastal Zone Management Act (CAP 394 – 1998) and the proposed revisions to the CZM Act (2020); Fisheries Act (2004).
POLICY OUTCOMES	Outcome 1 - Sustainable socioeconomic development is achieved. Outcome 2 - Coastal resources are protected and effectively managed. Outcome 4 - ICZM is delivered through a coordinated governance arrangement. Outcome 5 - Capacity for ICZM delivery is strengthened for all relevant sectors. Outcome 6 - Research, understanding and knowledge outreach is increased.
KEY POLICY GOALS	Goal 2.1 - Develop guidelines to help regulate and manage legally defined coastal resources. Goal 2.2 - Support the rehabilitation of CR through the mainstreaming and adoption of EBA approaches to increase the resilience.
TOPIC IMPORTANCE	Delivering Sustainable Development Goals (SDGs) on the coast requires strong and pragmatic policies, regulations and techniques to be in place to ensure ecosystem-based adaptation can be at the forefront of decision making.
DISASTER CYCLE PHASE	Preparedness Response Prevention

Table C.27. Policy outcomes, policy goals and the importance of considering this topic.

C7.1. Current status

OVERVIEW

The area covered by this ICZM Plan includes many of the most unspoilt landscapes in Barbados. The coastal scenery contains a mix of cliffs, pocket beaches, dune landscapes, rocky headlands and bays fringed by reefs. The dry woodland, vegetated dunes, cactus thorn scrub and coastal mat vegetation which overlays these features add to the variety.

Due to a combination of natural and anthropogenic factors, overall marine and terrestrial biodiversity levels in Barbados remain relatively low, especially as compared with other Caribbean countries. Factors influencing this include isolation and small land area with less variety in environmental conditions and habitat than in larger more mountainous islands. Naturally occurring biodiversity has also been significantly reduced by human impacts starting with extensive land clearing in the colonial period and followed by intense development since independence.

TERRESTRIAL ECOLOGY

Although many of the vegetated areas are small in size, Hackleton's Cliff woods being the main exception, the areas of terrestrial vegetation are of considerable botanical interest and add a degree of sustainability to the islands biodiversity. The areas of greatest diversity of terrestrial vegetation covered by the Plan are the forests and wetlands, the latter being restricted to tidal marshy estuaries such as Long Pond and swampy areas behind sand dunes such as Chancery Lane.

Marine Ecology

Similar to other Caribbean islands, aquatic ecosystems include wetlands, mangroves, strand vegetation, rocky intertidal areas, seagrass beds and coral reefs (hard coral, gorgonian, pavement, coral rubble and brown algal pavement). The extreme exposure of much of the area has resulted in unusual and ecologically valuable marine communities, particularly the gorgonian dominated limestone pavement habitat which may be a unique environment in terms of diversity and density of soft corals. The exposed conditions may also be responsible for the unusual growth forms of the barrel sponge and box fire coral.

Total coral reef area is estimated at 100 km2 (Roberts et al, 2020) with barrier reefs around the southern coast and fringing reefs elsewhere. Barbados has over 50 hard coral species and 600 species of fish. (UNEP, 2012). The north-west coast is particularly important, supporting the most diverse assemblage and highest percentage of hard coral cover in the ICZM Plan area. This location possesses the richest reefs in terms of hard coral in Barbados and amongst the richest in the whole of the Caribbean. It is hence considered as being of international conservation importance for conservation.

Coral reefs on the south and west coasts of Barbados consist of nearshore fringing reefs, intermediate patch reefs and further offshore, near continuous linear bank reef in depths of 14-45 m. On the south coast, the bank reef is more fragmented, and fringing reefs occur as relic reefs interspersed with areas of rubble. The reefs are the primary source of white carbonate sand that forms the beaches of these coasts.

However, coral reef quality within the Caribbean has been declining with time (Alvarez-Filip et al., 2009) including in Barbados (Jackson et al, 2014).

With regards to the status of coral reefs in Barbados, they are being impacted upon through numerous anthropogenic drivers, especially overfishing and pollution, the long-term effects of which are exacerbated by the impacts of climate change (Hughes, et al., 2017). Coral reefs are also the marine ecosystem most vulnerable to climate change, which specifically impacts coral reefs through warming ocean temperatures and ocean acidification. Each of these issues causes or contributes to other issues, such as increases in macro-algal cover, coral bleaching and disease outbreak, and the distinctions between and synergistic effects arising from the combination of issues are not well understood.

Fisheries

With marine biodiversity typically higher than that of terrestrial, this highlights the importance of fisheries and coral reefs to Barbados' overall biodiversity levels. Fisheries are linked to the biogeography of the island. Its unique location on the outer leeward edge of the western Caribbean means there is a high dependence on near shore coral reef dependent fisheries; however, the offshore pelagic fishery is the more significant of the two. The small-scale, male dominated, year-round open access, unmanaged and unmonitored spear fishery of Barbados is typical of the other reef fisheries in the island, contributing to the food and livelihood security of fishers with one or more alternative jobs (McConney 2011, Schuhmann et al. 2011).

The principle fisheries in the ICZM Plan area are for shallow reef fishes, deep reef slope fishes, lobsters, sea turtles and sea eggs *(Tripneustes ventricosus).* Some collecting of helmet shells and conch also takes place off the north west coast and it has been reported that some collection of fish for the aquarium trade takes place off the same coast.

The shallow reef fin-fishery is principally for surgeon fishes, squirrel fishes, goatfish, grunts and parrot fish. Most fish trapping takes place around Stroud Bay and also Tent Bay, Consett Bay ad Skeetes Bay. Spear fishing for these fish takes place seasonally and includes diving with SCUBA gear. The deep reef slope fishery targets snappers, grunts, groupers and squirrelfish with boats historically going out from Tent Bay, Martins Bay, Consett Bay and Skeets Bay. Lobster traps are used by fishers at Consett Bay, Martins Bay area, Archers Bay, Skeetes Bay and off Silver Sands.

There is limited monitoring in the Caribbean of fish and shellfish and the potential impacts of climate change on them, but Oxenford and Monnereau (2017) consider the reef-associated shallow shelf fish to be the most vulnerable group as their habitat is negatively affected by climate change and anthropogenic activities, stocks are over-fished in some locations and many species require specific benthic nursery habitats (which could be damaged by human activity or climate change).

Marine turtles have been used by coastal communities for centuries to provide eggs, meat, shell, oil, leather and other products (Ministry of Environment and Drainage, 2016). The Barbados Sea Turtle Project is involved in conservation through research, education and public outreach and is in Island Magazine's Blue List as one of the top 100 sustainable tourism activities on islands in the world.

Coastal Landscape

The value of the landscape is well recognised and consequently much of the land covered by this ICZM Plan lies within the Barbados National Park. There are also individual sites that have designations under the Barbados National Parks and Open Spaces System (Coastal Landscape Protection Zones as defined within the PDP (2017).

Coastal Wildlife

The ICZM Plan area is also significant for its coastal wildlife as it includes important stop-over points for migrating birds. In fact, the island's location on a major route for migratory birds has also resulted in some 150 species of being recorded. It is likely that the indigenous vertebrate fauna of Barbados was never very diverse because of the small size of the island, its low lying coralline topography and its relatively isolated position from North and South America.

Management Responsibilities

Fisheries Management

Fishing, as an economic activity, operates under the jurisdiction of the Fisheries Division of the MMABE. The objective of fisheries management and development in Barbados is to ensure the optimum utilization of the fisheries resources in the waters of Barbados for the benefit of the people of Barbados" (Fisheries Act section 3(3)). This is also the mission of the Fisheries Division for the Barbados fishing industry, and optimum utilisation has been interpreted to include non-commercial and non-food uses of "fish". The latter term is very broadly defined in the legislation to include most harvestable aquatic fauna and flora.

It is not a major contributor to the economy based on the official statistics, which suggest fishing provides 0.5-1.0% of Gross Domestic Product (GDP) annually. As for many eastern Caribbean nations, the true value of the fishing industry is seldom accurately estimated due to deficiencies in available information and the fact that ecological/environmental values such as biodiversity are often ignored within the national system of economic accounting.

The primary mechanism for incorporating biodiversity principles into fisheries management has been through the fisheries management planning process and implementation of the product as illustrated by the two Fisheries Management Plans (FMPs) that have been approved between 1997 and 2001. The 2001- 2003 FMP sets out guiding principles for the management of fisheries in Barbados summarised from the *Code of Conduct for Responsible Fisheries*. The FMP was first operationalized by the Fisheries (Management) Regulations of 1998. Also relevant to some aspects of fisheries management, particularly of the inshore fisheries, are the Coastal Zone Management Act (1998) and plans under the jurisdiction of the Coastal Zone Management Unit (CZMU) of the MMABE. The CZMU has authority over virtually all inshore areas and resources except those under the Fisheries Act or Fisheries Management Plans. Although still in a phase of administrative transition, the CZMU has legal authority over MPAs, the rules of which override normal fisheries management provisions within the boundaries of MPAs.

In more recent times, fishers are experiencing impacts from the increasing influx of sargassum into coastal waters, which is also thought to be related to climate change. Increasing levels of sargassum influx onto beaches has had particularly severe impacts on both the tourism and fisheries sector, sometimes accumulating in such great quantities that it prevents access of fishing vessels to beaches and jetties and may also interfere with harvest activities offshore (Ramlogan et al. 2017). If not promptly removed, which can be an extremely labour-intensive activity, the decomposing sargassum can also damage nearby marine electronics, including outboard motors, through the release of corrosive hydrogen sulphide gas. To date, fishers have adapted to these impacts primarily through short-term coping strategies, although there is interest in developing a more comprehensive response strategy (Ramlogan et al. 2017).

Coral Reef Management

The primary legislation governing coral reef management in Barbados is the CZMA, Cap. 394, 2000 which was enacted to provide for the more effective management of the coastal resources of Barbados, for the conservation and enhancement of those resources and for related matters. It also makes provision for the establishment of a CZMU, to administer the legislation.

The primary responsibility for management of coral reefs in Barbados therefore falls to the CZMU (within MMABE). Ministry of the Environment and Natural Beauty (MENB) is responsible for protection of the marine environment and beatification of the coast and beaches. EPD are responsible for addressing all sources of marine pollution, as well as the NCC who are responsible for the management of the Folkestone Marine Park.

Some key issues of relevance are listed below:

- Barbados ratified the LBS Protocol under the Cartagena Convention (Concerning Pollution from Land Based Sources) on 29 June 2019.
- Barbados has also developed a draft National Programme for the Rehabilitation of Barbados Coral Reefs (prepared in 2014 as a collaborative effort of various agencies of the then Ministry of Environment and Drainage). This plan focuses on rehabilitation through improving baseline information and measures to reduce stressors on coral reef, with no mention of restocking initiatives that were developed separately.
- Whilst Barbados does not have a 'coral reef report card'[18], there has been a long-running coral reef monitoring programme that has been in operation since 1982. The geographic focus, however, is on the more sheltered west and south coasts of the island, with less recent information available on the coral reefs of the Atlantic Coast (mainly as a consequence of logistical challenges and safety regarding monitoring Atlantic coast reefs).
- Barbados is the only one of the participating countries with a 'coral restocking' initiative initially let by the Government. Permission for this work is attained and granted through a "Coral Reef Research Permit" issued by MMABE.
- The Marine Pollution Act, Cap 392A of 1998 provides for the control of marine pollution and hence plays a key role in coral reef management and marine biodiversity. The Act provides extensive powers for the Director of the Environmental Engineering Division to control and investigate marine pollution (including land-based sources, sea-floor activities, ocean dumping and airborne sources). Under this Act, the Minister and the Director are required to operate under the provisions of the CZM Plan stipulated by the CZM Act.

Management approaches such as Ridge-to-Reef (R2R) and MSP recognise and attempt to address the impacts of land based activities and conflicting uses. To be effective, management must also consider societal attitudes and social impacts, engage with communities, and incorporate education and outreach programmes. While these approaches are not new, their effective implementation continues to be a challenge for many SIDS including Barbados.

The Barbados Coral Nursery Programme is of relevance towards supporting improve coral reef management in the country. It consists of two linked projects. That is, the Ecosystem-based Adaptation Pilot Project of the Coastal Risk Assessment and Management Programme (CRMP-EbA), executed by the CZMU, which established the first facility in Barbados to culture coral, using terrestrial aquaculture in controlled laboratory (lab) conditions. The Facility was established in a former wet lab at Bellairs Research Institute of McGill University (Bellairs), and on completion of the CRMP-EbA, the operation of the Facility was handed over to Bellairs as the new Executing Agency. The intention was that this arrangement would provide continuity for the operations of the Facility and the efforts established under the CRMP-EbA, and the Facility and its projected output of cultured corals would support the activities of the subsequent Public-Private Partnerships to Preserve Coral Reefs Project or BA-M1014. The Government of Barbados' investment in establishing the facility forms counterpart funding for BA-M1014. An NGO, Coral Reef Alliance of Barbados (CORALL) was established under BA-M1014, with the intention that the project would build the capacity of this NGO to carry on the work that has been initiated[19].

Importance of Target and Non Target Species in Biodiversity

The formal regulatory mechanism that provides legal authority for the Fisheries Division to prepare Fisheries Management Plans for the Fisheries Act (section 4). The Chief Fisheries Officer is responsible for developing and keeping such appropriate fishery "schemes" for the following 3 species. The Act sets out the mandatory content,

[18] Most are often based on a 4-index scoring system that is being adopted as standard by some international initiatives.
[19] The PPP framework and handover of operations from the government to the NGO established has encountered issues that have contributed to stalling operations. Formal PPP arrangements have not been established between the Government Agencies and the NGO CORALL; effective mechanisms for co-financing have not been established; and capacity building of the NGO CORALL does not appear to have been based on functional requirements to execute the required work.

urges consultation in preparation and review, and requires that approval for implementation be obtained from the Minister.

Reef Fish

Of the three fisheries of relevance within this ICZM Plan, reef fish represent the most complicated case due to the numerous and various uses of their habitat. Some examples of their importance locally include:

- Additional employment, food and income for full-time fishers and their households.
- Income or food supplement for part-time fishers after the main fishing season.
- Attraction for tourism based activities such as submarine tours, diving and snorkelling.

The core area for reef fish (within the CZMA) is the island shelf, which comprises both juveniles and adults, however, the distribution may be wider for early life stages due to egg and larval drift in ocean and coastal currents. This issue of connectivity in early life stages remains of serious concern to fisheries and MPA managers since the effects of events in one marine jurisdiction on another are often less obvious than with the more conspicuous adults. It is especially within these vulnerable stages that non-fishery factors such as water quality and habitat degradation can have influence on recruitment to a fishery in the same, or another, country. Also, coastal waters and coral reefs in Barbados are heavily used for an increasing variety of activities due to the growth and diversification of tourism that has led to a wide range of water-sports. Management of the reef fishery, in order to optimise economic returns from the resource, has to take into account multiple objectives and the different needs of stakeholders. Some of these include non-consumptive uses of the resources.

The objective for the reef fishery in Barbados, as part of this ICZM Plan, is to support the Fisheries Division to rebuild reef fish populations to levels capable of satisfying the requirements of both the commercial fishery, and recreational or tourism non-harvest uses, in order to obtain the optimum social and economic benefits from the resource.

The provisions covering reef fish under both the fisheries and CZM legislation are summarized within the Fisheries Act (i.e.: the use of dynamite, poisons and noxious substances is prohibited) plus the Fisheries (Management) Regulations. Co-management arrangements, in the context of this ICZM Plan and associated legislation, are also being vigorously promoted. This requires an integrated, participatory approach to reef fish management, involving all of the stakeholders and most of the management approaches above to deal with the complex issues surrounding this fishery.

Sea Urchins

Although the sea urchin harvest has been regulated for a longer period than the other fisheries it is currently in a poor shape as a consequence of overfishing. Ensuring the recovery and sustainability of the fishery is important for maintaining the biodiversity of fisheries resources in Barbados for several reasons including:

- Potentially very lucrative fishery for supplementing income for full-time fishers.
- Income alternative or supplement for part-time fishers after the main fishing season.
- Urchins perform important ecological functions through grazing algae and seagrass.

Discrete stocks of sea urchins probably do exist on the Barbados shelf (within the ZoI of the CZMA – see Part A2.1) given its relative isolation from other island shelves. Historically, this used to be an extremely important fishery for Barbados for income and employment (Mahon and Parker 1999) and there is a cultural attachment to sea egg consumption.

The objective of this fishery guideline, as part of this ICZM Plan, is to rebuild populations and establish a co-management arrangement with fishers to maintain populations at levels, which can sustain long term optimum yields for social and economic purposes.

The regulation of the sea urchin fishery is linked to a historic Sea Egg Preservation Act of 1879 that established a closed season encompassing what was observed to be the peak spawning period. The closed season has been the main regulatory measure, though in more recent times there was a moratorium from 1987 to 1989 when harvesting sea eggs was not allowed. Since 1989, the closed season has been from 1 January to 31 August. During the open season from, 1 September to 31 December, it was against the law to:

a) Leave the shell or offal of sea eggs on any bank or in shallow water.

b) Wilfully or wantonly destroy or injure any sea egg.

Due to inadequate enforcement and absence of social sanctions, illegal harvesting often started as early as July. The 1998 regulations imposed additional restrictions and closed the fishery for 3 years in order to facilitate recovery and establish co- management arrangements for the future of the fishery.

Sea Turtles

Within Barbados as well as for many SIDS, the sea turtle is the living coastal resource with most charisma and appeal to public conservation efforts. Global communication has made its plight well-known and the response has been encouraging because people perceive these animals as important for reasons including the following:

- Barbados has a global conservation responsibility for sea turtles;
- Recovery and resumption of a viable traditional fishery is possible;
- Turtle viewing and feeding can be a profitable tourism-based activity;
- Maintenance of turtle biodiversity may be used to promote eco-tourism.

The objective for this fishery is to promote the protection, conservation and recovery of the sea turtle populations which is in line with the FPMR as defined by the Fisheries Division (2001). This is the one fishery in Barbados where the objective should not contemplate even restricted consumptive use. Despite this, non-consumptive use such as viewing or swimming with turtles has the potential for generating economic returns under this strict conservation regime.

Habitat Rehabilitation

Many of the environmental stressors described, such as pollution and resulting poor water quality, are chronic and hence habitat rehabilitation techniques need to embrace a range of factors. In addition to this, whilst acute episodic damage can occur from natural hazards (such as storms), the same may apply from anthropogenic hazards such as ship groundings and oil or other contaminant spills. Hurricanes and coral bleaching have both direct and synergistic impacts on coral reefs in Barbados.

With regard to designing measures to address these hazards (notably habitat rehabilitation techniques), Barbados represents a useful example of the need to introduce “ridge-to-reef” targeted biodiversity conservation related

actions. Beaches, for example, are reproductive habitat for sea turtles and that this is the reason conservation of beach habitat is so important for these species. Several watersheds discharge into the FPMR, including the largest on the west coast, so that issues with LBS within this MPA cannot be ignored. However, these watersheds are the subject of an ongoing initiative to improve storm-water management and to implement best management practice with regards to rehabilitation and conservation related adaptation measures. In light of the observations at FPMR, success factors have been reduced on the west coast of Barbados for a number of reasons that include the following:

- Growth/production rates were significantly overestimated;
- Overall stock multiplication was not achieved which was attributed to issues with the facility setup and culture methodology adopted.
- The Private Public Partnership (PPP) framework and handover of operations from the government to the NGO which was established has encountered issues which contributed to stalling of the operations. Formal PPP arrangements need to be better established between Government Agencies and any NGO;
- Effective mechanisms for co-financing were not established; and
- Capacity building of the NGO was not based on functional requirements to execute the required work.

With specific reference to coral reefs, Barbados is one of the few countries in the Caribbean that have recently attempted to focus on ex situ coral culture. One specific intervention, the Barbados Coral Nursery Programme, consists of two linked projects, namely the EBA Pilot Project of the Coastal Risk Assessment and Management Programme (CRMP-ENA), executed by CZMU. The Facility was established in a former wet laboratory at Bellairs Research Institute of McGill University (Bellairs), and on completion of the CRMP-EBA, the operation of the Facility was handed over to Bellairs as the new Executing Agency. The intention was that this arrangement would provide continuity for the operations of the Facility and the efforts established under the CRMP-EBA, and the Facility and its projected output of cultured corals would support the activities of the subsequent Public-Private Partnerships to Preserve Coral Reefs Project or BA-M1014. The GOBs' investment in establishing the facility forms counterpart funding for the IDB funded (BA-M1014) project. An NGO, Coral Reef Alliance of Barbados (CORALL) was established under BA-M1014, with the intention that the project would build the capacity of this NGO to carry on the work that has been initiated.

C7.2. Implications

It is important to stress that current biodiversity levels witnessed in Barbados (coastal, terrestrial and marine) is the result of hundreds of millions of years of evolutionary history whilst also being shaped over time by human interventions. The various components of coastal and marine biodiversity, in particular, have enormous importance to all aspects of Barbadian life especially food (fisheries) in addition to providing the basis for recreation and tourism. Over time, the greatest value associated with biodiversity conservation and habitat rehabilitation issues may be found within the opportunities that they provide to Barbadians for adapting to climate change.

As defined within the PDP (2017), Barbados has a well-developed physical and social infrastructure including, transportation networks within the CZMA. It also has one of the highest population densities in the world. These factors, over time, have led to rapid development throughout the country, and resulted in the existence of very few areas that can be considered as being truly remote. Consequently, the island's biological diversity is limited, and the existing natural coastal resources are constantly under threat from the encroachment of human activities.

Climate change related threats are very real in Barbados and this will impact upon marine and terrestrial biodiversity levels is not managed accordingly. Hurricanes, for example, can create massive damage to the structure of coral reefs and cause widespread reef death. The combined effects of hurricanes and bleaching are blamed for much of the decline in coral cover in the places that are otherwise well managed. Sustained bleaching events also can cause reef death. In the past coral reefs have had time to recover from both hurricanes and episodic coral bleaching events. Within the next century, ocean acidification also poses a severe threat to corals and reef ecosystems (Burke et al, 2011). Ocean acidification can significantly impair larval success at levels of aragonite saturation, which is also a level some coral reefs will experience in the next decade (Albright et al, 2010; Chan and Connolly, 2013). Ocean acidification may therefore have more immediate effects on coral reefs at much less severe levels of acidification by impairing recovery between mortality events caused by bleaching and cyclones. Ocean acidification can directly damage coral reefs and can reduce their ability to recover from mortality events (Ferrario et al, 2014).

Other factors of importance related to water quality (see Section C2), the over exploitation of natural resources (see Section C8), direct habitat destruction (including construction and anchor damage – see Section C6) and invasive species (lionfish, sargassum, etc. – see Section C2).

Finally, biodiversity conservation is concerned not only with the protection of wild species but also with the safeguarding of the genetic diversity of cultivated and domesticated species on which Barbadians depend. The negative impacts on the natural environment (including biodiversity) from development activities have far-reaching social and economic implications. Thus, Barbados requires strong management, policies and regulations that relate to conservation which emphasise the importance of protecting the remaining coastal resources, habitats and species plus where appropriate, seeking to initiate rehabilitation programmes.

C7.3. Management guidance

According to the current status and implications as set out above, the following section provides national management guidance as follows.

Conservation and Marine Protected Areas

A MPA is a tool in the conservation space used to effectively manage natural resources of the marine environment with the intention of meeting targeted goals and objectives be it at the site, national or even regional level. Terms, functions, definitions and rules may vary, interchange and sometimes overlap by country but generally the overall desired outcomes are similar, be it a Marine Park, Marine Reserve, 'No Take' Area, Marine Managed/Management Area (MMA), Environmental Protection Area (EPA), Fish Sanctuary or even Special Conservation Area among others. They all have gazetted designations that empower their mandate. MPAs require active management from a governing body which can be the Government or by an NGO that is given the authority to do so through the respective government, that is, through a formal co-management arrangement.

MPAs that are well funded and supported work well and achieve their overall desired outcome. In the face of a changing climate and the need to employ more EBA and building resilience there is a push to expand the number and size of MPAs. This can be seen in the Caribbean Challenge Initiative (CCI), for example, which encourages regional governments to buy-in and commit to increased marine protected area incentivised by a well-conceived funding architecture (the Caribbean Biodiversity Fund).

In terms of protecting valuable marine biodiversity, Barbados has one formal MPA, the Folkestone Marine Protected Area (that was established on March 1, 1981 on the mid-west coast of the Island) and a proposed MPA along the south coast at Carlisle Bay. The Folkestone Park and Marine Reserve (FPMR) is managed by the GOB through the NCC under the Restricted Areas Order, 1981 and the Marine Areas (Preservation and Enhancement) (Barbados Marine Reserve) Regulation 1981. The FPMR management is, however, focused on the recreational uses of the Reserve and less so the conservation aspect. The FPMR comprises four (4) zones, these being the Scientific, Recreational and the Northern and Southern Water Sports Zones. In spite of this, Conservation Zone that is defined is considered to be inadequate in size for the desired outcome. Further, it is also faced with Land Based Sources (LBS) of pollution in particular, sewage from failed hotel and residential systems along the west coast of St James and St Lucy Parishes.



Figure C.13. Protected areas.

The proposed Carlisle Bay Marine Park (CBMP) is located on the south west coast of Barbados and is a calm, sheltered area where a variety of recreational activities occurs on a daily basis. The bay is popular for diving, snorkelling, and the anchoring and sailing of yachts. The marine biodiversity in Carlisle Bay is extremely rich, with more than three hundred and fifty (350) species of tropical flora and fauna. Among these are organisms such as the frog fish (*Antennarius multiocellatus*), which is rare in Barbados, and the sea horse (*Hippocampus erectus*) which is rare worldwide. These, and other organisms, live on the scattered patch reefs and artificial reefs in the form of sunken ships that make up the primary ecosystems in the area. At present, there are five (5) major wrecks in the bay: the Berwyn, the Fox, the C-Trec, the Bajan Queen and the Eillon, which attract more than forty (40) dive boats and glass bottom boats on a weekly basis.

The idea of protecting Carlisle Bay and forming a CBMP was brought to the Government by the Professional Association of Dive Operators (PADO) in 1993. The divers had observed a deterioration of the marine ecosystems in the area and attributed the decline to 'anchor damage, pollution from land-based sources and from heavy use of the area by visitors and locals'. Coupled with the uniqueness of the area, it seemed essential that the bay be protected in order to preserve and possibly rehabilitate the systems in the area. CZMU currently maintains demarcation lines that indicate the northern and southern limits of the protected area as well as a number of mooring buoys within this area.

Proposed Marine Management Areas (MMAs) are present within the CZMA. The boundaries extend 1km offshore and are found at the following locations:

c) St. Alban's Church/Weston to Fitts Village Esplanade St James and
d) Pierhead, St. Michael to Rockley/Caccrabank Christ Church.

Supporting Guidance and Policy

Sustainable development challenges persist with regards to implementing biodiversity conservation in Barbados. Anthropogenic stressors underlying the reef degradation persist and continue to be a management challenge in Barbados. Obvious examples include water quality related issues coupled with unplanned and sometimes illegitimate coastal settlements which directly and visibly impact the marine environment, sometimes in marine protected areas, such as at (or adjacent to FPMR). To this end, Management Guidance for biodiversity conservation and coastal habitat rehabilitation in Barbados needs to take into consideration the following for improved delivery (see Action Plan in Section C7.4):

- Compliance and enforcement with the current environmental regulatory system (see section C4 - ESIA) is paramount towards ensuring that existing and future development planning pays due cognisance to the principles of Ecosystem Based Management (Kp2), Islands Systems Management (Kp5) and Environmental liability (Kp8). Linked to this the spatial importance of both the CZMA and the buffer "ZoI" (see Part A1.2) must be embraced within development planning in order to embrace biodiversity conservation. Whatever development proposal that may be proposed in the future, that falls within either of the core CZMA or the ZoI, must be subjected to the procedures set out within the established Barbadian ESIA process (as part of the Planning and Development Act (2019)). The advisory role of the CZMU, being part of the Planning Development Board (as defined within the 2019 Act) should ensure that biodiversity conservation considerations will be raised early on within the planning process regardless of a development proposals spatial location. The importance of enforcement with existing regulation and legislation remains of pivotal importance.
- There is a need to reduce overlaps, conflicts, and gaps in management jurisdictions that relate to the coastal environment (within particular reference to water and groundwater quality) which hinders effective integrated management. The aspects apply to terrestrial issues and importantly (in the future) developmental proposal that may be proposed under new Blue Economy policies being developed by MMABE (post 2020). Watershed management (ground- and storm-water; sewage management) remains of importance here and actions in line with the Roof to Reef Programme remain of relevance here.
- This important issue (collaboration) is developed further within Part E of this ICZM plan (implementation).
- There are very few gaps in the sea turtle baseline monitoring data for Barbados and the data are made available if requested by Government agencies responsible for the management of the species and for management of their habitats. This dataset needs to be continually enhanced over time as far as possible. This important issue (information management) is developed further within Part E of this ICZM plan (implementation).
- Existing coral restocking initiatives vary in scope and scale. There are often no specific, "fit for purpose" policies and regulations for coral restocking activities at the national level. In some cases, the research permit process has been adapted to permit restocking activities, and in other cases exemptions from existing regulations are granted. The application processes are not typically standardised, and instead are often handled on a case-by-case basis and not strategically planned in any way. Some initiatives have been focused on research rather than production for restocking, which has significant implication in terms of scale and process.
- Co-management of MPAs (or similar) with intended self-sustaining revenue generation often encounter issues including revenues that fall short of original estimates as well as funding needs, non-compliance and inadequate enforcement, and inability to address impacts originating outside the MPA boundary. Legislation and regulation of MPAs is often disproportionally targeted on the fishing sector. Many initiatives focused on 'alternative livelihoods' for fishers have encountered issues associated with low or un-sustained uptake from the targeted groups. Also, it appears that such initiatives (MPAs, alternative livelihoods etc.) have often proceeded without being informed by detailed planning such as feasibility studies and market research.
- PPP or co-financing models must go well beyond nominal partnerships to formal detailed agreements that clearly identify and allocate risk, responsibility and identify limitations. Governance arrangements must also be in place to protect the parties involved and the stakeholders as well as to ensure transparency and accountability in the management of funds. The suitability and capacity of the parties must also be considered. More information on financing modalities for marine biodiversity related matters is included in Part E6.
- Reef fisheries and sea turtle management remains an important aspect for targeted attention, to ensure matters concerning stock depletion, habitat degradation and destruction, inadequate information, enforcement ability and conflicts between other fisheries and activities are addressed in a robust manner.
- Invasive Species management is another key issue. Marine pests are species that are not native to Barbados which can have a negative effect on the marine environment. These species are usually accidentally introduced from overseas by human activities, such as shipping. Improved monitoring and corresponding action is needed (see "State of the Coast" monitoring needs).

The above issues often relate to weaknesses regarding the jurisdiction of an MPA as defined by its boundary. Often there are adjacent land-based issues, that urgently need to be addressed in order to effectively manage a protected area but there is an inability to deal with the source of the impact that originates outside the boundary. It is therefore very important for future Management Guidelines to carefully select the boundaries of a protected area, not just for bio-physical and ecological importance, but also with consideration for the associated socio-economics impact and or there must be a plan for inclusion and integration.

One important Management Guidance recommendation, promoted within this ICZM Plan, is to produce "Health Report Cards" (in partnership with EPD) to cover a range of agreed habitat health parameters. They should be produced and designed to enable a reader (via print or online media) to quickly understand the status of a coastal habitat, and to understand important species that maybe found there plus the coastal pressures that are being upon them. Health Report Cards should be designed by CZMU (in partnership with the Fisheries Division, EPD and others as appropriate) to provide an overview of the health of a specific ecosystem, specific Parish coastlines, specific species (turtles/sea urchins/reef fish, etc.) or specific areas (e.g.: defined marine protected area). Within such Health Report Cards, a scoring system should be adopted. They should describe the status (the condition of an indicator) and trend (change in status through time) of each indicator. Status and trend can be stated for as far back as five years if trusted data is available, during which time any observed change should be captured if regular monitoring is in place. The scoring of habitat health status should use categories as follows:

SCORE					
Very Good	Good	Moderate	Poor	Very poor	Undetermined (*)

(*) If not enough data has been recorded or the data is too variable or natural levels of an indicator against which to compare current levels are uncertain).

Table C.28. Habitat health scoring.

The above collectively helps to convey the "ecological integrity" of a coastal or marine habitat, site or specific species type presenting it in a public-facing form, which summarises the various monitoring findings undertaken by CZMU and other partners on a monthly or annual basis into an easy read pamphlet format. This information can then be easily provided online onto the CZMU website. It will then help to provide the detail needed to deduce what approach is needed to successfully initiate habitat rehabilitation programmes in Barbados. Details on this are developed further in Part E.

In the interest of preserving coastal biodiversity the following recommended polices shall apply:

A) DIRECT CONSTRUCTION IMPACTS ON CORAL REEFS AND OTHER SENSITIVE HABITATS MUST BE AVOIDED

B) NO CONSTRUCTION MATERIAL SHALL BE PLACED ON THE ACTIVE BEACH FACE OR BE ALLOWED TO ENTER THE MARINE ENVIRONMENT

C) ALL POOL WATER AND SEWAGE DISCHARGE SHALL BE CONTAINED ON SITE AND SHALL NOT BE ALLOWED TO ENTER THE MARINE ENVIRONMENT

[20] Projects including the Ecosystem based Adaptation (EBA) Pilot Project (IDB funded Loan 2463/OC-BA project) have specific bio-indicator monitoring parameters already set up for coral reef rehabilitation/nurseries.

With specific reference to mangrove habitats, the following recommended policies shall apply:

A) THE STRATEGIC PLANTING OF INDIGENOUS SPECIES IS STRONGLY ENCOURAGED;

B) THE PLANTING OF MANGROVE SPECIES CONSISTENT WITH THOSE FOUND IN THE RESPECTIVE AREA MUST BE ADHERED TO.

C) THE REMOVAL AND DESTRUCTION OF MANGROVE STANDS IS STRICTLY PROHIBITED;

D) A 15 METRE DEVELOPMENT SETBACK BUFFER FROM THE LANDWARD EDGE OF THE MANGROVE MUST BE STRICTLY ADHERED TO

SELECTING BIO-INDICATORS TO ASSIST CONSERVATION AND REHABILITATION MEASURES

Selecting ecologically relevant biomarkers/bio-indicators (defined as processes/organisms) that provide information on the marine environmental quality through identifiable reactions (biochemical, physiological and morphological) is a useful exercise for CZMU to embrace. This should build on the existing good work already underway in terms of implementing the Barbados Water Quality Monitoring and Coral Reef Monitoring Programmes[20]. The approach for bio-monitoring programs for Barbados is beneficial to CZMU, not only for helping to monitor coastal ecosystems and marine protected areas in a more integrated manner, but also remains a critical aspect of any future Barbados "State of the Coast" reporting system (as proposed within this ICZM Plan) and also for annual SDG reporting responsibilities (see Part E).

One important bio-indicator to include in future decision making with regards to coastal habitat rehabilitation and wider conservation links to using invertebrates. As these are key components of all marine ecosystems and their health and survival are seriously threatened by marine pollution, it is relevant that a combination of appropriate invertebrate focused "biomarkers" are selected. Specific details on what "indicator" to be selected does require more field survey investigation to help identify the best biomarker and bio-indicator that may be used for Barbados. These can be used to act as appropriate prognostic tools to act as an "early warning system" on heightened marine pollution levels.

Secondly, a specific health score for coral reefs is relevant in Barbados and something that has not been formally set up. Coral cover is important to assess and a measure of the abundance of hard and soft corals and indicates the capacity of coral to persist under the current environmental conditions. Coral cover also represents the availability of brood-stock required for the ongoing supply of future coral generations. Coral change is a measure of the observed change in hard coral cover compared to modelled predictions. A healthy and resilient coral reef is expected to show an increase in coral cover and ultimately the number of reef fish/sea urchins/turtle populations during periods that are free from disturbances and this indicator directly assesses the rate of coral cover increase over the rolling four years of monitoring. Juvenile coral density cover is another important measure of the abundance of hard-coral juvenile colonies (up to five centimetres in diameter), standardised to the space available for coral settlement. This helps to indicate the ongoing replacement of corals necessary to recover from disturbances or stress.

Coral community composition is another important measure of changes in the relative abundance of coral species from a baseline. If the composition of communities moves beyond the standard error of their baseline condition toward a community indicative of higher concentrations of nutrients and turbidity, a score of zero is returned. Conversely, a score of one is given if the change is toward a community indicative of improved water quality conditions (Thompson *et al.,* 2017).

Macroalgal coverage (seaweed) can also be an important bio-indicator to measure. A low score for macroalgae (i.e. poor or very poor) means macroalgal cover is high, which is indicative of poor water quality. Conversely, a high score for macroalgae (i.e. good or very good) means cover is low. High macroalgal cover, once established, reduces the recovery of corals by denying them space or by producing chemical deterrents that limit the recruitment and growth of coral. It is proposed that in the short term, an aerial assessment of coverage is calculated using UAV (drone) technologies to calculate spatial coverage of seaweed compared to bare sand coverage.

Finally, a clear indicator relating to marine invasive species in Barbados needs to be monitored as part of any conservation or rehabilitation programme in any location. The key question that a future Marine Invasive Species Score Card should seek to answer includes *"What is the impact of marine pests on the coastal ecosystem and how is it changing?"*

Report Score Card "sections" of a proposed CZMU Coastal Ecosystem Health Card	**Recommended "Indicators" for Monitoring and subsequent Health Card Scoring**	
	Draft Indicators to be included in the Health Card	**Draft Indicators to be measured *(inappropriate to be included in the Health Card)***
THEME 1 Water Quality	• Total Nitrogen; • Total Phosphorus; • Suspended sediments (future parameter); • Dissolved Oxygen; • Chlorophyll "a";	• Salinity; • pH; • Temperature;
THEME 2 Public Health	• Lionfish observations • Bacteria (enterococci);	• E.coli (future parameter) • Seaweed coverage observations (using AUV/drone to calculate against sand coverage); • Reef rubble extent);
THEME 3 Biodiversity	• Percentage cover of corals (both live and dead), algae and non-living material; • Presence of newly settled corals and juveniles; • Frequency of marine invasive species; • Frequency of sea cucumbers; • Change in sea urchin coverage (*Diadema antillarum);*	• Species or genus composition and size structure of coral communities; • Numbers, species composition, size (biomass) and structure of fish populations; • Extent and nature of coral bleaching; and or extent and type of coral disease; • Macro-algal (seaweed) coverage (m2);

Table C.29. Recommended "Indicators" for Monitoring and subsequent Health Card Scoring

C7.4. Action brief

CODE	ACTION	LEAD ACTORS	OTHER ACTORS	RELATED ACTIONS	INDICATOR	TIME SCALE	COMMENTS
BIO1	Support the implementation and enforcement of actions within existing and updated FMPs (Fisheries Division) with specific regard to reef fish, sea urchins and sea turtles.	Fisheries Division	CZMU	Marine Spatial Plan and Blue Economy related project outputs being initiated by MMABE	Update to FMPs	Short term	This Action embraces the 1998 ICZM Action (Gen F.1) to help improve the status of suitable fisheries
BIO2	Creation of strict protected areas/zoning schemes to help support delivery of effective "refuge areas" for marine biodiversity and fisheries schemes as other options for management.	Fisheries Division	CZMU	Marine Spatial Plan and Blue Economy related project outputs being initiated by MMABE	Stock enhancement recordings	Short term	This Action embraces the 1998 ICZM Action (Gen Z.2) to help examine marine zoning schemes for the enhancement of fisheries and conservation needs.
BIO3	Initiate co-management demonstration projects to encourage sea urchin and reef fishery enhancement.	Fisheries Division	CZMU	Marine Spatial Plan and Blue Economy related project outputs being initiated by MMABE	Inception Meeting notes disseminated to all key partners	Medium term	This Action embraces the 1998 ICZM Action (Gen F.3) to help improve better enforcement of fishery regulations and stock recovery.
BIO4	Initiate a programme of "State of the Coast" reporting to support SDG and NBSAP update and reporting requirements.	CZMU	EPD, NCC, Fisheries Division	Bi-annual State of the Coast reporting activities coordinated by CZMU.	Production of a Planning Development Board authorised "State of the Coast" report (one a year)	Short term	Baseline information should be collected on factors affecting the status of key fish stocks and coral reefs and potential feasibility of interventions, such as land-based sources of pollution
BIO5	Production of a series of "Health Report Cards" on the health of the national coastal ecosystems.	CZMU	EPD, NCC, Fisheries Division	Marine Spatial Plan and Blue Economy related project outputs being initiated by MMABE	Production of annual health cards	Medium term	Details are presented in Part E of this Plan
BIO6	Habitat rehabilitation/ re-stocking/EBA strategy to embrace all terrestrial/marine habitat damage mitigation measures in a gender sensitive manner.	CZMU	TCDPO, EPD, NCC, SCU	Public awareness campaign to commence outlining the need for terrestrial/marine habitat restoration programmes and research needs, permissions and licensing requirements needed if damage occurs within the defined CZMA	Production of national costed strategy New appropriate policy and legal framework for coral restocking initiatives created	Short term	Alignment with any future Blue Economy strategy, plan or policy. This may manifest into the development of a broad Coral Reef Management and Action Plan which takes an integrated approach to address the various stressors on reef environments and also pays specific attention to the management of restocking/rehabilitation techniques.
BIO7	Improve public awareness on coastal biodiversity issues and workshops on coastal rehabilitation and EBA approaches.	CZMU	Fisheries Division, EPD, NCC	Public awareness campaign to commence outlining the need for terrestrial/marine habitat restoration programmes and research needs, permissions / licensing requirements needed if damage occurs within the defined CZMA	Production of public outreach campaign documentation.	Medium term	Close alignment required with other ongoing national outreach events and with guidance defined in section C10.

CODE	ACTION	LEAD ACTORS	OTHER ACTORS	RELATED ACTIONS	INDICATOR	TIME SCALE	COMMENTS
BIO8	Improved collaboration on coastal and marine biodiversity related research and data management relating to improved water quality and ship waste, etc.	Fisheries Division	CZMU, MMABE, Bellairs, UWI, EPD, Barbados Port Inc.	Research Strategy that aligns to the management guidance set out in section C9	Costed National Research Strategy on water quality related studies to support improved coastal and marine biodiversity conservation and coastal habitat rehabilitation	Short term	Details are presented in Part E of this Plan
Monitoring							
BIO9	Create a monitoring system to assess biodiversity conservation in the CZMA.	CZMU	NCC	Need for an improved MPA planning and management regime in Barbados.	Annual monitoring report	Annual	Details are presented in Part E of this Plan

Table C.30. Action brief for Biodiversity Conservation and Coastal Habitat Restoration.

C8. NON-LIVING RESOURCE EXPLORATION AND EXPLOITATION

The definition of a non-living resource includes quarried sands (on land), marine sands (nearshore or offshore), mineral deposits (terrestrial or marine), fossil fuel sources (oil and gas) plus also energy related resources (renewable sources such as solar, wind, tide and wave, etc.).

There are important reserves of sand, clay and limestone on the area covered by this ICZM Plan. Sand reserves are identified in the Chalk Mount and Springfield-Cattlewash areas, but active sand mining is concentrated around Walkers Savannah (Sub-Area 2) which is the site of an ancient dune system.

Fossil fuels are the main energy source used in Barbados. Other sources which are used on a smaller scale are solar energy and to a limited extent bagasse. Exploration and exploitation of oil, gas and aggregates are important industries in Barbados. Although being only a relatively small island of 166 sq. miles (431 sq.km), Barbados does possess a history of oil production dating as far back as the eighteenth century. There are circa 240 oil and associated gas wells onshore in Barbados waters of which 80 to 100 produce at any one time. These wells are located in the Woodbourne Development Area (WDA) and range in depth from 2000 to 6000 feet. Production is mainly from the Scotland Sand Formation[21].

Regarding, renewable energy sources, Barbados has committed to reducing its greenhouse gas emissions by 30% of 2010 levels by 2025 and has targets for an energy system that is 100% renewable by 2030 using geothermal, waste-to-energy, wind, and solar. A fuel levy on carbon has been imposed, and the GOB is also pursuing plans to become the home of the first climate resilient city in the world.

Topic (code)	Non-living Resource Exploration and Exploitation (REE).
Key Legislative Instrument	Coastal Zone Management Act (CAP 394 – 1998) Proposed revisions to the CZM Act (2020) Planning and Development Act (2019)
Policy Outcomes	Outcome 1 - Sustainable socioeconomic development is achieved. Outcome 2 - Coastal resources are protected and effectively managed. Outcome 3 - Climate and disaster risk adaptive capacity is strengthened. Outcome 4 - ICZM is delivered through a coordinated governance arrangement. Outcome 5 - Capacity for ICZM delivery is strengthened for all relevant sectors.
Key Policy Goals	Goal 1.1 – Apply risk resilient standards and procedures to support sustainable development within national socio-economic policies and development planning frameworks. Goal 1.2 – Encourage new and emerging sustainable opportunities within the CZMA that support the development of green and blue economies Goal 2.1 - Develop guidelines to help regulate and manage legally defined coastal resources. Goal 2.2 - Support the rehabilitation of CR through the mainstreaming and adoption of EBA approaches to increase the resilience.
Topic importance	Sustainable development of non-living resources provides a key opportunity for Barbados to generate significant socio-economic benefits that are promoted through policies that support key sectors and which support further implementation of the Blue Economy. This includes all strategic economic policy and planning and integrated multi-sector development in the CZMA and within the ZoI.
Disaster cycle phase	**Preparedness** **Prevention**

Table C.31. Policy outcomes, policy goals and the importance of considering this topic.

C8.1. Current status

Management Responsibilities

Land Based Quarries for Aggregate Extraction

The management responsibility for land based quarries in Barbados includes private sector owned quarries in tandem with GOB supported quarries. Limestone represents the majority of land based quarrying as this rock type covers 80% of the island, ranging in thickness from 45m (central) to 105m (near the coast). The thickest sections are about 190m and are found in the St. George to St. Philip Valley areas. Limestone that has more than 97% calcium carbonate in purity is mined throughout the island. Excavation techniques mainly use blasting and/or ripping by use of excavators. The resulting product ranges in size from boulders (often used for coastal protection schemes) to marl to dust (for use as concrete). Mining operations result in the removal of about 2.5 million tons of limestone per annum in Barbados.

Limestone quarrying takes place from about 16 registered quarries including near the Arawak Cement Plant, located south of Maycocks Bay. Quarries such as Black Bess (St. Lucy) and Lears Quarry (St. George) have been considered in the past (by private contractors) to have suitable quarried sands that may be a potential source of sand that may be used for beach nourishment. The material sourced from these quarries have been laboratory tested to determine if they are suitable to be used for EBA related interventions (beach nourishment) as opposed to using dredging techniques to extract marine sources of sand for beach rehabilitation projects. In general, there appears to be a good physical match between the sediment that could be used for beach nourishment and that already on the beaches around the south and west coast of Barbados. There is however, a tendency for such quarried sands to become quickly compacted when compared to natural beach material (which is commonly a medium sand with a median diameter (d50) of circa 0.6-0.7mm). It also appears that land based quarried sands are often slightly coarser with a d50 of approximately 1.2mm. Section C6 (Emerging Issues) considers this aspect in more detail.

Sand, clay and shale are mined from the exposed Pleistocene Scotland District in the east of the island. Of direct relevance to this ICZM Plan, the sand which is used for aggregates to support the construction industry is mined mainly from the Walkers dunes in St. Andrew. It is estimated that there are sand reserves of about 69.5 million tons to a 30 m depth. It has been stated that nearly every building in Barbados is constructed, in part, from Walker's Quarry sands though GOB estimate that at the current rate of mining extraction of about 250-300 thousand tons/annum of sand from the Walkers area. It is estimated that there is only a safe period of about 10 years remaining before adverse effects of the coastline environment occur.[22] Walkers quarry is located in close proximity

[22] https://www.energy.gov.bb/web/quarrying

to one of the largest native beach-side forests on the island and as a consequence, the scale of the operation and its expansion beyond the licensed areas has caused significant damage to this and associated coastal habitats. Nearing the end of its life as a sand mine, Walkers is now in transition, becoming a demonstration of ecological restoration known as Walkers Reserve.

Nearshore Aggregate Extraction

Marine aggregate extraction covers the offshore extraction of sand and gravel, and the inshore (nearshore) extraction of sand and gravel for terrestrial development projects. Marine reserves of silica (quartz) sand exist off the east coast but the extent of this resource is unknown though there are no plans, at present, to initiate offshore silica sand mining.

On the west coast, private sector funding (via EIA studies over recent years to seek potential sources of material for beach recharge purposes) has enabled the completion of some offshore jet-probing work at several sites. Possible sources of material offshore from Harrisons Point Lighthouse and also close to Maycocks Bay have been found with sand depths of over 2.5m in approximately 45ft of water.[23] These sites do not however, represent sources of sand for exploitation based on their proximity to important living coastal resources (coral reefs plus fish breeding grounds) in addition to being important feeding grounds for turtles (see Section C7).

Offshore Resources (non-renewable and renewable)

Oil and gas

Currently, the island's known tangible natural resources are its onshore oil and gas reserves and its industrial minerals of sand, clay and limestone. There are four (4) main stratigraphic units present in Barbados namely, Coral Limestone, Oceanics formation, Intermediate Unit and the Scotland formation in descending order. The Scotland formation is the deepest known producing unit in the stratigraphic column and is located within the Basal complex is structurally complex.

Like many island nations, Barbados is heavily reliant on fossil fuels for electricity generation, leaving it vulnerable to global oil price fluctuations that directly impact the cost of electricity. The government subsidizes the fuel charge for residential customers, partially shielding that sector from price volatility. The Ministry of Energy, Small Business and Entrepreneurship is charged with the mandate of monitoring petroleum price movements; preparing Cabinet Papers, briefs, speeches, position papers and comments on energy, geological and earth science-related matters. The Natural Resources Department (NRD), which falls within that Ministry, has the role to promote the development of all local natural resources, situated both on-shore and within our marine jurisdiction, including the Exclusive Economic Zone (EEZ), in an economically and environmentally sustainable manner. The recently produced Barbados National Energy Policy (BNEP) 2019-2030 document compliments this ICZM Plan on issues relating to offshore energy.

The Barbados National Oil Company Limited (BNOCL), a statutory corporation of the Barbados Government, currently operates the oil and gas industry in the island Barbados currently produces about 1000 barrels of oil per day (bopd) which is sent to Trinidad for refining (Mobil's refinery in Barbados ceased operations in 1998. The site is presently undergoing soil and groundwater remediation). A total of 2.3 Million Cubic Feet (mmcf is produced and is pipelined to the LPG plant in Woodbourne for processing while 1.6 mmcf of this gas is sold to the National Petroleum Corporation for domestic use before conversion. The Ministry of Energy, Small Business and Entrepreneurship is also responsible for monitoring the BNOCL and the Barbados National Terminal Company Ltd. (which is responsible for the storage of oil products and crude oil); and the National Petroleum Corporation (which distributes the gas produced by BNOCL).

At present, all operations take place in deep waters to the south and east of the island[24] beyond the limit of territorial waters (12nm) though within the ZoI defined within this ICZM Plan (see Part A1.2). This is relevant as should operations advance to the production stage, the siting of facilities, risk of pollution, and the impact on coastal resources and wildlife will need to be carefully considered as part of a future Blue Economy implementation strategy for Barbados.

Renewable Energy (RE)

The Renewable Energy & Energy Conservation Unit (within the Energy Division of the Office of the Prime Minister) are responsible for developing a strategy for future renewable energy use for Barbados which currently is targeted on land, including biomass, solar, wind, and potentially geothermal[25]. Marine renewable energy may include fixed and floating offshore wind, wave and tidal systems. However, there are currently limited opportunities for fixed offshore wind in the Caribbean region (including Barbados) due to nearshore depth constraints, and the fact that other sources of marine renewable energy are either not currently commercially viable or unfeasible when compared to onshore options in the wider Caribbean region. Despite this, consideration is currently being given to ocean thermal energy conversion (OTEC) as well as wave energy. Finally, using Barbados' marine space as a sink for carbon sequestration trade-offs has been raised, though not fully investigated.

The BNEP (2019-2030) document seeks to ensure that Barbados achieves the 100% renewable energy and carbon neutral island- state transformational goals by 2030. The GOB has an aspiration to understand what potential future opportunities exist and how they could be exploited sustainably, including zero domestic consumption of fossil fuels economy wide and creating a regional centre of excellence in RE research and development.

C8.2. Implications

The Barbados economy is faced with traditional challenges pertaining to its limited diversification and fiscal frailty. Barbados is a tourism-based economy whose marine based tourism and fisheries industries make sizable contributions to the nation's GDP. Yet despite the relative importance of ocean-based assets to the economy, GOB faces challenges in valuing, diversifying, and managing its coastal and marine resources (non-living) towards growth.

The implications of not effectively guiding and advising on the future management of non-living coastal resources in Barbados may include (amongst others) the following:

ONSHORE

a) Loss of landscape aesthetic value (quarrying);

b) Increased flood and erosion risk on beaches/dunes (quarrying and sand mining);

[23] BRI (2015) "EIA for Sandy Lane Beach Regeneration and Marine Conservation Project".
[24] http://www.internationalpavilion.com/ICE2019/Barbados_AAPG_ICE2019.pdf

[25] Barbados does not have geothermal energy opportunities as the other volcanic OECS islands do

c) Impact on dune ecosystem functions associated with land based coastal resources;

d) Impact on stabilising coastal vegetation health.

OFFSHORE

a) Increased siltation (plumes) affecting coastal resources;

b) Visual impact of dredging/offshore wind, etc.;

c) Impacts of offshore installations on marine wildlife and fisheries (air and underwater);

d) Pollution and navigational impacts (hydrocarbon exploration / extraction).

To address the implications set out above, and in line with Sustainable Development Goal (SDG) 14, Barbados is rethinking how its coastal society should interact with the vast economic development space around it (i.e.: within this ICZM Plans defined "ZoI") in order to generate new avenues of economic growth whilst ensuring the sustainability of the marine ecosystem's health and value.

The current focus on the Blue Economy offers opportunities for Barbados to diversify its economy into new emerging ocean-based activities and "non-living resource" sectors and to generate employment and growth whilst ensuring the sustainable use of its coastal resources into the future. The establishment of the MMABE is a positive development and creates a strong signpost for the future for Barbados. Given the role and mandate of the new ministry, the GOB has requested support for the institutional strengthening of its new Ministry in order to stimulate economic growth through the Blue Economy and to move towards recovery, diversification, and transformation.

There are also significant implications, from an environmental perspective, regarding the impacts of offshore drilling for non-living resources. Whilst, there is existing legislation to address the environmental management of offshore oil and gas activities, this now needs to be specifically refined.

The need to prevent, mitigate and minimise adverse environmental impacts of oil pollution in Barbadian waters remains paramount. Whilst Barbados has produced an National Oil Spill Contingency Plan (NOSCP - 2002[26]), , the potential risks to coastal resources within the core CZMA remain potentially very high should unregulated, poorly planned or weak Blue Economy policies be set for existing and future offshore drilling (exploration) programmes.

The current NOSCP (2002) and supporting Dispersant Use Policy for Barbados will require updating in line with this ICZM Plan and pending Blue Economy Plans, policies and institutional arrangements to ensure that an appropriate and updated approach is adopted for this issue in the coming years.

C8.3. Management guidance

According to the current status and implications as set out above, the following section provides national management guidance as follows.

In general terms with reference to non-living coastal resources, in order to meet current challenges and realise future opportunities the following management guidance considerations should be taken into account by GOB through a range of supporting authorities. Decision makers should:

- Ensure that a regulatory framework is in place for non-living resources (i.e.: for sub-sea mining, aggregate extraction purposes and exploration / exploitation of subsea and mineral resources found within the CZMA and surrounding ZoI), that will allow full consideration of the status of the associated coastal / marine environment, social and economic benefits of any new activity before it is authorised;
- Ensure that there is a full understanding of the non-living resources available (i.e.: for sub-sea mining, aggregate extraction purposes and exploration / exploitation of subsea and mineral resources found within the CZMA and surrounding ZoI) and the status of the associated coastal and marine environment before any new activity before it is authorised.

Land Based Quarries for Aggregate Extraction

The extraction of material from coastal hinterlands (including backshore beach areas and dunes) needs to be carefully evaluated, regulated and monitored. The PDP (2017) makes it clear that this activity should be strictly controlled in Natural Heritage Conservation Areas and should be carefully managed in other areas to ensure that impacts are minimised. Relevant provisions within the PDP (2017) include the following:

- Sand dunes and natural beaches on Barbados coastline are *key components* of the Natural Heritage System (NHS) that fall within category OS2 (PDP 2013) and are subject to the restrictive provisions for those areas (defined as "Natural Heritage Conservation Areas"). No development will generally be prohibited within the key components of the NHS.
- PDP Overarching Policy 11 states "mineral extraction will be limited to those resources for which there are no alternative sources of supply and the use of the resource is in the national interest".
- In addition, restoration of mineral extraction sites will be required at the earliest possible date and to the highest possible standard.
- The PDP also recognises the need to ensure proper management during the lifetime of the operation, and adequate rehabilitation prior to the closure of the facility.
- Applications for a change in land use or major development inside or within 50m of the boundary of the key components are required to submit an ESIA including for all new resource extraction operations. Approval will only be given if it demonstrated that the proposal will have acceptable impacts or if impacts can be adequately mitigated.
- The Coastal Zone Management Plan will implement the PDP policies for Open Spaces that occur, including OS2 Natural Heritage Conservation Areas.

Key directions are also set out within the Belleplaine Community Plan, emphasizing the need to capitalize on the restoration of Walkers Reserve as a potential employment centre for Belleplaine residents, and as a national tourist attraction by better connecting it to the core of Belleplaine. Key policies (PDP Section 14.4.4 – Policies 9-14 actively promote the need to protect core assets (Natural Heritage). Supporting relevant provisions within the PDP (2017 – Section 14.5) include the following:

[26] developed to facilitate and promote prompt, effective and soundly managed response to marine and terrestrial oil spill incidents

a) Walkers Reserve will be required to meet the provisions of Section 3.11 (Resource Extraction) regarding rehabilitation of the mine site after the sand mining operations have ceased.

b) Walkers Reserve will be promoted as part of the sustainable offering of Belleplaine and the Barbados National Park.

Nearshore Aggregate Extraction

It should be noted that an 'Exploration area' includes the 'act of investigating, through survey techniques for commercially viable aggregate resources within a defined area of seabed'. Aggregate exploration occurs within a defined search area which is larger than the area of the final production agreement. It is crucial that exploration areas have a level of protection, indicated by this policy to make sure that the smaller (in area) production agreements can be implemented.

Development applications located in or around aggregates extraction areas (to be determined following more detailed nearshore mapping to be undertaken through development of the "Blue Economy" to identify future aggregate licence areas) should demonstrate that they would not compromise any aggregate extraction activities. Public authorities should assess proposals for any compromise to, or conflicts with aggregate extraction. If these are identified, public authorities should consider through the existing EIA process, impacts to existing proposals, developments and activities encouraging satisfactory agreement between the relevant competing sectors where any conflict remains. This should include assessing the full range of impacts and benefits which could affect nearshore aggregate extraction licence (or non-licensed) areas. Public authorities should consult the CZMU and key marine stakeholders when considering a development's potential impacts on a nearshore aggregates extraction licence area. Proposals should demonstrate that relevant aggregate companies and others have been consulted, to determine compatibility and to satisfy the public authorities that the policy is met. Early consultation should encourage satisfactory agreement between the relevant competing sectors and help to avoid conflict arising after investment – increasing investor certainty at an early stage.

Exploration and follow up activities are subject to various conditions. The area to which this guidance applies will change, as exploration rights are surrendered over time to make way for production agreements. Where exploration areas are considered unsuitable for aggregate extraction and an operator's rights are relinquished, they then fall outside of the scope of this policy.

Offshore Resources (non-renewable and renewable)

Non renewable

Although there is no active productive of offshore oil or gas industry in Barbados at present, agencies such as CZMU and the Fisheries Division will need to be kept informed of proposed applications or developments. This will include a robust review of EIAs and Environmental Management Plans produced for the sector, including those related to any onshore facilities, and to advise on the necessary environmental and social safeguards (see Section C4). Of relevance to this ICZM Plan for non-renewable resources (oil and gas), the Barbados National Energy Policy (2017-2037) clearly states that in order to achieve sustainable production of oil and gas within Barbados' EEZ, all relevant entities in Barbados shall work together to:

- Develop policies and formulate clear legislation governing environmental management (potential impacts of pollution on the coastal and marine environment) relating to offshore oil and gas activities, with provisions for removal of licenses if stipulations are not met;
- Develop a licensing system with clear criteria on the ranking of various factors critical to the decision on bids.
- Build a defence and security framework to protect the EEZ.
- Establish a sustainable environmental management framework for the upstream offshore petroleum sector.

Renewable Energy

The GOB' National Sustainable Energy Policy has established a target for Renewable Energy Sources to constitute 29% of all energy by 2029. Additionally, Barbados has joined numerous other nations in ratifying the United Nations' Paris Agreement, which is a multilateral environment obligation requiring participants to take determined action to combat the effects of climate change.

The policies of this PDP (2017) establish a framework to build upon this success and continue Barbados' transition to the use of renewable energy. This includes the following:

- The Government will promote the use of renewable energy, a reduction in the use of fossil fuels and overall energy conservation as part of Barbados' transition to a green economy.
- Both large scale dedicated renewable energy generation projects and small-scale renewable energy infrastructure integrated with other land uses will be encouraged though proposals for renewable energy development. Projects over 2 megawatts will be subject to an EIA in accordance with Section 6 of the PDP.
- All land use regulations as prescribed by the PDP that apply to the primary use as well as for the renewable energy project must be satisfied.

C8.4. Action brief

Management guidance and goals described will be implemented through specific actions, presented in the following table. These actions do not exclude actions already performed by the CZMU.

CODE	ACTION	LEAD ACTORS	OTHER ACTORS	RELATED ACTIONS	INDICATOR	TIME SCALE	COMMENTS
REE1	Adopt policies set out within the PDP (2017) to recommend the future location/relocation of non-living resource extraction operations away from OS2 Natural Heritage Conservation Areas (NHCA) or areas with lower coastal hazard risks as identified within the ICZM Plan.	TCDPO	CZMU Fisheries Division	Marine Spatial Plan and Blue Economy related project outputs being initiated by MMABE	Reduced number of non-living resource exploitation/extraction project related EIAs located in inappropriate locations (NHCAs).	Medium term	
REE2	Develop CZM regulations to designate incipient dunes, beach and fore-dunes in areas where removal of vegetation or sand is prohibited.	CZMU	SCU/EPD/NCC/NRD	REE1	CPC endorsement and promulgation of new CZM Regulation 2020.	Medium term	
REE3	Mainstream the sustainable use of non-living resources within national policies and planning frameworks.	TCDPO	All relevant sectors		National Development Plan (NDP) reviewed to ensure that Blue Economy considerations are included	Medium term	
REE4	Develop Blue Economy Valuation Plan including a strategic approach to strengthening public private partnerships and the sustainable use and management of non-living coastal and marine resources.	MMABE	CZMU, EPD, NRD, NCC, Fisheries Division	Opportunities for possible use of seabed resources, renewable energy and based on coastal and marine non-living resources are assessed	Blue Economy Valuation developed and approved	Medium term	
REE5	Strengthen national legal frameworks and guidance (guidelines) for integrated planning and management of non-living resources.	Office of the Prime Minister	CZMU, EPD, NRD, NCC, Fisheries Division	implementation framework in place (including funding mechanisms etc)	Statutory framework and guidance for integrated planning and management reviewed, requirements identified and action plan developed	Medium term	
REE6	Develop a research strategy including national and regional action to support sustainable exploitation and exploration of non-living coastal resources.	CZMU	MMABE, UWI	Operational and monitoring requirements for coastal and marine research and data are identified		Medium term	Capacity, capability and partnerships need to be in place

Table C.32. Non-living Resource Exploration and Exploitation

C9. RESEARCH

Decision-making processes needs to be based on sound coastal knowledge. To obtain this knowledge, coastal managers need updated scientific information about the status of coastal resources and their planned uses in the medium and long term. The elaboration of a Coastal Research Agenda is a key objective for the improvement of coastal management in Barbados. Furthermore, contribution to dissemination, data storage, monitoring and management of research programs must be also a key objective to address the challenge of the transference of knowledge to the ICZM of Barbados.

Topic (code)	Research (R).
Key Legislative Instrument	Coastal Zone Management Act (CAP 394 – 1988) Proposed revisions to the CZM Act (2020)
Policy Outcomes	Outcome 4 - ICZM is delivered through a coordinated governance arrangement. Outcome 6 - Research, understanding and knowledge outreach is increased.
Key Policy Goals	Goal 4.1 - Data collection. Goal 6.4 - Research agenda.
Topic importance	Data and information (knowledge management) remains pivotally important if ICZM is to be successful and sustainable. New strategies are needed that encourage all members of society (private and public sectors plus local groups) have the opportunity to be involved whilst ensuring that nationally important resources (e.g.: genetic resources) are protected under national ownership.
Disaster cycle phase	**Preparedness** **Response** **Prevention** **Recovery** **Research**

Table C.33. Policy outcomes, policy goals and the importance of considering this topic.

C9.1. Current status

The existing legal and administrative arrangements requires harmonization to support more effective research management. Currently, coastal research is associated to two areas, namely the Fisheries Act (1995)[27] and the Coastal Habitat Research Permit [28]which falls under the remit and management of the CZMU. The latter is a permit supplied to any researcher wishing to carry out research within the coastal or marine environment.

From the tertiary education sector, coastal research in Barbados is also conducted through the Bellairs Research Institute of McGill University[29], the Biology Department and the Centre for Marine Resource and Environmental Management (CERMES) Programme of the University of the West Indies (UWI). CZMU also conducts some research topics related to coral, nearshore process, sedimentology and other applied aspects of coastal management. Overseas organizations conduct research near to shore and on deep water. This research programmes regularly are related to physical and biological oceanography.

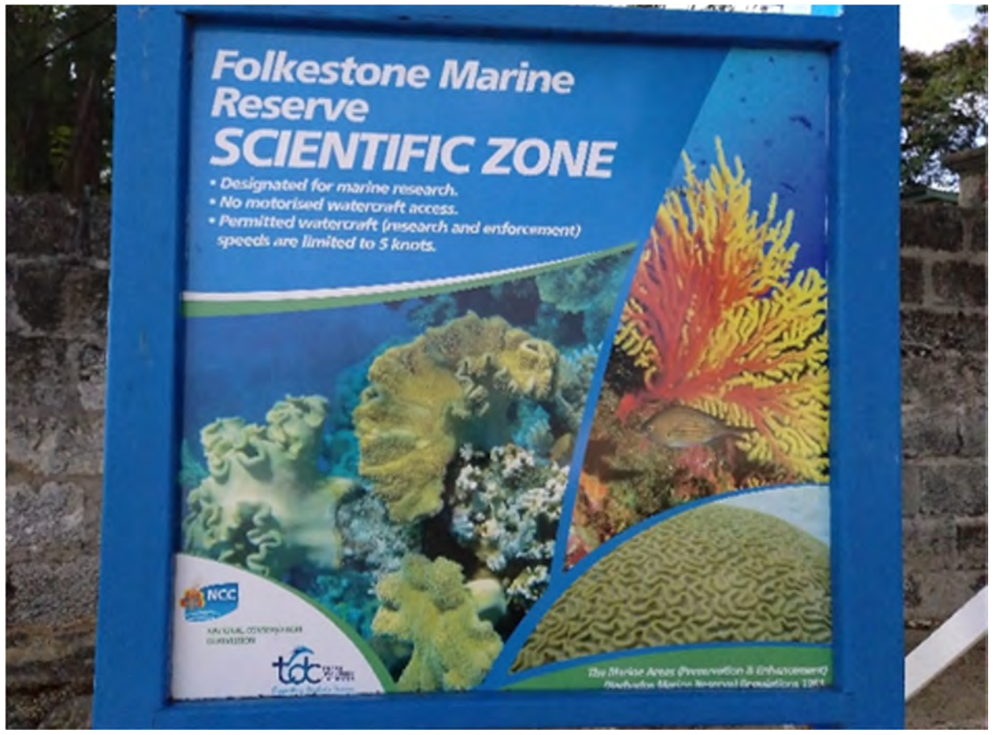


Figure C.14. Information panel of Folkestone Marine Reserve, Scientific Zone.

Actions to improve a more collaborative approach to coastal research may include working arrangements (MoUs, SOPs, etc.) between CZMU, Fisheries Division, Biodiversity Committee and Ministry of Foreign Affairs amongst others. This collaborative approach is important as each agency often has its own research specificity. What may be required is to ensure that each agency maintains a record of their own research as well as copies of all final documents generated from that research.

C9.2. Implications

The enhancement of research and the knowledge transfer to private sectors and to the society in general, is an important tool to face issues related to new evidence such as climate change. Barbados has to continue in the

[27] Clause 26 (2) states *"Subject to subsection (2), no person shall undertake fisheries-related research or survey operations in the waters of Barbados except with the prior written permission of the Minister"*

[28] The use of the research permit is to allow the government to have an appreciation of the research activity being implemented on island. The same applies to UWI. It is clear that the use of the permit by local researchers is not always adhered to.

[29] The field station of McGill University has no direct linkage with the government of Barbados as it is used solely for research of McGill University faculty and staff.

effort of supporting the research of the coast and an important effort has to be made to spread the knowledge to the private sector and to citizens in order to collaborate in the conservation and defence of the coastal resources.

For example, forecasting systems of extreme events is one of the most important challenges related to coastal hazard that requires support, and where research has a key role. Promotion of research focus on national issues will bring back positive outcomes for private and public sectors in Barbados in the mid-term.

C9.3. Management guidance

According to the current status and implications as set out above, the following section provides national management guidance on the following aspects:

- 2020-2030 Coastal Research Agenda.
- Data management, access and dissemination.

2020-2030 Coastal Research Agenda

Specific requirements to be satisfied by the new research agenda are:

- To ensure coordination and collaboration with McGill University, UWI and local research scientist.
- To define a list of main research topics and an annual budget.
- To develop at least a biannual Implementation Plan including cost and schedule of each research programme.
- To guarantee CCA and DRM to be included in the research programmes whenever possible.
- To ensure that all research program guarantee proper coordination, technological transfer and dissemination.
- To improve management of large datasets for archiving
- To provide a link with the Barbados Statistical Service in the collection and analysis of environmental statistics and potentially blue economy statistics.

In addition to the specific requirements mentioned before, some specific aspects should be addressed in the above-mentioned Implementation Plan in order to solve existing concerns:

- Guarantee funds and research for CCA and DRM in Barbados.
- Development and revision of ICZM geospatial information.
- Guarantee the correct working of met-ocean monitoring and ensure data access.
- Promote free access to all monitoring data funding by public entities for the elaboration of new research through collaboration programmes.
- Extend the scope of the beach profile monitoring.
- Ensure the improvement of biodiversity research and data management.
- Advance in the implementation of an integral system of prevention and management of oil spills in the marine environment considering the current Draft Dispersant Use Policy and the National Oil Spill Contingency Plan.
- Assess the feasibility for the development of a National Marine Spatial Planning System to help decision-makers.
- Guarantee the monitoring and result dissemination of the Special Marine Areas in order to promote the creation of reserves and scientific zones.

Data management, access and dissemination

It is recommended that GOB pay due cognizance to regional initiatives currently underway to help pursue meaningful marine and coastal research plus also to better manage new marine and coastal data that will be collected, either as part of the ICZM process or alternatively as part of the developing “Blue Economy” initiatives in Barbados being initiated by MMABE.

> A new coastal research agenda has to be developed to support the challenges and opportunities that face Barbados over the next 10-years. Some of these may relate to CCA and DRM, assurance of the water quality over an increased pollution tendency due to the national population growth and other possible impacts related to new emerging activities that may arise through pursuing a Blue Economy in Barbados.

For example, the OECS Marine Research Strategy (MRS) is currently being formalised has an overall aim to support the implementation of the Eastern Caribbean Regional Ocean Policy (ECROP) by proposing the means to create a more integrated, better-funded, more efficient and more useful framework for marine research in the OECS region. The focus of that Strategy is on improving interactions between marine research actors generally, rather than specifically addressing well established research sectors.

The Code of Conduct for Responsible Marine Research in the Eastern Caribbean region (the Code), is part of the OECS MRS. The Code is addressed both to marine scientists wishing to engage in research activities and to the national authorities of OECS Member States concerned with the granting of permission to conduct marine research activities. It seeks foremost to set general standards for conducting marine research in ways that minimise adverse impacts on the environment, provide the greatest results for the OECS region as an economic space, and encourage the development of research capacity and technology transfer for the benefit of OECS Member States.

OECS requests all scientists working in the maritime space of OECS Member States to adhere to the Code when planning, carrying out and reporting their research. When assessing research plans, OECS Member States are encouraged to ensure that the granting of research permission, the application of research funds and otherwise the conduct of marine research should be contingent on the application of the Code.

Of relevance to ICZM Delivery in Barbados, the Code itself contains the following appendices:

1. General Minimum Standards for the Collection of Data and Samples;
2. General Minimum Standards for Limiting Environmental Impact.

Data standards

The Ocean Data Standards and Best Practices (ODSBP) adopted by OECS nations already include a list of data standards that represent global best practice. When the actions set out within the ODSBP and the MSR are taken forward, or when they are reviewed, it is recommended that the Ocean Best Practices System Repository (OBPS-R)[30] be used as the main reference point. The OBPS-R is the hub of the Ocean Best Practices System (OBPS), which is an open access, permanent, digital repository of community best practices in ocean-related sciences and applications maintained by the International Oceanographic Data and Information Exchange (IODE) of the UNESCO-IOC. Barbados (through the CZMU) may wish to better engage with IODE and UNESCO-IOC to create a more formalised national link for marine and coastal data standards in Barbados, strategically linking this to the Barbados Statistical Service (BSS) as required.

Coastal Scientific Research and Access and Benefit Sharing

Ensuring that marine scientific research in carried out in a way that avoids environmental impact and respects a nation's right to the intellectual property arising from its natural resources is a key priority. It must provide clear guidance on how to conduct marine and coastal research plus clarity on what is considered best practice in terms of consents, permits or memorandums of understanding for anyone wishing to formally control marine scientific research within Barbadian waters.

The primary point of reference for any such control mechanism to be produced in Barbados should be the document written by the UN that includes practical guidance on the implementation of the provisions of the UN Convention on the Law of the Sea (UNCLOS) relating to marine scientific research[31]. Amongst other things, this sets out:

- what is considered scientific research under UNCLOS;
- an overview of rights and duties of the coastal state relating to the granting and withholding of consent;
- the procedure for requesting and granting consent;
- the code of conduct during marine scientific research; and
- rights and obligations after the completion of the research.

It also provides detailed guidance on implementing the provisions of the convention related to marine scientific research including three draft standard forms as set out below and included in Annex 8:

- Draft standard form A: Application for consent to conduct marine scientific research.
- Draft standard form B: Consent to conduct marine scientific research.

These draft standard forms should be used as the template for any future such forms or process in Barbados. Of particular note is the draft standard form B that sets out the consent to conduct marine scientific research. This has standard conditions within it relating to various aspects of the research being carried out, such as entry into an EEZ and compliance with relevant guidelines. Regarding data rights, there is a condition that states that *"provision of data … will be submitted to (the relevant authority) in a form acceptable to (coastal state) as possible but preferably no later than a 12-month period after the conclusion of the proposed research programme. The information will be treated as public information and may be made available…."* This condition sets out clearly that as a minimum any primary data and information that is produced as the result of marine research is treated as public information that Barbados can publish if it wishes.

For many countries, including Barbados, there is a desire to better control patent rights, intellectual property rights, access and benefit sharing that arises from any marine scientific research that is ongoing in their EEZ. The UNCLOS draft standard form B addresses the issue of access satisfactorily but does no address patents rights, intellectual property rights or benefit sharing arising from the commercial development of any marine scientific research that may occur in their waters.

Under the Convention for Biological Diversity, state sovereign rights (for Barbados) would be provided for with regards to access to genetic resources (Article 15, 16 and 19) which covers all biodiversity within Barbados' EEZ. In this case, access and benefit sharing laws of the provider countries are applied. If national regulations are applied, then prior informed consent, and mutually agreed terms, are required and could be based upon the draft standard forms set out by UNCLOS[32].

It should be noted that for the majority of marine scientific research, marine genetic resources fall into the domain of potential economic value rather than realised value. This has important implications for the design of a possible implementing agreement (or agreements) involving access and benefit-sharing within the framework of UNCLOS. The distinction needs to be made between the potential and actual commercial value of marine genetic resources. This distinction is important in debates on access and benefit-sharing because a failure to distinguish between actual and potential value can lead to misrepresentation of the economic value of genetic resources. These values can be considered in three categories:

1. Marine or coastal genetic resources that are of actual value for research in advancing knowledge and understanding of marine biodiversity but do not possess a realised, or realisable, commercial value.
2. Marine or coastal genetic resources that are a focus of research and development directed to the potential development of new and useful products but have not yet resulted in commercial products that have passed through the regulatory approvals process and reached the market.
3. Marine or coastal genetic resources or products that are on the market.

The first two categories are associated with the potential economic value of marine or coastal genetic resources. Scientific literature and patent applications and grants typically fall into these categories: the former because they may suggest or directly point to potential commercial applications and the latter because patent applications are a public indicator of commercially oriented research and development that applicants believe has the potential to create a marketable application or product.

It has been noted that that internationally there is a continuing lack of "user measures" that implement the benefit sharing obligations of CBD Parties, as well as support for user compliance with access and benefit sharing legislation in provider countries and negotiated mutually accepted terms conditions have been highlighted as persistent problems33. The UN Conference on Trade and Development have published a comprehensive review on “The Convention on Biological Diversity and the Nagoya Protocol: Intellectual Property Implications, A Handbook on the Interface between Global Access and Benefit Sharing Rules and Intellectual Property”. This report should be a point of reference for Barbados should they wish to understand how to set up an access and benefit sharing regulatory regime. It also sets out an evaluation of the regulatory regimes associated with access and benefit sharing in Thailand, Portugal, South Africa and Guyana that should be helpful to any administration wanting to set up similar regimes.

Reference should also be made to the access and benefit sharing clearing house (ABSCH) of the CBD34. This is a platform for exchanging information on access and benefit-sharing established by Article 14 of the Nagoya Protocol, as part of clearing-house mechanism under Article 18, paragraph 3 of the Convention. The ABS Clearing-House is a key tool for facilitating the implementation of the Nagoya Protocol by enhancing legal certainty, clarity and transparency on procedures for access and for monitoring the utilization of genetic resources along the value chain. By making relevant information regarding ABS available, the ABS Clearing-House helps users to gain access to genetic resources and associated traditional knowledge, and to ensure that providers fairly and equitably share the benefits arising from their utilization. On the ABSCH 64 governments have posted legal, administrative or policy measures relating to access and benefit sharing.

It should be noted that Barbados, through the CZMU, have developed a coastal habitat research permit application form that is used for anyone wishing to carry out research in their coastal or marine environment. This is less sophisticated than the UNCLOS draft Standard Form A but has been used in Barbados for several years. It is recommended that this current approach is updated in line with the international and regional best practice being adopted and as presented above (see Annex 8). CZMU has to centralize and normalize the relevant information for coastal managers and related stakeholders providing a useful source of information for contributions in the future development of the coast. Key aspects that have to be addressed in order to guarantee that CZMU provides an efficient service to possible users are:

- Provide a data catalogue at the CZMU website in order to facilitate data availability to users.
- Provide an efficient procedure to request and acquire data.
- Disseminate results of free-access information through web visors online.

Improvements in specific monitoring programmes have to be made in order to provide proper information that has to be included in the services. Guidelines for this improvement are divided into two different groups:

<u>ICZM geospatial information</u>

- Update of mapping inventory has to be undertaken annually.
- Complete geospatial information of all coastal resources has to be included.
- Any relevant information related to coastal resources should be included in the GIS layers.
- Geospatial information should be defined based on the physical boundaries of the feature creating a polygon feature. If there is punctual information, point designation will be considered.
- Geospatial information of external actors should be added if it is complete and relevant.
- Source and date of all geospatial information have to be included without exception.

<u>Specific coastal monitoring programmes</u>

- Improve sea level monitoring performance, implement web visor and provide access to data.
- Extend Beach Profile Monitoring to obtain a comprehensive characterization of the island.
- Guarantee the monitoring and dissemination of Special Marine Areas in order to promote the creation of new ones.
- Ensure the continuation of the reef and turtle monitoring (i.e.: via the Sea Turtle Project).
- Provide web access to bathing water quality results in order to inform the public.
- Provide access to monitoring results from conservation and restoration projects.

C9.4. Action brief

Management guidance and goals described will be implemented through specific actions, presented in the following table. These actions do not exclude actions already performed by the CZMU.

CODE	ACTION	LEAD ACTORS	OTHER ACTORS	RELATED ACTIONS	INDICATOR	TIME SCALE	COMMENTS
Research agenda							
R1	Create a 2020-2030 Coastal Research Agenda.	CZMU	McGill University, University of West Indies, TCDPO.		Technical report and implementation plan	Punctual, short term.	Including the implementation plan based on the topics proposed.
R2	Coordination with research institutions in Barbados.	CZMU	McGill University, University of West Indies, TCDPO.	R1	Nº of attendees Nº of meetings	Punctual, short term.	
Data management, access and dissemination							
R3	Complete, update and normalize all geospatial information related to ICZM.	CZMU			Annual inventory report	Punctual, Short term.	This information has to be at least annually updated.
R4	Improve sea level monitoring.	CZMU			Technical report Agreement with involved agencies	Punctual, Short term.	To be developed in collaboration with related agencies. Ensure tide gauges and wave buoys are working correctly and are maintained.
R5	Extend the scope of Beach profile monitoring programme.	CZMU			Nº of profiles. Profiles in all beaches of Barbados.	Punctual, Short term.	
R6	Develop a web data catalogue to provide access to data with specific reference to findings from biodiversity related research.	CZMU	Fisheries Division, EPD, UWI	BIO8	Web or web application.	Punctual, Short term.	This catalogue has to be updated regularly in accordance with the data updates.
R7	Develop a web viewer to disseminate and provide access to Geospatial information.	CZMU	BSS, GIS	R3	Web viewer.	Punctual, Short term.	
R8	Production of an Annual Research summary report.	CZMU		R1	Technical report	Annual	Brief report about the implementation, actions and results obtained from the research activity planned in the agenda for this year (feed into the annual “State of the Coast” reports.

Table C.34. Action brief for Research.

C10. PUBLIC AWARENESS AND STAKEHOLDER PARTICIPATION

Increasing public awareness, understanding and appreciation of the importance of the coast, the ICZM Plan and the wider "Blue Economy" in Barbados, through education and outreach, is an important short term action. This should include establishing a process for active public participation in planning, policy and decision making which is likely to include the need for a public awareness, education and outreach strategy to be developed and implemented. This includes the need to develop a digital tool for public access information concerning ICZM issues and how citizens can better appreciate the benefits of the coast (and ocean) to health and wellbeing.

Effective stakeholder engagement is therefore key to the successful implementation of the mandate of the CZMU. The successful implementation of the ICZM Plan is dependent on strong relationships and coordination between the CZMU and its diverse stakeholders.

Informed participation is a more intensive and active form of consultation. Typically, participation involves a more in-depth exchange of views and information, leading to joint analysis and decision- making. This increased level of involvement tends to generate a shared sense of ownership in a process and its outcomes. The more a particular stakeholder group is materially affected by an activity, the more important it is for them to be properly informed and encouraged to participate in matters that have direct bearing on them, including proposed mitigation measures, the sharing of development benefits and opportunities, and implementation or monitoring issues. In certain situations, capacity-building programs may be needed to enable affected stakeholders (particularly local communities and organizations) to be able to participate fully and effectively in the process.

Topic (code)	Public Awareness and Stakeholder Participation (PA).
Key Legislative Instrument	Planning and Development Act (2019)
Policy Outcomes	Outcome 3 - Climate and disaster risk adaptive capacity is strengthened. Outcome 4 - ICZM is delivered through a coordinated governance arrangement. Outcome 5 - Capacity for ICZM delivery is strengthened for all relevant sectors. Outcome 6 - Research, understanding and knowledge outreach is increased.
Key Policy Goals	Goal 6.1 - Increase public awareness. Goal 6.2 - Ensure needs of communities are considered.
Topic importance	Without a vehicle for effective and participatory public awareness and stakeholder involvement, ICZM programmes often fail. This aspect remains at the centre of sustainable ICZM in Barbados.
Disaster cycle phase	**Preparedness** **Response**

Table C.35. Policy outcomes, policy goals and the importance of considering this topic.

C10.1. Current status

The CZMU is committed to actively engage with stakeholders as part of its effort to instil a sense of ownership and ensure full transparency in the revision of the CZM Act [35]and any supporting Regulations that may be prepared as well as any research that has been conducted resulting in the development of plans, policies and guidelines. CZMU recognizes that diversity of opinion and identification of potential management gaps and solutions are essential to this process. Thus, every effort will be made to use various approaches of engagement to ensure that every opportunity is given to stakeholders to inform and be informed.

The term consultation, as defined by CZMU, describes the broad range of communication between the CZMU and stakeholders who have a vested interest in decisions being made with regard to the management and use of resources that fall within the CZMA of Barbados as defined in this ICZM Plan (Part A). Approaches to consultation will range from one-on-one discussions to interactive discussions and participation by stakeholders in the decision-making process.

The consultative process shall, for the most part, be a two-way dialogue that allows all stakeholders realistic and timely opportunities to influence decisions being made during the legislative review process. Consultation will take place where stakeholders:

- have a legal entitlement to be consulted.
- can reasonably expect to be consulted because various policies, legislation, and regulations under consideration by the revision of the CZM Act would have significant impact on them.
- will be expected to implement, contribute to or abide by the various policies, legislation, and regulations.

C10.2. Implications

From an international perspective, nations that apply ICZM policies and related interventions that are based purely on scientific information, with negligible community involvement often have limited success. Policies, plans or programmes are far more fruitful where the message, produced by any new scientific information collected, is effectively communicated to all stakeholders. The implications of not embracing improved communication of information to the public can often result in regulatory non-compliance, apathy towards good practice and a general mistrust of Government on coastal matters. The more a community of people is supported to take control of coastal activities to improve their lives, the more likely their health, livelihoods and wellbeing will improve.

Whilst Barbados cannot be characterised as being "data poor" there remains the need to improve on community engagement strategies that involve and engage coastal communities more fully in policy delivery at the local level. A citizen science approach is being promoted within this ICZM Plan, which will invite those individuals with a passion for their coastal environment and willingness to be involved via a range of engagement strategies. This has benefits not only for wider education and capacity development opportunities within the community, but also

[35] SCHEDULE 1 (Sections 12, 22(3)) of the proposed revisions to the CZM Act (2020).

across a range of government sectors that are seeking to improve outreach on climate change related matters. By positively engaging the public and coastal businesses to "buy-in" to their own protection from natural hazards which ultimately will aid disaster prevention.

C10.3. Management guidance

According to the current status and implications as set out above, the following section provides national management guidance as follows.

Caring for the coastal environment is the responsibility of everyone. However, insufficient awareness and lack of environmental education can result in low levels of personal accountability. Public participation is key to promoting and instituting a duty of care for the coastal environment. By adopting a range of stewardship initiatives, the GOB through CZMU and supporting partners, can encourage and empower citizens to recognise their responsibilities, be part of the management process and take action where necessary. Encouraging the active and meaningful participation of Barbadian citizens can enhance wellbeing and provide benefits for wider environmental health. An informed public increases participation in the successful delivery of this risk resilient ICZM Plan. To support this, the GOB will need to engage with civil society and local communities to ensure coastal and ocean literacy is increased and that the social and cultural benefits of the coast are fully realised.

Empowering and engaging local stakeholders and citizens is essential to promote stewardship and enhance decision-making, and continuation of on-going coastal and climate change related public initiatives is important. This should be coupled with the development of suitable engagement strategies for communities to ensure that coastal, marine and ocean literacy is developed in all parts of society. New approaches are hereby needed to enhance the role of stakeholders, communities and resource owners (including the private sector) in the development and application of local management arrangements for delivering risk resilient ICZM. This is because an informed public ensures the social acceptability that will enhance decision making and implementation. Community participation is a key to promoting and instituting a duty of care for the marine environment. Awareness creation, participation and consultation will assist in promoting understanding and stewardship by all stakeholders; ensuring that decision makers and members of the public are accountable for actions they take the affect both ocean and coastal resources.

Local communities will need to be encouraged to work with other partners (public and private) to promote the application of compatible policies by those partners in areas subject to their jurisdiction and surrounding waters. Coastal communities respect the rights and interests of others to participate in legitimate activities. With this sharing comes the expectation that they will meet their obligations and responsibilities to the coastal zone. There is a need to promote good stewardship, which refers to the need for an Operations Plan to encourage the active engagement by communities in caring for the coastal zone. It will need to draw upon ideas, policies, institutions and enforcement procedures needed to protect the coast from abuse including the effects of land based activities.

Effective Consultation

Effective consultation is essential in the development of quality policies. It helps to improve the quality of outcomes by ensuring that processes are well informed, technically viable and will work in practice. Effective consultation will ensure that outcomes are responsive to the knowledge, experience and opinions of stakeholders. If undertaken at the right time, in the right way, and with the right people, consultation will lead to better outcomes. It will help to identify problems that require new and /or modified responses and that need to be reformed. Effective consultation will also garner stakeholder support for the proposed amendments to the CZM Act and any supporting regulations. However, consultation will not necessarily lead to consensus. To this end, the consultation processes to be utilized (by any governmental or non-governmental organisation) will need to include the following features:

a) Be Timely

Consultation should occur early enough in the process to influence decision making. Stakeholders will need to be given a **maximum of two weeks** to properly consider the issues and submit their views.

b) Accessible and Representative

Consultation will need to involve all relevant stakeholders, including members of the public, interest groups, government agencies, NGOs or any other groups likely to be affected by the policy, legislation and/or regulation. It is important that all stakeholders are able to participate in the process, including those with special needs. Thus, the consultation process will need to be as inclusive as possible.

c) Be Focused

The objectives of the consultation and the particular amendments on which views are sought will be clearly stated. For context, stakeholders will need to be provided with sufficient background information to ensure that consultation goals are achieved.

d) Be Transparent

Stakeholders will need to be given sufficient information to enable them to understand the proposed amendments to any updated Plans, legislation or regulations. Submissions received as part of the consultation process will need to be made publicly available, except where a stakeholder specifically requests that a submission be treated as private or confidential.

e) Be Flexible

The consultation method will need to be chosen on a case-by-case basis (i.e. in-person interviews, meetings, workshops, discussion panel etc.). A comprehensive consultation strategy may be appropriate in some cases, whereas in others, more informal consultation may suffice.

f) Be Responsive

Outcomes of consultation processes will need to be communicated to stakeholders within two weeks of the meeting. Feedback will also need to be given to participants about how their input was considered and the reasons for any divergence between their input and the outcomes.

g) Allow the approach to be Evaluated

The success of the consultation process will need to be evaluated, and lessons learnt incorporated into future consultation strategies.



TYPES OF CONSULTATION

It is understood that the way consultation is undertaken, as well as the frequency, will affect the extent of participation. Thus, all consultation will need to be undertaken in a transparent, concise, accessible, and timely manner. The objectives and desired outcomes of consultation will need to be clearly stated so that stakeholders understand the scope and aims of the process. Examples of types of consultation are indicated below:

TYPE	WHEN TO USE IT	EXPLANATION
Informing	Where a decision has been taken and consultation is not required	Informing stakeholders of the need to revise and update Plans, the CZM Act and any future Regulations
Researching	Where information is needed to help to make a decision	Gathering information on opinions, attitudes and priorities to inform amendments
Consulting	Where views will be taken into consideration when making a decision	Obtaining views on proposed amendments to the CZM Plans, Act and supporting Regulations that will strengthen the roles of both the CZMU and stakeholders
Involving	Where ideas are being sought and involvement in making a decision is being sought.	Seeking new ideas and suggestions and encouraging stakeholders to participate in the review process
Partnership	Where we are making a Decision with others	Initiating joint working and decision-making

Table C.36. Types of consultation used by CZMU

C10.4. Action brief

Management guidance and goals described will be implemented through specific actions, presented in the following table. These actions do not exclude actions already performed by the CZMU.

CODE	ACTION	LEAD ACTORS	OTHER ACTORS	RELATED ACTIONS	INDICATOR	TIME SCALE	COMMENTS
PA1	Preparation of an operations manual to encourage the dissemination guidance /outreach approach to Coastal Communities *(internal and external communication).*	CZMU	DEM, EPD, NCC, TCDPO	PA2-5	Current operational processes for accessing information reviewed and requirements identified	Short term	
PA2	Formally adopt the draft Consultation Guidelines *(this Draft Guideline).*	CZMU	DEM, EPD, NCC, TCDPO	PA1-5	Consultation Guidelines developed and in place	Short term	
PA3	Preparation of a Strategy for Social Partnership engagement.	CZMU	DEM, EPD, NCC, TCDPO, GIS	PA1-5	Current processes for Social Partnerships are reviewed and requirements identified within a new formalised Strategy and are incorporated into public awareness campaigns	Medium term	
PA4	Prepare a Strategy to demonstrate message communication to persons with disabilities and other vulnerable groups.	CZMU	DEM, EPD, NCC, TCDPO, GIS	PA1-5	Communication Strategies for persons with disabilities (PWD) developed and in place	Short term	
PA5	Establish school level inclusive play and art-based activities (focusing on risk resilient ICZM).	CZMU	DEM, EPD, NCC, TCDPO, GIS	PA1-4	School level Guidelines for inclusive play and art-based activities developed and in place	Medium term	
PA6	Develop a digital social media tool/ website for public to access information concerning ICZM, marine spatial planning and the marine environment.	CZMU	DEM, EPD, NCC, TCDPO, GIS	PA1-5	Digital tool developed and in place	Short term	

Table C.37. Action brief for Public Awareness and Stakeholder Participation.

PART D
SUB-AREAS ACTION BRIEFS
(OCTOBER 2021)

PART D: SUB-AREAS ACTION BRIEFS

D1. INTRODUCTION

As identified in Part A, the CZMA includes eight Sub-Areas (Figure D.1), five of them are located along the Atlantic coast (Sub-Areas 1, 2, 3, 4 and 5) whilst the other three are located along the Caribbean coast (Sub-Areas 6, 7 and 8). These take into consideration the unique features and characteristics that are present within each Sub-Area. Importantly, the boundaries adopted reflect the unique risk exposure variances that the recent CRMP technical studies (Baird 2017) have identified.

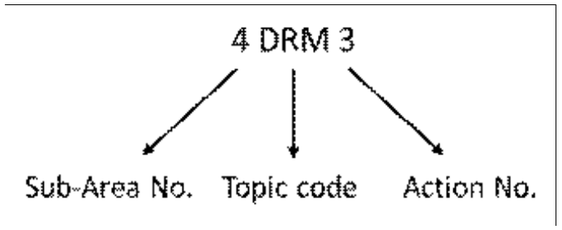


Figure D.1. Sub-Areas of the Coastal Zone Management Area.

The following text focuses on presenting the issues, challenges and opportunities facing each of the Sub-Areas and in turn providing a series of detailed Actions which are designed to pay due cognisance to the analysis of local characteristics and issues undertaken through field visits carried out during the preparation of the Plan. They also reflect, where appropriate, the general guidance presented in Part C.

For each Sub-Area, the information presented is structured as follows:

- Main theme: short title describing the major characteristics of the Sub-Area.
- Sub-Area description and context: description of the Sub-Area including land use and main economic activities, environmental and landscape resources, coastal risks and future planning scenarios.
- Main issues and strategic objectives: identification of key issues for coastal management and strategic objectives based on the current situation of the Sub-Area.
- Development Planning and Setbacks at Sub-Area scale: application of the General Guidance (section C3). This section also includes detailed maps including the delineation of appropriate setbacks *for new (planned) constructions/developments*.
- Action brief: a set of Actions to achieve the strategic objectives considering all national guidance topics. These Actions possess a specific code to indicate the geographic area, topic and the action number.



SUB-AREA 1: SOUTH POINT TO KITRIDGE POINT

Main themes

BIODIVERSITY AND LANDSCAPE RESOURCES FOR ECO-TOURISM AND RESIDENTIAL USES.

CLIFF COLLAPSE AND COASTAL EROSION.

Sub-Area description and context

This Sub-Area covers the southeast coast and represents an area of barren cliff top. There are a number of older settlements being increasingly influenced by residential sub-divisions, most of which have low levels of occupancy. This is an extensive and mostly undeveloped urban land reserve and an important recreation area.

The western section is dominated by the presence of Cobblers Reef along the nearshore area whilst Long Beach, with its backing dunes, forms a barrier that protects a lagoon system at Inch Marlowe and Chancery Lane Swamp. These areas are highly valuable from a biodiversity conservation perspective. Chancery Lane and the nearby Barbados Defence Force Paragon are designated as a Natural Heritage Area under the Barbados System of Parks and Open Spaces (PDP, 2017).

The Sub-Area, which is over 10km in length, also commands high landscape value with the marine zone from Kitridge Point to Crane Beach, that is classified (within the PDP 2017), as a "Natural Heritage Area". The coastal area is classified as a "Coastal Landscape Protection Zone". The natural beauty of pocket beaches, locally known as "secret beaches" such as a Bottom Bay, constitute an important well-being related resource for local recreation and for tourists to escape from crowded beaches along the Caribbean coast.

The sub-section *"Description maps of Sub-Area 1"* presents a detailed representation at the Sub-Area scale. This includes a collection of maps at a detailed scale, 1: 18,000, with specific information regarding natural and restricted areas, environmental characteristics, coastal and cliff classification, Sub-Area 1 exposure risk including flooding inundation, climate change related hazards coastal erosion, storm surge and cliff collapse. The loss of beach value, related to the reduction of beach width due to erosional processes, affects all beaches within this Sub-Area; and it is anticipated that this situation will be exacerbated by sea level rise in the future. In addition to this, there remain buildings/constructions threatened by cliff collapse, including key developments such as individual residencies and commercial assets. Storm surges may flood the coastal stretch between Silver Sands and Chancery Lane, thus impacting on infrastructure integrity plus beach recreational use, health and safety etc.



Figure D.2. Ad-hoc coastal protection schemes at Crane Beach

Within the medium and long term, this Sub-Area shall continue to be popular for future urban and tourism development. This relates to the Sub-Area being classified within the PDP (2017) as an "Urban Corridor" within the new Growth Management Framework. The protection of biodiversity and landscape, by any decision maker, should therefore be encouraged wherever possible, to help facilitate climate compatible and sustainable development within this Sub-Area for the benefit of the wider economy and local communities alike.

Main issues and strategic objectives

KEY ISSUES	STRATEGIC OBJECTIVES
• Residential and recreational area for Barbadians. • Development challenges linked to protection of natural resources and coastal landscape. • Development challenges linked to protection of the lagoon system between Inch Marlowe and Chancery Lane. • Cobblers and Fathom Reefs important for biodiversity. • Private developments may block beach access. • Major sargassum issue along this Sub-Area. • Small areas of wetland and coastal woodland present. • Severe erosion problems at Crane beach. • Loss of sand dunes.	• Enforce setbacks lines for the protection of landscape and wetlands. • Implement the PDP policies in Natural Heritage Area. • Develop new environmental-friendly economic opportunities that involve and benefit local communities in the Sub-Area (job creation, affordable housing and the reduction of poverty). • Ensure equitable access to coastal resources. • Control pollution and waste to the coast and marine environment. • Promote the awareness and involvement of local communities and private developers in ICZM and DRM. • Promote improved Storm Water Management/sewage and solid waste management strategies to limit garbage disposal in watersheds and promotion of adequate treatment of sewage in line with “Roof to Reef principles”.

Development Planning and Setbacks at Sub-Area scale

Setback recommendations are presented within a collection of maps provided in the sub-section entitled *“Setback maps of Sub-Area 1”*. These recommendations adhere closely to the National Guidance “Development Planning and Setbacks” (see section C3) for Sub-Area 1. This map provides the delineation of setbacks for this Sub-Area at a scale of 1:18000.

This planning related information should be used by public and private actors whom are involved in the management of the coast such as developers, owners and the general public. The setback guidance adopted is defined for four separate setback categories as appropriate, namely cliff, landscape, flood inundation and climate change.

Action brief

TOPIC	CODE	ACTION	LEAD ACTORS	OTHER ACTORS	TIME SCALE	COMMENTS	KEY POLICY OUTCOME
DRM and CCA	1DRM1	Conduct a comprehensive study to analyse coastal erosion in The Crane beach	CZMU		Short term, immediate		Outcome 3 - Climate and disaster risk adaptive capacity is strengthened
DRM and CCA	1DRM2	Contribute to a DRM Plan with emphasis on cliff collapse warning and evacuation.	CZMU	DEM		Under the frame of the National DRM Plan, this local plan should include (at least) the provision of warning signpost for pedestrians and swimmers, and evacuation plan in beaches and buildings in case of cliff collapse.	Outcome 3 - Climate and disaster risk adaptive capacity is strengthened
DRM and CCA	1DRM3	Prepare guidelines for the planting of indigenous vegetation to help stabilise slopes.	NCC	DEM, CZMU			Outcome 3 - Climate and disaster risk adaptive capacity is strengthened
Beach Management	1BM1	Prepare a beach management plan for Sub-Area 1 focused on landscape protection, maintenance of natural values of “secret beaches”, and zoning for water sports.	NCC	MTI, TCDPO, CZMU	Medium term, immediate		Outcome 2 - Coastal resources are protected and effectively managed
Beach Management	1BM2	Propose sustainable and environmental friendly tourism and recreational activities as coastal trail (i.e.: Inch Marlowe to Salt Cave), bike lane along the road to access secret beaches, etc.	MTI	NCC, CZMU	Medium term, immediate	If facilities are need for economic activities, only soft structures should be promoted. Rationalise car parking and promote public transportation to visit this area.	Outcome 2 - Coastal resources are protected and effectively managed
Beach Management	1BM3	Review the adequacy of recreational facilities for Foul beach and other beaches in this Sub-Area	NCC	CZMU	Short term, immediate		Outcome 2 - Coastal resources are protected and effectively managed
Beach Management	1BM4	Improve road signage to facilitate beach access.	NCC				Outcome 2 - Coastal resources are protected and effectively managed
Development Planning and Set backs	1S1	Prepare and distribute guidelines to enforce Landscape Setback in Sub-Area 1 for developers and public agencies.	TCDPO	CZMU	Medium term, immediate	Guidelines should explain why coastal landscape is important as coastal resource and attraction for visitors and recommendations for setback enforcement.	Outcome 1 - Sustainable socioeconomic development is achieved
Development Planning and Set backs	1S2	Prepare and distribute guidelines to enforce Conservation Setback in Sub-Area 1 for developers and public agencies.	TCDPO	CZMU	Medium term, immediate		Outcome 2 - Coastal resources are protected and effectively managed
Development Planning and Set backs	1S3	Organize meetings with key stakeholders to raise awareness on coastal resources and landscape.	CZMU	TCDPO	Medium term, immediate		Outcome 1 - Sustainable socioeconomic development is achieved
Development Planning and Set backs	1S4	Organize bilateral meetings with CZMU to review existing applications and evaluate landscape and environmental impacts.	TCDPO	CZMU	Short term, immediate		Outcome 1 - Sustainable socioeconomic development is achieved
Coastal Biodiversity	1BIO1	Analyse the integrity and ecological value of Cobblers Reef to be designated as a future Marine Protected Area.	CZMU	NCC, TCDPO	Short term, immediate		Outcome 2 - Coastal resources are protected and effectively managed
Coastal Biodiversity	1BIO2	Analyse the integrity and societal value of Inch Marlowe to be designated as future Natural Heritage Conservation Area.	CZMU	TCDPO, NCC	Short term, immediate		Outcome 2 - Coastal resources are protected and effectively managed
Coastal Biodiversity	1BIO3	Recommend Salt Cave Point (Gemswick) as a Natural Heritage Conservation Area.	CZMU	TCDPO, NCC	Short term, immediate		Outcome 2 - Coastal resources are protected and effectively managed
Coastal Biodiversity	1BIO4	Recommend the extension of the sewage treatment programme in Chancery Lane.	BWA	CZMU, EPD, TCDPO	Short term, immediate		Outcome 2 - Coastal resources are protected and effectively managed

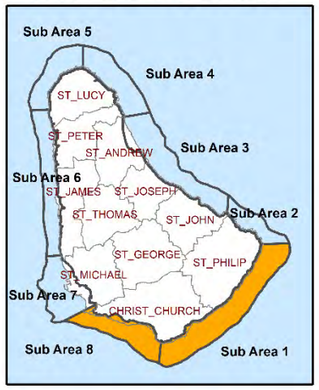
TOPIC	CODE	ACTION	LEAD ACTORS	OTHER ACTORS	TIME SCALE	COMMENTS	KEY POLICY OUTCOME
Coastal Biodiversity	1BIO5	Promote mangrove / coastal woodland restoration program.	CZMU	NCC	Short term, immediate		Outcome 2 - Coastal resources are protected and effectively managed
Public Awareness and Stakeholder Participation	1PA1	Identify local stakeholder at community level and private developers in the area.	CZMU				Outcome 6 - Research, understanding and knowledge outreach is increased
Public Awareness and Stakeholder Participation	1PA2	Conduct yearly public meetings to identify new issues in the Sub-Area.	CZMU	All stakeholders in the Sub-Area and key institutions at national level			Outcome 6 - Research, understanding and knowledge outreach is increased
Public Awareness and Stakeholder Participation	1PA3	Promote local recreational beach use and involvement in economic activities related to the beach plan and tourism opportunities.	NCC	MTI, CZMU			Outcome 6 - Research, understanding and knowledge outreach is increased
Public Awareness and Stakeholder Participation	1PA4	Improve signs to raise awareness on natural resources and valuable landscape.	CZMU				Outcome 6 - Research, understanding and knowledge outreach is increased

Table D.1. Action brief for Sub-Area 1.

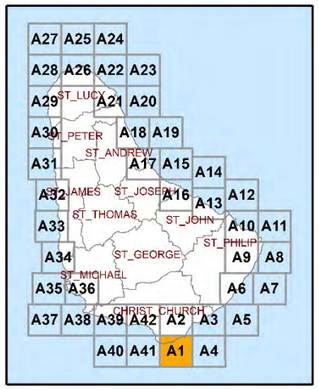
Description maps of Sub-Area 1

SUB AREAS 1, 8 - SHEET A1

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

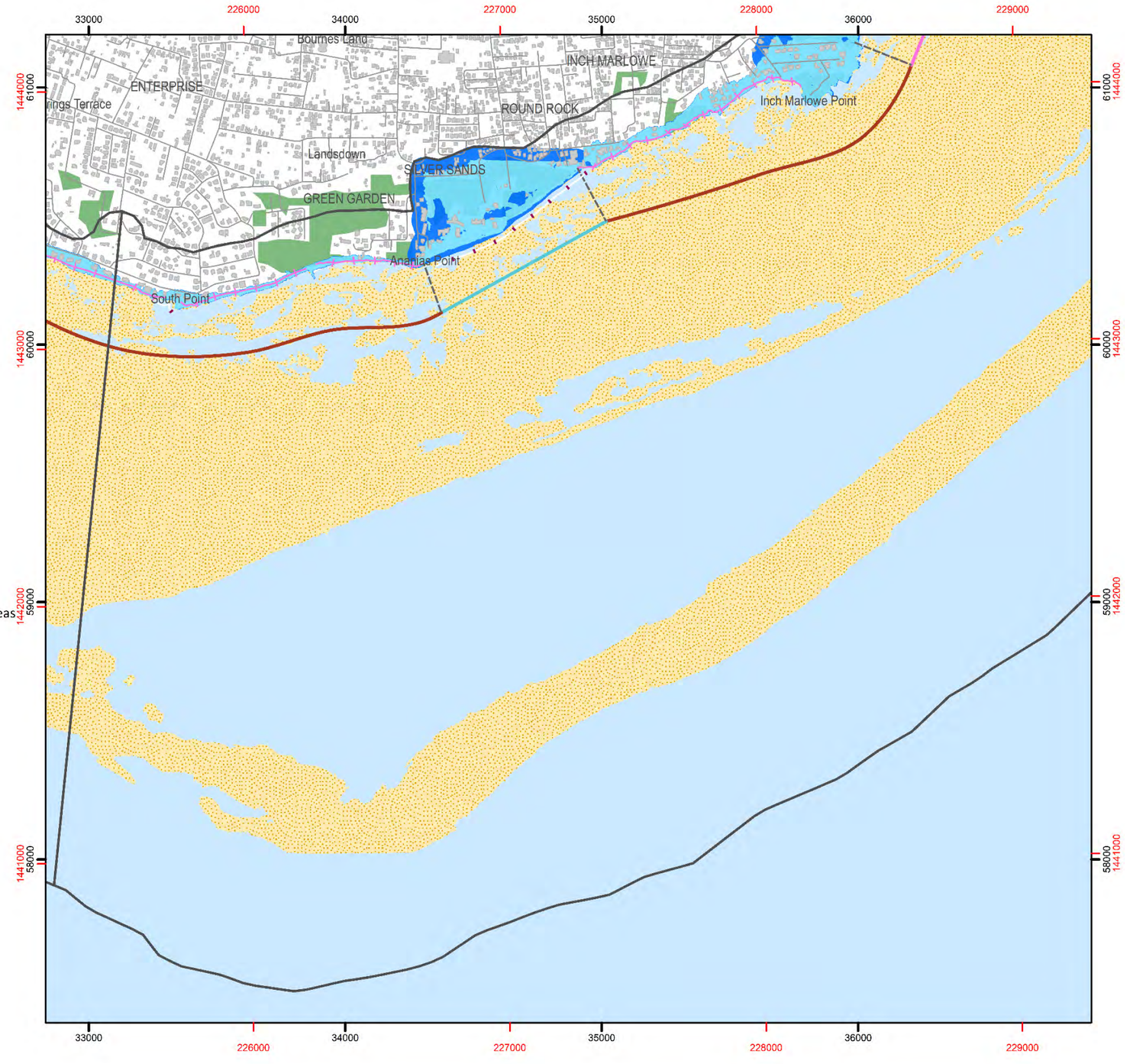
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

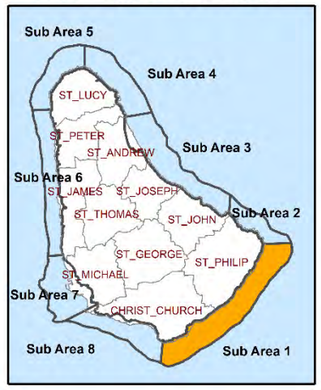
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

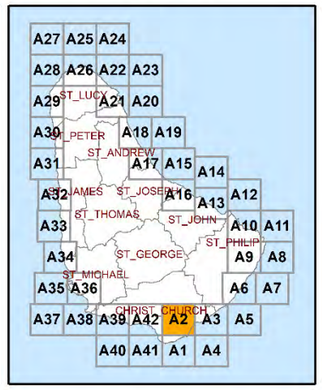


SUB AREA 1 - SHEET A2

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

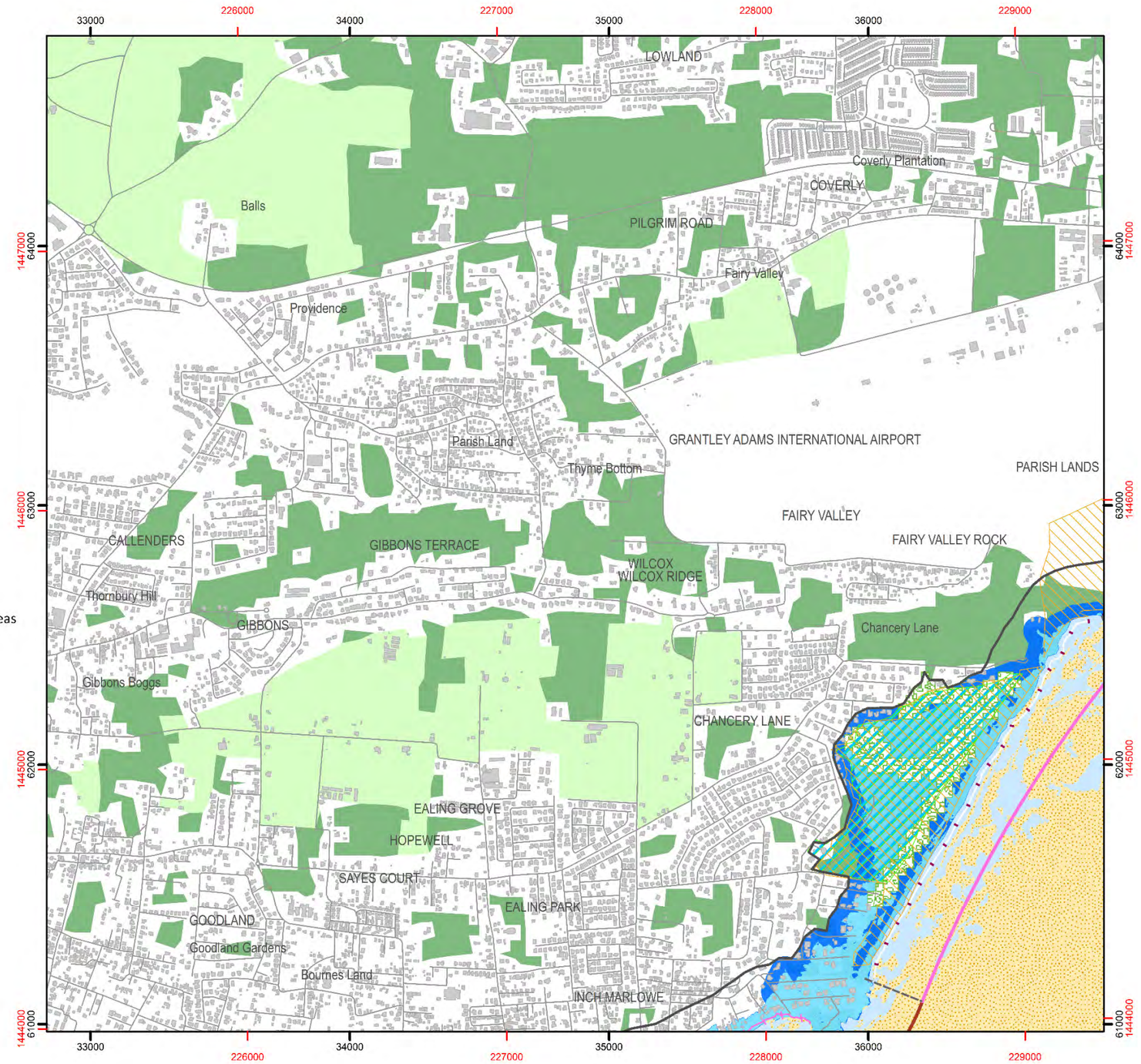
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

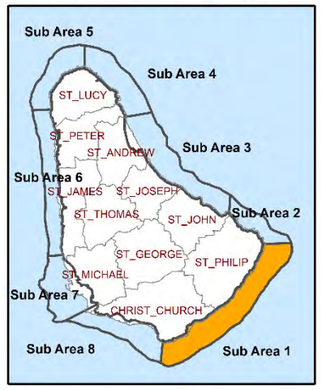
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

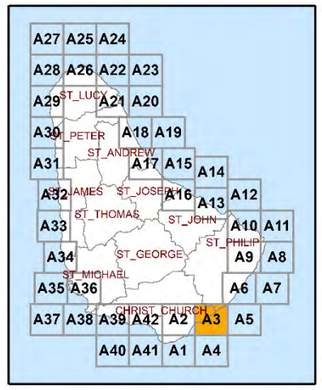


SUB AREA 1 - SHEET A3

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

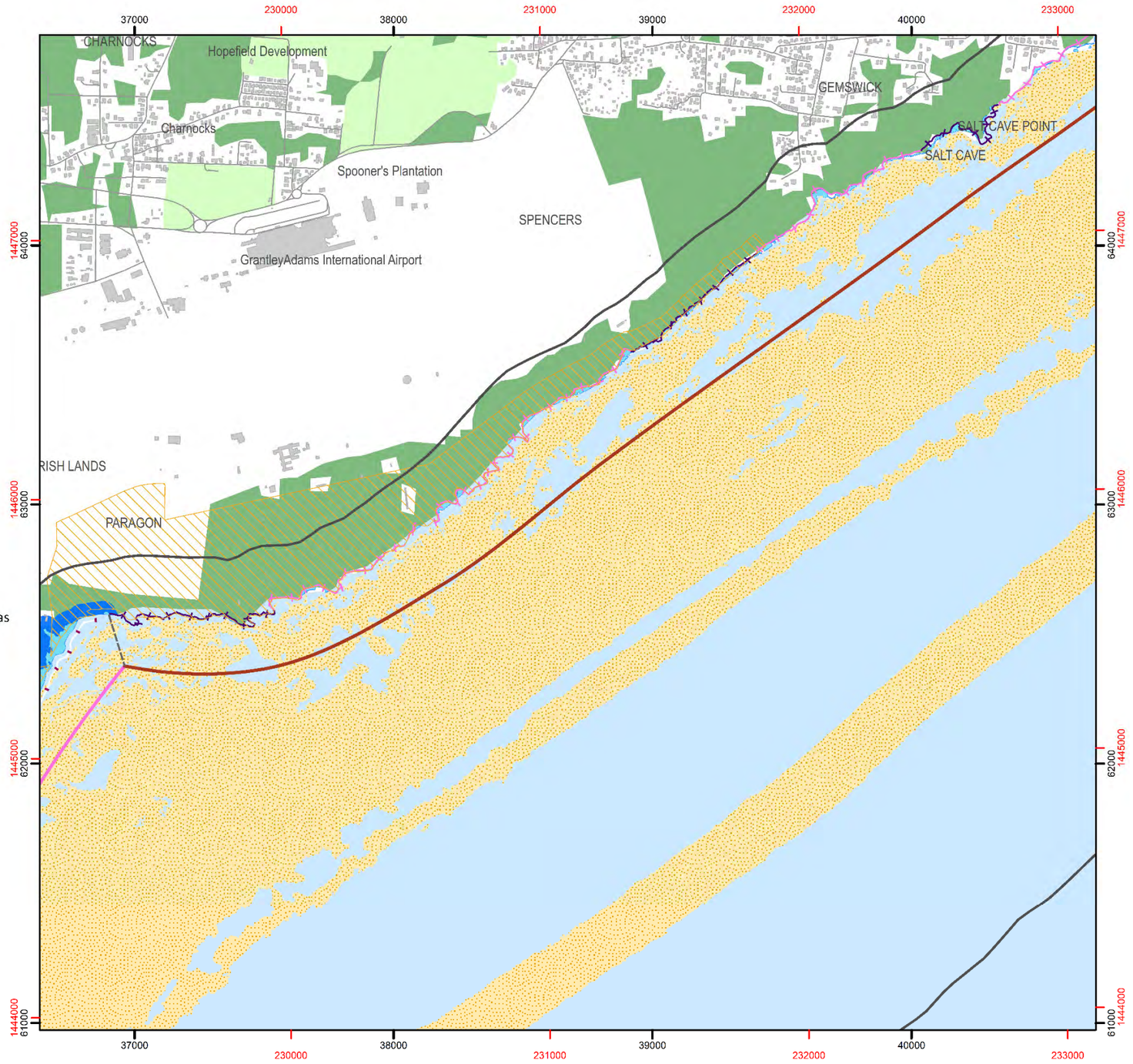
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

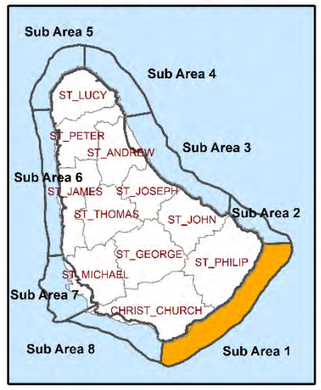
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

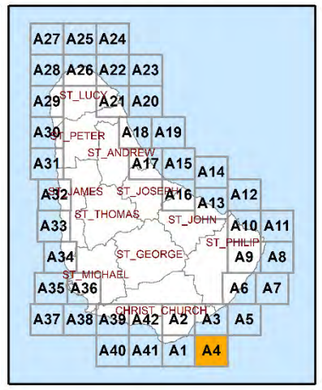


SUB AREA 1 - SHEET A4

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

Turtle nesting beach	Wetlands	Agriculture
National index beach (OS2)	Seagrass	Natural vegetation
Coral reefs	Mangroves	OS2 Natural heritage areas

Coast and cliff classification

Eroding Coast (Natural)	Eroding Coast (Engineered)
Accreting Coast (Natural)	Accreting Coast (Engineered)
Stable Coast (Natural)	Stable Coast (Engineered)
Dynamically Stable Coast (Natural)	Artificial Coast
Coastal Cliff	Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

Storm surge 100 years | Storm surge + Sea Level Rise (IPCC 2019)

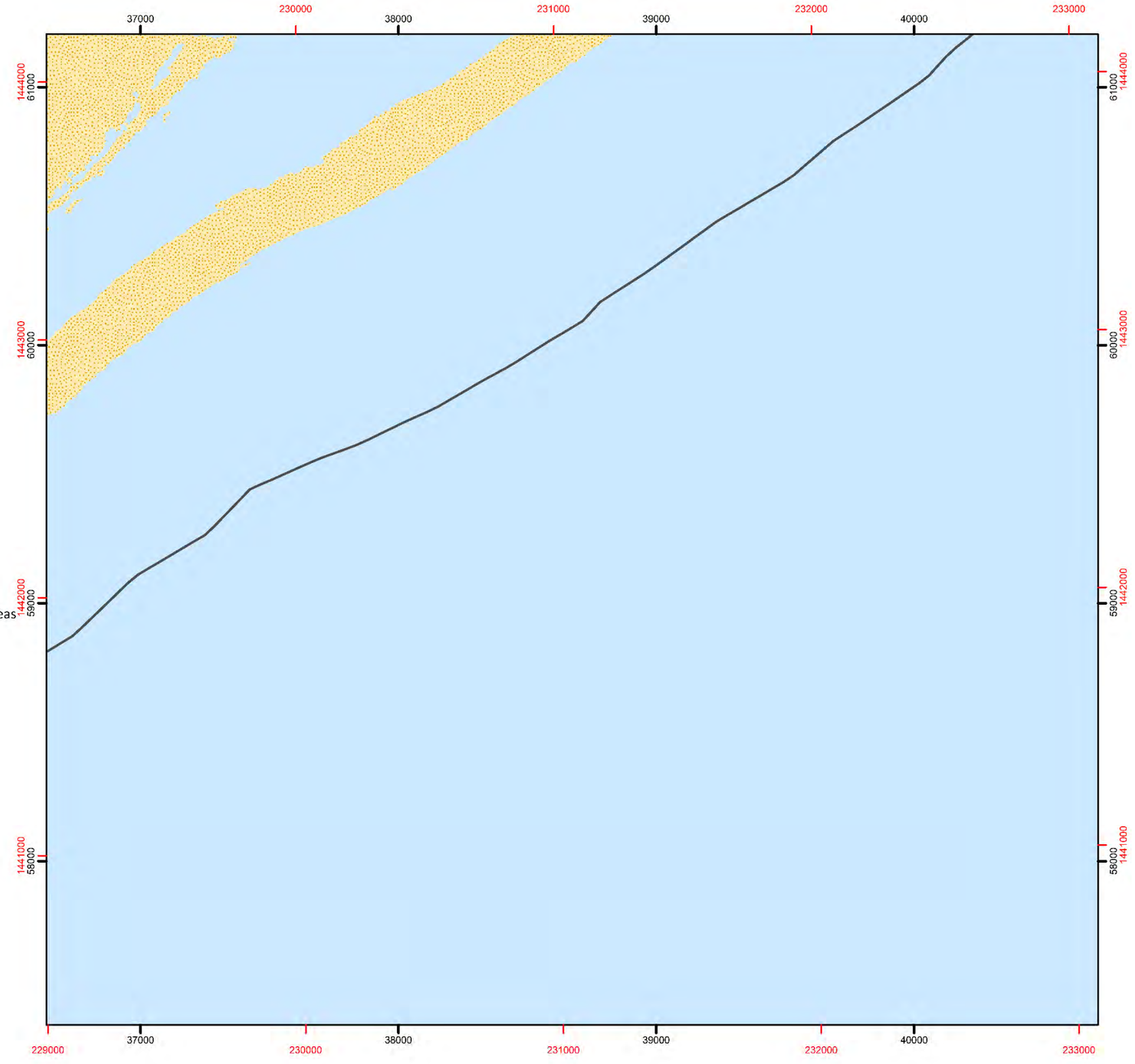
Tsunami 100 years

N

SCALE: 1:18,000

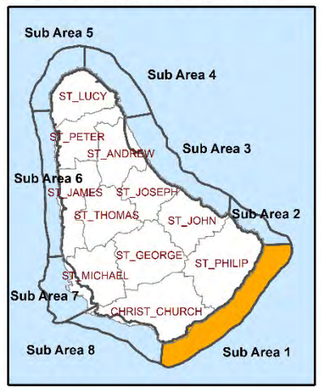
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

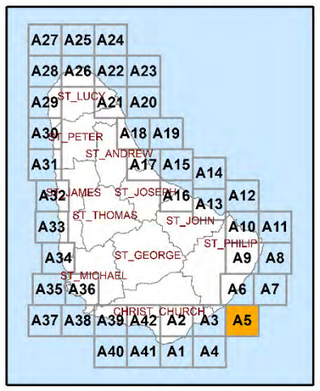


SUB AREA 1 - SHEET A5

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

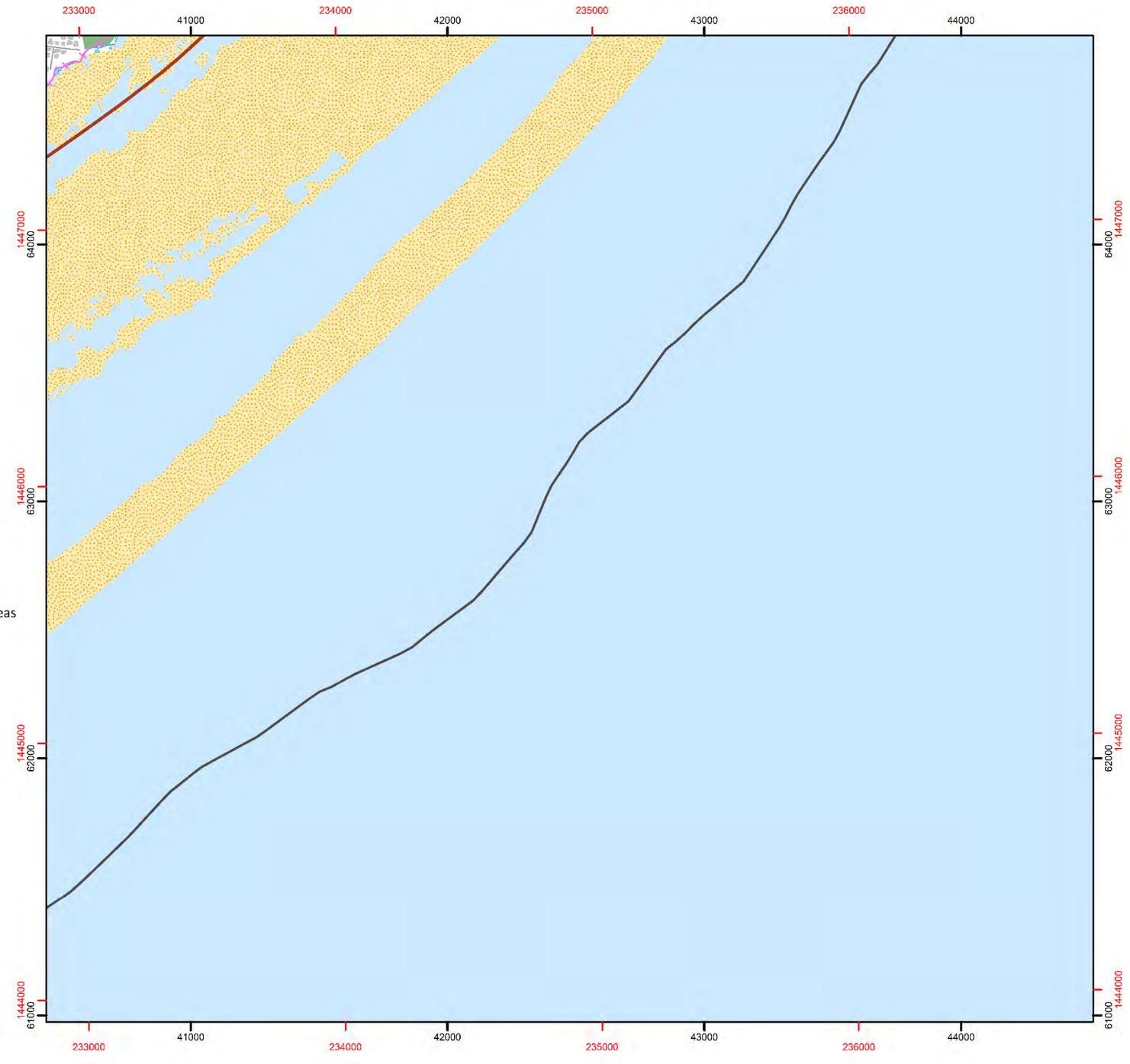
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

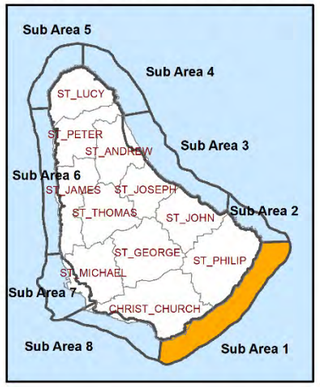
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

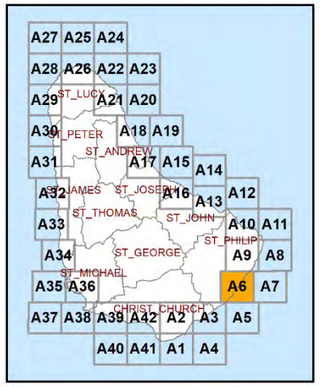


SUB AREA 1 - SHEET A6

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

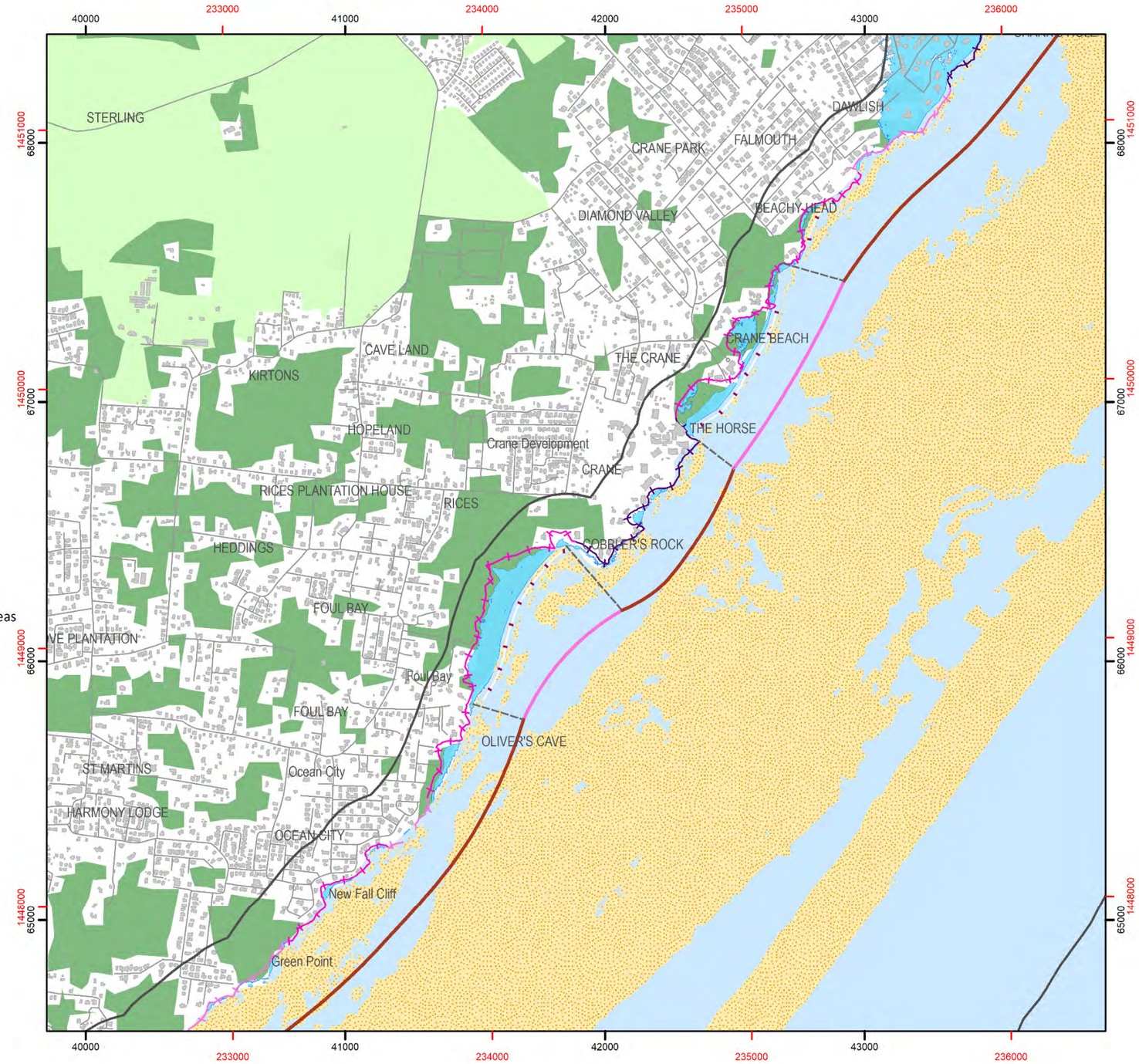
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

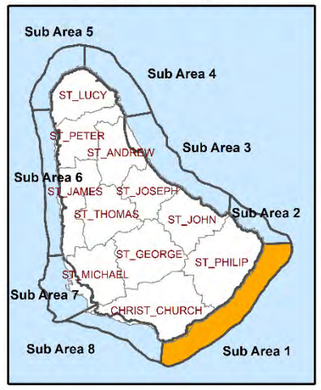
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

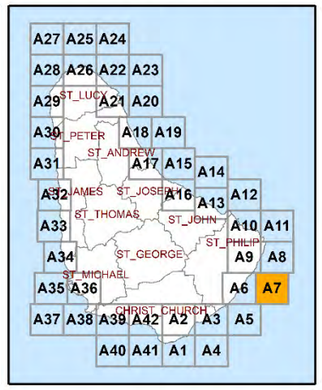


SUB AREA 1 - SHEET A7

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve
Restricted areas
Planned Marine Areas

Environmental characteristics

Turtle nesting beach
National index beach (OS2)
Coral reefs
Wetlands
Seagrass
Mangroves
Agriculture
Natural vegetation
OS2 Natural heritage areas

Coast and cliff classification

Eroding Coast (Natural)
Accreting Coast (Natural)
Stable Coast (Natural)
Dynamically Stable Coast (Natural)
Coastal Cliff
Eroding Coast (Engineered)
Accreting Coast (Engineered)
Stable Coast (Engineered)
Artificial Coast
Coastal classification division

Cliff failure

Very high
High
Medium
Low *(risk class)*

Flooding hazard

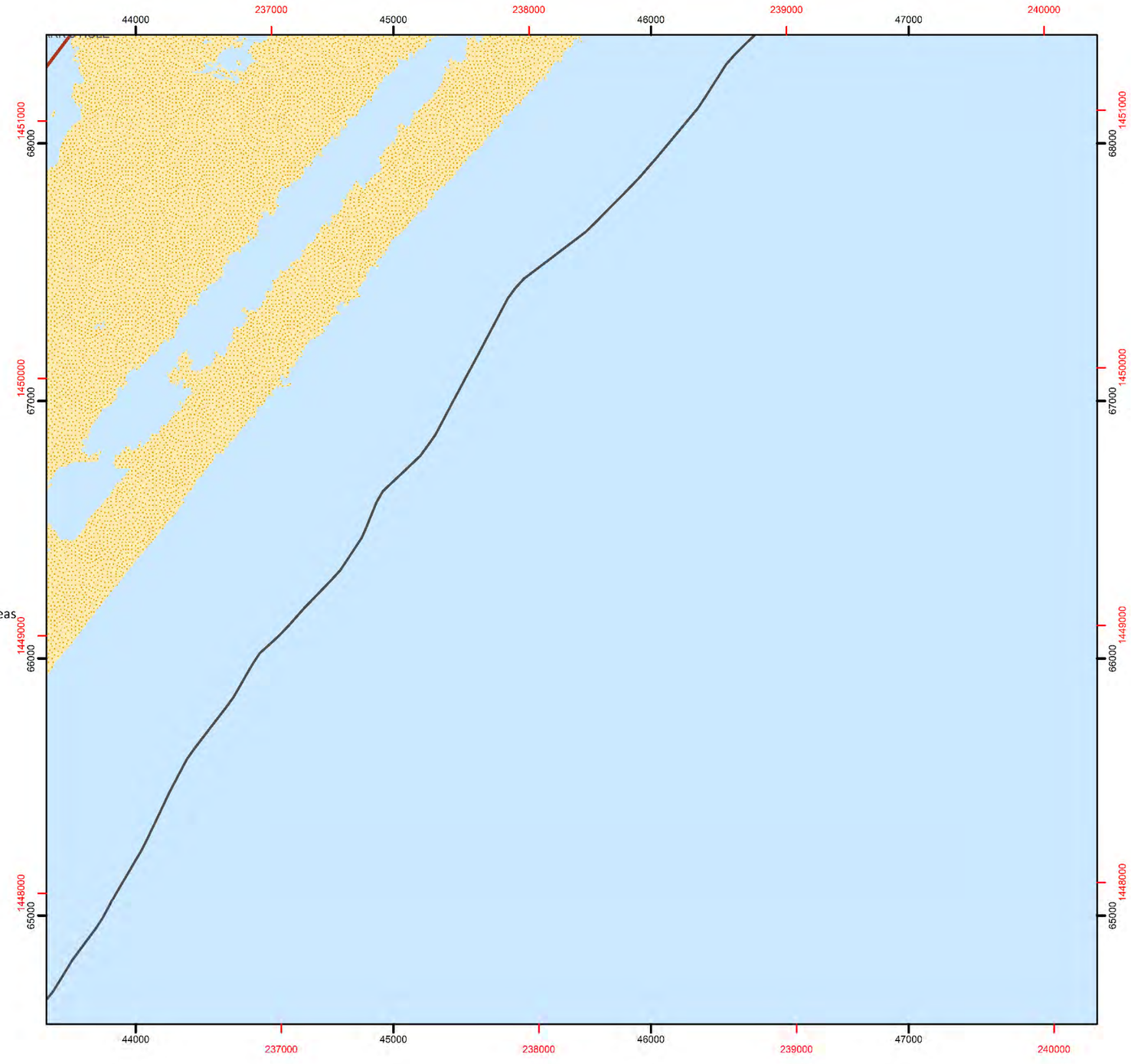
Storm surge 100 years
Storm surge + Sea Level Rise (IPCC 2019)
Tsunami 100 years

N

SCALE: 1:18,000

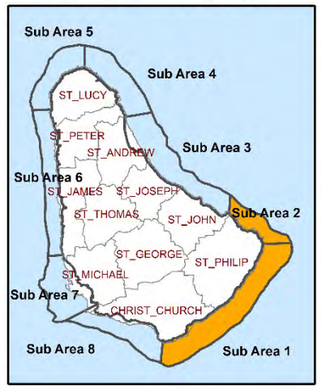
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

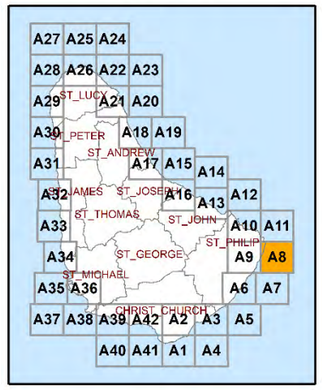


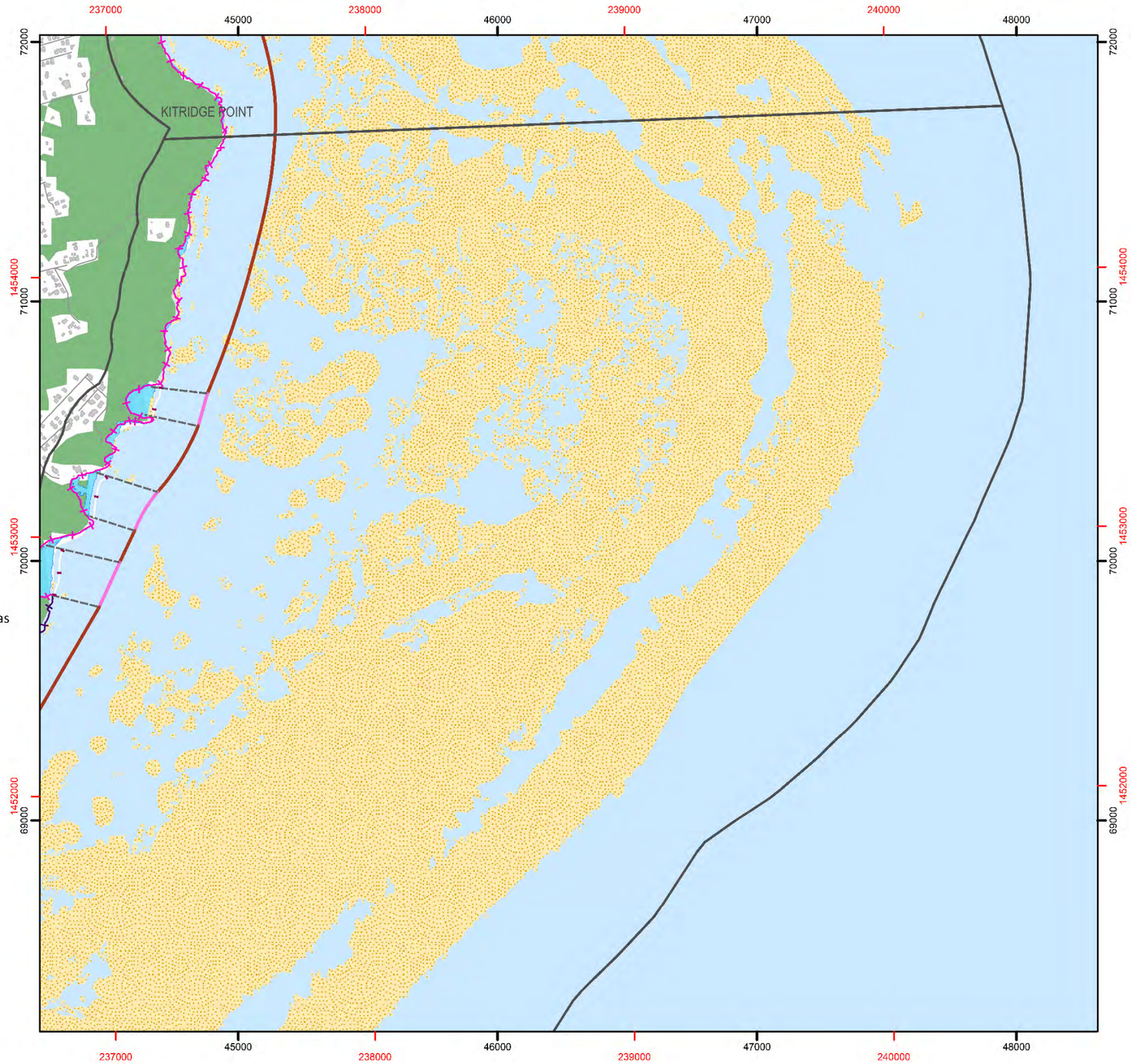
SUB AREAS 1, 2 - SHEET A8

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX





Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve
Restricted areas
Planned Marine Areas

Environmental characteristics

Turtle nesting beach
National index beach (OS2)
Coral reefs
Wetlands
Seagrass
Mangroves
Agriculture
Natural vegetation
OS2 Natural heritage areas

Coast and cliff classification

Eroding Coast (Natural)
Accreting Coast (Natural)
Stable Coast (Natural)
Dynamically Stable Coast (Natural)
Coastal Cliff
Eroding Coast (Engineered)
Accreting Coast (Engineered)
Stable Coast (Engineered)
Artificial Coast
Coastal classification division

Cliff failure

Very high
High
Medium
Low *(risk class)*

Flooding hazard

Storm surge 100 years
Storm surge + Sea Level Rise (IPCC 2019)
Tsunami 100 years

N

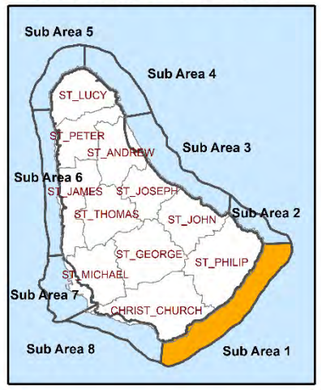
SCALE: 1:18,000

0 125 250 375 500 mts

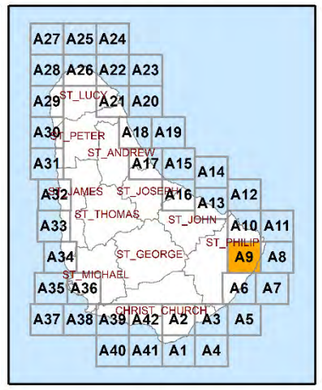
- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

SUB AREA 1 - SHEET A9

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

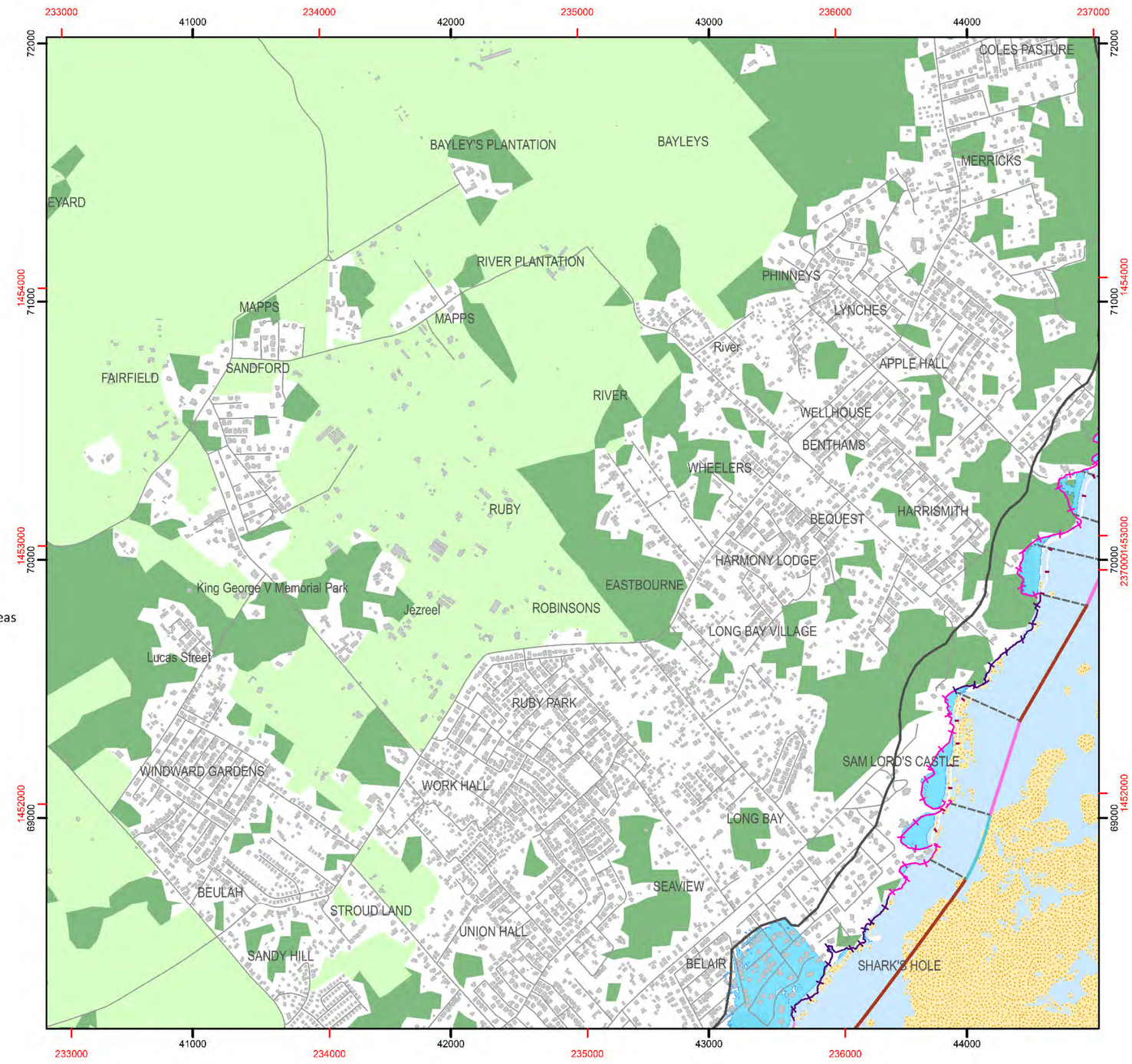
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

0 125 250 375 500 mts

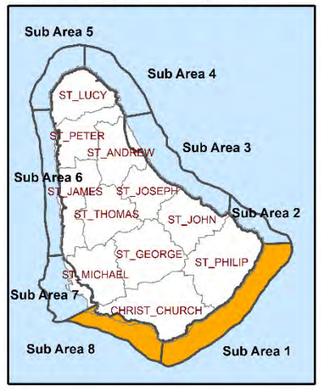
- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum



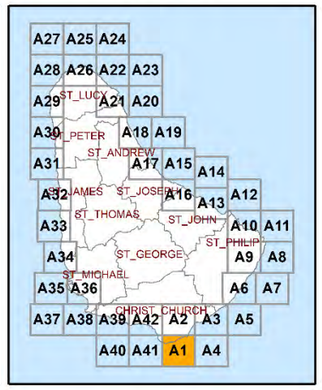
Setback maps of Sub-Area 1

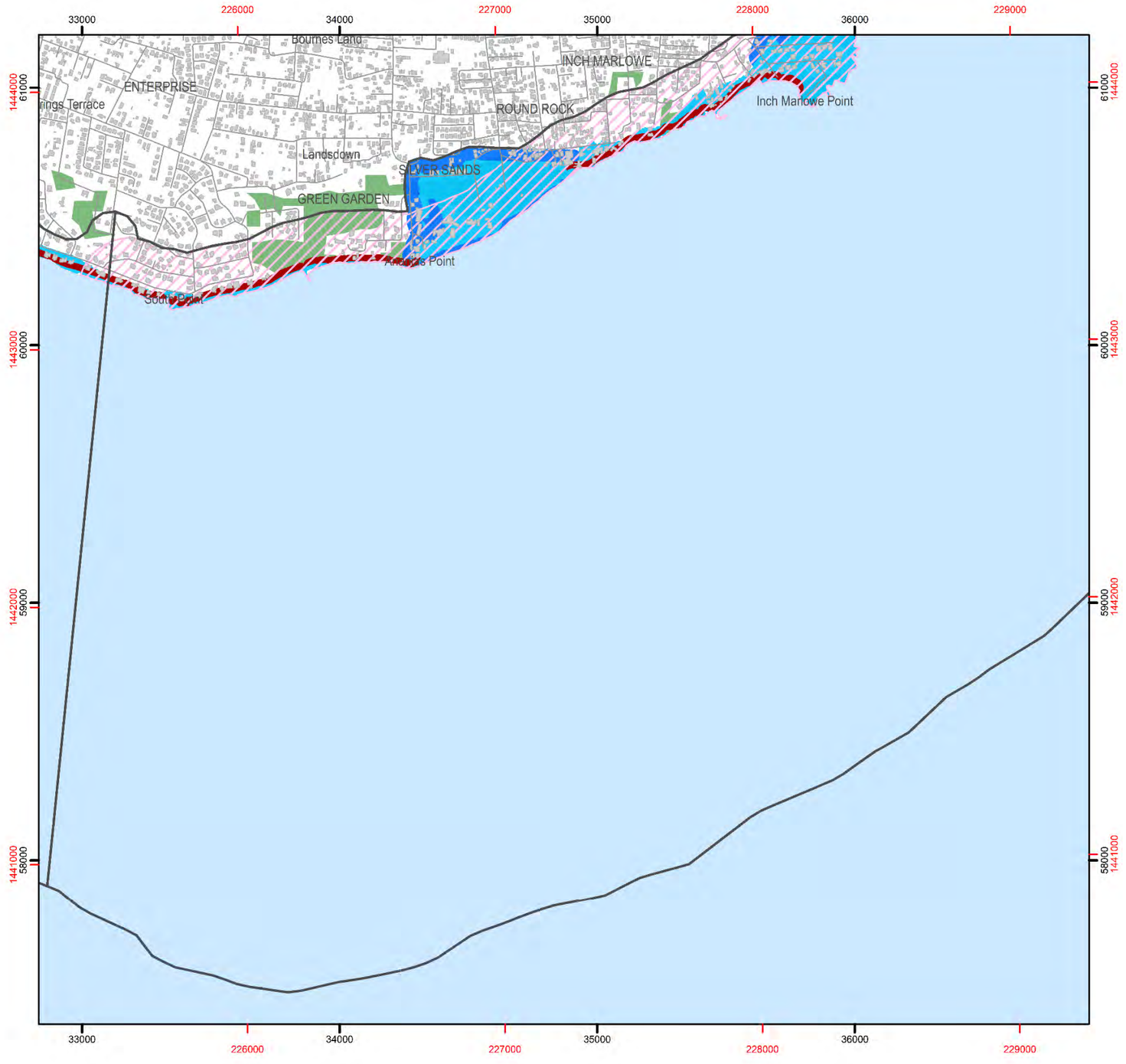
SUB AREAS 1, 8 - SHEET A1

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX





Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

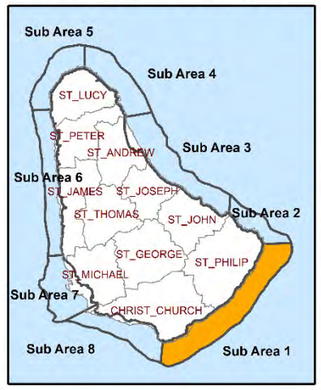
SCALE: 1:18,000

0 125 250 375 500 mts

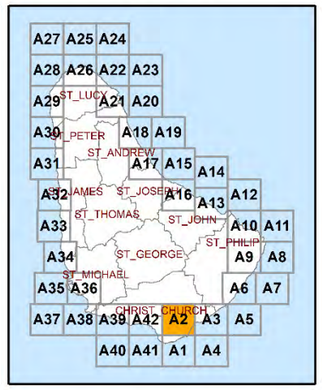
- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

SUB AREA 1 - SHEET A2

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

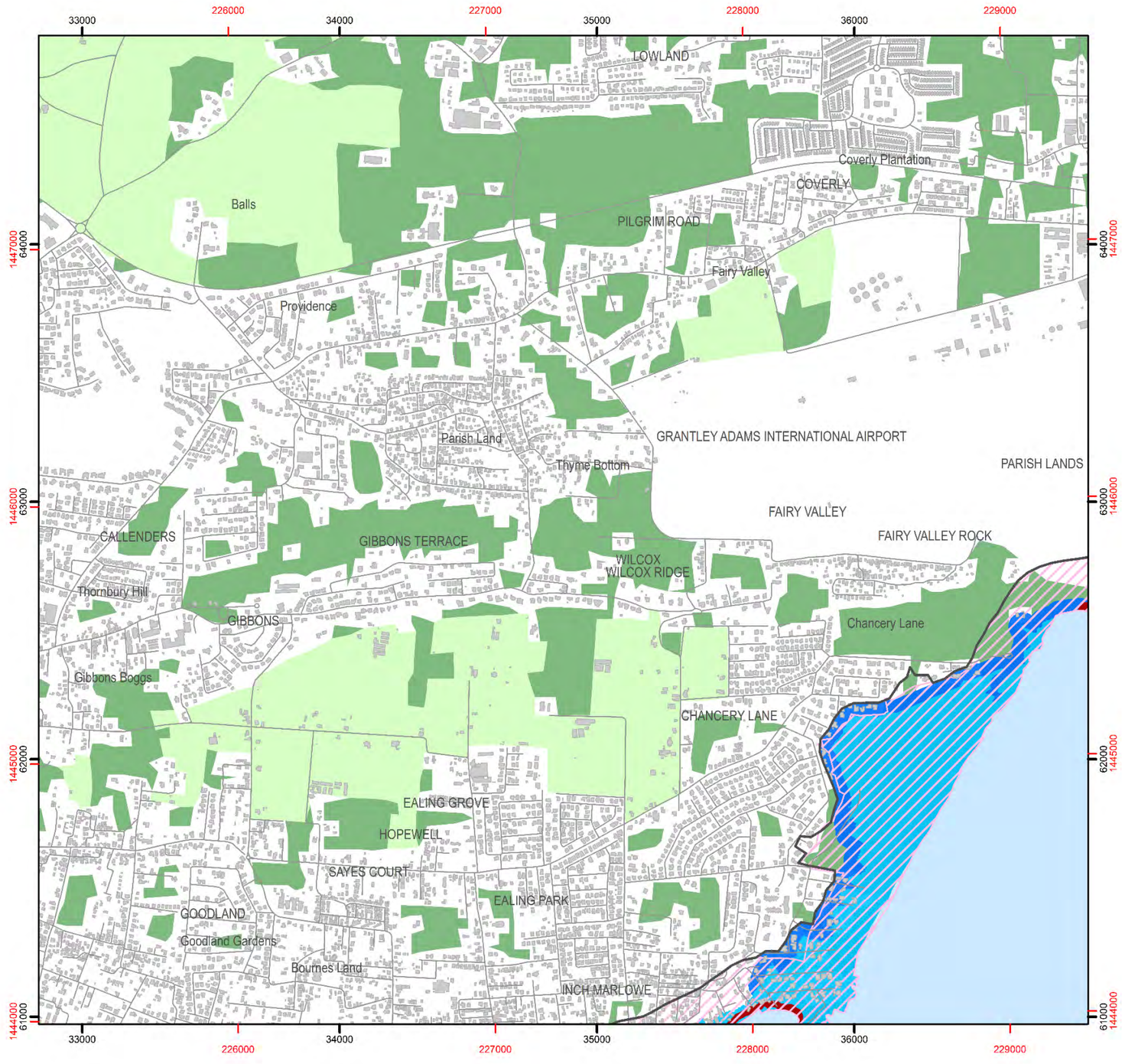
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

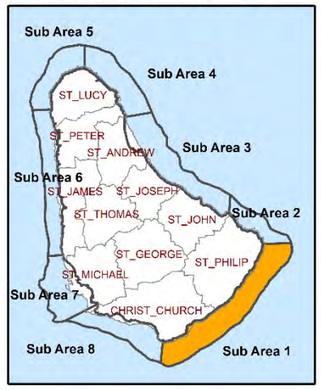
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

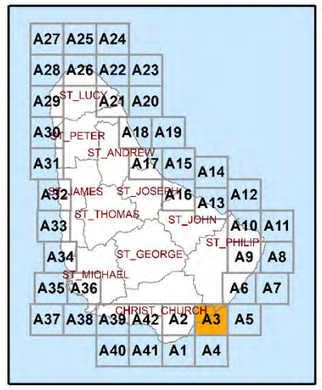


SUB AREA 1 - SHEET A3

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

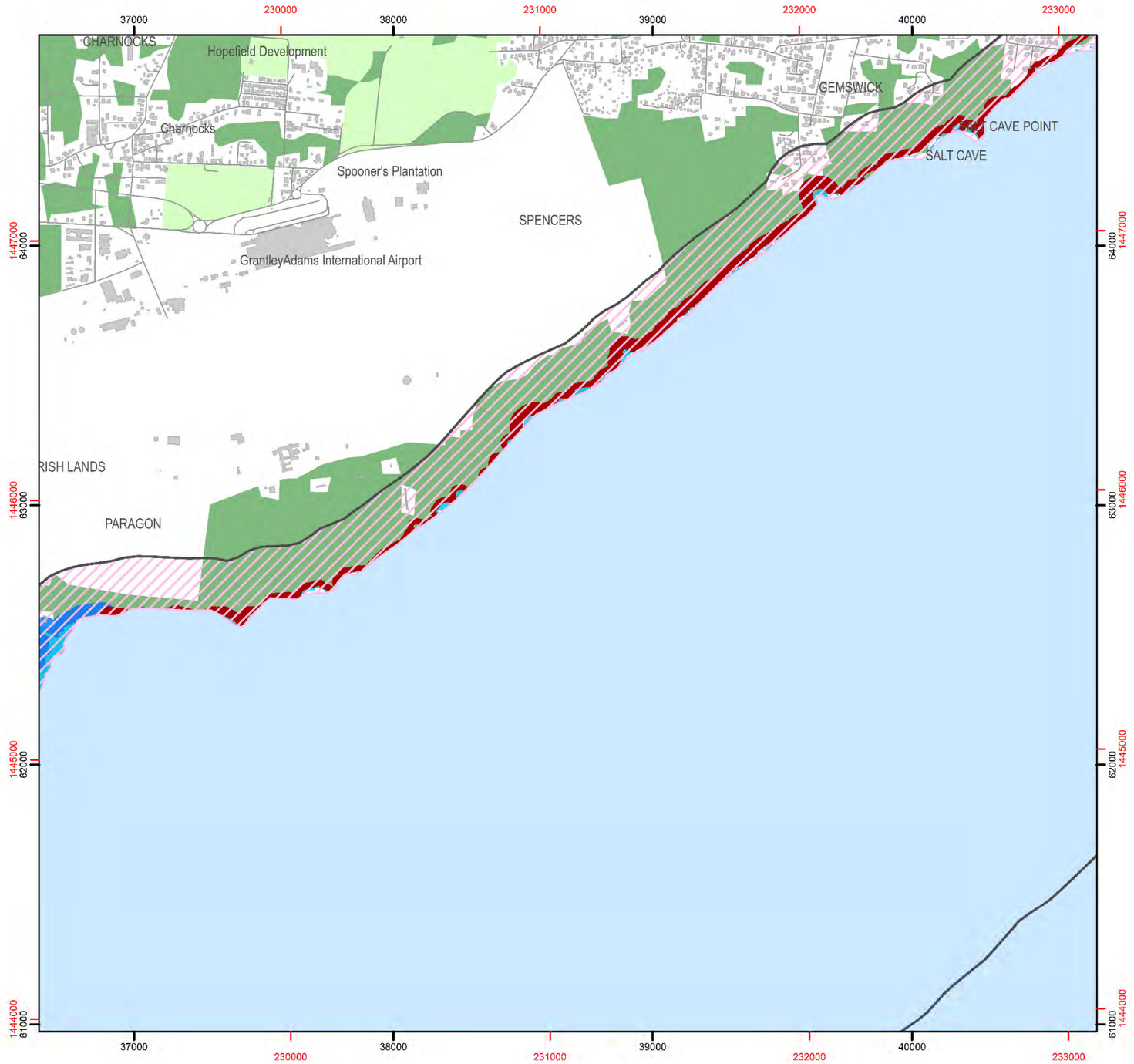
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

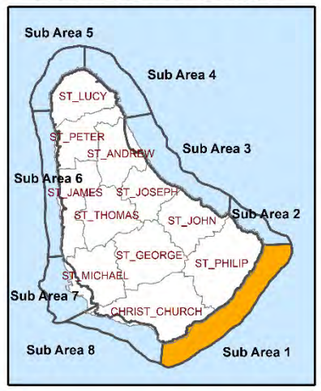
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

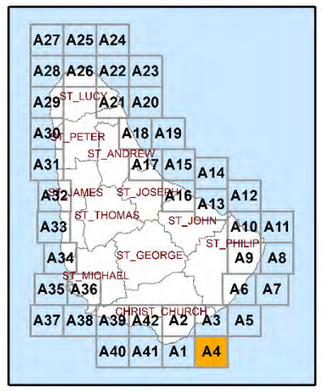


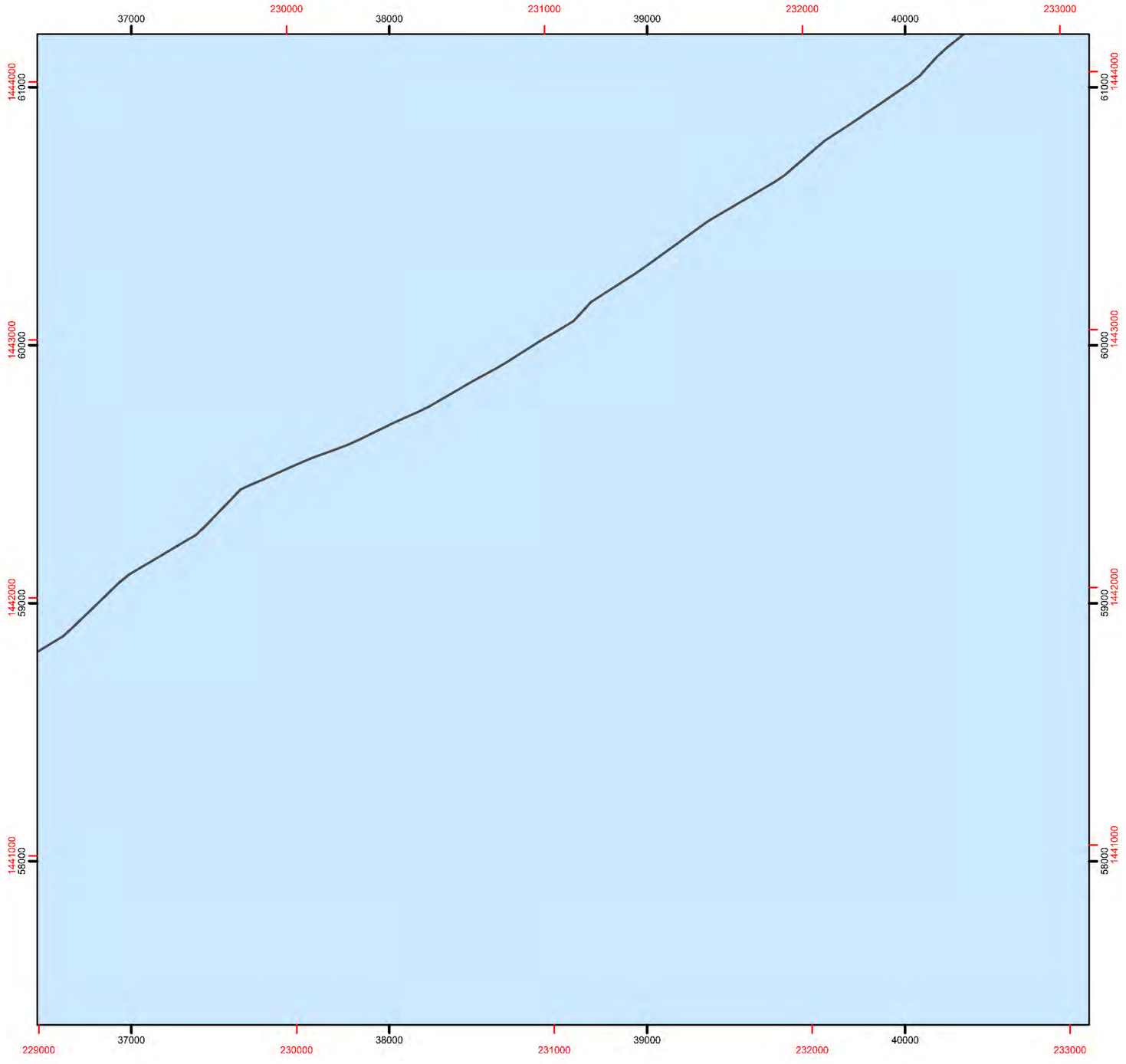
SUB AREA 1 - SHEET A4

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX





Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

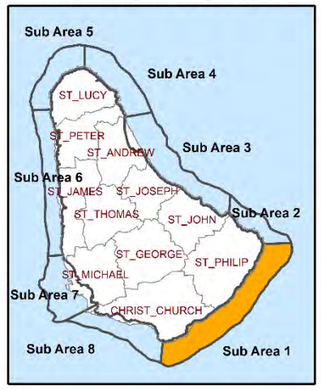
SCALE: 1:18,000

0 125 250 375 500 mts

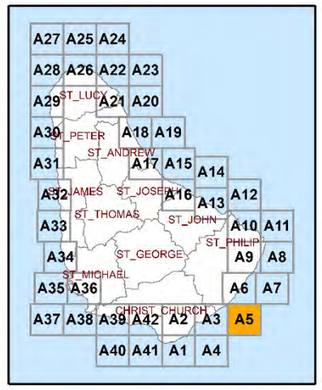
- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

SUB AREA 1 - SHEET A5

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

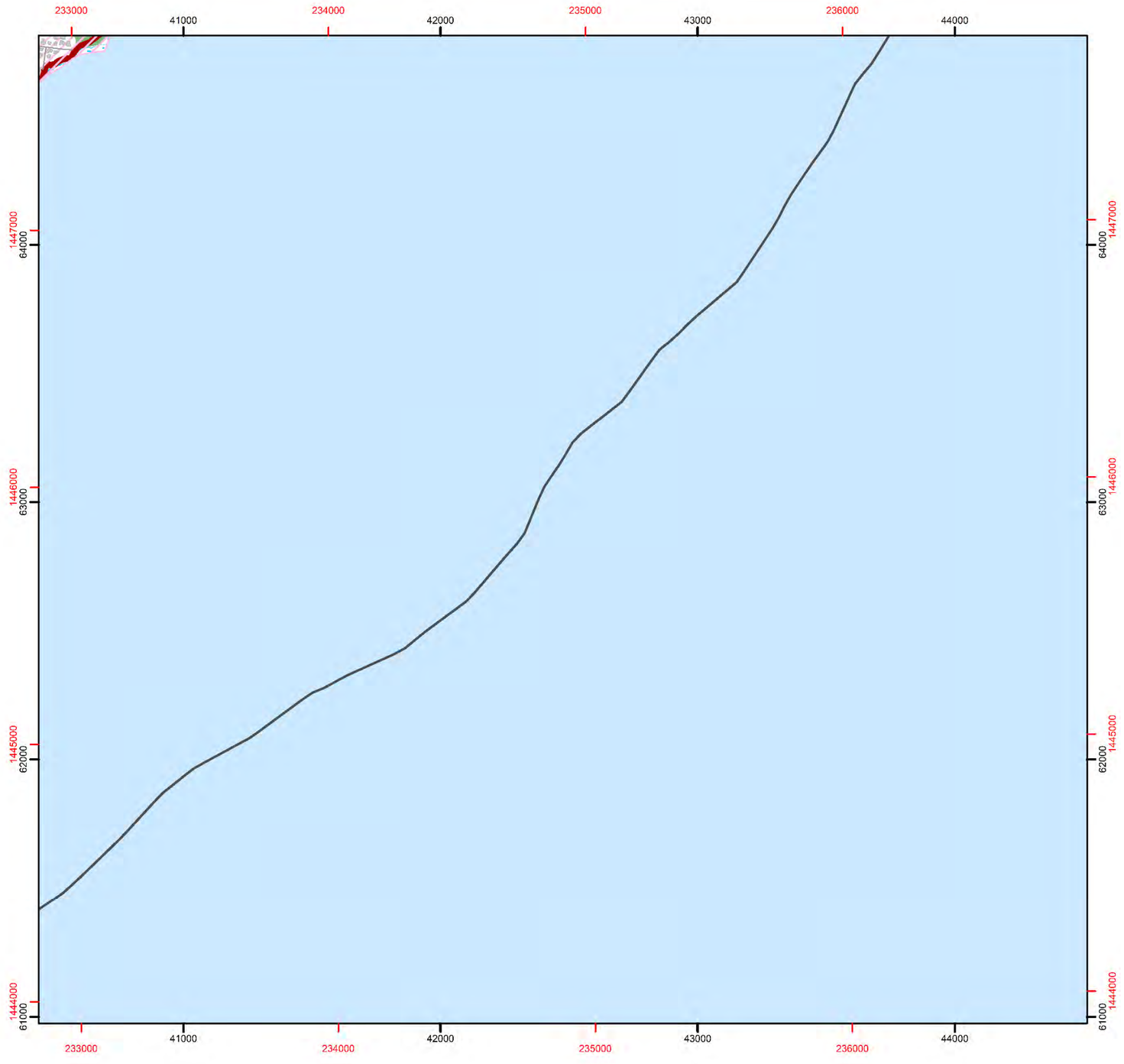
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

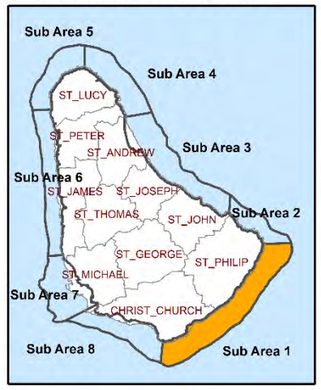
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

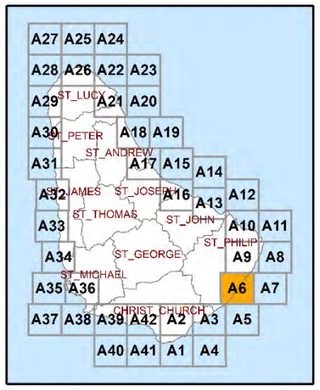


SUB AREA 1 - SHEET A6

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area ——

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

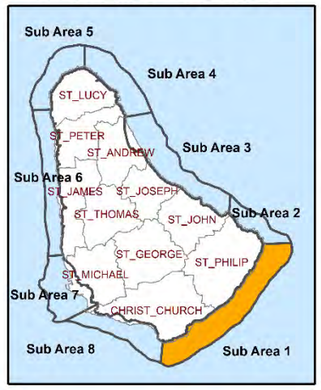
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

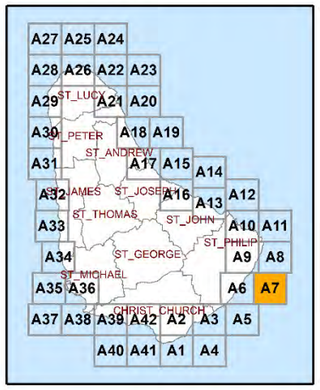


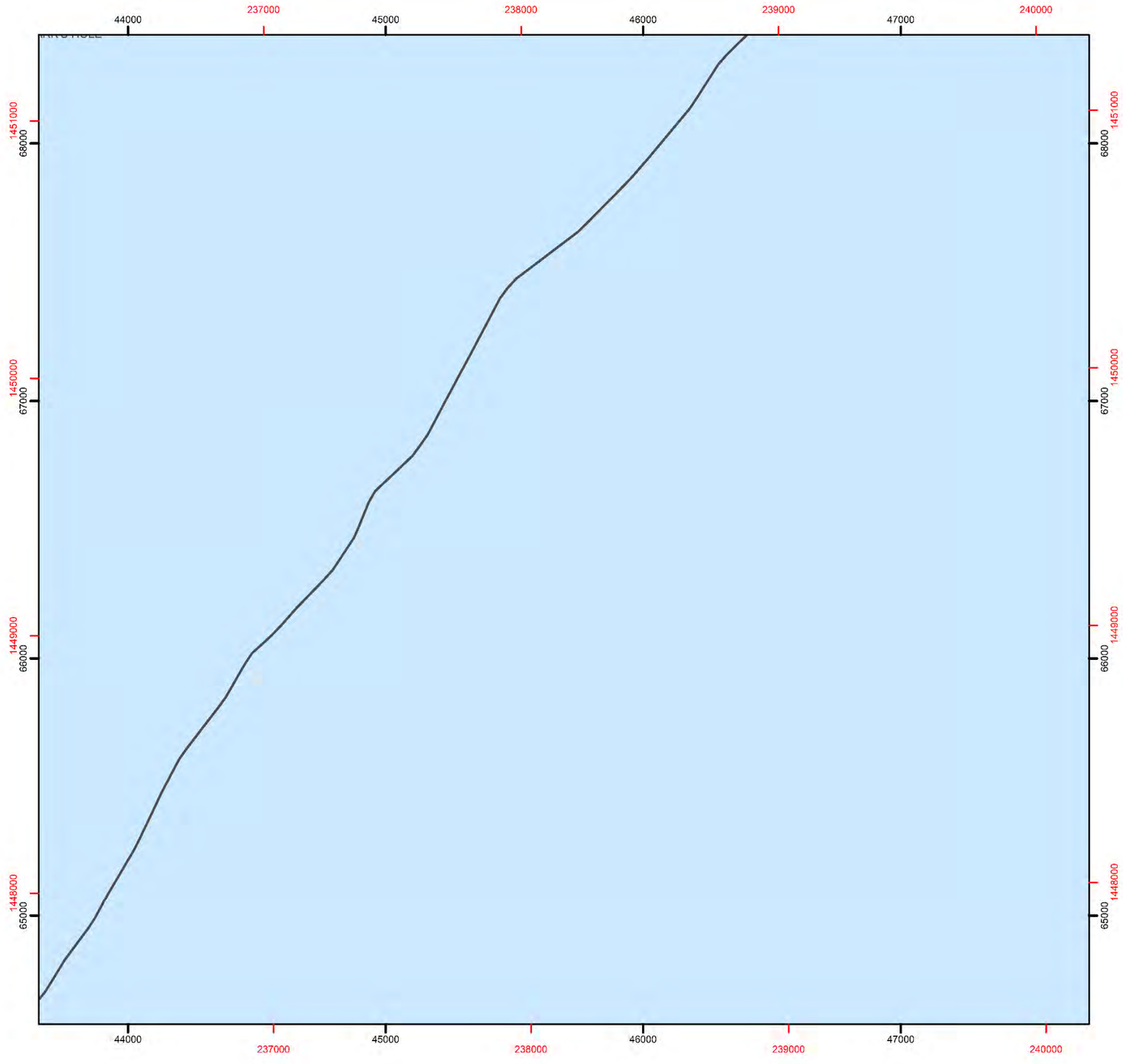
SUB AREA 1 - SHEET A7

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX





Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

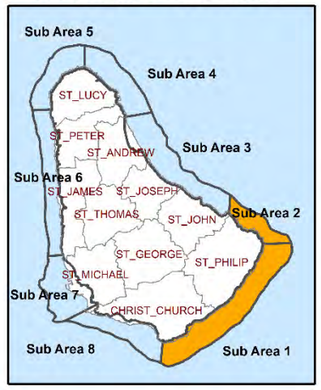
SCALE: 1:18,000

0 125 250 375 500 mts

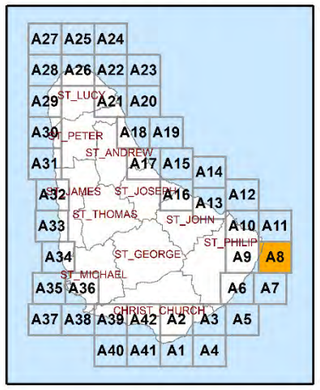
- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

SUB AREAS 1, 2 - SHEET A8

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

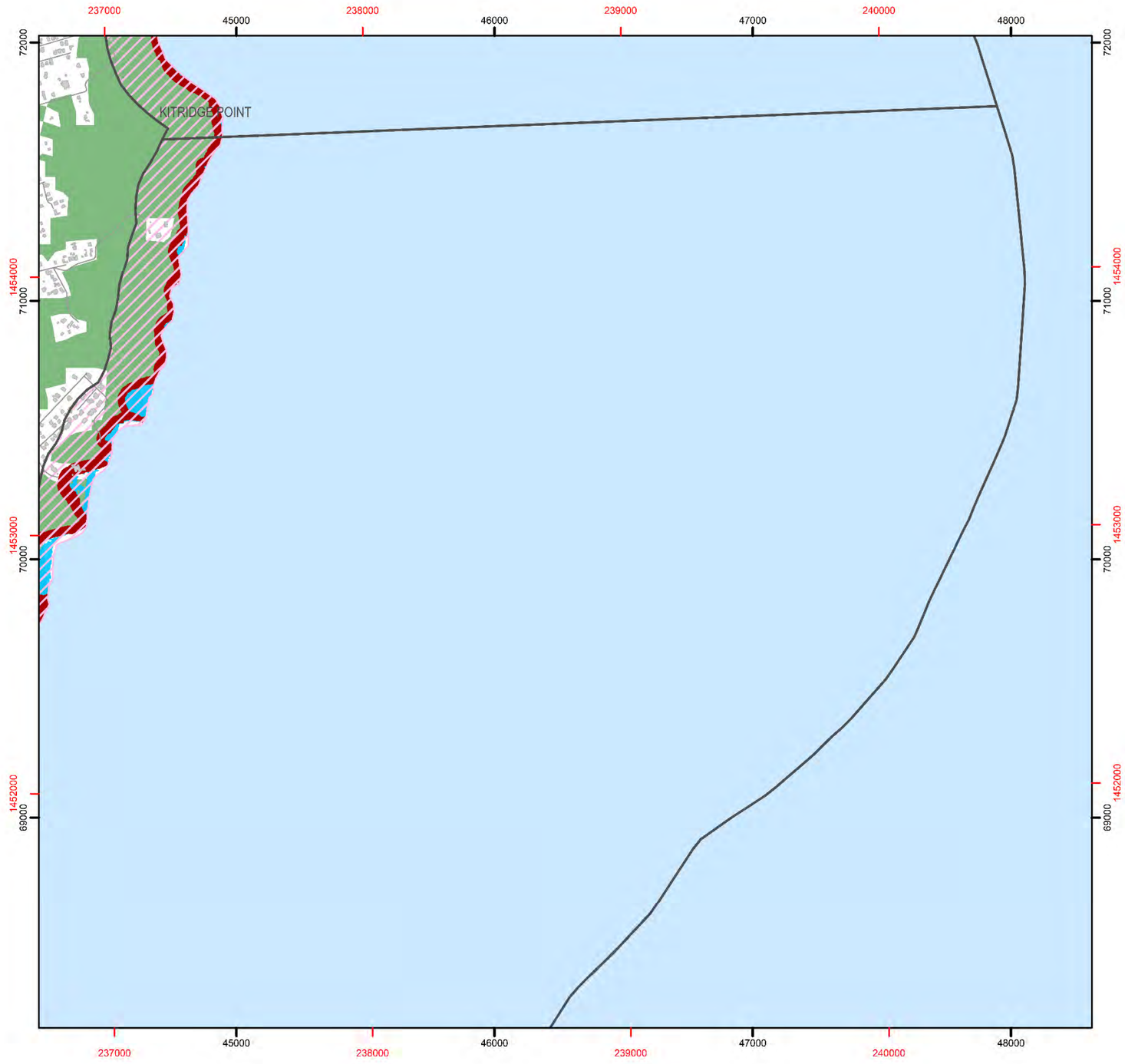
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

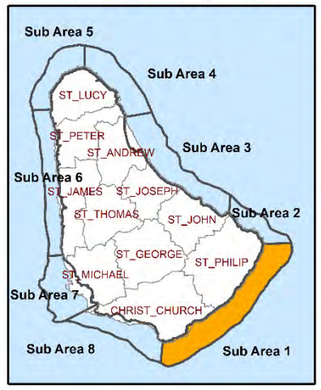
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

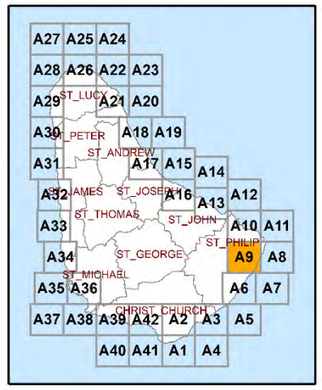


SUB AREA 1 - SHEET A9

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

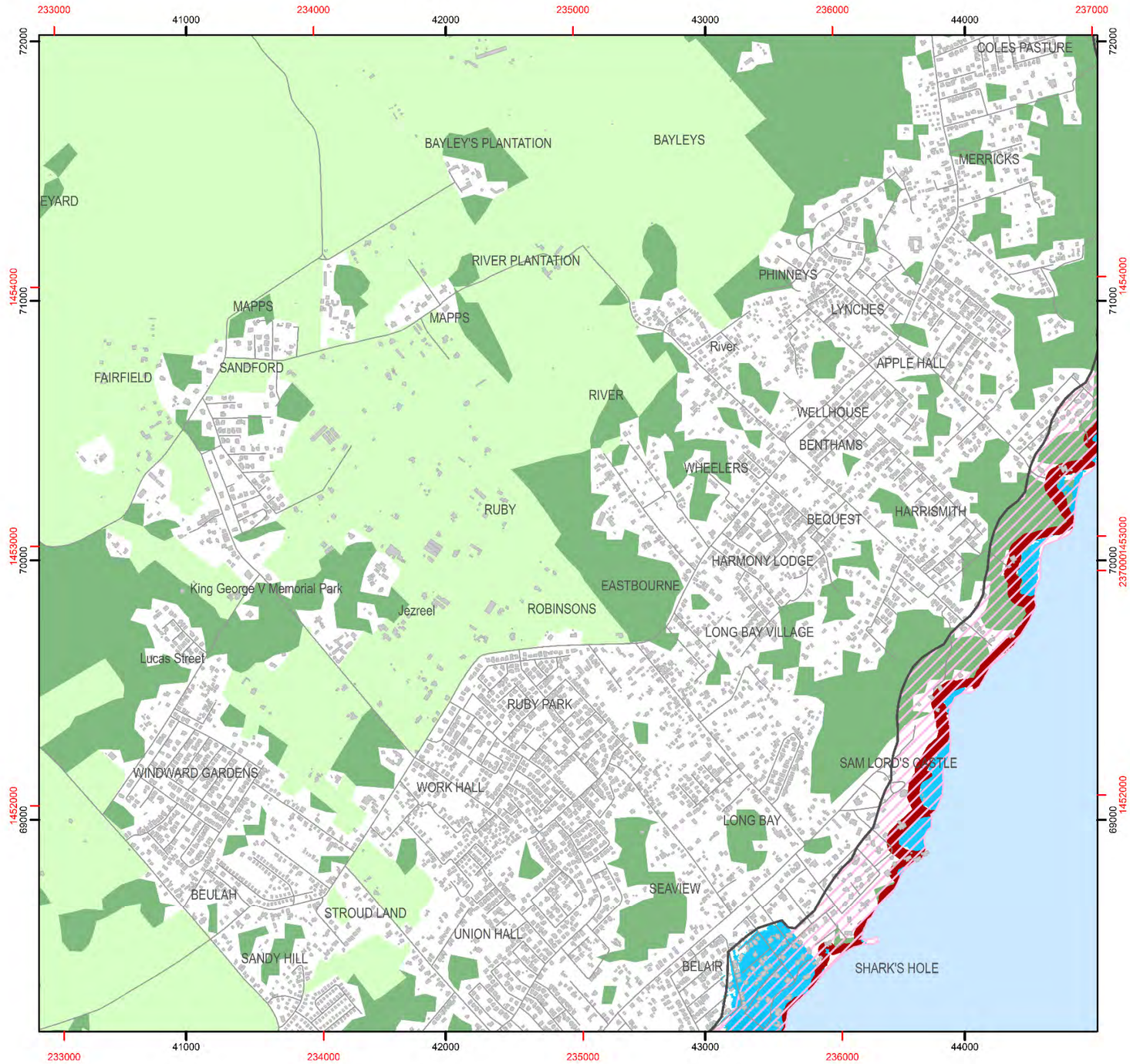
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum



SUB-AREA 2: KITRIDGE POINT TO CONSETT POINT

Main themes

RURAL CHARACTER AND FISHERIES ARE COMPATIBLE WITH PLANNED DEVELOPMENT.

LOW LEVELS OF COASTAL RISKS.

Sub-Area description and context

Sub-Area 2 is a short section along the east coast spanning from Kitridge Point to Consett Bay. The main settlements in the area include Sealy Hall, Whitehaven and Bayfield, surrounded by small-scale agricultural holdings. Skeete's Bay is an important base for local fisher-folk, who operate trap fisheries out on the nearby reefs as well as targeting deep slope pelagic fish stocks. As the fish market lies in an abandoned state, actions are required to rehabilitate the fish market for different uses.

The main landscape features of the rocky coastline are Ragged Point and Skeete's Bay. The whole coastline of Sub-Area 2 is classified within the PDP (2017) as a "Coastal Landscape Protection Zone". The marine habitats in the nearshore environment are comprised of coral rubble and supported algal beds.

Detailed representation at a Sub-Area scale is presented within the subsection entitled "*Description maps of Sub-Area 2"* which includes a collection of maps at a detailed scale (1:18,000) with specific information regarding natural and restricted areas, environmental characteristics, coastal and cliff classification and flooding inundation (and climate change related) hazards that Sub-Area 2 is exposed to.

The coastal risk assessment results (from the CRMP outputs) indicate low level of coastal hazard risks, with Skeete's Bay likely to be exposed to significant 1:25 year return period storm surge hazards. Cliff collapse induced risk is classified as being medium for most of the Sub-Area.



Figure D.3 Sargassum in the near of Skeete´s Bay.

The area from Kitridge Point to Skeete´s Bay is expected to host new urban and tourism developments within the medium and long term, as it has been classified as Urban Corridor in the new Growth Management Framework (PDP, 2017).

Main issues and strategic objectives

KEY ISSUES	STRATEGIC OBJECTIVES
• Valuable coastal landscape. • Presence of sargassum. • Challenges regarding public access to the coast. • Potential conflicts between new tourist and local recreational uses in Skeete´s Bay.	• Maintain the rural landscape and character whilst encouraging local coastal economy through support to fisheries. • Maintain access to the coast to sustain local recreational beach use. • Promote improved Storm Water Management/sewage and solid waste management strategies to limit garbage disposal in watersheds and promotion of adequate treatment of sewage in line with "Roof to Reef principles".

Development Planning and Setbacks at Sub-Area scale

Setback recommendations are presented within a collection of maps provided in the sub-section entitled "Setback maps of Sub-Area 2". These recommendations adhere closely to the National Guidance "Development Planning and Setbacks" (see section C3) for Sub-Area 2. This map provides the delineation of setbacks for this Sub-Area at a scale of 1:18000.

This planning related information should be used by public and private actors whom are involved in the management of the coast such as developers, owners and the general public. The setback guidance adopted is defined for four separate setback categories as appropriate, namely cliff, landscape, flood inundation and climate change.

Action brief

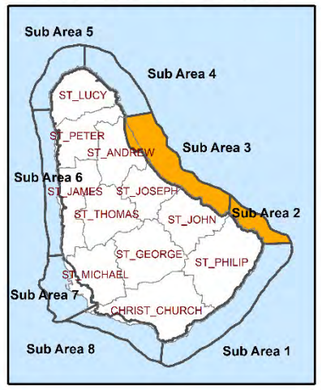
TOPIC	CODE	ACTION	LEAD ACTORS	OTHER ACTORS	TIME SCALE	COMMENTS	KEY POLICY OUTCOME
Beach Management	2BM1	Propose sustainable and environmental friendly tourism and recreational activities as coastal trail (i.e.: Inch Marlowe to Salt Cave), bike lane along the road, etc.	MTI	NCC, CZMU	Medium term, immediate	If facilities are need for economic activities, only soft structures should be promoted. Rationalise car parking and promote public transportation to visit this area.	Outcome 2 - Coastal resources are protected and effectively managed
Development Planning and Setbacks	2S1	Prepare and distribute guidelines to enforce Landscape Setback in Sub-Area 2 for developers and public agencies.	TCDPO	CZMU	Medium term, immediate	Guidelines should explain why coastal landscape is important as coastal resource and attraction for visitors and recommendations for setback enforcement.	Outcome 1 - Sustainable socioeconomic development is achieved
Development Planning and Setbacks	2S2	Prepare and distribute guidelines to enforce Cliff Collapse Setback in Sub-Area 2 for developers and public agencies.	TCDPO	CZMU	Medium term, immediate		Outcome 3 - Climate and disaster risk adaptive capacity is strengthened
Development Planning and Setbacks	2S3	Organize meetings with key stakeholders to raise awareness on coastal resources and landscape.	CZMU	TCPDO, NCC	Medium term, immediate		Outcome 1 - Sustainable socioeconomic development is achieved
Development Planning and Setbacks	2S4	Organize bilateral meetings to review existing applications and evaluate landscape and environmental impacts.	TCDPO	CZMU	Short term, immediate		Outcome 1 - Sustainable socioeconomic development is achieved
Coastal Biodiversity	2BIO1	Promote improved fisheries schemes for Skeete´s Bay.	MMABE	Fisheries, Fisher community, CZMU			Outcome 2 - Coastal resources are protected and effectively managed
Public Awareness and Stakeholder Participation	2PA1	Identify local stakeholder at community level and private developers in the area.	CZMU				Outcome 6 - Research, understanding and knowledge outreach is increased
Public Awareness and Stakeholder Participation	2PA2	Conduct yearly public meetings to identify new issues in the Sub-Area.	CZMU	All stakeholders in the Sub-Area and key institutions at national level			Outcome 6 - Research, understanding and knowledge outreach is increased
Public Awareness and Stakeholder Participation	2PA3	Promote local recreational beach use.	NCC	CZMU, MTI			Outcome 6 - Research, understanding and knowledge outreach is increased

Table D.2. Action brief for Sub-Area 2.

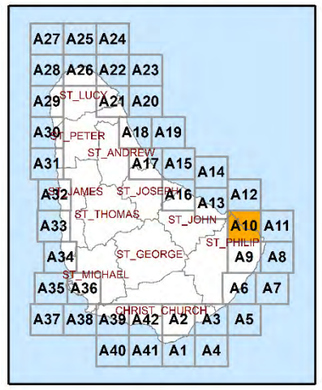
Description maps of Sub-Area 2

SUB AREAS 2, 3 - SHEET A10

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



— Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

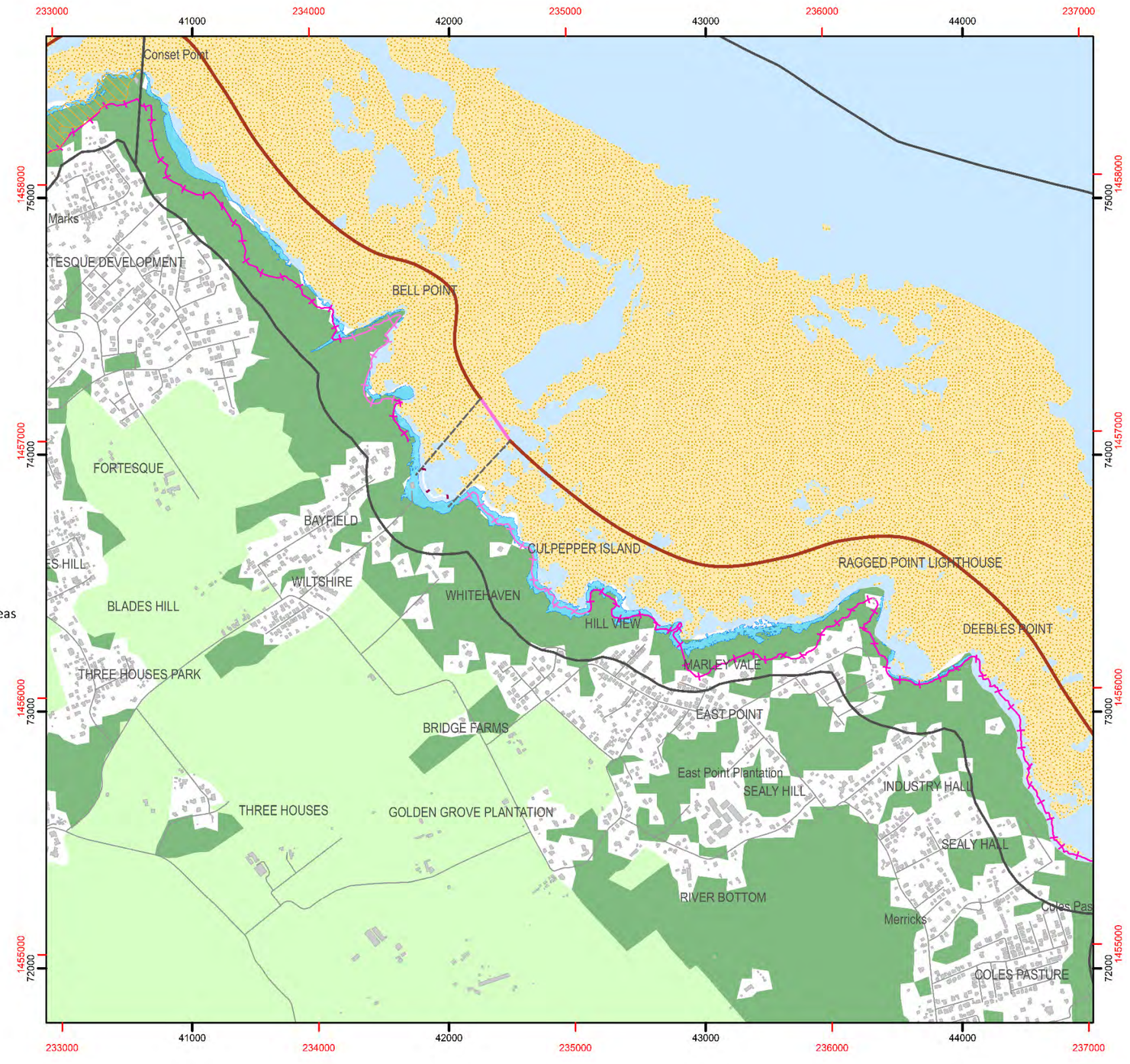
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

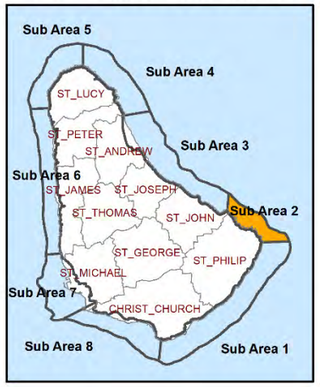
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

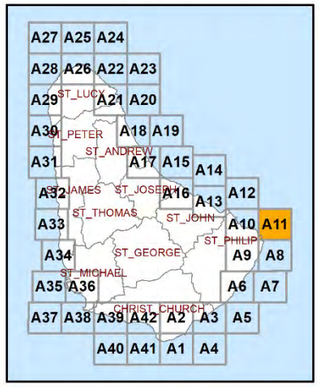


SUB AREA 2 - SHEET A11

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

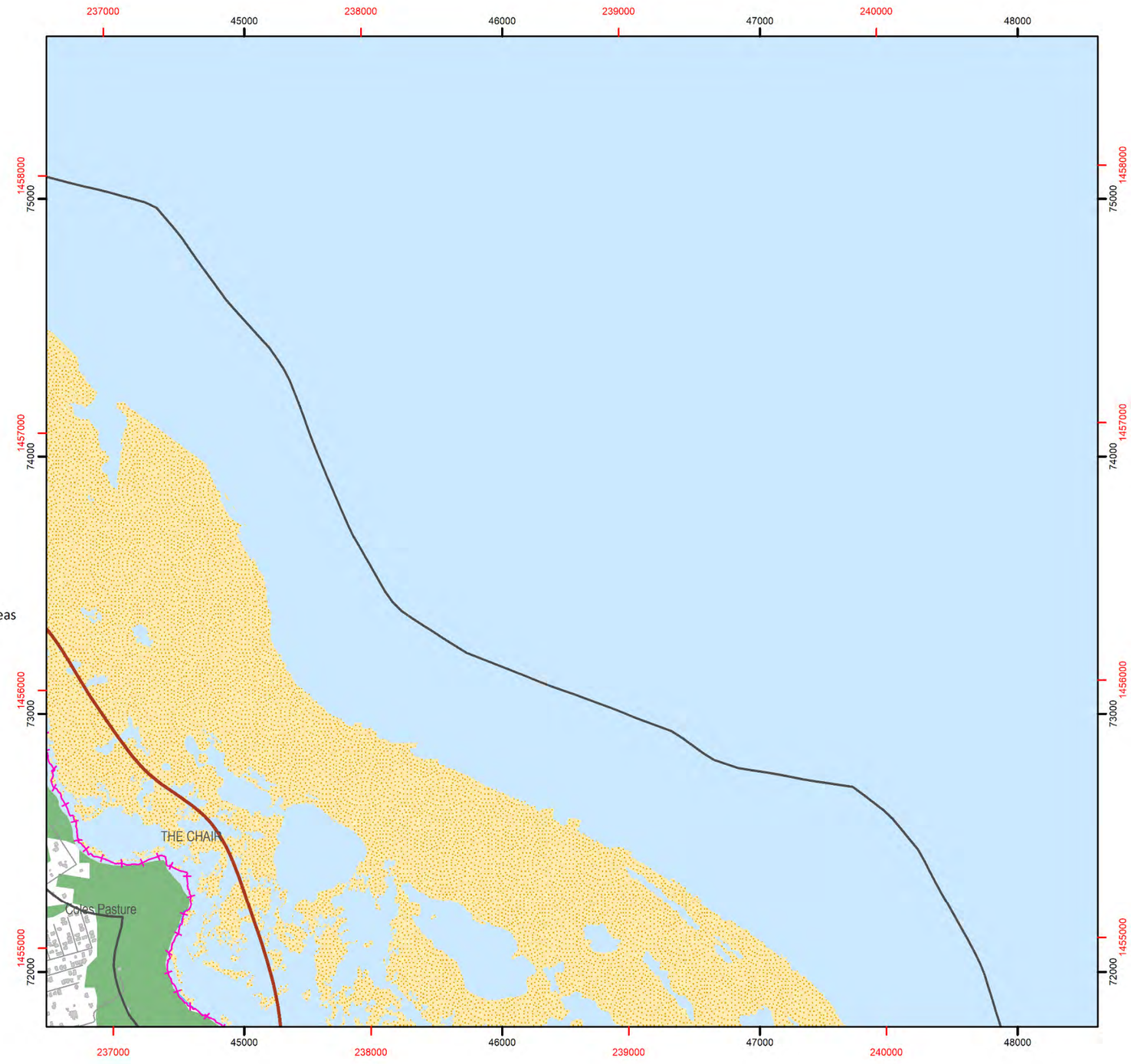
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

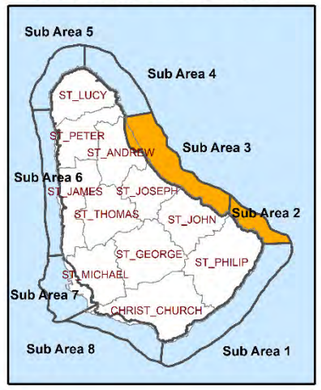
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

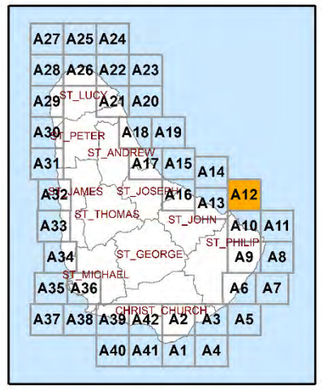


SUB AREAS 2, 3 - SHEET A12

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

Turtle nesting beach	Wetlands	Agriculture
National index beach (OS2)	Seagrass	Natural vegetation
Coral reefs	Mangroves	OS2 Natural heritage areas

Coast and cliff classification

Eroding Coast (Natural)	Eroding Coast (Engineered)
Accreting Coast (Natural)	Accreting Coast (Engineered)
Stable Coast (Natural)	Stable Coast (Engineered)
Dynamically Stable Coast (Natural)	Artificial Coast
Coastal Cliff	Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

Storm surge 100 years | Storm surge + Sea Level Rise (IPCC 2019)

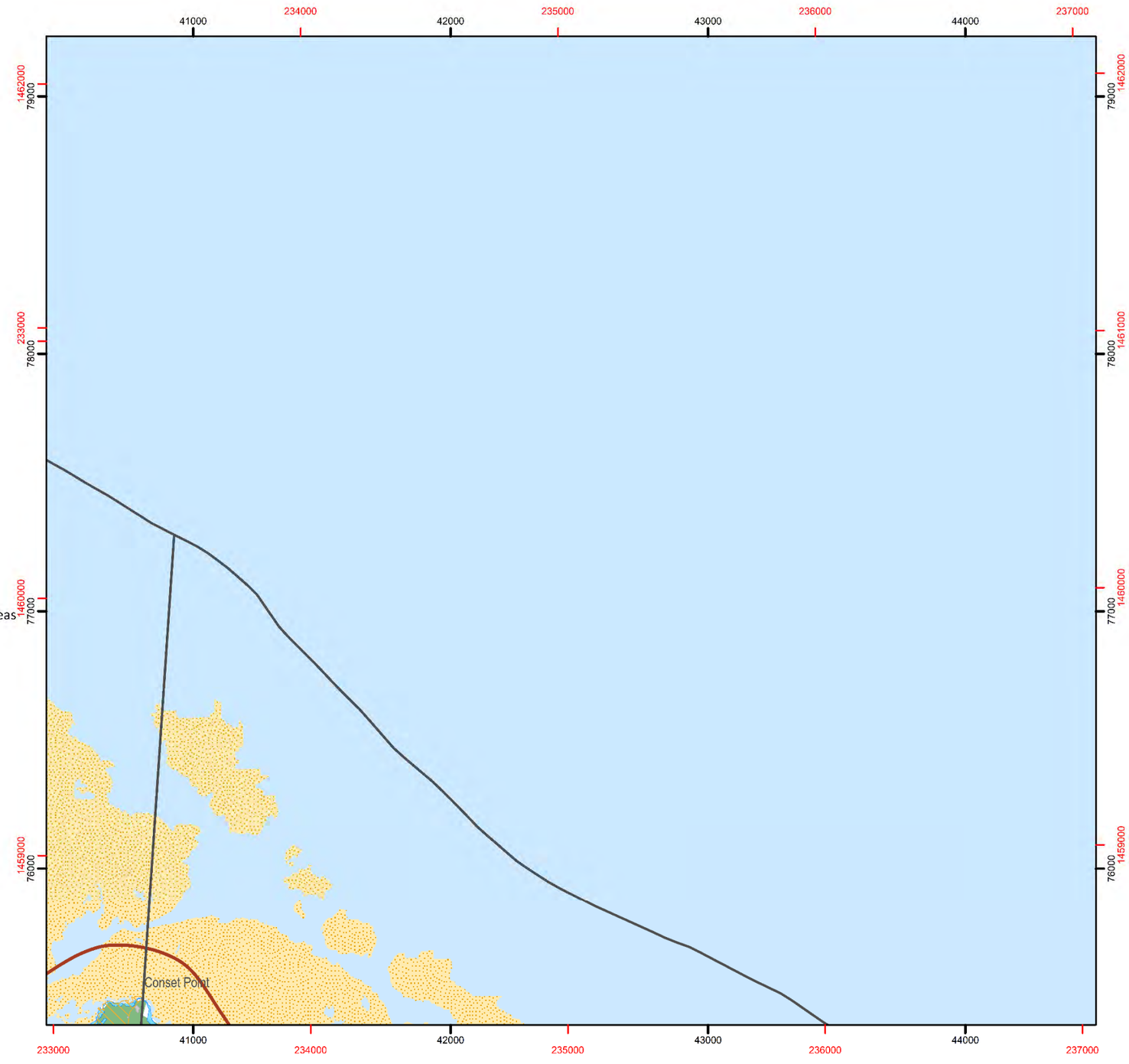
Tsunami 100 years

N

SCALE: 1:18,000

0 125 250 375 500 mts

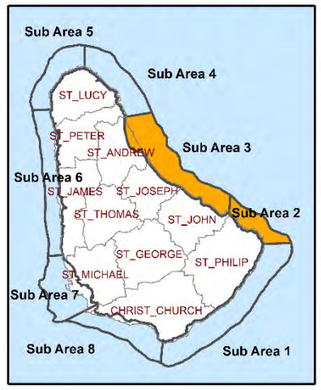
- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum



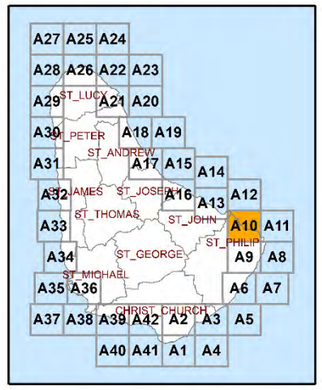
Setback maps of Sub-Area 2

SUB AREAS 2, 3 - SHEET A10

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

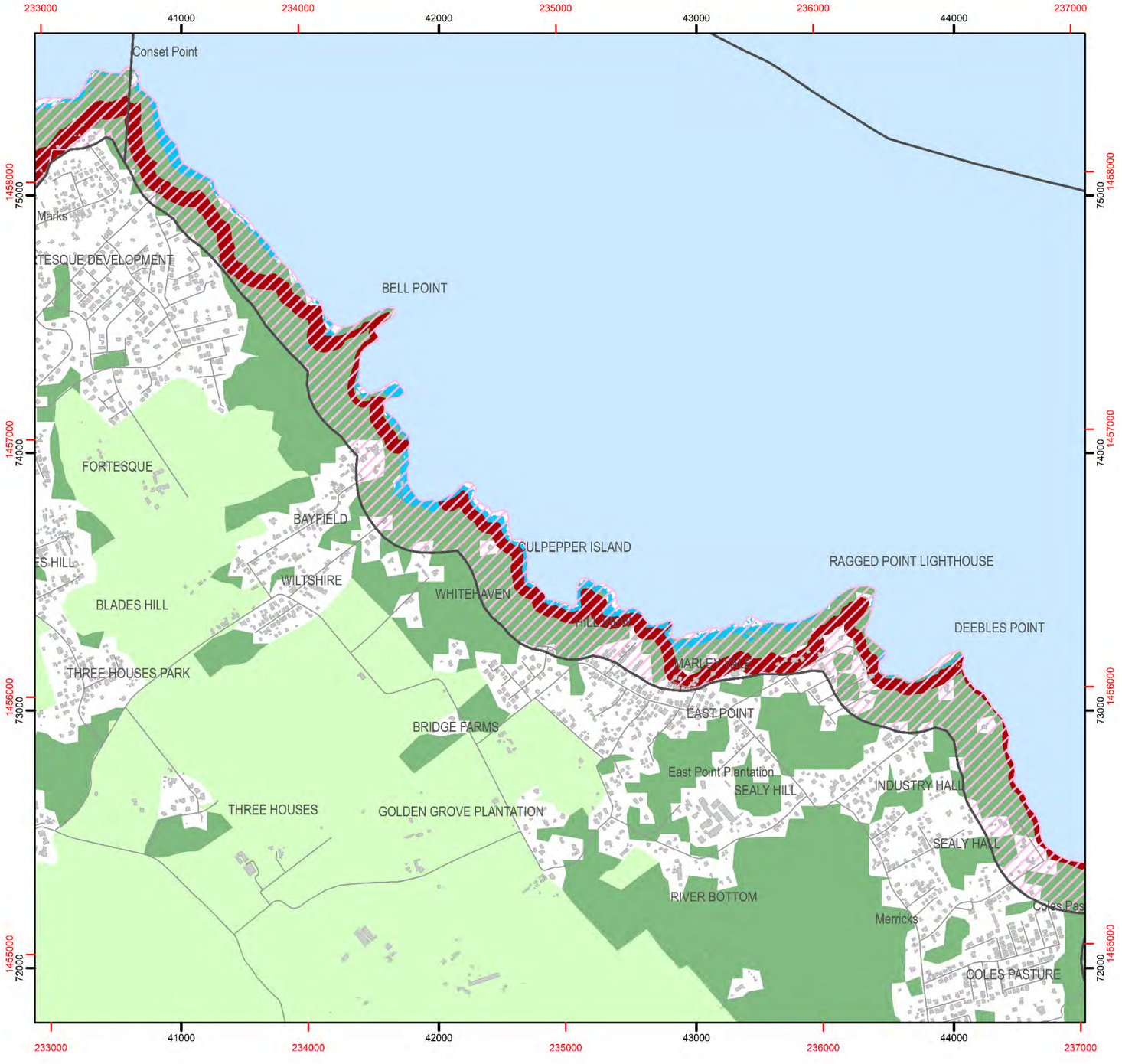
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

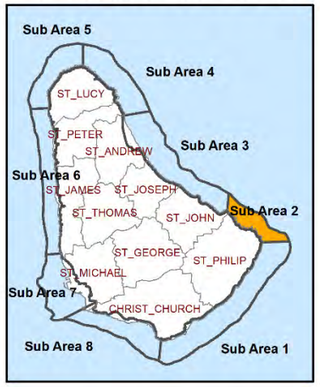
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

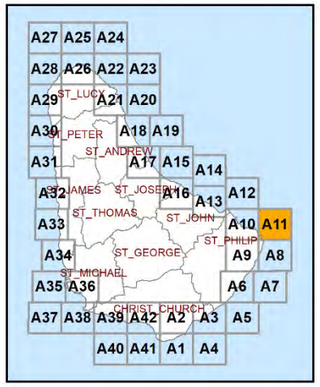


SUB AREA 2 - SHEET A11

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

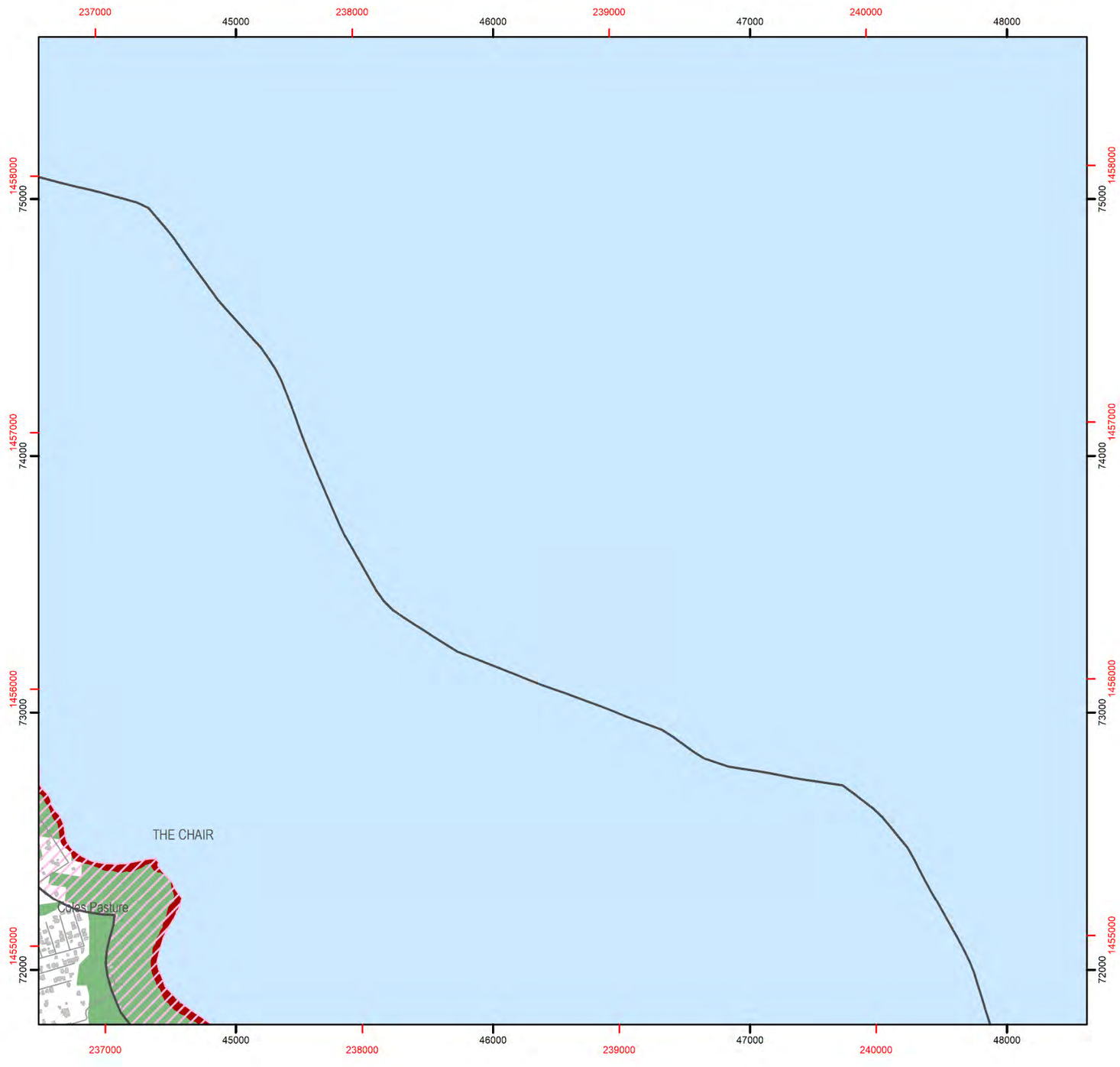
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

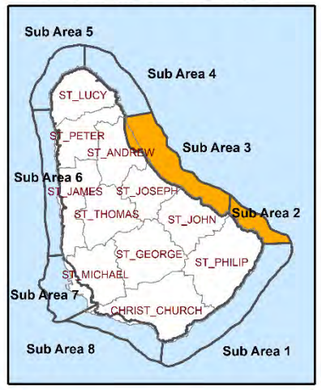
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

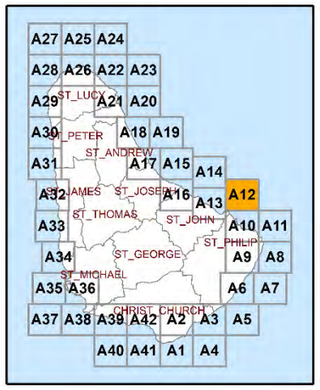


SUB AREAS 2, 3 - SHEET A12

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

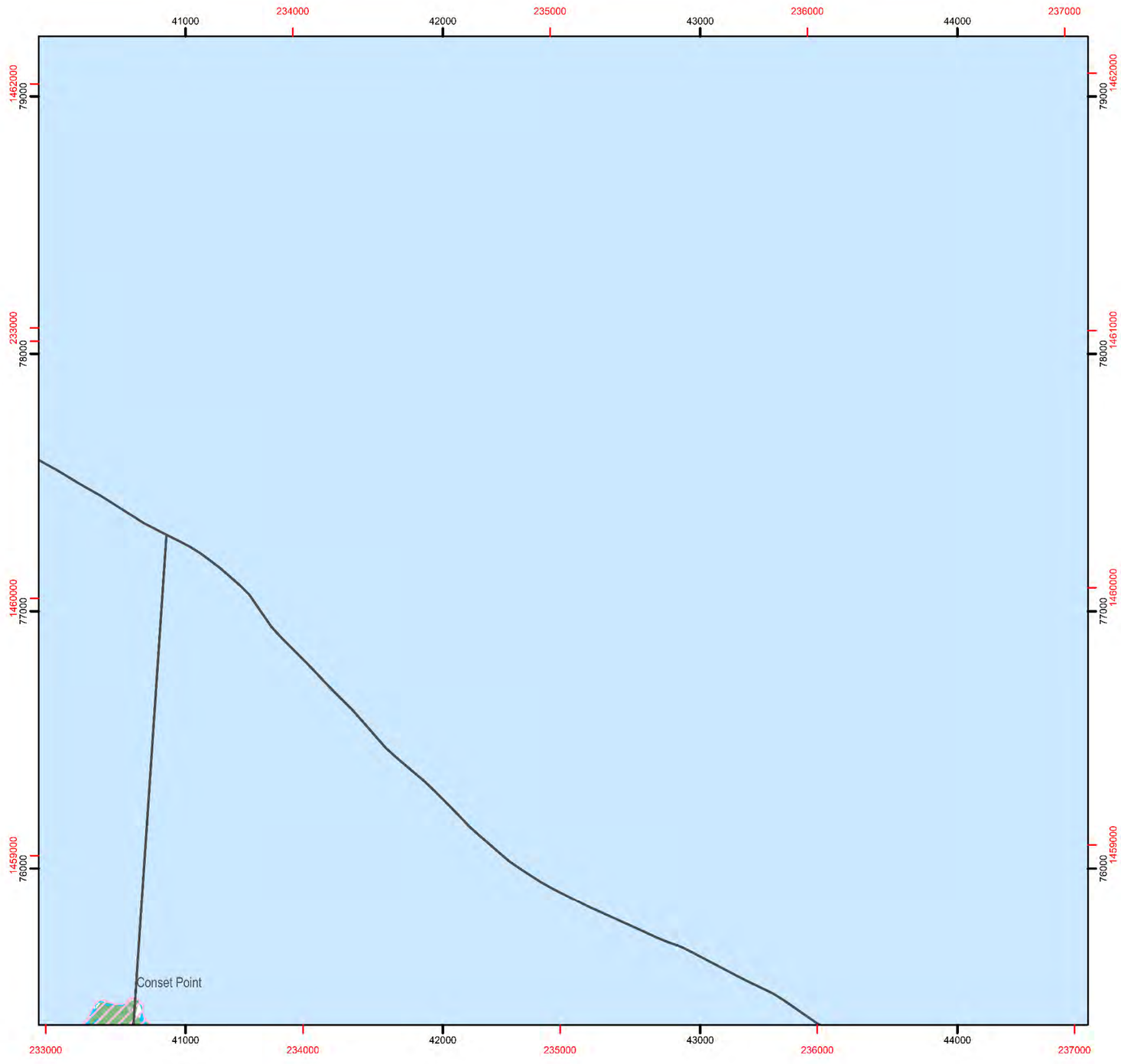
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum



SUB-AREA 3: CONSETT POINT TO THE CHOYCE

Main themes

LANDSCAPE AND NATURAL VALUES FOR RECREATION.

DIFFERENT COASTAL HAZARDS AT SPECIFIC LOCATIONS.

Sub-Area description and context

This Sub-Area covers most of the coastline of the Barbados National Park (PDP, 2017). Sub-Area 3 possesses a less homogeneous pattern of land use when compared to other parts of the Plan area. It is a predominantly rural area with agricultural land surrounding the main settlements of Bathsheba and Belleplaine. Consett Bay and Tent Bay are important bases for fishing activity. Its scenic attributes and undeveloped nature has made this Sub-Area particularly attractive for recreation and commands high potential for tourism development including experienced water sporting enthusiasts including surfers. From a commercial perspective, sand extraction activities continue to take place in the area though at a much reduced level over recent years as the dune system of Walker's Quarry. One encouraging feature is that a restoration project is currently underway at Walker's Reserve.

The Sub-Area contains more topographical variety when compared to the other parts of the coast. It consists of sloping areas that occur between the main escarpment and the coast. The seabed of the nearshore environment is dominated by sandy sediments that are derived from erosion and sediments derived from the Scotland District. The Natural Park and their Natural Heritage Conservation Areas host a mix of woodland, cliff scenery, bays, beaches, water bodies (Long Pond and Green Pond) and upland areas. The long sandy beach extends from Morgan Lewis to Windy Hill and it represents one of the most striking coastal landforms in the island. As for other Sub-Areas along the Atlantic coast, the presence of Sargassum remains a continuing logistical and management issue for the Sub-Area.

Detailed representation at Sub-Area scale is presented in sub-section *"Description maps of Sub-Area 3"* that includes a collection of maps at a detailed scale (1:18,000) with specific information regarding natural and restricted areas, environmental characteristics, coastal and cliff classification and flooding inundation (and climate change related) hazards that Sub-Area 3 is exposed to.

Due to the low level of development in this area, results from the assessment of coastal risk do not indicate a high-risk level to communities along this coast. Despite this, and considering recent sea-level rise projections (IPCC, 2020), flooding risk in the areas between Consett Bay and Bath, Martin´s Bay and from Tent Bay to The Choyce continues to be possible. Coastal erosion is reported from Chalky Mount to Hill Crest, and along the coast of Bath and Consett Bay. At Conger Rocks, cliff collapse induced risk is classified as being very high.



Figure D.4. Boulder in Bathsheba.

Within the new Growth Management Framework (PDP, 2017) the coast of this sub-Area is predominantly classified as Natural Park or Natural Park Village except for Bathsheba that constitutes a Community Core. The PDP also states that no new development on the seaward side of Ermie Bourne Highway is permitted.

Main issues and strategic objectives

KEY ISSUES	STRATEGIC OBJECTIVES
• Valuable seascapes and landscapes and associated natural resources fall within the National Park. • Presence of sargassum. • Potential for nature tourism and recreational activities. • Licensed sand extraction from dune area. • Potential storm surge risk considering last projections of sea-level rise. • Land based pollution affect dunes and beaches.	• Conserve and enhance the character and quality of the landscape, natural and cultural features of the Natural Park. • Restore and enhance coastal ecosystems, including sand dunes, beaches, wetlands, gullies and marine ecosystems through Ecosystem-based Adaptation interventions, including measures for pollution control. • Support and enhance heritage tourism that benefits local communities is economically viable, and is compatible with the environmental quality of the area. • Enforce sufficient setback to allow for safety, to preserve the character of the coastal landscape and retain views to the sea. • Provide opportunities for informal recreation and promote an understanding and enjoyment of the special qualities of the National Park. • Promote improved Storm Water Management/sewage and solid waste management strategies to limit garbage disposal in watersheds and promotion of adequate treatment of sewage in line with “Roof to Reef principles”.

Development Planning and Setbacks at Sub-Area scale

Setback recommendations are presented within a collection of maps provided in the sub-section entitled “Setback maps of Sub-Area 3”. These recommendations adhere closely to the National Guidance “Development Planning and Setbacks” (see section C3) for Sub-Area 3. This map provides the delineation of setbacks for this Sub-Area at a scale of 1:18000.

This planning related information should be used by public and private actors whom are involved in the management of the coast such as developers, owners and the general public. The setback guidance adopted is defined for four separate setback categories as appropriate, namely cliff, landscape, flood inundation and climate change.

Action brief

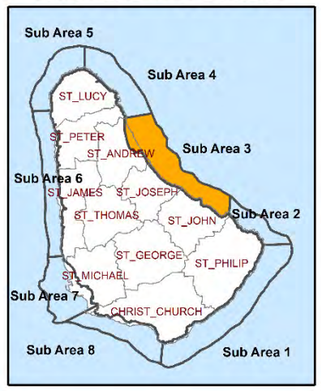
TOPIC	CODE	ACTION	LEAD ACTORS	OTHER ACTORS	TIME SCALE	COMMENTS	KEY POLICY OUTCOME
Beach Management	3BM1	Prepare a Plan to promote environmentally friendly tourism and recreational activities (i.e.: coastal trails, bike lanes, interpretation routes, etc.) and upgrading existing walks facilities.	NHD	NCC, CZMU, MTI	Medium term, immediate	If facilities are need for economic activities, only soft structures should be promoted. Rationalise car parking and promote public transportation to visit this area.	Outcome 2 - Coastal resources are protected and effectively managed
Beach Management	3BM2	Develop and implement a Beach Management Plan for the National Park.	NCC	TCDPO, CZMU, Walkers Reserve, NHD	Medium term, continuous	The beach plan in this area is to protect the natural beauty and recreation opportunities for Barbadians.	Outcome 2 - Coastal resources are protected and effectively managed
Development Planning and Setbacks	3S1	Prepare and distribute guidelines to enforce Landscape Setback in Sub-Area 3 for developers and public agencies.	NHD	TCDPO, CZMU	Medium term, immediate	Guidelines should explain why coastal landscape is important as coastal resource and attraction for visitors and recommendations for setback enforcement. They should include the provision of PDP related to the seaward of Ermie Bourne Highway.	Outcome 1 - Sustainable socioeconomic development is achieved
Development Planning and Setbacks	3S2	Organize meetings with key stakeholders to raise awareness on coastal resources and landscape.	CZMU	TCPDO, NCC, NHD	Medium term, immediate		Outcome 1 - Sustainable socioeconomic development is achieved
Coastal Biodiversity	3BIO1	Prohibit sand extraction from dunes.	NRD	NHD,TCDPO, CZMU	Short term, immediate		Outcome 2 - Coastal resources are protected and effectively managed
Coastal Biodiversity	3BIO2	Promote improved fisheries schemes for Consett and Tent Bay	MMABE	Fisheries, Fisher community, CZMU			Outcome 2 - Coastal resources are protected and effectively managed
Coastal Biodiversity	3BIO3	Promote monitoring of water quality at Green and Long Pond	EPD	NCC, CZMU, NHD, Biodiversity Section	Short term, immediate		Outcome 2 - Coastal resources are protected and effectively managed
Coastal Biodiversity	3BIO4	Promote the protection of leatherback turtles	CZMU	NCC, Turtle Group	Medium term, continuous		Outcome 2 - Coastal resources are protected and effectively managed
Coastal Biodiversity	3BIO5	Participate into restoration projects to provide advice on how to protect coastal resources and processes from an EbA.	NCC	NCC, CZMU, Walkers Reserve, NHD			Outcome 2 - Coastal resources are protected and effectively managed
Public Awareness and Stakeholder Participation	3PA1	Identify local stakeholder at community level and private developers in the area.	NHD				Outcome 6 - Research, understanding and knowledge outreach is increased
Public Awareness and Stakeholder Participation	3PA2	Conduct yearly public meetings to identify new issues in the Sub-Area.	CZMU	All stakeholders in the Sub-Area and key institutions at national level			Outcome 6 - Research, understanding and knowledge outreach is increased
Public Awareness and Stakeholder Participation	3PA3	Promote local recreational beach use.	NCC	NHD			Outcome 6 - Research, understanding and knowledge outreach is increased
Non-living Resource Exploration and Exploitation	3REE1	Formalise CZM Regulations to designate incipient dunes, beach and fore-dunes as areas in which removal of vegetation or sand is prohibited in Belleplaine and Walkers Savannah.	CZMU	SCU, EPD, NCC, NRD, NHD	Short term		Outcome 4 - ICZM is delivered through a coordinated governance arrangement
Non-living Resource Exploration and Exploitation	3REE2	Promote restoration of the incipient dunes, beach and fore-dunes as compensatory measures to developers that perform extraction activities in Belleplaine and Walkers Savannah.	CZMU	SCU, EPD, NCC, NRD, NHD	Short term		Outcome 2 - Coastal resources are protected and effectively managed

Table D.3 Action brief for Sub-Area 3.

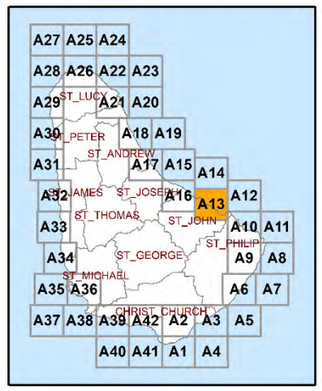
Description maps of Sub-Area 3

SUB AREA 3 - SHEET A13

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

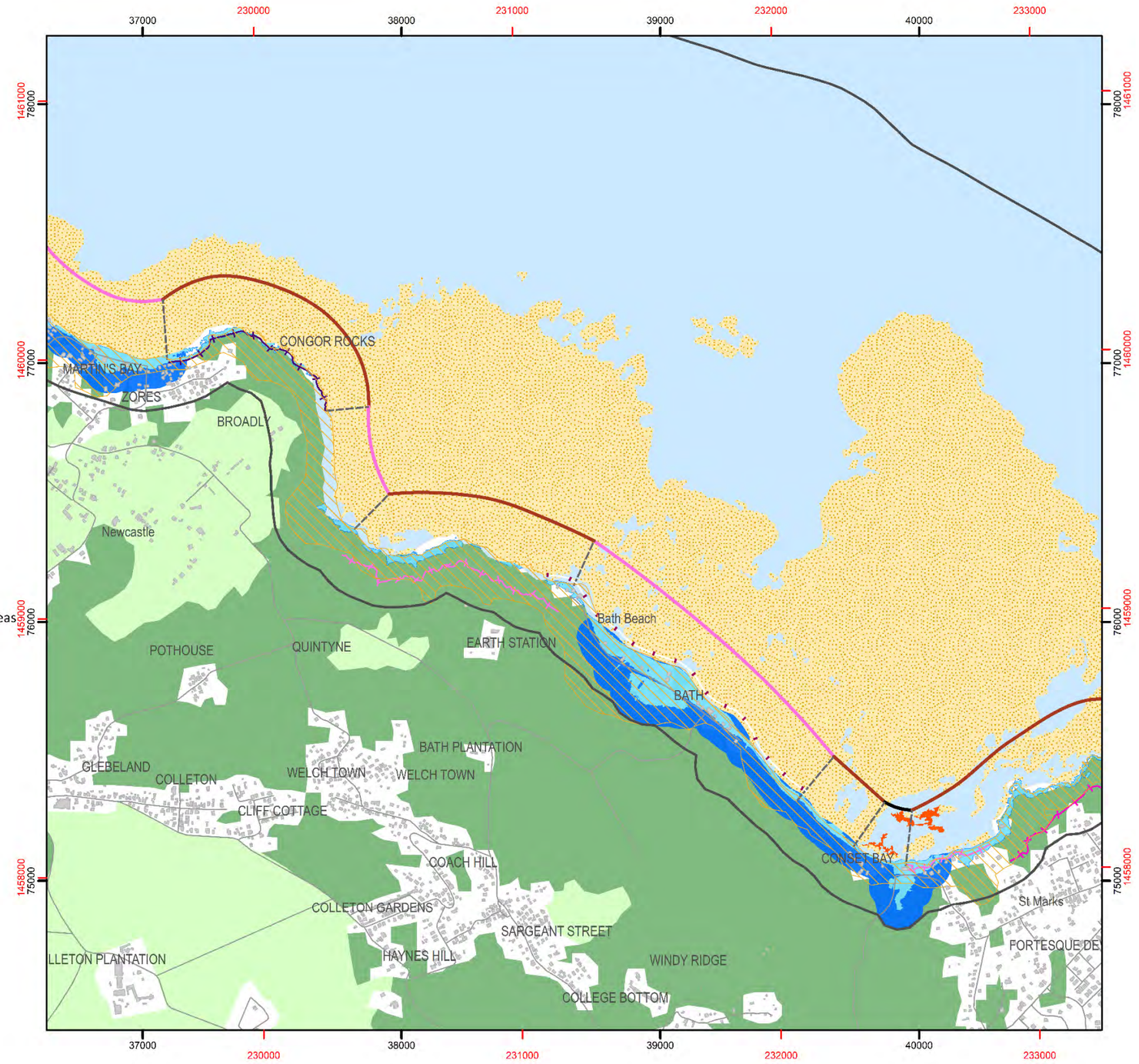
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

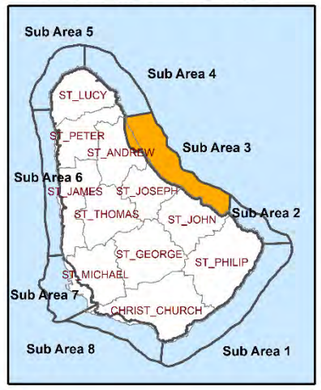
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

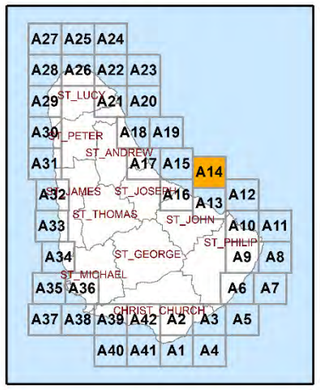


SUB AREA 3 - SHEET A14

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

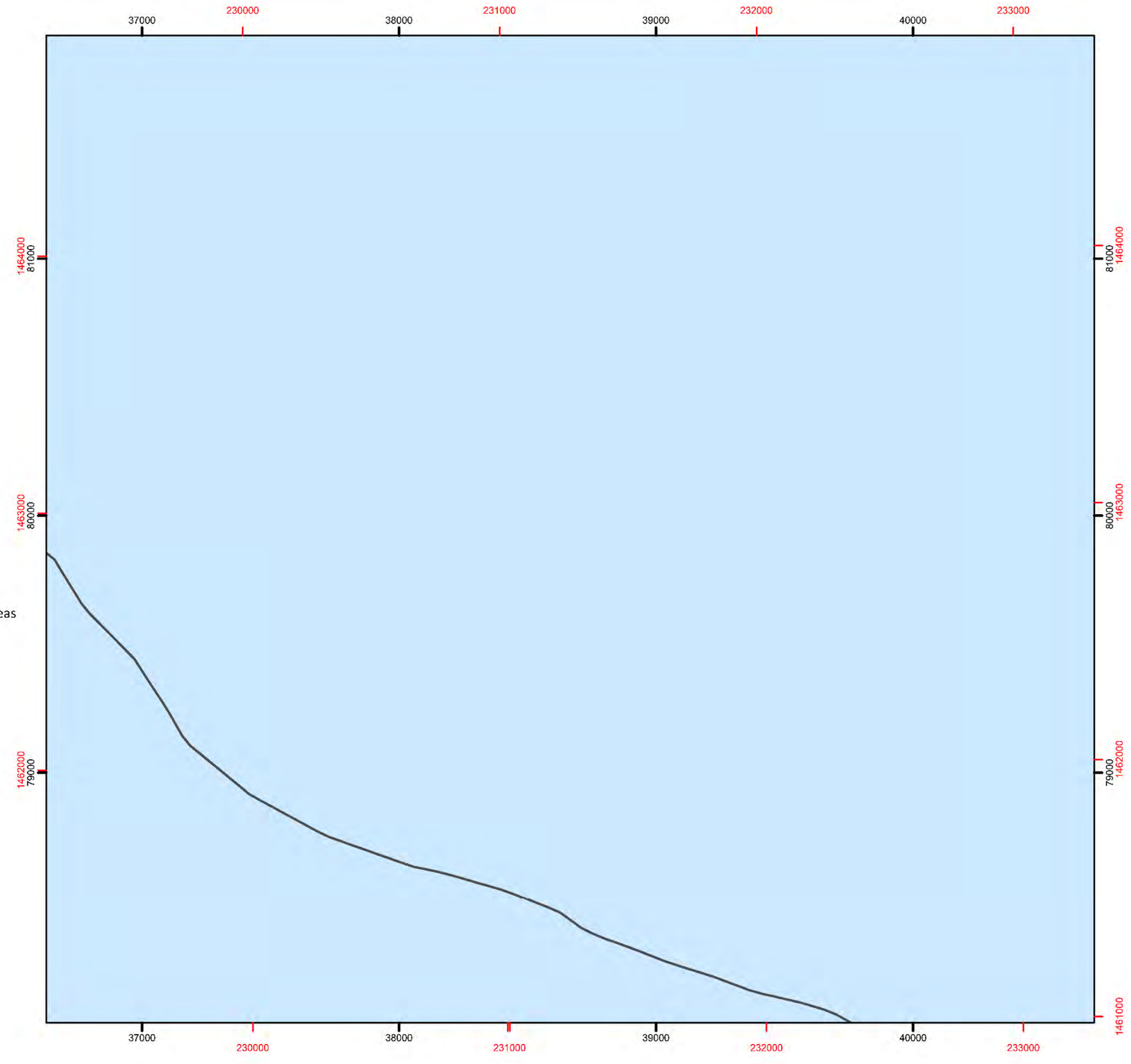
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

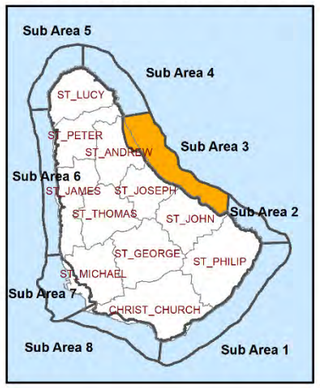
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

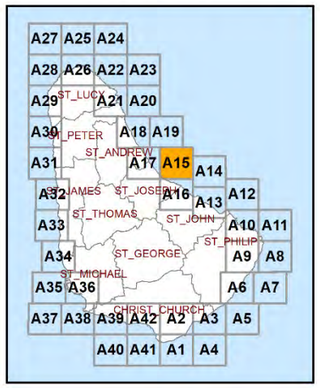


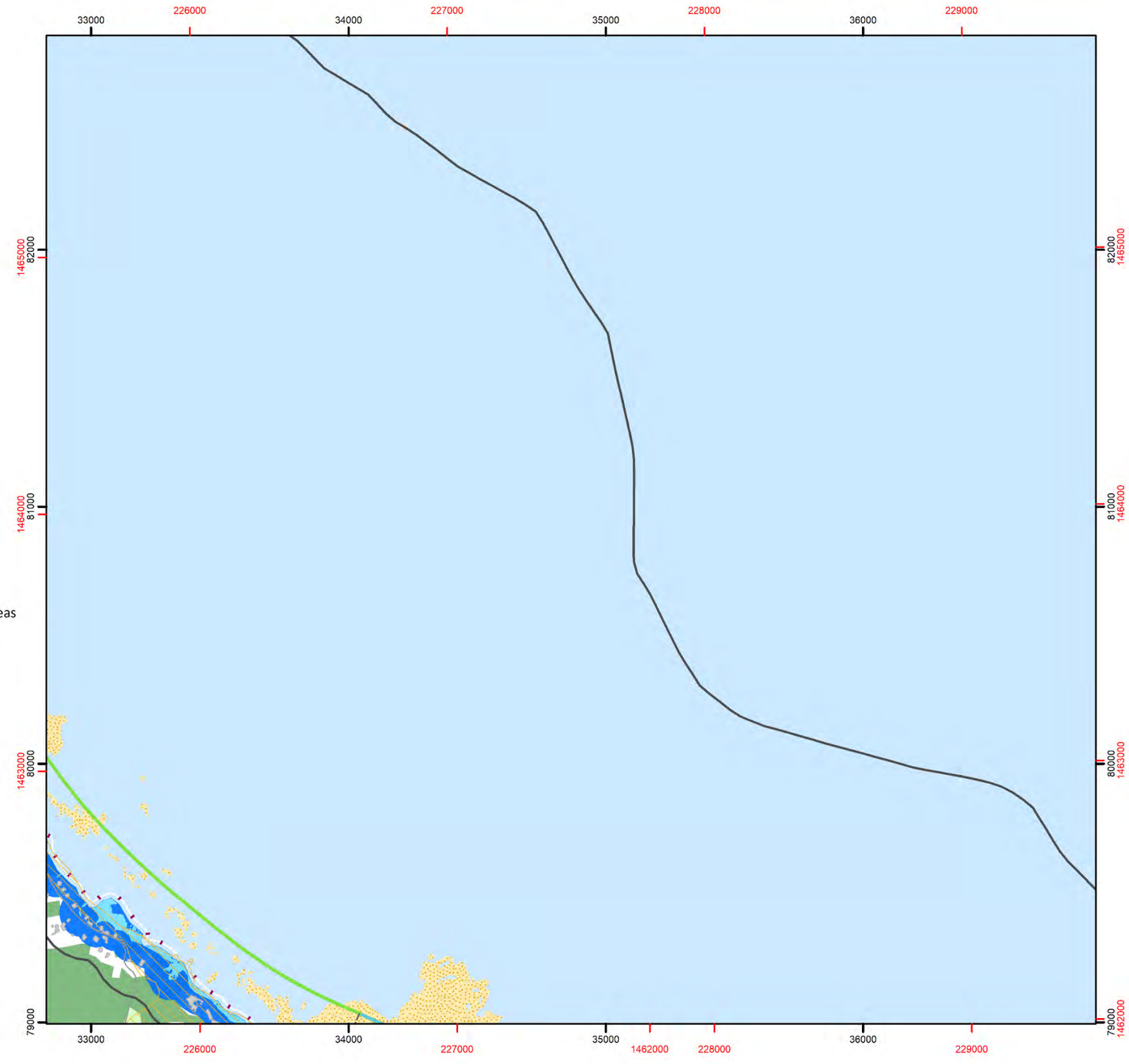
SUB AREA 3 - SHEET A15

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX





Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve
Restricted areas
Planned Marine Areas

Environmental characteristics

Turtle nesting beach
National index beach (OS2)
Coral reefs
Wetlands
Seagrass
Mangroves
Agriculture
Natural vegetation
OS2 Natural heritage areas

Coast and cliff classification

Eroding Coast (Natural)
Accreting Coast (Natural)
Stable Coast (Natural)
Dynamically Stable Coast (Natural)
Coastal Cliff
Eroding Coast (Engineered)
Accreting Coast (Engineered)
Stable Coast (Engineered)
Artificial Coast
Coastal classification division

Cliff failure

Very high
High
Medium
Low *(risk class)*

Flooding hazard

Storm surge 100 years
Storm surge + Sea Level Rise (IPCC 2019)
Tsunami 100 years

N

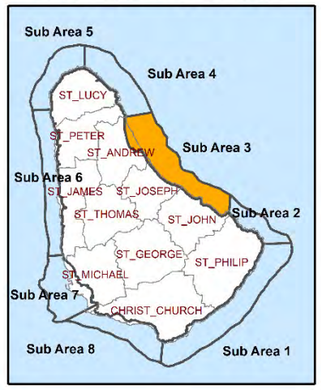
SCALE: 1:18,000

0 125 250 375 500 mts

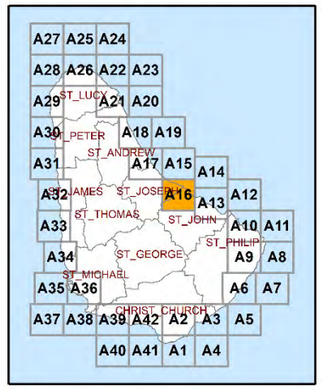
- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

SUB AREA 3 - SHEET A16

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

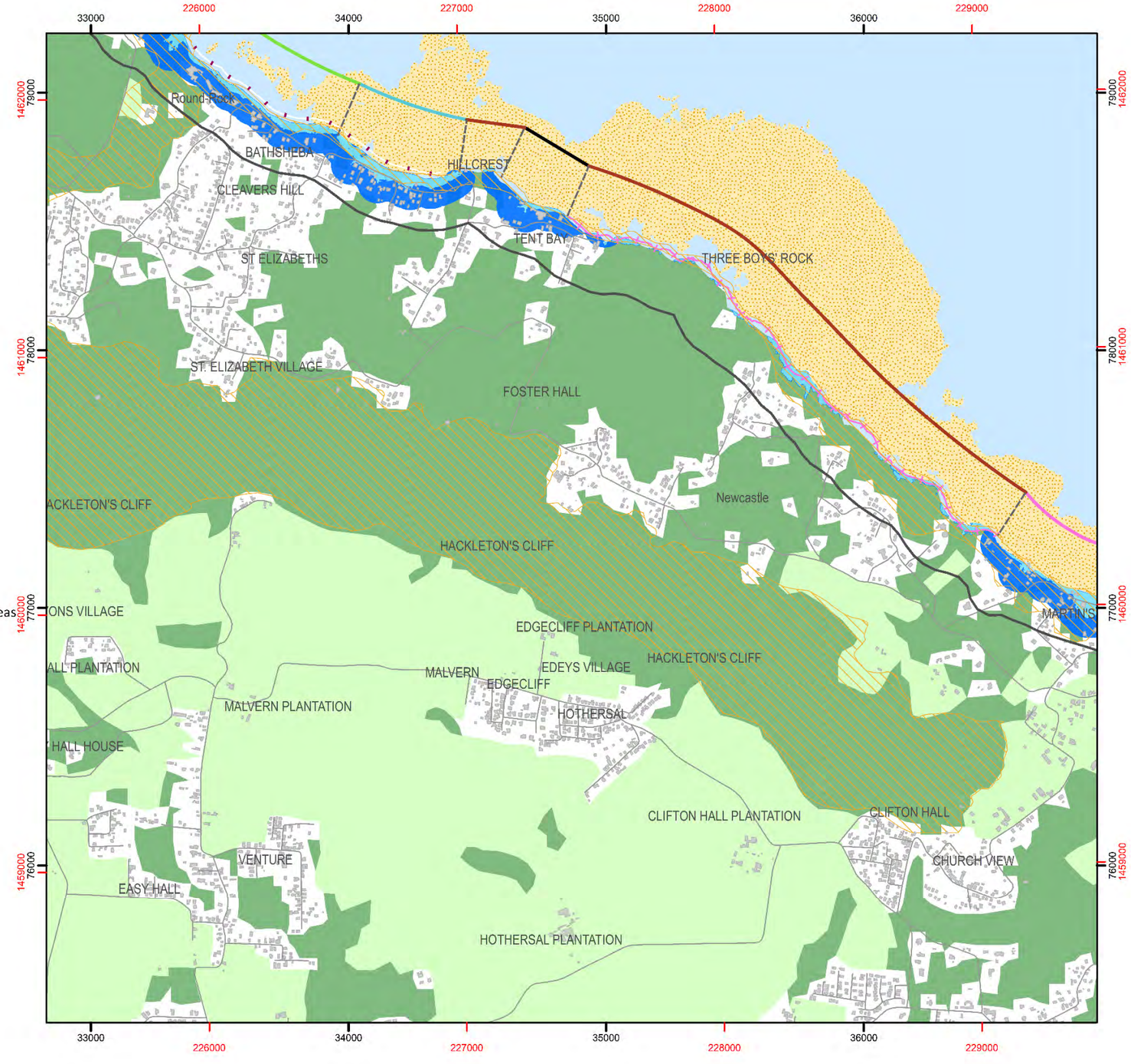
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

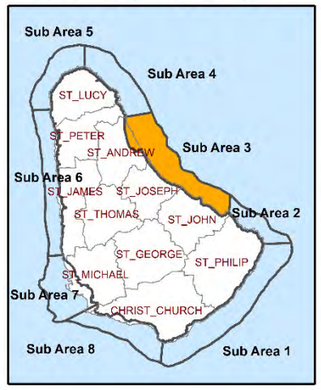
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

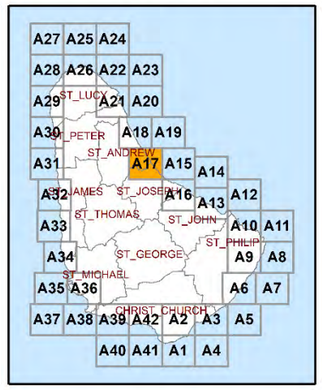


SUB AREA 3 - SHEET A17

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

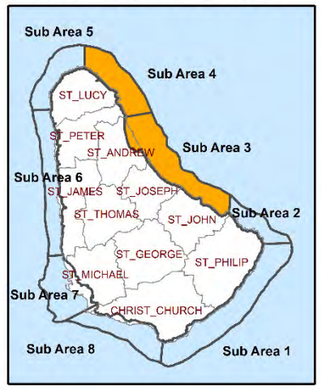
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

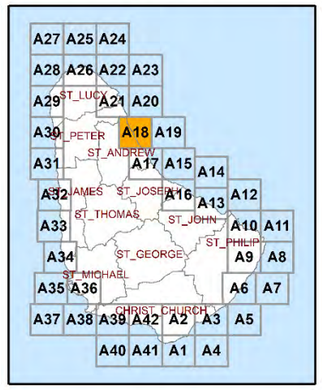


SUB AREAS 3, 4 - SHEET A18

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

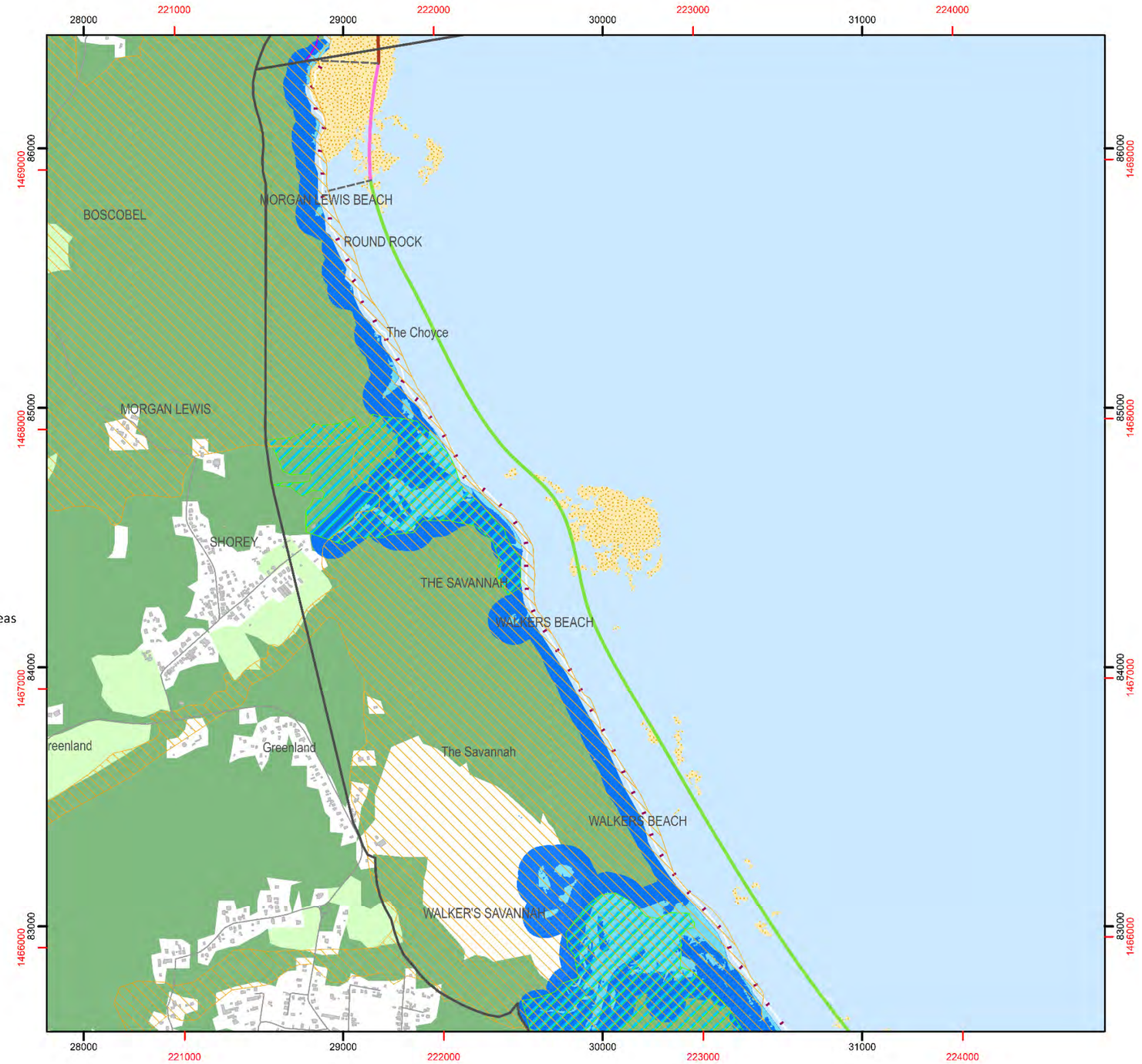
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

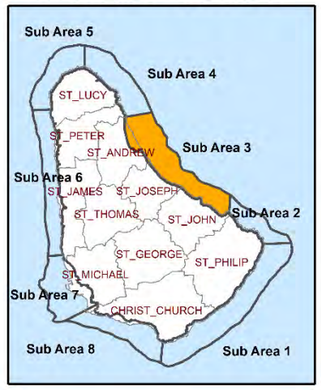
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

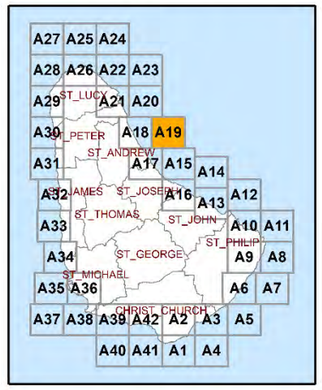


SUB AREA 3 - SHEET A19

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

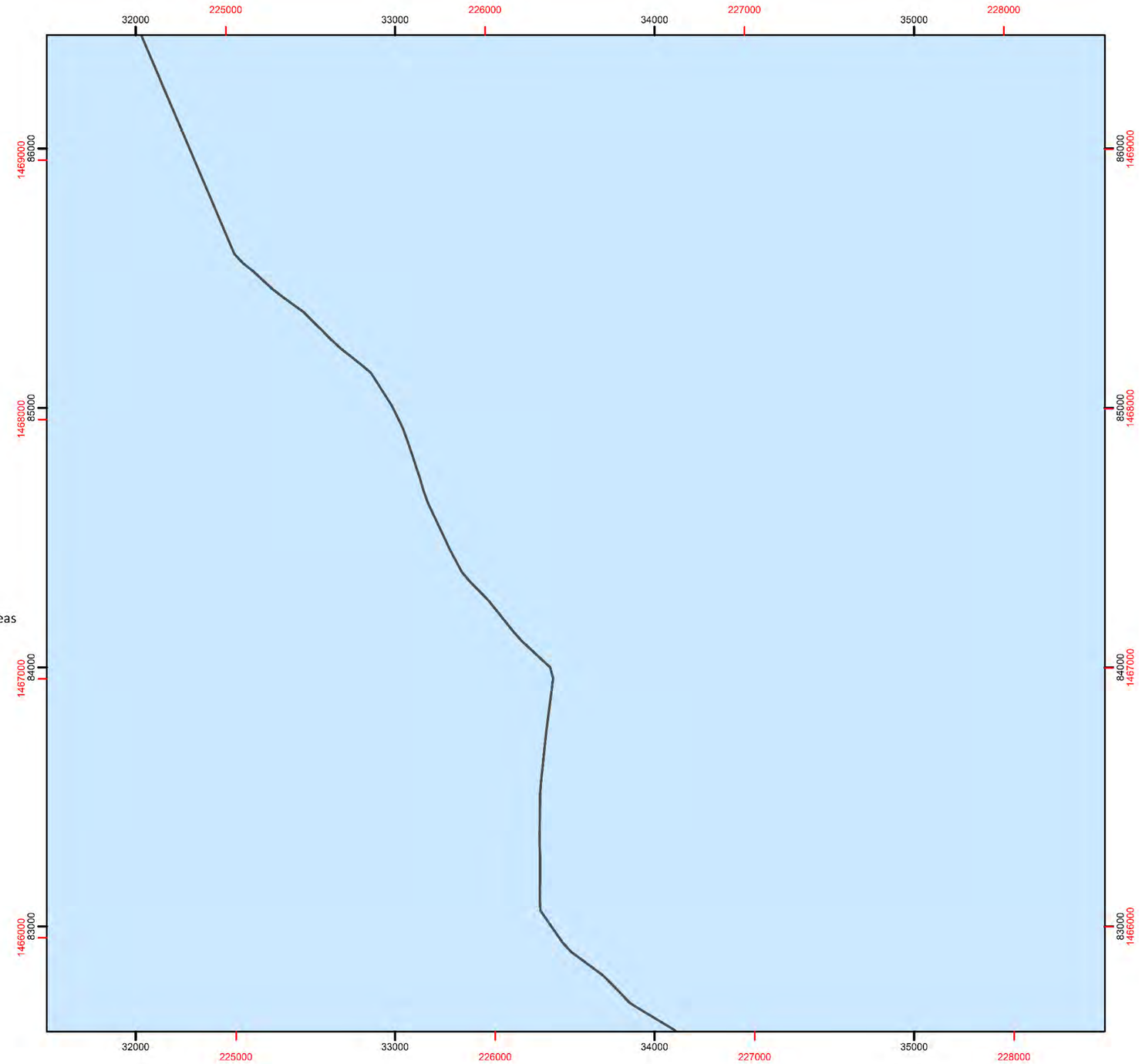
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

0 125 250 375 500 mts

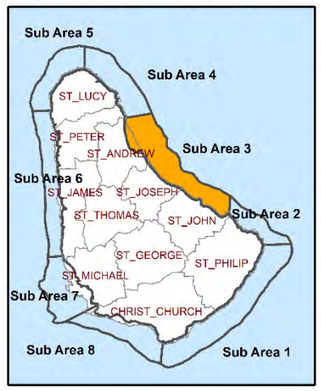
- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum



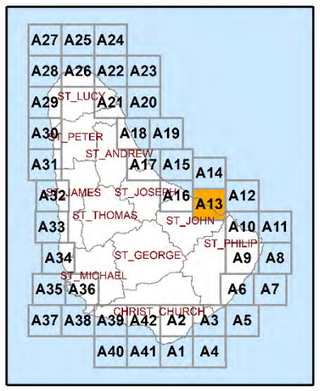
Setback maps of Sub-Area 3

SUB AREA 3 - SHEET A13

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

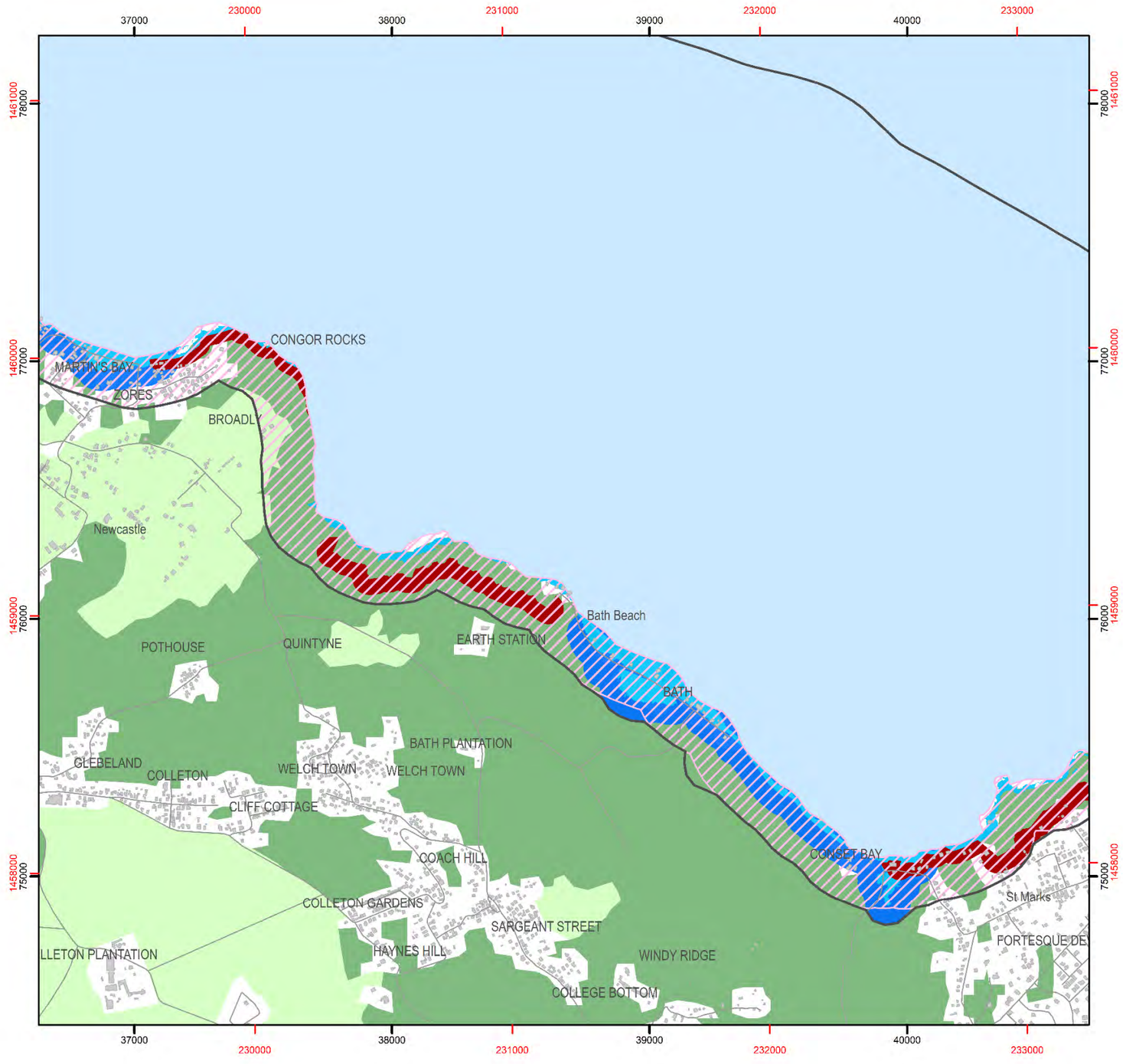
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

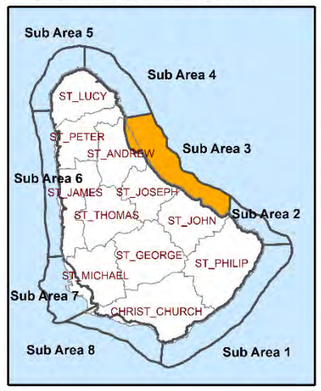
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

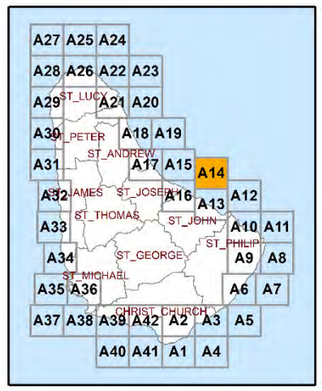


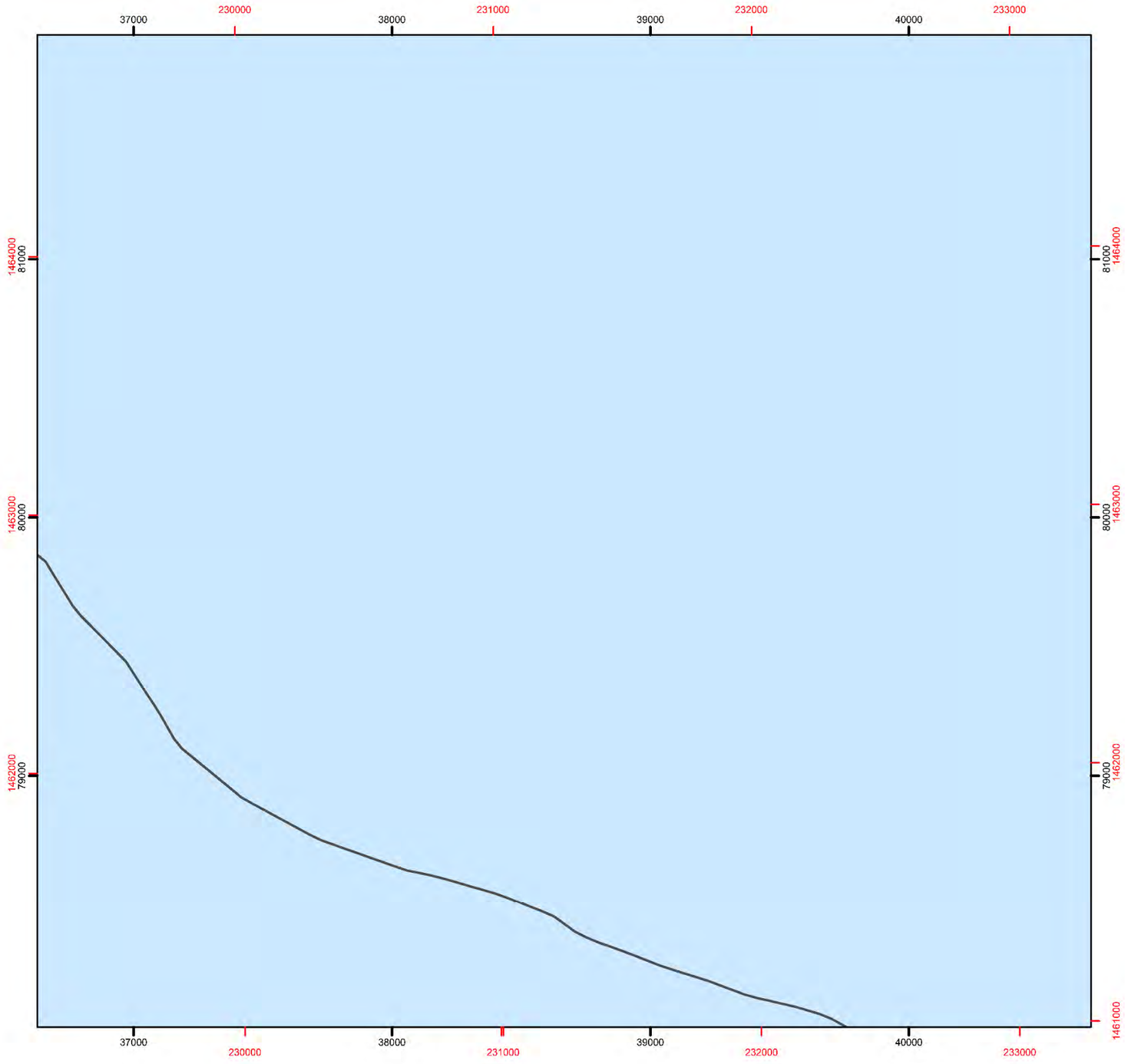
SUB AREA 3 - SHEET A14

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX





Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

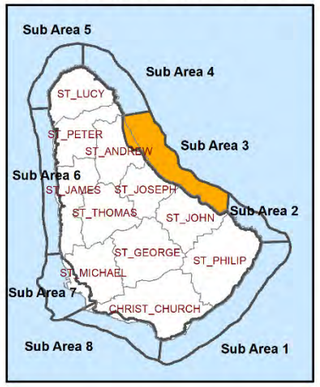
SCALE: 1:18,000

0 125 250 375 500 mts

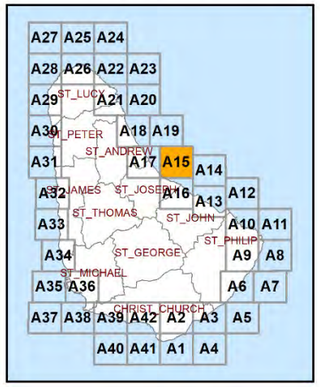
- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

SUB AREA 3 - SHEET A15

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

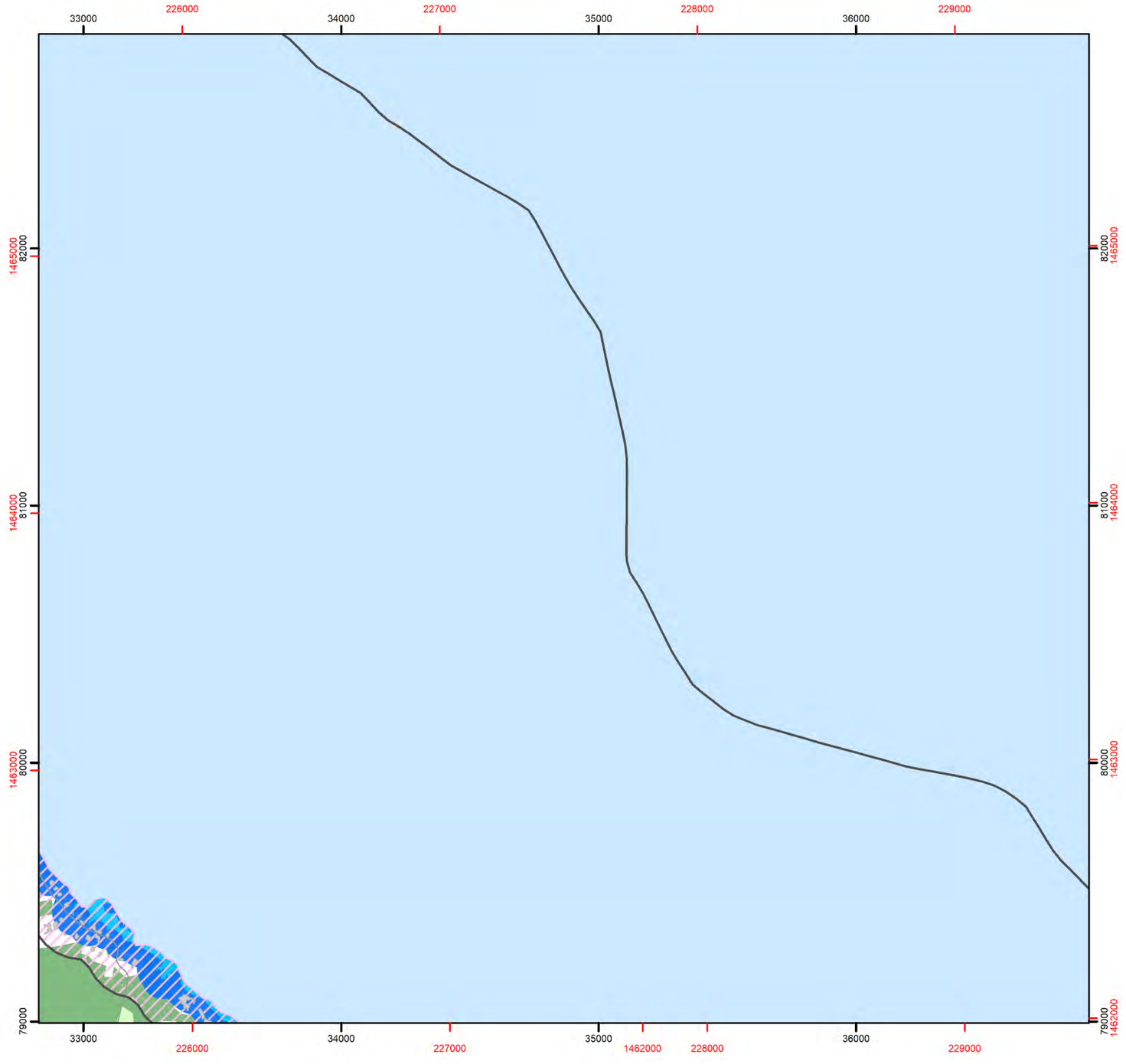
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

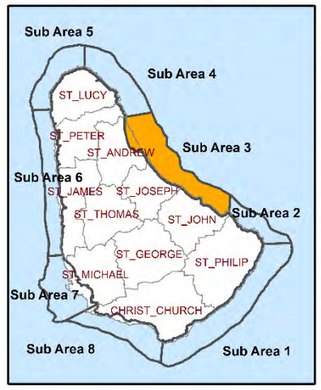
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

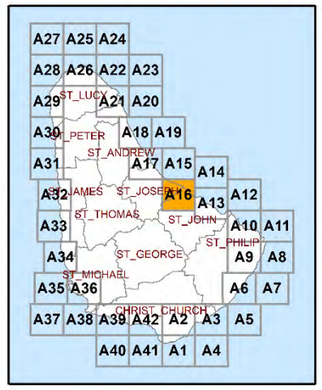


SUB AREA 3 - SHEET A16

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

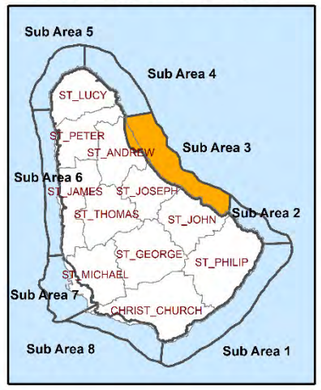
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

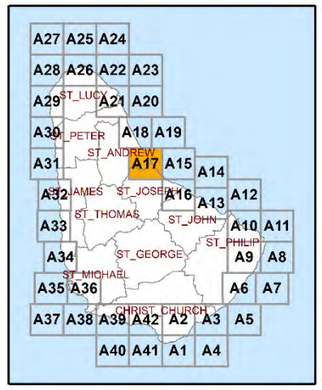


SUB AREA 3 - SHEET A17

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

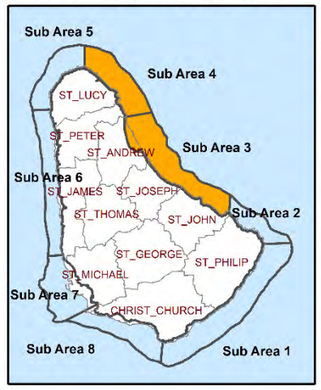
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

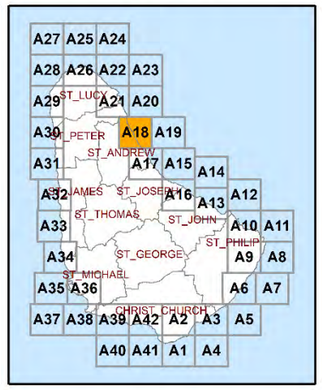


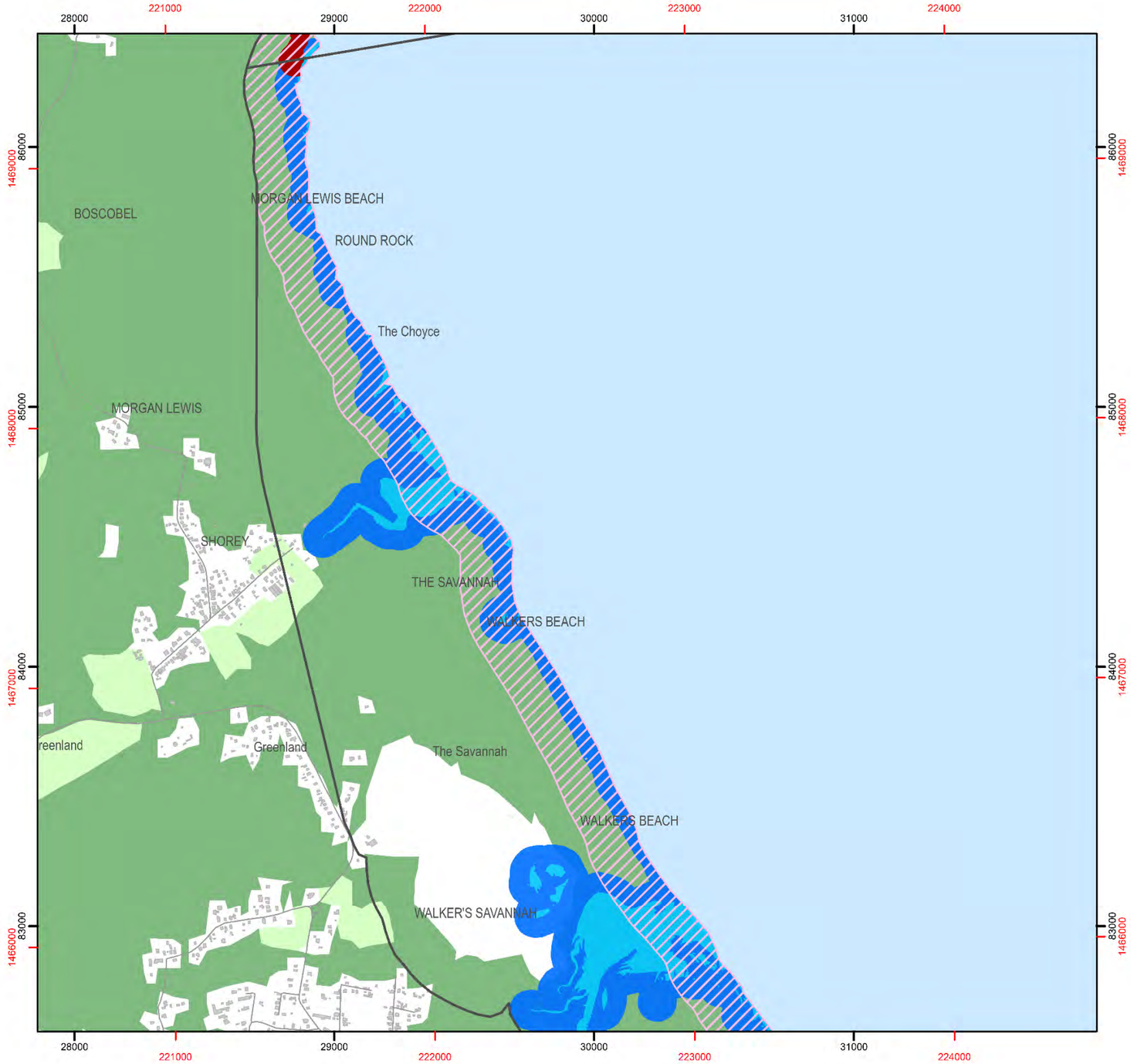
SUB AREAS 3, 4 - SHEET A18

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX





Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

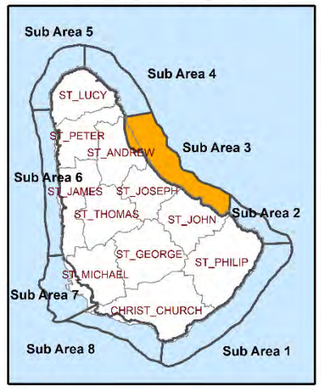
SCALE: 1:18,000

0 125 250 375 500 mts

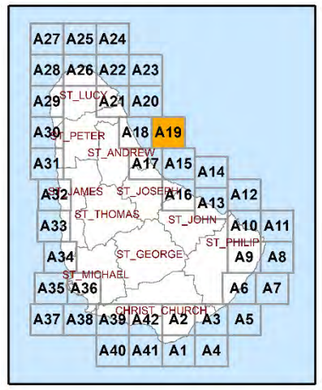
- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

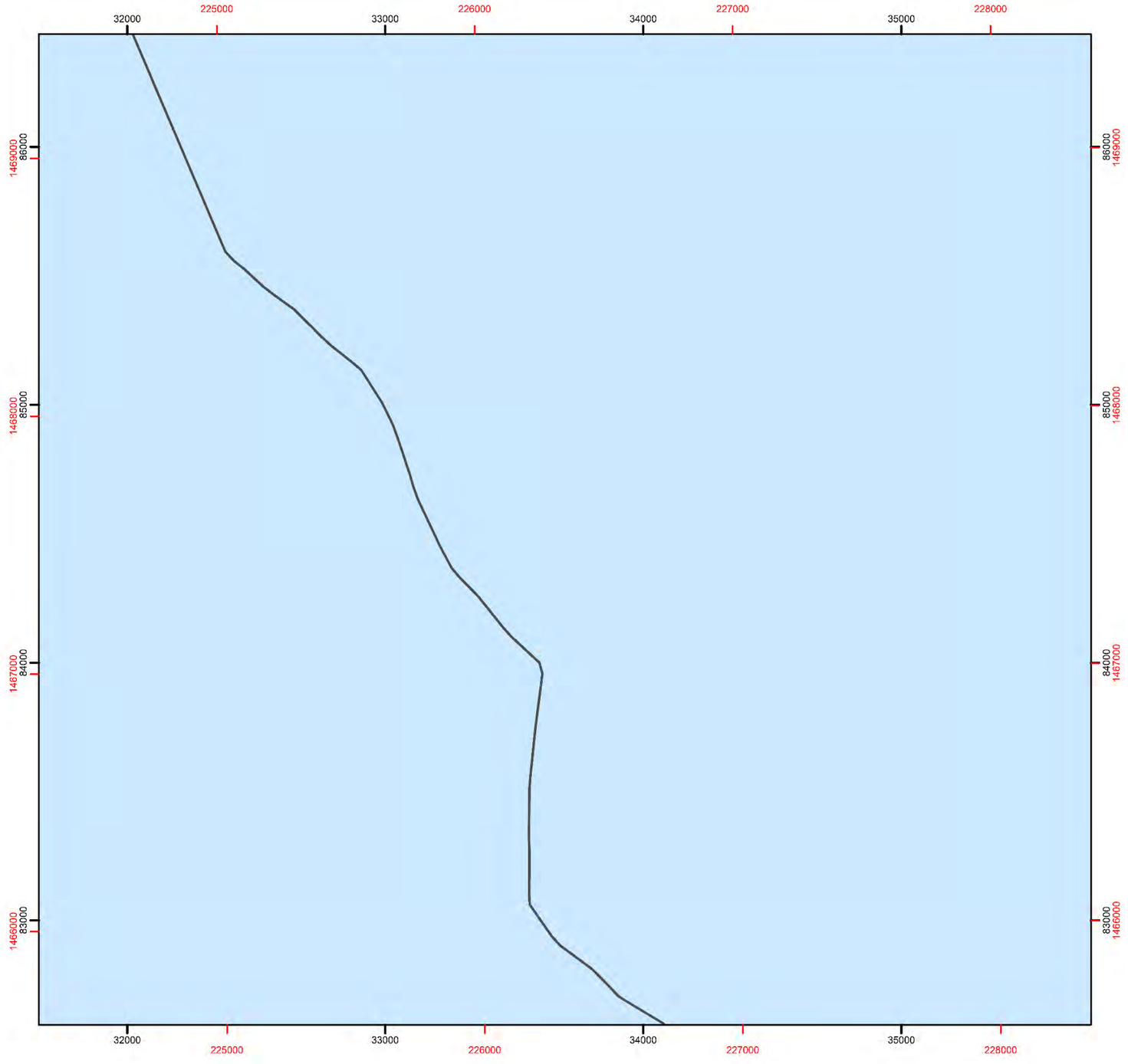
SUB AREA 3 - SHEET A19

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX





Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

SUB-AREA 4: THE CHOYCE TO NORTH POINT

Main themes

WILDERNESS CHARACTER AND GEOLOGICAL INTEREST.

RISKS DUE TO CLIFF COLLAPSE.

Sub-Area description and context

The coastal stretch of Sub-Area 4 falls entirely within the National Park, Growth Management Framework - PDP, 2017. North Point lies at the boundary between the Caribbean and Atlantic coasts of Barbados on the northernmost point of the island. Apart from the main settlements of Boscobelle and Rockfield (predominantly surrounded by rural areas with some agricultural land), there is limited built development within the Sub-Area. Popular yet informal recreation and relaxation tends to be focused at River Bay, Pico Teneriffe and Gay's Cove.

The Sub-Areas coastline is mostly very exposed to the elements, reflecting the barren cliff-top landscape. The coastal scenery is characterised by impressive high cliffs that are interspersed by a number of small bays and pocket beaches. All cliff classification “types” in Barbados maybe found within this Sub-Area. The nearshore environment is comprised of coral rubble, algal and gorgonian pavements. Further offshore, in the vicinity of The Choyce, a large marine “canyon” acts as a sediment sink, trapping material that is being transported by currents either southwards from North Point, or northwards from Bathsheba.

Detailed Sub-Area scale information is presented within subsection “Description Maps of Sub-Area 4” that includes a collection of maps at a detailed scale (1:18,000) with specific information regarding natural and restricted areas, environmental characteristics, coastal and cliff classification and flooding inundation (and climate change related) hazards to which Sub-Area 4 is exposed.



Figure D.5. Geological formations at Little Bay.

Results from the cliff collapse risk assessment exercise (obtained from the CRMP study) indicate that approximately half of the coastline is classified as being medium to very high risk, with the highest risk areas being located between The Choyce and Rocky Bay. Coastal erosion is especially significant adjacent to the North Point Surf Resort.

Main issues and strategic objectives

KEY ISSUES	STRATEGIC OBJECTIVES
• Presence of unique geological formations. • Important ecological and landscape value. • Presence of sargassum. • Potential for tourism and recreational activities. • Cliff collapse risk.	• Protect geological formations and coastal landscape such as Little Bay, St. Lucy. • Enforce setbacks to ensure safety of people, buildings and infrastructure facilities (such as at Little Bay and Cover Bay); and ensure new/maintenance interventions retain the wild and rugged characteristics of the coastline. • Enhance heritage tourism that benefits local communities, is economically viable, and is compatible with the environmental quality of the area. • Provide opportunities for informal recreation and promote an understanding and enjoyment of the special qualities of the National Park. • Promote improved Storm Water Management/sewage and solid waste management strategies to limit garbage disposal in watersheds and promotion of adequate treatment of sewage in line with “Roof to Reef principles”

Development Planning and Setbacks at Sub-Area scale

Setback recommendations are presented within a collection of maps provided in the sub-section entitled *"Setback maps of Sub-Area 4"*. These recommendations adhere closely to the National Guidance "Development Planning and Setbacks" (see section C3) for Sub-Area 4. This map provides the delineation of setbacks for this Sub-Area at a scale of 1:18000.

This planning related information should be used by public and private actors whom are involved in the management of the coast such as developers, owners and the general public. The setback guidance adopted is defined for four separate setback categories as appropriate, namely cliff, landscape, flood inundation and climate change.

Action brief

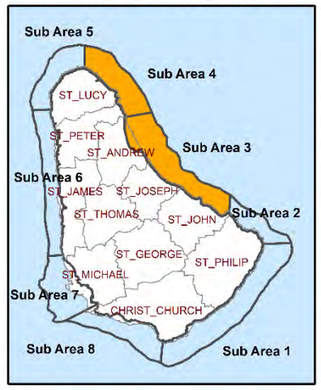
TOPIC	CODE	ACTION	LEAD ACTORS	OTHER ACTORS	TIME SCALE	COMMENTS	KEY POLICY OUTCOME
Development Planning and Setbacks	4S1	Prepare and distribute guidelines to enforce cliff collapse setbacks in Sub-Area 4 for developers and public agencies.	TCDPO	CZMU	Medium term, immediate	Guidelines based on GSI.	Outcome 3 - Climate and disaster risk adaptive capacity is strengthened
Development Planning and Setbacks	4S2	Organize meetings with key stakeholders to raise awareness on coastal resources and landscape.	CZMU	TCPDO, NCC, Developers	Medium term, immediate		Outcome 1 - Sustainable socioeconomic development is achieved
Coastal Biodiversity	4BIO1	Prepare a plan to improve geological heritage awareness.	NRD	NHD, CZMU	Medium term, immediate	For instance, create a coastal geology trail, improve geological heritage education, and enhance viewing areas and access to these at Choyce/Pico Tenerife.	Outcome 2 - Coastal resources are protected and effectively managed
Coastal Biodiversity	4BIO2	Produce guidelines for removal of sargassum in rocky/cliff areas, in collaboration with NCC.	MMABE	CZMU, NCC	Medium term, immediate		Outcome 2 - Coastal resources are protected and effectively managed
Public Awareness and Stakeholder Participation	4PA1	Identify local stakeholder at community level and private developers in the area.	CZMU				Outcome 6 - Research, understanding and knowledge outreach is increased
Public Awareness and Stakeholder Participation	4PA2	Conduct yearly public meetings to identify new issues in the Sub-Area.	CZMU	All stakeholders in the Sub-Area and key institutions at national level			Outcome 6 - Research, understanding and knowledge outreach is increased

Table D.4. Action brief for Sub-Area 4.

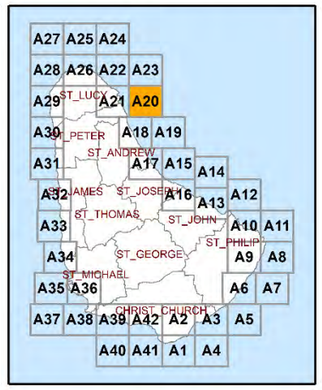
Description maps of Sub-Area 4

SUB AREAS 3, 4 - SHEET A20

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve
Restricted areas
Planned Marine Areas

Environmental characteristics

Turtle nesting beach
National index beach (OS2)
Coral reefs
Wetlands
Seagrass
Mangroves
Agriculture
Natural vegetation
OS2 Natural heritage areas

Coast and cliff classification

Eroding Coast (Natural)
Accreting Coast (Natural)
Stable Coast (Natural)
Dynamically Stable Coast (Natural)
Coastal Cliff
Eroding Coast (Engineered)
Accreting Coast (Engineered)
Stable Coast (Engineered)
Artificial Coast
Coastal classification division

Cliff failure

Very high
High
Medium
Low *(risk class)*

Flooding hazard

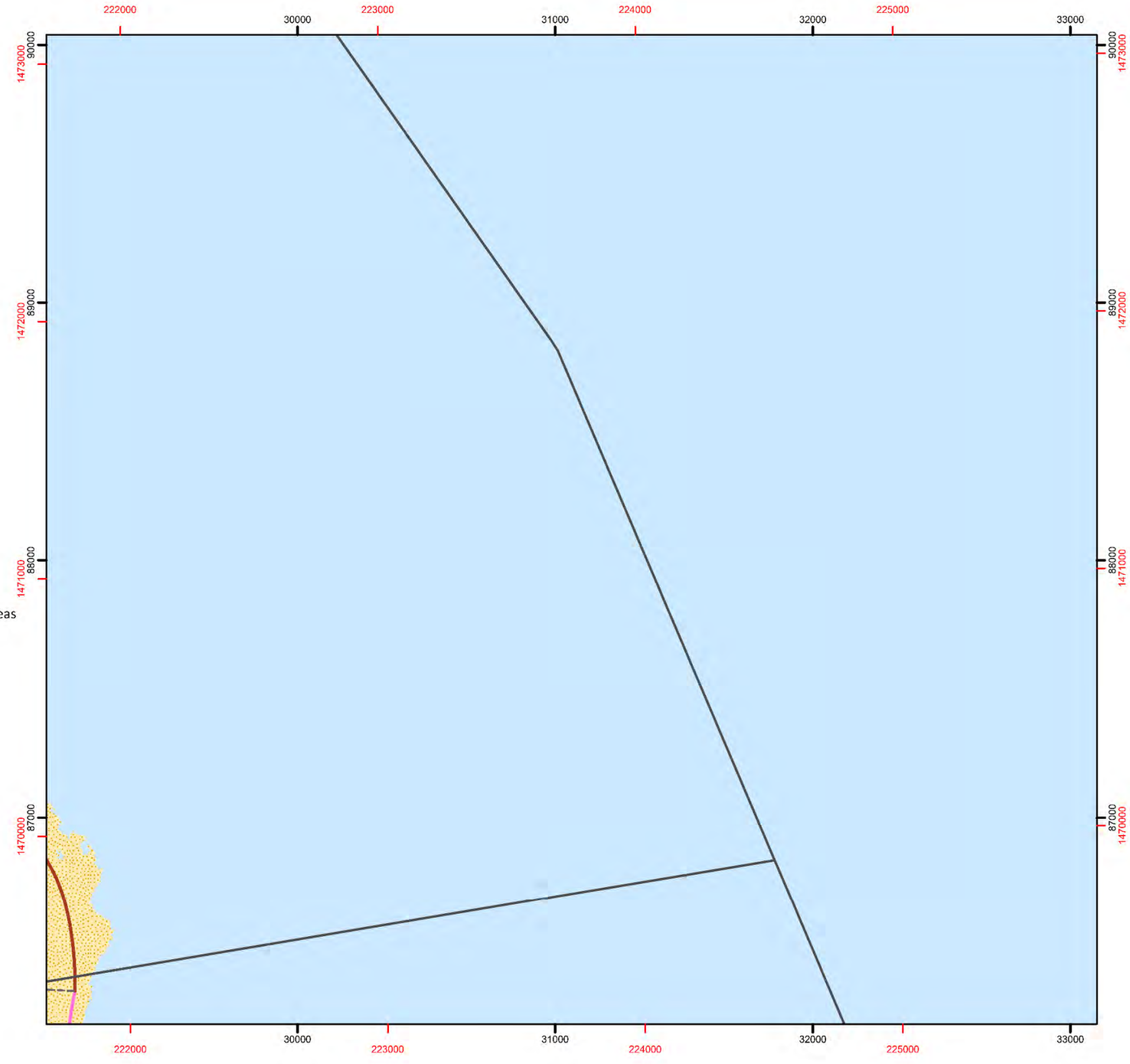
Storm surge 100 years
Storm surge + Sea Level Rise (IPCC 2019)
Tsunami 100 years

N

SCALE: 1:18,000

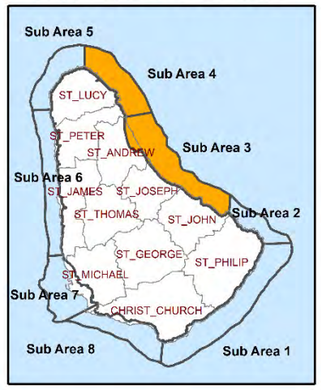
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

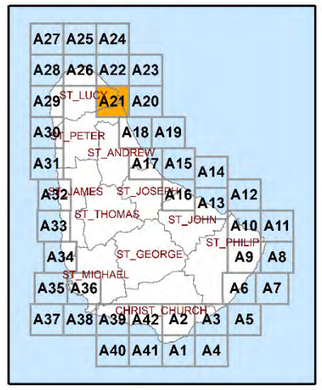


SUB AREAS 3, 4 - SHEET A21

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

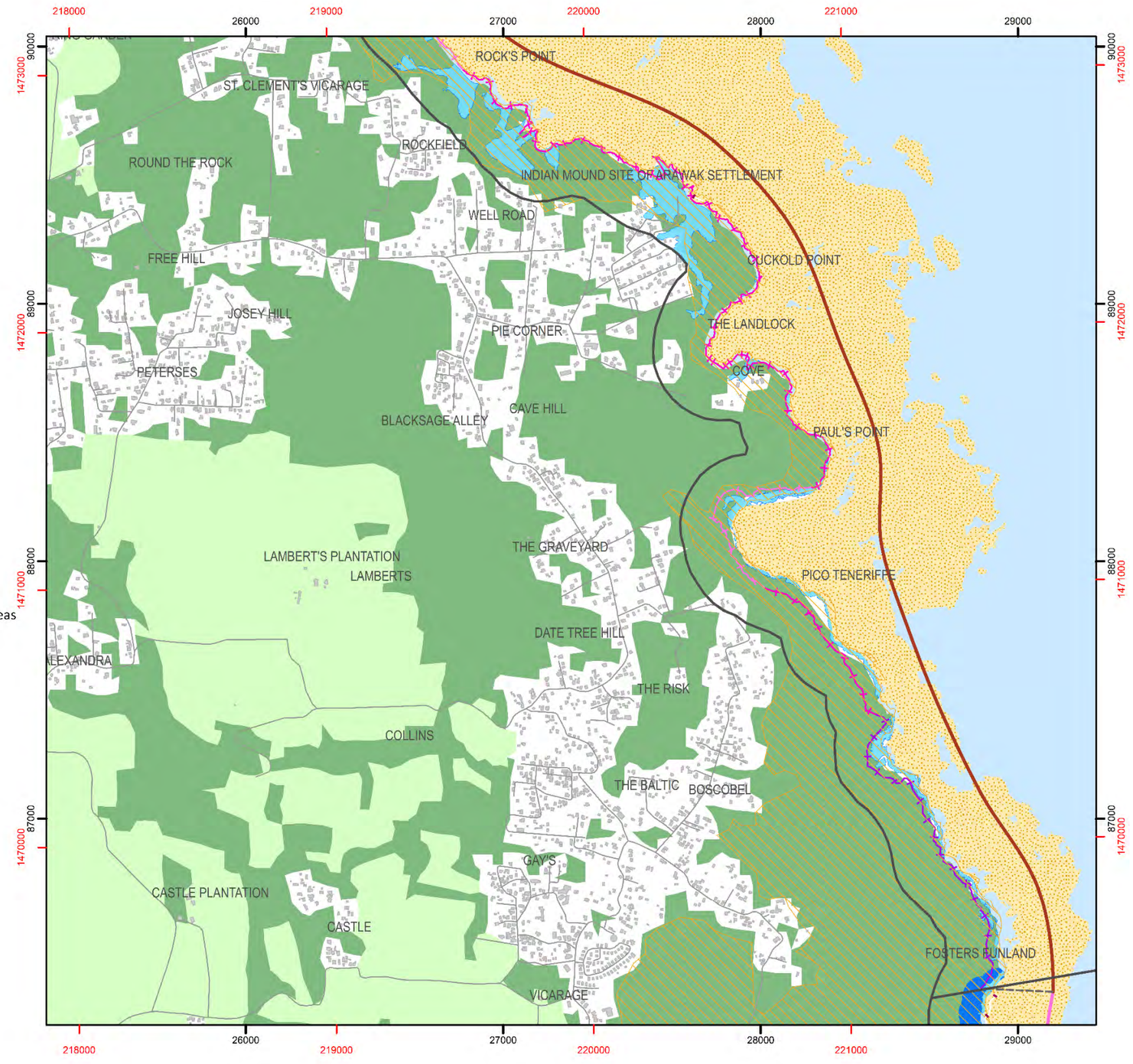
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

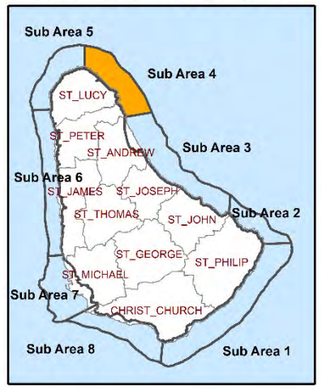
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

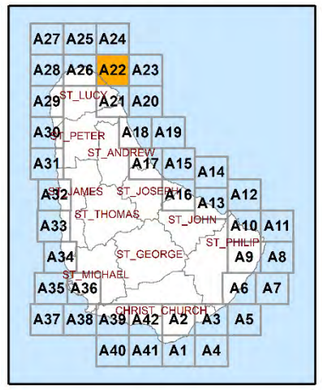


SUB AREA 4 - SHEET A22

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

Turtle nesting beach	Wetlands	Agriculture
National index beach (OS2)	Seagrass	Natural vegetation
Coral reefs	Mangroves	OS2 Natural heritage areas

Coast and cliff classification

Eroding Coast (Natural)	Eroding Coast (Engineered)
Accreting Coast (Natural)	Accreting Coast (Engineered)
Stable Coast (Natural)	Stable Coast (Engineered)
Dynamically Stable Coast (Natural)	Artificial Coast
Coastal Cliff	Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

Storm surge 100 years | Storm surge + Sea Level Rise (IPCC 2019)

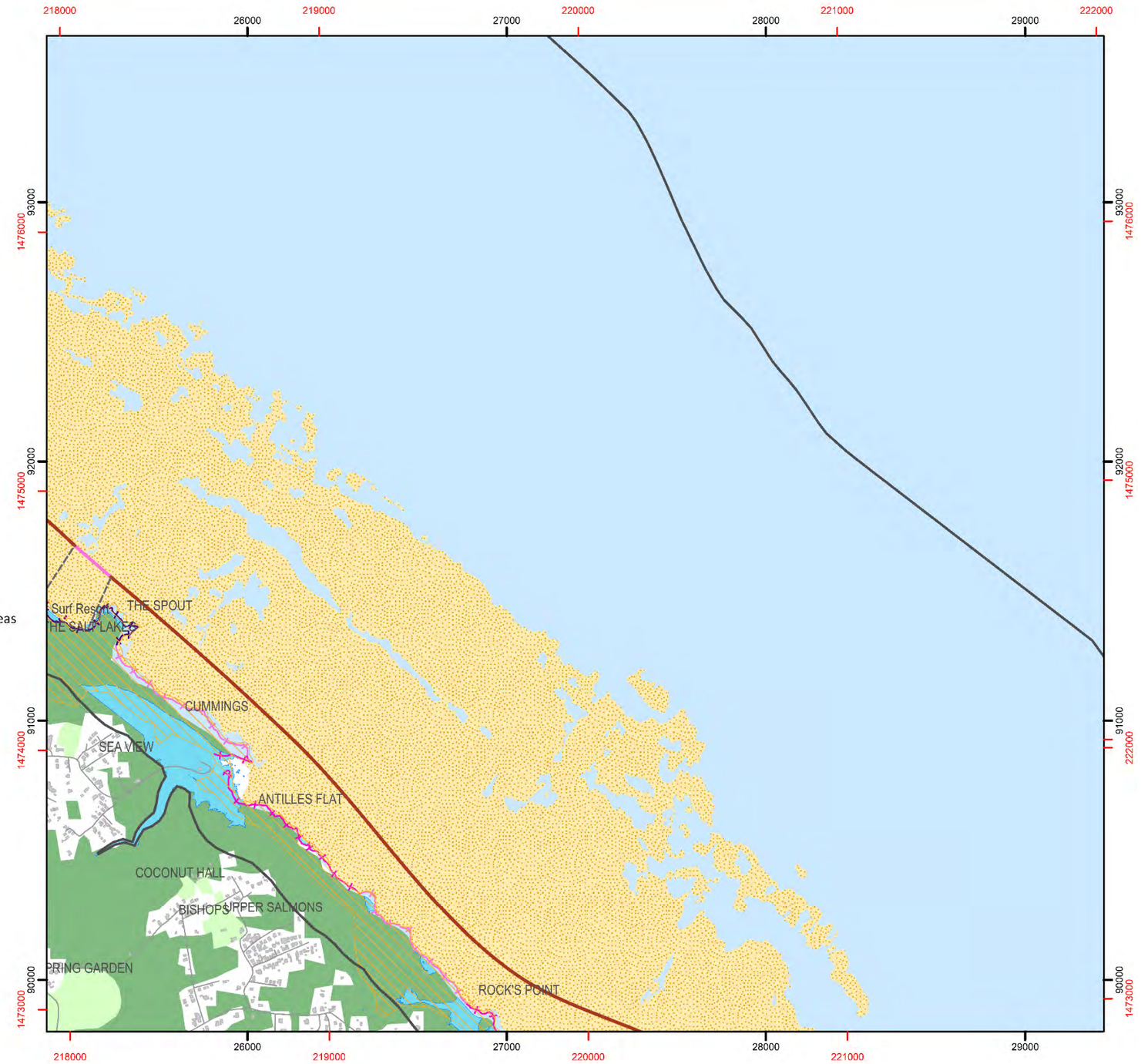
Tsunami 100 years

N

SCALE: 1:18,000

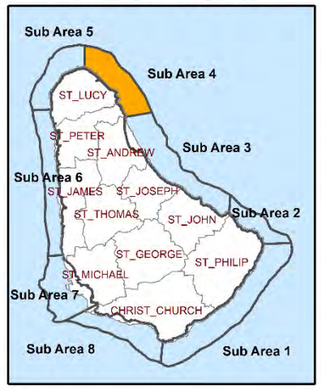
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

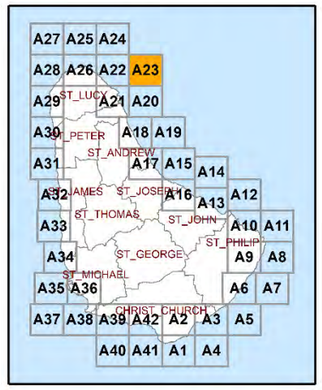


SUB AREA 4 - SHEET A23

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

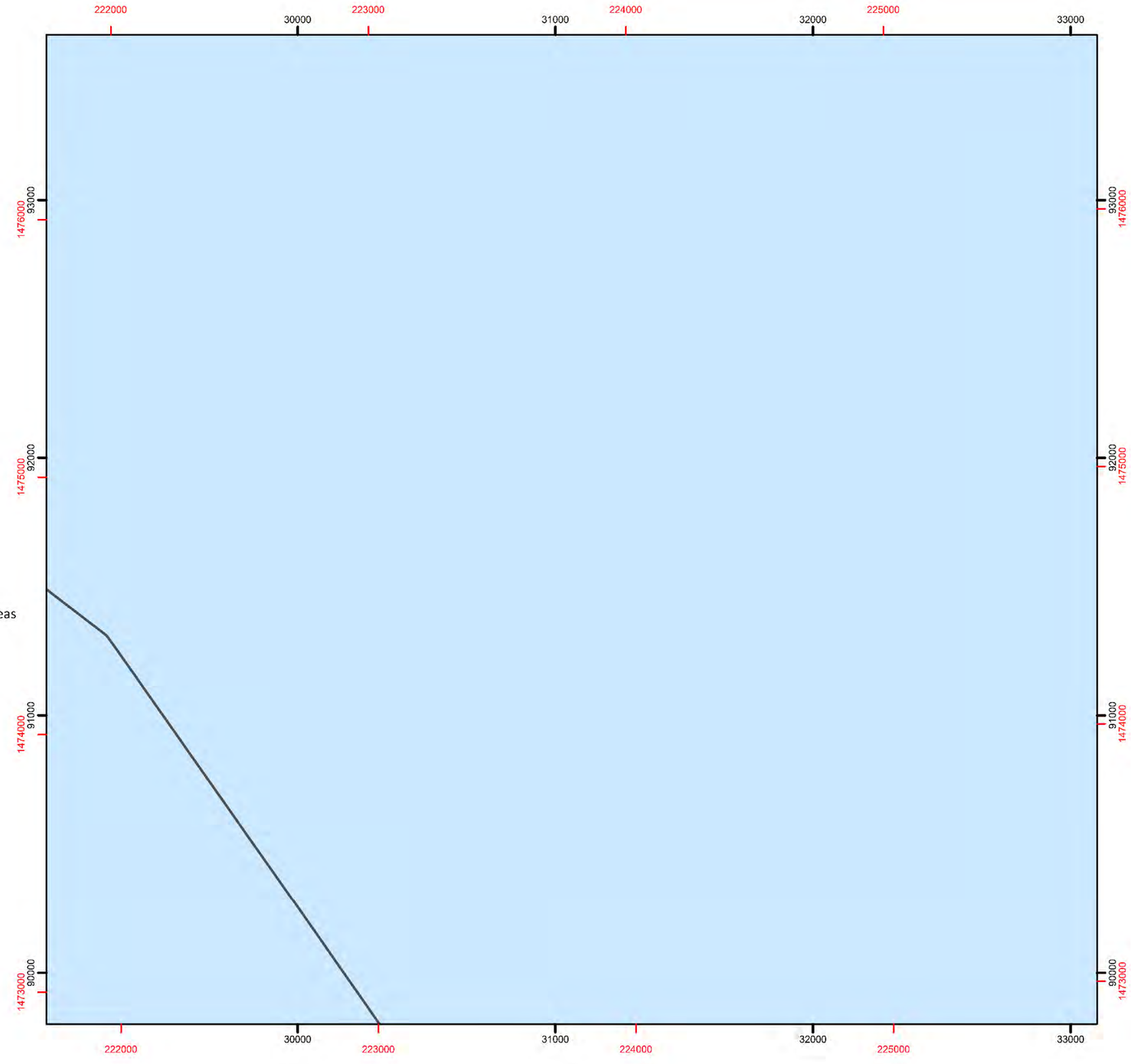
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

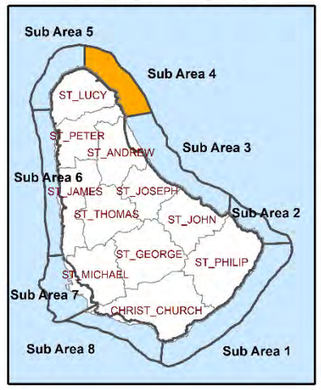
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

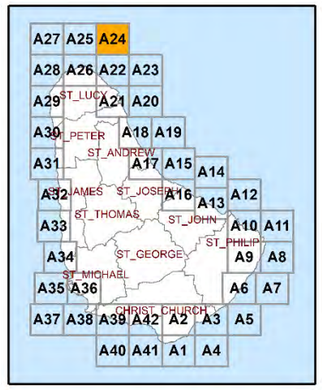


SUB AREA 4 - SHEET A24

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

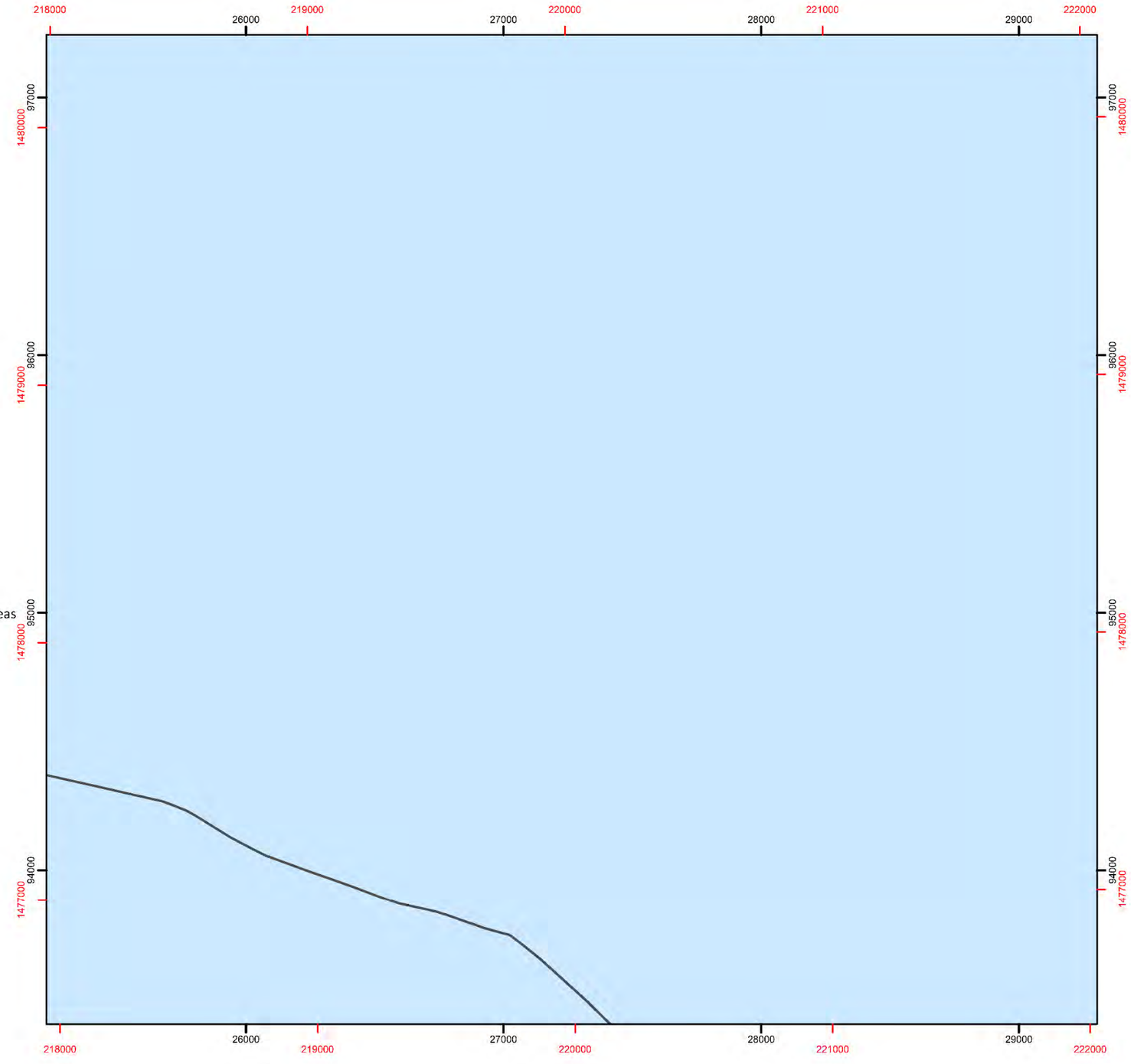
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

0 125 250 375 500 mts

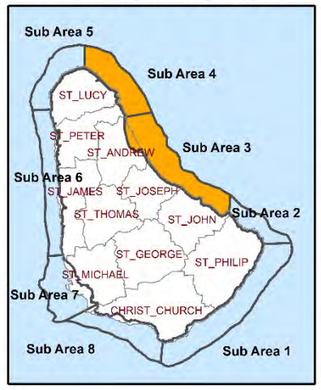
- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum



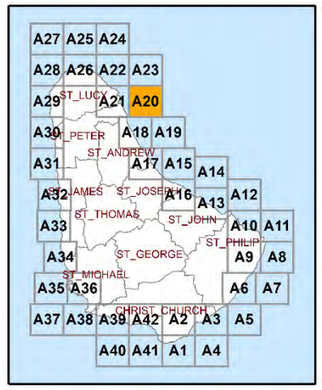
Setback maps of Sub-Area 4

SUB AREAS 3, 4 - SHEET A20

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

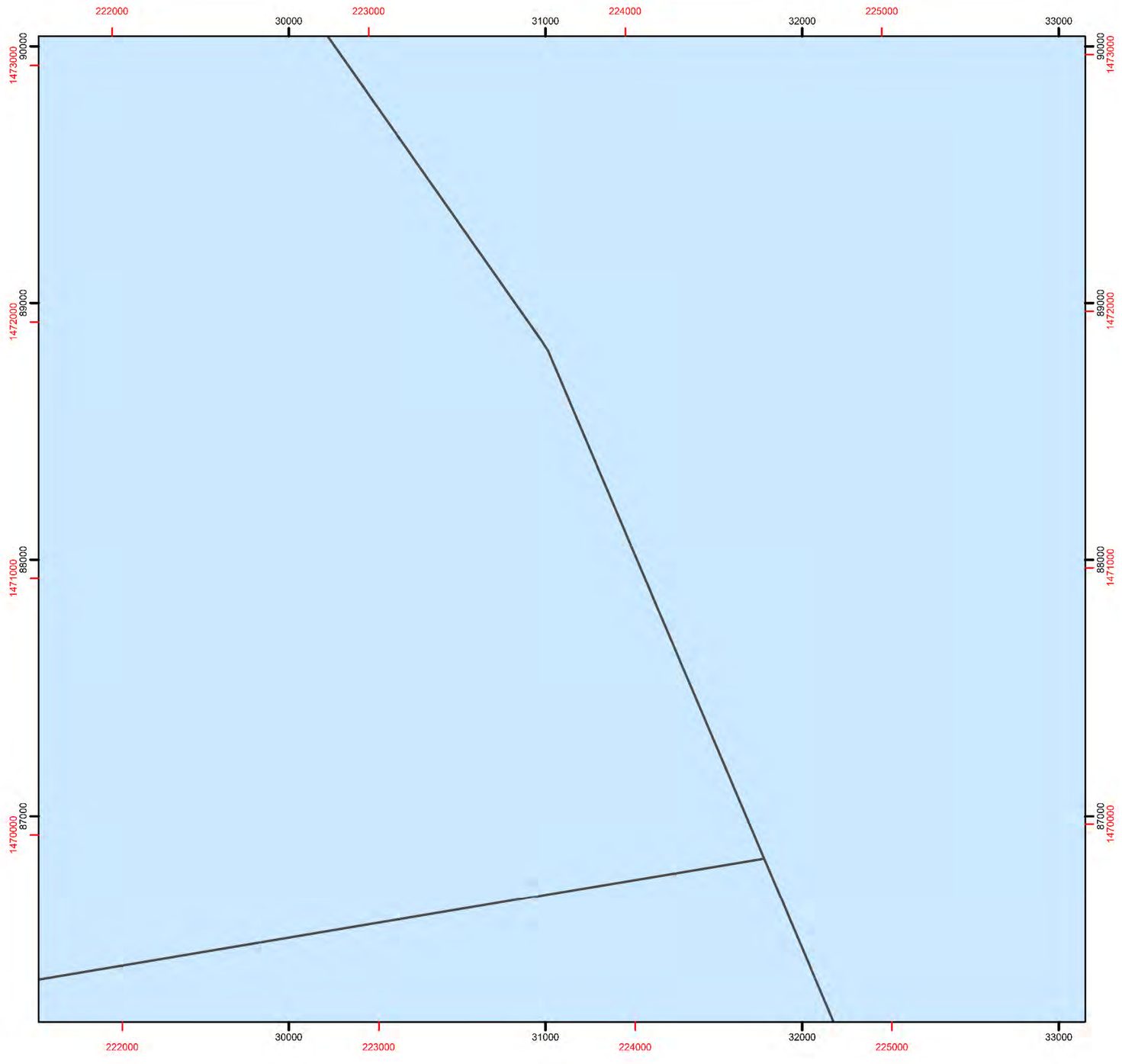
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

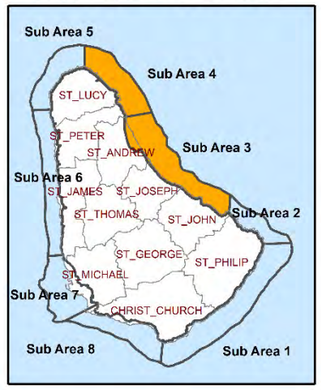
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

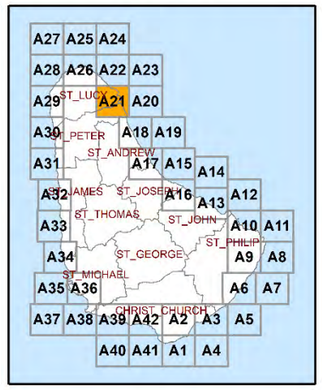


SUB AREAS 3, 4 - SHEET A21

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

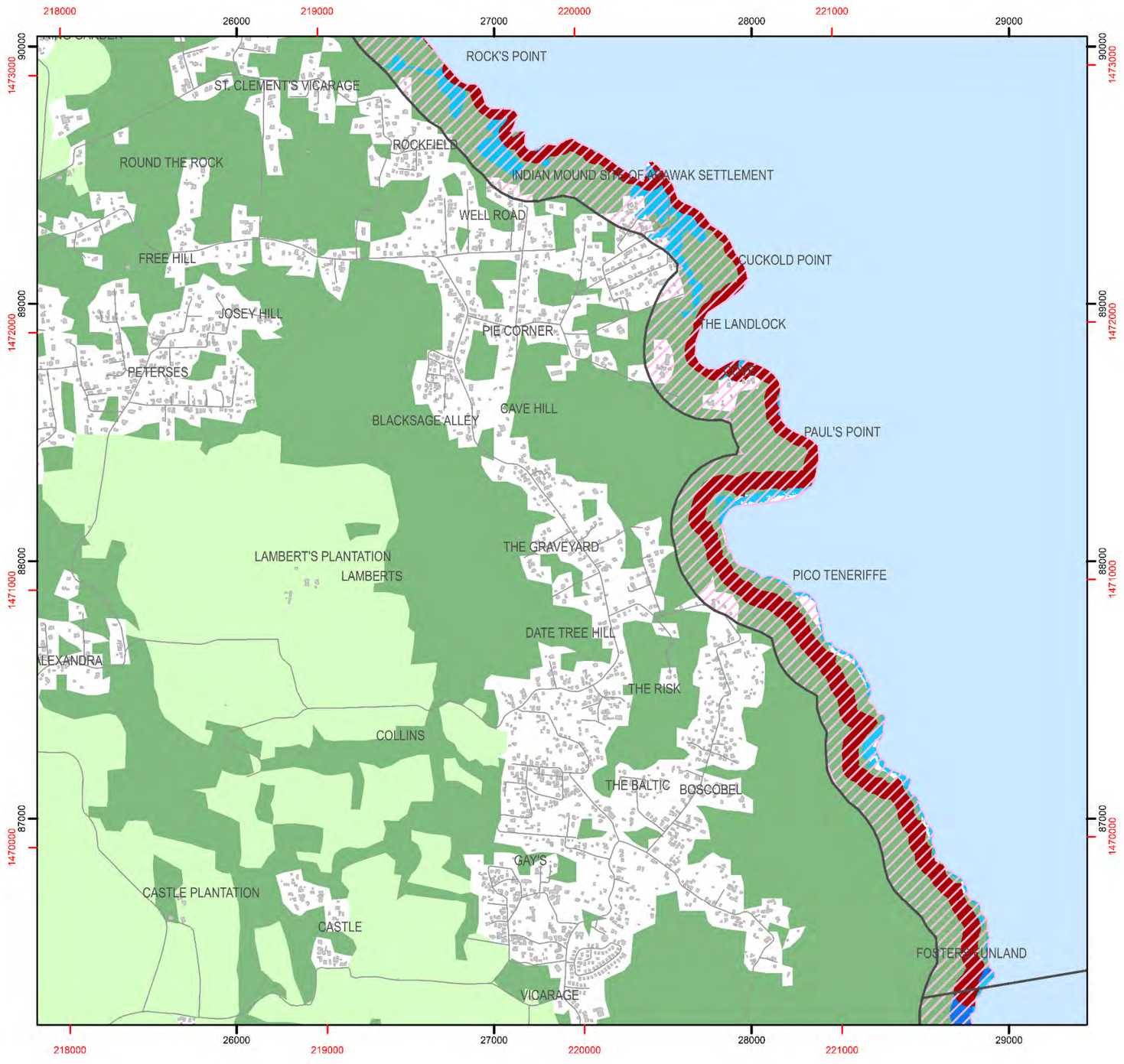
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

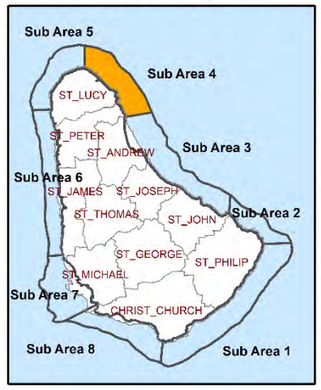
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

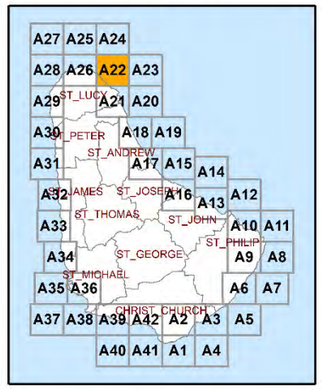


SUB AREA 4 - SHEET A22

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

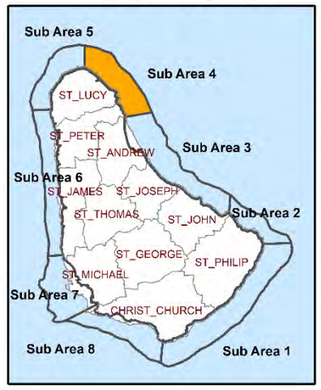
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

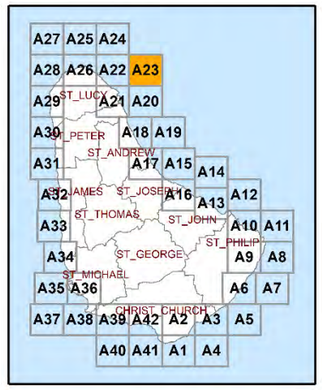


SUB AREA 4 - SHEET A23

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

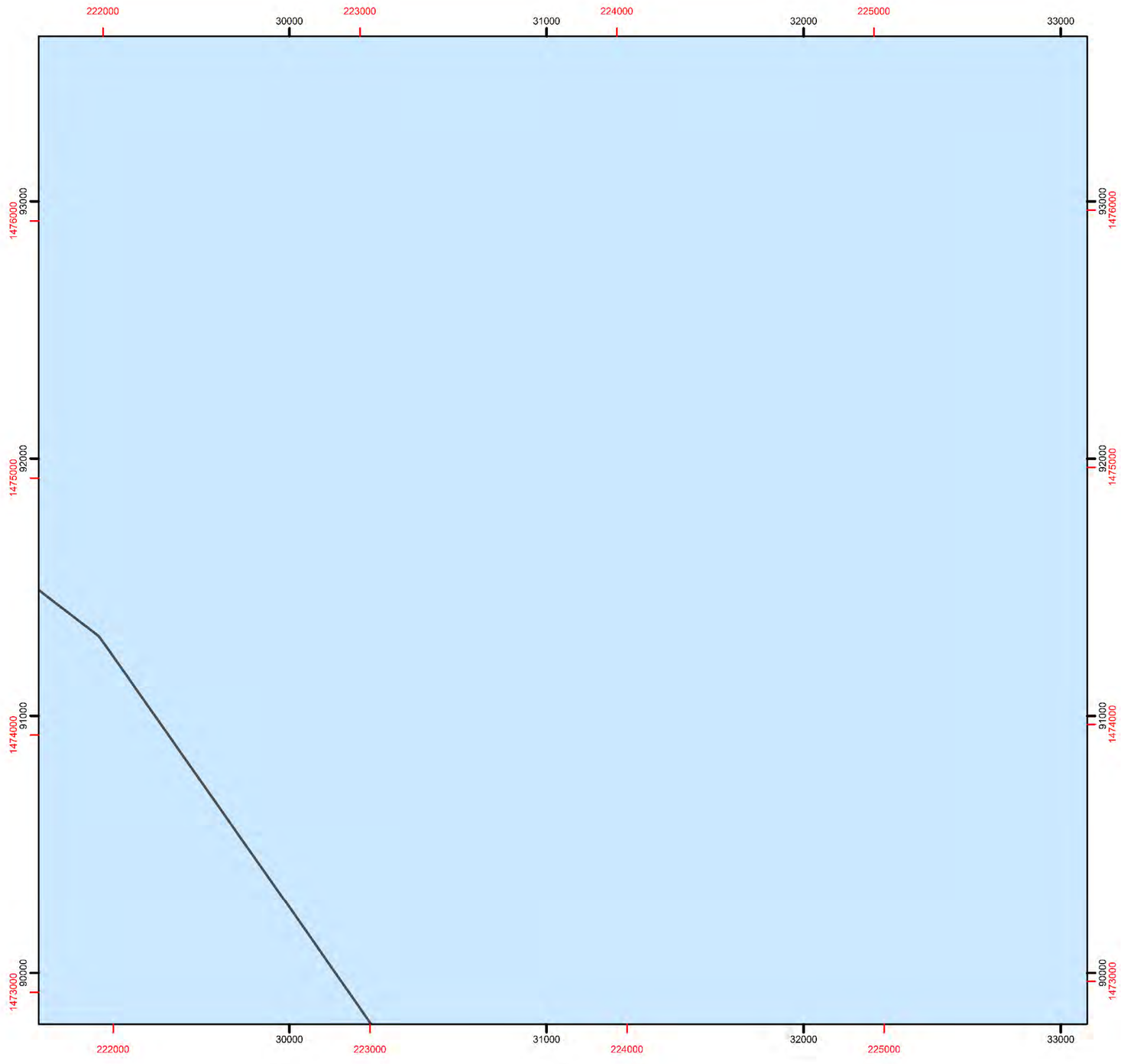
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

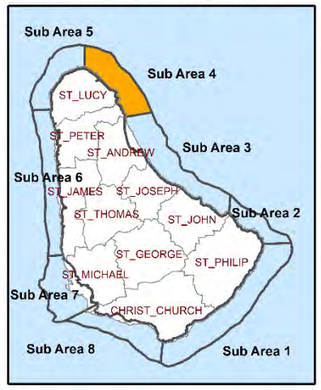
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

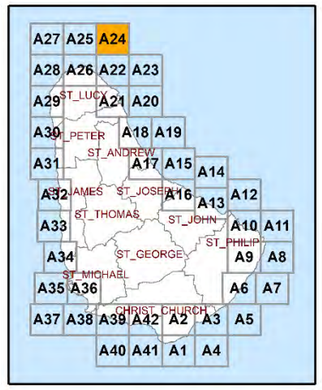


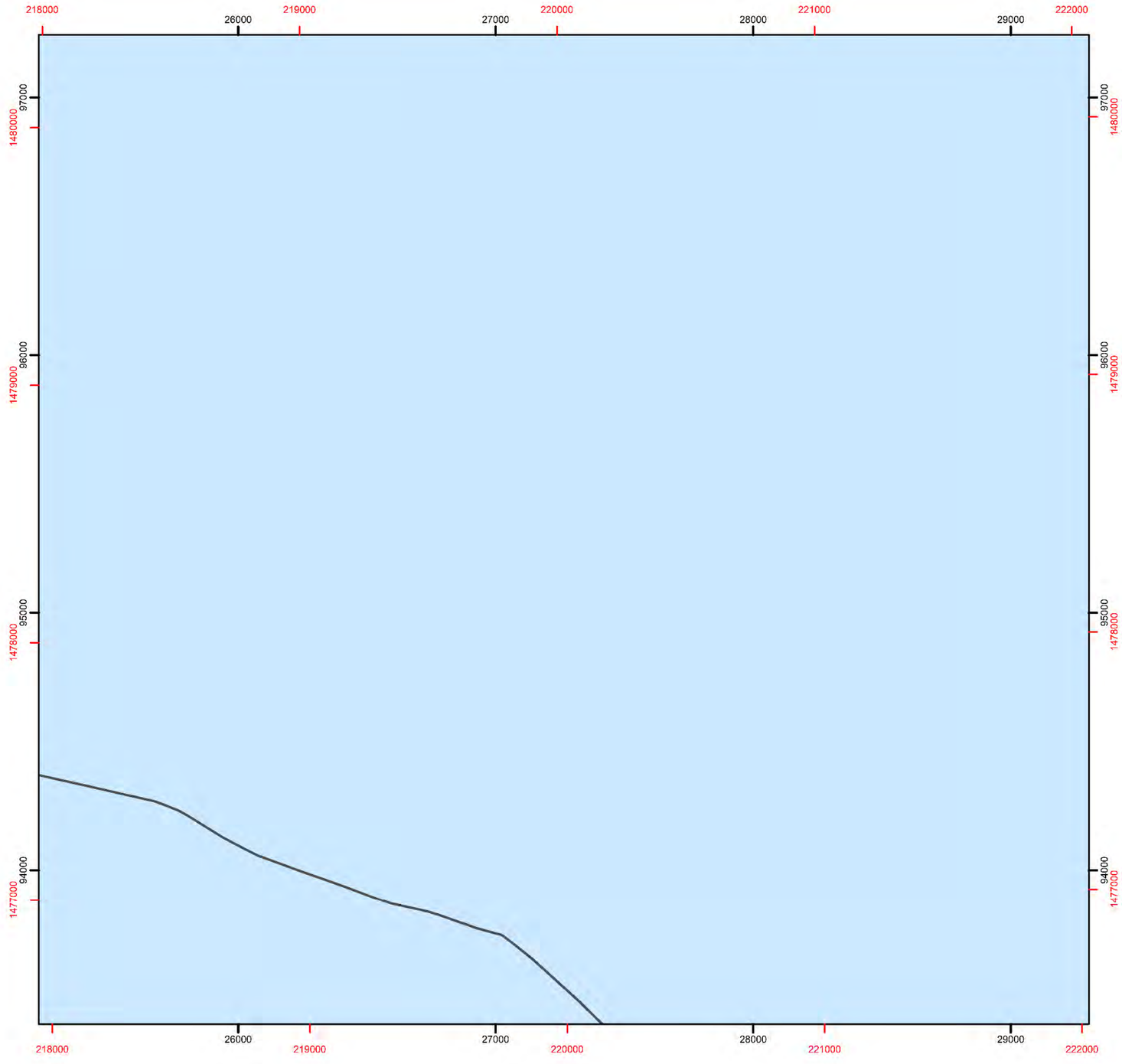
SUB AREA 4 - SHEET A24

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX





Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

Sub-Area 5: North Point to Maycock´s Bay

Main themes

Wilderness character and geological interest.
Risks due to cliff collapse.

Sub-Area description and context

Sub-Area 5 covers the north-west section of the island. The principal settlements are Archers, Greenidge, Crab Hill and Bromefield. There is some agricultural land in the north-west corner (used for sugar cane cultivation), but the area closest to the coast is used for little other than small scale grazing. An important feature along the southern section of this coast is the cement plant and associated quarry that operates at Checker Hall, St Lucy.

Much of the scenery of this Sub-Area comprises cliff top vegetation, known locally as 'rab' land. The coastal stretch has high landscape value classified by the PDP (2017) as a Coastal Landscape Protection Zone. The Growth Management Framework PDP, 2017 classifies this coastal area as National Park in the northern part and Stable Suburban and Rural Working Landscape between Crab Hill and Maycock´s Bay. The marine environment is very exposed at and around North Point though further south, where there is more shelter, and here areas of extensive gorgonian platform coupled with significant stands of massive coral species have developed giving the sea bed a different characteristic to that experienced along the east coast.

Detailed information of this Sub-Area scale is presented in the subsection entitled “Description maps of Sub-Area 5” which includes a collection of maps at a detailed scale (1:18,000) with specific information regarding natural and restricted areas, environmental characteristics, coastal and cliff collapse and flooding inundation (and climate change related) hazards that Sub-Area 5 is exposed to. At Harrisons and Cliffs, the risk of building damage (cliff collapse over the next fifty years) represents a key economic planning consideration for developers in this Sub-Area.



Figure D.6. Cliffs in Sub-Area 5.

Main issues and strategic objectives

KEY ISSUES	STRATEGIC OBJECTIVES
• Presence of unique geological formations. • Important ecological and landscape value. • Cliff collapse risk.	• Protect geological formations and coastal landscape. • Enhance heritage conservation. • Provide opportunities for informal recreation. • Provide opportunities for biodiversity conservation and education. • Enforce setbacks to ensure safety of people, buildings and infrastructures; and to retain the wild and rugged character of the coastline. • Promote improved Storm Water Management/sewage and solid waste management strategies to limit garbage disposal in watersheds and promotion of adequate treatment of sewage in line with “Roof to Reef principles”

Development Planning and Setbacks at Sub-Area scale

Setback spatial information at a regional scale is presented within a collection of maps provided in subsection entitled *"Setback maps of Sub-Area 5"*. This follows the application of the National Guidance "Development Planning and Setbacks" (section C3) for the Sub-Area 5. This map provides the delineation of setbacks for this Sub-Area at a scale of 1:18000.

This planning related information should be used by public and private actors whom are involved in the management of the coast such as developers, owners and the general public. The setback guidance adopted is defined for four separate setback categories as appropriate, namely cliff, landscape, flood inundation and climate change.

Action brief

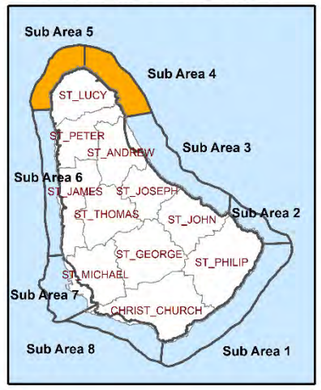
TOPIC	CODE	ACTION	LEAD ACTORS	OTHER ACTORS	TIME SCALE	COMMENTS	KEY POLICY OUTCOME
Development Planning and Setbacks	5S1	Prepare and distribute guidelines to enforce cliff collapse Setback in Sub-Area 5 for developers and public agencies.	TCDPO	CZMU	Medium term, immediate	Guidelines based on GSI.	Outcome 3 - Climate and disaster risk adaptive capacity is strengthened
Development Planning and Setbacks	5S2	Prepare and distribute guidelines to enforce Landscape Setback in Sub-Area 5 for developers and public agencies.	TCDPO	CZMU	Medium term, immediate		Outcome 1 - Sustainable socioeconomic development is achieved
Development Planning and Setbacks	5S3	Organize meetings with key stakeholders to raise awareness on coastal resources and landscape.	CZMU	TCPDO, NCC, Developers	Medium term, immediate		Outcome 1 - Sustainable socioeconomic development is achieved
Coastal Biodiversity	5BIO1	Prepare a plan to improve geological heritage awareness.	NRD	NHD, CZMU	Medium term, immediate	For instance, create a coastal geology trail, improve geological heritage education, and enhance viewing areas and access to the coast.	Outcome 2 - Coastal resources are protected and effectively managed
Coastal Biodiversity	5BIO2	Promote the rehabilitation of cultural resources to promote heritage and environmental tourism.	MTI	NHD		For instance: Harrison Point Lighthouse, Ruins of the Maycocks Bay fort and Stroud Point.	Outcome 2 - Coastal resources are protected and effectively managed
Public Awareness and Stakeholder Participation	5PA1	Identify local stakeholder at community level and private developers in the area.	CZMU				Outcome 6 - Research, understanding and knowledge outreach is increased
Public Awareness and Stakeholder Participation	5PA2	Conduct yearly public meetings to identify new issues in the Sub-Area.	CZMU	All stakeholders in the Sub-Area and key institutions at national level			Outcome 6 - Research, understanding and knowledge outreach is increased
Public Awareness and Stakeholder Participation	5PA3	Promote cultural and environmental awareness in this Sub-Area	NHD, EPD,	CZMU			Outcome 6 - Research, understanding and knowledge outreach is increased

Table D.5. Action brief for Sub-Area 5.

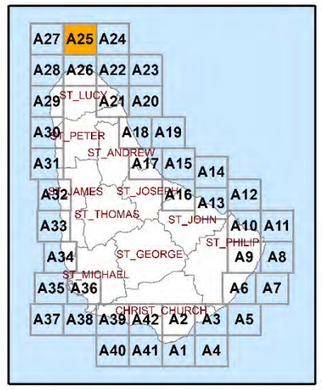
Description maps of Sub-Area 5

SUB AREAS 4, 5 - SHEET A25

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

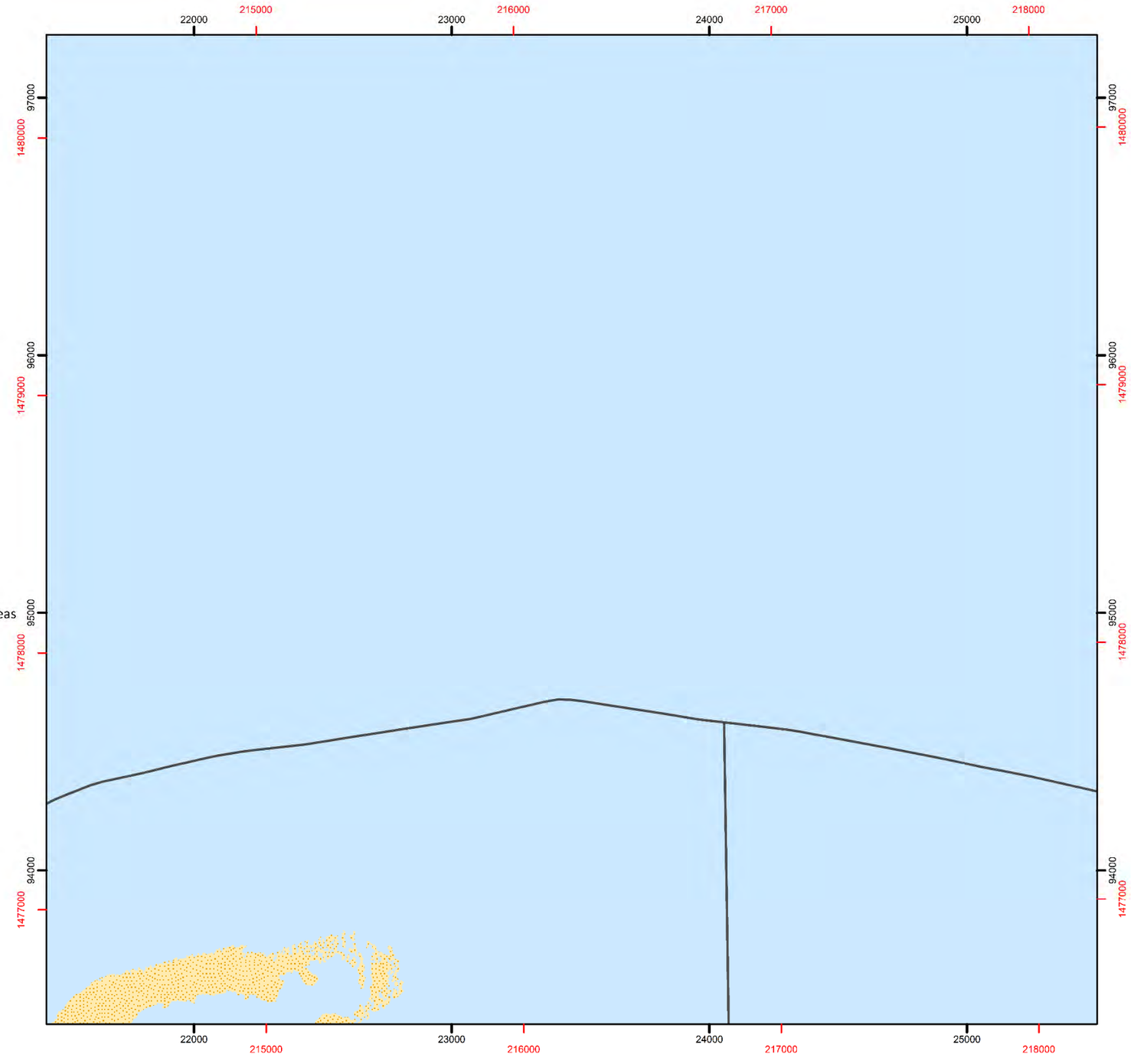
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

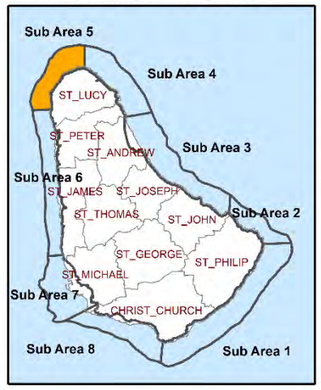
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

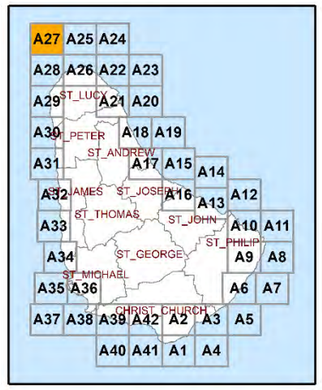


SUB AREA 5 - SHEET A27

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

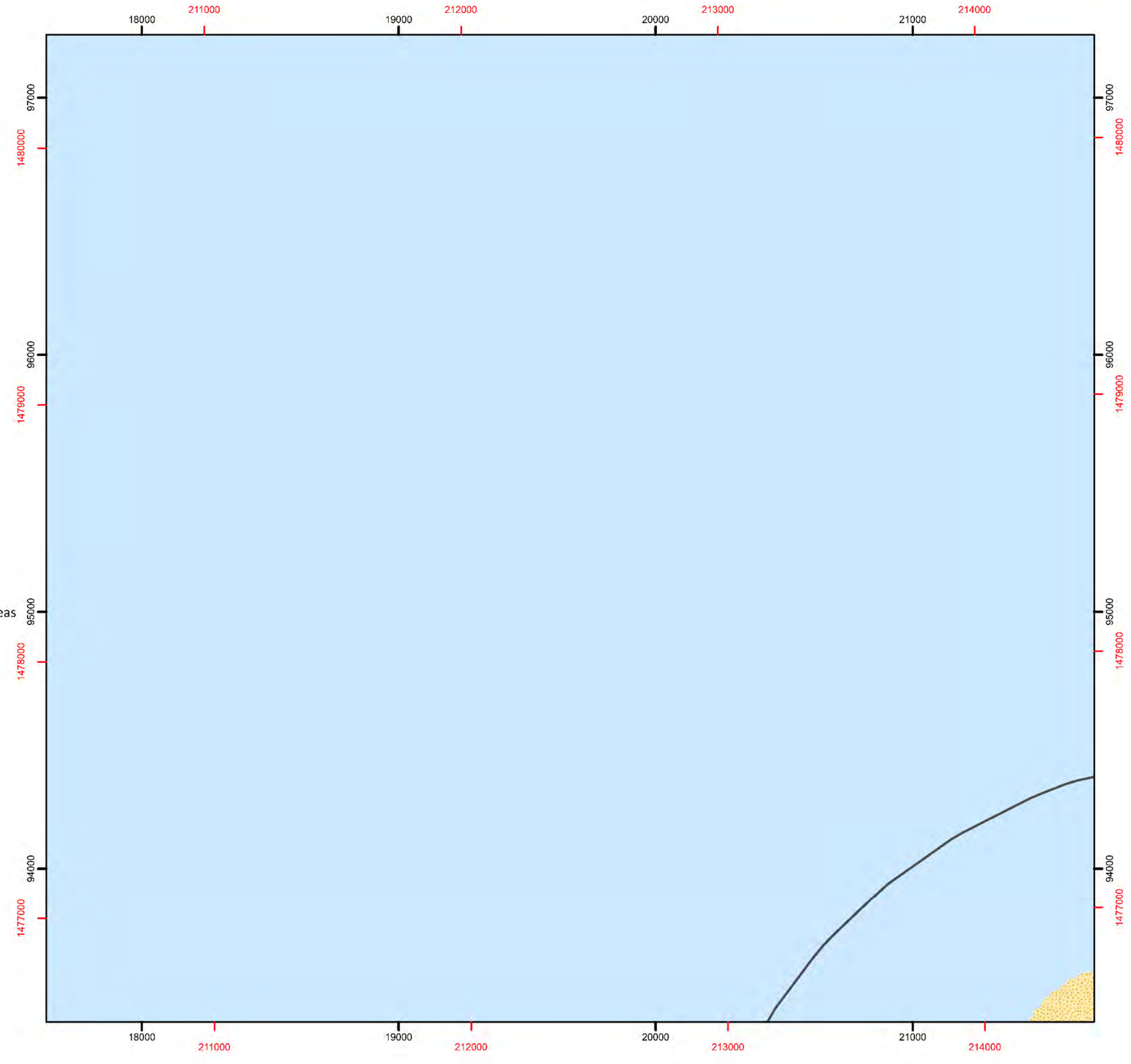
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

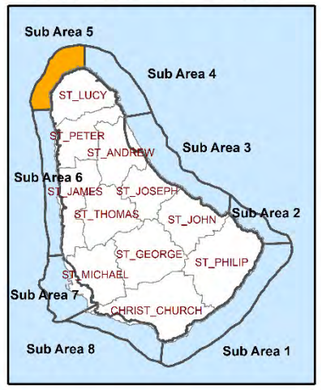
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

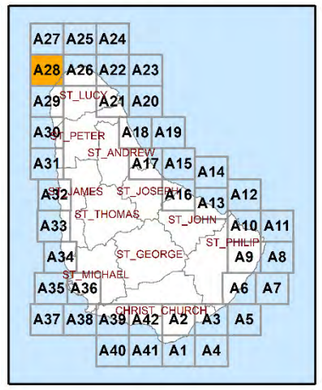


SUB AREA 5 - SHEET A28

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

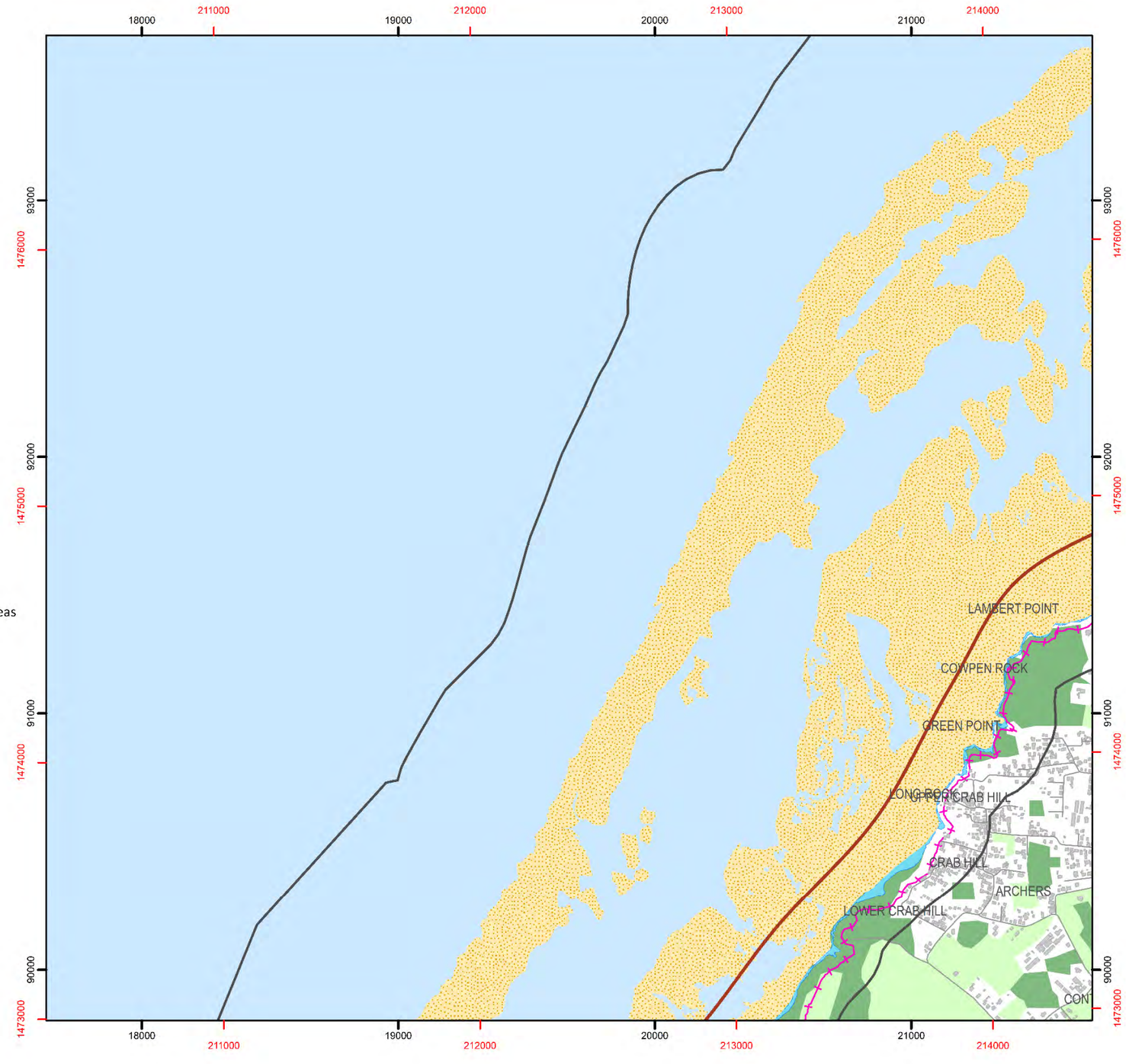
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

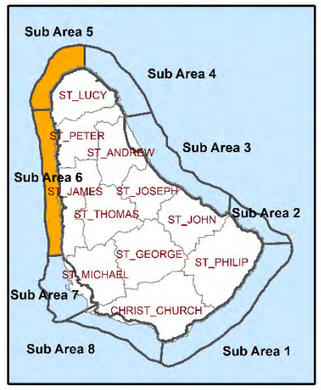
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

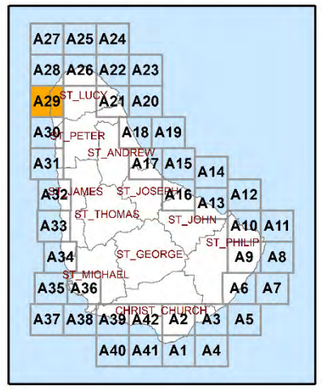


SUB AREAS 5, 6 - SHEET A29

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

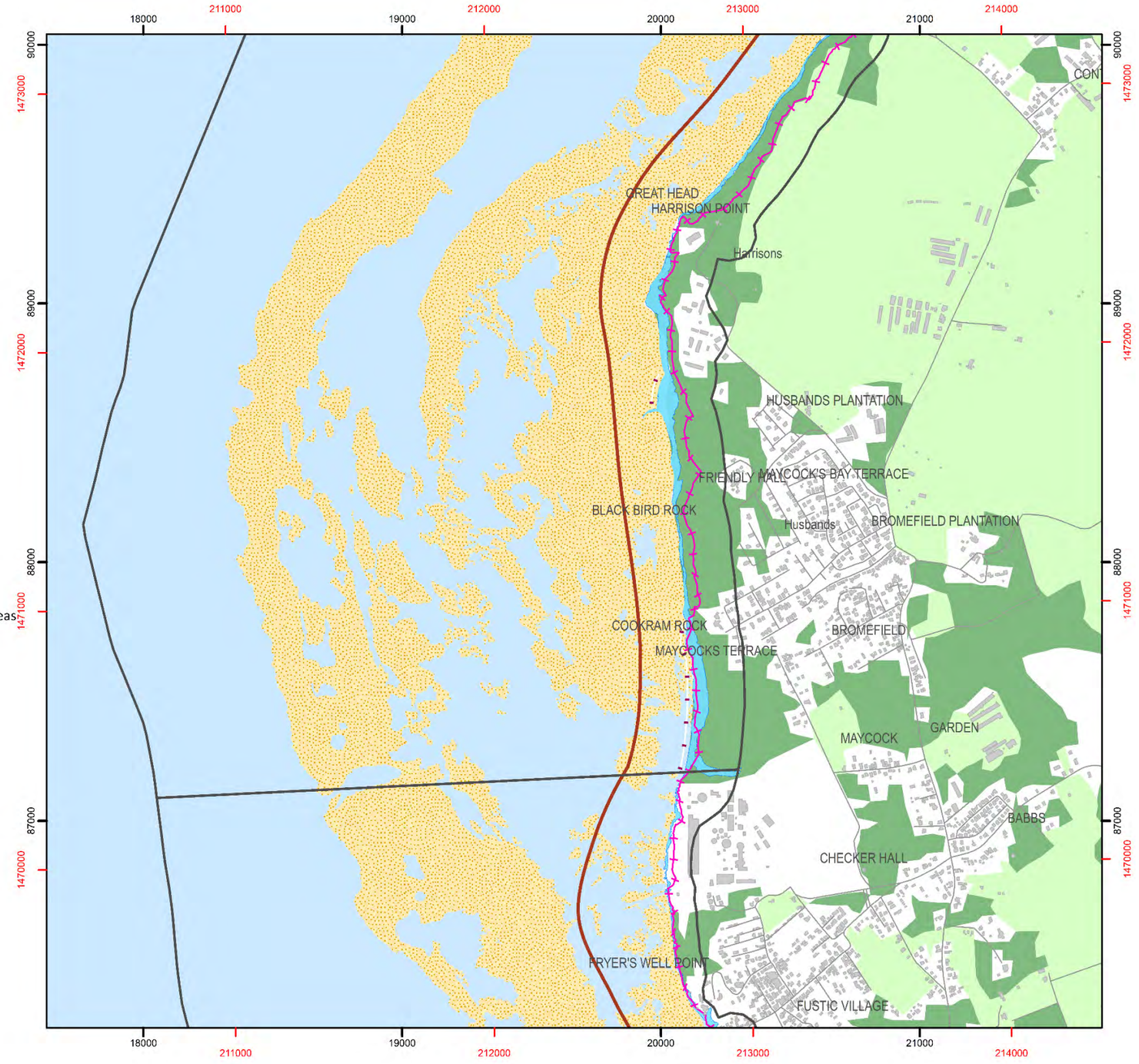
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

0 125 250 375 500 mts

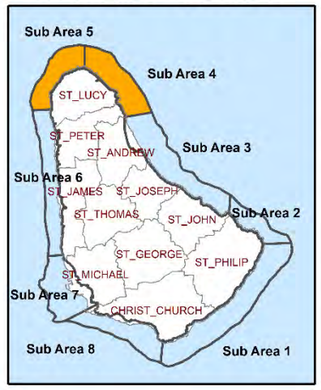
- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum



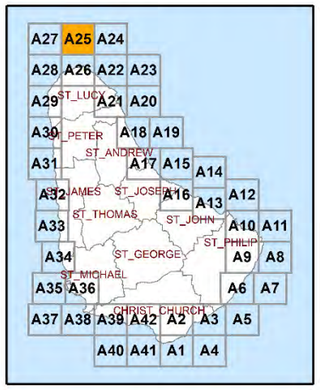
Setback maps of Sub-Area 5

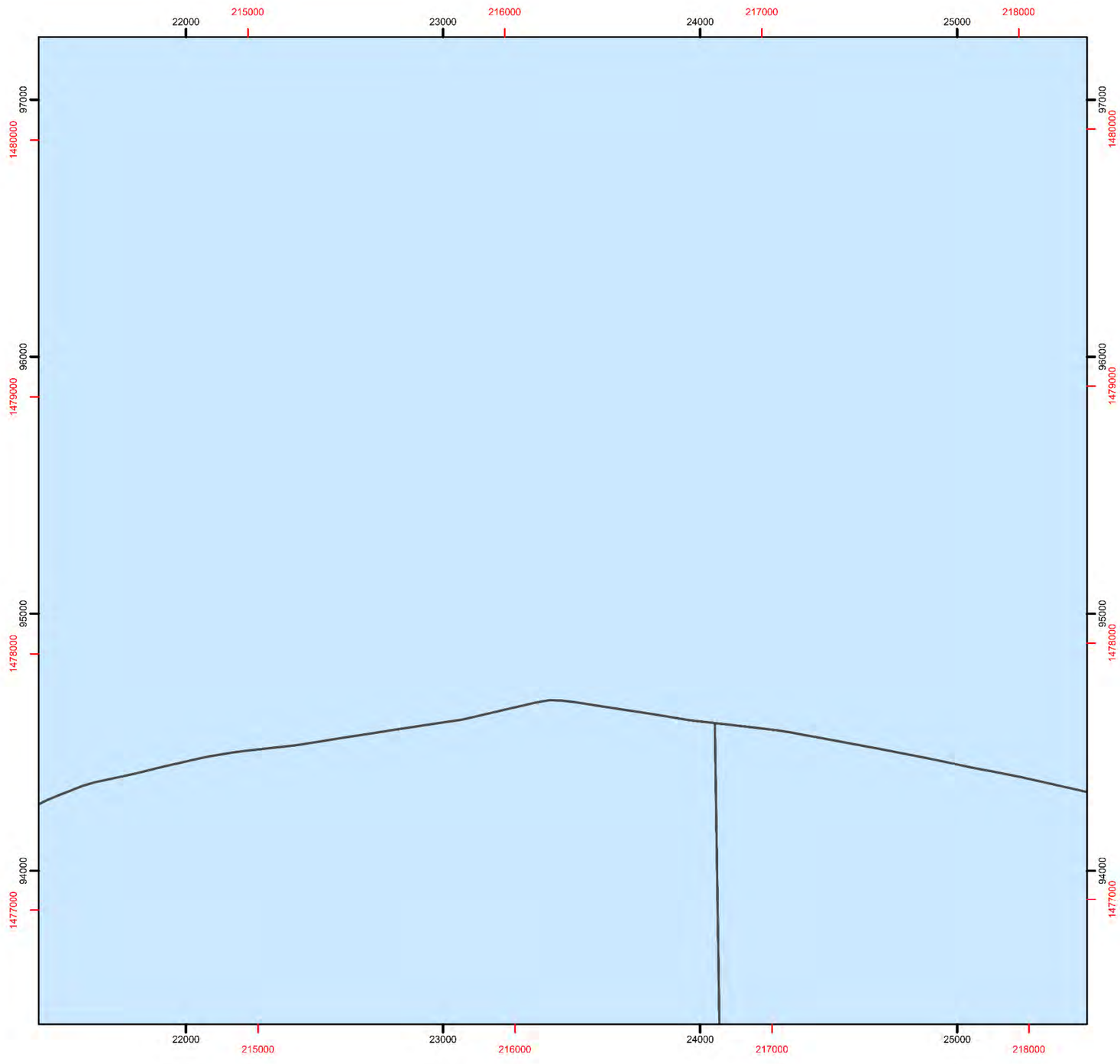
SUB AREAS 4, 5 - SHEET A25

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX





Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

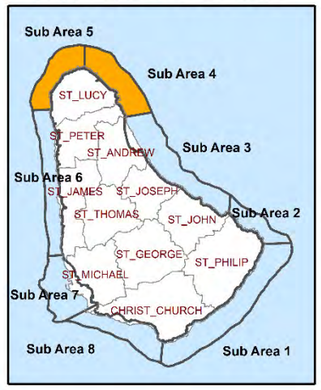
SCALE: 1:18,000

0 125 250 375 500 mts

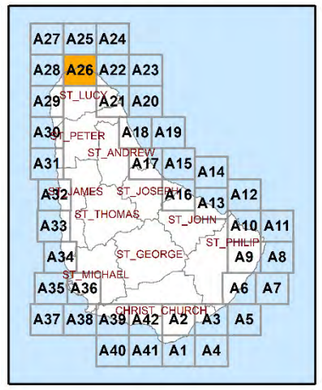
- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

SUB AREAS 4, 5 - SHEET A26

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

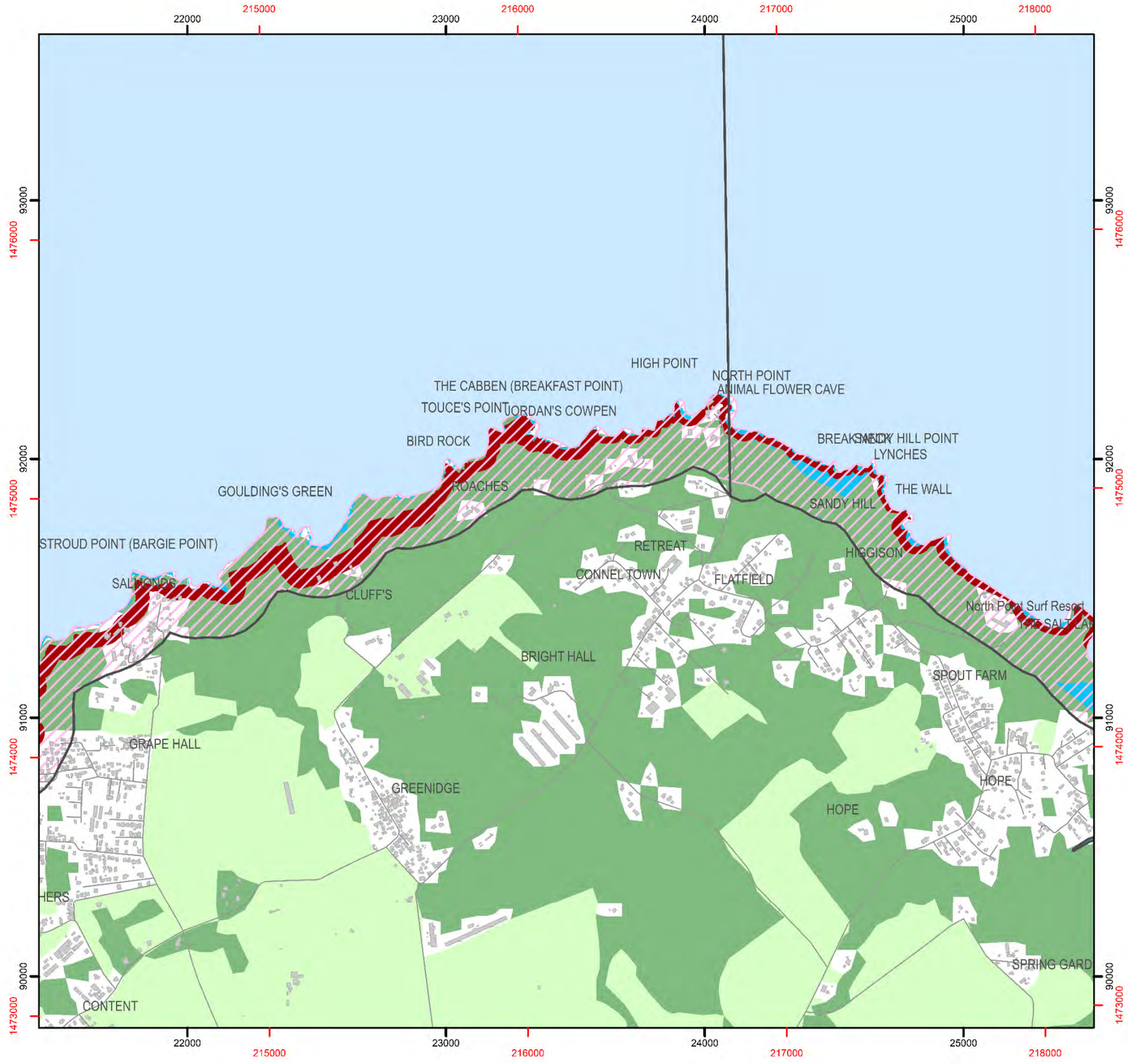
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

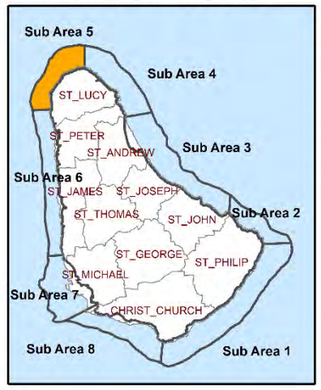
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

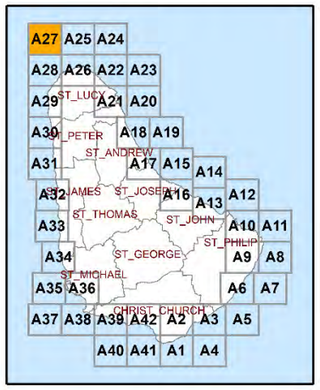


SUB AREA 5 - SHEET A27

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

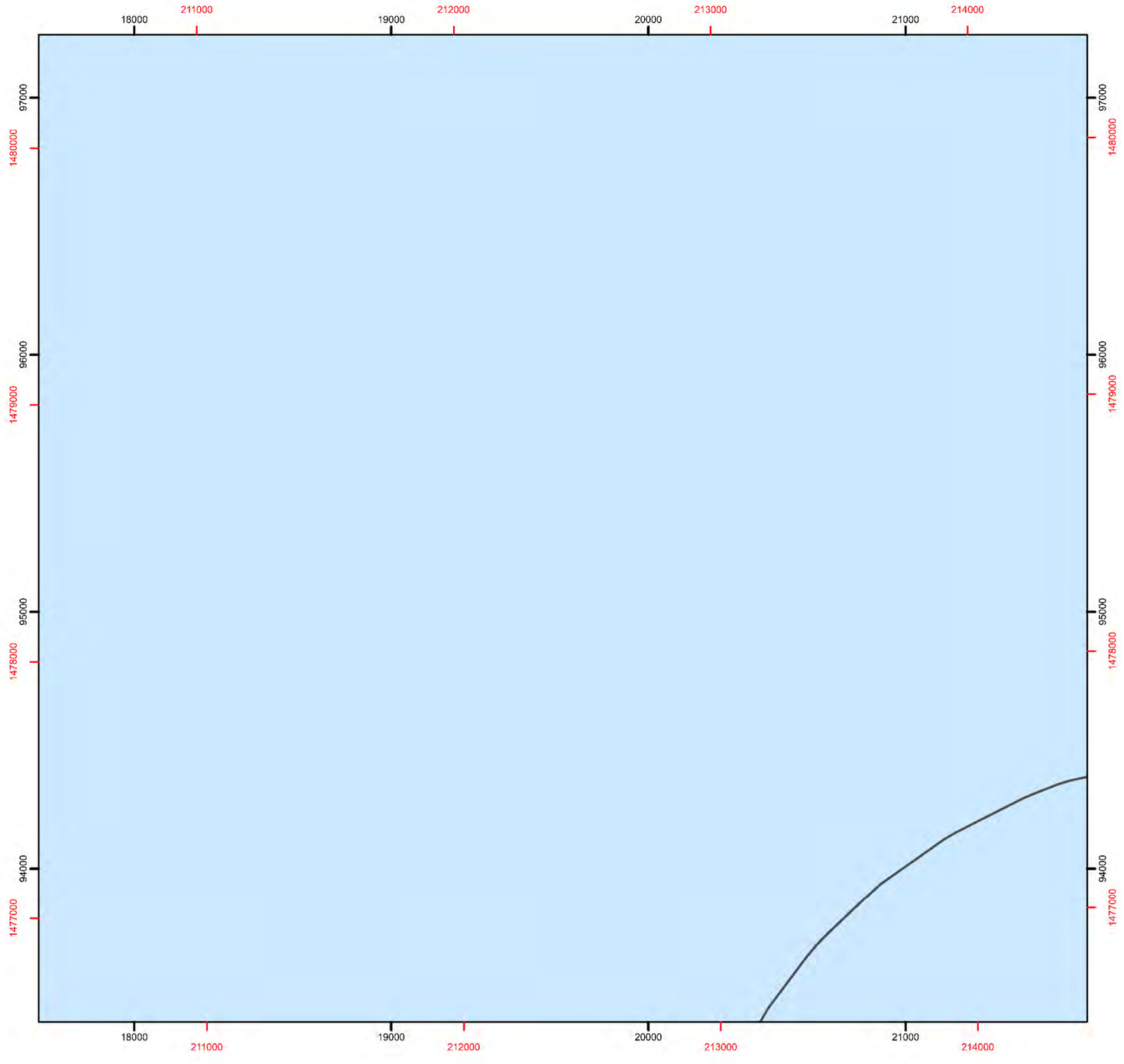
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

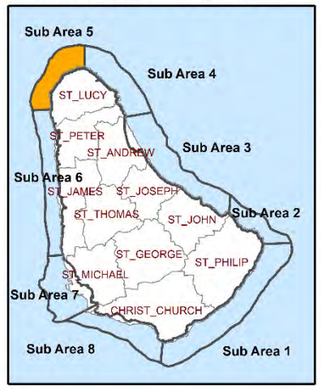
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

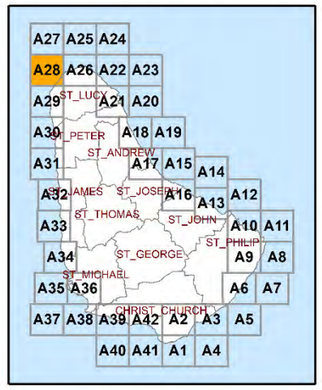


SUB AREA 5 - SHEET A28

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

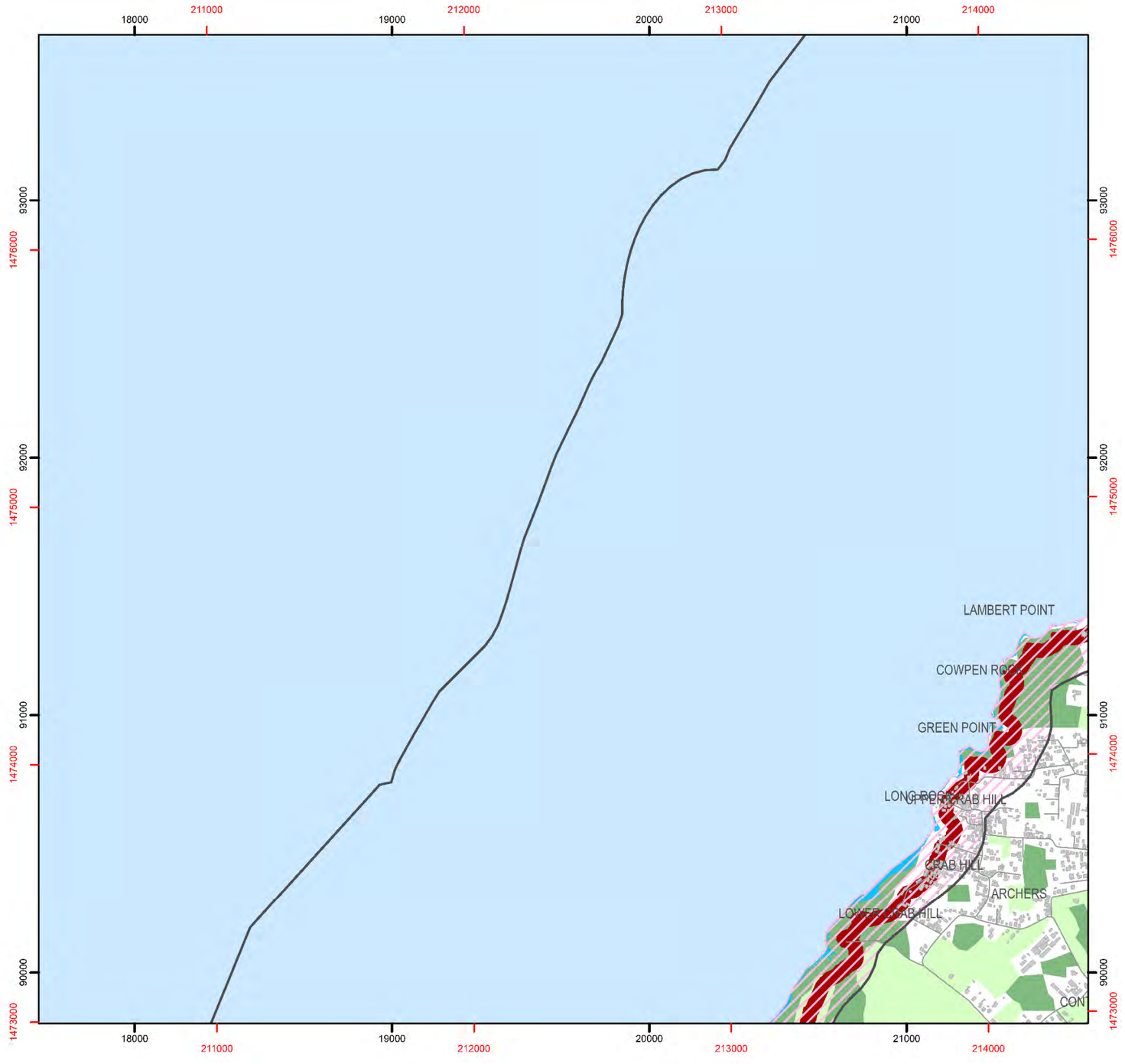
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

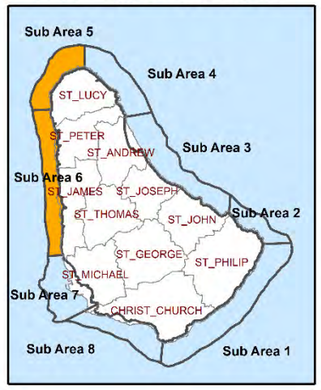
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

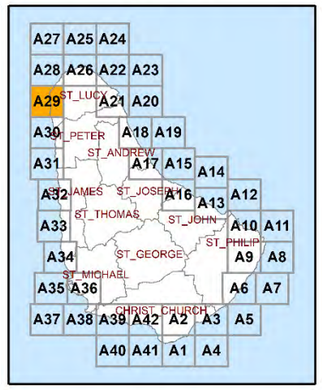


SUB AREAS 5, 6 - SHEET A29

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

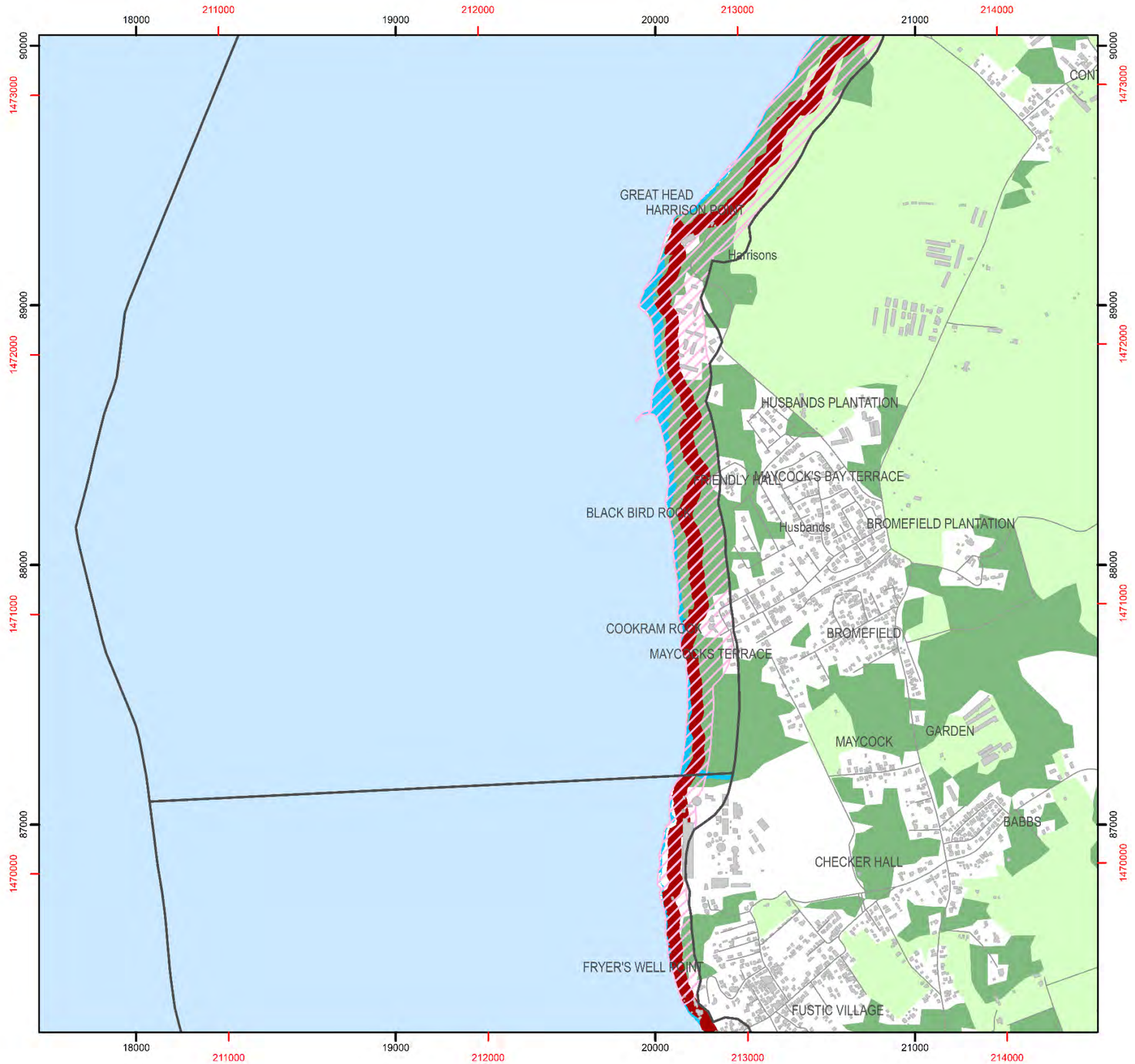
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum



SUB-AREA 6: MAYCOCK´S BAY TO BATT´S ROCK

Main themes

INTENSE TOURISM ACTIVITIES AND ENVIRONMENTAL DEGRADATION.
COASTAL EROSION AND FLOODING.

Sub-Area description and context

This Sub-Area extends along the leeward west coast of the island. Land use immediately adjacent to the coast is focused on tourism and residential development incorporating the regional centres of Speightstown and Holetown with a high population density that increases the closer in proximity to Bridgetown that is situated to the southern part of this Sub-Area. Hotel development dominates large sections of the seaward side of the coastal road where constructions occur very close to the shoreline.

The shoreline is relatively straight and characterised by generally narrow beaches located within numerous small bays commonly separated by fringing reef headlands. At a number of locations, small lagoons have formed from the ponding of surface and groundwater that has been separated from the sea by sand barriers (such as the Holetown "Hole", St. James). These may either discharge slowly through the sand barrier or during breaches of the barrier beach during larger rainfall events. Within the nearshore, the most distinctive feature is the bank barrier reef that lies parallel to the coast between 800-1000m offshore.

The Sub-Area contains turtle nesting sites. These remain threatened as a consequence of high human usage that is experienced in the Sub-Area. The Folkestone Marine Park and Reserve (to be extended from Fitts to Weston as a PDP defined "Natural Heritage Marine Areas NHCA") is located north to Holetown and contains coral habitats interspersed with areas of sand and rubble and a few seagrass beds. The PDP also designates the Heywoods Mangrove Swamp as Natural Heritage Conservation Area.

Detailed representation at Sub-Area scale is included within the subsection entitled *"Description maps of Sub-Area 6"* includes a collection of maps at a detailed scale (1:18,000) with specific information regarding natural and restricted areas, environmental characteristics, coastal and cliff classification and flooding inundation (and climate change related) hazards that Sub-Area 6 is exposed to. Recent studies within the CRMP (Baird, 2018) indicate that coastal hazards such as high winds, swell waves and storm surges occur along the whole coastline. Cliff collapse also occurs at Mount Standfast and Fitts Village. Severe beach erosion, exacerbated by climate change, is estimated along the whole Sub-Area. The UNESCO funded consultancy *Community Tsunami Inundation and Evacuation Maps for Select ICG/Caribe EWS Member States* (IHCantabria and EDANYA, 2020) revealed tsunami hazard impact from Mullins to Shermans.



Figure D.7. Recreational area at Folkestone Marine Park

The Growth Management Framework, PDP, 2017, classifies this coastal area as Urban Corridor with Community Cores at Speightstown and Holetown.

Main issues and strategic objectives

KEY ISSUES	STRATEGIC OBJECTIVES
• Intense urban and tourism development on the coastline. • Growing threat of inflatable beach recreation equipment and overwater restaurants/bungalows with no regulations in place. • Challenges related to access to the coast. • Turtle nesting and coral protection needs. • Water quality issues. • Severe beach erosion. • High-risk due to storm surge.	• Enforce setbacks to ensure safety of people, retain views to the sea, preserve environmental values and ensure access to the coast. • Determine beach carrying capacity, environmental conservation and secure beach access. • Improve water quality through the development of water quality standards. • Reduce current and coastal risks, especially due to storm surge and coastal erosion. • Promote improved Storm Water Management/sewage and solid waste management strategies to limit garbage disposal in watersheds and promotion of adequate treatment of sewage in line with "Roof to Reef principles.

Development Planning and Setbacks at Sub-Area scale

Setback spatial information at a regional scale is presented within a collection of maps provided in subsection "Setback maps of Sub-Area 6". This follows the application of the National Guidance "Development Planning and Setbacks" (section C3) for the Sub-Area 6. This map provides the delineation of setbacks for this Sub-Area at a scale of 1:18000.

This planning related information should be used by public and private actors whom are involved in the management of the coast such as developers, owners and the general public. The setback guidance adopted is defined for four separate setback categories as appropriate, namely cliff, landscape, flood inundation and climate change.

Action brief

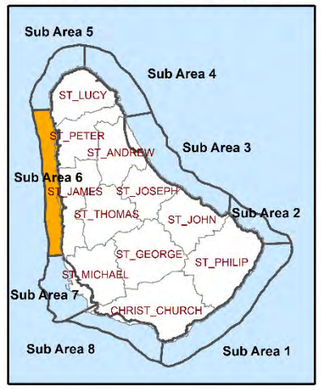
TOPIC	CODE	ACTION	LEAD ACTORS	OTHER ACTORS	TIME SCALE	COMMENTS	KEY POLICY OUTCOME
DRM and CCA	6DRM1	Identify and design mitigation measures for coastal flooding and erosion within the National DRM Plan.	MTWM	TCDPO, CZMU	Short term, continuous.		Outcome 3 - Climate and disaster risk adaptive capacity is strengthened
Beach Management	6BM1	Evaluate existing and propose new beach enhancement intervention projects within the framework of the National Beach Management Plan.	CZMU, TCDPO, NCC			These projects include at least (i) project proposed at Clinketts, St Lucy, to protect the road at Sand Street; (ii) project proposed at old Speightstown Road; and (iii) on the west coast in the area between St. Peter's Bay and Mullins Beach.	Outcome 2 - Coastal resources are protected and effectively managed
Beach Management	6BM2	Produce a DRM Emergency Plan for beaches considering tourism assets (as articulated within a National DRM Plan and Beach Management Plan).	DEM	TCDPO, CZMU			Outcome 3 - Climate and disaster risk adaptive capacity is strengthened
Beach Management	6BM3	Improve facilities and ease of access at popular recreation areas as this area.	NCC	TCDPO, CZMU			Outcome 2 - Coastal resources are protected and effectively managed
Development Planning and Setbacks	6S1	Enforce Coastal Setback on the shoreline.	TCDPO	CZMU	Short term, immediate		Outcome 1 - Sustainable socioeconomic development is achieved
Coastal Biodiversity	6BIO1	Verify that Beach Management Plan provisions protect turtle nesting sites.	NCC	CZMU			Outcome 2 - Coastal resources are protected and effectively managed
Public Awareness and Stakeholder Participation	6PA1	Identify local stakeholder at community level and private developers in the area.	CZMU				Outcome 6 - Research, understanding and knowledge outreach is increased
Public Awareness and Stakeholder Participation	6PA2	Conduct yearly public meetings to identify new issues in the Sub-Area.	CZMU	All stakeholders in the Sub-Area and key institutions at national level			Outcome 6 - Research, understanding and knowledge outreach is increased
Public Awareness and Stakeholder Participation	6PA3	Raise awareness on shoreline protection.	CZMU	TCDPO	Short term, continuous.		Outcome 6 - Research, understanding and knowledge outreach is increased

Table D.6. Action brief for Sub-Area 6.

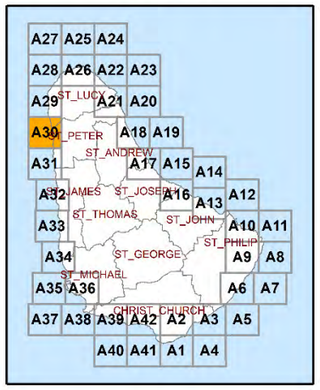
Description maps of Sub-Area 6

SUB AREA 6 - SHEET A30

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

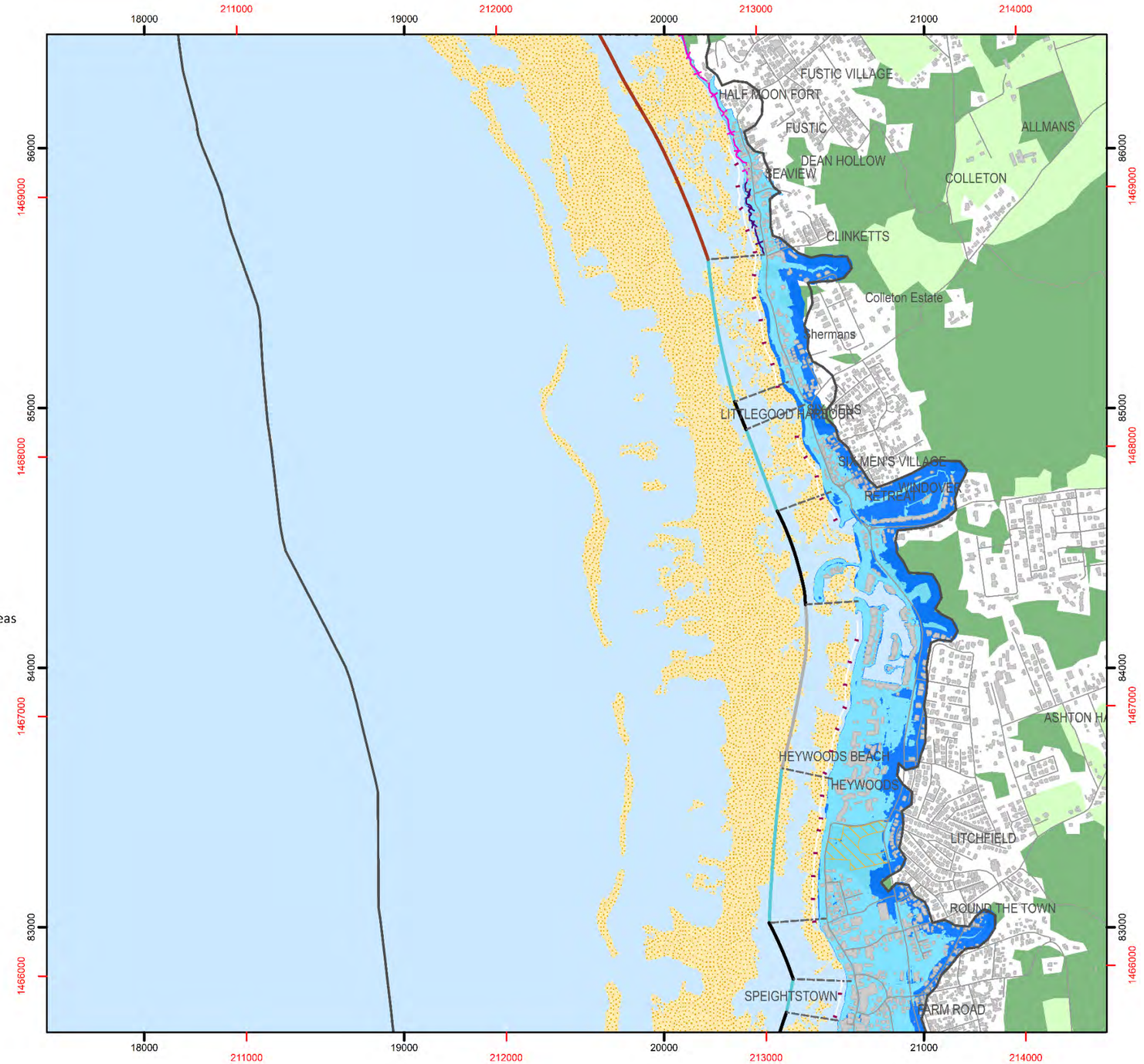
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

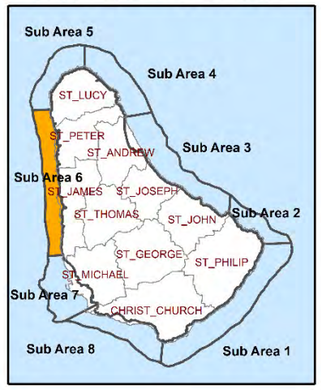
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

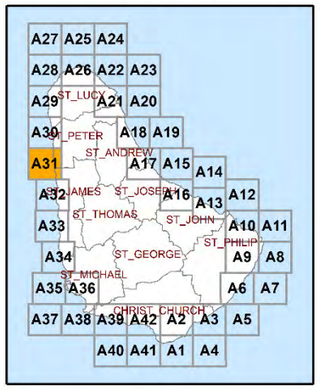


SUB AREA 6 - SHEET A31

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

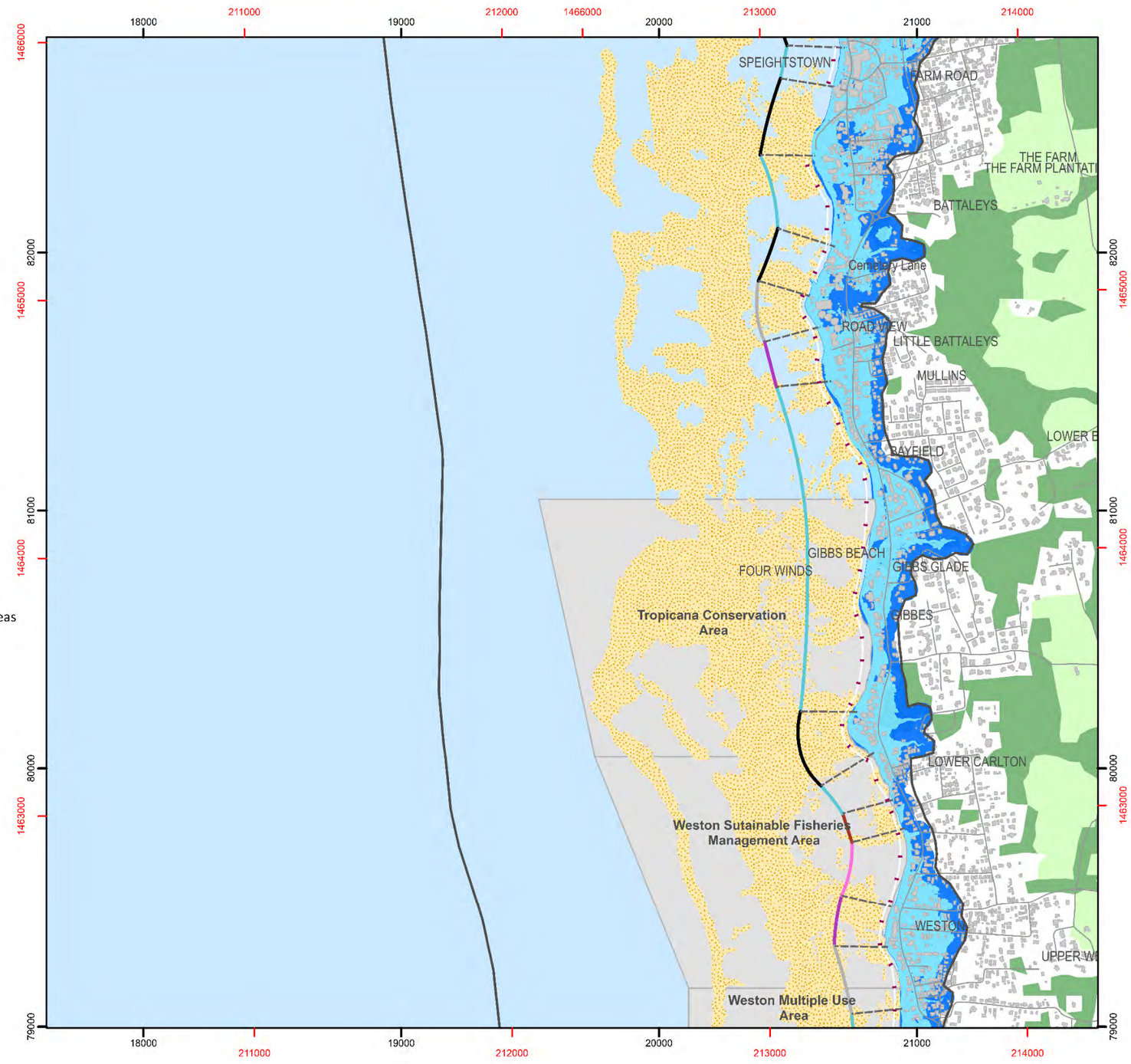
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

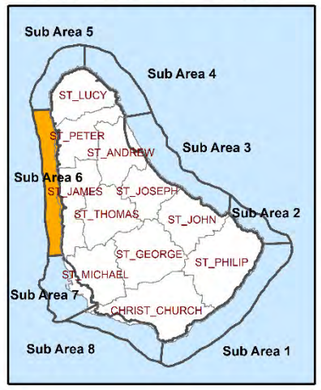
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

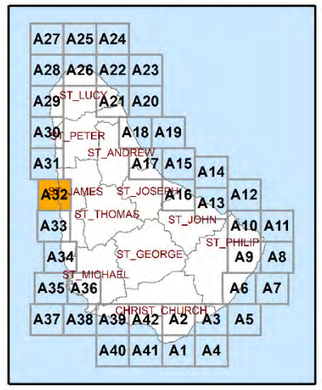


SUB AREA 6 - SHEET A32

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

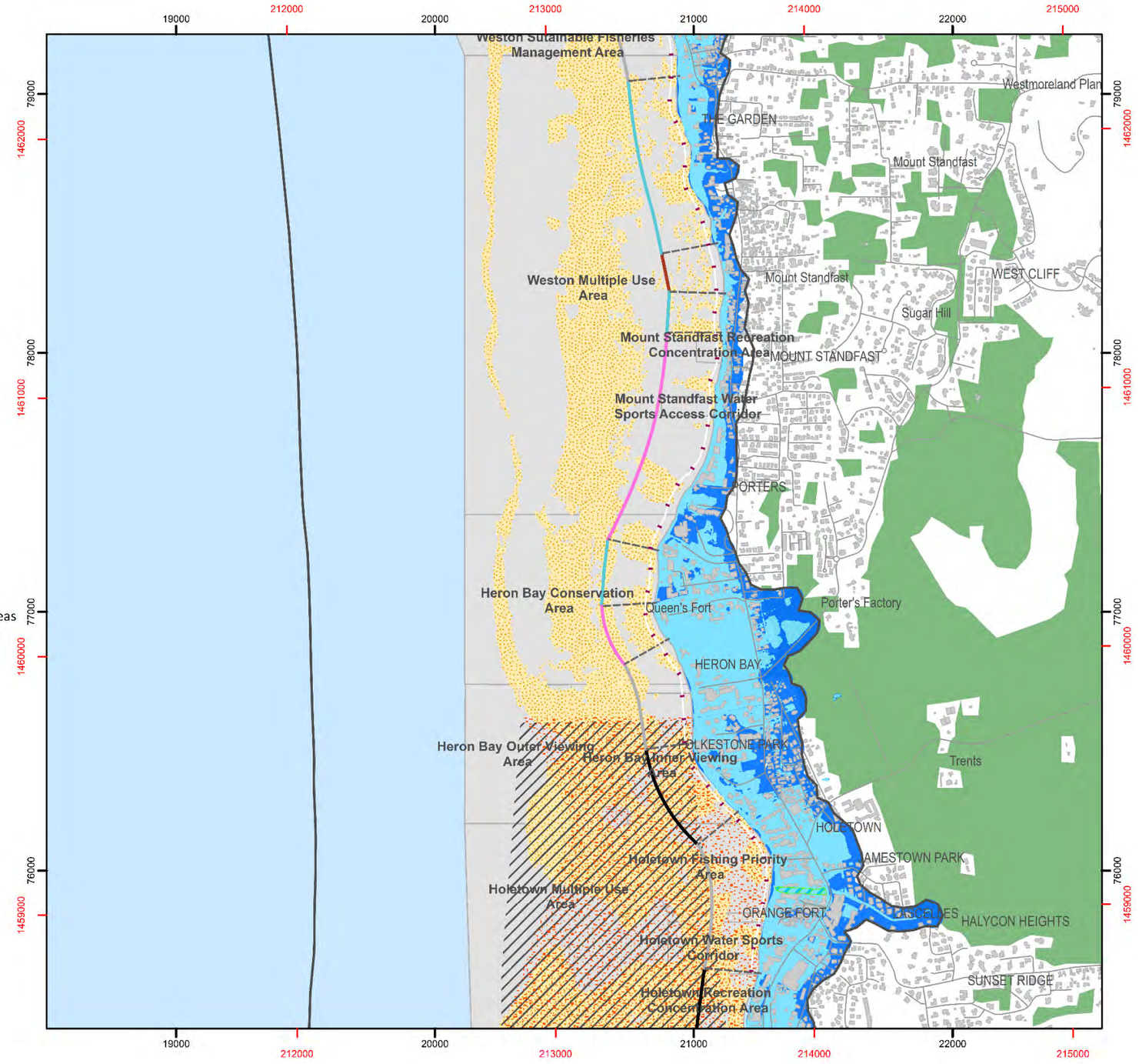
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

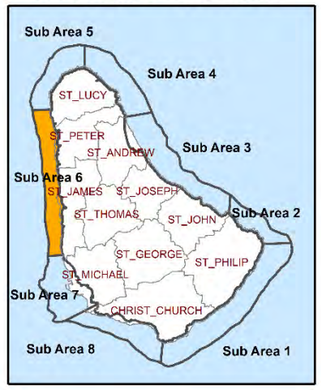
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

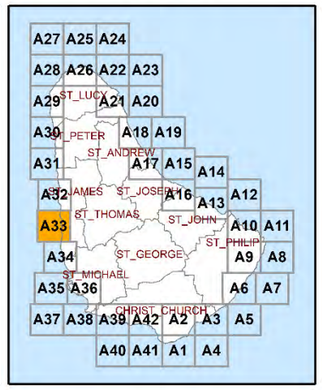


SUB AREA 6 - SHEET A33

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

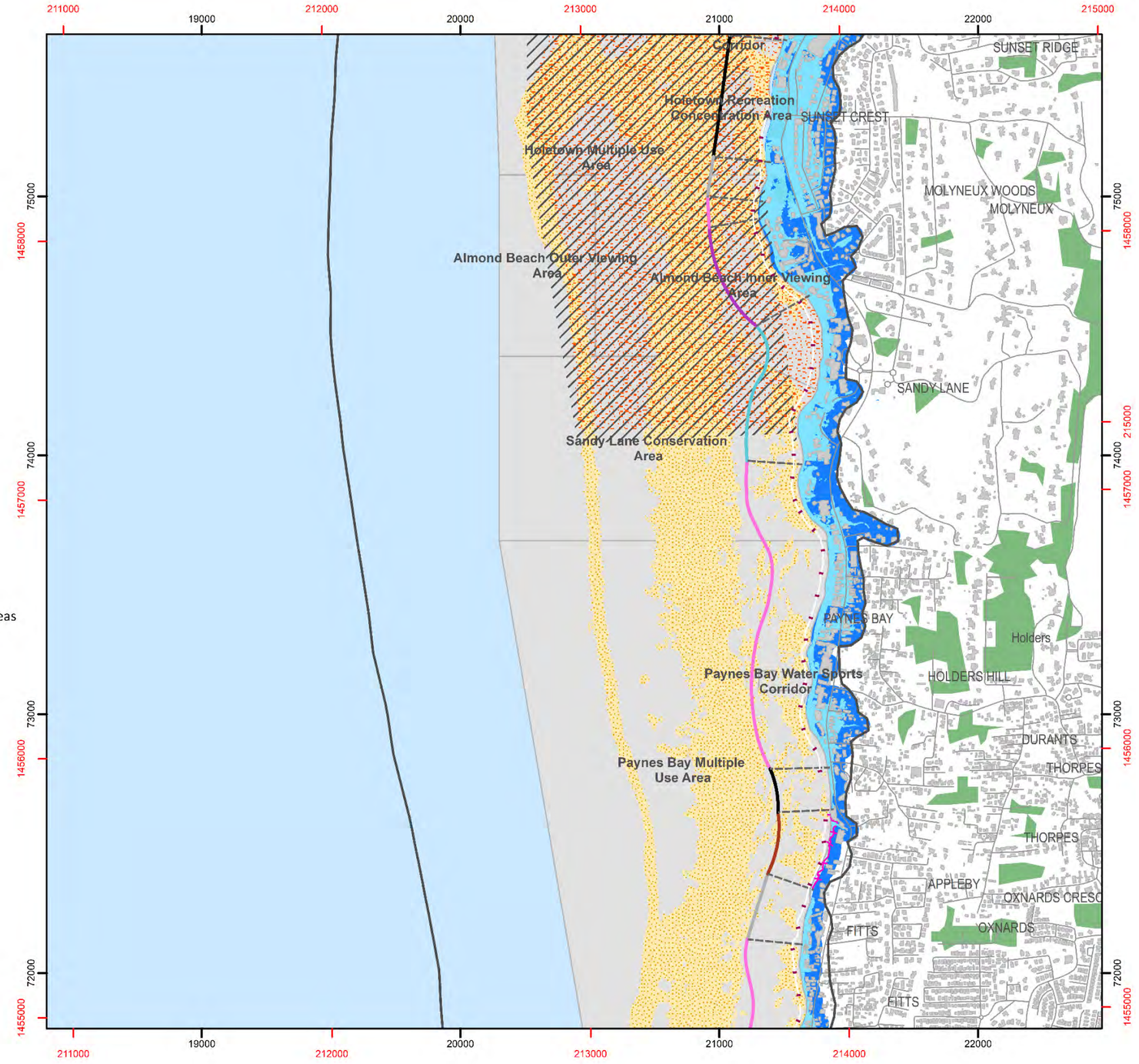
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

0 125 250 375 500 mts

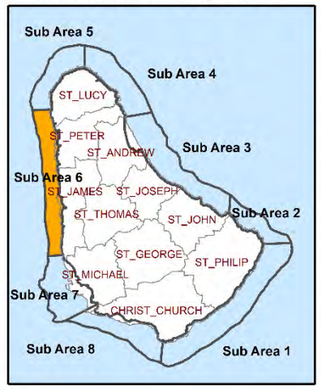
- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum



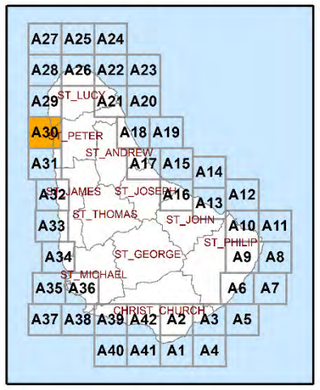
Setback maps of Sub-Area 6

SUB AREA 6 - SHEET A30

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

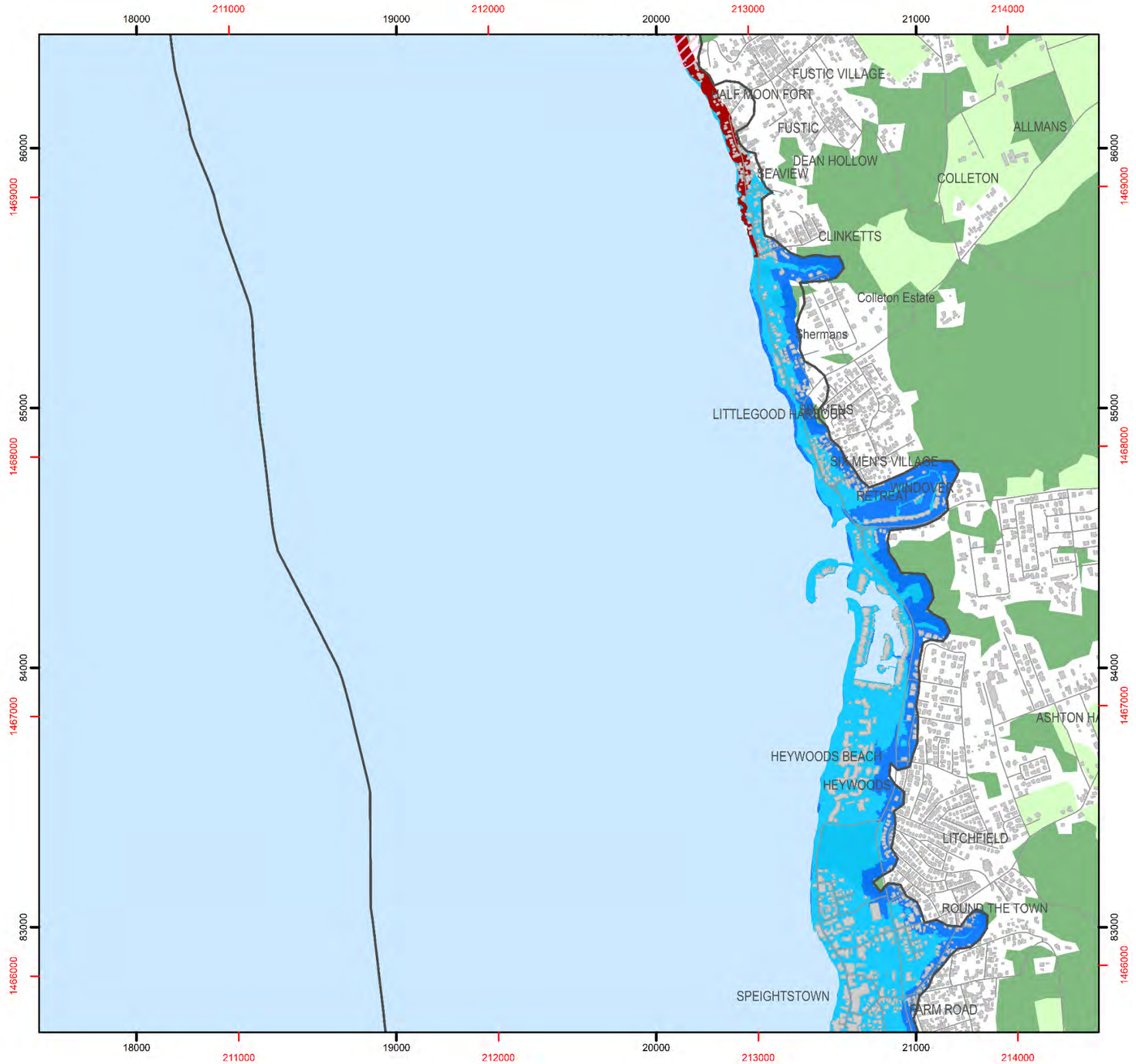
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

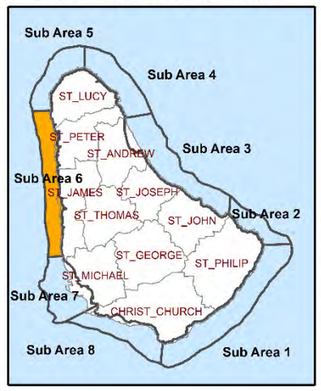
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

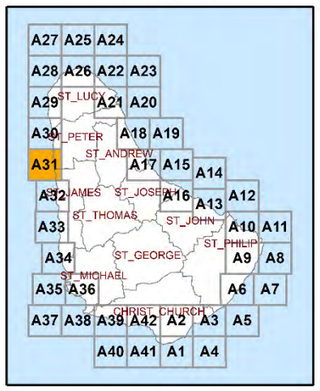


SUB AREA 6 - SHEET A31

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

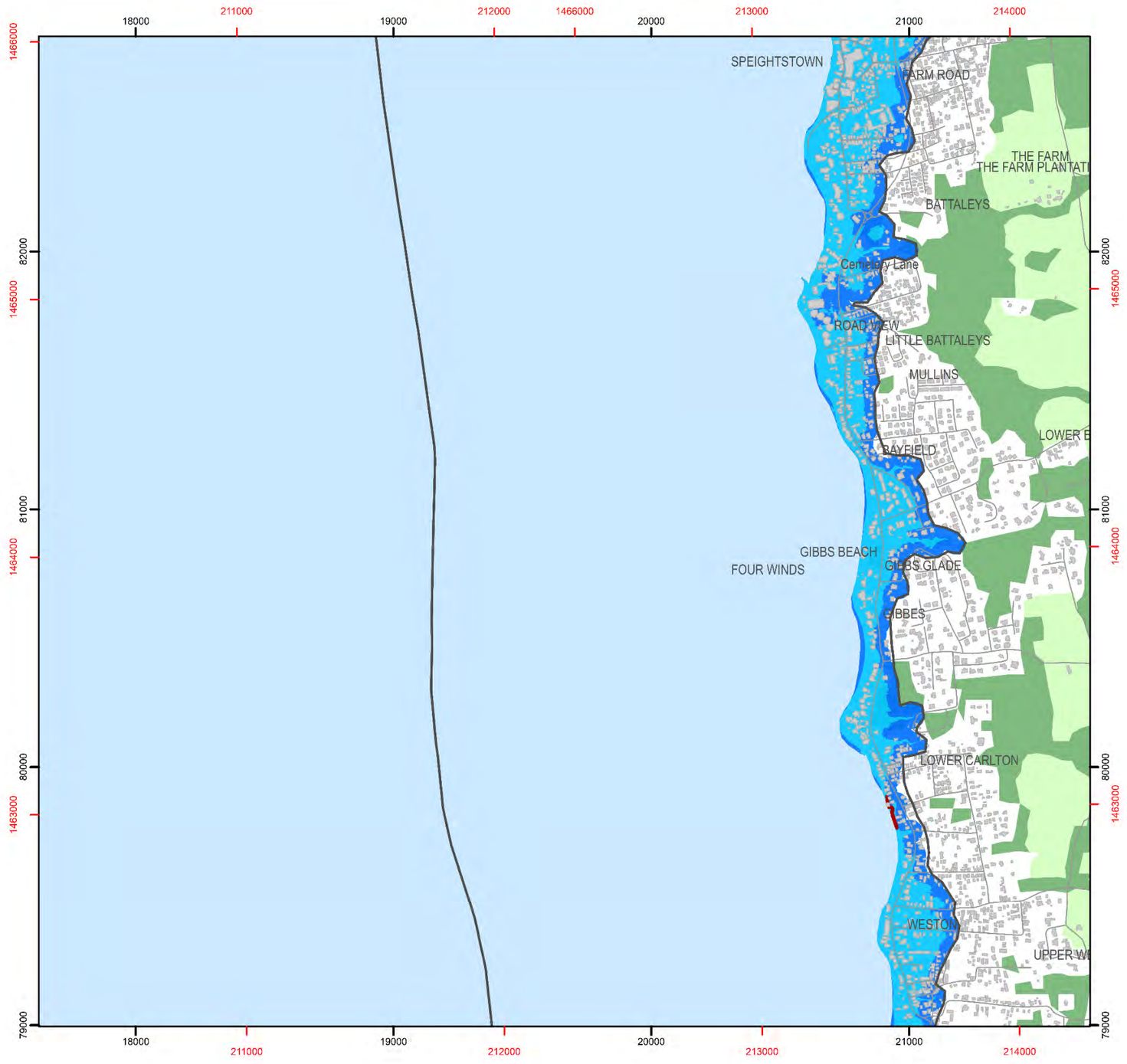
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

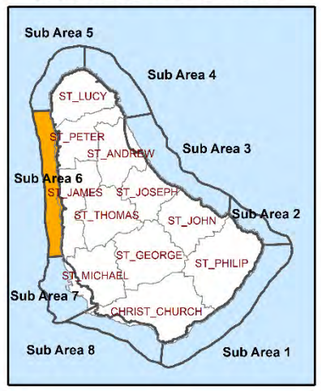
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

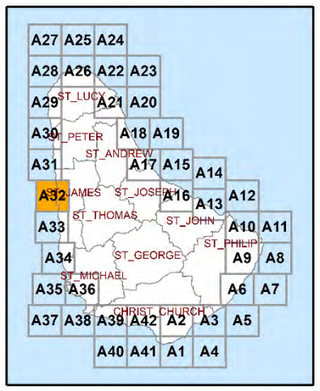


SUB AREA 6 - SHEET A32

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area ——

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

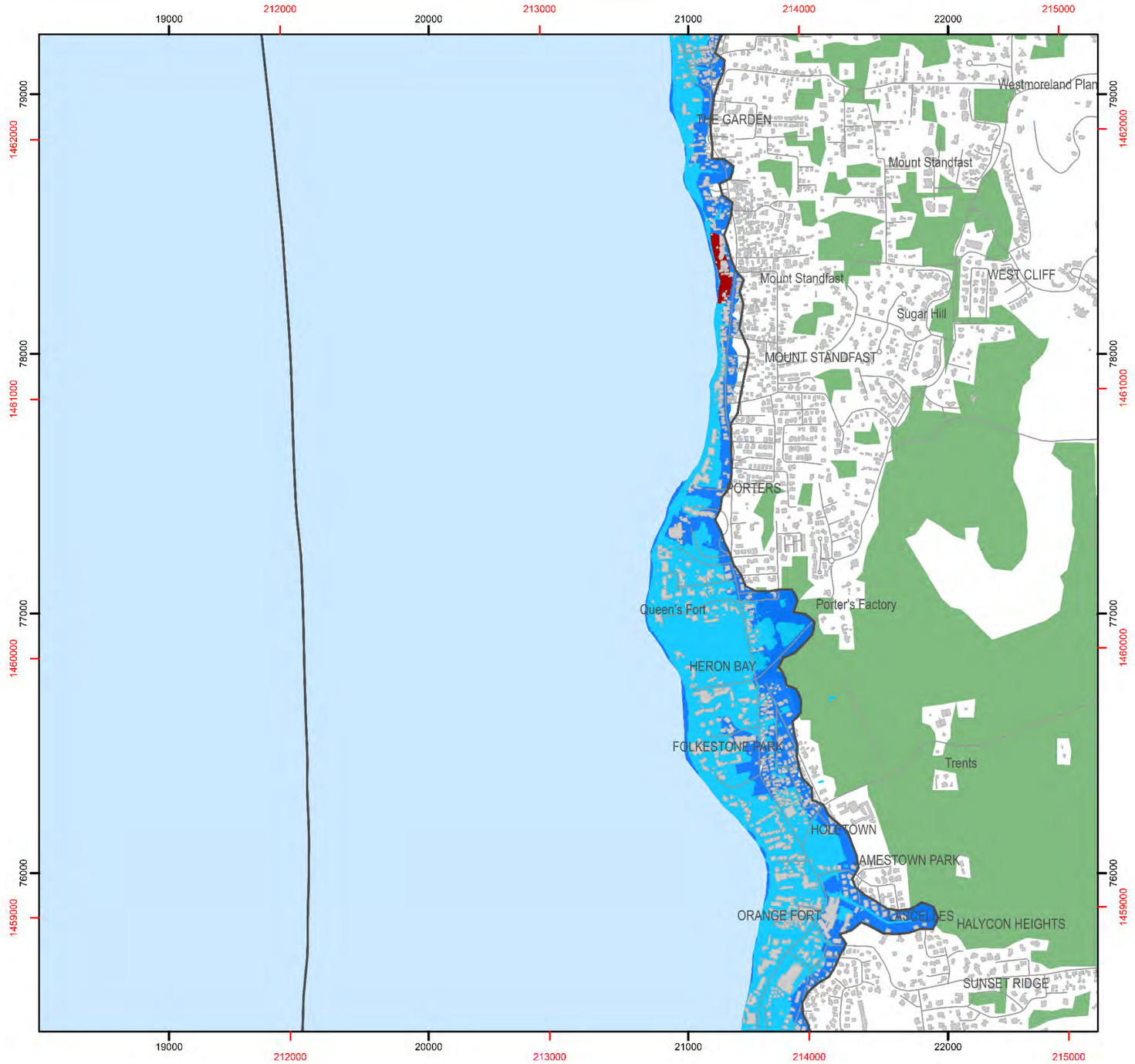
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

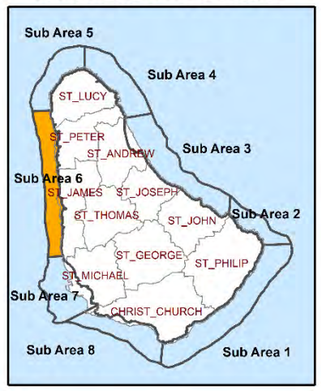
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

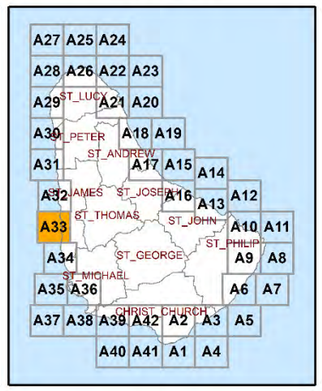


SUB AREA 6 - SHEET A33

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

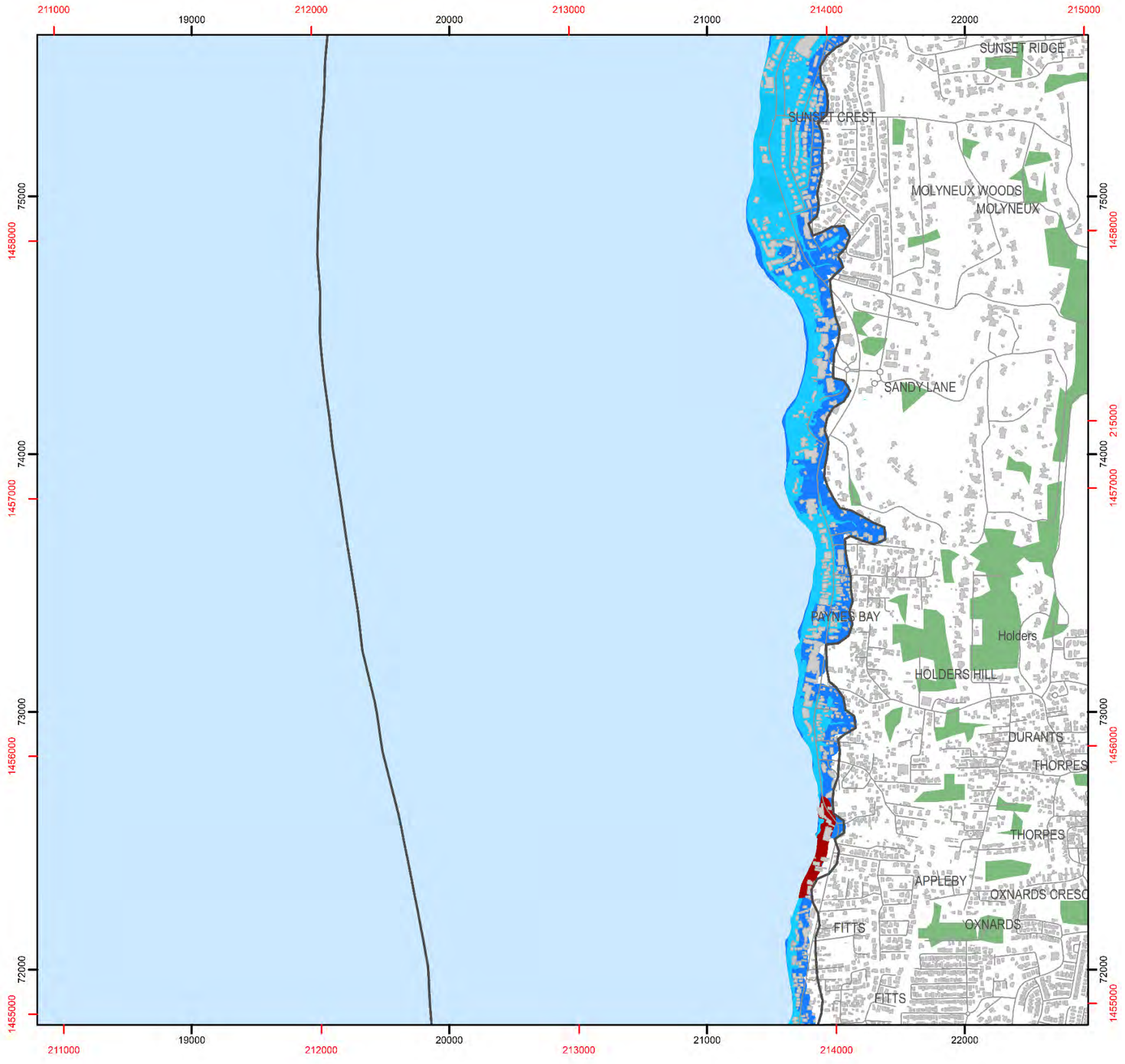
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

0 125 250 375 500 mts

- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum



SUB-AREA 7: BATT´S ROCK TO NEEDHAM´S POINT

Main themes

COEXISTENCE OF URBAN AND PORT ACTIVITIES WITH ENVIRONMENTAL VALUES.

IMPORTANCE OF NATURAL AND RECREATIONAL AREAS FOR CLIMATE CHANGE ADAPTATION.

Sub-Area description and context

This sector of the coastline is predominantly south-west facing. Land use is dominated by the capital city of Bridgetown and surrounding suburbs, which are important for industry, and contains the Bridgetown Port and associated deep-water harbour. The major natural coastal feature is the sheltered area of Carlisle Bay where the Constitution River discharges to the sea. The Bay provides a safe anchorage and is used extensively by small craft for recreational purposes. Itis therefore a focus for water sports.

Needham's Point forms the southern boundary of Carlisle Bay and offers some of the best views of Bridgetown. The Sub-Area includes the Historic Bridgetown and its Garrison, which achieved international recognition as a UNESCO World Heritage Site. Carlisle Bay is a Natural Heritage Conservation Area (PDP, 2017). The central part of the Bay is a proposed Marine Reserve, which will incorporate a number of wrecks that are popular dive sites.

Detailed representation at Sub-Area scale is presented in the subsection entitled *"Description maps of Sub-Area 7"*. This includes a collection of maps at a detailed scale (1:18,000) with specific information regarding natural and restricted areas, environmental characteristics, coastal and cliff classification and flooding inundation (and climate change related) hazards that Sub-Area 7 is exposed to which include key hazards such as storm surges and potentially tsunami. In terms of coastal erosion, Brandon Beach represents a medium level of loss of beach value. Considering the latest projections of sea level rise (IPCC, 2019) coupled with the smooth slope of this Sub-Area, storm surge events may cause extensive flooding. In this regard, the recreational area behind the beach of Carlisle Bay plays an important role to reduce the potential impacts of flooding.

The Growth Management Framework (PDP, 2017) classifies the north part of this Sub-Area as Urban Corridor and the southern as Community Core.



Figure D.8. Carlisle Bay: view to Radisson and Hilton hotels.

Main issues and strategic objectives

KEY ISSUES	STRATEGIC OBJECTIVES
• Intense urban and port developments. • Hotel facilities on the shoreline. • Shore access. • Pressure to turtles due to diving/snorkelling activities. • Recreational area at Carlisle Bay, with importance for flooding risk reduction. • Potential Marine Park in Carlisle Bay. • Presence of endangered species of sea turtles. • Cultural and historical values as UNESCO sites (Historic Bridgetown and Garrison). • Flooding risks due to storm surge and tsunami that may be highly exacerbated by sea-level rise. • Role of the ports original function to develop and sustain national tourism.	• Enforce setbacks to ensure safety of people and new buildings, preserve environmental values and ensure access to the coast. • Adapt urban areas to climate change. • Ensure coastal development is sympathetic to the remaining areas of environmental importance and where possible soften the urban and industrial setting in terms of landscape quality. • Enhance a network of open spaces including beach access points, views and connections. • Protect, enhance and use the built heritage and environment of the area. • Improve management of the marine area and species. • Improve management of beach activities and uses. • Promote improved Storm Water Management/sewage and solid waste management strategies to limit garbage disposal in watersheds and promotion of adequate treatment of sewage in line with "Roof to Reef principles". • Reinforce of building code for existing and new construction.

Development Planning and Setbacks at Sub-Area scale

Setback recommendations are presented within a collection of maps provided in the sub-section entitled *"Setback maps of Sub-Area 7"*. These recommendations adhere closely to the National Guidance "Development Planning and Setbacks" (see section C3) for Sub-Area 7. This map provides the delineation of setbacks for this Sub-Area at a scale of 1:18000.

This planning related information should be used by public and private actors whom are involved in the management of the coast such as developers, owners and the general public. The setback guidance adopted is defined for four separate setback categories as appropriate, namely cliff, landscape, flood inundation and climate change.

Action brief

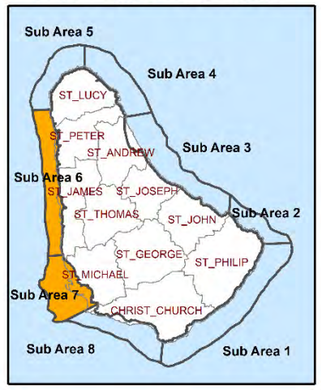
TOPIC	CODE	ACTION	LEAD ACTORS	OTHER ACTORS	TIME SCALE	COMMENTS	KEY POLICY OUTCOME
DRM and CCA	7DRM1	Identify and design mitigation measures for coastal flooding and erosion within the National DRM Plan.	CZMU	TCDPO	Short term, continuous.		Outcome 3 - Climate and disaster risk adaptive capacity is strengthened
Beach Management	7BM1	Verify that Beach Management Plan provisions protect turtle nesting sites.	CZMU				Outcome 2 - Coastal resources are protected and effectively managed
Beach Management	7BM2	Produce a DRM Emergency Plan for beaches articulated with the National DRM Plan and Beach Management Plan.	DEM	TCDPO, NCC			Outcome 3 - Climate and disaster risk adaptive capacity is strengthened
Beach Management	7BM3	Improve facilities and ease of access at popular recreation areas as this area.	NCC				Outcome 2 - Coastal resources are protected and effectively managed
Development Planning and Setbacks	7S1	Enforce Climate Change Setback.	TCDPO	CZMU	Short term, continuous		Outcome 3 - Climate and disaster risk adaptive capacity is strengthened
Coastal Biodiversity	7BIO1	Produce guidelines to improve the management of endangered species as marine turtles.	CZMU, NCC			Avoid feeding turtles to attract turtles for diving tours.	Outcome 2 - Coastal resources are protected and effectively managed
Public Awareness and Stakeholder Participation	7PA1	Identify local stakeholder at community level and private developers in the area.	CZMU				Outcome 6 - Research, understanding and knowledge outreach is increased
Public Awareness and Stakeholder Participation	7PA2	Conduct yearly public meetings to identify new issues in the Sub-Area.	CZMU	All stakeholders in the Sub-Area and key institutions at national level			Outcome 6 - Research, understanding and knowledge outreach is increased
Public Awareness and Stakeholder Participation	7PA3	Raise awareness on shoreline protection.	CZMU	TCDPO	Short term, continuous.		Outcome 6 - Research, understanding and knowledge outreach is increased

Table D.7. Action brief for Sub-Area 7.

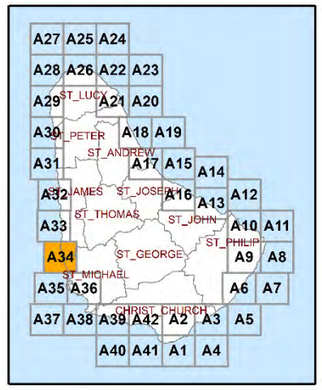
Description maps of Sub-Area 7

SUB AREAS 6, 7 - SHEET A34

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

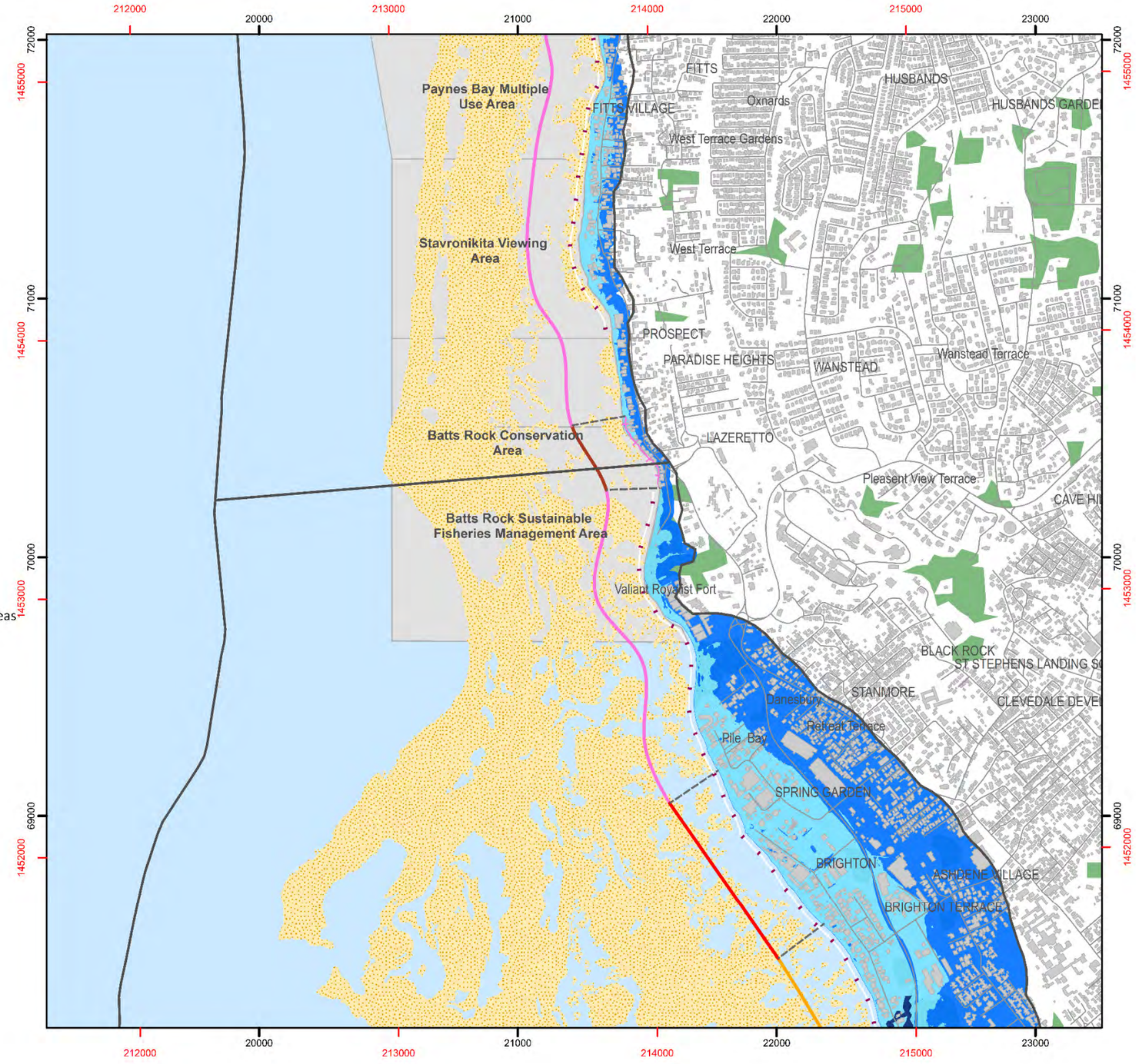
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

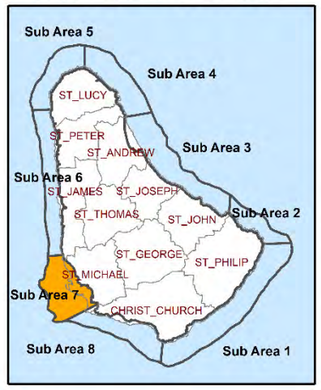
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

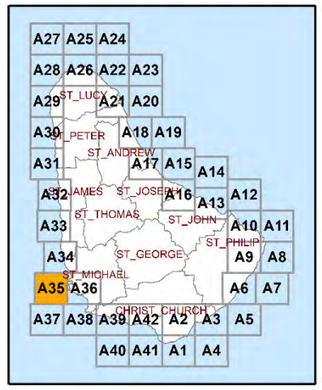


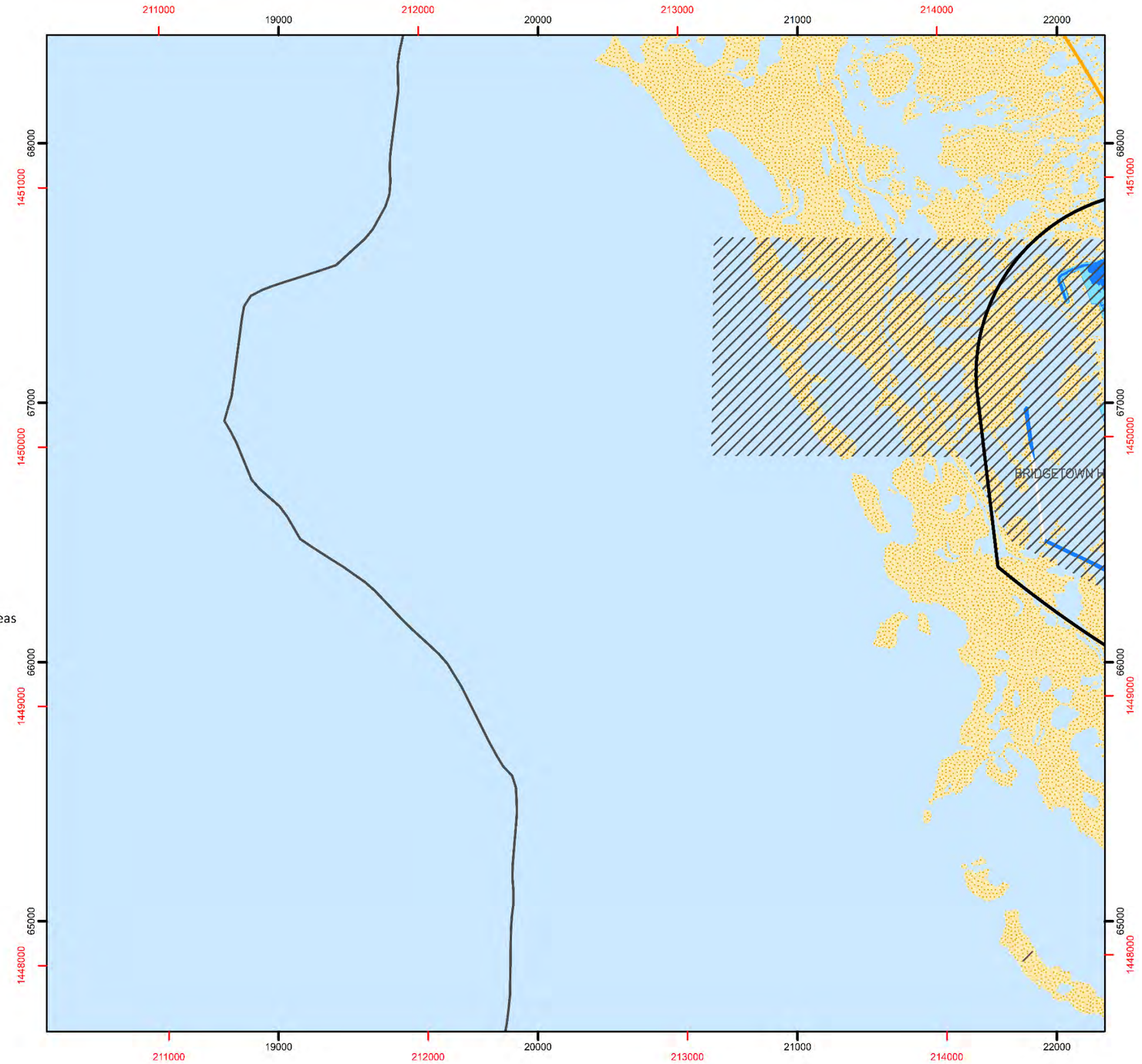
SUB AREA 7 - SHEET A35

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX





Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve
Restricted areas
Planned Marine Areas

Environmental characteristics

Turtle nesting beach
National index beach (OS2)
Coral reefs
Wetlands
Seagrass
Mangroves
Agriculture
Natural vegetation
OS2 Natural heritage areas

Coast and cliff classification

Eroding Coast (Natural)
Accreting Coast (Natural)
Stable Coast (Natural)
Dynamically Stable Coast (Natural)
Coastal Cliff
Eroding Coast (Engineered)
Accreting Coast (Engineered)
Stable Coast (Engineered)
Artificial Coast
Coastal classification division

Cliff failure

Very high
High
Medium
Low *(risk class)*

Flooding hazard

Storm surge 100 years
Storm surge + Sea Level Rise (IPCC 2019)
Tsunami 100 years

N

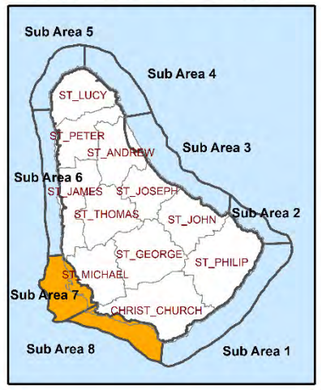
SCALE: 1:18,000

0 125 250 375 500 mts

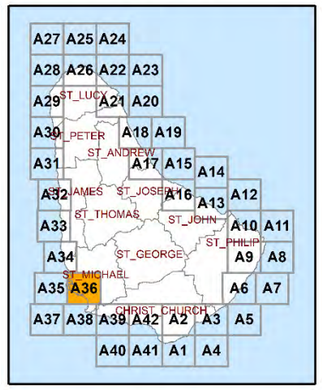
- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

SUB AREAS 7, 8 - SHEET A36

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

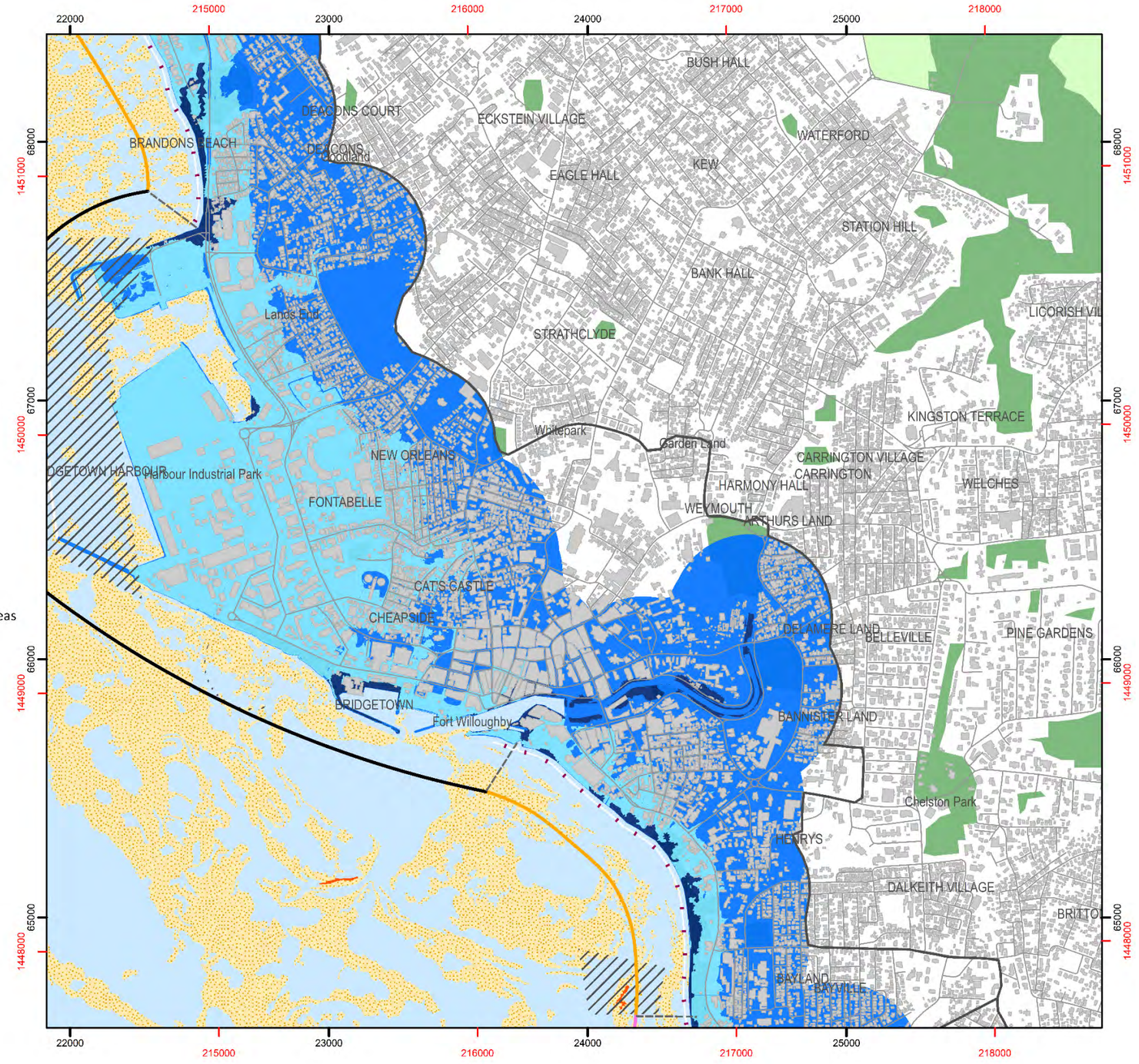
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

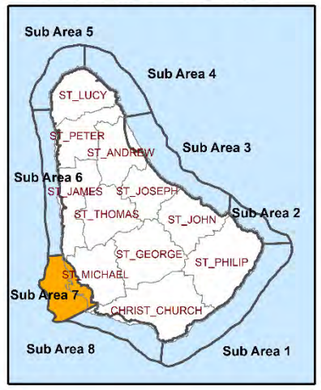
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

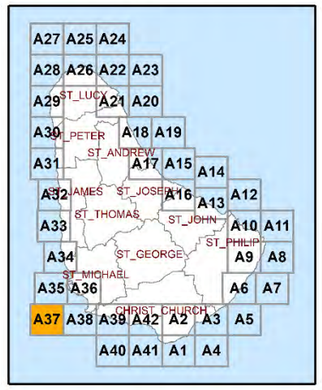


SUB AREA 7 - SHEET A37

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

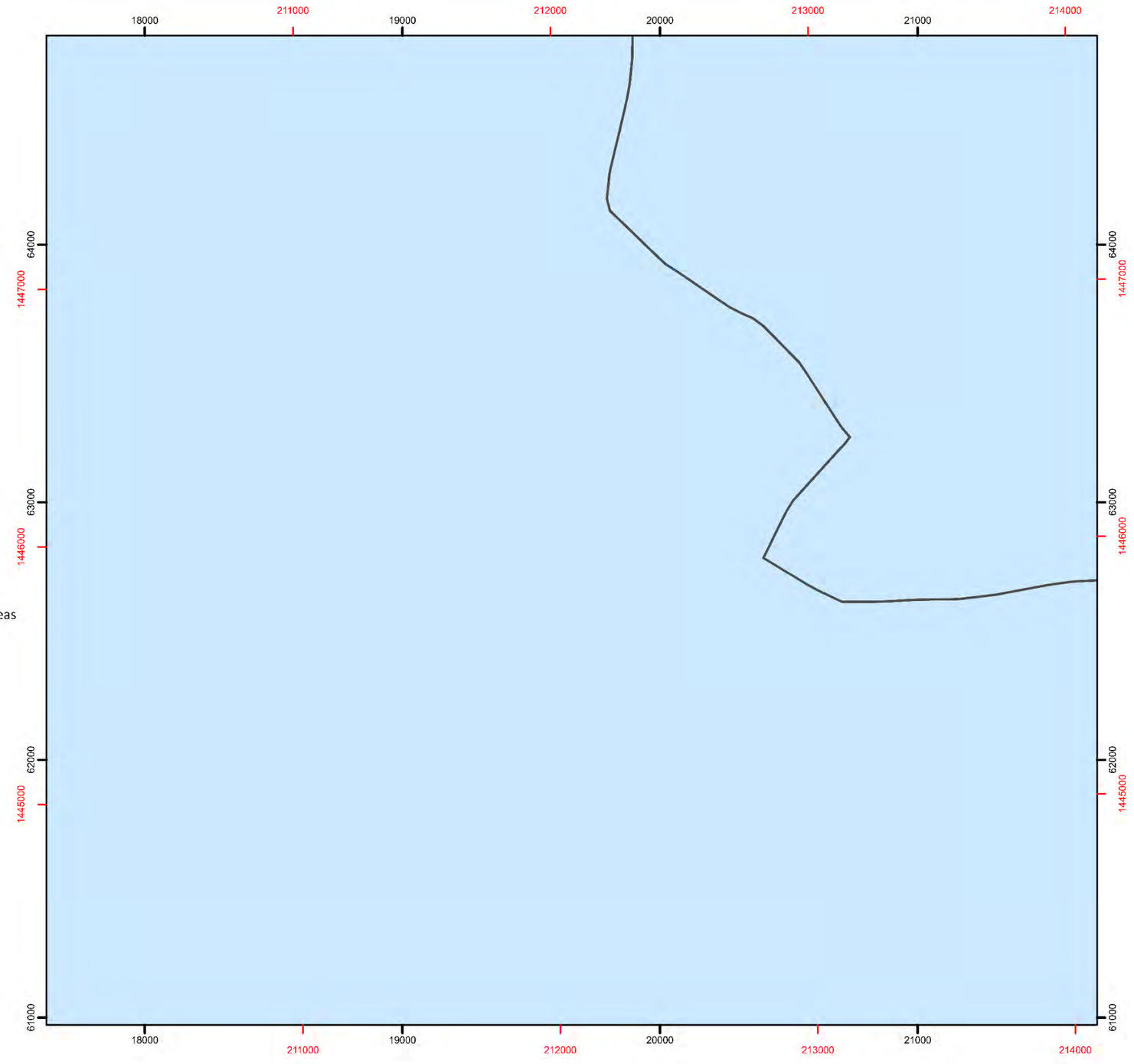
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

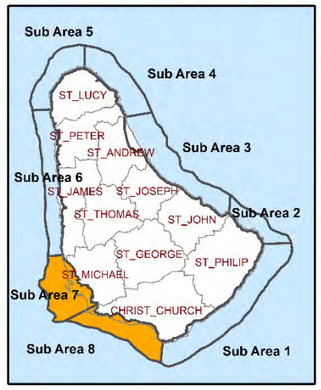
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

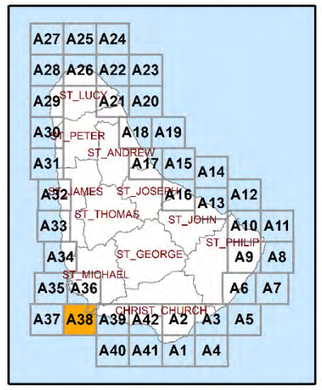


SUB AREAS 7, 8 - SHEET A38

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

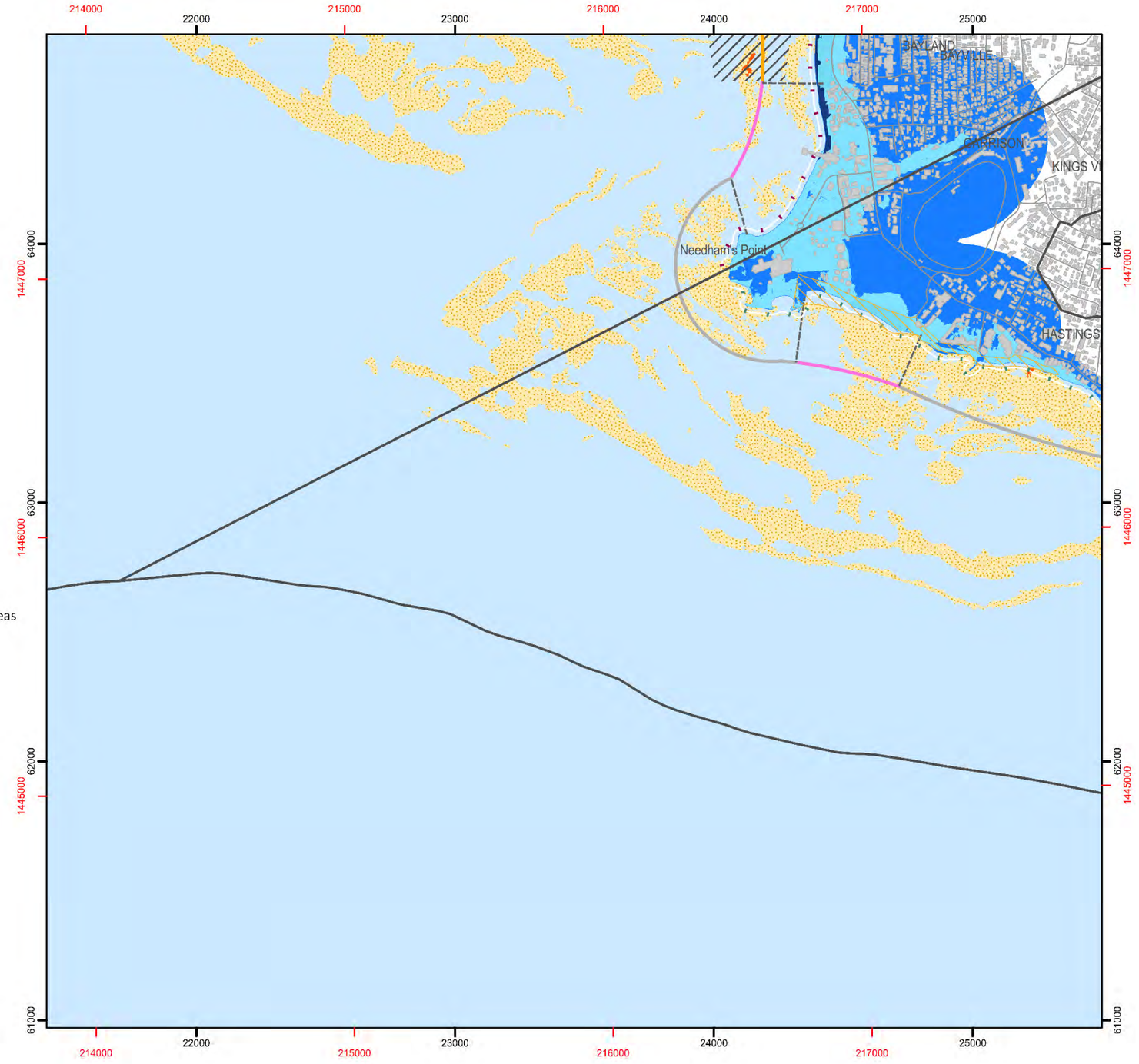
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

0 125 250 375 500 mts

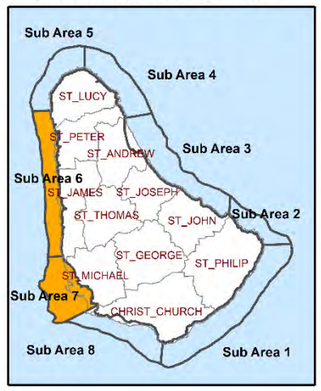
- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum



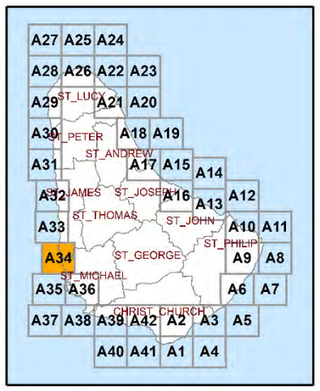
Setback maps of Sub-Area 7

SUB AREAS 6, 7 - SHEET A34

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

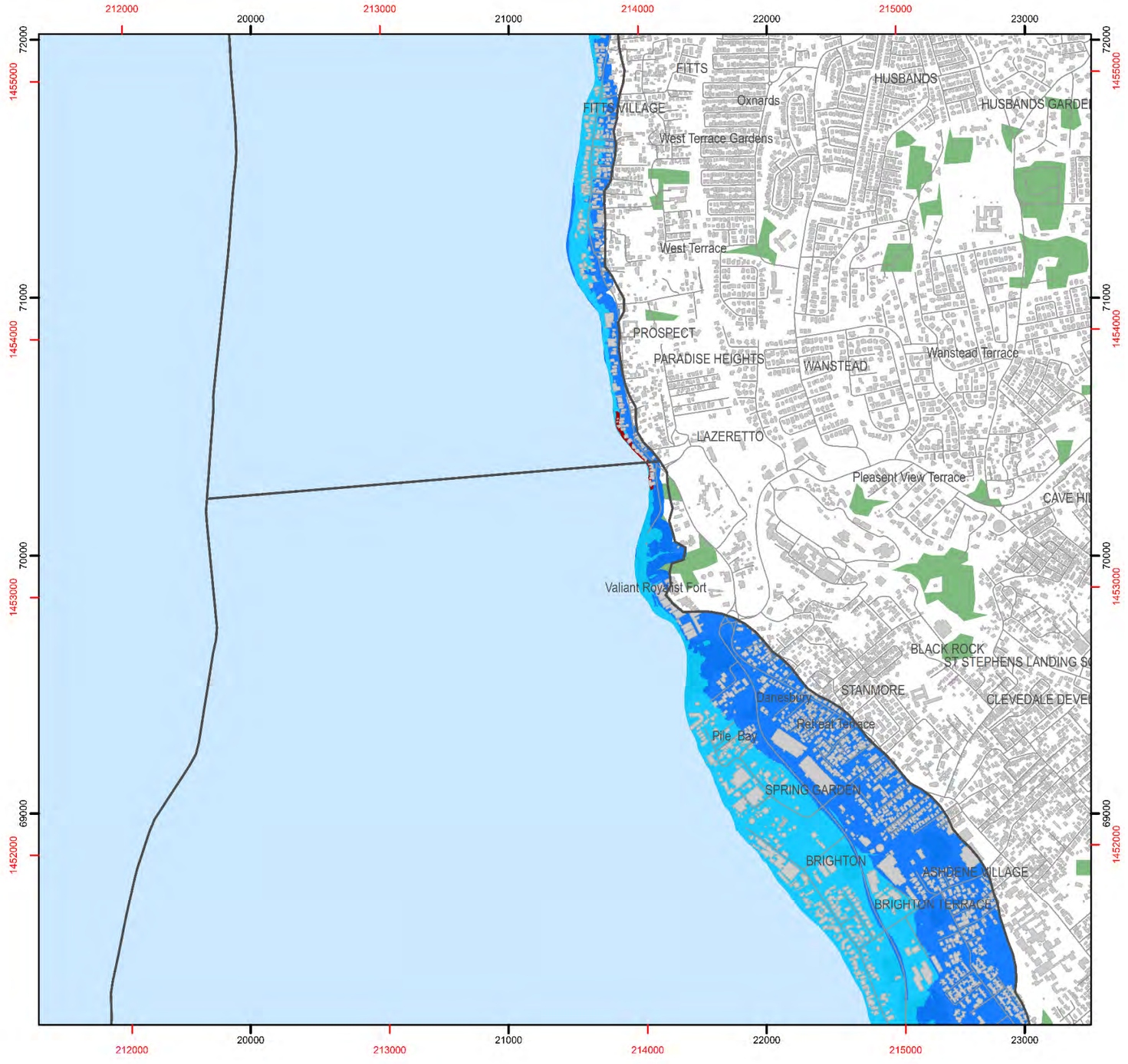
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

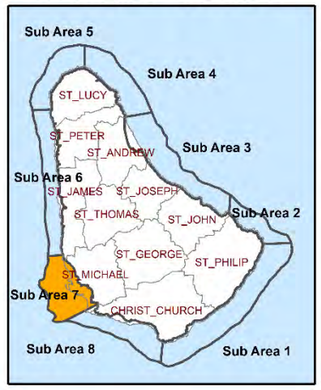
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

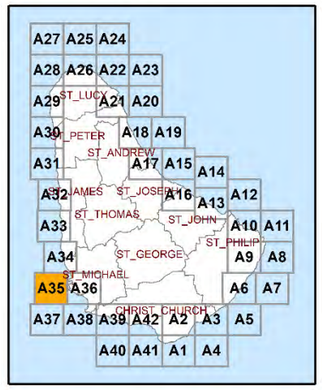


SUB AREA 7 - SHEET A35

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

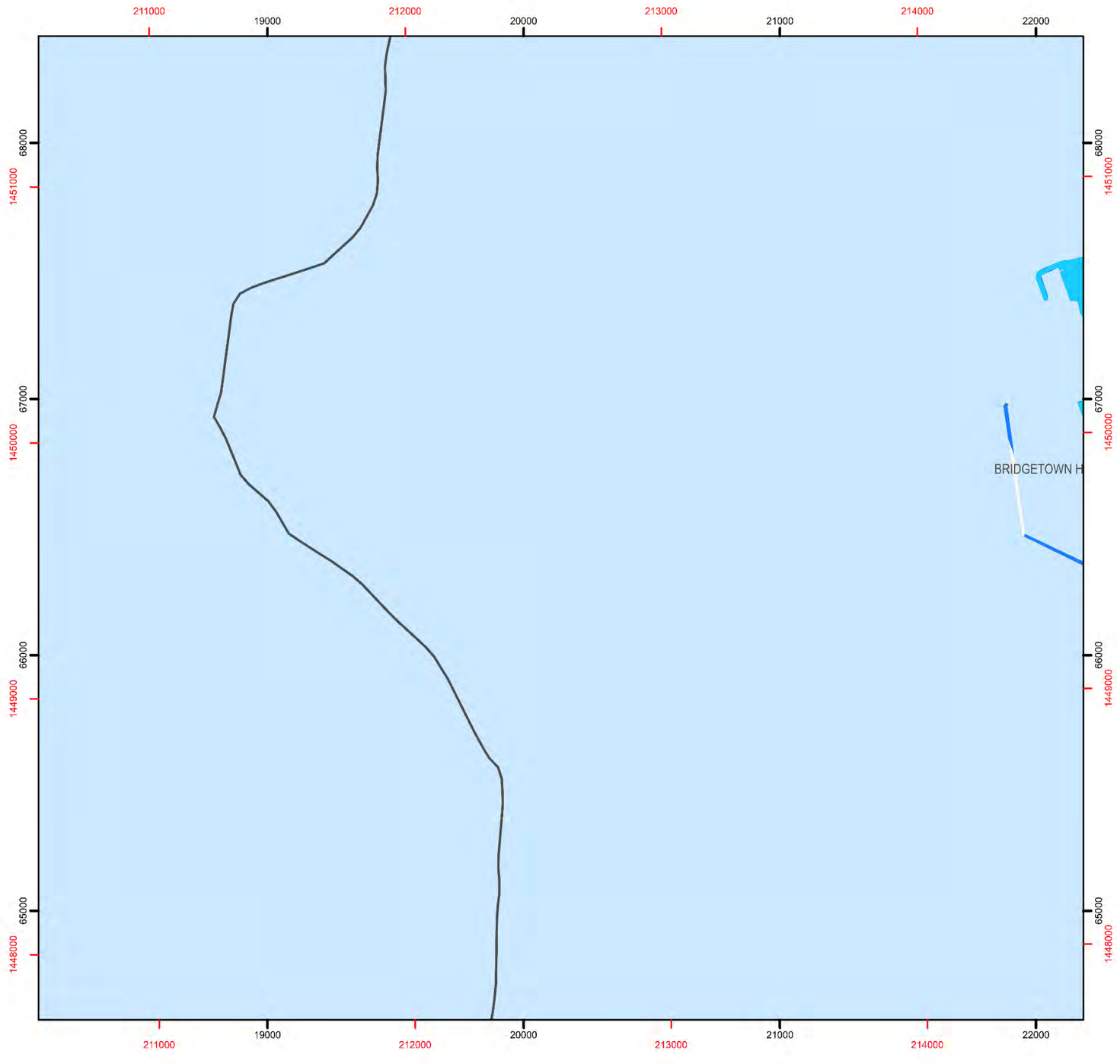
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

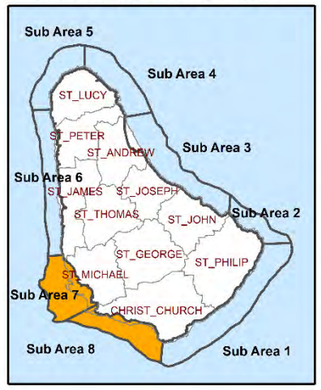
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

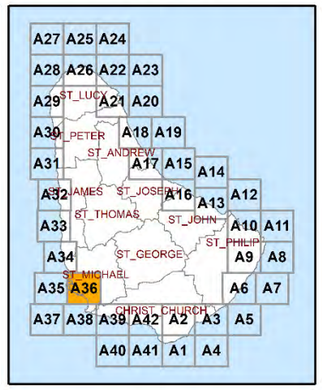


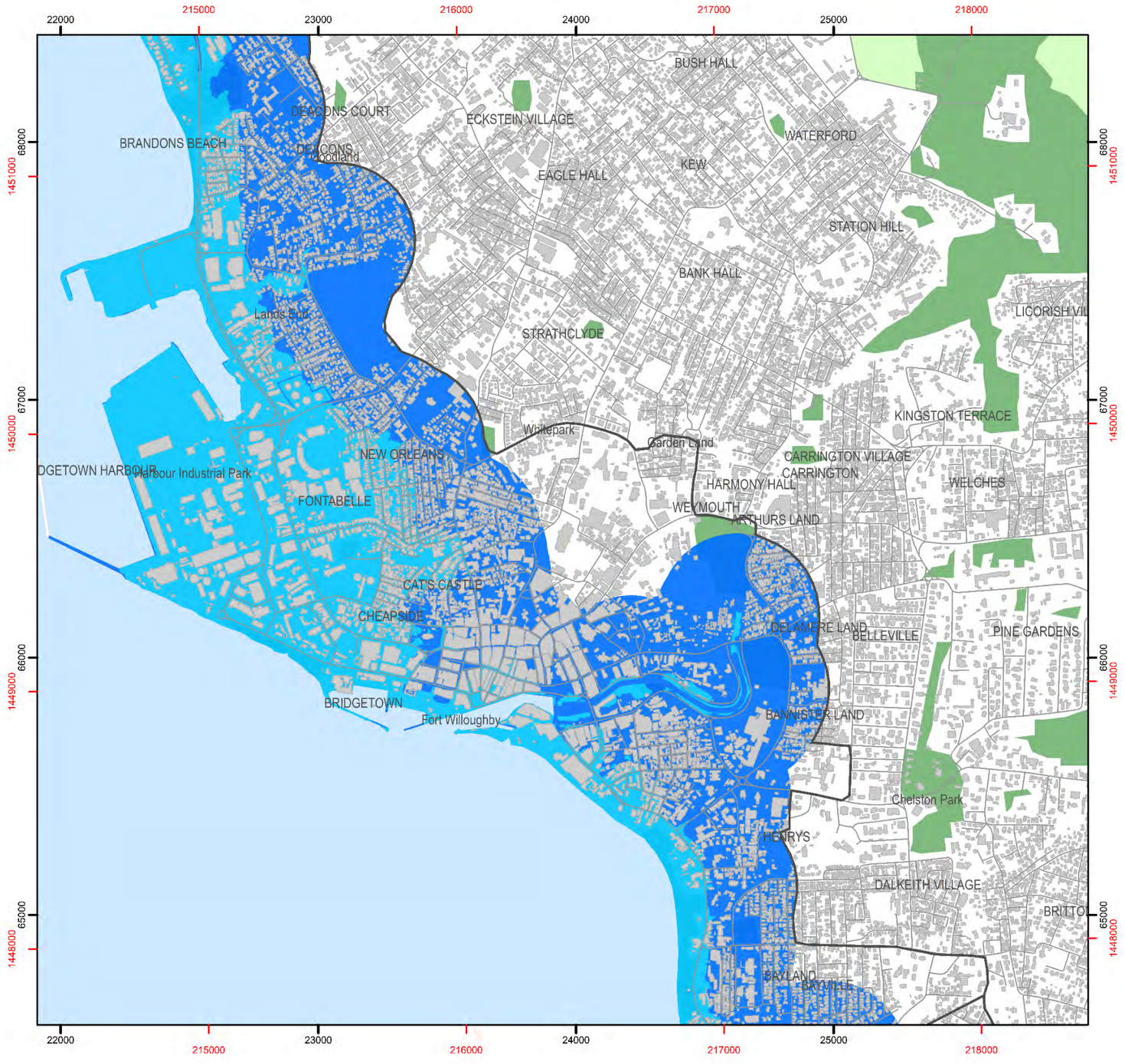
SUB AREAS 7, 8 - SHEET A36

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX





Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

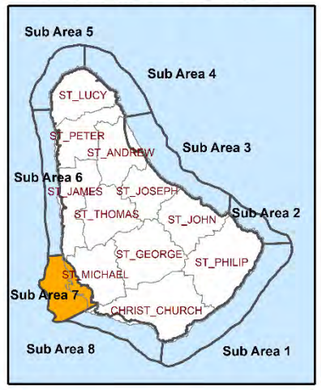
SCALE: 1:18,000

0 125 250 375 500 mts

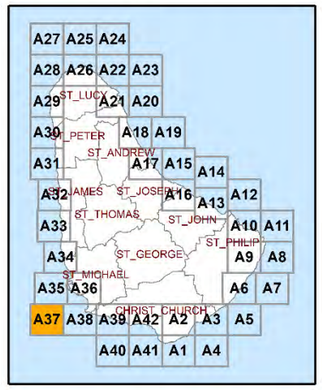
- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

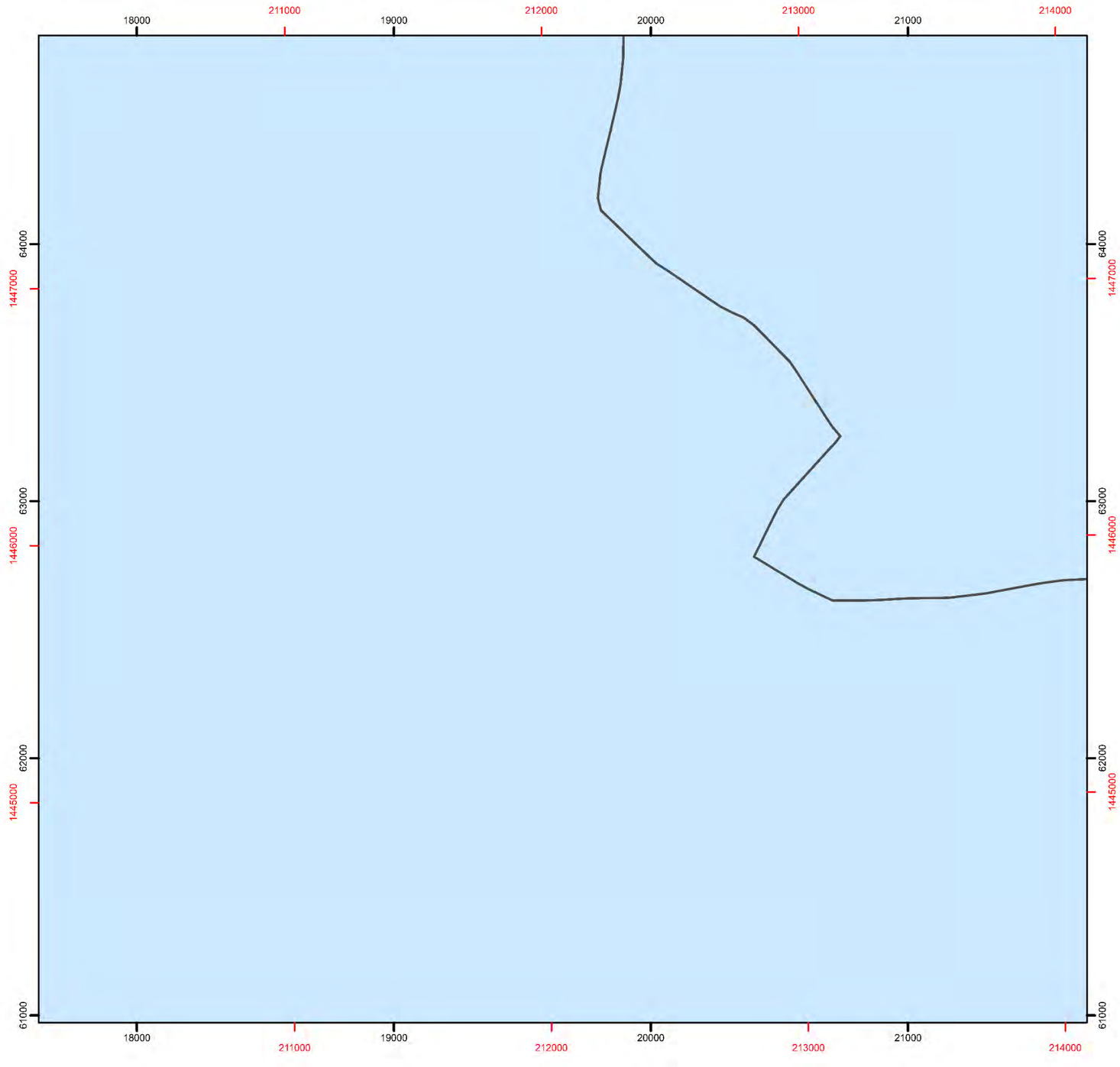
SUB AREA 7 - SHEET A37

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX





Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

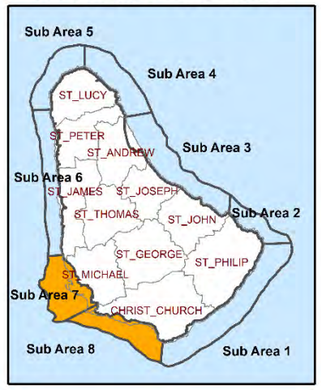
SCALE: 1:18,000

0 125 250 375 500 mts

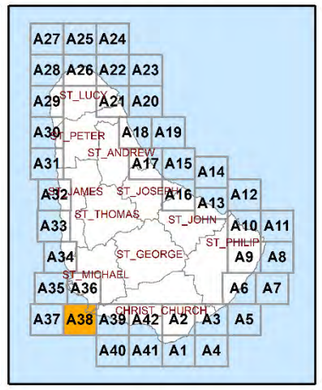
- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

SUB AREAS 7, 8 - SHEET A38

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

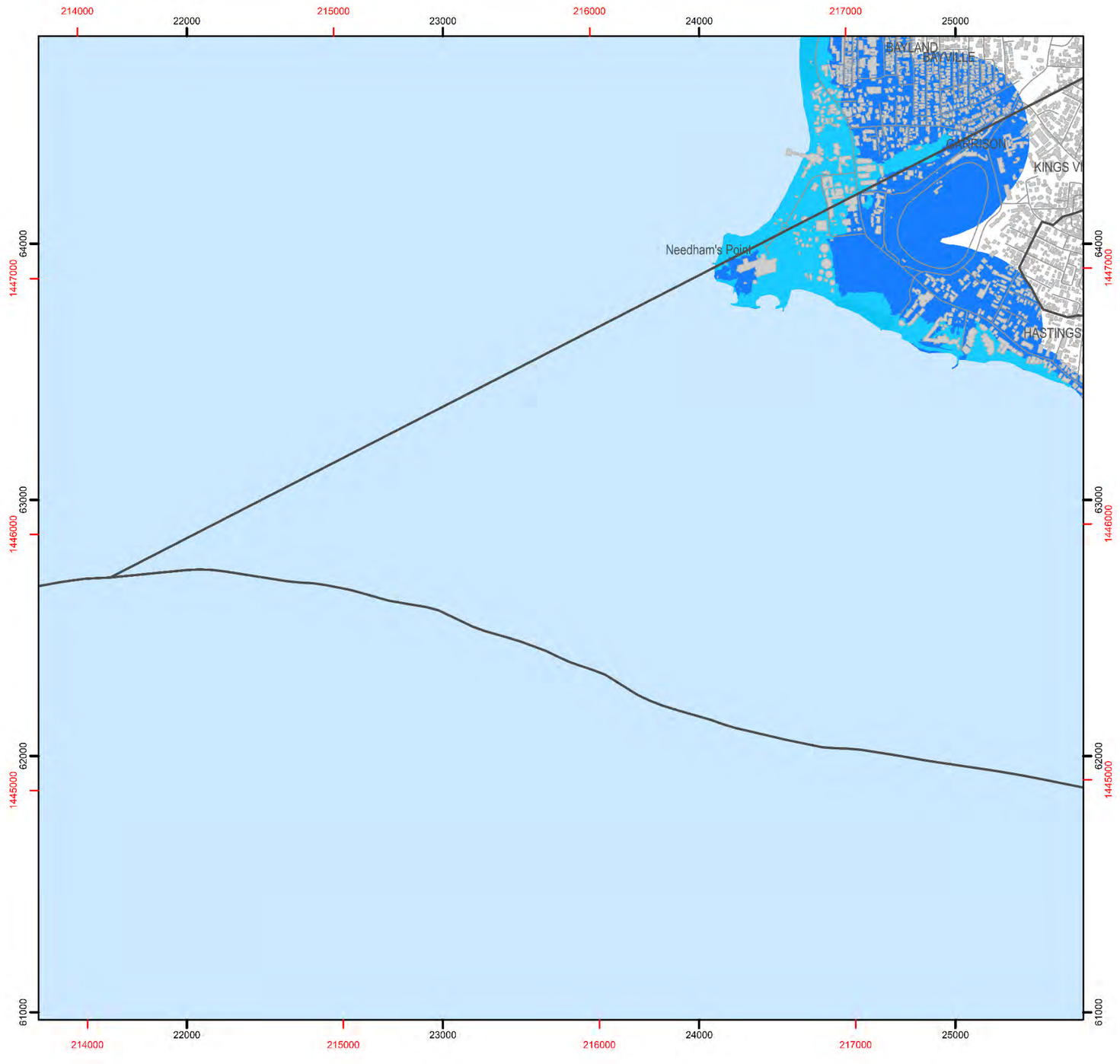
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

0 125 250 375 500 mts

- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum



SUB-AREA 8: NEEDHAM´S POINT TO SOUTH POINT

Main themes

RESIDENTIAL DEVELOPMENT AND LOCAL FISHERIES TO SUPPORT SMALL SCALE TOURISM.
STORM SURGE AND CLIFF COLLAPSE.

Sub-Area description and context

This Sub-Area extends along the south coast of the island and includes the broad sweep of Oistins Bay. It is principally a residential area though with a developing tourism focus. The Growth Management Framework (PDP, 2017) classifies this coastal area as Urban Corridor with a Community Core at Oistins. Oistins has in fact grown from a local fishing village to a regionally significant centre with a fish market complex that has become a growing recreational and tourist attraction. Plans are afoot to reallocate fishing facilities and update urban planning in the area to avoid current conflict among different activities.

Graeme Hall Swamp is present in the Sub-Area and is one of the last remaining coastal wetlands in Barbados comprising an extensive inland swamp, a large beach area, seagrass beds, and an offshore reef complex. It is designated a Natural Heritage Conservation (PDP, 2017), together with the Graeme Hall Beach, sea grass beds and reef ecosystem. The shore is fringed by sandy beaches interspersed with degraded coral cliffs, broadening out into Oistins Bay in the eastern part of this Sub-Area. Most of the beaches occur in conjunction with coast protection structures, typically shore-perpendicular groynes.

Detailed representation at Sub-Area scale is presented in subsection entitled *"Description maps of Sub-Area 8"* that includes a collection of maps at a detailed scale (1:18,000) with specific information regarding natural and restricted areas, environmental characteristics, coastal and cliff classification and flooding inundation (and climate change related) hazards that Sub-Area 8 is exposed to. In this regard, there are medium risk levels in the Sub-Area as a result of storm surge along the coastline which may be further exacerbated by sea-level rise as a consequence of the shallow topographic gradient se along the coast in the area of Needham´s Point. Cliff collapse assessment results indicate high cliff collapse risk at Keizer Hill and Kendal Point.



Figure D.9. Needham´s lighthouse.

Main issues and strategic objectives

KEY ISSUES	STRATEGIC OBJECTIVES
• Existence of valuable ecosystems. • Intense use of beaches. • Potential development of tourism. • Interest in re-developing Oistins area that may pose a threat to the Sub-Areas local character and cultural heritage. • Conflicts between recreational, tourism and fisheries activities. • Flooding risks due to storm surge that may be highly exacerbated by sea-level rise. • Sea turtles use beaches in the Sub-Area for nesting.	• Enforce of setbacks lines protection of wetlands. • Enforce setbacks for climate change adaptation. • Implement the PDP policies in Natural Heritage Areas. • Support and enhance tourism that benefits and embraces local communities, is economically viable and respects local character. • Regulate beach uses considering beach carrying capacity to ensure protection of endangered species especially sea turtles. • Improve facilities and ease of access at popular recreation areas. • Improve water quality. • Promote improved Storm Water Management/sewage and solid waste management strategies to limit garbage disposal in watersheds and promotion of adequate treatment of sewage in line with "Roof to Reef principles". • Ensure an urban design planning with considering the characteristics of existing buildings and with respect to the Natural Heritage Areas.

Development Planning and Setbacks at Sub-Area scale

Setback recommendations are presented within a collection of maps provided in the sub-section entitled *"Setback maps of Sub-Area 8"*. These recommendations adhere closely to the National Guidance "Development Planning and Setbacks" (see section C3) for Sub-Area 8. This map provides the delineation of setbacks for this Sub-Area at a scale of 1:18000.

This planning related information should be used by public and private actors whom are involved in the management of the coast such as developers, owners and the general public. The setback guidance adopted is defined for four separate setback categories as appropriate, namely cliff, landscape, flood inundation and climate change.

Action brief

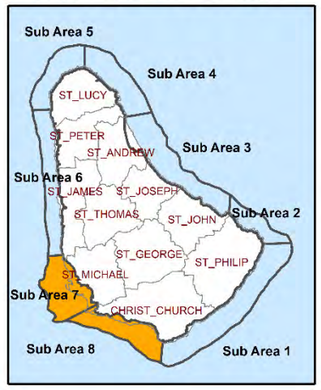
TOPIC	CODE	ACTION	LEAD ACTORS	OTHER ACTORS	TIME SCALE	COMMENTS	KEY POLICY OUTCOME
DRM and CCA	8DRM1	Contribute to and implement a DRM Plan with emphasis in cliff collapse warning and evacuation.	DEM	CZMU		Under the frame of the National DRM Plan, this local plan should include (at least) the provision of warning signpost for pedestrians and swimmers, and evacuation plan in beaches and buildings in case of cliff collapse.	Outcome 3 - Climate and disaster risk adaptive capacity is strengthened
Beach Management	8BM1	Consider carrying capacity, beach erosion estimations and existence of turtle nesting sites in Beach Management Plans.	NCC	Sea-turtle Project	Short term, immediate		Outcome 2 - Coastal resources are protected and effectively managed
Development Planning and Setbacks	8S1	Enforce Climate Change Setback.	TCDPO	CZMU	Short term, continuous		Outcome 3 - Climate and disaster risk adaptive capacity is strengthened
Development Planning and Setbacks	8S2	Prepare and distribute guidelines to enforce cliff collapse Setback in at Keizer Hill and Kendal Point.	TCDPO	CZMU	Medium term, immediate	Guidelines based on GSI.	Outcome 3 - Climate and disaster risk adaptive capacity is strengthened
Development Planning and Setbacks	8S3	Prepare and distribute guidelines to enforce Conservation Setback in Sub-Area 8 for developers and public agencies.	TCDPO	CZMU	Medium term, immediate		Outcome 2 - Coastal resources are protected and effectively managed
Development Planning and Setbacks	8S4	Organize meetings with key stakeholders to raise awareness on coastal resources and sea turtles.	CZMU	TCPDO, NCC, Sea turtle Project	Medium term, immediate		Outcome 1 - Sustainable socioeconomic development is achieved
Development Planning and Setbacks	8S5	Organize bilateral meetings to review existing applications and evaluate environmental impacts.	TCDPO	CZMU, other agencies	Short term, immediate		Outcome 1 - Sustainable socioeconomic development is achieved
Coastal Biodiversity	8BIO1	Organize meetings with Town Planning to ensure that upcoming works respect traditional architecture and cultural character of Oistins village.	CZMU, TCPDO	Fishermen community			Outcome 2 - Coastal resources are protected and effectively managed
Coastal Biodiversity	8BIO2	Organize meetings with Town Planning to address drainage issues behind the Belinda Cox Fish Market and improved beach access issues down to Miami Beach.	CZMU, TCPDO, MTWM				Outcome 2 - Coastal resources are protected and effectively managed
Coastal Biodiversity	8BIO3	Promote active management of mangrove / coastal woodland and beach sites (notably Natural Heritage Conservation Area (OS2) at Drill Hall), which is the most important hawksbill sea turtle nesting beach.	CZMU	NCC, Sea-turtle Project	Short term, immediate	Important "action" to ensure that Drill Hall (already designated as an OS2 site) continues to ensure that sea turtle protection is secured.	Outcome 2 - Coastal resources are protected and effectively managed
Public Awareness and Stakeholder Participation	8PA1	Identify local stakeholder at community level and private developers in the area.	CZMU				Outcome 6 - Research, understanding and knowledge outreach is increased
Public Awareness and Stakeholder Participation	8PA2	Conduct yearly public meetings to identify new issues in the Sub-Area.	CZMU	All stakeholders in the Sub-Area and key institutions at national level			Outcome 6 - Research, understanding and knowledge outreach is increased
Public Awareness and Stakeholder Participation	8PA3	Promote cultural and environmental awareness in this Sub-Area.	CZMU				Outcome 6 - Research, understanding and knowledge outreach is increased

Table D.8. Action brief for Sub-Area.

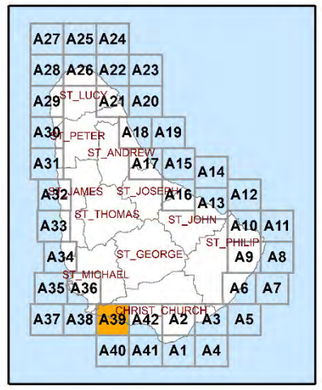
Description maps of Sub-Area 8

SUB AREAS 7, 8 - SHEET A39

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

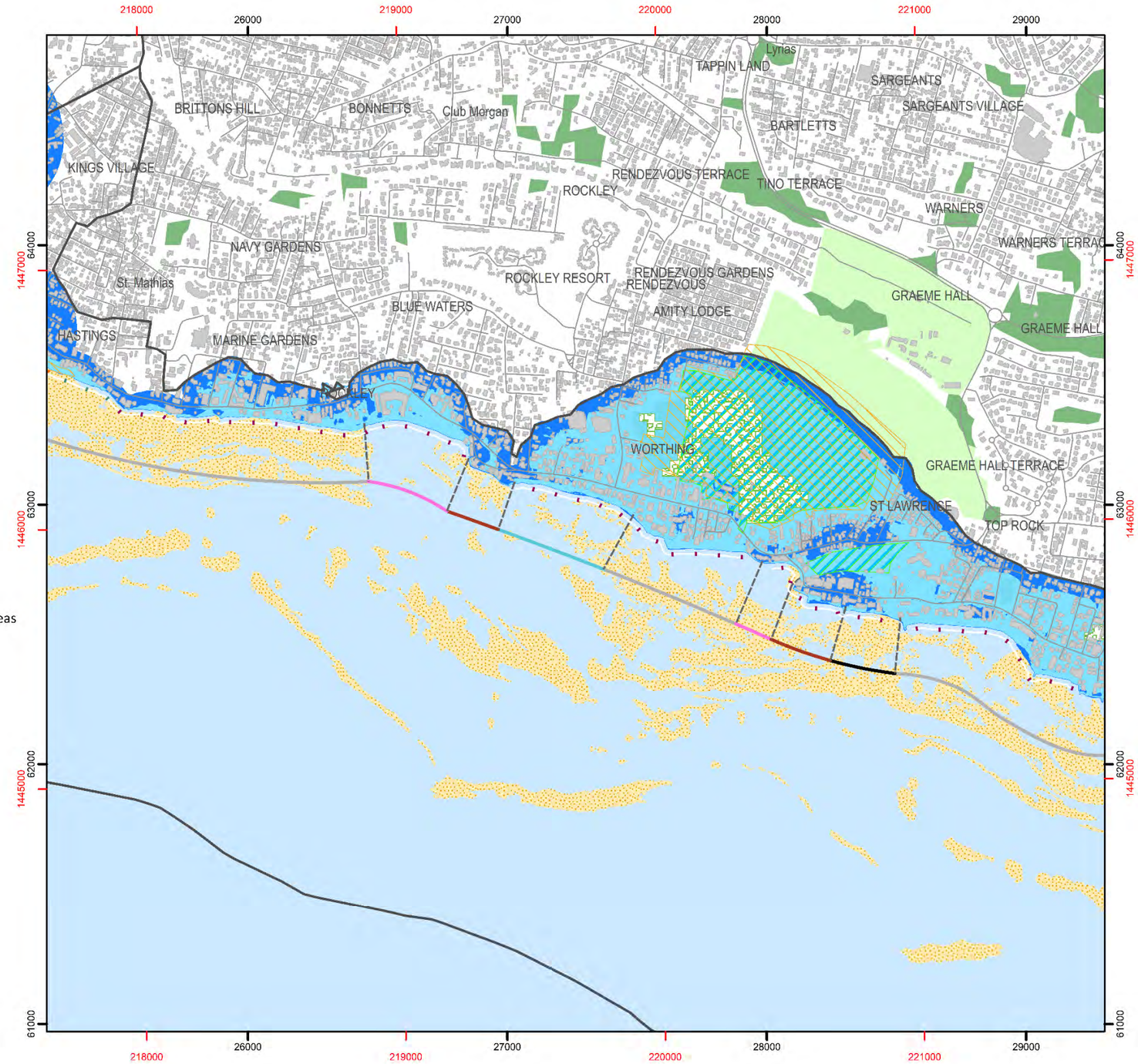
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

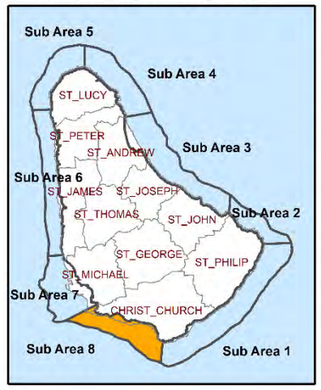
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

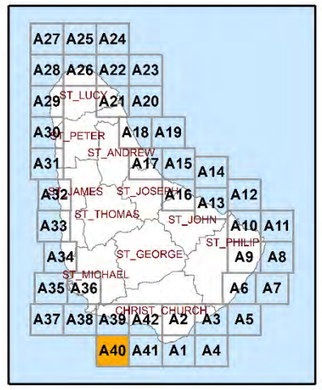


SUB AREA 8 - SHEET A40

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve | Restricted areas | Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

Very high | High | Medium | Low *(risk class)*

Flooding hazard

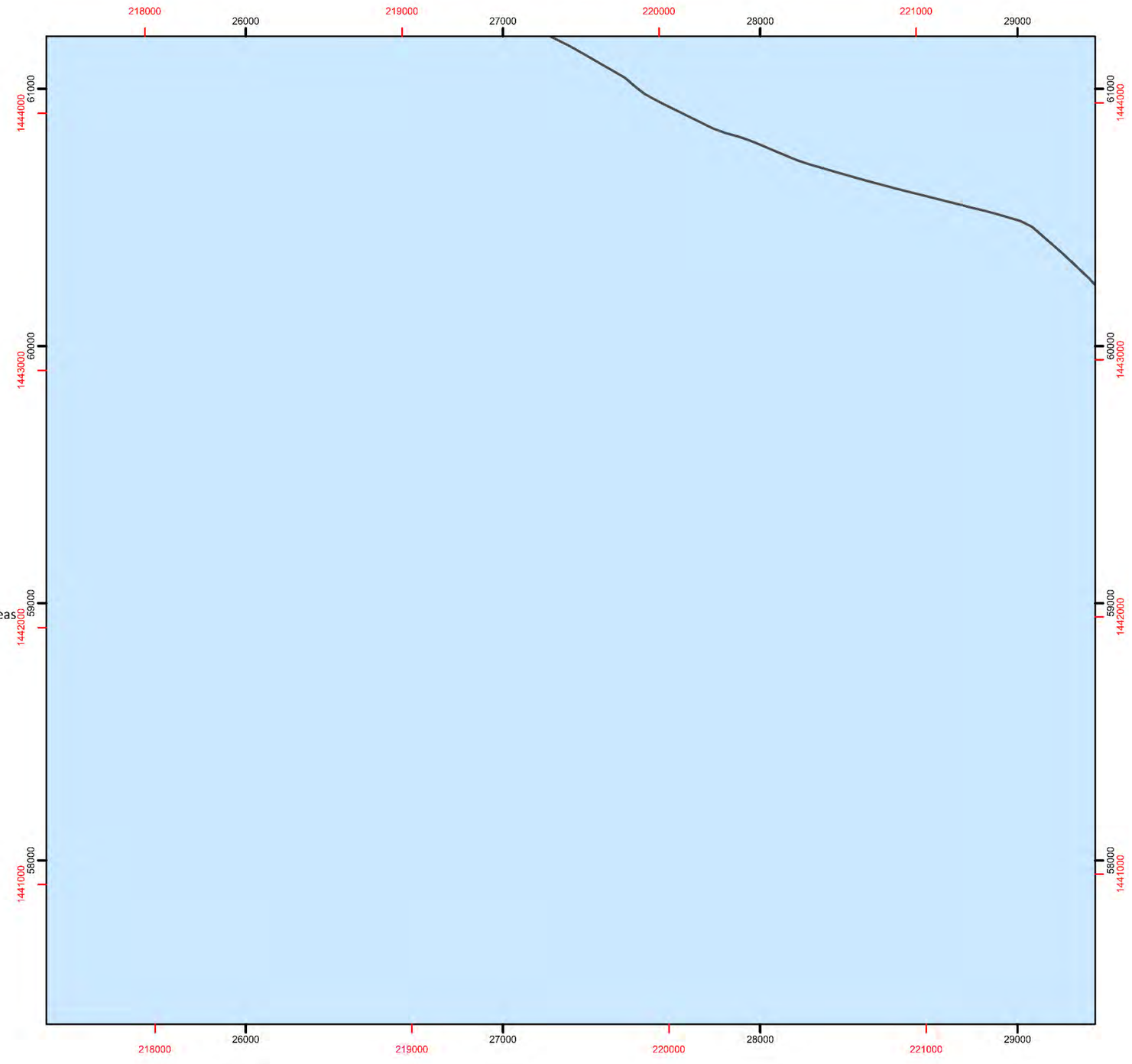
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

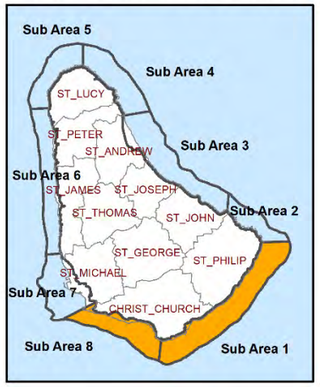
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

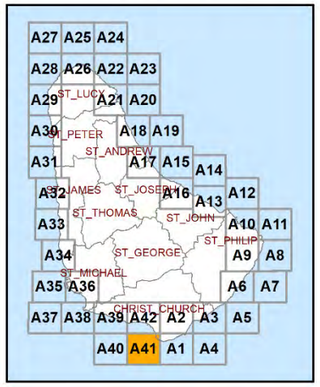


SUB AREAS 8, 1 - SHEET A41

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

Folkstone reserve
Restricted areas
Planned Marine Areas

Environmental characteristics

Turtle nesting beach
National index beach (OS2)
Coral reefs
Wetlands
Seagrass
Mangroves
Agriculture
Natural vegetation
OS2 Natural heritage areas

Coast and cliff classification

Eroding Coast (Natural)
Accreting Coast (Natural)
Stable Coast (Natural)
Dynamically Stable Coast (Natural)
Coastal Cliff
Eroding Coast (Engineered)
Accreting Coast (Engineered)
Stable Coast (Engineered)
Artificial Coast
Coastal classification division

Cliff failure

Very high
High
Medium
Low *(risk class)*

Flooding hazard

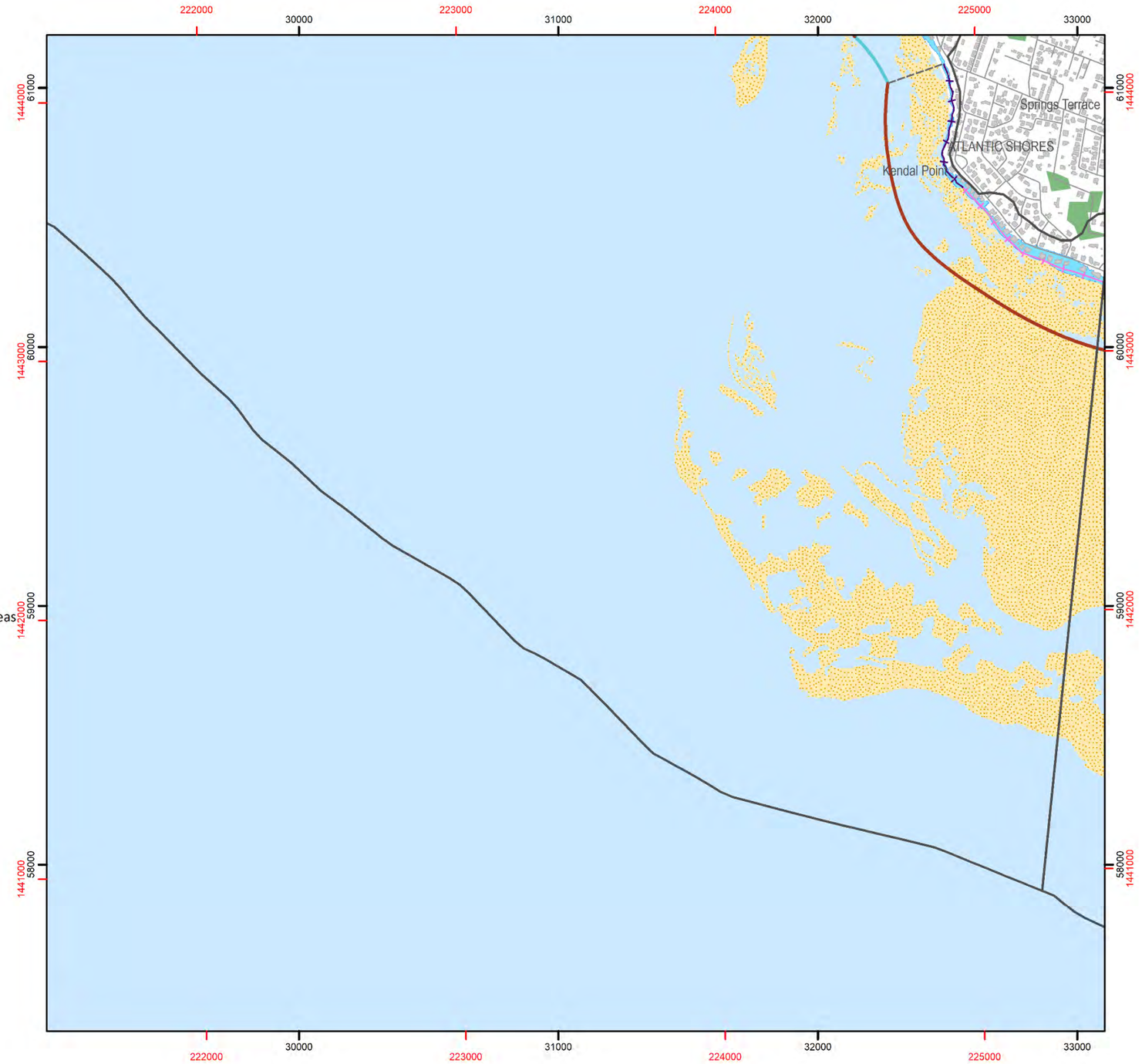
Storm surge 100 years
Storm surge + Sea Level Rise (IPCC 2019)
Tsunami 100 years

N

SCALE: 1:18,000

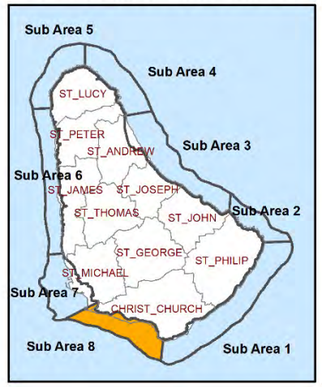
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum

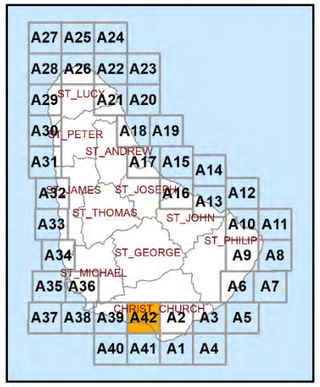


SUB AREA 8 - SHEET A42

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Natural and restricted areas

- Folkstone reserve
- Restricted areas
- Planned Marine Areas

Environmental characteristics

- Turtle nesting beach
- National index beach (OS2)
- Coral reefs
- Wetlands
- Seagrass
- Mangroves
- Agriculture
- Natural vegetation
- OS2 Natural heritage areas

Coast and cliff classification

- Eroding Coast (Natural)
- Accreting Coast (Natural)
- Stable Coast (Natural)
- Dynamically Stable Coast (Natural)
- Coastal Cliff
- Eroding Coast (Engineered)
- Accreting Coast (Engineered)
- Stable Coast (Engineered)
- Artificial Coast
- Coastal classification division

Cliff failure

- Very high
- High
- Medium
- Low *(risk class)*

Flooding hazard

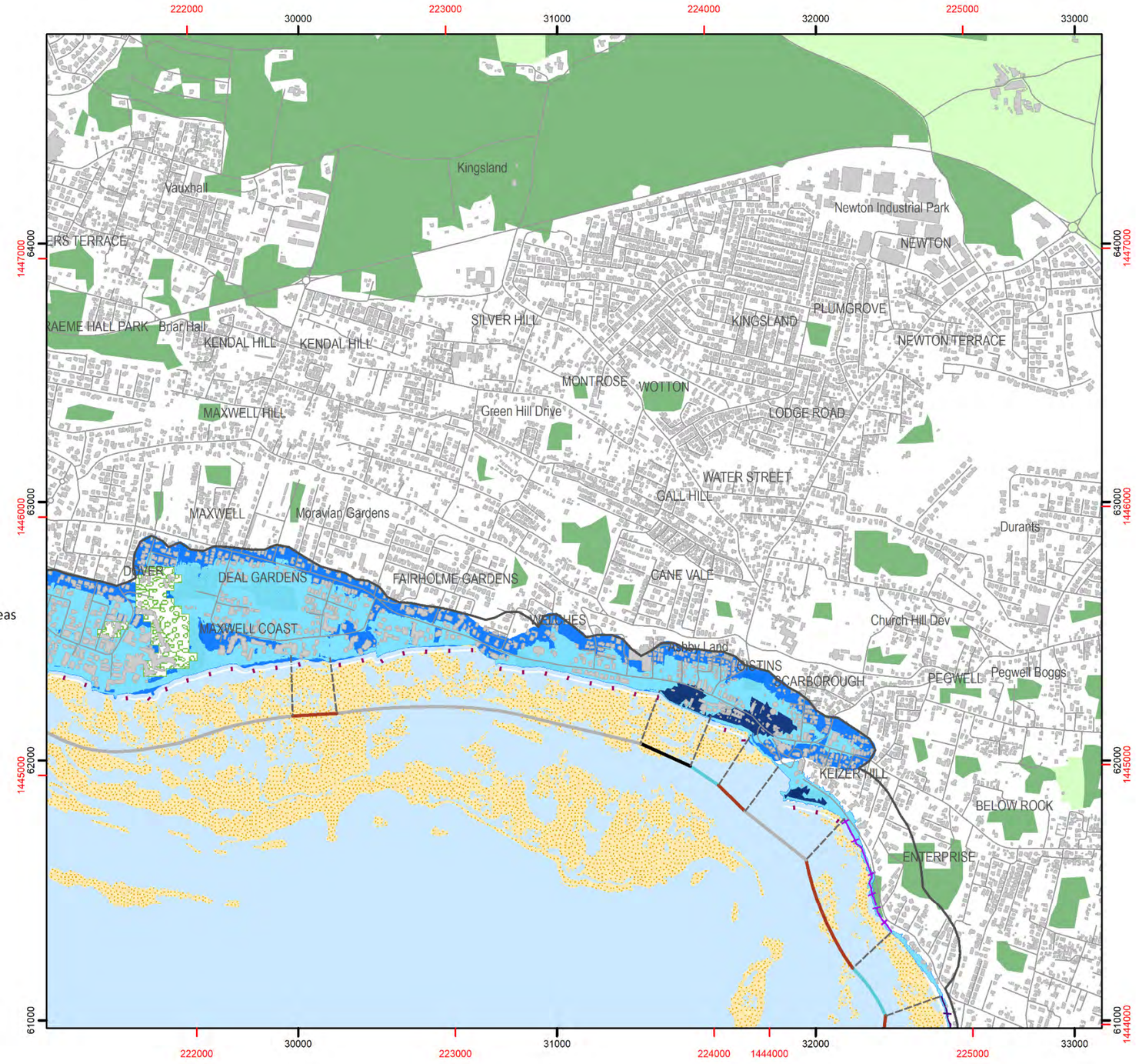
- Storm surge 100 years
- Storm surge + Sea Level Rise (IPCC 2019)
- Tsunami 100 years

N

SCALE: 1:18,000

0 125 250 375 500 mts

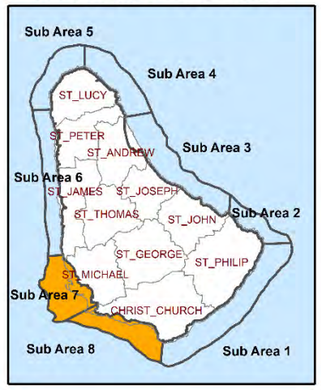
- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum



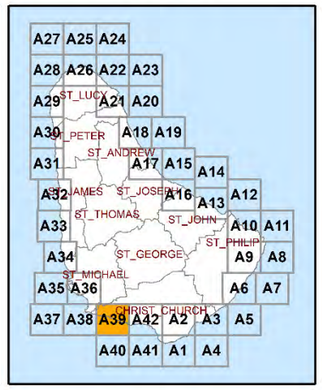
Setback maps of Sub-Area 8

SUB AREAS 7, 8 - SHEET A39

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

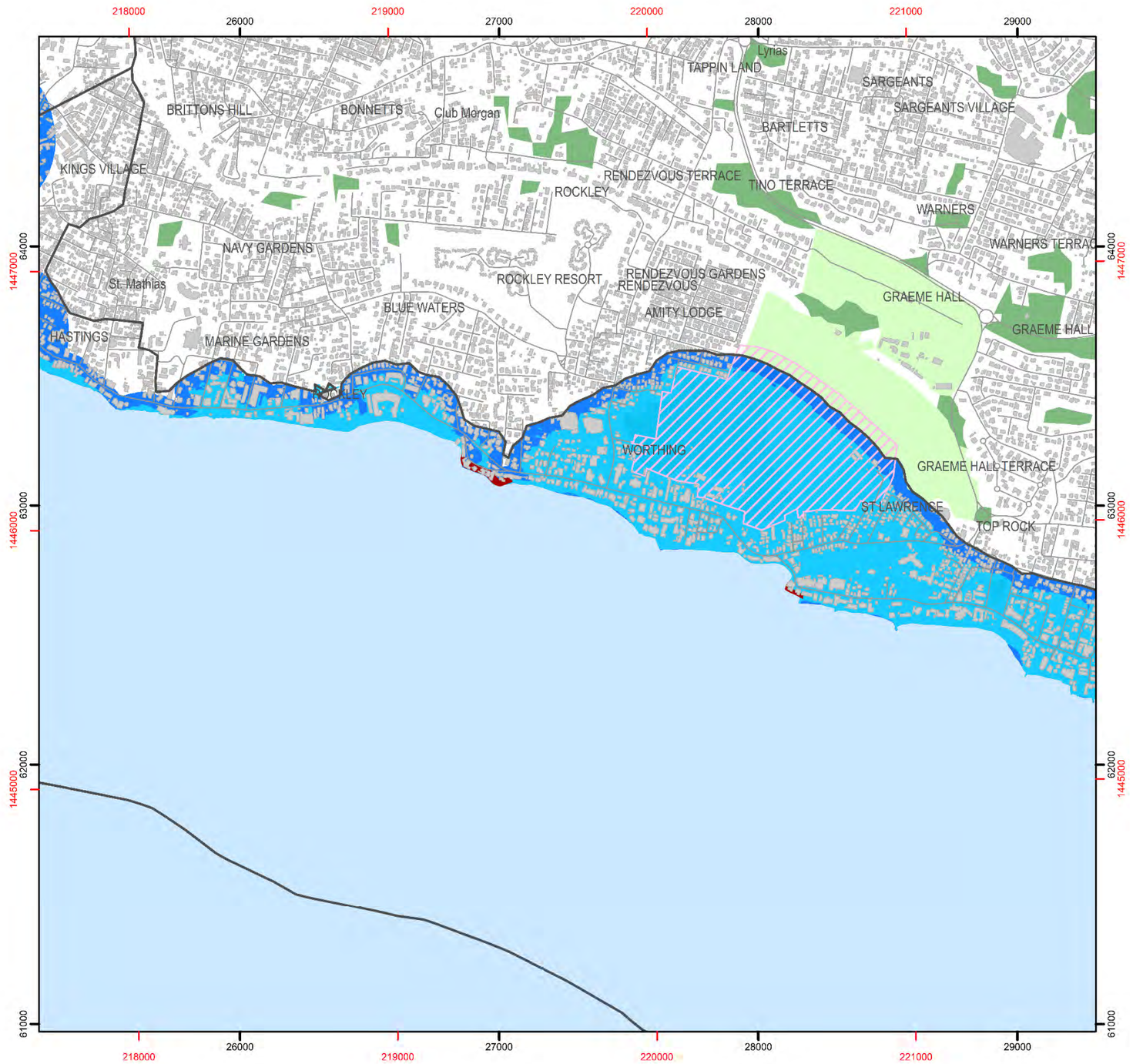
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

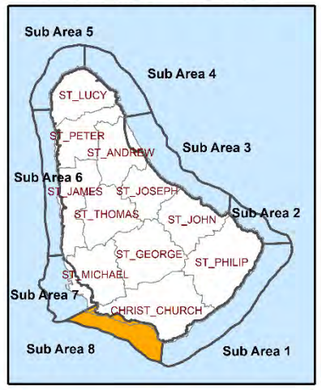
0 125 250 375 500 mts

- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

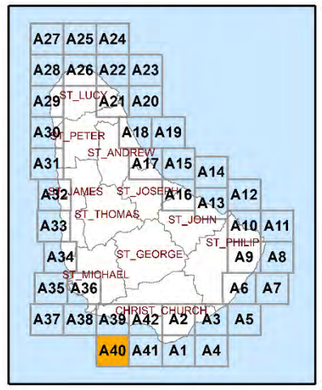


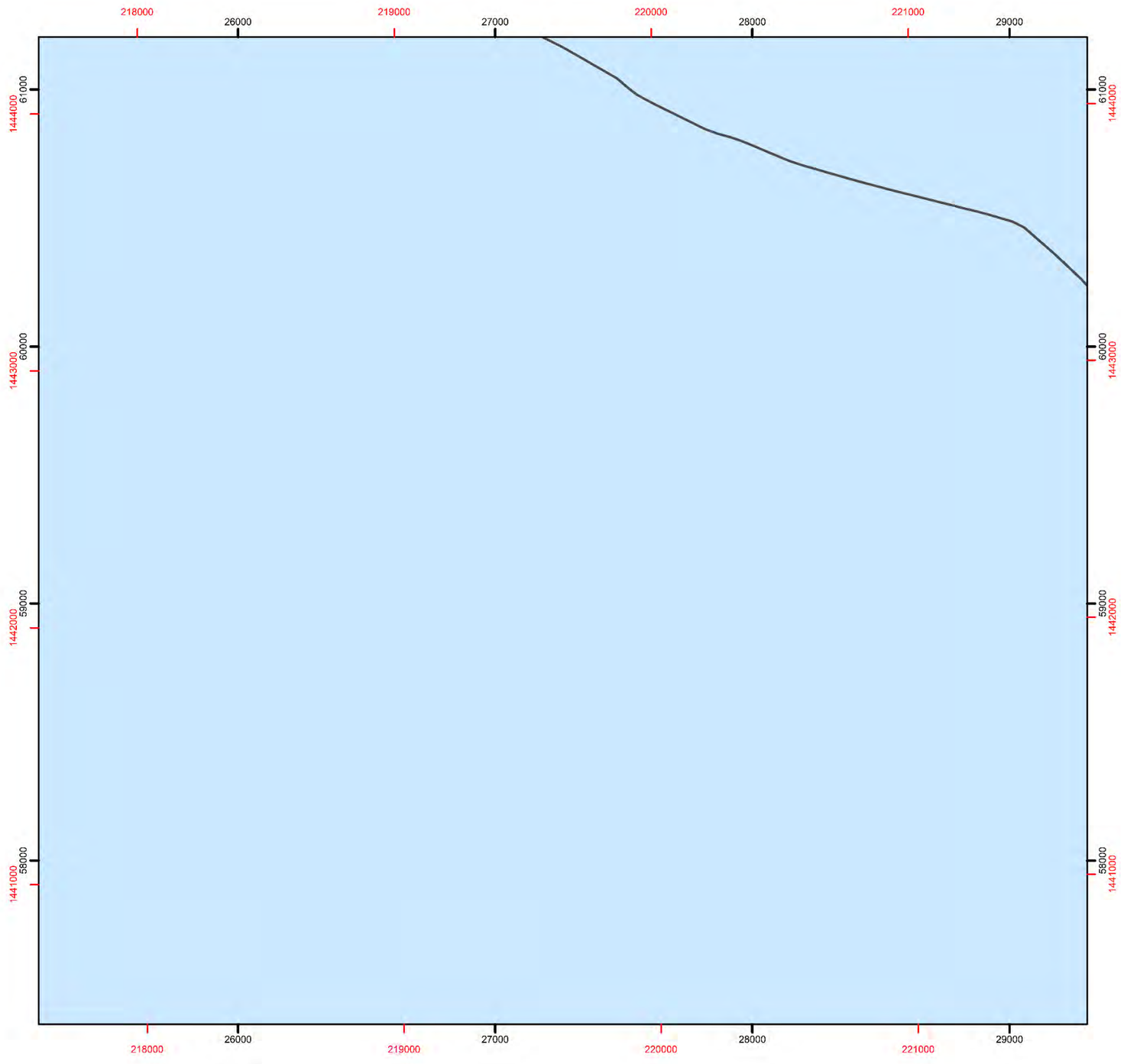
SUB AREA 8 - SHEET A40

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX





Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

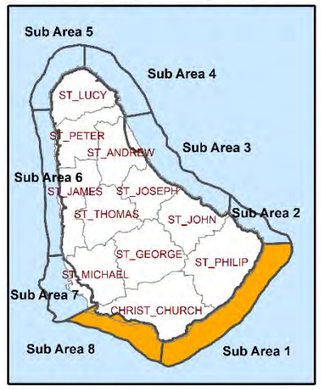
SCALE: 1:18,000

0 125 250 375 500 mts

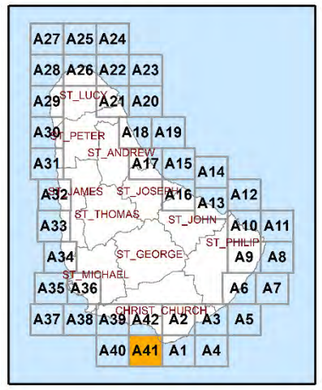
- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

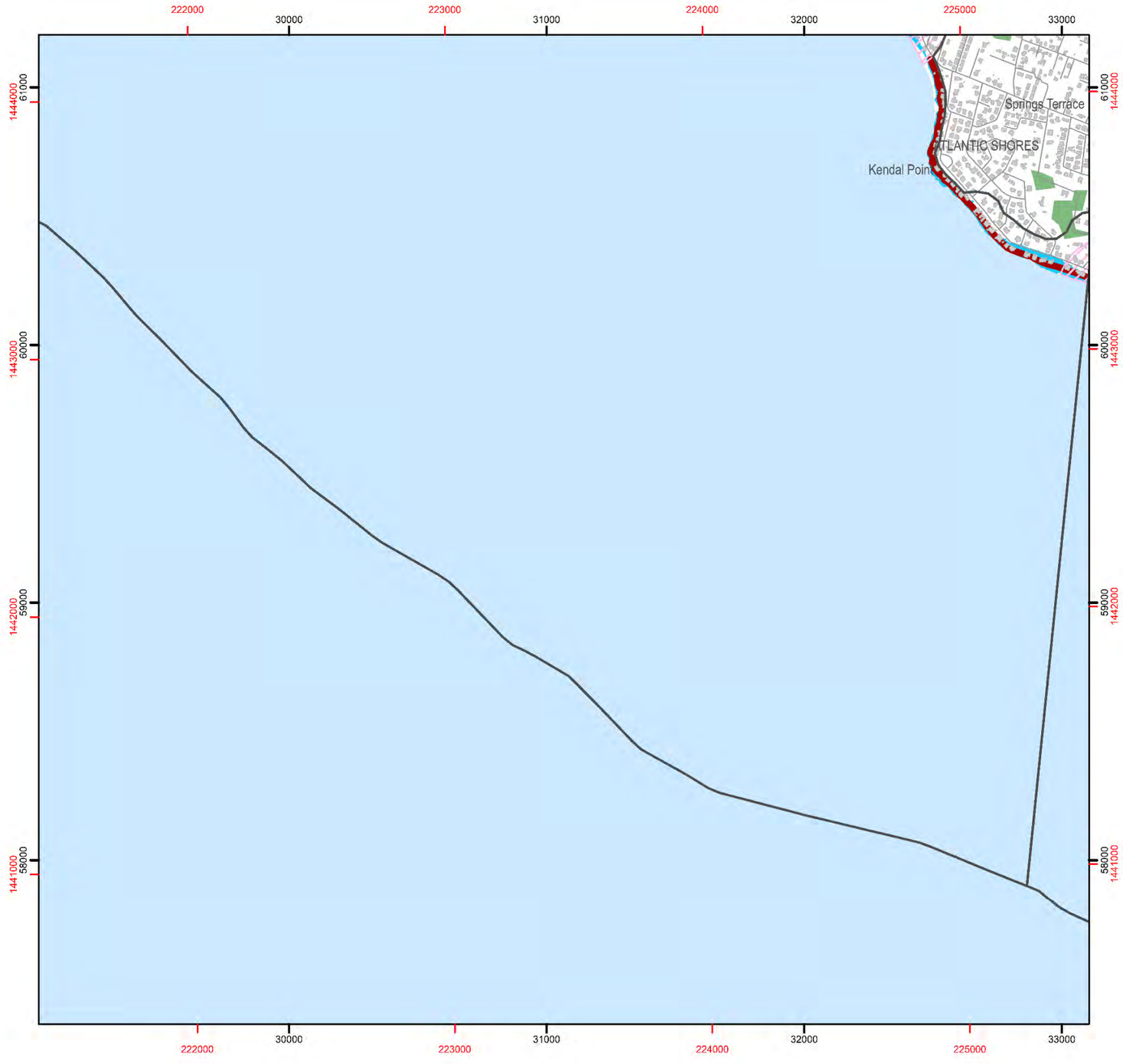
SUB AREAS 8, 1 - SHEET A41

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX





Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

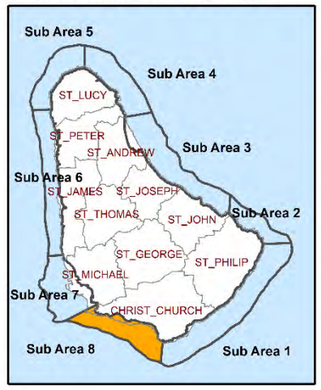
SCALE: 1:18,000

0 125 250 375 500 mts

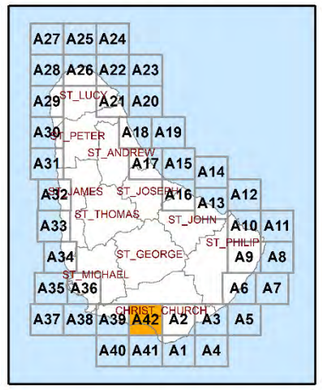
- Coordinate System: Barbados National Grid
  WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red:
  UTM Zone 21, WGS84 datum

SUB AREA 8 - SHEET A42

COASTAL ZONE MANAGEMENT SUB AREAS



MAP INDEX



Coastal Zone Management Area

Flood inundation setback

Climate change adaptation setback

Cliff collapse setback

Landscape setback

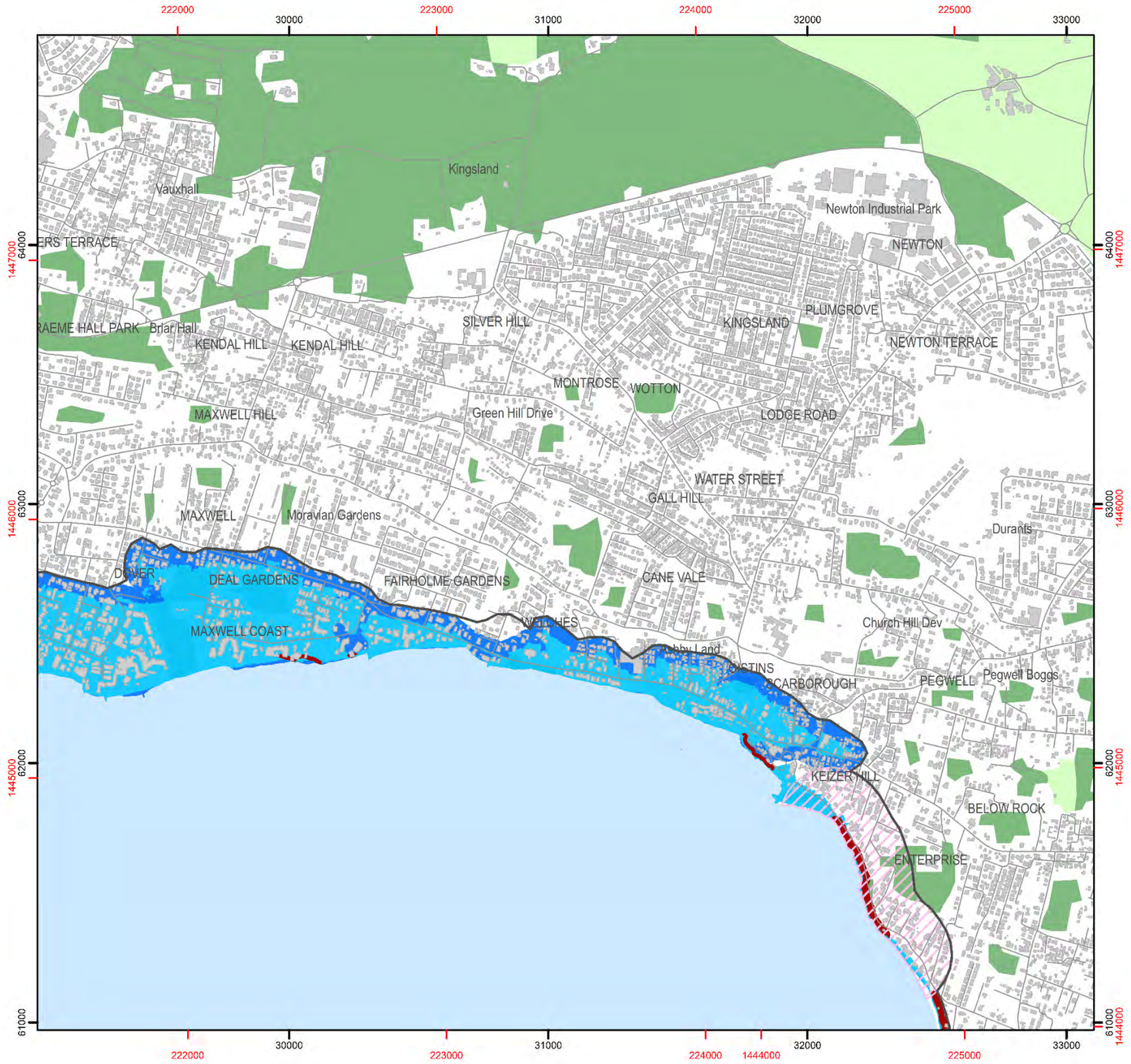
Setback	Description
Minimum 30 m setback	30 m from the HWM
Flooding inundation setback	Variable: flooded area due to storm surge and tsunami (T=100 years), according to NCRIPP hazard assessment.
Climate change adaptation setback	Variable: flooded area considering last IPCC (2019) sea level rise projections.
Cliff collapse setback	Variable: total setback according to Geotechnical Survey Investigation study
Landscape setback	Variable: 100 m from coastline in rural areas, and 200 m from coastline in landscape protection areas, according to the CZMA delimitation criteria

N

SCALE: 1:18,000

0 125 250 375 500 mts

- Coordinate System: Barbados National Grid WKID: 21292, Authority: EPSG
- UTM grid and labels shown in red: UTM Zone 21, WGS84 datum



PART E
IMPLEMENTATION PROCEDURES
(OCTOBER 2021)

PART E: IMPLEMENTATION PROCEDURES

OVERVIEW

Implementation of this ICZM Plan will be a long term and continuous process that involves a range of agencies, institutions and authorities. Some elements require immediate new actions whereas others may be more straightforward to incorporate into the day-to-day operations of the responsible agencies. In certain situations, elements can be built onto existing arrangements or require private individuals and the general public to support implementation. There may also be the need for some new procedures and practices developed over time because of the considerable scope and variety of topics covered by the plan including new emerging issues that may arise.

To assist, the following sections presents the essential requirements for successful ICZM Plan implementation, and from this, recommendations are proposed on how these might be achieved. Discussions surrounding implementation will, however, go beyond this on occasions because of the need to take account of other initiatives, partner priorities, capacities and resources, which will inevitably influence the delivery strategy for the current and future ICZM programme in order to create a favourable climate in which risk resilient ICZM can be advanced. The cross-sectoral nature of many objectives in the Plan will require maximum coordination and collaboration amongst all Government levels and agencies, developers and Barbadian communities alike if the intended outcomes are to be achieved.

Role of the Plan

The ICZM Plan provides a comprehensive set of policies, strategies and standards for the management and conservation of coastal resources mainstreaming DRM and CCA approaches. When approved, the ICZM Plan will have the following functions established:

- provisions for protecting coastal resources, land and seascapes and standards for activities that may affect them;
- provisions to develop plans and strategies to reduce current and future risks from coastal hazards, taking into account the effects of climate change;
- promotion of sustainable land use planning decision making through the provision of standards for ESIA;
- standards for coastal biodiversity and habitat conservation, including standards for managing marine areas and water quality;
- policies, strategies and standards for the development and the maintenance of coastal structures considering CCA principles;
- provisions to deal with emerging issues;
- recognition of the social and cultural values of the coastal zone;
- provisions for public access through and to the beach and other natural areas of the coastal zone;
- coordination of the policies and activities of government and public authorities relating to the coastal zone and facilitation of the integration of their management activities;
- provision for participation for all concerned persons in decision making with respect to coastal management and planning.

E1. ENABLING ACTIONS AND PRIORITIES

E1.1. Enabling Actions

This ICZM Plan has the following set of enabling actions and priorities that are required to create the necessary framework to show how ICZM is to be delivered in line with the administrative, legal and governance mechanisms required. These “Enabling Actions” are vital to make ICZM work in Barbados.

E1.1.1. Need for a Results Based Framework to measure ICZM success

Sustaining momentum for regional coordination, whilst supporting national collaboration to help implement the ICZM Plan, will be secured in the future through the production of a results framework. This is required to help measure the success of all activities identified within this ICZM Plan. The purpose of a results-based framework will be to formalise a regular process of evaluation and reporting on ICZM Plan implementation through a clear “theory of change” approach. This results-based framework and supporting costed action plan shall seek to measure the progress of the GoB towards the ICZM vision, as set out in Part A of this Plan. It shall be reviewed every 10 years, and shall guide the production of regular, high-level reports that serve as a basis to inform and coordinate ongoing national efforts and priorities for the future. Appendix 4 of Volume 1-ICZM Policy Framework (2020-2030) presents draft performance indicator tables that embrace separate Policy Outcomes and Goals.

E1.1.2. Need to coordinate monitoring and reporting in line with Agenda 2030

The development of a regional monitoring system for SDG Reporting, specifically for SDGs 13 and 14[1], will assist with wider regional coordination efforts. This approach, when planned and implemented effectively, can help to support SDG14 indicator monitoring on, for example, “Matters of National Environmental Significance (MNES)”. This in turn will allow for better insights into determining the effects of cumulative pressures and impacts on MNES values and from this, how best to respond to fluctuations in resources available for monitoring.

CZMU will assist in the coordination and communication of SDG14 findings through the preparation of “State of the Coast” Reports. Appendix 4.5 of Volume 1-ICZM Policy Framework (2020-2030) presents indicator data collection tables to support production of a “State of the Coast” report. Indicative samples, taken from similar approaches adopted within the Cook Islands where summary “health cards” have been used, clearly demonstrate what could be produced to convey coastal condition change over time (see Figure E.1).

[1] Under the Responsibility of MMABE

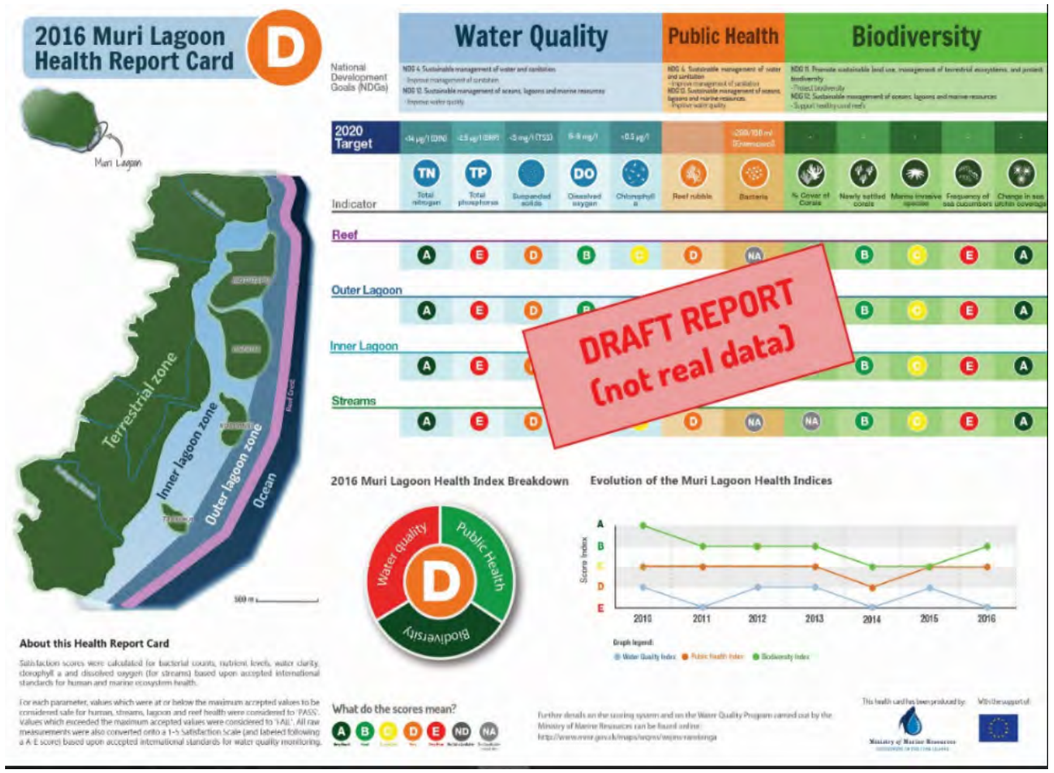


Figure E.1: Sample Style of Health Card adopted for Muri lagoon, Cook Islands (source AECOM 2018)2

E1.1.3. Implementation guidance to support ICZM principle delivery

The principles set within this ICZM Plan (see Part A) help to guide all that needs to be undertaken towards achieving the defined ICZM vision and to ensure national alignment to different sector strategies and plans. New guidance on the implementation of these principles is now required to ensure that national delivery of ICZM is aligned to national priorities.

E1.1.4. Ensure sustainable institutional capacity for ICZM delivery

In the short term, the greatest challenge facing ICZM in Barbados continues to be the allocation of scarce resources to help support implementation. The role of CZMU remains pivotal here to help support this process through improved national support, coordination and internal capacity related professional development. Issues surrounding this aspect, including required institutional strengthening capacity requirements, are considered in more detail within Section E5.

E1.2. Action Priorities

Based on the above Enabling Actions (Section E1.1), a number of "Action Priorities" are set out which are now aligned to the ICZM Policy Outcomes (see Figure E.1) and the more detailed action briefs outlined in Parts C and D (see Figure E.2). Action prioritization is based on a review of those actions that were nationally pressing and necessary with those that could be easily achieved in order to maintain momentum for effective risk resilient ICZM delivery.

Priorities are aligned to the ICZM Roadmap timelines set out in section E2 as being short (2020 – 2022) medium (2023 – 2026) and long term (2027 – 2030). The specific focus of each Action Priority is set out as follows:

- Priority 1: The need to improve the collaboration between sectors, institutions and stakeholders to better enable and support this ICZM Plan.
- Priority 2: The capacity for continuity and sustaining human resource training and capacity building to deliver the vision and objectives set within this ICZM Plan, the needs of the Government and regional and international agreements.
- Priority 3: Demonstrated commitment towards the implementation of regional and international agreements that seek to incorporate a range of instruments that help towards mainstreaming ICZM, adaptation to climate change and disaster risk management in tandem with future wishes for creating a framework for ocean governance into national sustainable development commitments (SDG14) and those of the climate change agenda.
- Priority 4: Improved awareness for all aspects of society from the highest level of government to local communities on ICZM related issues using a range of communication tools and techniques.

These four priority headers are articulated below to present the main areas of overarching support required. Reference to ICZM Policy Outcomes, as defined within Volume 1 – Policy Framework, are set out in Figure E2.

PRIORITY 1: COLLABORATION

A "Ridge to Reef" (Islands Systems Management) approach is essential in Barbados[3] to ensure that activities on land do not adversely impact upon the marine environment. To this end, specific guidance will be produced to help individual sectors to embody the 11 principles set out within Volume 1- ICZM Policy Framework (2020-2030) in a manner that will facilitate incorporation into government operations with minimal impact.

In order to create the necessary platform for future collaboration, all physical development applications will be coordinated through the planning section of the Prime Minister's Office or the TCDPO. Activities shall include consensus on the design of ESIA terms of reference to ensure that all future development proposals that fall within the defined CZMA, undertake the necessary studies to provide the evidence base for appropriate decision making that supports the ICZM Plan. Decisions made shall be collaborative amongst relevant organisations, adhering to new or existing operational guidance manuals or advisories that may need to be produced to support all sectors and individual agency expectations.

[2] Interdisciplinary Assessment of the Muri Lagoon Final Report Consolidating the Sanitation Development Upgrade for the Cook Islands Government (January 2018), AECOM.

[3] This term encapsulates similar terms being used in Barbados such as "Roof to Reef" etc.

It is the intention of the CZMU to formalise, in a collaborative manner, the annual review of coastal environmental health as defined within this ICZM Plan to ensure continued performance and delivery of ICZM Policy Framework expectations in a collaborative manner. This includes the development of clear actions, for various organisations, that shall help to provide the necessary updated information on regional and international commitments that Barbados are signatories to plus sectoral analyses to help in the production of an "State of the Coast" Report for Barbados.

A legal and regulatory review will need to establish and develop the necessary mandate and governance structure that links this ICZM Plan seamlessly with the pending Blue Economy framework for Barbados being pursued by GoB, through MMABE. This shall assess the current governance structures within which this ICZM Plan, and any future Marine Spatial Plan (MSP) for Barbados would operate to provide a consistent and collaborative institutional delivery approach.

Finally, a coastal and marine research strategy will need to be developed for Barbados in a similar vein to international models that exist such as the OECS Code of Conduct for Responsible Marine Research and Marine Research Strategy. A new and bespoke Barbados coastal and marine research strategy will have due recognition of the Government's climate change policy plus any ocean related research strategy designed by MMABE to move forward the Blue Economy in Barbados. In line with the implementation priority below, capacity for continuity, this should include a review of capacity, capability and partnership requirements for such a coastal and marine research strategy followed by subsequent mechanisms for implementation. In terms of collaborative partnership arrangements, an important short-term task is to develop and implement regulatory mechanism for third party research permits and arising intellectual property. Issues surrounding the charging of fees for any research vessel operating in Barbadian waters must be considered as part of the broader National Ocean Policy (NOP) that is being developed concurrently by MMABE.

Priority 2: Capacity

A key challenge remains over human resource capacity to take forward an ICZM across all departments and agencies in Barbados. With regard to the development of a Blue Economy, Barbados recently made a step forward by creating the MMABE in 2018. A new Blue Economy Policy and Strategic Action is being prepared for MMABE under a parallel IDB project. The outcomes of this institutional capacity will need to be embraced within the sentiments and intended actions set out within this ICZM Plan in due course.

The sustainable management, use and conservation of living and non-living coastal resources outlined in see Part C above, including fishing for local food security to aggregate extraction, onshore and offshore, are both of national importance to help develop and maintain a vibrant and sustainable economic sector. In the main, coastal resource management (living or non-living) is challenged by limited human operational capacity for research, monitoring, compliance and enforcement. The GoB has recognised the need to appreciate the potential for sustainable coastal resource management in tandem with improved conservation. For example, as part of this ICZM Plan, a role of Sensitive Marine Areas (SMAs) and MPAs are critical to understand the role and potential of these areas in future sustainable resource management and conservation. Future capacity to deliver their potential role will need constant assessment and update as appropriate to help identify new MPA locations as well as the management systems and capacity requirements needed in the future.

As stated above, the need to advance coastal and marine research is recognised which may include national and regional action. In line with Priority 3 below, this is expected to include a review of capacity, capability and partnership requirements for such a coastal and marine research strategy followed by subsequent mechanisms for implementation. This seeks to build upon embryonic discussion on the establishment of a "Blue Economy Academic Program for professional development and the creation of new skills in support of Blue Economy in Barbados, using IDB donor funded support (BA-T1063-P002)[4]. In addition, other ongoing consultancies are underway to help move forward the Blue Economy in Barbados[5]. The outcomes of these issues need to be recognised as future inputs to an updated ICZM Plan in the coming decade.

Finally, the GoB through MMABE intends to focus attention on delivering on the potential of the Blue Economy, including a strategic approach towards strengthening public private partnerships (PPPs) and the sustainable use and management of ocean resources. This will give due consideration to sustainable finance mechanisms including those that exist whilst securing of budgets and opportunities for revenue generation set out in Part E7.

Priority 3: Commitment

The GoB has recognised that future funding to tackle ICZM issues will be dependent on Barbados being able to demonstrate, through the cost recovery mechanisms identified within section E6 of this ICZM Plan that it will lead to a beneficial legacy for citizens and the wider coastal environment in general. It is of priority importance, therefore, that a fully costed Results Based Framework , Section E1.1) and supporting Strategic Action Plan (SAP), endorsed by the Ministry of Finance, is suitably aligned to Government sectoral budgets, with due consideration of national circumstances and limitations noted in Priority 1 "collaboration" above. In addition, finance and co-financing mechanisms will need to be clearly identified and disbursement modalities secured for relevant ICZM Plan delivery.

The GoB will maintain the continued value of Barbados' natural capital, with further development of the understanding of the value of coastal resources overall. This is expected to include the continuation of natural capital evaluation studies of Barbados' marine and coastal environment and the production of new guidelines based on new findings of which are expected to be derived from the annual "State of the Coast" Reports.

Formal governance arrangements will need to be put in place that are both endorsed across Government and appropriately resourced with key parties given the power and influence to implement the vision and policy outcomes presented within the ICZM Plan. To achieve this, institutional, policy and legal arrangements to provide coordinating mechanisms for ICZM delivery will need to be reviewed and improved where necessary.

Priority 4: Communication

Continuation of on-going coastal and marine-related public initiatives is important. This needs to be coupled with the development of suitable engagement strategies for communities to ensure that ocean and coastal literacy is developed in all parts of society.

[4] "Consultant Firm to help design an Institutional Capacity Building Program – Eqo Nixus 2020"

[5] Anniver undertaking a Stakeholder sensitization Blue Economy project (2020); Integrated Sustainability Consultants undertaking an Integrated Blue Economy Policy Framework and Strategic Action Plan project (2020).

Increasing public awareness, understanding and appreciation of the importance of the coast, the ICZM Plan and the Blue Economy, through education and outreach is an important short term action. This is expected to embrace the creation of a process for active public participation in planning, policy and decision making which is likely to include the need for a public awareness, education and outreach strategy to be developed and implemented. This will include a range of options, such as the development of digital tools that are accessible for the public to access information concerning ICZM issues. In addition, efforts are needed to show how citizens can better appreciate the benefits of the coast to their health and wellbeing. This should include a focused programme, implemented by NCC, to improve coastal access through a formalised beach management and safety strategy for Barbados, which builds on current international work to deliver an International Standard for beaches (ISO13009).

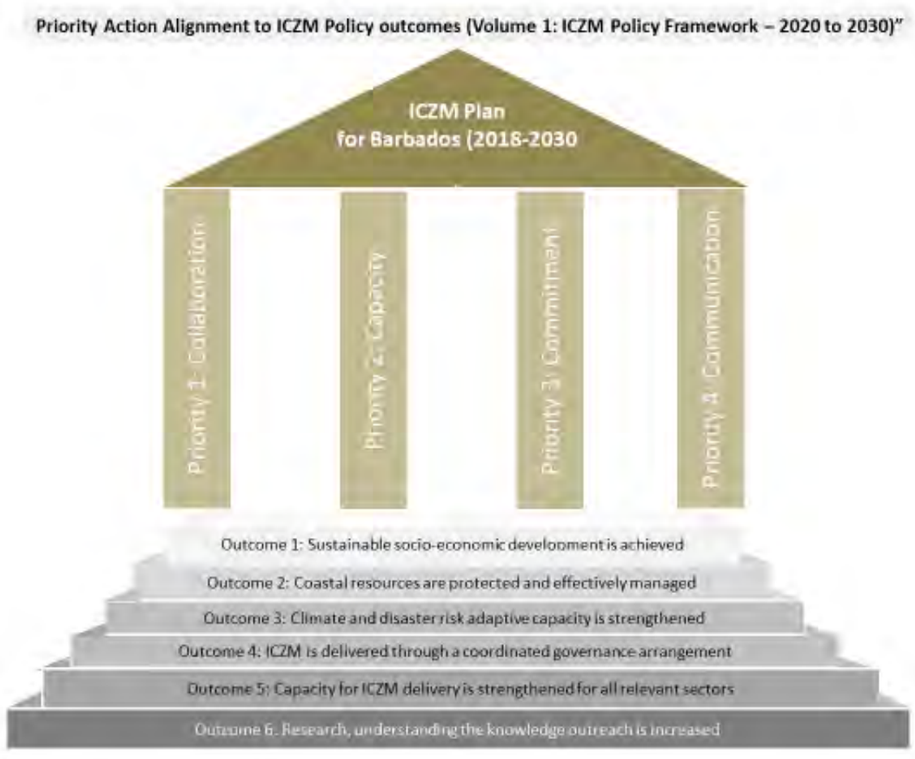


Figure E.2: Priority Action alignment to ICZM Policy Outcomes (2020).

E2. ROAD MAP FOR IMPLEMENTATION

The Road Map shown in Figure E2 above is designed to link the various National Guidance actions in Part C to the six ICZM Policy Outcomes outlined in Figure E1 above. Each specific action in the National Guidance is assigned to one or more of ICZM Policy Outcomes, as appropriate. These are then assigned a Road Map "timeline" that reflects the timelines set in Part C for each activity as follows:

a) Roadmap 1: Short Term (2020 to end of 2022) X

b) Roadmap 2: Medium Term (2023 to end of 2026) X

c) Roadmap 3: Long Term (2027 to end of 2030) X

Additional commentary on the indicative delivery is presented in sub-sections E3 to E7 accordingly.

It should be noted that the implementation strategies outlined in Table E.1 will require the relevant human and technological resources, not presently in place at the CZMU nor amongst other strategic partners.

Table E1: Implementation Road Map of National Guidance Actions and compliance to ICZM Outcomes (Volume 1)

	Action	Outcome 1: Sustainable socioeconomic development is achieved	Outcome 2: Coastal resources are protected and effectively managed	Outcome 3: Climate and disaster risk adaptive capacity is strengthened	Outcome 4: ICZM is delivered through a coordinated governance arrangement	Outcome 5: Capacity for ICZM delivery is strengthened for all relevant sectors	Outcome 6: Research, understanding and knowledge outreach is increased
Disaster Risk Management and Climate Change Adaptation (DRM)							
DRM 1	Produce a specific roadmap to improve collaboration with DEM (national) that embraces the principles of the Sendai Framework.			X			
DRM 2	Produce and implement a plan for continuous maintenance and improvement of NCRIPP data and risk results.			X			X
DRM 3	Collaborate with DEM in the production of a National DRM and CCA Plan for the CZMA.		X	X	X		
DRM 4	Conduct the necessary interventions (physical and non-physical) to implement DRM measures defined in the DRM Plan.	X		X			
DRM 5	Conduct a specific training program, delivered by CZMU and DEM staff on DRM and CCA to other sectors.					X	
DRM 6	Collaborate with the Ministry of Finance in the production of a financial plan for DRM and CCA for the CZMA.			X			
DRM 7	Prepare and implement an indicator system to monitor DRM.			X		X X X	
Beach Management (BM)							
BM1	Update the inventory and classification of beaches.		X		X		
BM2	Develop and implement a Barbados Beach Management Plan (BBMP).		X		X		
BM3	Develop and implement a National Beach Risk Management Framework (ISO13009).				X		X
BM4	Development of local beach management plan by Sub-Areas.		X		X		
BM5	Organize working meetings for the coordination of each National Programme of Action defined in the BBMP.					X	
BM6	Create a Beach Access/ Enhancement Plan.	X	X				
BM7	Coordination meetings with NCC to ensure implementation of guidance related to commercial applications/large entertainment events.				X	X	
BM8	Develop a procedure and implement bathing water profile results (as required).		X				
BM9	Organize working meetings with EPD and Bes Dos Santos laboratory to agree on technical aspects related to BM8.	X			X		
BM10	Creation of a Beach monitoring system				X		
Development Planning and Setbacks (S)							
S1	Formally delineate the definition of HWM within statute.			X	X		
S2	Agree on setbacks policies and required studies (set out within this ICZM Plan) with TCPDO.			X	X		
S3	Map setbacks distances that embrace the newly defined HWM.			X			
S4	Include setback distances within the NCRIPP platform to support the review and approval of applications/plans and official decisions.			X			X
S5	Prepare a simple informative technical guidance (/update the Applicants Handbook to Development Planning) note describing the setback approach (including managed realignment of specific defences) to property owners and developers and the establishment of coastal foreshore reserves (as required).		X		X		
S6	Create a national inventory and assessment of coastal landscape /seascape values establishment of coastal foreshore reserves (as required).		X				
S7	Disseminate setbacks (including lateral setback agreements) and recommendations through geo-viewer/website.						X

Action		Outcome 1: Sustainable socioeconomic development is achieved	Outcome 2: Coastal resources are protected and effectively managed	Outcome 3: Climate and disaster risk adaptive capacity is strengthened	Outcome 4: ICZM is delivered through a coordinated governance arrangement	Outcome 5: Capacity for ICZM delivery is strengthened for all relevant sectors	Outcome 6: Research, understanding and knowledge outreach is increased
S8	Update periodically setbacks based on updated coastal risks and coastal resources information and maps.			X X			
S9	Agree a calendar to coordinate PDP and ICZM Plan provisions/regulations/updates relating to developmental setbacks and studies required.		X	X	X	X	
S10	Deliver bilateral meetings with selected staff and managers to discuss developmental planning issues and compliance aspects to the ICZM Plan.					X	
S11	Agree on existing and new setback and provisions within the CZMA (based on new monitoring related information) and publish within the annual State of the Coast reporting system.				X		X
S12	Prepare supporting documentation to update the PDP (2017) regarding the definition of the CZMA, HWM and development setbacks in the CZMA.			X			X
S13	Prepare an indicator system to evaluate the success in setback implementation (linked to the CZMA (Enforcement) Regulations and the number of "coastal zone protection notices" submitted to offenders in any one year.			X X	X		
Compliance to Environmental and Social Safeguards (ESIA)							
ESIA1	Coordination meetings with TCDPO to agree on new requirements to update the ESIA process to help support and improve sustainable development within the CZMA.	X				X	
ESIA2	Revision, update and suitable dispatch of "The Applicant's Handbook and Guide to Coastal Planning in Barbados".		X	X	X		
ESIA3	Improved monitoring and evaluation procedures are adopted (with the endorsement of the Planning and Development Board) of current and future development applications.	X			X		
ESIA4	Elaboration of an indicator system to assess the effects of ESIA procedures.	X			X		
Construction and Maintenance of Coastal Structures (CS)							
CS1	Produce technical "White Papers" for wide dissemination to clearly articulate recent findings for the study on shoreline dynamics, considering CCA and the national position on Managed Realignment.			X			X X
CS2	Organize bilateral working meetings with CZMU to agree on technical aspects related to CS1.			X		X	
CS3	Organize training activities undertaken by CZMU staff for public sector and private sector audiences to better incorporate CCA into the design of coastal structures.					X	
CS4	Review (in partnership with TCDPO) all current and future planning applications that request the need for new coastal structures and other construction activities within the CZMA to ensure that they are consistent with the policies and CCA requirements of the plan.	X X		X	X		
CS5	Support TCDPO to ensure conditions for the approval of coastal structures are incorporated in all development permits. Undertake site inspection during construction to ensure compliance.	X		X			
CS6	In partnership with DEM, support the preparation of new procedures for managing emergency maintenance works.			X			
CS7	Undertake assessment reports on the adequacy of existing infrastructures to projected SLR (feeding into the State of the Coast annual reporting system).			X			
CS8	Prepare Monitoring and Maintenance Strategy Instruction procedures/guidelines (for pre and post monitoring of coastal structures) in line with the updated ICZM Plan.			X	X		
CS9	Update the existing NCRIPP architecture to establish a comprehensive database for the inventory and assessment of coastal structures.			X			X
CS10	Update the inventory and assessment database based on the results of monitoring activities.			X			
CS11	Formalize (through a new MoU) a collaborative arrangement /agreement between CZMU, EPD, Drainage Division and NCC for ensuring the monitoring and maintenance of beach facilities, beach and storm-water facilities cleaning.		X	X	X		
Emerging Issues (EI)							
EI1	Devise a National Policy Position Paper on Coastal transportation services and associated jetties	X			X		
EI2	Devise a National Policy Position Paper on Use of 4x4 Vehicles on coastal habitats to support updates to new amended legislation.		X		X		

Action		Outcome 1: Sustainable socioeconomic development is achieved	Outcome 2: Coastal resources are protected and effectively managed	Outcome 3: Climate and disaster risk adaptive capacity is strengthened	Outcome 4: ICZM is delivered through a coordinated governance arrangement	Outcome 5: Capacity for ICZM delivery is strengthened for all relevant sectors	Outcome 6: Research, understanding and knowledge outreach is increased
EI3	Devise a National Policy Position Paper on Over Water Bungalows and other buildings.	X			X		
EI4	Devise a National Policy Position Paper on Use of Quarried Sands for Beach Recharge.	X	X		X		
EI5	Devise a National Policy Position Paper on Carrying Capacity of beaches based on the National Beach Management Plan.	X	X		X		
EI6	Devise a National Policy Position Paper on Water Parks and use of inflatable structures.		X		X		
EI7	Agree on analysing and applying approaches (screening tools) to identify possible emerging challenges and from this, shortlist those emerging issues of immediate importance.	X			X		
EI8	Automate existing screening approaches, tools, and formal sustainability assessments for the rapid analysis that responses to new issues will require.						X
EI9	Create a searchable database of valuable lessons learned (identify, track, and address unintended consequences of an emerging issue).				X		X
Biodiversity Conservation and Coastal Habitat Rehabilitation (BIO)							
BIO1	Support the implementation and enforcement of actions within existing and updated FMPs (Fisheries Division) with specific regard to reef fish, sea urchins and sea turtles.	X	X				
BIO2	Creation of strict protected areas/zoning schemes to help support delivery of effective “refuge areas” for marine biodiversity and fisheries schemes as other options for management.		X		X		
BIO3	Initiate co-management demonstration projects to encourage sea urchin and reef fishery enhancement.		X				
BIO4	Initiate a programme of “State of the Coast” reporting to support SDG and NBSAP update and reporting requirements.		X				X
BIO5	Production of a series of “Health Report Cards” on the health of the national coastal ecosystems.						X
BIO6	Habitat rehabilitation/ re-stocking/EBA strategy to embrace all terrestrial/marine habitat damage mitigation measures in a gender sensitive manner.	X	X				
BIO7	Improve public awareness on coastal biodiversity issues and workshops on coastal rehabilitation and EBA approaches.					X	X
BIO8	Improved collaboration on coastal and marine biodiversity related research and data management relating to improved water quality and ship waste, etc.		X				X
BIO9	Create a monitoring system to assess biodiversity conservation in the CZMA.		X		X		
Resource Exploration and exploitation							
REE1	Adopt policies set out within the PDP (2017) to recommend the future location/relocation of non-living resource extraction operations away from OS2 Natural Heritage Conservation Areas (NHCA) or areas with lower coastal hazard risks as identified within the ICZM Plan.	X	X				
REE2	Develop CZM regulations to designate incipient dunes, beach and fore-dunes in areas where removal of vegetation or sand is prohibited.		X	X	X		
REE3	Mainstream the sustainable use of non-living resources within national policies and planning frameworks.	X	X		X		
REE4	Develop Blue Economy Valuation Plan including a strategic approach to strengthening public private partnerships and the sustainable use and management of non-living coastal and marine resources.	X				X	
REE5	Strengthen national legal frameworks and guidance (guidelines) for integrated planning and management of non-living resources.		X				
REE6	Develop a research strategy including national and regional action to support sustainable exploitation and exploration of non-living coastal resources.			X			X
Research (R)							
R1	Create a 2020-2030 Coastal Research Agenda.				X		X

Action		Outcome 1: Sustainable socioeconomic development is achieved	Outcome 2: Coastal resources are protected and effectively managed	Outcome 3: Climate and disaster risk adaptive capacity is strengthened	Outcome 4: ICZM is delivered through a coordinated governance arrangement	Outcome 5: Capacity for ICZM delivery is strengthened for all relevant sectors	Outcome 6: Research, understanding and knowledge outreach is increased
R2	Coordination with research institutions in Barbados.				X		X
R3	Complete, update and normalize all geospatial information related to ICZM.				X		
R4	Improve sea level monitoring.			X	X		
R5	Extend the scope of Beach profile monitoring programme.				X		X
R6	Develop a web data catalogue to provide access to data with specific reference to findings from biodiversity related research.						X
R7	Develop a web viewer to disseminate and provide access to Geospatial information.						X
R8	Production of an Annual Research summary report.						X
Public Awareness and Stakeholder Participation (PA)							
PA1	Preparation of an operations manual to encourage the dissemination guidance /outreach approach to Coastal Communities *(internal and external communication).*			X			X
PA2	Formally adopt the draft Consultation Guidelines *(this Draft Guideline).*				X		
PA3	Preparation of a Strategy for Social Partnership engagement.					X	
PA4	Prepare a Strategy to demonstrate message communication to persons with disabilities and other vulnerable groups.						X
PA5	Establish school level inclusive play and art-based activities (focusing on risk resilient ICZM).			X			X
PA6	Develop a digital social media tool/ website for public to access information concerning ICZM, marine spatial planning and the marine environment.						X

E3. INFORMATION NEEDS AND DATA MANAGEMENT

E3.1. Overview

GoB need to take stock to consolidate the new data and information presented within Part A2 of this ICZM Plan with regards to data and information management in order to help provide clear advisories on Risk Resilient ICZM topics. There is an immediate need to consolidate and streamline data capture programmes on agreed ICZM topics to help transform scientific data into meaningful and digestible policy statements for decision makers. To this end, a new focus is needed that links scientific knowledge into the provision of relevant decision making product support to those who need it most.

New efforts are needed on the use of new or developing technology innovations that can provide efficient and cost-saving solutions in data-poor contexts. For example, probabilistic risk assessment enables quantitative valuation of risk plus economic valuation of the coastal protection services obtained from ecosystems. In addition, innovation is required to target how best to integrate monitoring approaches that support, for example, the greater uptake of nature-based coastal protection solutions and supporting data collection programmes that will help support the sustainable design of coast protection schemes and flood conveyance and watershed interventions that may help support the design of coral reef/wetland conservation schemes.

Once targeted information is collected, being able to communicate the outcomes and results requires a new shift in role for CZMU, changing from purely collecting information, to be the key "messenger" of new innovative strategies for both risk resilient ICZM as outlined in Part E4. In all instances an improved efficiency drive is needed across all GoB sectors on data collection and hence information provision. To this end, efforts to improve the accessibility of NCRIPP information online is needed to help improve message conveyance to help the private sector to have the latest information to hand to help in the design of future development applications that fall within the CZMA.

E3.2. Streamlining and targeting data collection Programmes

Being mindful of the challenging macro-economic context that Barbados is currently facing, there is a strong priority consideration needed to better demonstrate value for money, return on investment and improved public sector decision-making efficiency across GoB sectors as part of any new data collection programme. GoB must therefore demonstrate improved public sector efficiency in coastal data use and application.

Being able to focus on priority data collections programmes is critical to streamline workloads and focus on areas that Barbados, through the CZMU, expects to focus on. Whilst it is not viable to engage in long-term back catalogue collection programmes that gather historical data from various national and regional sources, for example detailed historical hurricane data, improvements can be made to current and future data collection regimes from now and into the future. This may involve identifying opportunities to partner with private or regional entities to install monitoring to help collect information that may support risk resilient ICZM datasets to be enhanced. For example, to improve understanding on coastal flood risk and inland flood limits to better define the CZMA inland limits, topographic relief data, drainage and flow data may be required[6].

[6] The Drainage Unit of MTW is a critical strategic partner in this example, though this may require training of their staffs along with those of the CZMU. Tailored changes to agency specific work programmes may be required as necessary.

Presently, CZMU manages a sound coastal data collection and monitoring regime that provides data to support and improve the understanding of coastal processes, hazards and resulting risks facing the coastline. Part C included information on the key datasets currently monitored. More quantifiable baseline data relating to coastal hazards and disaster impacts, which had been severely lacking prior to the onset of the CRMP project, has therefore significantly improved over recent years (Baird 2017) plus the use of this data to produce a series of supporting natural hazard risk maps presented within this ICZM Plan.

E3.3. Oceanographic and Coastal Engineering Data Collection

Oceanographic, engineering and coastal forecasting related data collection by the Barbados Meteorological Services - BMS remains critical for GoB to pursue under the role of the CZMU. Enhancing the existing ocean and nearshore wave data monitoring programme, both spatially and temporally, should be encouraged where possible to help provide CZMU to collate data to help with improved coastal model certainty through improved data calibration and validation. It is proposed that up to six Acoustic Wave and Current (AWAC) instruments should be in operation around the Barbados coast within the first few years of this ICZM Plan Roadmap (see Section E2). Two additional units are recommended to be used for swapping during retrieval/deployment and in the case of maintenance issues or damage. Cost savings are proposed through measuring shallow non-directional waves/currents using a combination of the existing S4 gauges and newly purchased shallower water wave/current profilers, thereby costing less (capital cost and operation cost) than the AWAC. Regarding deeper water wave measurements, wave directions in the nearshore zone are generally well understood, with any site-specific directional validation being completed on an as-needs basis and funded by the private sector.

Due to a lack of wave overtopping data collection especially for post-storm events, there is a need to improve the measurement of storm surge impacts (inland spatial extent) to help ensure that current flood inundation maps, as presented within this ICZM Plan, are updated to continue influencing development control policy in Barbados. Understanding the data output by models, particularly improved knowledge and training on coastal structure overtopping rates is also needed to better understand model design needs and the interpretation of joint probability (water level and wave) complexities plus any associated risks that may arise as a consequence. Through enhancing the existing CZMU wave monitoring programme with the collection of certain offshore and nearshore wave climate parameters, new data on overtopping rates, currents and water levels would become available for effective use within new coastal models. Without accurate data collection, incorrect data subsequently placed into numerical models can easily result in under or over calculation estimations of flood extent and hence risk. Improving this situation could then help to launch a new and robust platform from which the ICZM Plan and future developmental control can be used to best effect.

It is also beneficial to ensure that data collection, both quantitative and qualitative information, is undertaken during any storm surge event that may occur. In addition, a record of any associated impacts of such events on hard coastal defence structures is needed especially where defence crest level data is known. Such results will support the calculation of more accurate estimations of overtopping during any surge/flood events. Coastal flood mapping activities can also be greatly improved through the collection of new focused geospatial data on structural assets that occur within the CZMA especially engineered or built structures found within or adjacent to villages

and towns. This could be supplemented with improved and updated information on real-time storm precipitation intensity or wave overtopping frequency volumes etc. during storm event situations (derived from BMS).

Finally, attention needs to be placed on monitoring post event coastal flooding episodes to more accurately record flood depth and extent (through photography, drone and/or video coverage etc) which can all be used to support the "communication" of what happens during such events to other stakeholders, emergency responders, decision makers, consultants and local engineers etc. In part, the Drainage Division currently is acting on this in tandem with the private sector to collect storm water/flooding data. CZMU will need to encourage closer collaboration with both the Drainage Division and BMS (along with having their own improved relationships with the private sector) to help achieve improved outcomes regarding this issue. The training of volunteers to help capture information on such events needs to be considered, possibly using specific Android "apps" as appropriate, in order to reduce surveillance costs whilst introducing specific activities whereby the public can feel engaged as stated in Section E4 – "Education, Training and Public Outreach Needs".

E3.4. Socio-economic Data Collection

Data collection programmes to collect socio-economic information represents a new technical area that would easily add value to both CZMU and the GoB. Through the establishment of specific MOU's with relevant agencies, new socio-economic information may be sourced.[7] Annex 9 sets out a draft "Guideline" document to collect socio-economic data which may be used and disseminated to develop applicants by the CZMU as required.

The use of probabilistic risk assessment also needs to be initiated. This would enable the quantitative valuation of risk to be compiled in addition to new information regarding the economic valuation of coastal protection services obtained from ecosystems. These assessments ,financial protection and risk transfer, can both be used to, for example, develop more affordable insurance schemes for developments proposed within the CZMA of Barbados. As empirical risk assessment relies exclusively on historical data and is usually insufficient to determine maximum probable losses or average annual losses, probabilistic risk assessment approaches therefore should be adopted into data collection and analysis systems as this often addresses these shortcomings and allows for a sound understanding of the processes and roles of different risk drivers. Probabilistic risk assessment also provides a quantitative estimation of the maximum probable losses and average annual losses, which support the identification of appropriate risk reduction measures. This approach could also embrace the economic values of Barbadian ecosystem services that may be mainstreamed into the scope of public budgeting to help justify future budgetary resource allocations to the CZMU into the future. Such an approach needs to be interpreted and/or provided to GoB economists in a useable and digestible form so they can shape the financial protection strategy for the country as well as to inform new public investments of options and alternatives.

E3.5. Geotechnical and Seismic Data Collection

Further studies are required to improve aspects of seismic hazard assessment plus soil classification parameters for specific sites for development proposals. Currently, relatively little site-specific field investigation, in-situ and laboratory testing is available for use and hence this important information is not sufficiently embraced within the CRMP natural hazard risk mapping exercises and hence within the maps presented within this ICZM Plan. It is recommended that a closer partnership arrangement is needed between CZMU and TCDPO, with the Energy Division and Soil Conservation Unit, to better communicate natural hazard risk developmental control needs on coastal cliff and landslide-prone areas.

In a similar vein to the above, tsunami studies are broader in scale and require Caribbean wide physical information and historical data. Whilst that data cannot be collected solely by GoB, any new data that is available, even at this regional scale, should be used by CZMU to update ICZM maps and used within the NCRIPP database so that output findings are communicated accordingly to key decision makers. A comprehensive tsunami study for the entire Barbados coastline is recommended to more precisely determine inundation extent that is based on a pre-determined wave originating from a range of directions (i.e.: NE, SW and SE).

E3.6. Systems Required to Update the CZMA Inland Limits

In partnership with other key stakeholders, improvements towards delimiting natural hazard risk extents and limits could be achieved through additional work as follows;

- A more thorough understanding of the variability in the geotechnical conditions by the Natural Resources Unit[8] and the Energy Division, the response of the slopes to extreme events such as heavy rainfall, heavy sea states, seismic activity, etc., and long-term slope stability behaviour (see E3.5 above);
- Additional automated weather stations (AWS) should be encouraged to be installed by the BMS which coupled with long-term monitoring of groundwater levels, could be used to attempt to establish a trend between daily rainfall and response of groundwater levels in different areas geologic units.
- New geophysical investigations to measure the actual shear wave velocity to categorize soils by seismic site class by the SCU.
- Effective development and use of the CZMU NCRIPP system.

The following actions are listed below to help improve efficiencies in coastal data collection:

1. Actively find opportunities to work under private and public partnerships (PPP) to install monitoring facilities on properties[9] to collect information will support risk resilient planning, particularly for wind and rainfall, or for monitoring purposes by CCTV, Argus beach surveillance, drone projects;
2. Facilitate the improved storage and access of coastal monitoring and mapped data for further analysis, working towards a data repository that has validated metadata and consistent data upload mechanism;
3. Improve the approaches towards the accurate prediction of coastal risk using early warning systems (EWS)

[7] CZM Regulation 2020 sets out the legislative approach towards setting up MOUs to assist in this process.

[8] NRU have capacity to understand variability in geological conditions through their geotechnical engineers.

[9] Issues including site access, maintenance and site clearance will be important aspects to include.

such as improved numerical modelling and adopting online open access forecasting tools.

4. GoB needs to consider the creation of a National Coastal Data Policy, which compliments the structure being set for the Barbados Statistical Survey (BSS) set out in Annex 9.

In addition to the above actions, the development of a NCRIPP database platform, intended as the recognized national repository for coastal zone-specific disaster risk data, is required so that it is the primary instrument for data sharing and dissemination in Barbados. Whether the NCRIPP database is effectively used as the sole tool for coastal risk mitigation and development planning within Barbados will depend on its ability to adopt a new mechanism that enables it to store regular updates from relevant departments. Improvements to data sharing protocols between agencies are also required to help promote the use of hazard data within sectoral plans shown in Annex 10. The issue of implementing an Integrated Monitoring Programme (IMP), that uses the current NCRIPP database platform, is discussed further in sub Part E3.5.

E3.7. Creating Guidelines and State of the Coast Reports

A ***bespoke set of planning and support guidelines, rules and policies*** needs to be produced that reflects the new data collected (as set out in E3.2-E3.6) to help implement this ICZM Plan and hence steer sustainable development within the CZMA. A suite of guidance manuals (including one that updates the current Coastal Planning Guide produced in 2010 with others as set out in Part C of this ICZM Plan) need to be produced. This should help enable regulators and private developers to ensure that new coastal developments are designed in an appropriate sustainable manner (adhering to EbA and DRM principles) whilst ensuring that they are consistent with environmental and land related policies, laws and regulations. It also will provide consistency and transparency for decision makers and enables them to support their decisions with auditable evidence. Through this approach, and supporting the improved communication concept (see sub Part E3.3), CZMU can offer strengthened support on updating existing planning regulations and be made more up to date with regards to climate predictions.

Such guidelines, when produced, need to consider the setting of appropriate "rules" or "standards" for coastal development within defined boundaries. The outcome of the guidelines should be to establish a set of development controls for buffer and setback areas for watersheds and development behind mean high water. They also need to be written in partnership with all Ministries and Departments, whom have different yet related responsibilities.

"State of the Coast" reporting is a key recommendation that is central to ensuring the success of the ICZM Plan[10]. Periodic reviews (every 2 years) of data management arrangements or data collection protocols may be undertaken throughout this process to better take account of advances in technology whilst in addition, recommending specific audits are undertaken to assess conformance with draft Standard Operating Procedures (SOPs) or monitoring protocols. The "State of the Coast" reporting approach should also embrace SDG indicator assessment work for the country (see ICZM Volume 1 Appendix 4 for additional details). To this end, there remains a core need for CZMU to champion the collection of marine ecological information as discussed in Part C (Section C7 – Biodiversity).

The production of a series of "***Health Report Cards***" (see Figure E.1) supports the need to capture the health and status of key marine ecological habitats and faunal assemblages. This data, once collected, may represent annexes to future "State of the Coast" annual reports to help report on "ecological integrity" which determines how native, pristine, diverse and resilient a legally defined coastal resource is and if all of its components are present and functioning. Commonly used bio-indicators to be used include water quality, the diversity of marine invertebrate species present and the number of introduced species found and the presence and health of sensitive species (in a healthy condition). They should be produced (using newly collected marine ecological datasets) and designed to enable a reader (via print or online media) to quickly understand the status of a coastal resource, and to understand important species that may be found plus the climate or man-induced pressures that are being upon them. A series of report cards sections (as part of the overall Health Card) should focus on the following Themes (see Volume 1 Appendix 4.5 for more details):

1. Theme 1: Water Quality (led by EPD);
2. Theme 2: Public Health (led by EPD);
3. Theme 3: Marine Biodiversity (led by the Ministry of Environment and Natural Beautification with support from CZMU);
4. Theme 4: Land Use or Sea Use Change within the CZMA (led by TCDPO with CZMU support).

[10] this may need reflecting in draft Regulations/legislation already prepared.

E4. EDUCATION, TRAINING AND PUBLIC OUTREACH NEEDS

E4.1. Education and Training Needs

In the short term, the greatest challenge for GoB continues to be the allocation of scarce resources to help support agencies, including amongst others DEM, to safeguard life and property, particularly in coastal settlements and flood prone areas especially in rural Parishes of Barbados. The lack of institutional capacity within some departments to perform a staff capacity building and coordinating role remains a constant challenge. It is therefore critical that counterpart organizations within the private sector and the NGO community maintain an effective link to public agencies to ensure harmony in developing, implementing and monitoring policies and regulations as they relate to entire spectrum of CCA and DRM related activities. There is scope, however for greater coordination between DEM, the Ministry of Housing and the private sector in the areas of safer building construction. The role of the CZMU could prove pivotal here to help support the process of improving inter-departmental staff coordination. From this, updates may be included within existing CZM related legislation.

CZMU, for example, must improve its role as a "train the trainer" body, ensuring that a percentage of its staff component are not only able to undertake and take ownership of training delivery to other Departments, but also be financially compensated to help GoB to better transfer or export certain skillsets. To support this requirement, CZMU need to recognise the capacity that does exist at a national, regional or wider Caribbean level and determine what needs exist, now and in the future. This, for example, may require the services of coastal resource economics[11]. Upgrading skills and understanding of decision makers and professionals is therefore still needed for continuity purposes with all sectors.

One key challenges facing both TCDPO and CZMU relates to the need to ensure that employees are well-versed in a new planning procedures (linked to the new PDA 2019), and how this may be applied to the benefit of all Barbadians. CZMU are encouraged to help TCDPO by introducing a formalized management system that includes tools, training and monitoring activities to implement within the current planning system. This "system" should guide employees to ensure appropriate consideration of the coastal environmental effects of a relevant decision. Training and awareness sessions, consistent templates and tools, quality tracking, and monitoring are all key parts of CZMU's commitments towards improving risk resilient ICZM within this Plan. To this end, it is recommended that a Risk Resilient ICZM Environmental Compliance Awareness Program should be initiated by CZMU in partnership with a range of organisations including EPD, NCC, DD and TCDPO. GoB should actively promote activities to ensure that staff members are trained in new environmental compliance procedures so that all organisations are able to demonstrate how they can incorporate this new knowledge and regulation into daily work regimes. A draft training course module should be designed to educate stakeholders on risk resilient ICZM awareness issues. The training content should include updates to any legislation, compliance and liability, as well as due diligence issues. The work and decisions of individuals who comprise a more environmentally conscious and knowledgeable public service culture will have beneficial and cumulative impacts towards sustainable development.

The continual improvement and development of numerical modelling capacity within the CZMU is needed, building on the NCRIPP studies by consulting firm Baird (2017). These models can be used for training purposes, which can be further developed with new data as it becomes available internally. Training in numerical modelling, statistical analysis, and -data analysis needs to be continued in partnership with private engineering consultants or regional expertise as appropriate. This will ensure that the proposed CZMU Data and Information team (see Section E5.2) are capable of analysing model outputs or re-running coastal models, communicating the updated findings to key stakeholders and from this, providing "train the trainer" events using new and updated DRR/CCA related information.

GIS training will still be required as the type of information collected by CZMU will continue to be different to that of other agencies. BSS, for example, are the national repository for risk information, though DEM and/or CZMU need to consider how to collaborate efforts with BSS towards delivering suitable knowledge exchange mechanisms. Agreements need to be reached on which organisation is best placed to expand its full-time staff in terms of hiring extra GIS specialists. This is important in order to understand who is responsible to develop the national capacity and to update and disseminate information on national hazard maps produced by CZMU through the NCRIPP. Supporting this, it is proposed that careful collaboration is required by setting out a national Integrated Monitoring Programme (IMP) that designates functions between GIS teams in the BSS and within the CZMU or DEM. The GIS framework should always be complimented by appropriate and coherent training programmes in hazard identification and risk assessment for staff within all three organizations.

A new training area for GoB staff, especially for staffs within MMABE, is on the importance of cost: benefit analyses. Cost benefit analysis (CBA) approaches in many countries including Barbados often show a bias towards environmental concerns leading to a divide that usually emerges between ecologists and economists, yet identifying and implementing robust adaptation approaches that are cost-effective and build resilience across a range of potential future climates remains critical for Barbados. To date, the dominant approach has been a mix of hard engineering interventions such as sea walls, offshore breakwaters or novel designs to create "boardwalk" related infrastructure coupled with more planning related interventions such as early warning systems and awareness raising. However, there is growing recognition that nature-based solutions (i.e.: restoration and protection of natural habitats) when applied strategically and equitably cannot only safeguard biodiversity and ecosystem services but also help people adapt to the effects of climate change. CBA has a key role to play in Barbados to help embrace social aspects as a method for creating a "decision rule" for choosing a preferred alternative, and/or as a component of a comprehensive policy analysis with a heuristic purpose. This requires CBA to consider the financial flows between stakeholders to include the social and economic aspects of a strategy or policy.

Efforts are currently underway, using IDB donor funds, to produce a Blue Economy Training Programme (EQO-NIXUS 2021) that addresses identified staffing knowledge and capacity gaps for Blue Economic development and promotes professional development for the public and private sector in Barbados and in the region. This includes a robust academic program, designed in coordination with UWI, MMABE and IDB, to define aspects such as target audience, type and length of courses offered, learner experience and interaction, instructional delivery modalities, visual appearance of course brand, course syllabus, learning objectives, annotated outlines of curriculum content,

[11] Financial risk management experts fall within the expertise required in the Ministry of Finance only.

curriculum resources, formative assessment instrument preferences and choice of learner credentialing process. Potential collaboration with other providers in the region may include:

- SDG Academy, author of the online course “One Planet, One Ocean”;
- The Centre for the Blue Economy and Innovation (CBEI);
- The Caribbean Natural Resources Institute (CANARI);
- Caribbean Maritime Institute;
- The Caribbean Institute for Meteorology and Hydrology ;
- The Caribbean Meteorological Organisation ;
- Government Meteorological Departments;
- The Caribbean Environmental Health Institute I;
- Caribbean Community Climate Change Centre ;
- University of the West Indies - Mona Campus (UWI);
- St Georges University, Grenada (Marine Biology Dept);
- Bellairs Research Institute (McGill University);
- UNDP Blue Economy Accelerator “Laboratory” (Barbados);
- International Oceanographic Commission (IOC);
- NOAA;
- UK Met Office.

The production of a future academic training program will ensure that:

1. MMABE staff receives required training for their organizational development purposes.
2. A wider public composed of associate undergraduate, early career professionals, technical college students and experienced professionals, through the UWI structure, enhance their knowledge and technical capacities on ICZM and Blue Economy development.

From this, the GoB will possess the necessary skills, qualifications knowledge and overall capacity to fulfil its mandate and new developed strategies for ICZM and Blue Economy development. In addition, a wider professional community of professionals will be created to work both at public and private level on Blue Economy development.

Finally, there is no organization that possesses trained staff to address psychological and socioeconomic impacts of climate induced or disaster events (individual or multiple disasters occurring simultaneously) This represents a new training area that could help assist both DEM and CZMU during recovery times (post event).

E4.2. South-South Cooperation (SSC)

SSC is a process whereby two or more developing countries pursue their individual and/or shared national capacity development objectives through exchanges of knowledge, skills, resources and technical knowhow, and through regional and interregional collective action. This includes partnerships involving governments, regional organizations, civil society, academia and the private sector, for their individual and/or mutual benefit within and across regions[12]. In fact, the UN 2030 Agenda and its Sustainable Development Goals (SDGs) acknowledges the critical role that SSC plays in global development. This is also reflected in other important global agendas, notably the Sendai Framework for Disaster Risk Reduction, the Paris Agreement on Climate Change, and the Addis Ababa Action Agenda on Financing for Development.

The aim of SSC is to generate both new ideas and concrete projects plus also as a means to enable voices from the Global South to drive innovation and promote development. The division of “North” and “South” is used to refer to the social, economic and political differences that exist between developed countries (North) and developing countries (South). Although most of the higher income countries are indeed located in the northern hemisphere, the division is not (in total) faithful to the actual geographical division. North-South cooperation, which is the most traditional type of cooperation, occurs when a developed country supports economically, or with other kinds of resources, a developing country. Hence whilst the Wider Caribbean is not within the Southern Hemisphere, the principles of SSC apply to the region.

Together with political dialogue and financial cooperation, SSC may prove a valuable “tool” for Barbados to pursue as it has promoted a large number of knowledge and expertise exchanges through programs, projects and initiatives that have helped solve specific problems in the countries of the Global South. For example, the UN Office for SSC has published the “South-South in Action Series” gathering more than 100 successful experiences that have contributed to the development of countries around the world[13]. SSC may therefore prove to be a useful tool to help GoB agencies to collaborate and share knowledge, skills and successful initiatives in specific areas such as climate change and ocean governance.

A specific recommendation is to initiate dialogue between OECS and the GoB, specifically with the MMABE, to enhance SSC on how climate and disaster resilience can be inculcated into the development of ocean policy, coastal and marine spatial planning with direct implications on governance arrangements required to help deliver a Blue Economy. Barbados currently is developing its own National Ocean Policy (NOP), whereas OECS have recently initiated the production of a series of NOPs[14]. Lessons learned from the Barbados experiences over 25 years of taking forward ICZM culminating now in their work to pioneer “Risk Resilient ICZM” out to their territorial limits,12 nautical mile limit, could be of high value to better disseminate for wider reflection and adoption within the wider Caribbean region.

[12] UN High Level Committee on South Cooperation, Framework of operational guidelines on United Nations support to South-South and triangular cooperation SSC/17/3 (2012).

[13] https://www.unsouthsouth.org/library/publications/south-south-in-action-series/

[14] NOPs prepared for Saint Lucia, St Vincent and Grenadines, Dominica, Grenada and St Kitts and Nevis (Howell Marine Ltd and Sustainable Seas Ltd 2019).

E4.3. Public Outreach Needs

CZMU have experienced a mixed response to their public outreach programmes over recent years. Despite this, the programmes adopted are critical as caring for the coastal and marine environment is the responsibility of every Barbadian. However, insufficient awareness and lack of environmental education and outreach can result in low levels of personal accountability. Public participation is key to promoting and instituting a duty of care for the coast. By adopting a range of stewardship initiatives, the GoB can encourage and empower citizens to recognise their responsibilities, be part of the management process and take action where necessary. Encouraging the active and meaningful participation of Barbadians can enhance wellbeing and provide benefits for coastal environmental health.

An informed public increases participation in the successful delivery of this ICZM Plan. To support this, the CZMU and supporting partners will engage with civil society and local communities to ensure that literacy on coastal matters is increased and that the social and cultural benefits of their coasts are fully realised.

There is a need for awareness raising among the public and among sectors in government, civil society such as school and university students and researchers, and the private sector. Cross-sectoral awareness raising among government sections should address coastal risks, coastal management priorities, and the effects of coastal climate change and adaptation needs. Communication tools such as videos, factsheets, and posters could facilitate this process.

As stated in the latest PDP (2017) the GoB is committed to creating an environment that encourages citizens to become more involved in the planning process. To this end, the process will be transparent and the public will be encouraged to participate. This thereby also applies to the implementation approach for this ICZM Plan.

Specific recommendation or actions to adopt by key public sector bodies (to help improve public outreach on ICZM related matters) include the following:

- Develop communication materials to inform other sectors such as tourism, investment companies, infrastructure, and transport agencies;
- Raise awareness among the population and district administrators of the importance of maintaining coastal ecosystems and resources for resilience and flood prevention using visuals, videos, and info-graphics describing the functions of this natural infrastructure;
- Create education programs in schools that focus on the impact of climate change and the importance of coastal ecosystems for Barbados;
- Strengthen collaboration with NGOs and other partners on the communication of adaptation projects and use new outreach techniques and tools to inform stakeholders of stipulations for coastal construction.
- Document stories, scenarios and challenges encountered during work or consultations and from this, compile a database to store this information for future re-use and update. The database should highlight issues or problems experienced by the public or are specifically expressed by stakeholders as it relates to coastal construction and other coastal related issues. The database will help with developing a “Frequently Answered Questions (FAQs) segment for the CZMU website[15] and social/ traditional media platforms and also for the story-telling aspect at national consultations.
- ICZM related messages to the public often resonate with some and not others. That should not preclude CZMU doing as a good a job in sharing the message or story. It might take multiple efforts or reframing the message because it is not a “one size fits all” approach. Therefore, it is imperative to repeat the message in various formats and using a range of tools or procedures to support monitoring and evaluation.

E4.4. Communication

E4.4.1. Improving Message Communication

Reporting and communication is an essential, yet currently under-used function within current GoB departmental workloads. The results and findings attained from the recent donor funded CRMP project (Baird 2017) must now be better used to a better understand the “message” of risk resilient ICZM. A range of communication tools, including mobile phone applications for example, is required to convey new science, technical facts and to make ICZM messages more digestible and understood by non-experts, policy makers and Cabinet members. Summarized and comprehendible information such as simple sound-bites/”White Papers” or fact sheets need to be prepared to help support updates to building standards regulation (see Part C) so these may be more easily inculcated into development planning, for example. CZMU plays a key coordinating role to help implement improved climate compatible development interventions within the CZMA.

Delivering messages, founded within the integration of monitoring data from numerous monitoring programs, is key as it helps to convey information sourced from new scientific findings. A commitment to regular “State of the Coast” reporting is therefore required (see Section E3) through new and meaningful data collection and monitoring programs. The types of monitoring reports and information products to be used should include data summary reports, trend analysis and synthesis reports, coastal resource “health” score cards as shown in Figure E.1, report cards, simple annual summary reports and in depth twice-yearly periodic reports that synthesise long-term trends from larger data ranges. Therefore, reporting and communicating skills within GoB need to be developed. This can be achieved by creating a single fully searchable, open access, online system that may be accessed and interrogated by a range of beneficiaries including schools, children, consultants and public bodies alike. Such a system may also hold all reports, manuals, model outputs and historical data and be held in one central repository.

An Integrated Communications Plan, between CZMU, EPD, DEM, TCDPO and NCC, will help provide the necessary clarity, certainty and transparency for internal and external users. It should identify clear aims and target audiences, match reports and communication products to targeted audiences, identify any necessary standards such as templates for communications or reports, and identify necessary roles and responsibilities.

[15] http://www.coastal.gov.bb/

E5. INSTITUTIONAL AND CAPACITY REQUIREMENTS

E5.1. Government Responsibility and Authority for ICZM

The lead agency for overseeing the implementation of this ICZM Plan is the CZMU, within MMABE, whose remit and powers articulated within the updated CZM Bill (2020). Following Ministerial approval of the Plan, it will become a statutory document.

The institutional requirements to implement ICZM in Barbados will vary depending upon the stages in the cycle of the ICZM Plan (i.e.: implementation, monitoring, evaluation, review, revision, etc. – see Figure B.1 in Part B) but it will be the CZMU, with their overseeing and coordinatory role, who will be the focal point throughout the process.

When the ICZM Plan becomes statutory, the CZMU will have an enforcement as well as an advisory role. Staff, for example, may act as enforcement officers or be requested to initiate "Coastal Zone Protection Notices" with support from other agencies[16]. Procedural Guidance, in additional to agency specific Operational Manuals to guide day to day work standards and expectations, should be developed to guide the national approach to ICZM implementation to provide consistency and rigour. This is essential as in certain instances, legal action may need to be taken as a result of infringements to coastal zone related legislation or regulation. This guidance shall help communicate compliant issues and regulatory expectations for developers or equally help convey to user groups what activities and behaviours are suitable within the CZMA. These may also promote mitigation strategies or advisories for how compliant solutions or control measures (such as NbS) could be included within individual planning applications, designs or specific interventions to help promote best practice.

Any action proposed by a future Sustainable Ocean Based Economy (SOBE - or alternatively referred to as the "Blue Economy") initiative that either contradicts or jeopardises ICZM Plan implementation may need to be carefully and respectively reviewed to ensure compliance. An integrated and all-encompassing delivery model is needed that ensures institutional, planning and regulatory synergies under the responsibility of MMABE to anything already legally established to support ICZM delivery in Barbados from 2020 onwards.

E5.2. CZMU Restructuring

In light of the points raised in sub-section Part E5.1, and appreciating that institutional re-structuring of MMABE is underway as part of a specific Blue Economy assessment for Barbados, a revised institutional arrangement for CZMU is proposed. This is required to assist with the future delivery of the ICZM Plan (2020-2030). This re-structure, building on the work of McCue (2018[17]), minimises unnecessary wholesale alterations to CZMU though is designed to allow CZMU to operationally function to deliver its legal obligations whilst embracing any new focus that MMABE may require in the future within the life span of this ICZM Plan. The intention is to ensure that the CZMU have the capacity to enable the transition from an organisation has been focused on coastal conservation and engineering, to one that is now better able to take forward through improved coordination a cost effective support role for GoB with regards to Risk Resilient ICZM implementation.

As part of this new proposed institutional structure, in addition to consolidating on the existing Marine (now entitled "Marine and Coastal Resources"), Engineering and an enhanced Planning and Economics Section, a new *Data and Information Section* needs to be set up and formalised within CZMU. It is also recommended that a new *Communications and Outreach Section* is formalised to help sensitize and educate Barbadians about risk resilient ICZM.

Finally, the introduction of a formal Project Execution Unit is proposed as a stand-alone and permanent team. Its role is to identify and pursue new project opportunities and to assist in securing future project funding and to support any programme performance monitoring as required and on behalf of MMABE. A formal "CZMU Operations Manual" will be an important document to produce. This shall contain the exact internal specifications for operation, outlining the specific roles and delivery activities of each team in more detail.

The required CZMU teams, their purpose, proposed additional staffing needs, are summarised in Table E.2 and Figure E.3 as follows.

NB: the above does not take into consideration any initiative that GoB may need to rapidly undertake as a consequence of the global COVID 19 pandemic.

[16] As defined within the "CZM Bill (2020)" and the supporting "CZMA (Enforcement) Regulation (2020)"

[17] McCue JW (2018) "Preparation of a Strategic Action Plan (SAP) for Disaster Risk Management and Climate Change Adaptation" MMABE, 2018.

Table E.2: CZMU Team Structure to support ICZM Plan implementation

CZMU Team Title	Purpose of Section	Indicative Staffing Needs (2020-2030)
Marine and Coastal Resources Section	Continue delivering the existing coastal water quality and coral reef monitoring programmes plus support for marine protected area management (notably for Carlisle Bay), diversifying into new marine and coastal resource data collection programmes as required and as mandated by MMABE (in partnership with other agencies that may include marine biology assistance for new MSP initiatives). New section tasks shall be to promote (through the production of new guidelines etc.) the supply of practical advisories on the implementation of habitat rehabilitation, ecosystem-based approaches and coordination of "Health Cards" to support production of marine biological and ecological science inputs to the "State of the Coast" reporting tasks. Upon the request of MMABE (and budget dependent), extend marine biodiversity knowledge advisories and water quality assessment work. This should help future delivery expectations of a Blue Economy strategy and policy framework whilst extending the support to help deliver the expectations of SDG14 regarding offshore marine ecosystem health and condition (supporting extensions to the "State of the Coast" reporting approach as budgets dictate).	Within existing workloads, the Marine and Coastal Resources Section staffs (led by the Senior Marine Biologist) should also be able to appraise likely impacts on all marine and coastal resources and habitats (coral reefs, seagrass, mangroves/wetlands, beaches/sand dunes etc.). Staff roles within this Section shall be designed within the context of preparedness, response, risk reduction, risk identification, recovery, financial protection and risk transfer. Appraisal of these actions would then constitute the strategic action basis for how they bring DRM and CCA into ICZM operational planning of this Section. Under the leadership of a Senior Marine Biologist, he/she would be supported by a range of Research Officers and Field Inspectors, plus mapping and data analysts to support the Senior Marine Biologist and water quality analyst on matters relating to biodiversity conservation, resource management and SMA/MPA regulation and management delivery.
Coastal Planning and Risk Assessment Section	This Section takes full responsibility (on behalf of CZMU) to lead the implementation of planning considerations within the ICZM Plan. This will include providing the Director with advice on whether Coastal Zone Protection Notices (as defined within the CZM Regulations 2020) should be made on non-compliant actors or activities. The Section will continue delivering coastal policy support on existing hazard and risk developmental control reviews in line with the ICZM Plan, plus supporting legislation and regulations, Policy Framework and associated CZMU mandate. The Section should, however, relinquish its role on public education and outreach (see new Communication and Outreach Section below) in favor of diversifying into new marine spatial planning programmes as required and as mandated (in partnership with other agencies such as MMABE). New focus on probabilistic risk transfer and assessment is also proposed as an additional area of expertise. In support of the new probabilistic risk expertise proposed, a new research office position is proposed for inclusion within the Section to help on matters relating to resource economic valuation/return on investment/cost effectiveness/cost recovery roles for Risk Resilient ICZM etc.	Within existing workloads, the Coastal Planning and Risk Assessment Section staffs should be able to support on all coastal planning matters plus also to appraise likely climate or disaster risk scenarios that may face Barbados. Their roles should be to support on issues relating to disaster preparedness, response, risk reduction, risk identification, recovery, financial protection and risk transfer. The Section will continue with its important partnership relationship with DEM (on the Coastal Hazards Committee or similar) and the role played regarding CTIC (specific research office position is proposed. Under the leadership of a Senior Coastal Planner, he/she would be supported by the following: • an additional "Coastal Planner" (to support the current Senior Coastal Planner) focusing on planning application matters • a "Coastal Hazards" planner, Both of the above shall be supported by Research Officers and field officers to help deliver the new expected support roles needed in this topic area. This may include the need for support on coastal planning and development control plus data collection regarding socio-economic data collection etc (see Section E3.4 and Annex 9).
Data and Information Management Section	A new "team" is recommended to support all Sections of the CZMU on data and information related issues. The key management tool for the new Section shall be the NCRIPP, the management, update and development of which shall be responsibility of this new Section. The NCRIPP shall be developed in an iterative manner to support the effective and efficient use of a cross-sectoral Integrated Data Platform for all future Risk Resilient ICZM datasets required. Key delivery roles shall include support to the Project Team (see Figure E.3) and to help with the provision of maps/data to support the annual "State of the Coast" information production and reporting. Training of Data an Information Management Section staff in ways that the NCRIPP could be used to streamline the generation of maps for assessment may be needed. Data and information management (including data archiving of all data in the office such as NCRIPP data) may also be required. If requested of MMABE, the Data and Information Management Section could provide key support towards the delivery of SOBE for Barbados and as mandated under updated ICZM Plans and laws (in partnership with other agencies) to help support SDG14 "State of the Ocean" information production and reporting (as budgets dictate).	A key task of the team should be able to provide new formats for data collection for different reporting requirements. Production of user-friendly data representation maps and figures for publication will be needed that includes integrated outputs of data representation as required. Development of automated approaches may also be required to quickly capture post event disaster data in the field. This could include the integration of real time risk assessment and or damage assessment data collection. Under the leadership of the Coastal Information Systems Manager, a Deputy Coastal Information Systems Manager position should be created to support the Section lead. The role of the Deputy Manager (as the Registry Clerk for the Section) shall also be of support to the Coastal Planning and Risk Assessment Section on data related matters as required. They both shall be supported by a GIS Systems Officer and research officers/technicians (draughtsman - land valuation officer and one support statistician) whom shall both help the Senior Data Manager to deliver and implement the new requirements and expectations of NCRIPP as set out within the updated Policy Framework and updated ICZM Plan (2020 onwards).
Coastal Engineering and Oceanography Section	The team shall continue in terms of collecting existing (and updated) beach profile, tide, wave, geotechnical and structural and landscape monitoring and maintenance programmes as dictated by updated ICZM Plans, legislation and mandate, (in partnership with other agencies). Within existing workloads, the Coastal Engineering and Oceanography Section staffs should be able to appraise likely disaster risk scenarios and the roles their Section would be required to play within the context of preparedness, response, risk reduction, risk identification, recovery. Appraisal of these actions would then constitute the strategic action basis for how they bring DRM and CCA into ICZM operational planning of their Section. Upon the request of MMABE, the Section shall provide key support towards the engineering or oceanographic requirements and delivery of SOBE for Barbados. This would involve adopting a new marine engineering focus to help collect necessary offshore datasets/engineering advice which may include new design work for offshore structures, platforms, maritime engineering support (should this not exist in other agencies in Barbados).	Under the leadership of the Senior Coastal Engineer, one additional "Coastal Engineer" position shall be created, whom shall be supported by 3 separate Technical Officer positions (oceanographer/modeler/marine engineer) plus part time Draughtsman (as required) to assist in field data collection. as well as a part time Hydrographer who shall support on deploying oceanographic equipment and retrieval as required as well as validating engineering structures conditions etc. These shall help the current Hydrographer to deliver and implement the necessary pre- and post-structure maintenance works plus support for drone pilot training as required. Possible consideration for drone pilot training for Hydrographer as required. Additional divers may be required (though these may be seconded from the private sector as required to reduce costs) to assist with field surveying to assist in beach profiling and marine ecosystem mapping.
Communication and Outreach Section	Communication need to be an ongoing outreach initiative and hence a new Section is proposed within the CZMU organisational structure. This section will be the Public Relations (PR) "face" of the CZMU specifically (not for MMABE overall), though if required, it should contribute towards improving data and knowledge/message conveyance to MMABE. It will be responsible for a range of tasks including the following: • general enquiries, • attending school invitations to do presentations and job fairs and career show cases,	Within existing workloads, this Section should also be able to appraise likely disaster risk scenarios and the roles they would be required to play within the context of preparedness, response, risk reduction, risk identification, recovery, financial protection and risk transfer. Appraisal of these actions would then constitute the strategic action basis for how they bring DRM and CCA into ICZM operational planning of the Section. Under the leadership of the Senior Communications Manager, the staff requirements include a Communications Officer

CZMU Team Title	Purpose of Section	Indicative Staffing Needs (2020-2030)
	• liaising with different ministries when looking to put on “expos” or participating in expos, • promoting the function of the CZMU • developing information in a user friendly form for all social media platforms and web page. This new “team” shall help support all Sections of the CZMU on matters relating to external stakeholder communication and outreach delivery (from a CZMU organization perspective to governmental and non-governmental groups). The focus shall be on communicating Risk Resilient ICZM related topics and as mandated under updated ICZM Policy Framework and ICZM Plans and laws (in partnership with other agencies) and to help support “State of the Coast” knowledge dissemination.	(public education) and once for Social Media content. Senior Research Officer, Policy Development Officer Environmental Officer and Research Officer. This section will also collaborate with the Unit's sections in the formulation of policy requirements and information needs for policy development. Any videography services or similar would need to be sub-contracted.
Project Execution Unit	The Project Execution Unit should be a permanent team created to play an important and specific role towards ensuring that CZMU have the critical technical supporting individuals to deliver the required Project Management support to donors/GoB teams as related to future ICZM projects. Specific new capacity requirements maybe required on such individuals who understand budget support related financial modalities. It is necessary to be as multifaceted as possible seeing the project proposals writing and project execution will require a different complement of skillsets leading to a team that is diverse in its function. Expanded staffing competencies will therefore be essential for independent project proposal and project implementation with the core team being responsible for the overarching supervision and execution.	The staffing make up of this Team shall mirror similar structures already adhered to through the implementation of ICZM. Individuals selected (originally “seconded” from other CZMU Sections as required) shall be made permanent within the Project Team to help support the technical requirements of CZMU and others to help implement and monitor progress against possible Project Proposals that are pursued and implemented (e.g.: Regional GCF focused projects etc.). The likely organogram structure for this Team is outlined in Figure E3. Should demands be significant (more than 1 project underway at any one time), potential secondment of Senior Staff from other Departments may be necessary. The Project Team shall be populated (in the first instance) with core members of the Admin Section (see below) namely an accountant and secretarial support as a minimum. Admin staff may be replaced on short term contracts (to supplement the other CZMU Sections ongoing workloads) if required.
Admin Section	To continue to provide the administrative support (accounting, secretarial, human resource support to GOB etc.) as required for the successful continued delivery of Risk Resilient ICZM.	Under the leadership of the Administrative Executive Coordinator. The staff requirements include Executive Secretary, Registry Clerk and 2 Clerical Officers; Executive Officer and Personnel Officer, Accountant, Assistant Accountant and Accounts Clerk; Maid, General Worker and Messenger Driver.
Research and Policy Development	This section will also collaborate with the Unit's sections in the formulation of policy requirements and information needs for policy development.	The staff requirements include Senior Research Officer, Policy Development Officer Environmental Officer and Research Officer.



Figure E.3: Future CZMU Organogram (Under Administration, staff requirements include Executive Secretary, Registry Clerk and 2 Clerical Officers; Executive Officer and Personnel Officer, Accountant, Assistant Accountant and Accounts Clerk; Maid, General Worker and Messenger Driver. Under Research and Policy Development, staff requirements include Senior Research Officer, Policy Development Officer Environmental Officer and Research Officer. This section will also collaborate with the Unit's sections in the formulation of policy requirements and information needs for policy development. External donor funded consultancies may be needed to support the CZMU in implementing many of the proposed actions set out in Table E.1.

E6. EVALUATION AND MONITORING PROCEDURES

E6.1. Performance Management and Evaluation

Details on Performance Management and Evaluation (PME) as part of the future ICZM process in Barbados is clearly set out in Appendix 4 of Volume 1 (ICZM Policy Framework). That Volume includes a set of governance related performance indicators that is designed to help assist implementation of the ICZM Policy Framework up to 2030. It also measures the performance of the responses to adapt to climate related pressures facing the CZMA of Barbados. They focus on variables that relate to inputs, processes, outputs, outcomes and impacts of a Risk Resilient ICZM programme.

The indicators proposed within, as set out in Volume 1: Appendix 4, are also designed to measure the progress and quality of the governance process itself, that is, the extent to which Risk Resilient ICZM is addressing the issue(s) that triggered its initiation in the first place. Four main areas of performance evaluation proposed include:

1. **Institutional coordination and coherence** to ensure that (i) the functions of administrative actors are properly defined, including through the establishment of a coordinating mechanism; a legal framework exists to support ICZM and the pursuance of coherent objectives; the impacts of sectoral plans, programmes and projects potentially affecting coastal zones are taken into account through procedures for environmental impact assessment (EIA), and carrying capacity assessment; and conflict resolution mechanisms are available to anticipate, resolve, or mitigate conflicts over the use of coastal areas and resources;
2. **Quality and effectiveness of managemen**t by (i) the formal adoption of the ICZM Plan (Volumes 1 and 2); (ii) active implementation of these via agreed Action Plans; (iii) routine monitoring and evaluation of management and its outputs, outcomes and impacts, as well as the consideration of results in adaptive management; and (iv) the sustained availability of human, financial and technical resources to enable effective management;
3. **Improved knowledge, awareness and support** by ensuring (i) the production of results from scientific research, its use for management and its dissemination to a wider audience; (ii) the participation of stakeholders in decision-making processes; (iii) the activities of NGOs and CBOs; and (iv) the introduction of ICZM related subjects into educational and training curricula for the formation of ICZM cadres;
4. **Mainstreaming ICZM into sustainable development** by (i) the development and application of technologies that can enable and support ICZM; (ii) the use of economic instruments to promote ICZM objectives through the private sector; and (iii) the incorporation of ICZM objectives into broader sustainable development strategies.

E6.2. Integrated Monitoring Programmes

The GOB, through the coordinatory role of the CZMU, needs to focus efforts on implementing an Integrated Monitoring Programme (IMP) that uses the current NCRIPP database platform and updating its functionality accordingly to support implementation of a national IMP approach. This would provide GoB with three primary benefits:

- better understanding of cause-and-effect relationships within social-ecological systems and the response of these systems to management actions (represented by a Driver-Pressure-State-Impact-Response model);
- cost-effective use of available resources for monitoring the status of coastal resources (see E3.7 – “State of the Coast” reporting);
- improve insights into the effects of cumulative pressures and impacts on coastal resources.

One suggested addition to the NCRIPP dataset (as part of a future IMP) should be through improved coastal asset inspection and reporting for all structures within the CZMA (built and natural – see Part C5). A new focus could perhaps be placed on how the coastal assets (defences, man-made or natural features) perform under storm conditions as this would (for example) would additionally support the understanding of climate resilient performance with regards to climate/disaster induced risks (e.g.: wave or flood overtopping early warning systems – see Sub Part E3.3).

The creation of an asset register to record the state of all natural (typically soft and rocky shorelines i.e. reef, beaches, mangrove, cliffs etc.) and man-made (hard structural engineering and artificial beaches) assets is highly recommended for the reduction of risk on the coast. Known weak spots should be identified and focused upon for monitoring under storm event situations such as where drainage infrastructure (i.e.: fluidizers for watercourses, etc.) is needed to protect assets or if poor drainage is impacting upon the ability of key (post event) drainage mitigation related machinery to operate efficiently.

Finally, the inclusion of socio economic data into NCRIPP would also be highly beneficial at the individual property level. A guide to support this is presented within Annex 9.

E7. FINANCIAL CONSIDERATIONS

E7.1. Overview

This part of the ICZM Plan considers how to pay for the implementation of Plan. MMABE, on behalf of the GoB, is concerned not only with economic instruments, but also in mechanisms through which the private sector may be better involved to play a larger role in supporting the delivery of ICZM, and to introduce new finance blending opportunities to help GoB to raise the funds needed to finance its own investments.

This sub-Part places emphasis on the economic understanding of "economic instruments". It also considers mechanisms for encouraging private sector contribution towards financing ICZM. A range of possible instruments are considered as mechanisms for raising funds (cost recovery) that may finance the investments required.

There are many possible financial pathways to help support the financing of this ICZM Plan. One approach, often preferred by economists, is by “stacking” or “blending” several funding and financing sources to address the lifecycle requirements of public infrastructure assets. To this end, a range of potential funding and financing sources for supporting the implementation of this Plan (including a range of coastal/flood resilience projects into the future) are now considered for adoption.

KEY MESSAGE

For several reasons, this ICZM Plan cannot accurately estimate the cost of protecting the Barbados CZMA. This is because there are many possible coastal management technologies that may be used, all with widely varying costs. The Plan does not determine which approach is most suitable for each stretch of coastline, which in fact is for the existing Barbadian planning and EIA process to determine. Rather, this sub-Part considers the strengths and weaknesses of the different technologies and their suitability for different types of landscape, and then sets forth a process that the GoB can use in choosing among them for each site. Consequently, it is uncertain, at this time, which interventions will be chosen, nor is it known the time frames required for addressing the problems along different parts of the coastline, hence it is not possible to estimate without detailed site-specific analysis, the cost of a given intervention. As GoB begins to set priorities for where to begin work, and to evaluate the options for the coast, it will be able to estimate the actual costs of each option and compare that with the benefits it should achieve; this however cannot be completed at this juncture. Consequently, the ICZM Plan cannot accurately state how much money the government needs to raise in order to address ICZM.

Despite this, there is a general sense of what the money will have to cover. Major capital investments will be required to construct structures that can protect specific stretches of coast. Somewhat lower investments will be required for "soft" coastal protection. All of these investments will require ongoing maintenance to keep them operational, both as storms and sea level rise affect them and as human activities may cause further degradation. In addition, funds will be needed to educate coastal communities about how to protect their resources and how to adapt to avoid the harm that will unavoidably be caused by increasingly severe storms. Without knowing precisely which investments will make most sense, no monetary figure can be placed on these costs; nevertheless, the Plan anticipates that these will be high, and will increase over time as our knowledge on climate change evolves.

Finally, the COVID 19 global pandemic is likely to place unprecedented economic pressures for all nations of the world for the next decade. At the time of writing this Plan, nations are in lockdown and national budgets are being stretched to keep sectors afloat. This crisis may have significant ramifications on the extent that any of the economic measures presented may have in practice over the coming decade.

E7.2. Current Macro-economic Situation

Due to the current debt situation facing Barbados (and other Caribbean nations exacerbated by the global COVID-19 pandemic) within the next 3 years (up to 2023), the GoB will need to focus all of its sectoral efforts on improved reform, efficiency, productivity and debt management. This commonly means more financial prudence in relation to the justification and use of key public resources (i.e.: budgets etc). As for many countries facing similar economic challenges, it is those Units or Departments that can better embrace and justify their service value (within an IMF structural reform program) that are the ones that will garner the most political and hence financial budgetary support. In light of this, the GoB (through this ICZM Plan 2020 – 2030) intend to create the necessary platforms to be able to put necessary technical requirements in place (e.g.: economic valuation models) to help its core work requirements to be mainstreamed into annual public accounting and associated budget lines. This work will set Risk Resilient ICZM on a financially sustainable footing, whilst seeking to support the foundation for an all-encompassing sustainable ocean based economy in years to come.

Tourism remains one of the main driving forces behind the current Barbados economy. It currently accounts for about 12.9% of the GDP and is the leading sector within the economy. The tourism sector employs about 26,000 persons and about 13,000 persons employed in hotels[18]. Consequential losses to coastal ecosystems services and the public and private infrastructure that depend on them represent significant threats to the resilience of the economy (Barbados National Assessment Report 2010). The economic impact of climate change on the coastal zone is very significant as it has exposed assets that will reach an estimated to US$4.7 billion in 2020 under an A2 scenario in 2020 with a maximum of US$44 billion for 2100 under a B2 scenario[19]. For these reasons, and mindful of GoB policy and CZMU interventions, the ICZM Plan must be designed to support this national position by deriving an innovative approach towards integrating coastal protection needs, improved longitudinal beach access and marine conservation.

The ICZM Plan also seeks to identify the “signposts” for “added value” new technical areas that if pursued effectively and efficiently, will benefit the nation economically. This is especially of relevance based on recent new tourism surcharges which GoB have imposed from late June 2018 whereby additional tourist fees were introduced ranging from $2.50 (£1.90) to $10 (£7.60) per room per night, depending on accommodation class. The money will be collected in resort and is applicable to all existing bookings though money will not be released for environmental improvements.[20] The new levy follows the introduction of an “airline travel and tourism development fee” of $70 (£53) to be imposed on travellers leaving the country from October 1 2018, while VAT in the tourism sector will rise from 7.5 per cent to 15 per cent in 2020.

[18] Clyde Mascoll 2013, The Promotion of Greater Inter-Sectorial Linkages with the Tourism Sector in the Barbados Economy. Barbados Private Sector Association, ATN/ME-11627-BA; BA-M1007.

[19] A2 and B2 scenarios are from the Special Report on Emission Scenarios (SRES) for the period 2010 to 2100 and as detailed by the Intergovernmental Panel on Climate Change (IPCC). See http://www.eclac.org/publicaciones/xml/7/45297/LCARL.326.pdf.

[20] https://www-telegraph-co-uk.cdn.ampproject.org/c/s/www.telegraph.co.uk/travel/destinations/caribbean/barbados/articles/barbados-tourist-tax-cost/amp/

Complementing the discussion on tourism presented above, Barbados has already begun to take steps to 'green' its economy by incorporating renewable energy into its energy mix (including tourism). Barbados is one of 22 countries in the Partnership for Action on the Green Economy (UNEP 2014) that aims to place sustainability at the heart of economic policies and practices to advance the 2030 Agenda for Sustainable Development and support the reframing economic policies and practices around sustainability to foster economic growth, create income and jobs, reduce poverty and inequality, and strengthen the ecological foundations of economies. The "Green Economy" framework (UNEP 2014) will hopefully assist in delivering sustainable development, and it is expected that as part of this reconfiguration of the national economy, very strong links will be forged between environmental management, CCA and DRM in order to achieve national goals for social and economic well-being. All financial institutions are seeking to consider CCA and DRM in their economic models[21].

E7.3. Possible Financing Mechanisms

Many different mechanisms (see Appendix A) are in existence to create a financial incentive for effective ICZM implementation including raising funds to cover the costs of protecting the coast (i.e.: often referred to as "cost recovery"). This sub-Part briefly reviews a number of economic instruments for environmental protection currently adopted to fund coastal zone adaptation elsewhere in the world. For each option, it also considers how it is now being used in Barbados (if at all), and whether it represents a viable measure as part of a national ICZM cost recovery exercise.

E7.3.1. Environmental taxes

A common economic approach to environmental protection is to charge for the right to make use of environmental services, with the objective either of reducing the use of those services to a sustainable level, or of generating revenue, or both. "Environmental services" could mean several things; the pollution-absorbing capacity of the environment (this would be an emissions tax), the production of renewable resources (this could be a charge for fishing quota or a stumpage fee), or the right to use land with particular amenities such as being on the coast. In its theoretical form, such charges are the only tool used to reduce the use of the services; there would be no quota.

Environmental taxes could also be imposed on non-renewable resources, to slow down their consumption or create an incentive to use them more sustainably. Various land-based taxes could operate in this way. A tax on impervious (paved) surfaces might encourage leaving as much space as possible unpaved (green), which could facilitate absorption of water into the ground, reducing runoff, flooding, and coastal pollution. An increased tax value on all coastal land might encourage developers to move inland from the defined CZMA whenever possible, reducing coastal pollution and reducing the risks from storm surges and sea-level rise. Where the demand for land within the CZMA is high and most of it has already been developed, as in Barbados, such a tax might however be more effective as a way to generate revenue than as a way to reduce development.

Usually such measures are designed both to reduce activities to a sustainable level and to raise revenue. The revenues raised could be placed directly into the GOBs' general fund or could be earmarked for environmental protection activities. Economists typically prefer that they become part of general revenues, arguing that the priorities for how government money should be spent are unrelated to how the funds are generated. Environmentalists argue for such funds being allocated to environmental protection, often because they suspect that they will guarantee more funds for the environment this way than through the priorities guiding the general government budgeting process.

The design of these taxes involves finding a balance between reducing undesirable activities and generating revenue. A very high fee will reduce environmental harm altogether but generate no revenue. A very low fee will neither reduce harm nor generate substantial revenue. At the fee level that maximizes revenue in the short run, too many actors in the industry may choose to make use of the service (emitting pollution, catching fish, etc.), which will not be environmentally sustainable. Alternately, the fee level that maximizes revenue could lead consumption to be below sustainable yield, unnecessarily reducing the level of economic activity. Setting the level of such taxes is often difficult, and calls for a detailed understanding both of the physical or biological nature of the environmental services and of the market for those services.

Designing environmental taxes that actually do create incentives for better coastal management would not be straightforward. While threats to the Barbados coast coming from land management practices, land-based pollution, or fishing, other more serious long-term threats are being derived from climate change. Whilst this may be influenced by environmental taxes in the major GHG emitting countries, it will not be addressed by taxes imposed on consumers in Barbados. Taxes that are borne by those making use of the coast, notably tourists, serve only to generate revenue, not to create economic incentives to engage in activities that actually resolve coastal management problems.

E7.3.2. Cap and Trade Schemes

Cap and trade schemes have the same objective as environmental taxes; that is to create an incentive to reduce pollution or resource use to an acceptable level. Instead of using the tax level to achieve that goal, these schemes set a ceiling on the total amount that can be emitted or used, and then issue marketable permits to pollute or to use the resource. When the system is introduced, those permits are either given away (usually based on previous level of emissions or use) or auctioned off. From both an economic and a financial perspective, the latter is better, since it ensures that those who have the most to gain from either polluting or harvesting resources will purchase the permits. It also provides a one-time infusion of income to the government, ensuring that the public sector is compensated for private use of the resources. However, in practice permits are usually given away rather than auctioned off, because politically this is much more acceptable.

Once permits are allocated, companies can sell them if they wish. The sale price is set by the market. As with environmental taxes, this ensures that the companies with the most to gain (i.e. those facing the highest costs to reduce pollution or those with the highest profits from resource use) will end up buying the permits, since they will be willing to pay the most for them. Those who do not buy permits will reduce their emissions or stop using the resources. This means that emissions reductions will be achieved at the lowest possible cost to the total economy, i.e. in the most efficient way.

Barbados currently has no cap and trade schemes in place, though with the onset of a SOBE (Blue Economy), issues linked to the control of pollution plus limiting the harvest of a renewable offshore resource may need to be better considered in the Barbados context in the future as a way of improving management of the coast.

[21] http://www.preventionweb.net/files/31056_brb_NationalHFAprogress_2011-13.pdf

E7.3.3. Environmental Fees

Environmental fees can be similar to taxes; however, the concept here is that the user of a service is paying for the costs involved in providing that service. This is the principle behind waste disposal (trash) management fees, drinking water charges, or sanitation charges; in all of those cases, the public sector is providing a service that the user should pay for as if it were provided privately. If the logic of such fees is followed closely, the level is set based on what it costs to provide the service, and the revenue is used to cover those specific government costs.

However, revenues do not always go to cover the costs of service provision. For example, international experience with national park entry fees shows that there is often some disagreement about whether parks are a public amenity that should be available to everyone, or simply a form of recreation that should be fully paid for by those who engage in it. Historically, national parks and protected areas have been regarded as a public amenity paid for out of general revenues. The entry fees are often not sufficient to cover the full costs of the park system – or even its operating costs, not including the direct or opportunity cost of the land – and they often go to the treasury rather than being dedicated for park management.

A *"Coastal Zone Management Area Housing (or Resort) Scheme*" and/or Permanent Resident Scheme could be introduced to encompass an environmental fee, in the form of the registration fee of an agreed amount that is required on each property sold within the defined Barbados CZMA. This fee could be regarded as a disincentive to coastal development, intended to slow down the rate at which the limited resource of coastal land is consumed. This, however, is often not the case as most developable coastal land in Barbados has already been allocated and developed in one way or another, and these schemes simply change the form of that development. Such a scheme could be set up primarily to create a way for the government to raise money from wealthy people who have the funds to purchase very expensive residences. The Scheme, in particular, could be regarded as the sale of the right to live in the country in return for a large contribution to the real estate market and high tax payments.

Because these schemes depend on access or proximity to the coast, a case could be made that the resulting tax revenues should be used for coastal management purposes. For at least a few years, until the demand for high-end residences is saturated or the available land has been built on, this could generate enough funds to cover some of the capital costs of improved ICZM.

E7.3.4. Payments for Environmental Services

Payments for Environmental Services (PES) are mechanisms through which individuals or companies that rely on an environmental service (often related to access to clean water or sea water) pay those upstream from them to stop engaging in activities that might disrupt that service (typically to reduce sedimentation or pollution from upstream or within a catchment). The key feature of PES as an economic instrument is that it involves a willing seller of services (in the private sector), and a willing buyer (in the private or public sector), exchanging at a price they agree on.

In the case of PES systems related to clean water (as an example), the downstream user is facing high costs to treat water for drinking or food processing, and it would cost less to pay those upstream not to pollute than it would cost to treat the water prior to use. The classic case of such a PES system is the payments made by the New York City to communities near the city's water supply reservoirs, in return for those communities not allowing development of land whose runoff would flow into the reservoirs. This ensured that the water flowing to the city would be clean enough that the city would not have to invest in a water treatment plant. While this is economically rational from the perspective of a city, it is worth noting that it runs directly counter to the polluter pays principle, which virtually all governments say they subscribe to. It implicitly says that the upstream residents have a right to use their land as they wish, and those downstream who want clean water must pay them not to pollute.

The New York example is a "pure" PES system, in that the direct beneficiaries of the clean water (New York City taxpayers) are paying those who can ensure access to clean water (the communities in the Catskill Mountains where the reservoirs are located) to continue providing that service. In some cases, however, the government payments to upstream "providers" of environmental services are not directly linked to benefits from the services. Those are not market-based economic instruments, because there is not a clear beneficiary of the service who is willing to bear the cost of ensuring that it will continue to be provided, as there is in the New York City case. Rather, it is simply the taxpayers, many of whom may not benefit from upstream environmental conservation activities, who are paying. These could be simply considered subsidies, if PES is actually defined as a measure that depends on the working of a market in a way that leaves both the sellers (those protecting the environment) and the buyers (those paying to ensure that environmental services will be available) better off.

There are currently no PES systems in place in Barbados. If threats to the coast clearly come from economic activities, such as rapid land development or polluting industry, a PES system to prevent that harm would need to involve those who want to make use of ecosystem services (e.g. clean beaches – managed for a number of specific beaches by NCC etc) paying the developers or polluters to change their behavior. This implicitly assumes that the developers or polluters have the right to do whatever they want on the coast, and other users have to pay to ensure their access to the same resources. With the onset of a SOBE (Blue Economy), issues linked to PES may need to be better considered in the Barbados context in the future as a way of improving management of the coast.

E7.3.5. Insurance

Insurance has been proposed as a way to manage the costs imposed by coastal flooding or other weather-related disasters, particularly as climate change worsens. This would fund the response to disasters; it would not fund the coastal zone management tools that could prevent them. It would shift the burden of the cost from those who are actually affected by them to the pool of people (or organizations) that have purchased insurance. As climate change impacts become more prevalent, the risk will increase, and the insurance premiums will go up; even now, premiums for flood insurance are typically too high for most at-risk property owners to be able to afford it. While this may seem like a useful short-term approach, it does not replace coastal adaptation; in fact, it can create an incentive not to invest in adaptation, if those at risk expect their homes or other property to be replaced by the insurance company when there is a flood. It also does not generate the funds needed to implement this ICZM Plan.

Notwithstanding these caveats, there is considerable appeal for insurance as a way to eliminate the financial shocks from hurricane events impacting on Barbados. The GoB may investigate the possibility of purchasing a so-called "parameterized" insurance policy that would pay out in the case of a storm exceeding specified levels of wind, water heights, or other measures. However, the premiums are likely to be so high that it may not prove viable. If any companies were, for example, to offer climate change insurance products, they would be required to build the capacity to analyze whether the industry could actually afford to pay out on claims without bankrupting itself. Elsewhere around the world, some insurance companies are using differential pricing to create an incentive to invest in adaptation measures, since those will reduce the risk of disaster and thus the probability that the insurance company will have to pay out. This highlights the limited extent to which Barbados can rely on insurance

alone to address the risks imposed by climate change. The country must focus on adaptation in order to prevent disaster in the first place; insurance cannot change that, and is likely to be unaffordable even if it is available.

E7.3.6. Public-Private Partnerships (PPPs)

Public-private partnerships (PPPs) typically involve a private company that builds and operates some kind of public facility under contract to the government. The facility – for example, a trash incinerator or a water treatment system – generates revenue from the fees paid by all citizens for the services it provides. The company operates the plant and keeps the revenue for a pre-determined period of time, during which it recovers its investment plus a reasonable profit. At the end of that period the facility reverts to the government, which then operates it and earns the revenue. Such a system enables the public sector to get the facility built without having to put in the investment capital itself.

It is not clear that this kind of system is a viable mechanism for developing coastal zone management infrastructure, however, because such infrastructure does not generate revenues. One could imagine such a partnership between, for example, a resort (or large hotel) owner on the south or west coast of Barbados and the government, to cover the costs of infrastructure needed to protect the resort. The "revenue" could be construed as a portion of the resort charges. However, it is likely that the resort developer would not want to turn management of the infrastructure (and associated revenues) over to the government after some period of time, because that would put them at risk if the government did not maintain it well enough. Since the resort (rather than the community as a whole) would be the beneficiary of the infrastructure, the developer (or later resort owner) has a much greater incentive to ensure maintenance of that investment than the government does. To this end, PPPs certainly play a potentially significant role in supporting the implementation of ICZM in Barbados. Perhaps the best example internationally is that undertaken at Pevensey Bay (southern England) which provides a very interesting framework “model” for which Barbados may potentially follow. For the government (i.e. specifically CZMU), the advantage of a PPP approach is that for engineering projects, the fixed costs of the coastal protection/adaptation approach is paid over an extended time period, and the care and maintenance are undertaken by a third party. Here, contractual agreements and division of risks are important. The PPP model, with relevant authorities cooperating with private partners to provide public services under contracts, sharing responsibility, risks and benefits will be an optimal model. However, there is a need for setting up such system in place as well as investing in protective measures for which long term maintenance will be secured through the PPP contractual arrangement.

E7.3.7. Debt for nature swaps

Debt for nature swaps are mechanisms through which an impact investor (sometimes an environmental NGO) buys back a portion of a country's debt at a discounted rate and issues a new, lower loan to the country on condition that the country spend the savings on some form of conservation. The greater the risk that the country has defaulting on an original debt, the greater the discount available to the purchaser of the debt, thus the more the debtor country can gain from the transaction. In addition to the direct financial benefits, the restructured debt is typically repaid in local currency, allowing the debtor country to retain its foreign exchange reserves for purposes other than loan repayment. Debt for nature swaps were first developed by the World Wildlife Fund (WWF) in the 1980s, and have been used by many countries (including small island developing states) to generate funds for biodiversity conservation. While the country benefits from the debt reduction and restructuring, these mechanisms require them to spend more on conservation than they would have done otherwise, even if this would not be their highest priority for use of the resources.

Such a mechanism has recently been developed by The Nature Conservancy in the Seychelles, to fund marine conservation and coastal zone management. Using a combination of debt refinancing and grant, TNC, through its “Nature-Vest” finance arm, has arranged to purchase $21.6 million in debt for $20.2 million, a rather modest discount on the overall value. This has been funded with $15.2 million in loans from impact investors and a $5 million grant from TNC. A portion of the proceeds – essentially the grant amount plus the savings on the debt – will be put into marine and coastal conservation measures.

Whether such a mechanism might be viable in Barbados depends on whether holders of the country's debt would be willing to sell it back at a discount; i.e. on whether they expect to get paid back what they have invested in the country. While in general the higher bond rating is good for the country, this suggests that debt for nature swaps is not that likely to be a useful strategy for raising funds for ICZM in Barbados.

E7.3.8. Blue bonds

"Blue bonds" are bonds whose revenue is used for activities related to ocean conservation, ICZM, or similar issues. They are analogous to the "green bonds" that have become a relatively common conservation finance mechanism. These bonds attract investors who have a moral commitment to putting their funds into projects that will benefit the environment or who have some regulatory or certification requirement mandating that they do so. Green bond funds are being used for a variety purposes, including pollution reduction, brownfields clean-up, and reducing greenhouse gas emissions. As the market has grown, concerns have arisen about whether the bonds actually benefit the environment. In response, both international and national certification systems have been developed, with third-party verification, to ensure that the environmental goals are actually being achieved.

Similar financial instruments are under discussion to raise funds for "blue" issues such as marine conservation and ICZM. The Seychelles is taking a lead in this arena, through the bonds that they are issuing in connection with the debt for nature swap discussed above. Because these instruments are new, the certification systems are not yet fully in place; more work will be needed before this become a routinely accessible source of financing for ICZM. Moreover, while bonds may be a useful tool for obtaining capital needed for coastal zone management, this does not address the question of how the money will be paid back. Such bonds do not increase the total funding available; they only offer a way to borrow money that must be repaid later out of government revenue.

E7.3.9. Lotteries

In some jurisdictions, lotteries are routinely used to raise funds for conservation or other environmental activities. The UK Heritage Lottery Fund and the State of Oregon Lottery (in USA) are examples of well-established systems raising funds that are allocated to community projects including environmental protection, conservation of rivers and marine areas, and other activities. The amount that can be raised from a lottery depends on ticket price, how many tickets can be sold, how much of the revenue goes to prizes, and the administrative cost. According to the UNDP, just under 30% of the revenue usually funds projects, the rest going to prizes and administration.

Barbados has had a national lottery that was established in 2005 to support Youth, Sports and Culture. Lottery proceeds support many youth, sports and cultural programs throughout the community, including its biggest benefactors-The Barbados Cricket Association, Barbados Turf Club, Barbados Olympic Association and the National Sports Council. The Lottery currently offers players a suite of seven games: Super Lotto, Pick 3, Pick 4, Double Draw, Mega 6, Scratch & Win, Caribbean Keno and its newest game coming in October 2016 “Express Cash.

It is possible that a separate lottery could be established to raise funds for ICZM and coastal adaptation. Such a lottery would have to be distinctly different from the national one in order to avoid being in direct competition with it. This might be done by presenting the purchase of those tickets much more explicitly as a social act rather than as gaming. If the funds were clearly earmarked for something of public interest, such as maintenance and protection of public beaches, the public might be interested in buying the special tickets, possibly even if they cost more than the national lottery tickets and the expected payoff were lower. If this were of interest, it would make sense to consult with the Barbados Lottery; if they could take on the management of a second lottery, with tickets sold through the vendors with whom they already work, it would probably be more efficient than trying to create a second network for selling tickets.

E7.3.10. Premium plates or stamps

Some countries use premium license plates or postage stamps to raise funds for specific social programs, including environmental protection. In the USA, the states of Maryland and Virginia both offer special license plates that support the protection of the Chesapeake Bay, Maryland charging an initial $20 premium for the plate and an annual $10 premium each time the registration is renewed, Virginia charging a $25 premium each year. A portion of the premium in each state goes to a special trust that supports projects related to the clean-up of the Bay. In Maryland, the plates brought in about $3.6 million per year for environmental activities in 2015 and 2016. In Virginia, the plates have brought in only about 10% that amount; the reason for the difference is not clear.

In Barbados, such a scheme would probably bring in less money, primarily because its population is much lower than that of Virginia or Maryland. Although vehicle registration fees are low in Barbados, the road taxes are much higher than vehicle registration charges in either state. This might make people less willing to pay a premium to support conservation, reducing the potential to generate revenue in this way.

Some countries use premium stamps to raise money for specific causes, referred to as semi-postal or charity stamps. In Europe and the United States, they have commonly been used to raise funds for health-related causes. More interestingly for Barbados, several SIDS have used them to raise funds for disaster relief after major storms, including St. Vincent and the Grenadines and Tonga. Given Barbados's history as a key country in the world of philately, it is possible that such stamps might be of interest to collectors, as well as being used to send letters. However, the potential of such stamps to raise significant revenues for coastal zone protection is probably limited.

E7.3.11. Subsidies

Subsidies are public funds provided to cover the costs of actions considered desirable, without anything given in return. In a country like Barbados they would typically be paid either out of national government revenue or with foreign grants, i.e. paid by the taxpayers of another country. In the first case, the question becomes one of where the government would get the funds, which private sector actors should receive compensation, and why. Since the government's primary focus in considering how to finance coastal zone management is to find a way to induce the private sector to contribute more than it does now, using tax revenue to subsidize private actions to protect the coasts does not address the problem.

The second option (international donor support for ICZM) is obviously of relevance to Barbados. Substantial funding is, of course, available for climate change adaptation in developing countries (for example through the Green Climate Fund – GCF). However, because Barbados is defined as a developing “high income” economy[22], the expectation is that international funds will become increasingly difficult to obtain, which is why the government is currently focused on how to generate more money from private sources.

E7.3.12. Voluntary contributions

The possibility of using voluntary contributions to fund ICZM has received a fair bit of attention in Barbados. Voluntary contributions to support coastal zone management are an interesting idea, but should not be part of the government's strategy for raising funds. Rather, the government should encourage an NGO to work with the hotels to set up such a system nationwide, and to manage the allocation of the proceeds to support targeted coastal zone investments. This seems a more appropriate approach to voluntary donations than running it through government, because the establishment of a government-run voluntary contribution system would create an undesirable mixing of mandatory and voluntary funding systems. Moreover, because voluntary contributions have been initiated by the private sector, other companies may be more willing to participate if the scheme remains in their hands. This is particularly true because of the private sector discomfort with the shifting of a majority of their Corporate Social Responsibility (CSR) levies into the public treasury, leaving them unable to continue supporting communities who had previously been receiving their CSR contributions, and blurring the distinction between the CSR funds and any other taxes

In the case of other tourist focused SIDS, such as Mauritius (Lux Hotel group case), about two thirds of the revenues are used for energy efficiency projects, and the remainder to offset the company's carbon emissions with forestry projects. Since improvements in energy efficiency benefit the company financially, that portion of the voluntary contributions is paying for something that the company would presumably choose to do even without them; it amounts to giving the company the capital needed for those investments rather than the company using its own capital or borrowing funds for that purpose. Thus, it essentially saves the company the interest on borrowing money for those investments, or allows them to show a higher profit margin because they do not have to pay for their own investments in energy efficiency. The carbon offsetting investments involve tree planting, insofar as possible in communities near the hotels. This is presumably of benefit to the communities themselves, or they would not allocate land for the trees to be planted. It may or may not have any financial payoff for the hotels, depending on where the trees are planted and whether they contribute to reducing erosion that affects hotel properties.

[22] https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/WESP2020_FullReport.pdf

If such voluntary contributions could be collected at a similar rate from all visitors to the country, this measure might generate a significant amount of money. For a number of reasons, actual collection rates from a national program would be lower than that. Firstly, as Lux observes, visitors staying in the most expensive hotels are most likely to contribute while those in less expensive hotels contribute less often. If Lux represents the top of the market, the overall contribution rate should be lower nationwide. In addition, while Lux is enthusiastic about encouraging its guests to contribute when the company will control use of the funds, they might be less enthusiastic about it if the funds were to go to a national trust of some sort, and were to be invested in coastal zone improvements that might not benefit the hotel itself. Moreover, at present Lux can use this voluntary contribution as a way to set their company off from the competition. They may be more enthusiastic about it this way than they would be if all hotels were doing the same. It is also likely that not all hotels would choose to participate in this scheme, especially smaller ones or those offering less expensive lodging.

Nevertheless, this strategy might be worth considering, as a national or perhaps an NGO-sponsored venture in Barbados, with the revenues going into a "Coastal Zone Trust" or something similar. Participating hotels might be offered the opportunity to retain a modest portion of the funds, to allocate according to their own priorities, with the rest going to the trust. Participation would give the hotels both reputational benefits and some funds; if participation were made as simple as possible, so the administrative costs were low, many of them might be willing to join the scheme. The revenues they retain might in some sense offset the CSR funds that they no longer control because of the recent changes in the structure of that revenue source, enabling them to continue supporting projects in the communities around them. The trust would manage the bulk of the money, using it to address coastal zone issues that benefit the general public rather than the hotels themselves.

E7.4. Summary of Recommended Options

Whilst none of the options considered above are flawless, some of them do offer some potential to help fund implementation of ICZM in Barbados. In addition to the list of options presented in Annex 9, the following financing mechanisms are identified as being suitable to help raise funds for ICZM for Barbados:

- Mechanism 1: Pursue "Debt for Nature" swaps. The greater the risk that Barbados may have regarding any defaulting on original debts, the greater the discount available to the purchaser of the debt, thus the more the debtor country can gain from the transaction. In addition to the direct financial benefits, the restructured debt is typically repaid in local currency, allowing the debtor country to retain its foreign exchange reserves for purposes other than loan repayment.
- Mechanism 2: Consider setting up an Environmental Protection Fee (EPF); possibly in tandem with Mechanism 3 below. Expanding the base of the EPF to include additional sectors that benefit from or rely on the environment in general and the coastal zone in particular is an appropriate strategy for increasing revenue and reducing private sector opposition to the levy.
- Mechanism 3: Earmark all or a portion of the EPF (in its current form or a broader version) for coastal zone management, following the procedures now being used for the Corporate Social Responsibility (CSR) revenues. Additional analysis is needed to determine exactly the fee would be designed for each new sector, particularly how it would levied on second homes that benefit from proximity to the coast. The revenues from the EPF should be 100% earmarked for environmental protection, and a significant share of those levies should be earmarked for coastal zone management in particular. This is essential in order for industry to accept a broadening of the base of the fee. This should be feasible if management of the fee is patterned on the mechanism now being used to manage revenues from the CSR levy.
- Mechanism 4: Voluntary contributions by hotel guests that are collected by an independently managed "Coastal Zone Trust". Whilst this mechanism may be an effective way to raise additional funds for coastal zone management, this should be left in the hands of the private sector and NGOs, and should not be managed by GoB.
- Mechanism 5: Private Public Partnership (PPP) arrangements should be pursued further. This initiative is not new to Barbados as a quasi PPP was executed as part of the CRMP for the Holetown area where the private sector paid for the costs of baseline studies and preliminary engineering design costings for the study area. GoB evaluated the preliminary components (having developed the TOR) and from this set the design standards and requirements for TCDPO application procedures. The government then reviewed the project to make it socially equitable before approaching donors (IDB) for construction funding. Care and maintenance of the final structure remains the responsibility of the GoB.

APPENDIX A. REVIEW OF FUNDING AND FINANCE OPTIONS FOR RISK RESILIENT ICZM IN BARBADOS

FUNDING TOOL		GENERAL CHARACTERISTICS		
TYPE	SOURCE	LIKELY APPLICABILITY TO SUPPORT BARBADOS COASTAL RESILIENCE	EXPLANATION OF TOOL[1]	NOTES ON APPLICABILITY
DIRECT FEES	User fees and charges	*Medium*	User fees include the fees charged for the use of public infrastructure or goods (e.g., a toll road or bridge, water or wastewater systems, or public transit). Fees are typically set to cover a system's operating and capital expenses each year.	Public infrastructure or goods that can collect a user fee (e.g., a toll road or bridge, water or wastewater systems, or public transit).Fees can then be used to cover debt service for improvements to the system or to pay directly for capital or operating expenditures.
	Property taxes/general fund revenues	*High*	For uses that don't have revenue- generating potential, the implementing Agency could devote some of its scarce General Fund revenues, generated from property taxes or General Fund operating reserves/surpluses, to help get activities started. With voter approval, special taxes could also be considered which could enable a dedicated source of funding. Examples include an open space millage structured around a Metropolitan District, or a Community Preservation Fund.	For current general fund revenue, uses that do not have revenue-generating capability. Special mileages would have greater flexibility based on how they are structured.
	Public benefit funds	*Low*	Public benefit funds are the collection of funds generated by a small surcharge on a customer's electricity bills, without regard to who the electric provider is.	Have mostly been used to support energy efficiency and energy renewal projects.
	Ground lease financing	*Medium*	Agency would lease land for resilience infrastructure use and securitize future lease payments using any proceeds to acquire or develop future land.	
	Transfer fee fund	*Medium*	Private fees levied in certain real estate transactions where a transfer of property ownership occurs, typically as a percentage of the transaction price. Community Preservation Funds (CPF) are tax programs implemented by US states and municipalities to fund their open space protection and enhancement. New York's was established largely with a transfer fee. CPF is then used to purchase land or development rights from willing sellers in order to protect community character.	Likely will have greater support if it is framed around a use with a clear public benefit and one that may increase property value. This can be argued for coastal resilience delivery.
DEBT TOOLS	Industrial loan companies, industrial banks, Industrial revenue bonds	*High*	A debt instrument issued by an agency, most commonly issued as part of an economic development initiative in which the municipal agency issues IRBs and then gives the proceeds to a private firm for development. The private entity is responsible to repay the debt over time.	Because IBs issue loans that must be repaid, they appear to be most applicable to infrastructure types that generate revenue, such as sewer or water projects that charge a user fee. However, IBs appear to be largely untested in financing more general public infrastructure.
	International Finance Institution (Bank) Loan'	*High*	Long-term debt issued by a bank such as the Inter-American Development Bank (IDB). With appropriate documentation, loans are sometimes offered at rates favorable in comparison with some other long-term financing options when projects are confirmed to be financially viable and support development in a sustainable, climate resilient manner.	The Barbados coastal/flood resilience programs are in strong alignment with goals of international banks like IDB. In particular, the full National Program, when more fully documented in planned studies, would seem to fit scale and purposes of interest to agencies like IDB, if a sufficient basis for repayment can be detailed and confirmed.
	General obligation bonds	*High*	Bonds issued by municipalities that represent an obligation of the full faith and credit of the property owners within the municipality.	Can also be used for projects that do not generate revenue; either for large projects or grouping several to many smaller project together as transaction costs are expensive.
	Revenue bonds	*Medium*	Bonds issued by municipalities that are secured by a dedication of an identified revenue stream (e.g., water and sewer system bonds are typically repaid through user fees from system customers).	Assets that will generate reliable revenue.
	Green bonds	*High*	Bonds that are issued specifically to address projects that accomplish identified 'green' objectives, such as clean power, carbon reducing projects and environmental restoration. There are various levels of green certification, with the most rigorous requiring independent certification and ongoing monitoring. Green bonds appeal to some classes of investors who are specifically interested to support sustainable solutions as part of their investment portfolio.	Projects that investors see as "green", but generally utilize underlying type of bond (aka, general obligation or revenue). Several utilities in the US have issued green bonds to address stormwater management issues. Some of these have included external verifications, following models used in certifying bonds as "green" in Europe and some other parts of the world. Resilience focus of the Barbados program seems well suited to satisfying green certification requirements.
	Pooled bond financing	*Medium*	Regional/National agency acts as bonding agency on behalf of multiple municipal entities, typically for similar or related projects (e.g. water or wastewater projects, public building projects).	Potential application if multiple Barbados municipalities can develop resilience programs in parallel.
	Certificates of participation	*Low*	Tax-exempt bonds usually secured with revenue from an equipment or facility lease; issued by state authorized entities (e.g. state public works boards, joint powers authorities, municipalities, or transit agencies).	Have been used in public finance to support a broad variety of projects and programs, including acquisition of land or equipment, transportation (e.g., light rail and toll bridges), water and wastewater treatment facilities, and real estate (e.g., parking facilities, public buildings). Not suitable for funding operations and maintenance activities.
	Revolving loan funds	*Medium*	A revolving loan fund (RLF) is a pool of money dedicated to specific kinds of investments. The money used to repay loans replenishes the fund and is loaned out again.	RLFs can provide access to capital markets for projects that have poor risk profiles to meet economic development (e.g. new business development), environmental (e.g. safe drinking water), or other public policy goals. RLF financing can also be useful for projects where the revenue stream might be irregular. RLF customers can include local governments, special districts, state agencies, private corporations, or non-profit organizations.
	Linked deposit programs	*Low*	Below market bank loans subsidized by corresponding 'linked' state deposits. The source of capital is state tax surpluses.	Can be used for numerous things, including upgrade infrastructure; depends on the state for eligible uses.
CREDIT	Credit assistance tools or loan guarantees	*High*	Credit assistance improves local agencies' creditworthiness and thus lets them access better borrowing terms and reduce financing costs. US Federal and state agencies have developed a variety of financial tools to help local governments access credit to expedite projects. This credit assistance can take several forms.	For socially beneficial projects with reasonable expectation of private market success, but little history (Tesla is an example). When a project cannot get reasonably priced capital to get to scale.
	On-bill financing	*Medium*	Utilities bill customers a monthly fixed charge to recoup costs of required property-level upgrades.	Energy efficiency and other improvement benefits that stay with the property, not the resident or current property owner.

FUNDING TOOL		GENERAL CHARACTERISTICS		
TYPE	SOURCE	LIKELY APPLICABILITY TO SUPPORT BARBADOS COASTAL RESILIENCE	EXPLANATION OF TOOL[1]	NOTES ON APPLICABILITY
PRIVATE SOURCES/ EQUITY	Public-private partnership	*High*	(P3) is defined as "a contractual agreement between a public agency (federal, state, or local) and a private- sector entity. Through this agreement, the skills and assets of each sector (public and private) are shared in delivering a service or facility for the use of the general public.	Projects that generate revenue and can write a strong contract for; parking facilities, toll roads, airports, and ports; schools, hospitals, or libraries; These bundled projects could involve parks; streetscaping; road, bicycle, or pedestrian improvements; sewer, water, storm drain, and other utilities; or parking.
	Program- related investment (PRI)	*High*	Generally, foundation or public investment offering longer and more flexible investment terms, as compared to tradition private financing. PRIs can be structured as debt tools or equity stakes.	Could pool PRI investment to a fund for the benefit of entrepreneurial ventures utilizing open space.
	Impact bonds/Social impact bonds	*High*	A bond instrument in which the payment is contingent on the outcomes agreed upon by the investor and issuer. Impact bonds have a broader range of public benefits, including environmental, social, and economic. Private investors assume the risk for improvement to outcomes. SIBs reference a category of investments focused more squarely on social impacts.	Require negotiated criteria for measuring success in determining funding; could have multiple measures of success. Based on some recent precedents in the US, might have some applicability for the Barbados program, including initial pilot projects.
	Pay for success	*High*	Similar to social impact bonds. A pay for success or pay-for-performance option is a contractual relationship in which the private sector is engaged to accomplish a public objective, with incentives for the private entity for performance above an agreed-upon minimum performance level.	Could be adapted to coastal resilience around provision of amenity and environmental benefits Based on some recent precedents in the US, might have some applicability for the Barbados program, including initial pilot projects.
	Pooled lease- purchase	*Medium*	A government agency purchases property or equipment on an annually renewable contract basis.	Particularly beneficial to states because smaller projects can be combined to receive longer loan terms and beneficial interest rates. However, forming a pooling agreement can be difficult when attempting to combine projects at the same time for financing.
	Loan loss reserve funds (LRF)	*Medium*	LRFs improve under-banked consumers' small dollar loan options by expanding the number of responsible lenders and products available in the marketplace. The source of capital is a combination of the public sector and private banks.	Where financial institutions make a series of small loans for projects such as energy efficiency improvements or residential solar.
	Infrastructure Investment Funds	*Medium*	A pool of funds collected from many investors to invest in infrastructure, often in the form of a public-private partnership. An infrastructure investment fund can be the financing tool that pays for a public project's capital cost under a public-private partnership.	Have supported projects in a broad range of sectors such as transportation (e.g. toll roads, airports, ports, and transit), regulated utilities (e.g. water and power), cable and wireless communication, and social infrastructure (e.g. schools, hospitals, public and military housing, and civic buildings); seek projects with stable, predictable, and long-term income streams.
	Securitization and structured funds	*Medium*	A "structured fund" is a loan fund that pools money from different investors with varying risk and return profiles. Structured funds have a very specific dedicated purpose, which is clearly defined prior to forming the fund, and are managed by professionals with fund formation and loan underwriting experience. Structured funds often combine both equity and fixed- income products to provide investors with a degree of both capital protection and capital appreciation.	Applicability for the coastal resilience will depend in part on the types of investors that the agency focuses on to support development and their resulting level of interest in this program.
	Greenhouse emissions allowance auctions	*Low*	States pool their total emission allowances and sell them in an auction format.	Market-efficient way to have polluters pay for pollution emitted.
	Stormwater/ green stormwater infrastructure credit trading programs	*Low*	Cities enable and administer a market in which developers who accomplish documented stormwater management objectives are allowed to sell credits to property developers who need to accomplish stormwater management objectives on site for new development.	No established stormwater management objectives set for Barbados and developments.
	Green Stormwater Infrastructure Bank	*Low*	An alternative to credit trading, enables developers to purchase retention credits from the green stormwater infrastructure bank that invests in large green stormwater infrastructure projects.	Would be focused on larger sites being developed by a single entity.
	New Market Tax Credits	*High*	Allows corporate or individual investors to receive a tax credit for investing in a community development entity (CDE) in a low-income community.	Proven financing method for some open space uses, such as urban farming and biofuel, but has wider applicability.
	Carbon credits	*Medium*	Not specifically a funding mechanism, but may provide value for carbon capture in the future depending upon regulations.	Likely need to be for large, permanent projects, though tree farms could be applicable.
	Individual or peer-to-peer funding	*Medium*	Pooling monetary investments, loans or donations from a large number of private individuals. More commonly referenced as "crowdfunding" or "crowd lending/investing." These can be structured as donations, equity positions, loans or investments receiving some form of return (product or monetary).	Likely more successful when a tangible good can be returned in a short period of time or where there is some broader social or public benefit.
VALUE CAPTURE MECHANISMS	Developer fees and exactions or impact fees/tap fees	*Medium*	Developer fees and exactions include: Impact fees, which include system development charges and connection or facility fees, and Negotiated exactions and agreements.	Impact fees impose a fee on developers to fund additional service capacity required by the development. New development can instigate the need for coastal resilience measures/investment.
	Value capture	*Medium*	Value capture is the identification and capture of increased land value resulting from public investment in infrastructure.	Applicable for situations where substantial increases in land value are likely in response to public investment. This may be the case for coastal protection measures protecting backing development, raising property values.
	Linkage fees	*High*	Agency or municipality charges developers a fee for new development, typically based on a percentage of the sales price.	Pay for the secondary effects of development. This could include mitigating the impacts of mangrove clearance and provision of flood infrastructure to reduce risks to development.
	Developer dedication requirements	*Low*	Where imposed, developers are required to donate land and/or facilities for public use.	Theory behind these requirements is that a City's existing residents should not subsidize developers who bring in new residents.

FUNDING TOOL		GENERAL CHARACTERISTICS		
TYPE	SOURCE	LIKELY APPLICABILITY TO SUPPORT BARBADOS COASTAL RESILIENCE	EXPLANATION OF TOOL[1]	NOTES ON APPLICABILITY
	Special districts/ Improvement districts	*Medium*	A value capture tool that can include benefit assessment districts, business improvement districts, business improvement areas, business revitalization zones, community improvement districts, local improvement districts, special services areas, and special improvement districts, are formed to include a geographical area in which property owners or businesses agree to pay an assessment to fund a proposed improvement or service from which they expect to directly benefit.	Commonly used to fund infrastructure such as sewer, water, utilities, or streets. Special districts can be used either for pay-as you- go improvements or to finance the issuance of bonds backed by the assessment revenue; can be used to fund infrastructure that does not generate revenue, so the tool is applicable to a wide variety of uses. However, there must be a clear benefit to property owners who will be paying the assessment. Because assessments do not need to be tied to revenue- generating infrastructure, they could be particularly useful coastal resilience measures that provide protection to an area.
	PILOT bond	*Medium*	Bond that is repaid by some or all property taxes for properties bordering major open space developments to fund construction of open space. These are similar to improvement districts but more binding.	Most applicable to uses with clear benefit to surrounding property owners, most often major parks, but could also be considered for coastal resilience.
	Tax increment financing	*Medium*	Enables the public sector to "capture" growth in property taxes (or sometimes sales taxes) from new development and increasing property values. Tax increment is collected for a set period, usually between 15 and 30 years. It can be used either on a pay-as-you-go basis over time or can be bonded against to provide an upfront source of revenue.	Most common uses of TIF are for environmental clean-up, land assembly, or local infrastructure; to help pay for major development initiatives or infrastructure investments that catalyze private investment and increase property values; can be applied to infrastructure that does not generate revenue. Typical items financed include street improvements; sidewalks; street lighting; utilities, including water lines, storm and sanitary sewers, and plant expansions; parks and open space; and off-street parking.
	Joint development	*Medium*	A real estate development project undertaken by a public agency and a private partner; many joint development projects are designed to meet multiple goals such as providing affordable housing, local jurisdictions can also help finance aspects of the project; requires a strong real estate market and a specific development opportunity.	Could be applicable in specific contexts where a developer's interests in a specific project coincides with public agencies' interest to support the open space reuses such as parks and greenways or tree farms.
GRANTS	National Govt. grants	*High*	Money made available by the National government, typically to address specific public purposes through a specific National Agency	Worth at least exploring opportunities for grants from the National government to support some portions of the Barbados resiliency program.
GRANTS	Foundation grants	*High*	Money made available to test or implement solutions to public challenges by philanthropic entities.	Worth at least exploring opportunities for grants from foundations or other philanthropic sources to support some portions of the Barbados resiliency program.

[1] Taken or adapted in some cases from the TOD and Smart Cities Guides. Smart Cities Financing Guide (Smart Cities Council, 2014), http://smartcitiescouncil.com/resources/smart-cities-financing-guide. Infrastructure Financing Options for Transit-Oriented Development (US EPA, 2013), http://www2.epa.gov/smartgrowth/infrastructure-financing-options-transit-oriented-development

BIBLIOGRAPHY
(OCTOBER 2021)

BIBLIOGRAPHY

Aguirre-Ayerbe, I., Martínez Sánchez, J., Aniel-Quiroga, Í., González-Riancho, P., Merino, M., Al-Yahyai, S., González, M., and Medina, R., 2018. From tsunami risk assessment to disaster risk reduction – the case of Oman, Nat. Hazards Earth Syst. Sci., 18, 2241-2260, https://doi.org/10.5194/nhess-18-2241-2018

Baird, 2017. National Coastal Risk Information and Planning Platform - Final Hazard Report.

Baird, 2018. National Coastal Risk Information and Planning Platform - National Hazard Mapping Risk Atlas.

Christiansen, L., Ray, A. D., Smith, J. B., & Haites, E. 2012. Accessing International Funding for Climate Change Adaptation: A Guidebook for Developing Countries. UNEP Risø Centre on Energy, Climate and Sustainable Development. Department of Management Engineering. Technical University of Denmark (DTU). TNA Guidebook Series.

Clyde Mascoll, 2013. "The Promotion of Greater Inter-Sectorial Linkages with the Tourism Sector in the Barbados Economy". Barbados Private Sector Association, ATN/ME-11627-BA; BA-M1007.

Coastal Zone Management Unit, 2010. Applicant's Handbook and Guide to Coastal Panning in Barbados.

Doyle, E. and J. Franks. 2015. Sargassum Fact Sheet. Gulf and Caribbean Fisheries Institute.

Golder Associates, 2017. Geotechnical Surveys Investigations. Final Assessment Report. Coastal Risk Assessment and Management. Coastal Zone Management Unit.

Halcrow, 1998a. Integrated Coastal Management – The Barbados Policy Framework. Government of Barbados: Ministry of Health and the Environment. Coastal Zone management Unit.

Halcrow, 1998b. Integrated Coastal Management Plan for the West and South Coasts of Barbados – The Caribbean Coast. Government of Barbados: Ministry of Health and the Environment. Coastal Zone management Unit.

Halcrow, 1998c. Integrated Coastal Management Plan for the South-east and North-West Coasts of Barbados – The Atlantic Coast. Government of Barbados: Ministry of Health and the Environment. Coastal Zone management Unit.

IHCantabria and Edanya, 2020. Community Tsunami Inundation And Evacuation Maps For Select Icg/Caribe Ews Member States under the project Strengthening Capacities of Early Warning and Response for Tsunamis and Other Coastal Hazards in the Caribbean. Final Report.

IHCantabria, 2019. Baseline Knowledge Report. Preparation of a Draft Updated Integrated Coastal Zone Management Plan and Amendment of the CZM Act and Preparation of CZM Regulations Incorporating Disaster Risk Management and Climate Change Adaptation Principles. Coastal Risk Assessment and Management. Coastal Zone Management Unit.

IHCantabria, 2019. Draft Policy Paper. Preparation of a Draft Updated Integrated Coastal Zone Management Plan and Amendment of the CZM Act and Preparation of CZM Regulations Incorporating Disaster Risk Management and Climate Change Adaptation Principles. Coastal Risk Assessment and Management. Coastal Zone Management Unit. Under revision.

IHCantabria, 2019. Redefined boundary of the Coastal Zone Management Area (CZMA). Preparation of a Draft Updated Integrated Coastal Zone Management Plan and Amendment of the CZM Act and Preparation of CZM Regulations Incorporating Disaster Risk Management and Climate Change Adaptation Principles. Coastal Risk Assessment and Management. Coastal Zone Management Unit.

International Finance Corporation. A Guide to Biodiversity for the Private Sector: The Social and Enivornmental Impact Assessment Process. https://www.ifc.org/wps/wcm/connect/9608497e-56e8-4074-bab6-45c61a36a4ad/ESIA.pdf?MOD=AJPERES&CVID=jkCYZ3G

IPCC, 2019: Summary for Policymakers. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, M. Nicolai, A. Okem, J. Petzold, B. Rama, N. Weyer (eds.)]. In press.

Landscape Institute, 2020. Reviewing Landscape and Visual Impact Assessments (LVIAs) and Landscape and Visual Appraisals (LVAs). Technical Guidance Note 1/20.

McCue, J. 2018a. Preparation of a Strategic Action Plan (SAP) for Disaster Risk Management and Climate Change Adaptation – Baseline Report.

McCue, J..2018b. Preparation of a Strategic Action Plan (SAP) for Disaster Risk Management and Climate Change Adaptation – Final Strategic Action Plan (2018-2030).

Mimura, N., R.S. Pulwarty, D.M. Duc, I. Elshinnawy, M.H. Redsteer, H.Q. Huang, J.N. Nkem, and R.A. Sanchez Rodriguez, 2014: Adaptation planning and implementation. In: Climate Change 2014: Impacts,Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 869-898.

Town & Country Development Planning Office, 2017. Amended Physical Development Plan (PDP).

Town & Country Planning, 2002. The Applicant's Handbook and Guide to Town Planning.

ANNEXES
(OCTOBER 2021)

ANNEX 1. LIMITS OF THE COASTAL ZONE MANAGEMENT AREA

Geographic coordinates of the updated Coastal Zone Management Area (CZMA) are provided in this annex. CZMA is defined by two boundaries, inland boundary and offshore boundary defined by (longitude (LON) and latitude (LAT) coordinates each 50m. A total of 2185 points delineate the inland boundary and a total of 2171 points delineate the offshore boundary.

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
0	33129,503482	60518,520431	0	32864,620164	57899,926814
1	33175,481689	60500,283748	1	32910,702853	57880,770010
2	33207,016813	60462,165900	2	32949,327379	57849,018696
3	33216,996867	60414,073641	3	32987,951905	57817,267381
4	33265,000648	60400,585712	4	33031,081557	57792,742066
5	33309,059459	60377,662765	5	33076,593404	57772,037674
6	33358,739843	60372,707805	6	33122,105250	57751,333282
7	33406,749291	60359,147353	7	33167,617096	57730,628890
8	33453,621097	60371,489339	8	33211,423965	57707,778422
9	33501,788711	60384,806880	9	33241,882941	57668,126805
10	33550,887472	60393,535126	10	33272,341918	57628,475188
11	33600,066243	60400,840846	11	33316,243303	57605,577115
12	33648,592275	60412,495938	12	33361,589284	57584,542159
13	33692,851431	60435,496806	13	33410,496698	57574,146733
14	33737,127479	60458,668604	14	33459,404112	57563,751308
15	33784,024583	60475,815860	15	33508,311526	57553,355883
16	33832,772498	60486,299483	16	33555,579324	57537,358287
17	33880,844948	60498,616056	17	33602,373986	57519,744101
18	33928,331845	60514,024567	18	33650,958798	57509,142894
19	33977,825750	60520,867731	19	33700,470711	57502,173644
20	34027,766270	60520,704260	20	33749,982624	57495,204393
21	34077,407497	60523,395850	21	33799,494538	57488,235142
22	34127,273442	60525,571097	22	33848,468902	57494,314261
23	34177,168156	60523,507852	23	33897,239794	57505,332431
24	34226,706915	60517,593309	24	33946,010686	57516,350602
25	34264,834194	60520,626893	25	33994,784214	57527,354964
26	34255,546436	60567,661047	26	34044,184152	57535,078057
27	34252,621091	60616,394240	27	34093,584090	57542,801150
28	34254,605799	60665,784066	28	34142,641319	57552,437580
29	34269,416665	60712,071036	29	34191,650708	57562,341106
30	34315,221770	60727,422554	30	34240,660096	57572,244632
31	34362,605574	60717,561653	31	34288,857260	57585,178647

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
32	34409,778081	60733,197030	32	34336,250356	57601,112711
33	34452,454386	60752,452078	33	34381,345210	57621,730521
34	34498,084909	60768,697896	34	34422,947863	57649,465323
35	34546,818201	60769,622903	35	34464,550516	57677,200126
36	34596,323438	60766,219959	36	34506,153169	57704,934928
37	34646,222748	60764,813245	37	34551,789312	57724,596400
38	34696,163911	60764,235231	38	34598,949209	57741,207966
39	34738,071628	60789,005128	39	34646,109106	57757,819531
40	34777,898464	60819,155989	40	34692,621089	57776,104159
41	34816,105716	60851,317892	41	34739,322123	57793,857325
42	34860,493938	60874,027406	42	34786,756001	57809,669574
43	34908,875231	60886,340856	43	34834,536977	57824,148917
44	34953,817651	60907,387859	44	34883,658494	57833,480403
45	34994,598151	60935,602599	45	34932,780010	57842,811889
46	35036,783568	60962,367915	46	34981,901526	57852,143375
47	35082,535267	60982,240234	47	35030,394117	57863,314847
48	35131,492561	60991,773257	48	35074,950100	57886,003267
49	35178,722866	61000,785809	49	35119,506083	57908,691686
50	35223,131617	61023,457505	50	35164,062066	57931,380106
51	35266,209976	61048,511324	51	35211,922602	57945,490330
52	35311,485933	61069,637268	52	35260,184769	57958,557971
53	35356,753322	61090,481318	53	35308,446935	57971,625613
54	35401,511525	61111,632802	54	35356,357078	57985,406011
55	35441,845235	61141,048824	55	35396,068100	58015,787498
56	35483,424550	61168,801362	56	35435,779121	58046,168986
57	35523,843668	61198,168844	57	35475,490142	58076,550474
58	35569,041631	61219,207783	58	35515,201163	58106,931961
59	35618,044836	61228,437112	59	35554,912184	58137,313449
60	35656,900213	61253,991231	60	35594,623206	58167,694937
61	35704,934422	61251,837441	61	35637,224539	58193,477035
62	35733,498324	61290,491270	62	35683,092016	58213,347632
63	35755,213537	61334,378441	63	35729,146049	58232,816222
64	35793,630008	61364,584561	64	35775,200082	58252,284813
65	35839,466800	61356,896273	65	35821,254115	58271,753404
66	35848,898620	61405,515581	66	35867,308148	58291,221995
67	35878,116268	61444,623009	67	35913,362181	58310,690586
68	35890,255590	61489,616053	68	35956,128007	58336,038163
69	35922,584749	61526,659628	69	35996,822377	58365,089294
70	35925,254510	61567,075618	70	36037,516747	58394,140426
71	35876,119913	61576,337982	71	36078,600843	58422,578869
72	35826,985316	61585,600345	72	36122,162514	58447,122318

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
73	35782,460143	61596,455315	73	36165,724184	58471,665767
74	35812,166138	61633,645631	74	36209,215398	58496,304884
75	35770,560668	61661,376207	75	36245,578410	58530,622975
76	35790,017586	61700,480170	76	36281,941422	58564,941066
77	35831,534323	61697,027553	77	36318,304433	58599,259157
78	35871,261087	61721,416980	78	36354,667445	58633,577248
79	35909,036345	61754,043154	79	36397,717709	58658,905965
80	35920,280631	61798,821013	80	36441,041311	58683,867245
81	35935,470807	61845,198176	81	36482,708368	58711,325481
82	35919,239366	61892,102984	82	36522,548655	58741,537259
83	35900,550165	61938,176332	83	36565,066018	58767,825816
84	35881,415814	61982,370882	84	36607,724088	58793,908167
85	35865,420345	62028,481236	85	36650,382158	58819,990518
86	35868,360253	62076,472228	86	36693,040228	58846,072870
87	35900,248911	62114,291584	87	36735,698298	58872,155221
88	35921,846756	62157,934816	88	36772,527271	58905,786864
89	35952,680760	62196,626835	89	36808,552756	58940,459107
90	35997,298723	62217,147226	90	36844,578241	58975,131349
91	36047,154322	62218,808347	91	36880,603726	59009,803593
92	36095,606451	62219,276363	92	36916,629211	59044,475835
93	36137,171241	62235,982420	93	36952,654696	59079,148078
94	36156,991139	62266,159556	94	36990,997922	59110,962935
95	36176,811037	62296,336626	95	37034,024949	59136,432033
96	36204,933621	62318,215935	96	37077,051976	59161,901131
97	36216,450633	62356,691091	97	37120,079003	59187,370229
98	36236,288031	62326,525423	98	37163,106030	59212,839327
99	36286,288028	62326,540130	99	37206,133057	59238,308425
100	36306,125526	62296,374614	100	37249,160084	59263,777523
101	36352,548337	62312,596105	101	37285,684496	59297,474600
102	36390,423937	62341,713270	102	37320,407160	59333,451490
103	36436,486643	62358,294173	103	37355,129824	59369,428380
104	36459,124893	62394,304478	104	37389,852488	59405,405269
105	36475,620284	62441,362207	105	37424,575152	59441,382159
106	36502,182504	62483,558704	106	37469,603225	59462,196644
107	36525,098386	62527,924437	107	37515,718680	59481,510574
108	36556,340383	62566,698074	108	37561,380741	59501,881538
109	36580,257210	62610,563971	109	37607,042802	59522,252502
110	36606,817344	62652,606131	110	37652,704864	59542,623466
111	36635,907364	62693,090784	111	37698,741330	59562,068275
112	36674,095088	62725,141235	112	37745,731943	59579,152838
113	36718,981033	62746,891261	113	37792,722555	59596,237401

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
114	36766,578685	62762,001675	114	37839,401921	59614,089994
115	36815,714009	62771,253430	115	37884,953725	59634,700038
116	36865,244064	62777,457915	116	37929,886932	59656,631907
117	36913,246973	62785,164914	117	37974,820140	59678,563776
118	36961,531304	62797,632736	118	38019,753347	59700,495645
119	37011,263134	62802,799932	119	38065,467993	59720,746000
120	37061,192267	62802,546020	120	38111,204067	59740,950245
121	37111,122906	62799,961818	121	38155,994362	59763,010780
122	37161,065240	62797,650239	122	38199,223936	59788,134551
123	37210,966296	62795,017778	123	38242,453511	59813,258322
124	37260,956702	62795,997213	124	38285,683085	59838,382094
125	37310,932488	62795,536814	125	38328,912659	59863,505865
126	37359,744856	62785,342628	126	38372,882633	59887,306475
127	37400,795080	62799,213363	127	38416,908136	59911,007847
128	37443,341128	62825,198469	128	38459,685233	59936,843238
129	37490,984758	62839,873666	129	38501,920583	59963,604689
130	37540,786872	62842,373211	130	38544,155933	59990,366139
131	37589,721556	62843,841211	131	38586,391283	60017,127589
132	37638,334191	62854,992224	132	38629,464925	60042,514945
133	37678,214668	62881,164692	133	38672,584977	60067,826231
134	37718,503794	62910,527558	134	38715,016052	60093,990496
135	37764,803607	62929,036650	135	38748,830992	60130,821866
136	37809,701562	62947,311274	136	38782,645933	60167,653236
137	37849,131846	62978,032787	137	38824,520485	60194,879004
138	37890,473739	63006,154804	138	38866,665668	60221,782229
139	37929,357770	63037,534954	139	38908,810851	60248,685455
140	37969,383564	63067,412279	140	38950,956034	60275,588681
141	38011,005870	63095,111791	141	38992,225350	60303,777715
142	38051,926385	63123,843507	142	39032,690645	60333,147086
143	38090,764503	63155,287957	143	39073,155940	60362,516456
144	38129,321840	63187,120278	144	39113,621234	60391,885827
145	38164,837337	63222,221897	145	39154,086529	60421,255198
146	38198,659990	63259,022552	146	39194,551823	60450,624568
147	38231,262916	63296,929410	147	39235,017118	60479,993939
148	38264,615253	63334,180202	148	39278,057829	60505,433844
149	38297,967591	63371,430995	149	39321,134529	60530,818838
150	38331,031384	63408,937937	150	39364,211229	60556,203831
151	38364,505098	63446,067740	151	39407,287929	60581,588824
152	38399,689522	63481,593172	152	39450,364630	60606,973818
153	38437,165067	63514,549141	153	39493,441330	60632,358811
154	38480,695791	63539,047002	154	39534,710888	60660,263221

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
155	38525,334829	63561,558857	155	39572,565226	60692,928939
156	38570,540508	63582,923467	156	39610,419563	60725,594656
157	38616,311741	63603,028062	157	39648,273901	60758,260374
158	38661,965931	63623,239838	158	39686,128239	60790,926092
159	38701,092253	63654,122908	159	39727,990052	60818,241126
160	38739,635445	63685,970287	160	39769,984358	60845,379259
161	38774,858328	63721,417737	161	39811,412096	60873,371085
162	38815,573121	63750,240335	162	39852,731763	60901,525749
163	38859,521569	63773,997916	163	39894,051431	60929,680412
164	38900,213817	63802,186477	164	39935,352825	60957,861862
165	38938,021829	63834,901591	165	39976,641995	60986,061232
166	38975,710095	63867,756511	166	40017,931164	61014,260603
167	39016,588213	63896,158595	167	40057,049803	61044,953317
168	39049,773030	63933,531826	168	40090,668728	61081,963693
169	39086,835719	63967,089439	169	40124,287653	61118,974068
170	39124,783050	63999,639935	170	40160,955378	61152,735394
171	39163,094712	64031,766608	171	40200,026761	61183,935185
172	39203,750837	64060,853184	172	40239,098144	61215,134977
173	39244,898848	64089,253955	173	40278,169528	61246,334769
174	39286,523925	64116,955091	174	40312,384541	61282,629995
175	39326,437599	64146,837309	175	40345,424422	61320,158201
176	39363,244722	64180,678640	176	40378,464303	61357,686407
177	39399,956219	64214,623535	177	40411,504185	61395,214613
178	39436,795841	64248,423326	178	40451,585144	61424,668794
179	39457,960753	64293,265779	179	40493,259267	61452,296089
180	39488,292477	64332,852781	180	40533,564268	61481,683462
181	39527,493376	64363,668667	181	40570,595607	61515,279294
182	39573,081025	64383,847543	182	40607,144081	61549,390977
183	39622,237652	64392,156633	183	40643,110201	61584,124796
184	39671,770195	64393,175912	184	40679,076322	61618,858615
185	39711,861051	64422,949045	185	40715,042442	61653,592434
186	39748,867783	64456,506367	186	40751,008563	61688,326253
187	39788,758013	64486,650702	187	40785,203189	61724,789318
188	39832,200500	64511,137723	188	40819,058917	61761,583199
189	39880,342211	64524,199147	189	40852,914646	61798,377080
190	39929,738716	64531,857165	190	40886,770374	61835,170961
191	39970,606655	64552,779044	191	40921,832447	61870,674430
192	40008,991684	64584,589274	192	40960,820266	61901,978583
193	40052,228559	64609,685615	193	40999,966629	61933,082462
194	40098,658469	64627,883084	194	41039,382689	61963,845658
195	40146,786319	64640,670123	195	41082,973366	61988,233970

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
196	40179,237950	64678,639631	196	41126,928046	62012,066429
197	40216,525523	64711,945711	197	41170,882726	62035,898889
198	40256,976577	64741,121570	198	41214,837406	62059,731348
199	40295,454836	64771,570516	199	41258,792085	62083,563808
200	40333,575150	64803,875219	200	41299,587067	62112,368107
201	40373,331028	64834,140734	201	41339,828300	62142,043739
202	40416,364980	64859,502045	202	41380,069533	62171,719372
203	40456,203835	64889,707646	203	41420,310766	62201,395004
204	40499,913495	64913,882708	204	41460,551999	62231,070637
205	40546,176354	64932,572087	205	41501,798930	62258,933672
206	40573,872416	64971,419397	206	41547,965805	62278,031095
207	40601,921216	65012,688146	207	41591,852255	62301,988964
208	40633,551939	65051,411484	208	41635,832363	62325,758734
209	40668,693987	65086,922521	209	41681,399311	62346,341573
210	40700,524144	65125,372664	210	41726,966259	62366,924412
211	40731,792036	65164,389555	211	41772,533207	62387,507250
212	40763,290739	65203,220051	212	41818,100155	62408,090089
213	40795,833714	65241,142187	213	41861,655752	62431,925962
214	40831,379809	65276,294477	214	41900,431618	62463,492277
215	40872,746808	65304,150286	215	41939,207483	62495,058592
216	40908,097995	65336,150887	216	41979,229233	62525,014687
217	40936,197631	65377,506599	217	42019,519064	62554,624307
218	40969,569615	65414,563857	218	42059,808894	62584,233926
219	41008,735712	65445,594651	219	42100,098725	62613,843546
220	41053,448826	65467,682718	220	42134,232807	62650,082125
221	41098,589008	65485,658886	221	42166,739889	62688,072777
222	41132,925878	65521,987538	222	42199,246970	62726,063429
223	41163,342063	65561,671990	223	42231,754052	62764,054081
224	41189,204526	65604,353497	224	42264,616102	62801,734122
225	41213,437417	65648,088472	225	42297,957085	62838,995078
226	41232,958852	65694,071105	226	42326,788525	62879,087806
227	41250,198920	65741,004889	227	42345,867490	62925,304612
228	41270,240346	65786,739829	228	42364,946455	62971,521417
229	41286,366472	65833,899044	229	42384,025419	63017,738222
230	41301,949085	65881,397860	230	42405,632135	63062,598433
231	41321,470188	65927,332493	231	42433,600216	63104,044620
232	41347,076290	65970,276294	232	42461,568297	63145,490807
233	41373,242398	66012,882673	233	42487,989644	63187,897825
234	41392,507674	66058,866221	234	42512,751531	63231,335700
235	41400,536784	66108,003960	235	42546,899932	63266,652717
236	41412,719030	66156,426960	236	42586,324536	63297,404963

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
237	41427,778715	66204,099594	237	42625,749140	63328,157208
238	41444,143508	66251,345690	238	42665,173744	63358,909453
239	41461,949976	66298,063761	239	42704,598348	63389,661698
240	41485,161148	66342,231446	240	42734,410568	63429,631047
241	41500,376224	66388,110255	241	42763,481193	63470,311493
242	41536,183244	66420,487614	242	42792,551818	63510,991940
243	41565,861264	66460,707591	243	42821,622443	63551,672387
244	41597,839058	66499,118453	244	42851,174265	63591,898958
245	41631,007504	66536,530030	245	42890,087995	63623,295162
246	41666,069211	66572,173521	246	42927,472918	63656,376409
247	41703,828082	66604,797119	247	42962,495592	63692,061311
248	41748,335719	66627,283227	248	42999,241511	63725,891293
249	41796,456493	66640,785404	249	43037,404072	63758,196384
250	41845,941194	66646,986434	250	43075,566634	63790,501475
251	41895,753493	66642,914884	251	43113,729196	63822,806566
252	41944,401542	66631,956300	252	43151,891757	63855,111656
253	41968,166409	66665,073477	253	43180,205831	63896,154866
254	41995,705452	66706,658299	254	43207,737686	63937,892103
255	42028,037574	66744,762955	255	43235,269542	63979,629340
256	42062,398031	66780,905032	256	43262,801397	64021,366577
257	42075,365029	66827,821123	257	43290,333252	64063,103814
258	42095,831663	66873,278382	258	43315,509138	64106,248929
259	42124,311114	66914,358781	259	43337,940040	64150,880975
260	42132,861718	66963,226415	260	43362,388531	64194,240453
261	42151,909596	67009,316793	261	43390,225319	64235,774936
262	42181,793713	67049,232403	262	43418,062107	64277,309418
263	42220,601223	67080,527638	263	43446,070372	64318,724057
264	42264,473251	67104,448978	264	43475,507949	64359,139760
265	42304,895750	67133,211615	265	43504,945526	64399,555463
266	42331,905610	67174,927808	266	43528,490438	64443,417317
267	42353,827699	67219,769743	267	43549,281834	64488,889482
268	42381,301714	67261,354056	268	43570,073230	64534,361648
269	42404,946214	67305,363934	269	43590,864626	64579,833814
270	42429,006550	67349,044537	270	43611,656022	64625,305980
271	42444,997316	67396,188197	271	43642,734565	64664,232745
272	42460,541690	67443,704974	272	43675,116136	64702,330433
273	42466,306877	67493,170758	273	43701,871181	64744,507905
274	42472,815976	67542,620675	274	43728,017188	64787,126989
275	42491,324225	67588,920810	275	43754,427203	64829,567231
276	42520,686384	67629,210451	276	43784,308273	64869,656153
277	42557,444050	67663,065746	277	43814,189343	64909,745075

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
278	42574,452669	67707,062988	278	43844,070413	64949,833997
279	42591,968162	67753,740159	279	43871,923019	64991,209880
280	42611,453965	67799,648147	280	43895,463243	65035,321759
281	42637,129917	67842,395753	281	43919,003466	65079,433638
282	42668,307686	67881,482306	282	43943,938618	65122,761094
283	42704,855073	67915,454602	283	43969,401943	65165,791539
284	42744,086754	67946,445043	284	43994,865267	65208,821982
285	42784,175615	67975,493831	285	44020,328591	65251,852427
286	42805,250740	68020,341154	286	44043,309165	65296,201100
287	42832,658547	68062,117170	287	44064,690946	65341,398659
288	42866,172466	68099,043814	288	44086,072728	65386,596219
289	42907,739198	68126,600701	289	44107,454509	65431,793779
290	42954,592194	68143,883468	290	44128,903361	65476,957870
291	42997,757627	68168,426432	291	44152,162480	65521,218613
292	43033,450138	68202,887331	292	44175,417863	65565,481314
293	43062,944648	68241,991980	293	44198,575402	65609,795289
294	43071,765524	68291,207752	294	44227,453388	65650,451747
295	43080,586400	68340,423523	295	44257,958678	65690,067744
296	43085,027564	68390,090464	296	44288,463969	65729,683741
297	43086,816001	68440,058469	297	44318,969260	65769,299739
298	43088,267435	68489,697965	298	44349,474551	65808,915736
299	43124,547152	68521,149293	299	44378,836120	65849,297941
300	43163,197685	68552,868944	300	44403,867200	65892,581252
301	43203,537373	68581,434984	301	44428,898281	65935,864563
302	43251,012219	68596,915022	302	44453,929361	65979,147874
303	43295,413278	68610,760852	303	44481,340082	66020,515930
304	43318,700574	68584,010199	304	44518,272631	66054,220333
305	43346,434279	68580,266557	305	44555,205181	66087,924736
306	43382,750949	68614,627606	306	44589,928464	66123,814418
307	43420,285282	68647,631318	307	44623,227683	66161,112703
308	43443,069314	68690,820653	308	44656,582071	66198,359833
309	43468,322334	68733,821943	309	44691,262064	66234,377858
310	43496,219451	68774,990317	310	44725,942057	66270,395883
311	43527,028838	68814,196635	311	44760,622050	66306,413907
312	43563,315723	68848,212550	312	44794,242743	66343,278799
313	43584,428865	68893,488839	313	44821,742087	66385,037464
314	43614,307420	68933,482083	314	44849,241431	66426,796129
315	43647,031455	68970,514352	315	44876,740775	66468,554793
316	43661,731702	69018,158158	316	44896,893911	66514,176421
317	43675,485514	69065,597845	317	44915,712135	66560,500006
318	43692,633703	69112,409876	318	44934,530358	66606,823590

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
319	43716,343862	69155,082570	319	44959,113395	66649,212023
320	43716,223729	69205,017799	320	44995,398589	66683,612383
321	43725,326966	69254,151442	321	45031,683782	66718,012742
322	43741,083014	69301,468739	322	45067,968976	66752,413102
323	43742,248938	69350,701743	323	45104,254169	66786,813461
324	43738,586551	69400,520077	324	45133,608902	66827,215564
325	43744,619949	69450,091506	325	45162,471404	66868,043936
326	43756,484027	69498,555562	326	45186,026675	66912,066443
327	43775,800624	69544,667193	327	45209,071220	66956,435409
328	43800,133169	69588,199615	328	45232,678353	67000,511517
329	43834,371954	69624,434754	329	45256,285486	67044,587625
330	43875,962539	69652,066180	330	45279,892619	67088,663733
331	43919,154471	69676,328234	331	45303,499751	67132,739840
332	43945,707820	69718,619376	332	45327,164077	67176,785110
333	43981,082986	69753,774031	333	45350,489541	67221,010925
334	44019,849978	69785,292299	334	45373,815006	67265,236740
335	44049,573417	69824,987925	335	45397,140470	67309,462555
336	44070,835494	69869,160850	336	45420,465935	67353,688370
337	44075,477172	69918,943670	337	45443,888830	67397,853079
338	44087,890355	69967,240407	338	45473,546493	67438,107558
339	44092,387538	70016,715339	339	45506,884339	67474,715859
340	44099,402857	70066,151228	340	45546,861777	67504,745918
341	44113,811892	70114,021932	341	45586,734267	67534,914988
342	44134,112338	70159,569416	342	45626,566118	67565,137887
343	44164,940852	70198,759956	343	45666,397969	67595,360786
344	44204,535323	70229,081937	344	45706,229820	67625,583686
345	44232,037867	70263,752119	345	45746,061671	67655,806585
346	44241,470138	70312,849278	346	45781,889815	67690,589442
347	44252,981631	70361,500031	347	45817,011555	67726,176847
348	44271,691663	70407,726252	348	45852,133294	67761,764252
349	44301,128333	70447,980259	349	45887,255034	67797,351658
350	44322,624126	70489,994673	350	45922,376774	67832,939063
351	44334,669711	70538,375352	351	45956,729401	67869,231192
352	44358,200759	70582,338740	352	45989,441056	67907,042097
353	44387,780946	70622,630414	353	46022,190333	67944,816605
354	44423,809310	70657,180442	354	46054,229697	67983,202529
355	44465,201430	70685,001615	355	46086,269062	68021,588453
356	44487,801417	70727,209970	356	46118,308426	68059,974376
357	44503,647112	70774,618873	357	46150,347791	68098,360300
358	44514,406550	70820,562490	358	46182,387155	68136,746223
359	44509,424835	70870,165147	359	46209,756919	68178,550341

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
360	44516,845526	70919,466951	360	46236,664906	68220,692485
361	44534,152715	70966,333966	361	46263,572894	68262,834627
362	44542,020368	71013,638157	362	46290,480881	68304,976770
363	44546,988319	71063,242169	363	46322,996308	68342,591465
364	44561,013941	71111,219618	364	46358,521777	68377,775852
365	44577,054376	71157,670359	365	46394,296451	68412,703388
366	44580,449840	71207,426081	366	46430,537963	68447,149764
367	44596,139490	71254,761994	367	46466,466899	68481,907315
368	44613,012036	71299,795263	368	46500,750126	68518,303198
369	44609,255742	71349,643579	369	46535,033354	68554,699081
370	44612,193649	71399,528940	370	46569,316582	68591,094964
371	44620,458749	71448,723276	371	46603,599810	68627,490847
372	44640,302956	71494,465434	372	46631,717722	68668,744514
373	44667,759076	71536,233590	373	46659,083303	68710,590959
374	44692,580252	71579,125343	374	46686,448883	68752,437405
375	44712,967883	71624,779617	375	46713,757886	68794,320679
376	44734,998336	71667,600097	376	46740,946260	68836,282475
377	44694,259626	71696,554597	377	46768,134634	68878,244271
378	44655,144480	71727,662391	378	46799,165208	68916,520266
379	44618,067109	71761,202811	379	46839,961571	68945,427994
380	44583,594590	71797,416635	380	46880,757934	68974,335723
381	44553,126935	71836,907679	381	46921,809116	69002,867905
382	44532,935401	71882,534104	382	46963,744911	69030,096367
383	44514,082450	71928,819601	383	47005,680705	69057,324829
384	44500,809769	71976,925590	384	47047,616500	69084,553291
385	44493,798853	72026,352879	385	47086,703443	69115,592439
386	44498,281074	72076,010145	386	47124,685173	69148,109945
387	44510,071108	72124,599150	387	47162,666904	69180,627450
388	44523,972103	72172,624590	388	47200,648635	69213,144955
389	44528,378421	72210,351959	389	47238,331519	69245,983408
390	44478,432441	72212,651503	390	47273,471859	69281,552447
391	44429,055932	72220,332512	391	47309,281134	69316,408221
392	44380,180080	72230,690677	392	47347,028775	69349,197176
393	44334,409942	72250,565270	393	47382,171044	69384,607806
394	44290,503768	72274,444603	394	47415,194821	69422,150184
395	44250,651427	72304,592650	395	47448,218599	69459,692562
396	44212,920177	72337,330760	396	47481,242376	69497,234940
397	44182,901670	72377,165917	397	47514,266154	69534,777317
398	44158,390640	72420,683737	398	47543,079665	69575,547305
399	44143,298865	72468,265073	399	47570,757773	69617,187698
400	44125,959899	72514,037542	400	47598,435880	69658,828091

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
401	44101,559397	72557,656097	401	47626,113988	69700,468485
402	44075,774601	72600,025905	402	47645,666716	69746,415299
403	44051,141041	72643,478941	403	47664,587122	69792,697242
404	44036,516813	72691,138040	404	47683,546259	69838,961941
405	44034,059533	72740,942788	405	47705,279501	69883,991556
406	44015,854459	72787,186585	406	47727,012743	69929,021170
407	44008,585289	72836,513409	407	47748,745986	69974,050784
408	43999,766886	72882,518966	408	47770,479228	70019,080399
409	43969,669545	72922,062825	409	47792,212470	70064,110013
410	43928,657503	72934,295075	410	47813,945713	70109,139628
411	43881,338523	72918,548714	411	47836,986745	70153,512817
412	43831,746832	72912,609526	412	47855,305660	70200,025909
413	43782,151621	72917,666840	413	47875,225713	70245,876623
414	43735,299208	72934,736884	414	47895,581684	70291,545369
415	43686,899011	72945,358746	415	47915,937655	70337,214116
416	43640,200717	72963,059289	416	47936,293626	70382,882863
417	43597,670130	72989,075482	417	47956,649597	70428,551610
418	43562,858114	73024,773734	418	47975,942110	70474,626767
419	43535,871251	73066,840395	419	47991,231524	70522,231744
420	43515,557151	73112,378164	420	48006,520938	70569,836721
421	43490,903790	73152,153614	421	48021,810352	70617,441698
422	43446,842211	73154,945266	422	48027,274500	70666,931315
423	43397,858294	73144,979025	423	48030,684919	70716,814870
424	43348,085366	73140,886031	424	48034,095338	70766,698425
425	43298,133137	73141,135089	425	48037,505757	70816,581979
426	43248,822997	73141,169164	426	48040,895685	70866,466915
427	43200,260924	73130,186060	427	48044,207170	70916,357135
428	43150,775828	73124,530829	428	48047,518655	70966,247355
429	43101,274214	73118,006652	429	48050,830141	71016,137575
430	43053,631438	73106,738495	430	48054,141626	71066,027795
431	43009,402888	73084,137588	431	48052,606141	71115,838268
432	42960,569427	73076,315680	432	48047,655206	71165,592547
433	42911,129249	73079,254249	433	48042,704270	71215,346825
434	42861,729076	73086,079187	434	48037,753335	71265,101104
435	42815,547921	73104,929704	435	48032,802399	71314,855383
436	42773,709889	73132,103270	436	48027,850444	71364,609560
437	42730,363521	73155,905245	437	48022,898421	71414,363730
438	42689,354276	73184,391056	438	48017,946398	71464,117901
439	42644,162091	73203,109998	439	48012,994376	71513,872071
440	42598,806084	73213,101735	440	48004,906942	71562,995566
441	42550,804280	73199,607270	441	47990,236482	71610,794914

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
442	42500,965563	73198,383019	442	47975,566021	71658,594261
443	42452,368850	73209,502132	443	47960,829819	71706,373085
444	42407,450052	73230,695283	444	47945,701498	71754,029500
445	42358,543592	73240,457620	445	47930,573177	71801,685915
446	42313,605324	73262,069711	446	47915,444856	71849,342330
447	42275,402654	73294,101949	447	47900,316535	71896,998745
448	42243,126188	73331,535483	448	47885,254585	71944,676047
449	42204,513413	73363,068006	449	47870,364843	71992,407542
450	42174,878771	73403,162385	450	47851,518669	72038,621735
451	42155,637038	73449,210394	451	47828,418783	72082,955705
452	42143,945248	73497,703878	452	47804,497176	72126,855657
453	42128,143763	73542,137616	453	47779,734466	72170,293063
454	42102,033147	73584,605624	454	47754,971756	72213,730468
455	42071,045448	73621,544120	455	47730,209046	72257,167874
456	42024,713809	73614,592301	456	47705,446336	72300,605279
457	41974,917724	73612,065604	457	47680,965934	72344,195799
458	41925,087582	73613,828621	458	47658,063356	72388,642081
459	41876,108993	73623,207090	459	47635,160778	72433,088362
460	41829,847548	73642,057488	460	47610,592234	72476,437303
461	41788,612837	73670,100792	461	47578,799883	72515,028058
462	41755,456267	73707,384468	462	47547,007531	72553,618813
463	41726,468830	73748,091935	463	47515,215179	72592,209568
464	41701,924687	73791,624703	464	47479,222646	72626,438981
465	41686,506944	73839,043093	465	47439,462740	72656,756464
466	41680,546669	73888,671540	466	47399,702833	72687,073948
467	41678,483008	73938,607040	467	47359,538396	72716,436952
468	41683,179530	73988,193892	468	47310,101966	72723,922898
469	41650,199921	74023,709005	469	47260,665536	72731,408845
470	41620,526810	74063,775813	470	47211,229106	72738,894791
471	41581,138876	74094,200932	471	47161,917557	72747,103433
472	41546,670460	74130,400241	472	47112,835703	72756,641337
473	41517,843628	74171,200219	473	47063,710648	72765,937359
474	41496,993446	74216,483694	474	47014,361640	72773,979459
475	41487,968515	74265,520637	475	46965,012632	72782,021559
476	41491,085262	74315,319127	476	46915,663623	72790,063659
477	41462,466069	74349,916803	477	46868,255204	72805,691367
478	41425,752065	74383,708502	478	46821,106868	72822,335715
479	41392,440962	74420,960870	479	46778,960187	72848,478594
480	41360,156403	74458,273922	480	46738,558605	72877,935549
481	41327,220168	74495,721909	481	46698,157023	72907,392503
482	41300,462863	74537,956110	482	46656,136648	72933,830512

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
483	41272,041078	74578,628829	483	46609,243867	72951,181797
484	41236,038470	74613,299425	484	46562,351086	72968,533083
485	41206,053305	74653,252620	485	46515,458305	72985,884368
486	41176,027243	74693,046440	486	46469,252927	73004,987790
487	41143,130517	74730,669130	487	46422,600351	73022,960158
488	41110,279559	74768,074075	488	46375,795413	73040,547021
489	41073,732493	74802,055913	489	46328,963331	73058,059680
490	41033,687965	74831,474738	490	46281,857820	73074,824846
491	40998,867366	74867,169223	491	46234,752308	73091,590012
492	40970,095759	74908,046792	492	46187,646796	73108,355177
493	40931,258622	74936,965047	493	46141,154762	73126,744921
494	40888,431564	74962,612031	494	46094,725398	73145,300627
495	40852,968130	74997,674767	495	46048,296035	73163,856332
496	40825,744724	75039,563764	496	46001,859053	73182,392851
497	40805,425056	75085,100558	497	45955,346829	73200,739866
498	40779,531863	75127,281083	498	45908,834605	73219,086882
499	40754,002200	75170,235395	499	45862,322380	73237,433898
500	40733,295553	75215,624879	500	45819,788148	73263,577018
501	40708,089440	75225,963056	501	45777,636966	73290,470844
502	40666,133570	75198,926595	502	45735,485784	73317,364669
503	40619,006842	75182,651392	503	45693,334602	73344,258495
504	40569,325072	75178,199711	504	45651,183420	73371,152320
505	40531,484026	75153,368375	505	45610,349530	73399,816503
506	40490,497835	75125,972068	506	45574,853260	73434,730322
507	40475,165779	75080,252617	507	45546,005343	73475,424231
508	40444,655009	75041,128364	508	45521,200447	73518,837560
509	40407,996861	75007,326988	509	45496,395551	73562,250889
510	40364,749998	74982,325162	510	45471,590655	73605,664218
511	40319,966712	74960,097232	511	45446,785759	73649,077547
512	40274,594437	74939,099765	512	45421,980863	73692,490876
513	40226,458439	74926,106944	513	45400,402037	73737,520654
514	40178,207845	74914,875669	514	45380,476661	73783,378907
515	40128,950716	74907,137426	515	45360,551285	73829,237160
516	40083,499992	74886,634228	516	45340,882715	73875,205405
517	40034,460864	74877,508001	517	45321,437273	73921,269217
518	40000,467494	74849,127336	518	45301,991832	73967,333030
519	39962,654805	74817,246935	519	45282,546390	74013,396842
520	39913,899253	74810,296262	520	45264,598492	74060,051377
521	39867,374441	74826,594133	521	45247,359818	74106,985672
522	39840,039875	74867,339722	522	45230,121143	74153,919968
523	39797,142837	74882,439610	523	45212,801881	74200,823737

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
524	39751,286741	74902,030860	524	45194,618552	74247,400196
525	39705,792208	74921,960902	525	45176,435224	74293,976655
526	39663,143559	74947,801040	526	45153,385285	74338,147766
527	39624,750322	74979,769908	527	45126,173363	74380,078699
528	39594,253034	75019,222352	528	45097,479420	74420,955059
529	39557,644129	75052,346684	529	45063,952715	74458,048994
530	39514,544950	75077,505353	530	45030,426009	74495,142929
531	39476,267423	75109,446029	531	44996,899304	74532,236864
532	39443,767348	75147,431416	532	44963,372598	74569,330800
533	39410,124822	75182,766625	533	44930,410357	74606,882640
534	39369,913661	75212,271120	534	44901,027421	74647,338085
535	39333,426368	75246,457045	535	44871,644485	74687,793531
536	39296,655504	75280,331956	536	44842,261549	74728,248976
537	39261,132568	75315,518896	537	44812,878613	74768,704422
538	39219,529771	75334,835499	538	44784,244617	74809,692420
539	39174,017922	75354,228463	539	44755,680042	74850,729781
540	39143,453642	75393,116875	540	44724,753277	74889,936339
541	39135,192758	75441,878553	541	44692,138911	74927,834929
542	39138,577233	75485,114277	542	44659,524545	74965,733519
543	39094,867380	75509,392612	543	44615,946051	74986,377113
544	39054,643759	75538,959230	544	44567,783107	74999,805845
545	39016,468593	75571,229811	545	44519,620163	75013,234577
546	38979,114051	75599,909574	546	44471,457220	75026,663310
547	38929,731881	75604,826972	547	44422,893559	75038,489467
548	38883,531265	75621,837838	548	44374,116378	75049,469134
549	38842,785176	75649,509761	549	44325,669606	75061,834822
550	38816,333142	75691,592487	550	44277,222833	75074,200509
551	38779,868662	75717,959887	551	44228,776060	75086,566196
552	38737,941110	75744,220347	552	44180,286728	75098,761762
553	38708,013515	75783,955630	553	44131,724287	75110,665093
554	38670,507166	75816,624061	554	44083,218547	75122,782304
555	38630,204342	75846,215992	555	44035,137205	75136,500339
556	38590,421086	75876,471563	556	43987,055862	75150,218374
557	38557,471538	75913,900697	557	43938,974519	75163,936409
558	38532,905152	75957,365076	558	43890,893177	75177,654444
559	38486,593757	75966,142774	559	43842,811834	75191,372479
560	38438,980915	75980,905341	560	43794,730491	75205,090514
561	38396,432150	76006,906654	561	43747,097595	75220,180243
562	38356,973590	76037,035270	562	43703,632939	75244,506896
563	38308,230984	76047,694966	563	43661,245565	75271,026898
564	38261,626979	76065,803831	564	43618,858190	75297,546900

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
565	38217,919739	76089,807484	565	43576,470816	75324,066902
566	38173,996387	76111,586792	566	43534,083442	75350,586903
567	38132,870252	76086,985389	567	43491,696067	75377,106905
568	38086,778116	76067,976433	568	43449,523523	75403,955220
569	38037,408963	76061,035092	569	43408,250426	75432,178108
570	37987,725536	76057,114621	570	43366,977328	75460,400996
571	37937,782542	76056,891809	571	43325,704230	75488,623884
572	37888,365439	76063,641457	572	43283,490180	75515,214468
573	37842,158397	76082,387557	573	43238,382926	75536,786108
574	37796,383326	76101,492393	574	43193,275672	75558,357748
575	37752,597376	76125,327596	575	43148,565513	75580,725467
576	37716,058496	76159,238104	576	43104,199941	75603,784002
577	37685,266034	76198,626511	577	43059,834369	75626,842538
578	37640,756974	76219,391584	578	43015,468798	75649,901073
579	37599,188069	76247,034542	579	42971,103226	75672,959608
580	37560,874423	76279,038200	580	42926,367810	75695,164615
581	37530,953512	76318,917029	581	42879,204543	75711,766610
582	37511,872697	76364,981112	582	42832,839413	75730,345069
583	37504,815100	76414,331753	583	42787,372925	75751,148877
584	37501,140417	76464,101753	584	42741,798592	75771,715239
585	37496,322900	76513,849934	585	42696,216433	75792,264370
586	37496,182706	76563,441995	586	42650,634274	75812,813501
587	37491,252600	76613,063701	587	42605,052115	75833,362632
588	37498,052968	76662,508617	588	42559,469956	75853,911762
589	37491,741078	76711,624886	589	42514,881477	75876,514284
590	37481,473247	76760,538559	590	42470,482729	75899,508874
591	37471,218893	76809,452059	591	42426,083981	75922,503464
592	37457,103646	76852,906428	592	42382,213560	75946,403992
593	37418,827684	76884,661932	593	42340,337089	75973,723603
594	37371,350917	76900,294382	594	42298,460618	76001,043214
595	37327,967734	76924,885824	595	42257,263447	76029,266501
596	37288,184299	76899,326271	596	42219,382439	76061,901286
597	37245,834530	76872,749206	597	42181,501431	76094,536072
598	37199,999644	76853,121880	598	42143,620423	76127,170857
599	37151,789006	76839,866663	599	42106,361784	76160,463114
600	37103,150043	76828,464746	600	42071,699695	76196,498369
601	37053,829471	76820,250050	601	42037,037607	76232,533625
602	37004,247919	76814,362010	602	42001,803045	76268,005593
603	36954,707262	76819,890660	603	41966,333124	76303,245977
604	36906,922456	76834,551366	604	41930,240467	76337,807877
605	36859,322263	76849,855666	605	41892,095528	76370,133775

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
606	36811,451424	76864,287464	606	41853,950589	76402,459673
607	36763,703750	76879,114208	607	41815,805651	76434,785570
608	36716,234133	76894,809559	608	41778,942477	76468,414110
609	36669,661055	76912,972270	609	41746,004562	76506,031842
610	36624,946713	76935,339841	610	41713,066647	76543,649573
611	36578,296047	76952,526615	611	41680,128731	76581,267305
612	36533,738299	76972,174687	612	41646,858352	76618,571549
613	36484,285976	76971,535954	613	41611,239072	76653,660961
614	36440,586101	76994,724072	614	41575,619791	76688,750373
615	36413,409282	77036,046557	615	41541,125423	76724,936686
616	36402,165699	77082,583408	616	41506,945181	76761,429302
617	36368,515630	77119,482216	617	41472,265544	76797,438538
618	36324,241286	77135,799792	618	41436,905933	76832,789604
619	36275,765496	77147,789829	619	41401,546321	76868,140671
620	36231,291164	77170,341414	620	41366,186710	76903,491737
621	36193,787420	77203,208746	621	41333,103159	76940,740039
622	36163,076877	77242,649649	622	41304,696873	76981,887128
623	36136,127149	77284,742266	623	41276,290587	77023,034217
624	36105,506219	77320,390667	624	41247,884301	77064,181305
625	36060,445342	77341,974045	625	41212,697008	77099,288569
626	36018,454551	77368,960450	626	41175,097475	77132,247257
627	35977,464866	77397,535870	627	41137,497941	77165,205944
628	35939,029015	77429,480625	628	41097,767784	77195,516225
629	35902,540145	77463,481534	629	41057,521003	77225,184333
630	35873,436163	77504,096023	630	41015,324495	77251,690114
631	35834,316584	77532,475871	631	40970,740825	77274,324080
632	35792,762716	77560,057594	632	40926,157156	77296,958047
633	35759,334739	77597,058394	633	40881,573487	77319,592013
634	35732,971846	77639,012112	634	40837,294630	77342,762070
635	35696,822130	77673,509622	635	40795,044598	77369,500335
636	35668,650089	77714,673724	636	40752,794566	77396,238599
637	35640,562113	77754,937063	637	40710,544534	77422,976864
638	35601,996600	77786,523259	638	40668,294502	77449,715128
639	35571,040788	77825,727000	639	40624,823679	77474,415756
640	35539,242745	77864,030293	640	40581,316815	77499,056226
641	35502,568469	77897,202379	641	40538,684296	77525,162610
642	35462,754052	77927,399159	642	40495,581928	77550,476656
643	35420,788347	77954,479565	643	40451,995990	77574,976984
644	35381,919727	77985,752085	644	40408,410053	77599,477311
645	35340,279203	78013,245005	645	40364,824115	77623,977638
646	35306,476630	78049,888634	646	40321,238178	77648,477966

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
647	35282,791225	78093,748646	647	40277,652240	77672,978293
648	35261,747858	78137,235571	648	40234,475090	77698,189448
649	35215,910319	78151,142957	649	40191,377826	77723,539514
650	35168,636062	78167,011485	650	40148,280563	77748,889581
651	35125,619828	78192,431854	651	40104,439452	77772,900214
652	35080,534319	78213,030954	652	40060,139966	77796,085457
653	35033,233084	78220,175360	653	40015,840479	77819,270699
654	34983,464833	78217,130078	654	39972,684589	77844,054347
655	34934,509610	78226,604454	655	39936,438753	77878,496173
656	34889,411828	78247,861562	656	39900,192918	77912,937999
657	34844,274696	78267,474048	657	39863,947082	77947,379826
658	34799,623469	78289,693952	658	39827,701247	77981,821652
659	34761,090916	78321,472998	659	39787,535567	78011,084623
660	34723,496322	78354,430797	660	39744,545464	78036,615996
661	34677,353596	78370,334781	661	39700,722812	78060,655392
662	34629,492666	78384,471012	662	39654,530490	78079,217480
663	34583,668528	78404,466031	663	39606,689247	78093,750735
664	34542,091378	78432,011508	664	39558,549473	78107,164621
665	34505,549980	78466,133194	665	39509,824755	78118,385223
666	34464,673052	78493,919802	666	39461,100038	78129,605825
667	34417,470952	78479,116478	667	39412,375320	78140,826427
668	34368,805905	78467,833934	668	39364,204894	78153,892273
669	34318,900417	78465,236609	669	39317,362455	78171,379007
670	34268,989251	78466,389493	670	39270,520015	78188,865742
671	34220,773807	78479,122161	671	39223,590542	78206,098921
672	34173,021845	78493,088702	672	39175,883498	78221,066818
673	34124,024531	78502,996477	673	39128,176454	78236,034716
674	34077,328368	78520,731233	674	39080,469410	78251,002613
675	34031,718394	78541,156691	675	39032,925390	78266,431864
676	33990,477462	78569,310325	676	38986,405691	78284,759921
677	33950,689559	78599,584348	677	38939,885993	78303,087978
678	33910,864239	78629,681728	678	38893,021126	78320,492720
679	33869,752932	78658,050396	679	38845,886571	78337,176058
680	33826,269558	78676,584411	680	38798,752017	78353,859396
681	33776,563026	78681,868939	681	38752,640143	78373,025914
682	33727,128582	78689,097464	682	38708,008501	78395,358394
683	33679,961708	78705,477933	683	38667,510655	78424,682862
684	33633,688253	78724,411699	684	38627,012809	78454,007331
685	33588,328869	78745,372356	685	38581,109293	78473,501792
686	33548,550224	78775,452073	686	38534,654549	78491,993866
687	33514,567674	78811,987789	687	38488,199806	78510,485940

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
688	33475,784905	78843,477315	688	38441,745062	78528,978014
689	33430,645532	78864,593535	689	38394,815139	78546,073191
690	33391,455391	78895,486566	690	38346,720311	78559,743871
691	33351,452536	78925,086753	691	38298,656310	78573,522171
692	33312,568775	78956,491903	692	38250,617701	78587,389111
693	33273,387529	78987,548031	693	38202,579092	78601,256051
694	33237,438017	79022,113717	694	38154,158940	78613,597721
695	33210,974055	79064,370250	695	38105,249196	78623,982179
696	33174,688424	79092,677476	696	38056,339453	78634,366638
697	33126,609059	79105,927940	697	38008,967498	78650,189532
698	33083,317264	79130,687711	698	37961,861970	78666,954652
699	33047,497168	79165,373705	699	37914,756443	78683,719772
700	33021,139000	79207,722179	700	37867,645104	78700,468490
701	32990,238670	79237,267748	701	37820,491354	78717,097497
702	32940,851622	79244,177372	702	37773,337604	78733,726504
703	32894,723400	79263,124625	703	37726,183854	78750,355511
704	32854,709824	79292,874423	704	37681,396459	78772,313421
705	32823,058445	79331,430202	705	37637,440107	78796,142797
706	32791,656953	79370,232296	706	37593,483756	78819,972174
707	32760,471566	79408,925875	707	37549,527405	78843,801550
708	32725,429173	79444,588628	708	37505,571053	78867,630926
709	32695,005194	79484,099440	709	37461,614702	78891,460303
710	32671,218163	79527,708009	710	37418,121267	78915,977573
711	32628,106733	79552,777929	711	37379,492412	78947,723621
712	32592,563776	79587,760591	712	37340,863556	78979,469668
713	32566,802791	79630,454245	713	37302,234701	79011,215716
714	32533,630741	79667,358508	714	37263,605846	79042,961764
715	32503,223323	79707,042893	715	37224,976990	79074,707811
716	32470,269691	79744,598984	716	37186,348135	79106,453859
717	32444,085757	79787,020831	717	37155,501032	79144,742684
718	32427,666674	79834,194317	718	37130,859098	79188,248719
719	32413,237968	79881,680862	719	37106,217164	79231,754754
720	32390,501583	79926,130887	720	37079,801851	79274,174555
721	32357,377708	79962,659615	721	37052,241787	79315,893170
722	32316,347824	79990,656925	722	37024,681723	79357,611786
723	32278,791894	80023,587963	723	36997,631254	79399,658413
724	32236,577077	80050,224026	724	36970,680854	79441,773172
725	32194,514128	80077,114272	725	36935,815515	79477,566423
726	32159,385409	80112,553495	726	36900,698249	79513,158242
727	32126,822237	80150,494649	727	36865,580983	79548,750061
728	32100,176627	80192,642102	728	36830,463716	79584,341881

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
729	32076,872861	80236,577558	729	36795,346450	79619,933700
730	32045,371320	80275,333095	730	36764,032448	79658,508548
731	32018,007529	80317,180709	731	36737,832326	79701,094387
732	31991,679164	80359,651777	732	36711,632204	79743,680225
733	31967,615908	80402,268952	733	36685,432082	79786,266063
734	31927,912274	80432,455202	734	36659,231960	79828,851901
735	31892,687564	80467,939634	735	36621,358481	79860,230810
736	31851,140513	80494,761529	736	36579,875789	79888,144717
737	31808,477745	80520,134702	737	36535,645143	79911,302343
738	31776,930785	80558,218939	738	36488,478498	79927,005897
739	31765,098389	80606,128112	739	36439,858070	79938,670117
740	31738,741881	80648,617327	740	36390,959264	79949,007552
741	31712,621682	80691,245666	741	36341,750835	79957,869299
742	31693,773745	80737,405779	742	36292,542407	79966,731047
743	31648,963346	80756,464093	743	36243,333978	79975,592795
744	31607,254700	80783,799221	744	36194,400852	79985,654624
745	31573,604006	80820,587678	745	36146,250180	79999,127293
746	31550,102158	80864,549817	746	36098,099508	80012,599961
747	31528,235493	80908,542962	747	36049,905987	80025,916656
748	31504,817931	80952,552003	748	36001,630341	80038,934415
749	31483,947754	80997,593163	749	35953,354695	80051,952173
750	31458,278622	81040,347287	750	35905,079050	80064,969932
751	31415,043882	81041,425854	751	35856,803404	80077,987690
752	31366,283103	81044,626249	752	35808,828702	80092,063176
753	31340,050301	81072,339366	753	35760,727904	80105,712837
754	31343,331002	81122,168501	754	35712,627106	80119,362498
755	31340,137505	81172,066413	755	35664,526309	80133,012160
756	31329,374274	81213,438525	756	35616,425511	80146,661821
757	31279,449183	81210,702593	757	35569,905520	80164,966417
758	31240,252915	81220,573624	758	35523,439964	80183,431305
759	31234,969083	81270,293652	759	35481,660842	80210,034479
760	31229,685252	81320,013679	760	35442,367290	80240,954000
761	31251,120849	81357,487922	761	35403,073739	80271,873522
762	31215,708290	81392,602948	762	35365,105794	80303,992717
763	31190,088093	81435,384524	763	35338,248997	80346,167502
764	31166,735834	81479,047973	764	35311,392200	80388,342286
765	31144,683380	81523,766346	765	35285,023465	80430,791651
766	31133,339300	81572,388278	766	35262,921037	80475,641207
767	31126,087020	81621,491074	767	35240,818609	80520,490763
768	31117,422226	81670,711801	768	35218,716181	80565,340319
769	31102,990278	81717,622673	769	35196,613752	80610,189875

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
770	31061,476764	81745,252798	770	35174,511324	80655,039430
771	31020,826964	81774,154532	771	35149,148787	80697,950513
772	30988,405181	81812,027911	772	35121,851473	80739,754377
773	30966,390650	81856,764983	773	35109,242900	80786,858979
774	30949,184378	81903,375382	774	35107,821251	80836,817976
775	30911,665220	81932,931803	775	35108,171233	80886,816751
776	30873,990406	81965,611779	776	35108,521215	80936,815526
777	30845,588997	82006,598173	777	35108,871198	80986,814301
778	30828,210593	82053,328107	778	35109,221180	81036,813076
779	30818,115812	82102,159637	779	35109,571162	81086,811851
780	30795,794790	82146,803868	780	35109,921145	81136,810626
781	30770,561570	82189,969648	781	35108,992714	81186,776178
782	30738,142101	82227,896752	782	35103,787623	81236,386739
783	30704,563151	82264,943400	783	35093,493951	81285,315670
784	30671,002806	82302,006622	784	35082,445214	81334,078303
785	30639,910787	82341,159076	785	35071,230982	81382,804487
786	30609,041958	82380,491491	786	35060,016751	81431,530671
787	30576,342913	82418,317044	787	35048,802519	81480,256855
788	30544,161363	82456,566212	788	35037,588287	81528,983039
789	30514,562692	82496,860859	789	35027,190631	81577,884762
790	30472,839150	82502,577186	790	35017,390224	81626,914876
791	30424,679370	82489,137113	791	35007,589817	81675,944989
792	30376,519590	82475,697040	792	34981,781693	81718,244060
793	30328,359810	82462,256967	793	34953,599153	81759,544719
794	30309,336023	82431,011031	794	34925,416613	81800,845378
795	30300,559144	82382,329923	795	34897,234072	81842,146037
796	30269,590739	82343,772218	796	34871,853160	81885,132227
797	30223,909462	82324,781961	797	34848,568007	81929,379279
798	30174,735175	82330,105187	798	34825,282854	81973,626332
799	30134,088634	82358,280093	799	34801,997702	82017,873384
800	30090,321279	82351,790206	800	34778,712549	82062,120437
801	30047,532764	82326,434596	801	34754,887377	82106,072846
802	30008,195752	82295,578262	802	34728,421068	82148,104599
803	29962,117716	82286,681818	803	34687,431735	82176,418126
804	29919,437135	82271,505386	804	34644,235443	82201,578634
805	29873,677310	82288,080216	805	34600,512973	82225,834473
806	29837,940107	82321,554515	806	34556,790504	82250,090311
807	29801,045172	82354,607821	807	34513,068035	82274,346149
808	29788,821127	82402,179167	808	34469,345565	82298,601987
809	29768,448934	82438,683546	809	34426,215287	82323,762866
810	29754,701240	82486,756417	810	34386,481484	82354,114553

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
811	29740,953547	82534,829288	811	34346,747682	82384,466240
812	29727,205853	82582,902159	812	34307,013879	82414,817928
813	29701,643606	82621,973886	813	34267,280076	82445,169615
814	29676,505543	82664,109920	814	34225,251062	82472,180224
815	29672,909429	82705,432614	815	34182,664827	82498,379700
816	29641,883732	82668,584881	816	34145,203401	82530,855150
817	29600,281554	82653,779195	817	34111,019494	82567,344333
818	29551,147466	82663,016304	818	34076,835587	82603,833517
819	29504,159487	82679,812151	819	34033,916603	82629,469270
820	29458,371285	82699,892740	820	33990,963014	82655,062027
821	29414,183325	82723,135825	821	33948,009426	82680,654784
822	29370,867017	82748,109582	822	33905,426113	82706,715036
823	29331,743509	82779,227126	823	33870,676892	82742,666276
824	29296,655014	82814,771001	824	33835,927671	82778,617516
825	29265,820502	82854,056889	825	33800,108170	82813,343556
826	29234,469610	82888,101900	826	33759,813832	82842,947041
827	29213,499458	82931,951728	827	33719,519494	82872,550526
828	29197,548349	82978,990132	828	33679,225156	82902,154011
829	29184,747216	83026,734394	829	33645,460456	82938,121621
830	29160,576108	83070,486838	830	33616,901046	82979,162577
831	29142,434044	83117,015447	831	33588,341636	83020,203534
832	29130,121840	83165,454502	832	33559,782226	83061,244490
833	29125,059599	83215,179505	833	33557,723655	83110,460040
834	29123,452600	83265,134896	834	33558,200776	83160,457764
835	29094,865754	83277,443423	835	33558,677897	83210,455487
836	29076,514327	83309,721805	836	33559,155019	83260,453211
837	29059,515559	83356,455577	837	33557,251834	83310,399779
838	29038,410385	83401,369572	838	33557,113184	83360,382607
839	29026,701124	83449,979172	839	33557,657155	83410,379647
840	29014,991862	83498,588772	840	33558,201127	83460,376688
841	29003,282601	83547,198372	841	33558,745098	83510,373729
842	28991,573339	83595,807972	842	33562,498231	83560,186466
843	28979,864077	83644,417572	843	33567,681675	83609,917059
844	28968,154816	83693,027171	844	33572,865118	83659,647653
845	28956,445554	83741,636771	845	33578,048562	83709,378246
846	28944,736293	83790,246371	846	33583,294753	83759,101531
847	28933,027031	83838,855971	847	33589,679234	83808,692240
848	28921,317770	83887,465571	848	33596,063715	83858,282949
849	28909,608508	83936,075170	849	33602,448196	83907,873658
850	28897,899247	83984,684770	850	33608,832677	83957,464366
851	28886,189985	84033,294370	851	33597,551323	84000,622864

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
852	28874,480724	84081,903970	852	33560,776195	84034,498961
853	28862,771462	84130,513570	853	33524,001067	84068,375058
854	28851,062201	84179,123170	854	33487,225939	84102,251156
855	28839,352939	84227,732769	855	33454,522873	84139,930948
856	28827,643678	84276,342369	856	33423,228681	84178,926762
857	28815,934416	84324,951969	857	33391,934489	84217,922576
858	28804,225155	84373,561569	858	33360,640296	84256,918390
859	28792,515893	84422,171169	859	33325,962511	84292,889433
860	28780,806632	84470,780769	860	33290,703990	84328,341326
861	28769,097370	84519,390368	861	33258,477917	84366,045850
862	28757,388109	84567,999968	862	33234,719925	84410,040825
863	28745,678847	84616,609568	863	33211,317974	84454,215631
864	28733,969586	84665,219168	864	33190,008782	84499,447460
865	28723,369886	84714,042132	865	33168,699589	84544,679288
866	28716,215794	84763,527675	866	33147,390397	84589,911117
867	28709,061703	84813,013219	867	33126,081204	84635,142946
868	28701,907611	84862,498762	868	33109,126300	84681,870580
869	28700,181646	84912,368878	869	33095,566989	84729,930395
870	28700,287366	84962,368766	870	33079,701036	84777,346337
871	28700,393086	85012,368655	871	33063,835082	84824,762278
872	28700,498805	85062,368543	872	33047,969129	84872,178220
873	28700,604525	85112,368431	873	33030,865256	84919,099361
874	28700,710245	85162,368319	874	33009,676921	84964,387930
875	28700,815964	85212,368208	875	32987,198368	85008,968046
876	28700,921684	85262,368096	876	32960,355947	85051,151982
877	28701,027404	85312,367984	877	32933,513525	85093,335917
878	28701,133123	85362,367872	878	32906,671104	85135,519853
879	28701,238843	85412,367760	879	32868,527579	85167,510615
880	28701,344563	85462,367649	880	32829,327081	85198,548027
881	28701,450283	85512,367537	881	32790,126583	85229,585440
882	28701,556002	85562,367425	882	32753,503446	85263,518133
883	28701,661722	85612,367313	883	32718,135602	85298,860963
884	28701,767442	85662,367202	884	32682,767758	85334,203793
885	28701,873161	85712,367090	885	32647,387180	85369,531692
886	28701,978881	85762,366978	886	32606,906103	85398,879305
887	28701,016953	85812,343796	887	32566,425026	85428,226919
888	28701,390439	85862,320647	888	32526,667767	85458,456577
889	28690,678085	85910,892573	889	32489,983944	85492,431525
890	28688,478705	85960,787338	890	32453,300121	85526,406473
891	28692,573197	86010,566664	891	32414,196403	85557,562672
892	28689,554381	86059,905335	892	32380,722535	85592,991277

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
893	28677,518296	86108,287889	893	32361,145678	85638,999392
894	28663,001977	86155,945710	894	32341,568821	85685,007507
895	28652,919806	86204,799750	895	32321,991964	85731,015622
896	28652,670563	86254,753717	896	32302,415107	85777,023737
897	28662,592588	86303,615127	897	32282,838250	85823,031853
898	28678,053245	86350,876819	898	32263,261393	85869,039968
899	28696,481123	86397,194768	899	32243,684536	85915,048083
900	28721,109671	86439,179044	900	32224,107678	85961,056198
901	28719,932039	86489,153940	901	32204,530821	86007,064313
902	28716,365110	86537,740867	902	32184,953964	86053,072429
903	28682,662910	86574,487242	903	32165,377107	86099,080544
904	28658,527474	86618,164307	904	32145,800250	86145,088659
905	28622,314155	86651,020635	905	32126,223393	86191,096774
906	28587,170021	86686,403919	906	32106,646536	86237,104890
907	28553,019834	86722,741198	907	32087,069679	86283,113005
908	28528,763901	86766,291210	908	32067,492822	86329,121120
909	28516,025714	86814,495437	909	32047,915965	86375,129235
910	28507,534347	86863,551340	910	32028,339107	86421,137350
911	28494,498325	86911,205080	911	32008,762250	86467,145466
912	28473,937629	86956,682405	912	31989,185393	86513,153581
913	28446,489084	86998,168665	913	31969,608536	86559,161696
914	28415,551954	87034,933331	914	31950,031679	86605,169811
915	28375,876941	87065,161598	915	31930,454822	86651,177927
916	28344,886276	87104,226113	916	31910,877965	86697,186042
917	28313,121092	87141,903803	917	31891,301108	86743,194157
918	28293,588544	87187,340742	918	31871,724251	86789,202272
919	28289,979919	87236,805061	919	31852,147394	86835,210388
920	28287,384816	87286,672915	920	31832,570536	86881,218503
921	28292,488546	87336,277376	921	31812,993679	86927,226618
922	28268,429877	87379,635508	922	31793,416822	86973,234733
923	28255,041175	87427,659705	923	31773,839965	87019,242848
924	28253,902412	87477,499649	924	31754,263108	87065,250964
925	28212,040098	87501,518084	925	31734,686251	87111,259079
926	28170,248120	87528,847969	926	31715,109394	87157,267194
927	28134,681639	87563,827967	927	31695,532537	87203,275309
928	28107,167800	87605,420125	928	31675,955680	87249,283424
929	28089,975564	87652,293990	929	31656,378823	87295,291540
930	28078,581529	87700,326517	930	31636,801965	87341,299655
931	28035,358972	87725,212771	931	31617,225108	87387,307770
932	27989,808723	87741,852207	932	31597,648251	87433,315885
933	27943,582592	87760,547659	933	31578,071394	87479,324001

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
934	27903,215075	87789,766698	934	31558,494537	87525,332116
935	27856,840636	87808,090610	935	31538,917680	87571,340231
936	27816,186957	87837,000220	936	31519,340823	87617,348346
937	27782,169062	87873,489540	937	31499,763966	87663,356461
938	27753,930891	87914,642321	938	31480,187109	87709,364577
939	27727,768671	87957,128359	939	31460,610252	87755,372692
940	27711,743602	88004,341956	940	31441,033394	87801,380807
941	27702,977152	88053,411518	941	31421,456537	87847,388922
942	27690,317928	88101,736644	942	31401,879680	87893,397038
943	27687,430387	88151,507543	943	31382,302823	87939,405153
944	27695,068748	88200,884133	944	31362,725966	87985,413268
945	27712,008557	88247,789750	945	31343,149109	88031,421383
946	27736,238940	88291,478810	946	31323,572252	88077,429498
947	27764,983721	88332,284206	947	31303,995395	88123,437614
948	27802,535243	88365,099956	948	31284,418538	88169,445729
949	27845,925515	88389,906813	949	31264,841681	88215,453844
950	27892,424529	88407,904077	950	31245,264824	88261,461959
951	27941,708570	88416,144152	951	31225,687967	88307,470075
952	27948,838478	88441,012897	952	31206,111109	88353,478190
953	27928,197977	88486,388589	953	31186,534252	88399,486305
954	27917,740900	88535,233954	954	31166,957395	88445,494420
955	27883,923408	88548,495873	955	31147,380538	88491,502535
956	27833,939814	88547,696936	956	31127,803681	88537,510651
957	27784,496524	88554,170313	957	31108,226824	88583,518766
958	27738,149105	88572,584409	958	31088,649967	88629,526881
959	27695,035895	88597,837271	959	31069,073110	88675,534996
960	27657,793147	88631,017073	960	31049,496253	88721,543111
961	27626,504828	88669,878157	961	31029,919396	88767,551227
962	27603,038062	88714,000548	962	31010,342538	88813,559342
963	27586,644925	88761,088564	963	30983,046705	88855,277539
964	27582,310939	88810,757301	964	30954,312753	88896,196483
965	27585,046870	88860,682171	965	30925,578801	88937,115428
966	27592,475433	88909,998808	966	30896,844850	88978,034372
967	27608,936974	88957,194797	967	30868,110898	89018,953316
968	27626,659537	89003,947586	968	30839,376946	89059,872261
969	27648,107747	89049,011025	969	30810,642994	89100,791205
970	27675,151400	89090,986726	970	30781,909042	89141,710150
971	27710,942738	89125,703821	971	30753,175090	89182,629094
972	27712,136699	89155,374174	972	30724,441138	89223,548038
973	27679,567391	89193,176925	973	30695,707187	89264,466983
974	27655,196605	89212,445877	974	30666,973235	89305,385927

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
975	27611,843054	89237,158176	975	30638,239283	89346,304872
976	27573,758444	89269,508993	976	30609,505331	89387,223816
977	27527,589355	89282,898426	977	30580,771379	89428,142761
978	27480,896989	89300,359646	978	30552,037427	89469,061705
979	27438,111339	89326,205908	979	30523,303475	89509,980649
980	27396,091003	89353,286737	980	30494,569524	89550,899594
981	27355,213244	89382,068162	981	30465,835572	89591,818538
982	27314,292106	89410,775042	982	30437,101620	89632,737483
983	27268,265580	89419,878699	983	30408,367668	89673,656427
984	27219,569888	89410,741360	984	30379,633716	89714,575371
985	27171,048697	89398,910508	985	30350,899764	89755,494316
986	27121,203401	89398,200188	986	30322,165812	89796,413260
987	27072,725840	89409,807830	987	30293,431861	89837,332204
988	27028,076760	89432,154595	988	30264,697909	89878,251149
989	26988,253571	89462,175226	989	30235,963957	89919,170093
990	26957,088253	89501,093183	990	30207,230005	89960,089038
991	26918,882390	89533,087446	991	30178,496053	90001,007982
992	26889,578583	89573,410664	992	30149,762101	90041,926927
993	26855,870457	89607,821974	993	30121,028150	90082,845871
994	26818,873877	89641,240489	994	30092,294198	90123,764815
995	26790,992836	89682,469412	995	30063,560246	90164,683760
996	26748,342139	89708,341402	996	30034,826294	90205,602704
997	26712,300233	89742,917574	997	30006,092342	90246,521649
998	26679,217858	89780,388210	998	29977,358390	90287,440593
999	26645,350759	89817,158941	999	29948,624438	90328,359537
1000	26614,892485	89856,807569	1000	29919,890487	90369,278482
1001	26583,807298	89895,963179	1001	29891,156535	90410,197426
1002	26548,267361	89931,105592	1002	29862,422583	90451,116371
1003	26510,668815	89964,023440	1003	29833,688631	90492,035315
1004	26476,661451	90000,485882	1004	29804,954679	90532,954259
1005	26448,764673	90040,681981	1005	29776,220727	90573,873204
1006	26406,650196	90067,588371	1006	29747,486776	90614,792148
1007	26369,395271	90100,757758	1007	29718,752824	90655,711093
1008	26335,631124	90137,615702	1008	29690,018872	90696,630037
1009	26299,766241	90169,771078	1009	29661,284920	90737,548981
1010	26257,250133	90195,823553	1010	29632,550968	90778,467926
1011	26221,641254	90230,825667	1011	29603,817016	90819,386870
1012	26185,299961	90265,139396	1012	29575,083064	90860,305815
1013	26152,706713	90303,021382	1013	29546,349113	90901,224759
1014	26121,161677	90341,806919	1014	29517,615161	90942,143703
1015	26092,477872	90382,708866	1015	29488,881209	90983,062648

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1016	26055,836629	90416,724027	1016	29460,147257	91023,981592
1017	26019,120449	90450,663384	1017	29431,413305	91064,900537
1018	25974,284511	90469,922108	1018	29402,679353	91105,819481
1019	25927,006570	90485,951730	1019	29373,945401	91146,738425
1020	25882,104209	90507,849023	1020	29345,211450	91187,657370
1021	25842,956076	90538,724165	1021	29316,477498	91228,576314
1022	25812,673373	90578,338058	1022	29287,743546	91269,495259
1023	25793,178807	90624,228075	1023	29258,294478	91309,729212
1024	25775,489168	90670,622459	1024	29218,649293	91340,196559
1025	25777,719496	90720,037538	1025	29179,004107	91370,663907
1026	25757,536629	90737,538212	1026	29139,358922	91401,131254
1027	25727,422517	90747,220747	1027	29099,713736	91431,598601
1028	25705,707922	90718,999498	1028	29060,068550	91462,065949
1029	25691,038385	90683,878370	1029	29020,423365	91492,533296
1030	25680,491793	90644,718768	1030	28980,778179	91523,000644
1031	25660,712453	90614,602135	1031	28941,132994	91553,467991
1032	25631,918442	90593,315418	1032	28901,487808	91583,935339
1033	25599,209197	90579,820621	1033	28861,842623	91614,402686
1034	25580,542922	90548,614406	1034	28822,197437	91644,870034
1035	25564,638991	90518,659089	1035	28782,552251	91675,337381
1036	25526,509472	90530,257476	1036	28742,907066	91705,804728
1037	25488,873525	90521,588252	1037	28703,261880	91736,272076
1038	25456,764038	90503,549348	1038	28663,616695	91766,739423
1039	25424,941422	90485,229588	1039	28623,971509	91797,206771
1040	25423,599596	90491,212403	1040	28584,326323	91827,674118
1041	25452,993617	90511,911210	1041	28544,681138	91858,141466
1042	25483,206530	90531,807846	1042	28505,035952	91888,608813
1043	25520,098549	90543,183935	1043	28465,390767	91919,076161
1044	25557,218168	90532,574560	1044	28425,745581	91949,543508
1045	25569,325301	90570,205789	1045	28386,100396	91980,010855
1046	25587,585210	90597,853332	1046	28346,455210	92010,478203
1047	25612,339625	90623,096038	1047	28307,509720	92041,789401
1048	25639,501256	90645,980946	1048	28270,228211	92075,107399
1049	25649,121637	90682,090964	1049	28232,946701	92108,425398
1050	25654,703271	90722,156578	1050	28203,072033	92148,183919
1051	25667,055399	90755,590367	1051	28175,255024	92189,731651
1052	25684,763718	90785,757333	1052	28147,438015	92231,279382
1053	25678,130461	90798,681511	1053	28119,621005	92272,827114
1054	25671,855343	90822,603262	1054	28088,057323	92311,505729
1055	25637,669579	90848,860639	1055	28055,198384	92349,192465
1056	25608,090363	90870,115782	1056	28023,778536	92387,954941

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1057	25572,786063	90905,425302	1057	27996,934105	92430,137597
1058	25539,413873	90942,605214	1058	27970,089674	92472,320254
1059	25493,243276	90960,517359	1059	27943,245244	92514,502911
1060	25449,708165	90984,823545	1060	27909,622112	92551,248799
1061	25411,632297	91017,162011	1061	27874,273115	92586,610480
1062	25377,320423	91053,399470	1062	27838,924119	92621,972161
1063	25341,144021	91087,787362	1063	27811,077112	92663,036458
1064	25310,050938	91126,765924	1064	27786,463040	92706,558262
1065	25277,788101	91159,817324	1065	27762,204489	92750,266773
1066	25231,254449	91178,065016	1066	27740,346472	92795,235952
1067	25189,020038	91204,582473	1067	27718,488455	92840,205132
1068	25149,555580	91235,280763	1068	27696,630437	92885,174311
1069	25110,059701	91265,928055	1069	27674,772420	92930,143490
1070	25068,207100	91293,278251	1070	27655,139055	92976,120373
1071	25026,148111	91320,311467	1071	27635,750804	93022,208286
1072	24984,595135	91348,117986	1072	27616,362553	93068,296199
1073	24941,608637	91373,655429	1073	27596,208685	93114,052951
1074	24900,014402	91401,272123	1074	27575,899393	93159,742476
1075	24865,233999	91436,980770	1075	27547,118584	93221,724765
1076	24827,831854	91469,579023	1076	27523,747837	93265,923896
1077	24778,864879	91479,322291	1077	27499,750939	93309,789017
1078	24732,986726	91498,865278	1078	27470,481324	93349,645560
1079	24692,076100	91527,547731	1079	27434,631895	93384,499806
1080	24654,208845	91560,109030	1080	27398,782467	93419,354053
1081	24624,439849	91600,103652	1081	27362,933039	93454,208299
1082	24597,680859	91642,200978	1082	27327,083611	93489,062546
1083	24568,455065	91681,791227	1083	27290,156502	93522,763418
1084	24540,890911	91723,341753	1084	27252,952624	93556,168080
1085	24507,486771	91750,003540	1085	27215,748747	93589,572742
1086	24458,347364	91758,456734	1086	27178,544869	93622,977405
1087	24412,788023	91778,697794	1087	27141,340991	93656,382067
1088	24370,628914	91805,333171	1088	27102,141817	93687,352646
1089	24323,800416	91822,131420	1089	27063,148617	93718,559681
1090	24276,670167	91838,443010	1090	27023,607991	93747,453882
1091	24234,568244	91865,286290	1091	26975,347124	93760,526322
1092	24193,081931	91841,172755	1092	26927,174335	93773,884036
1093	24143,816485	91836,877115	1093	26879,944115	93790,294590
1094	24098,469851	91856,662786	1094	26832,713894	93806,705145
1095	24068,299831	91895,873831	1095	26785,483674	93823,115699
1096	24043,497207	91932,581969	1096	26737,876894	93838,195895
1097	23999,409728	91955,947254	1097	26689,052341	93848,973792

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1098	23954,897194	91969,649927	1098	26640,227788	93859,751688
1099	23910,264583	91943,712780	1099	26591,403236	93870,529584
1100	23864,885372	91923,048059	1100	26544,281245	93887,046648
1101	23817,633635	91907,527285	1101	26497,477781	93904,637435
1102	23769,261687	91895,450855	1102	26450,674318	93922,228222
1103	23719,399459	91895,655420	1103	26403,870854	93939,819009
1104	23670,122049	91891,680774	1104	26356,708991	93956,422872
1105	23621,488130	91886,250571	1105	26309,524238	93972,963704
1106	23577,198294	91863,177658	1106	26262,368477	93989,585855
1107	23529,432099	91848,611899	1107	26215,361516	94006,625387
1108	23479,919191	91842,711980	1108	26168,354556	94023,664920
1109	23430,482590	91849,217147	1109	26121,363325	94040,747581
1110	23384,084442	91867,547436	1110	26074,423546	94057,971319
1111	23337,598438	91882,796002	1111	26029,792837	94080,377874
1112	23293,017798	91879,383552	1112	25985,595787	94103,757796
1113	23254,974430	91847,060242	1113	25941,398736	94127,137718
1114	23210,746731	91823,940495	1114	25898,907799	94153,488509
1115	23167,419351	91800,047036	1115	25856,439546	94179,878800
1116	23127,419415	91771,380018	1116	25813,971293	94206,269092
1117	23091,517569	91736,800239	1117	25770,766053	94231,195496
1118	23049,451580	91709,851295	1118	25724,273430	94249,592126
1119	23003,692766	91689,758872	1119	25677,622865	94267,477592
1120	22956,185609	91674,267391	1120	25628,856251	94278,514682
1121	22907,602481	91662,647042	1121	25580,089636	94289,551771
1122	22858,657910	91653,063988	1122	25531,323022	94300,588860
1123	22808,863005	91655,729413	1123	25482,574352	94311,704619
1124	22768,537725	91636,421722	1124	25433,845271	94322,906253
1125	22739,073748	91596,171495	1125	25385,070590	94333,907110
1126	22708,386991	91556,796771	1126	25336,283404	94344,852907
1127	22673,171775	91521,371129	1127	25287,496217	94355,798703
1128	22631,281994	91494,349782	1128	25238,709031	94366,744500
1129	22584,604787	91476,519933	1129	25189,661661	94376,439010
1130	22535,960855	91465,582273	1130	25140,555044	94385,848586
1131	22486,077801	91466,546926	1131	25091,448426	94395,258163
1132	22436,775709	91474,672723	1132	25042,368866	94404,801112
1133	22389,363541	91490,127454	1133	24993,477658	94415,272489
1134	22349,071489	91487,134984	1134	24944,586450	94425,743867
1135	22319,627158	91448,784324	1135	24895,573497	94435,625752
1136	22296,409424	91404,675775	1136	24846,534065	94445,379426
1137	22263,180626	91367,482839	1137	24797,494634	94455,133100
1138	22223,547689	91337,212532	1138	24748,408117	94464,644927

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1139	22177,696601	91317,647133	1139	24699,291348	94474,001372
1140	22128,627867	91308,468460	1140	24650,155269	94483,255093
1141	22078,823497	91310,510315	1141	24600,993739	94492,373421
1142	22029,259799	91307,077045	1142	24551,832208	94501,491750
1143	21979,789736	91313,318586	1143	24502,670678	94510,610078
1144	21933,997672	91328,892774	1144	24453,509147	94519,728407
1145	21903,218204	91289,627724	1145	24404,347617	94528,846735
1146	21864,739465	91257,766086	1146	24355,202361	94538,052003
1147	21827,056857	91225,103091	1147	24305,872856	94546,077800
1148	21783,962366	91199,904498	1148	24256,226802	94552,008750
1149	21737,820396	91180,782252	1149	24206,552722	94557,708381
1150	21690,294782	91165,386686	1150	24156,878643	94563,408013
1151	21646,362675	91144,125650	1151	24107,204563	94569,107644
1152	21601,611269	91122,115266	1152	24057,530483	94574,807276
1153	21563,940160	91096,379865	1153	24007,856403	94580,506907
1154	21558,540163	91046,816413	1154	23958,182324	94586,206538
1155	21561,906825	90998,033708	1155	23908,826455	94593,994123
1156	21562,025768	90948,162449	1156	23859,619144	94602,824861
1157	21549,847226	90899,805306	1157	23810,202276	94610,438872
1158	21527,725692	90855,086556	1158	23760,785408	94618,052883
1159	21504,434571	90811,803011	1159	23711,368540	94625,666894
1160	21482,736586	90766,903471	1160	23661,951672	94633,280905
1161	21451,121226	90728,282086	1161	23612,534804	94640,894917
1162	21412,372491	90696,905956	1162	23563,117936	94648,508928
1163	21367,760620	90674,715539	1163	23513,701068	94656,122939
1164	21337,439606	90635,120317	1164	23464,075786	94662,068507
1165	21305,864688	90599,442985	1165	23414,407599	94664,166833
1166	21305,125648	90549,556098	1166	23365,151287	94655,575226
1167	21296,540102	90500,412407	1167	23316,391170	94644,543935
1168	21276,433236	90454,792136	1168	23267,692028	94633,212846
1169	21247,596624	90413,993860	1169	23218,992886	94621,881758
1170	21216,835088	90374,661460	1170	23170,293744	94610,550670
1171	21182,054783	90338,860391	1171	23121,594602	94599,219581
1172	21143,683873	90306,850837	1172	23072,833675	94588,214098
1173	21104,110007	90276,334832	1173	23023,368831	94580,918264
1174	21064,395316	90245,995979	1174	22973,903781	94573,623830
1175	21027,786967	90211,972187	1175	22924,471384	94566,113402
1176	20992,408312	90176,777455	1176	22875,059559	94558,466731
1177	20954,034117	90144,805618	1177	22825,647734	94550,820060
1178	20916,431242	90113,220310	1178	22776,235910	94543,173389
1179	20887,507242	90073,393826	1179	22726,824085	94535,526718

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1180	20875,309414	90025,000718	1180	22677,412260	94527,880048
1181	20854,051058	89979,892392	1181	22628,000435	94520,233377
1182	20823,827169	89940,111453	1182	22578,616078	94512,415546
1183	20787,690610	89905,692410	1183	22529,292713	94504,217637
1184	20753,224937	89870,185662	1184	22479,881055	94496,573736
1185	20725,828952	89828,531821	1185	22430,452906	94489,033304
1186	20705,438475	89782,917536	1186	22380,798177	94483,216988
1187	20677,012907	89741,859027	1187	22331,100113	94477,730417
1188	20644,546587	89703,868267	1188	22281,402049	94472,243845
1189	20609,747540	89668,097345	1189	22231,703986	94466,757273
1190	20585,543811	89624,518619	1190	22182,099500	94460,598216
1191	20563,987057	89579,572208	1191	22132,791573	94452,307960
1192	20538,779502	89536,496234	1192	22083,483646	94444,017704
1193	20509,609086	89495,910167	1193	22034,610954	94433,547279
1194	20480,793754	89455,087880	1194	21985,899431	94422,269536
1195	20450,167403	89415,691761	1195	21937,187907	94410,991793
1196	20416,067319	89379,583165	1196	21888,476384	94399,714050
1197	20384,655875	89340,725176	1197	21840,025750	94387,368869
1198	20360,862474	89302,250746	1198	21791,334343	94376,043310
1199	20367,419083	89253,222571	1199	21742,469514	94365,449516
1200	20349,558797	89207,087047	1200	21693,604685	94354,855722
1201	20311,791684	89175,161052	1201	21644,739856	94344,261927
1202	20263,342644	89165,164013	1202	21596,941725	94330,126049
1203	20219,452482	89171,427105	1203	21550,353058	94311,974021
1204	20206,991530	89123,010720	1204	21503,764391	94293,821994
1205	20193,639817	89074,829492	1205	21457,717284	94274,461088
1206	20174,991650	89028,571624	1206	21413,157583	94251,779971
1207	20187,967607	88986,213073	1207	21368,597883	94229,098854
1208	20215,452409	88944,444836	1208	21324,038182	94206,417736
1209	20242,937211	88902,676598	1209	21279,478481	94183,736619
1210	20257,634987	88859,219768	1210	21234,918781	94161,055502
1211	20237,402300	88816,774391	1211	21190,359080	94138,374385
1212	20209,751173	88776,346726	1212	21147,560815	94112,773229
1213	20215,677474	88726,857815	1213	21106,714846	94083,935636
1214	20209,234690	88677,404425	1214	21065,868877	94055,098043
1215	20194,704771	88630,841321	1215	21025,022907	94026,260449
1216	20212,122233	88584,031714	1216	20984,176938	93997,422856
1217	20223,902198	88535,476605	1217	20943,330969	93968,585262
1218	20233,823581	88486,491681	1218	20902,485000	93939,747669
1219	20240,284215	88436,925658	1219	20865,951916	93905,629677
1220	20244,363698	88387,390461	1220	20829,539120	93871,364414

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1221	20250,660310	88337,812453	1221	20793,126324	93837,099150
1222	20248,246910	88287,932341	1222	20756,713528	93802,833886
1223	20242,128219	88238,488078	1223	20720,300732	93768,568623
1224	20254,403707	88190,090618	1224	20684,039963	93734,142617
1225	20265,335919	88141,318962	1225	20649,864784	93697,746613
1226	20271,228607	88091,680850	1226	20618,005247	93659,225896
1227	20271,156467	88041,787433	1227	20587,766286	93619,406238
1228	20277,565935	87992,224856	1228	20557,527324	93579,586579
1229	20284,531986	87942,715608	1229	20527,288363	93539,766920
1230	20287,839240	87892,872556	1230	20497,049402	93499,947262
1231	20290,789458	87843,042505	1231	20466,862296	93460,093132
1232	20298,543366	87794,111704	1232	20441,850927	93416,798428
1233	20302,024536	87744,272234	1233	20416,839558	93373,503724
1234	20314,311139	87696,349945	1234	20391,388372	93330,471387
1235	20317,861206	87646,914709	1235	20365,173892	93287,894386
1236	20319,954005	87596,965258	1236	20338,959412	93245,317385
1237	20321,732961	87546,996915	1237	20313,593751	93202,333025
1238	20323,256064	87497,020145	1238	20294,491419	93156,299344
1239	20324,174610	87447,041542	1239	20265,988632	93119,630174
1240	20320,322211	87397,195938	1240	20216,168822	93116,712548
1241	20316,384756	87347,352509	1241	20167,943949	93103,824916
1242	20312,418218	87297,517238	1242	20122,970756	93082,127217
1243	20307,136586	87247,797151	1243	20082,151668	93053,341822
1244	20298,944454	87198,477572	1244	20045,816791	93019,050293
1245	20293,030215	87168,966263	1245	20013,949968	92980,557416
1246	20280,975768	87120,458639	1246	19986,371168	92938,877506
1247	20259,860446	87075,295288	1247	19962,824305	92894,789359
1248	20228,249856	87036,746582	1248	19943,061719	92848,876920
1249	20188,096603	87007,194099	1249	19926,879746	92801,581262
1250	20149,699414	86980,419637	1250	19914,100523	92753,253478
1251	20128,882626	86935,702167	1251	19904,580556	92704,178379
1252	20119,082023	86886,785791	1252	19898,212788	92654,594441
1253	20116,378997	86837,389431	1253	19894,949664	92604,709020
1254	20116,930260	86790,074754	1254	19894,759790	92554,717729
1255	20132,503217	86743,115425	1255	19878,817048	92508,380744
1256	20129,313207	86694,122401	1256	19857,505466	92463,150042
1257	20138,258454	86645,023652	1257	19836,193884	92417,919339
1258	20140,056301	86595,067214	1258	19814,882302	92372,688636
1259	20146,471157	86545,696311	1259	19789,206323	92329,817195
1260	20150,297129	86496,032297	1260	19766,591566	92285,303184
1261	20165,705519	86448,787183	1261	19746,530558	92239,504243

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1262	20175,186053	86399,936099	1262	19726,259574	92193,802292
1263	20162,246577	86352,192136	1263	19704,423178	92148,822610
1264	20166,401678	86311,131262	1264	19682,586782	92103,842928
1265	20204,333049	86279,696925	1265	19660,750386	92058,863246
1266	20222,728151	86240,971610	1266	19638,913990	92013,883564
1267	20268,871116	86258,816676	1267	19620,822019	91967,312503
1268	20317,911057	86252,441258	1268	19603,593462	91920,374493
1269	20357,930434	86223,354959	1269	19586,364906	91873,436482
1270	20378,981092	86178,589634	1270	19569,136349	91826,498472
1271	20376,078183	86129,221137	1271	19550,871845	91779,954549
1272	20349,857038	86087,270075	1272	19532,547353	91733,433446
1273	20308,090980	86062,378916	1273	19514,222860	91686,912344
1274	20321,611514	86016,905527	1274	19499,450542	91639,206243
1275	20348,856856	85988,054449	1275	19486,174495	91591,000988
1276	20381,849308	85980,171091	1276	19472,898448	91542,795733
1277	20384,617026	85957,459920	1277	19459,622401	91494,590479
1278	20404,325217	85911,903366	1278	19446,080980	91446,465684
1279	20406,911838	85875,927899	1279	19430,351590	91399,004265
1280	20422,166966	85850,371366	1280	19413,637417	91351,917602
1281	20446,785967	85829,018951	1281	19390,293492	91308,046202
1282	20432,000696	85822,869748	1282	19360,427076	91267,956394
1283	20406,653811	85804,142059	1283	19325,077764	91232,595030
1284	20408,035240	85767,146026	1284	19289,728451	91197,233665
1285	20409,889708	85736,691835	1285	19254,379139	91161,872301
1286	20409,304243	85699,707459	1286	19219,029826	91126,510936
1287	20418,711576	85662,826289	1287	19183,680514	91091,149572
1288	20447,318286	85652,920992	1288	19157,450345	91048,779966
1289	20483,701442	85623,280118	1289	19132,378030	91005,520528
1290	20518,368499	85595,717861	1290	19107,305714	90962,261090
1291	20564,365272	85578,967536	1291	19082,233398	90919,001652
1292	20610,159511	85588,969058	1292	19057,739002	90875,415600
1293	20657,316166	85582,120758	1293	19033,612703	90831,621517
1294	20704,306976	85582,447452	1294	19011,331314	90787,067193
1295	20722,432605	85539,197167	1295	18997,599656	90738,989739
1296	20692,334654	85500,907573	1296	18952,784335	90729,911656
1297	20646,127101	85488,728015	1297	18919,210565	90692,860314
1298	20599,049365	85486,286856	1298	18885,636794	90655,808971
1299	20552,507703	85481,600672	1299	18852,063024	90618,757629
1300	20565,973102	85451,840483	1300	18818,489254	90581,706287
1301	20570,766680	85402,616472	1301	18784,915484	90544,654945
1302	20551,450194	85357,082951	1302	18751,341714	90507,603603

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1303	20540,056846	85316,873535	1303	18717,767943	90470,552261
1304	20554,762774	85272,038568	1304	18684,194173	90433,500919
1305	20552,374671	85225,377631	1305	18650,620403	90396,449577
1306	20570,984453	85179,394728	1306	18617,046633	90359,398234
1307	20609,832182	85158,669044	1307	18583,472862	90322,346892
1308	20646,721457	85125,714264	1308	18549,899092	90285,295550
1309	20663,184637	85079,061687	1309	18516,325322	90248,244208
1310	20655,291892	85030,242551	1310	18482,751552	90211,192866
1311	20625,016018	84991,118142	1311	18449,179695	90174,140315
1312	20625,079834	84961,669829	1312	18430,144945	90127,905282
1313	20658,978220	84925,621626	1313	18411,110195	90081,670249
1314	20670,892005	84879,999571	1314	18392,075445	90035,435215
1315	20706,994721	84847,527364	1315	18373,040696	89989,200182
1316	20729,166909	84803,384926	1316	18354,005946	89942,965149
1317	20760,230919	84765,078166	1317	18334,971196	89896,730116
1318	20785,223602	84724,708740	1318	18315,936446	89850,495082
1319	20818,872860	84693,995179	1319	18296,901697	89804,260049
1320	20864,003333	84710,267229	1320	18277,866947	89758,025016
1321	20909,399027	84729,747085	1321	18258,832197	89711,789983
1322	20954,872391	84749,305202	1322	18239,797447	89665,554950
1323	20998,160812	84773,579604	1323	18220,762697	89619,319916
1324	21040,028339	84798,973172	1324	18201,727948	89573,084883
1325	21089,158351	84796,338735	1325	18182,693198	89526,849850
1326	21138,103258	84795,181784	1326	18163,658448	89480,614817
1327	21164,985169	84761,338877	1327	18144,623698	89434,379783
1328	21157,611390	84740,070907	1328	18125,588948	89388,144750
1329	21134,379330	84698,096009	1329	18106,554199	89341,909717
1330	21118,936061	84651,890018	1330	18087,519449	89295,674683
1331	21122,756015	84606,998751	1331	18068,484699	89249,439650
1332	21087,566705	84575,363357	1332	18049,449949	89203,204617
1333	21043,568757	84553,137074	1333	18030,415199	89156,969584
1334	20996,324874	84539,591208	1334	18011,380449	89110,734550
1335	20947,046307	84534,300714	1335	17992,345700	89064,499517
1336	20899,014842	84528,805161	1336	17973,310950	89018,264484
1337	20890,124077	84488,090822	1337	17956,996098	88971,313403
1338	20896,216644	84441,419056	1338	17950,797312	88921,699141
1339	20921,798536	84406,798564	1339	17944,598526	88872,084878
1340	20941,174942	84366,072290	1340	17938,399741	88822,470616
1341	20985,089489	84363,606690	1341	17932,200955	88772,856353
1342	21032,672136	84359,394705	1342	17926,002169	88723,242090
1343	21058,005709	84317,709578	1343	17911,494371	88675,943312

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1344	21067,669861	84269,617418	1344	17893,340605	88629,355323
1345	21043,517083	84227,040334	1345	17877,152601	88582,142910
1346	21064,736879	84207,534542	1346	17865,094041	88533,618780
1347	21108,610674	84184,595661	1347	17853,035482	88485,094651
1348	21129,710692	84141,411907	1348	17840,976923	88436,570521
1349	21104,386242	84102,045567	1349	17829,757231	88387,847389
1350	21056,571423	84107,702108	1350	17818,734980	88339,077419
1351	21027,044047	84096,828362	1351	17806,292497	88290,655496
1352	21017,237929	84048,013980	1352	17793,516588	88242,315283
1353	21009,415963	84001,795189	1353	17780,740680	88193,975071
1354	21013,311843	83953,066997	1354	17767,964771	88145,634858
1355	21008,843960	83903,494945	1355	17775,264669	88097,080658
1356	20999,896466	83855,340450	1356	17787,007276	88048,479103
1357	21007,968083	83809,243406	1357	17798,749884	87999,877547
1358	21006,242607	83761,266181	1358	17810,492492	87951,275992
1359	21004,817202	83711,832760	1359	17822,530774	87902,747102
1360	20988,239837	83666,672950	1360	17834,653741	87854,239023
1361	20975,515518	83620,073190	1361	17846,573565	87805,680684
1362	20930,121453	83606,741315	1362	17858,468204	87757,116112
1363	20902,068083	83633,196137	1363	17870,362842	87708,551541
1364	20896,661848	83585,552324	1364	17884,687342	87660,788156
1365	20918,537022	83551,506371	1365	17904,010963	87614,673108
1366	20954,163936	83522,017207	1366	17923,157633	87568,485022
1367	20951,751071	83475,014336	1367	17941,987147	87522,166026
1368	20914,352707	83448,514249	1368	17960,816660	87475,847029
1369	20920,633394	83402,066108	1369	17979,646174	87429,528033
1370	20914,622139	83353,472104	1370	17998,475687	87383,209036
1371	20904,714698	83305,988279	1371	18011,291024	87335,108402
1372	20929,231840	83265,795690	1372	18020,728773	87286,007191
1373	20909,777637	83222,719844	1373	18030,166522	87236,905980
1374	20868,021216	83200,039595	1374	18039,167983	87187,723419
1375	20834,456236	83173,853314	1375	18045,930666	87138,193780
1376	20863,184976	83138,595452	1376	18052,197390	87088,588052
1377	20892,916098	83171,448825	1377	18058,464113	87038,982325
1378	20940,180992	83164,832887	1378	18064,730837	86989,376598
1379	20962,502040	83122,144448	1379	18070,997561	86939,770871
1380	21003,474382	83098,706793	1380	18077,264285	86890,165144
1381	21021,059851	83053,704115	1381	18083,531008	86840,559416
1382	21033,009445	83016,204693	1382	18091,867195	86791,265123
1383	21080,149345	83027,858354	1383	18099,921128	86741,928175
1384	21122,035524	83006,127005	1384	18106,219040	86692,326398

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1385	21171,631796	83002,662246	1385	18112,455631	86642,718071
1386	21197,691508	83040,133147	1386	18116,775644	86592,905046
1387	21234,194484	83069,363510	1387	18121,095657	86543,092021
1388	21274,072283	83044,975740	1388	18125,415670	86493,278995
1389	21272,860777	82996,514284	1389	18129,735683	86443,465970
1390	21246,636679	82954,983629	1390	18135,544981	86393,821397
1391	21208,622858	82923,836955	1391	18142,460396	86344,301935
1392	21159,664831	82917,548412	1392	18149,375810	86294,782474
1393	21130,306424	82889,980519	1393	18161,942366	86246,401082
1394	21099,971344	82851,633356	1394	18174,733831	86198,064983
1395	21065,693693	82816,650628	1395	18187,525295	86149,728884
1396	21046,877139	82771,383403	1396	18200,316759	86101,392785
1397	21012,306086	82736,558845	1397	18207,413718	86052,001333
1398	21003,525567	82691,539739	1398	18223,232030	86004,954892
1399	20989,656125	82649,290324	1399	18242,325331	85958,744007
1400	21006,777189	82603,420615	1400	18261,418631	85912,533122
1401	20997,913238	82555,404405	1401	18280,511931	85866,322237
1402	20988,075735	82515,463486	1402	18297,741066	85819,504504
1403	21010,580107	82476,244088	1403	18309,510285	85770,909386
1404	21021,785386	82428,269863	1404	18321,279504	85722,314268
1405	20997,822861	82386,746205	1405	18335,786523	85674,538988
1406	20949,002690	82381,734481	1406	18352,663074	85627,473268
1407	20914,317758	82372,187134	1407	18369,539625	85580,407548
1408	20883,867543	82335,396243	1408	18386,416176	85533,341828
1409	20910,187452	82295,746130	1409	18403,292728	85486,276107
1410	20912,019517	82246,803557	1410	18420,169279	85439,210387
1411	20905,239343	82199,133742	1411	18437,045830	85392,144667
1412	20884,154366	82154,341859	1412	18444,964204	85343,002362
1413	20912,075150	82141,029654	1413	18447,804293	85293,083088
1414	20943,634290	82104,120249	1414	18450,644382	85243,163814
1415	20939,268131	82055,159119	1415	18453,484471	85193,244540
1416	20981,007350	82047,214479	1416	18456,567177	85143,343284
1417	21026,024590	82031,330445	1417	18461,131793	85093,552077
1418	21030,003853	81984,606056	1418	18465,696410	85043,760870
1419	20987,218017	81964,829022	1419	18470,261027	84993,969663
1420	20945,547077	81977,703607	1420	18474,825643	84944,178457
1421	20898,505283	81966,768319	1421	18482,015638	84894,766661
1422	20888,575533	81924,559530	1422	18488,921551	84845,280461
1423	20896,902373	81877,661570	1423	18494,639216	84795,608454
1424	20865,202685	81842,552865	1424	18500,356881	84745,936447
1425	20838,593780	81802,400084	1425	18506,074546	84696,264439

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1426	20790,041188	81802,348040	1426	18511,792211	84646,592432
1427	20782,218598	81791,307145	1427	18517,509876	84596,920425
1428	20830,410325	81782,829783	1428	18523,227541	84547,248418
1429	20870,053824	81759,109163	1429	18531,937954	84498,118863
1430	20901,030826	81724,218055	1430	18544,017948	84449,600065
1431	20882,070912	81681,830576	1431	18567,051311	84405,243975
1432	20878,383463	81632,847287	1432	18590,244334	84360,948561
1433	20865,444435	81585,454572	1433	18613,437356	84316,653147
1434	20873,684291	81539,507409	1434	18636,630379	84272,357733
1435	20884,291265	81493,168865	1435	18659,960971	84228,134807
1436	20864,130416	81452,692200	1436	18682,975806	84183,748615
1437	20868,433326	81403,591862	1437	18705,637048	84139,178803
1438	20869,202250	81354,474334	1438	18728,298289	84094,608992
1439	20875,621241	81305,383482	1439	18750,959530	84050,039180
1440	20890,838858	81264,378277	1440	18773,620772	84005,469368
1441	20908,580263	81218,215727	1441	18790,991798	83958,809811
1442	20949,735748	81209,399201	1442	18804,907263	83910,785235
1443	20998,164876	81208,687958	1443	18817,635616	83862,444571
1444	21044,974552	81194,020116	1444	18829,444287	83813,859025
1445	21057,270808	81148,729845	1445	18841,252959	83765,273479
1446	21028,703374	81115,406139	1446	18853,061631	83716,687933
1447	21055,580680	81075,693020	1447	18864,870302	83668,102387
1448	21069,459672	81029,181561	1448	18876,678974	83619,516841
1449	21074,507940	80981,783874	1449	18888,487645	83570,931295
1450	21097,101207	80938,407598	1450	18898,971466	83522,182850
1451	21144,492440	80926,902452	1451	18899,284406	83472,183829
1452	21189,619662	80907,945557	1452	18899,597347	83422,184809
1453	21218,637911	80870,196572	1453	18899,910288	83372,185788
1454	21195,932795	80829,197961	1454	18900,223229	83322,186767
1455	21149,060444	80835,916267	1455	18900,536170	83272,187747
1456	21112,171492	80815,509048	1456	18900,849111	83222,188726
1457	21064,630176	80811,548760	1457	18901,162052	83172,189705
1458	21020,240336	80826,691792	1458	18901,474993	83122,190685
1459	20983,566429	80802,034062	1459	18901,787934	83072,191664
1460	20976,527534	80754,476822	1460	18909,297834	83022,892006
1461	20994,061613	80718,109365	1461	18915,143509	82973,234901
1462	20996,652792	80671,191520	1462	18920,989184	82923,577796
1463	20953,247781	80652,999212	1463	18926,834858	82873,920691
1464	20941,529039	80622,837580	1464	18932,680533	82824,263586
1465	20925,871967	80577,268739	1465	18938,526207	82774,606481
1466	20929,111489	80528,526906	1466	18944,371882	82724,949376

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1467	20932,062743	80478,795765	1467	18950,217556	82675,292270
1468	20938,381588	80430,864095	1468	18955,454319	82625,570531
1469	20941,490371	80381,806892	1469	18961,769898	82575,989724
1470	20956,181994	80334,582242	1470	18969,088984	82526,528676
1471	20958,870913	80285,366647	1471	18976,149777	82477,029735
1472	20964,937400	80239,089659	1472	18983,210571	82427,530794
1473	21005,551995	80251,956214	1473	18990,271364	82378,031852
1474	21050,644070	80238,560900	1474	18997,332158	82328,532911
1475	21057,489519	80190,787964	1475	19004,392951	82279,033970
1476	21029,919083	80152,249886	1476	19011,658574	82229,565383
1477	21028,451984	80136,204309	1477	19019,256960	82180,146110
1478	21066,835965	80107,126173	1478	19026,937598	82130,739746
1479	21062,673863	80059,841658	1479	19034,843635	82081,368757
1480	21017,466464	80046,276320	1480	19042,749672	82031,997767
1481	20976,594691	80039,076159	1481	19050,421438	81982,590941
1482	20977,298132	79991,226956	1482	19057,636607	81933,114266
1483	20980,742418	79941,515005	1483	19064,851776	81883,637591
1484	20994,543386	79898,208254	1484	19072,372939	81834,208598
1485	21016,251222	79853,772279	1485	19080,553756	81784,882396
1486	21032,937143	79806,857634	1486	19088,734572	81735,556193
1487	21058,508634	79765,553835	1487	19096,915388	81686,229991
1488	21071,691191	79717,754990	1488	19103,812318	81636,709162
1489	21076,786253	79668,564462	1489	19110,617970	81587,174497
1490	21071,721109	79619,076836	1490	19117,423623	81537,639831
1491	21089,187947	79582,965949	1491	19124,229275	81488,105166
1492	21128,247359	79553,309611	1492	19131,095912	81438,579012
1493	21152,693666	79513,883035	1493	19138,113234	81389,073889
1494	21179,008768	79472,688919	1494	19145,130555	81339,568766
1495	21172,746895	79426,223369	1495	19152,147876	81290,063642
1496	21194,834090	79382,482283	1496	19159,165197	81240,558520
1497	21187,343350	79334,383171	1497	19161,117406	81190,751727
1498	21161,191353	79293,032122	1498	19160,025726	81140,763646
1499	21139,685318	79249,049820	1499	19158,934046	81090,775565
1500	21117,869903	79205,128361	1500	19157,842366	81040,787485
1501	21103,426667	79158,300625	1501	19156,388258	80990,809776
1502	21139,397578	79131,055091	1502	19154,991878	80940,830518
1503	21134,673058	79083,655022	1503	19153,927944	80890,841839
1504	21115,338558	79041,245053	1504	19152,864011	80840,853160
1505	21099,916796	78994,925763	1505	19151,800078	80790,864481
1506	21093,624240	78945,878314	1506	19150,831498	80740,873998
1507	21086,571286	78897,357338	1507	19150,004181	80690,880843

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1508	21085,950905	78850,140030	1508	19149,176863	80640,887688
1509	21092,969127	78800,800951	1509	19148,349545	80590,894533
1510	21090,713998	78751,359110	1510	19148,059350	80540,916800
1511	21136,811207	78750,114547	1511	19149,823908	80491,001347
1512	21174,293983	78722,112862	1512	19148,826735	80441,011292
1513	21162,430891	78675,889251	1513	19147,829561	80391,021236
1514	21119,210114	78655,037798	1514	19146,832388	80341,031181
1515	21131,776831	78610,553660	1515	19146,817893	80291,075098
1516	21169,126206	78582,383254	1516	19151,265061	80241,273264
1517	21164,852916	78533,651265	1517	19155,712229	80191,471430
1518	21149,262257	78487,935857	1518	19160,159397	80141,669596
1519	21137,858411	78456,965136	1519	19165,072853	80091,919845
1520	21153,136258	78410,419740	1520	19171,723785	80042,364168
1521	21164,500612	78364,856755	1521	19177,146954	79992,666519
1522	21182,726857	78320,599565	1522	19181,981097	79942,900757
1523	21213,028232	78285,151382	1523	19186,815240	79893,134995
1524	21198,025366	78240,203591	1524	19191,649383	79843,369233
1525	21211,998824	78192,788395	1525	19201,995066	79794,481228
1526	21204,472648	78143,912023	1526	19212,859180	79745,675787
1527	21196,514095	78097,682815	1527	19224,169894	79696,991682
1528	21213,276398	78059,782702	1528	19239,495983	79649,398500
1529	21232,940734	78014,384400	1529	19254,822072	79601,805318
1530	21228,272919	77965,133230	1530	19270,148162	79554,212135
1531	21216,446020	77917,410929	1531	19285,474251	79506,618953
1532	21206,567369	77868,784465	1532	19300,800340	79459,025771
1533	21197,572366	77820,228347	1533	19315,433275	79411,230053
1534	21190,079730	77771,346744	1534	19326,613070	79362,550640
1535	21163,776690	77730,488930	1535	19336,705297	79313,599584
1536	21165,656351	77681,372758	1536	19347,631410	79264,807985
1537	21164,766860	77632,721985	1537	19357,787956	79215,888342
1538	21167,130640	77583,886467	1538	19363,249552	79166,187528
1539	21166,173458	77534,539980	1539	19368,711148	79116,486713
1540	21157,744218	77485,778882	1540	19374,172744	79066,785899
1541	21129,628309	77446,782779	1541	19379,634340	79017,085084
1542	21122,661297	77400,255423	1542	19385,095936	78967,384270
1543	21103,167266	77361,604484	1543	19391,080281	78917,745465
1544	21125,801400	77317,685538	1544	19396,073185	78867,995615
1545	21138,443530	77274,375343	1545	19401,017244	78818,240653
1546	21160,265447	77231,470102	1546	19405,961303	78768,485691
1547	21175,292358	77186,427164	1547	19410,905362	78718,730728
1548	21202,858316	77149,750799	1548	19415,849421	78668,975766

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1549	21220,827718	77104,276247	1549	19420,793480	78619,220804
1550	21260,032172	77086,599189	1550	19425,737539	78569,465841
1551	21309,235149	77085,297431	1551	19430,694211	78519,712140
1552	21350,687820	77092,701406	1552	19435,696634	78469,963012
1553	21399,439549	77092,475489	1553	19439,440273	78420,109515
1554	21420,899813	77050,807192	1554	19442,699426	78370,215849
1555	21404,905121	77004,261453	1555	19446,109461	78320,332277
1556	21451,298535	76997,836716	1556	19449,525617	78270,449115
1557	21486,086057	76965,695940	1557	19452,941773	78220,565953
1558	21477,059170	76918,736426	1558	19456,357930	78170,682790
1559	21444,089022	76882,476852	1559	19459,774086	78120,799628
1560	21409,346620	76847,970003	1560	19463,078804	78070,909036
1561	21364,615665	76829,079364	1561	19466,314687	78021,013856
1562	21348,699415	76794,364785	1562	19468,879243	77971,084531
1563	21366,505386	76767,888273	1563	19470,722399	77921,118514
1564	21379,650559	76722,718137	1564	19472,510837	77871,150736
1565	21414,747776	76710,515570	1565	19473,887197	77821,169683
1566	21433,964882	76667,426719	1566	19475,263557	77771,188630
1567	21433,034029	76618,604716	1567	19476,639918	77721,207577
1568	21401,414029	76583,722456	1568	19478,016278	77671,226525
1569	21407,166816	76539,763457	1569	19479,769137	77621,257740
1570	21419,631625	76494,182871	1570	19481,649560	77571,293113
1571	21417,531370	76447,340847	1571	19483,635384	77521,332884
1572	21428,782066	76402,648794	1572	19485,924728	77471,385323
1573	21439,824094	76363,605006	1573	19488,214072	77421,437761
1574	21474,606718	76329,811243	1574	19492,224072	77371,623937
1575	21477,592409	76281,191130	1575	19497,679915	77321,922490
1576	21518,727445	76264,861694	1576	19503,135757	77272,221044
1577	21540,150645	76223,152061	1577	19508,210538	77222,491116
1578	21575,792045	76192,595182	1578	19510,203662	77172,530857
1579	21613,074198	76160,583963	1579	19512,196787	77122,570598
1580	21629,747862	76114,440162	1580	19514,183276	77072,610110
1581	21647,786474	76068,567019	1581	19515,649725	77022,631619
1582	21655,361680	76019,862203	1582	19517,116174	76972,653129
1583	21631,082054	75977,579438	1583	19518,582623	76922,674638
1584	21643,575282	75946,669007	1584	19519,647798	76872,686714
1585	21680,521457	75915,184343	1585	19520,531494	76822,694524
1586	21723,636806	75891,388551	1586	19521,514999	76772,704719
1587	21762,651489	75861,630368	1587	19523,020308	76722,727383
1588	21809,183732	75854,234817	1588	19524,525616	76672,750048
1589	21857,841624	75860,226257	1589	19526,030925	76622,772713

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1590	21898,012965	75887,656649	1590	19527,835414	76572,805524
1591	21942,685311	75870,568626	1591	19529,719419	76522,841031
1592	21962,198569	75826,110568	1592	19531,603423	76472,876538
1593	21941,837237	75783,630417	1593	19533,034057	76422,906805
1594	21895,032260	75783,710128	1594	19532,305397	76372,912115
1595	21848,114482	75768,982244	1595	19532,009593	76322,923401
1596	21798,517461	75763,956428	1596	19534,118254	76272,967886
1597	21749,296941	75767,311680	1597	19536,226916	76223,012370
1598	21706,306942	75791,192552	1598	19538,335577	76173,056854
1599	21666,492325	75809,691095	1599	19539,088269	76123,076694
1600	21628,274762	75778,473896	1600	19538,796268	76073,077547
1601	21582,091977	75762,706107	1601	19538,504267	76023,078399
1602	21608,021182	75726,756128	1602	19538,212266	75973,079252
1603	21585,040727	75685,664920	1603	19536,641263	75923,106927
1604	21567,425407	75643,906990	1604	19534,836843	75873,139497
1605	21542,556124	75601,803574	1605	19534,520575	75823,140585
1606	21500,325393	75576,876318	1606	19534,210223	75773,141548
1607	21463,499307	75544,786204	1607	19533,899870	75723,142512
1608	21438,929700	75503,457412	1608	19532,065884	75673,220513
1609	21441,371114	75457,000176	1609	19527,331423	75623,445169
1610	21463,698528	75414,601996	1610	19522,596962	75573,669825
1611	21469,228641	75365,614295	1611	19517,930613	75523,890331
1612	21465,709467	75318,061223	1612	19516,587099	75473,908384
1613	21430,754503	75283,687866	1613	19515,243585	75423,926438
1614	21444,907901	75252,699099	1614	19512,919112	75373,998726
1615	21449,835810	75205,901680	1615	19508,744558	75324,173300
1616	21445,455741	75157,129324	1616	19504,570004	75274,347873
1617	21448,439327	75107,656906	1617	19500,700026	75224,506432
1618	21438,750908	75059,098238	1618	19499,626234	75174,517964
1619	21427,291155	75011,359756	1619	19498,552443	75124,529495
1620	21433,524212	74969,833265	1620	19497,304926	75074,546278
1621	21426,829867	74923,208467	1621	19495,357588	75024,584214
1622	21394,023731	74893,301679	1622	19493,410249	74974,622150
1623	21410,942515	74847,896775	1623	19491,462910	74924,660085
1624	21440,943669	74858,547675	1624	19490,043101	74874,681857
1625	21484,333510	74881,754217	1625	19488,927885	74824,694295
1626	21532,223722	74885,482399	1626	19487,812668	74774,706734
1627	21554,331549	74844,147768	1627	19491,147066	74724,846388
1628	21536,687614	74799,072969	1628	19495,116424	74675,004195
1629	21509,180216	74768,741497	1629	19499,085783	74625,162002
1630	21527,947088	74725,838881	1630	19498,950608	74575,174900

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1631	21493,852910	74693,827149	1631	19498,506056	74525,176877
1632	21476,867097	74673,824139	1632	19498,061505	74475,178853
1633	21481,914043	74624,572659	1633	19500,532652	74425,308995
1634	21489,280873	74577,860835	1634	19505,362546	74375,542820
1635	21498,436440	74530,538916	1635	19510,192439	74325,776646
1636	21515,557068	74484,230711	1636	19516,266592	74276,156148
1637	21508,478789	74435,284426	1637	19523,062906	74226,620200
1638	21493,560832	74389,499581	1638	19529,859219	74177,084253
1639	21490,133914	74340,165920	1639	19536,655533	74127,548305
1640	21490,302095	74294,432474	1640	19541,503929	74077,789144
1641	21530,772274	74285,594622	1641	19546,808020	74028,087762
1642	21555,767880	74245,250092	1642	19554,359420	73978,661287
1643	21530,782719	74204,731309	1643	19561,910819	73929,234813
1644	21489,331614	74179,245868	1644	19569,462219	73879,808339
1645	21465,636387	74138,743412	1645	19576,939850	73830,370766
1646	21456,552885	74091,626089	1646	19584,265377	73780,910311
1647	21471,625279	74046,138602	1647	19591,590903	73731,449855
1648	21466,452406	73998,566408	1648	19598,916430	73681,989400
1649	21457,504974	73951,164414	1649	19606,457398	73632,563831
1650	21455,033303	73912,152330	1650	19615,115145	73583,319101
1651	21468,218073	73873,515121	1651	19622,852092	73533,921805
1652	21489,734832	73830,771468	1652	19630,539576	73484,516313
1653	21516,492517	73790,688838	1653	19638,227061	73435,110822
1654	21561,167923	73780,737459	1654	19645,914546	73385,705331
1655	21603,924748	73757,270094	1655	19651,508672	73336,019404
1656	21644,297395	73734,492238	1656	19657,096008	73286,332568
1657	21688,646014	73715,595827	1657	19662,887864	73236,681778
1658	21691,305471	73668,682853	1658	19674,623999	73188,078660
1659	21647,985958	73650,862856	1659	19686,360134	73139,475541
1660	21602,118538	73664,332418	1660	19698,096269	73090,872423
1661	21557,463817	73682,294611	1661	19709,832405	73042,269304
1662	21534,852050	73670,846988	1662	19719,297345	72993,231005
1663	21537,905621	73621,630347	1663	19726,358420	72943,732104
1664	21546,495321	73572,982675	1664	19733,303150	72894,216833
1665	21557,953483	73525,239440	1665	19741,328474	72844,917041
1666	21558,521406	73476,762640	1666	19753,630369	72796,454030
1667	21565,033670	73428,530137	1667	19765,932265	72747,991020
1668	21551,948641	73388,200328	1668	19778,234160	72699,528010
1669	21564,580267	73341,179634	1669	19790,536056	72651,065000
1670	21549,382401	73295,335298	1670	19802,837951	72602,601989
1671	21509,951667	73266,875717	1671	19813,181842	72553,701686

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1672	21461,812936	73261,368292	1672	19822,667494	72504,609707
1673	21463,696539	73216,323874	1673	19832,606744	72455,611432
1674	21465,097891	73167,333742	1674	19842,680484	72406,641375
1675	21473,681209	73118,616685	1675	19852,105124	72357,537646
1676	21501,635737	73094,861403	1676	19861,529764	72308,433917
1677	21529,455785	73054,915007	1677	19870,954404	72259,330189
1678	21537,316682	73007,341886	1678	19880,379044	72210,226460
1679	21571,296739	72983,913361	1679	19889,803684	72161,122732
1680	21576,403486	72937,218938	1680	19899,228324	72112,019003
1681	21535,404355	72914,333666	1681	19908,238231	72062,838092
1682	21508,918394	72894,309041	1682	19917,109226	72013,631330
1683	21515,712317	72845,830641	1683	19920,436294	71963,832316
1684	21511,329887	72796,560506	1684	19922,160280	71913,862046
1685	21508,297186	72748,106196	1685	19924,890934	71863,952620
1686	21491,523129	72701,580350	1686	19929,198003	71814,138474
1687	21487,048096	72653,322999	1687	19933,505071	71764,324328
1688	21491,116670	72605,903067	1688	19937,812139	71714,510181
1689	21530,364887	72577,488344	1689	19941,328548	71664,649667
1690	21532,025127	72530,677812	1690	19942,873733	71614,673548
1691	21495,127660	72506,670151	1691	19944,418918	71564,697430
1692	21511,544874	72460,001751	1692	19942,247098	71514,863477
1693	21503,594865	72411,191558	1693	19936,889113	71465,151386
1694	21473,274112	72372,103857	1694	19931,531127	71415,439295
1695	21427,864265	72352,468451	1695	19927,790141	71365,580263
1696	21405,337153	72310,480924	1696	19924,099449	71315,716662
1697	21409,183166	72261,630338	1697	19920,408758	71265,853060
1698	21430,533098	72219,221472	1698	19916,718067	71215,989458
1699	21436,974553	72170,180490	1699	19912,335149	71166,186546
1700	21420,888563	72123,438054	1700	19907,292732	71116,441455
1701	21420,934007	72073,855150	1701	19902,179787	71066,703694
1702	21424,284207	72024,540123	1702	19896,886617	71016,984660
1703	21427,672133	71975,094588	1703	19891,632648	70967,261485
1704	21436,261508	71929,977246	1704	19886,421995	70917,533735
1705	21448,725617	71882,099022	1705	19881,211341	70867,805986
1706	21444,073293	71832,736955	1706	19876,000688	70818,078236
1707	21429,622943	71785,421611	1707	19870,790035	70768,350486
1708	21423,070925	71737,357203	1708	19865,579381	70718,622736
1709	21418,837760	71690,438837	1709	19860,359530	70668,895957
1710	21406,783612	71645,435500	1710	19855,151573	70619,171835
1711	21415,110165	71597,109098	1711	19855,713378	70569,174991
1712	21412,707027	71547,531446	1712	19852,128874	70519,304298

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1713	21401,876090	71500,358022	1713	19848,528646	70469,434082
1714	21396,029564	71452,273715	1714	19844,928418	70419,563867
1715	21370,564115	71413,038573	1715	19841,328190	70369,693652
1716	21370,237509	71364,545386	1716	19837,727962	70319,823437
1717	21374,520982	71315,578999	1717	19834,127735	70269,953222
1718	21373,409412	71266,557023	1718	19830,527507	70220,083007
1719	21374,475184	71217,595919	1719	19826,927279	70170,212792
1720	21374,141848	71171,440375	1720	19830,924011	70120,383635
1721	21372,352155	71121,878582	1721	19835,721899	70070,614364
1722	21400,631106	71083,569111	1722	19840,519786	70020,845094
1723	21422,791787	71039,652928	1723	19845,317673	69971,075823
1724	21446,808390	70996,402772	1724	19850,115560	69921,306553
1725	21447,082403	70946,944407	1725	19854,913447	69871,537282
1726	21423,685776	70903,369604	1726	19859,711334	69821,768012
1727	21430,542316	70856,206692	1727	19864,509222	69771,998742
1728	21426,954761	70807,026919	1728	19869,691293	69722,268530
1729	21433,274196	70758,268448	1729	19865,650113	69673,294085
1730	21440,205663	70709,927710	1730	19854,708252	69624,578386
1731	21452,073641	70662,609919	1731	19846,913347	69575,189729
1732	21468,555570	70618,624092	1732	19839,118441	69525,801072
1733	21492,486573	70575,326199	1733	19831,323535	69476,412415
1734	21492,643307	70525,865245	1734	19823,528630	69427,023758
1735	21498,474770	70479,857178	1735	19815,733724	69377,635101
1736	21522,768421	70438,837131	1736	19807,938818	69328,246444
1737	21556,942221	70404,332579	1737	19799,785178	69278,916322
1738	21586,528259	70365,813537	1738	19788,193645	69230,607130
1739	21613,008845	70324,044431	1739	19764,038064	69187,001287
1740	21616,194073	70274,676147	1740	19736,731280	69145,116450
1741	21623,642855	70230,624490	1741	19709,424496	69103,231614
1742	21635,037181	70182,480663	1742	19682,117712	69061,346777
1743	21621,806998	70134,811750	1743	19654,810928	69019,461941
1744	21635,346094	70090,825446	1744	19627,504143	68977,577104
1745	21644,759783	70054,325063	1745	19608,486231	68931,704210
1746	21685,778097	70030,672271	1746	19592,798824	68884,228899
1747	21678,161050	69984,338750	1747	19577,111416	68836,753587
1748	21631,823581	69969,424513	1748	19561,424008	68789,278275
1749	21623,186081	69932,218231	1749	19549,084741	68740,873063
1750	21629,102837	69885,098922	1750	19538,042606	68692,107591
1751	21608,367797	69847,542462	1751	19527,000472	68643,342119
1752	21639,296336	69811,167821	1752	19516,276195	68594,508794
1753	21676,451109	69781,324043	1753	19506,443233	68545,485199

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1754	21726,418385	69783,132719	1754	19496,610272	68496,461604
1755	21776,378839	69782,877299	1755	19486,706333	68447,452825
1756	21825,667496	69774,848133	1756	19476,105569	68398,589508
1757	21872,945095	69758,747999	1757	19465,504805	68349,726190
1758	21916,888693	69735,005671	1758	19458,525709	68300,541485
1759	21956,256184	69704,269728	1759	19460,356286	68250,575006
1760	21989,983627	69667,439772	1760	19461,590471	68200,635085
1761	22021,394006	69628,686813	1761	19455,325899	68151,029086
1762	22061,150337	69598,527027	1762	19449,061327	68101,423087
1763	22096,698356	69563,445396	1763	19442,796755	68051,817088
1764	22126,818718	69523,592892	1764	19436,532183	68002,211089
1765	22158,329486	69485,321078	1765	19430,267611	67952,605090
1766	22199,286557	69457,226327	1766	19428,768830	67902,823662
1767	22244,377483	69435,815740	1767	19431,199973	67852,893894
1768	22286,902031	69409,626752	1768	19427,093496	67803,062811
1769	22324,737381	69377,034111	1769	19411,913335	67756,575345
1770	22356,667858	69338,631387	1770	19387,755615	67712,798586
1771	22386,518662	69298,579158	1771	19363,597896	67669,021828
1772	22420,687260	69263,926507	1772	19332,141851	67630,995276
1773	22458,498015	69231,308990	1773	19295,233134	67597,264775
1774	22492,307350	69194,494320	1774	19258,324418	67563,534275
1775	22522,878456	69154,957649	1775	19221,415701	67529,803775
1776	22554,993461	69118,037366	1776	19174,163875	67513,843539
1777	22599,167111	69094,729294	1777	19126,605354	67498,410228
1778	22638,865241	69064,428892	1778	19079,046833	67482,976917
1779	22672,973519	69027,957157	1779	19031,488312	67467,543606
1780	22700,592637	68986,357717	1780	18983,929791	67452,110294
1781	22720,952512	68940,759081	1781	18937,128461	67434,878533
1782	22751,329349	68903,810651	1782	18893,106997	67411,275179
1783	22787,148627	68868,968251	1783	18867,041920	67371,355938
1784	22819,543548	68830,912405	1784	18858,541148	67322,153845
1785	22846,563029	68788,917991	1785	18851,963406	67272,588400
1786	22866,276622	68743,041035	1786	18845,385664	67223,022956
1787	22878,369786	68694,598628	1787	18838,807922	67173,457511
1788	22895,207057	68647,565158	1788	18832,230180	67123,892066
1789	22904,173464	68598,429058	1789	18825,652438	67074,326622
1790	22919,361312	68551,197496	1790	18819,074696	67024,761177
1791	22934,700826	68503,823843	1791	18804,547447	66977,041738
1792	22953,288075	68457,445857	1792	18791,062234	66929,907894
1793	22964,497960	68408,787255	1793	18816,519034	66886,873590
1794	22967,575406	68358,941405	1794	18839,263976	66842,495632

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1795	22962,603042	68309,244740	1795	18858,081709	66796,171849
1796	22988,961174	68267,204681	1796	18876,899441	66749,848065
1797	23009,125800	68221,521288	1797	18895,717174	66703,524281
1798	23021,421006	68173,117680	1798	18927,970704	66666,788872
1799	23025,542846	68123,341965	1799	18965,659528	66633,932328
1800	23021,425370	68073,565373	1800	19003,348353	66601,075783
1801	23009,124073	68025,163263	1801	19032,916680	66561,520343
1802	22996,625800	67977,596607	1802	19058,009102	66518,272565
1803	22999,558337	67927,694331	1803	19083,101525	66475,024786
1804	23035,856031	67918,176889	1804	19123,878445	66446,846629
1805	23085,831773	67917,527021	1805	19166,088701	66420,045615
1806	23135,425269	67911,622314	1806	19208,298957	66393,244602
1807	23183,345572	67897,572485	1807	19250,500464	66366,430468
1808	23228,278369	67875,792465	1808	19291,472890	66337,772828
1809	23269,001438	67846,892671	1809	19332,445315	66309,115187
1810	23304,360132	67811,624824	1810	19370,082781	66276,593993
1811	23333,390963	67770,982549	1811	19404,418052	66240,247202
1812	23355,225278	67726,060703	1812	19438,753322	66203,900411
1813	23369,198598	67678,108214	1813	19473,088592	66167,553620
1814	23375,209176	67628,532592	1814	19508,649597	66132,445595
1815	23372,992118	67578,646883	1815	19545,357434	66098,496593
1816	23362,585220	67529,806520	1816	19582,065270	66064,547591
1817	23344,206035	67483,369395	1817	19618,773107	66030,598590
1818	23318,380016	67440,617568	1818	19651,266861	65993,185413
1819	23285,768695	67402,786995	1819	19677,471830	65950,602557
1820	23270,848754	67357,501465	1820	19703,676798	65908,019700
1821	23257,125377	67309,478452	1821	19726,024119	65863,293778
1822	23259,662742	67264,539556	1822	19748,333983	65818,547046
1823	23291,891934	67226,389482	1823	19770,643846	65773,800315
1824	23321,552462	67187,645436	1824	19792,953710	65729,053583
1825	23368,027433	67169,586546	1825	19816,047059	65684,715530
1826	23413,153978	67148,208840	1826	19839,977495	65640,814115
1827	23454,972793	67120,857781	1827	19865,902591	65598,364256
1828	23499,183944	67097,713617	1828	19900,316368	65562,091787
1829	23539,486943	67068,234728	1829	19914,491192	65517,018367
1830	23574,373606	67032,507013	1830	19917,552396	65467,112164
1831	23602,842100	66991,475509	1831	19918,568381	65417,226158
1832	23624,122153	66946,290154	1832	19914,522273	65367,390136
1833	23637,559447	66898,184484	1833	19910,476164	65317,554115
1834	23642,841535	66848,520644	1834	19906,430055	65267,718094
1835	23661,463727	66802,754895	1835	19902,383946	65217,882073

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1836	23692,784618	66790,756372	1836	19901,247197	65168,050152
1837	23737,028118	66814,048273	1837	19905,433757	65118,225733
1838	23781,271619	66837,340174	1838	19905,444005	65068,489241
1839	23825,515119	66860,632075	1839	19899,164115	65018,885179
1840	23869,758620	66883,923976	1840	19895,721869	64969,081637
1841	23915,883962	66903,067575	1841	19895,000205	64919,086845
1842	23965,208890	66910,217257	1842	19894,278541	64869,092054
1843	24014,929292	66906,355830	1843	19893,556877	64819,097262
1844	24063,400279	66894,089535	1844	19892,835213	64769,102470
1845	24111,621079	66880,901154	1845	19892,113549	64719,107678
1846	24159,153285	66865,507775	1846	19887,159658	64669,361597
1847	24201,501487	66841,292958	1847	19881,474728	64619,702501
1848	24231,148003	66806,219152	1848	19872,814483	64570,458210
1849	24280,850964	66811,439070	1849	19861,894074	64521,681374
1850	24303,125481	66845,841884	1850	19850,309678	64473,041866
1851	24340,020691	66863,243410	1851	19838,725281	64424,402357
1852	24388,580374	66857,466827	1852	19827,140885	64375,762849
1853	24435,773195	66853,258850	1853	19815,556488	64327,123341
1854	24475,320889	66833,005000	1854	19804,011090	64278,477221
1855	24470,210778	66783,266818	1855	19798,916957	64228,737400
1856	24465,100667	66733,528636	1856	19793,822823	64178,997579
1857	24455,815236	66684,931407	1857	19805,704796	64131,651891
1858	24451,123048	66637,190775	1858	19841,674955	64096,922255
1859	24450,252505	66587,508628	1859	19877,645114	64062,192618
1860	24465,052368	66553,297685	1860	19913,615273	64027,462982
1861	24515,011322	66552,413803	1861	19949,585432	63992,733345
1862	24564,115917	66544,181243	1862	19985,555591	63958,003709
1863	24612,182166	66531,501237	1863	20021,887263	63923,734882
1864	24655,654234	66546,892343	1864	20064,180777	63897,065448
1865	24697,704580	66520,253430	1865	20105,642247	63869,132189
1866	24697,297379	66477,022050	1866	20146,856777	63840,823843
1867	24739,112855	66458,617006	1867	20188,071308	63812,515496
1868	24784,545464	66437,800690	1868	20229,285839	63784,207150
1869	24826,355066	66410,475573	1869	20271,056177	63756,759863
1870	24863,051076	66376,599031	1870	20315,300323	63733,705193
1871	24893,605074	66337,100259	1871	20361,114313	63713,678253
1872	24917,207371	66293,097472	1872	20400,653103	63684,549216
1873	24933,491561	66245,878605	1873	20435,664486	63648,853236
1874	24941,948369	66196,655076	1874	20470,675870	63613,157255
1875	24944,112153	66146,735752	1875	20505,687253	63577,461274
1876	24939,358162	66097,002768	1876	20540,698636	63541,765294

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1877	24936,040663	66047,841217	1877	20568,589654	63500,371794
1878	24956,761418	66002,592814	1878	20595,738396	63458,384346
1879	24972,933859	65955,346735	1879	20622,887138	63416,396898
1880	24981,035119	65906,065316	1880	20650,035880	63374,409449
1881	24981,245937	65856,107134	1881	20677,184622	63332,422001
1882	24973,543891	65806,765450	1882	20704,333364	63290,434553
1883	24958,337293	65759,175234	1883	20736,459834	63252,852536
1884	24938,610125	65713,273530	1884	20717,162081	63227,147568
1885	24913,689243	65669,965886	1885	20683,268098	63190,516124
1886	24961,281503	65666,840222	1886	20649,736809	63153,426332
1887	25010,862961	65660,930204	1887	20616,205521	63116,336540
1888	25060,771388	65657,905489	1888	20582,674232	63079,246748
1889	25066,657716	65614,925082	1889	20549,142943	63042,156955
1890	25064,846214	65564,957908	1890	20515,611655	63005,067163
1891	25063,034712	65514,990734	1891	20489,410340	62963,015729
1892	25061,223209	65465,023560	1892	20467,434873	62918,103828
1893	25031,902741	65445,922880	1893	20445,459406	62873,191927
1894	24983,081871	65456,717443	1894	20423,483939	62828,280026
1895	24934,248680	65467,452035	1895	20401,516508	62783,370482
1896	24885,107850	65476,673203	1896	20444,272020	62757,448171
1897	24835,728842	65484,529005	1897	20487,027532	62731,525861
1898	24830,302018	65436,832835	1898	20529,783044	62705,603550
1899	24827,900752	65387,036908	1899	20572,538556	62679,681239
1900	24828,303970	65337,038534	1900	20616,490819	62655,970470
1901	24792,000753	65321,206386	1901	20661,578297	62634,357528
1902	24806,511903	65281,378583	1902	20706,665776	62612,744585
1903	24831,081155	65237,910363	1903	20756,592755	62612,975417
1904	24848,006803	65190,921617	1904	20806,589764	62613,522336
1905	24856,873295	65141,767401	1905	20856,586773	62614,069254
1906	24857,501341	65091,824590	1906	20906,528710	62616,206433
1907	24849,923906	65042,464600	1907	20956,443776	62619,119530
1908	24842,136514	64993,680586	1908	21006,367772	62621,778850
1909	24844,900569	64944,320273	1909	21056,364144	62622,381185
1910	24851,984277	64894,888685	1910	21106,360516	62622,983520
1911	24894,198255	64886,077483	1911	21156,356887	62623,585855
1912	24944,181543	64884,784828	1912	21206,026417	62629,191422
1913	24994,158265	64883,263974	1913	21255,676244	62635,098592
1914	25044,133203	64881,681048	1914	21305,265260	62641,404459
1915	25094,108140	64880,098122	1915	21354,418479	62650,567483
1916	25144,088605	64878,797329	1916	21403,571698	62659,730508
1917	25194,087192	64878,421404	1917	21452,724918	62668,893532

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1918	25243,985449	64877,100437	1918	21501,878137	62678,056557
1919	25292,994163	64867,211496	1919	21551,372399	62685,089228
1920	25342,314115	64859,042626	1920	21600,929640	62691,728491
1921	25391,090048	64848,891185	1921	21650,811636	62694,559016
1922	25440,910883	64846,350732	1922	21700,759024	62696,681060
1923	25490,881557	64845,107126	1923	21750,523050	62701,533047
1924	25540,801044	64842,407023	1924	21800,287075	62706,385034
1925	25587,622037	64836,239046	1925	21850,051101	62711,237021
1926	25595,592796	64786,878561	1926	21899,815126	62716,089008
1927	25597,807973	64737,410317	1927	21949,579151	62720,940995
1928	25583,011639	64689,704868	1928	21999,343177	62725,792982
1929	25585,421779	64640,510748	1929	22049,267503	62728,337293
1930	25610,118781	64597,541301	1930	22099,176300	62726,509930
1931	25630,380730	64553,319049	1931	22148,767238	62720,533644
1932	25620,307466	64504,479349	1932	22198,149679	62712,699452
1933	25611,687343	64455,661655	1933	22247,532119	62704,865259
1934	25600,553474	64406,917045	1934	22296,914560	62697,031066
1935	25589,419604	64358,172436	1935	22346,297000	62689,196874
1936	25578,285735	64309,427827	1936	22395,679441	62681,362681
1937	25567,151866	64260,683217	1937	22445,417795	62676,875588
1938	25556,170983	64211,909848	1938	22495,343444	62674,149864
1939	25549,119930	64162,442170	1939	22544,708908	62667,042464
1940	25512,244456	64135,274229	1940	22593,714488	62657,120112
1941	25465,285236	64118,772435	1941	22642,720069	62647,197760
1942	25418,624247	64105,531653	1942	22690,934006	62634,016920
1943	25381,757252	64073,113448	1943	22739,029540	62620,348723
1944	25338,391645	64085,948824	1944	22787,125074	62606,680526
1945	25315,098998	64041,706235	1945	22836,313380	62597,887149
1946	25293,117302	63996,797383	1946	22885,641229	62589,716264
1947	25271,135607	63951,888530	1947	22934,969077	62581,545378
1948	25249,153911	63906,979677	1948	22982,815543	62568,648552
1949	25267,498514	63868,399614	1949	23027,981307	62547,199688
1950	25296,699021	63827,877531	1950	23073,147071	62525,750824
1951	25318,905610	63783,132569	1951	23118,312835	62504,301960
1952	25342,912309	63743,557829	1952	23165,171205	62487,325507
1953	25390,328133	63727,701456	1953	23213,220769	62473,496576
1954	25437,940736	63712,496388	1954	23261,270334	62459,667645
1955	25479,444938	63719,860257	1955	23308,909514	62444,587734
1956	25528,208034	63716,046084	1956	23355,813616	62427,267075
1957	25576,343550	63710,524670	1957	23402,717718	62409,946415
1958	25626,041055	63705,461711	1958	23447,431122	62387,884094

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
1959	25619,355585	63658,312826	1959	23492,762388	62367,283812
1960	25609,690434	63609,256328	1960	23540,077593	62351,119920
1961	25650,423341	63599,766625	1961	23587,392798	62334,956027
1962	25682,167648	63578,180240	1962	23633,830106	62316,943197
1963	25678,076920	63528,347862	1963	23676,261837	62290,494225
1964	25673,986192	63478,515483	1964	23718,693569	62264,045252
1965	25677,167992	63438,407494	1965	23761,125301	62237,596280
1966	25726,466394	63442,706149	1966	23806,125920	62216,303051
1967	25756,082382	63471,850443	1967	23852,794385	62198,357176
1968	25795,595497	63501,013501	1968	23900,314962	62182,948285
1969	25838,129498	63524,572858	1969	23948,354356	62169,084064
1970	25880,789315	63548,389397	1970	23996,393749	62155,219843
1971	25924,920413	63568,709588	1971	24044,433143	62141,355622
1972	25972,342613	63561,208352	1972	24091,514928	62124,548619
1973	26005,575376	63525,474824	1973	24139,198435	62109,783801
1974	26028,620519	63504,960033	1974	24187,868966	62098,330441
1975	26076,564412	63498,850077	1975	24236,539496	62086,877081
1976	26115,526801	63471,932871	1976	24285,210027	62075,423721
1977	26160,377506	63474,703963	1977	24333,951016	62064,289414
1978	26206,631441	63460,788287	1978	24382,918501	62054,180734
1979	26254,304938	63449,119174	1979	24431,885986	62044,072056
1980	26293,620698	63438,642611	1980	24480,853472	62033,963377
1981	26288,901783	63467,041510	1981	24530,622447	62030,427245
1982	26317,542426	63450,879443	1982	24580,584202	62028,471984
1983	26330,139224	63441,490858	1983	24630,322389	62024,227836
1984	26343,382461	63471,131319	1984	24679,718184	62016,478296
1985	26362,974320	63455,921271	1985	24729,113980	62008,728757
1986	26368,384816	63453,395604	1986	24778,497519	62000,905266
1987	26334,499504	63441,057418	1987	24827,752151	61992,304032
1988	26300,613886	63428,719241	1988	24877,006783	61983,702799
1989	26341,865722	63406,122301	1989	24926,404646	61975,990095
1990	26386,370630	63425,139139	1990	24975,867106	61968,678110
1991	26393,035261	63471,604080	1991	25025,329565	61961,366125
1992	26424,748159	63507,504923	1992	25074,792024	61954,054139
1993	26466,748790	63530,921952	1993	25124,254483	61946,742154
1994	26510,950447	63550,550973	1994	25173,631362	61938,886379
1995	26559,019737	63559,262269	1995	25222,948744	61930,652557
1996	26604,714335	63543,843726	1996	25272,174473	61921,888556
1997	26653,086716	63549,501112	1997	25321,255103	61912,353790
1998	26687,510405	63515,906842	1998	25370,291003	61902,582376
1999	26721,068988	63503,829100	1999	25419,326903	61892,810962

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
2000	26768,782659	63495,864400	2000	25468,362803	61883,039548
2001	26804,187465	63463,103301	2001	25517,398702	61873,268134
2002	26834,596901	63424,535737	2002	25566,434602	61863,496720
2003	26851,667996	63378,757520	2003	25614,172874	61848,992819
2004	26865,525012	63332,211822	2004	25661,334856	61832,387175
2005	26905,044000	63307,171750	2005	25703,454538	61805,688317
2006	26952,259242	63296,553665	2006	25745,055191	61777,950515
2007	26998,952930	63285,708697	2007	25786,584697	61750,112885
2008	27024,953729	63245,497911	2008	25826,379134	61719,840740
2009	27015,619612	63196,937742	2009	25866,173572	61689,568595
2010	27035,491269	63184,461879	2010	25905,968009	61659,296450
2011	27053,376522	63230,056274	2011	25949,051097	61634,418100
2012	27089,768379	63261,502662	2012	25994,187331	61612,907164
2013	27106,330991	63306,929246	2013	26039,323565	61591,396228
2014	27152,328509	63320,621508	2014	26084,459799	61569,885292
2015	27195,623836	63338,556208	2015	26129,596033	61548,374356
2016	27243,643548	63347,518881	2016	26173,057400	61523,655395
2017	27273,399766	63384,201772	2017	26216,508200	61498,916197
2018	27315,762871	63406,988399	2018	26264,608381	61486,543619
2019	27360,771704	63425,790443	2019	26313,595338	61476,529723
2020	27400,924687	63453,437458	2020	26362,582294	61466,515828
2021	27448,286544	63463,663037	2021	26411,569251	61456,501932
2022	27486,518679	63489,619291	2022	26460,556207	61446,488037
2023	27533,542505	63505,483375	2023	26509,543163	61436,474141
2024	27580,158305	63518,389553	2024	26558,420179	61426,038073
2025	27607,359248	63559,723263	2025	26606,739184	61413,873678
2026	27648,498200	63586,908239	2026	26656,294985	61407,223669
2027	27696,001077	63598,631093	2027	26705,850785	61400,573661
2028	27745,674315	63597,639835	2028	26753,216232	61385,088722
2029	27795,148910	63596,858964	2029	26800,139368	61367,819693
2030	27841,393380	63581,816463	2030	26847,062503	61350,550665
2031	27890,124455	63583,787072	2031	26893,985639	61333,281637
2032	27939,398639	63578,869462	2032	26940,908774	61316,012608
2033	27985,941813	63565,623976	2033	26987,438875	61297,717818
2034	28032,118857	63547,532767	2034	27033,879517	61279,192563
2035	28075,821303	63524,280162	2035	27078,585050	61256,800258
2036	28120,334739	63503,651081	2036	27123,290583	61234,407954
2037	28160,428947	63474,886516	2037	27167,996116	61212,015649
2038	28201,890604	63447,846576	2038	27212,701650	61189,623345
2039	28241,961188	63418,475150	2039	27257,407183	61167,231040
2040	28274,345619	63382,408344	2040	27300,883136	61142,551577

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
2041	28315,994232	63358,321495	2041	27344,219478	61117,612423
2042	28350,237170	63322,707810	2042	27387,555821	61092,673269
2043	28389,610355	63293,035780	2043	27430,892164	61067,734115
2044	28426,394359	63260,445274	2044	27474,228507	61042,794961
2045	28459,854935	63224,439321	2045	27511,848436	61010,343262
2046	28488,297135	63184,555339	2046	27550,589819	60979,509443
2047	28536,114250	63179,539026	2047	27594,720959	60956,005348
2048	28560,843073	63138,324272	2048	27639,041408	60932,871160
2049	28569,479909	63092,176643	2049	27683,917836	60910,823344
2050	28594,141971	63054,242596	2050	27728,794264	60888,775528
2051	28634,354523	63025,795695	2051	27773,670693	60866,727712
2052	28670,538488	62992,205277	2052	27818,547121	60844,679895
2053	28707,678127	62959,867615	2053	27865,418203	60827,905647
2054	28737,941637	62920,910044	2054	27913,652527	60814,735607
2055	28766,475404	62880,486317	2055	27960,818134	60798,460786
2056	28805,139989	62851,719259	2056	28006,939414	60779,152043
2057	28846,741759	62831,483424	2057	28053,060693	60759,843300
2058	28888,477350	62805,642833	2058	28099,181973	60740,534557
2059	28932,934134	62787,344638	2059	28145,303253	60721,225814
2060	28977,810294	62766,602740	2060	28192,741397	60705,655502
2061	29016,265162	62736,481845	2061	28240,782053	60691,795655
2062	29060,283509	62738,189060	2062	28288,822709	60677,935808
2063	29106,663898	62721,562432	2063	28336,863365	60664,075960
2064	29154,979838	62711,595554	2064	28384,904021	60650,216113
2065	29203,331472	62699,706627	2065	28433,182920	60637,213577
2066	29251,828148	62689,631409	2066	28481,486475	60624,299762
2067	29297,750555	62675,291150	2067	28529,819026	60611,497862
2068	29343,397837	62691,403094	2068	28578,316113	60599,330997
2069	29372,308454	62706,665873	2069	28626,813199	60587,164131
2070	29362,874042	62754,207942	2070	28675,310285	60574,997266
2071	29368,442885	62802,426778	2071	28723,807372	60562,830401
2072	29389,790343	62846,869985	2072	28772,296215	60550,631299
2073	29432,311539	62869,680937	2073	28820,680951	60538,025056
2074	29475,561849	62848,914851	2074	28869,318325	60526,469248
2075	29498,922943	62825,883811	2075	28917,587053	60513,524055
2076	29543,576997	62843,400715	2076	28965,573074	60499,476214
2077	29583,467251	62816,797164	2077	29013,559095	60485,428374
2078	29632,630722	62810,028791	2078	29057,055036	60463,168023
2079	29674,953423	62829,537046	2079	29094,780916	60430,354033
2080	29723,745514	62826,515287	2080	29132,506796	60397,540042
2081	29772,716527	62821,267096	2081	29170,232676	60364,726052

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
2082	29821,888211	62815,112555	2082	29206,836135	60330,673410
2083	29870,927034	62816,069875	2083	29243,196825	60296,352859
2084	29915,377751	62834,586599	2084	29279,557515	60262,032308
2085	29964,291671	62825,464015	2085	29313,238093	60225,189100
2086	30005,404658	62799,432776	2086	29345,297025	60186,819517
2087	30046,709158	62773,233000	2087	29377,355958	60148,449935
2088	30089,713778	62750,094943	2088	29410,615453	60111,181902
2089	30131,868169	62737,839725	2089	29446,090751	60075,946931
2090	30179,610376	62725,738191	2090	29481,566050	60040,711960
2091	30221,602514	62700,837801	2091	29516,828867	60005,267070
2092	30270,141641	62694,485623	2092	29551,630812	59969,366867
2093	30313,354834	62670,786015	2093	29586,432757	59933,466663
2094	30343,579004	62632,619317	2094	29621,234702	59897,566459
2095	30388,554910	62612,844634	2095	29658,214012	59863,930360
2096	30437,460402	62608,431213	2096	29695,445661	59830,556654
2097	30485,436302	62598,407292	2097	29732,677311	59797,182948
2098	30533,127584	62593,396428	2098	29764,824826	59759,201025
2099	30581,733284	62583,838174	2099	29794,390451	59718,878900
2100	30629,681889	62571,585629	2100	29823,956076	59678,556774
2101	30677,080361	62558,591235	2101	29857,377453	59641,963493
2102	30724,292881	62543,872263	2102	29896,687886	59611,065438
2103	30759,562527	62552,519995	2103	29935,998320	59580,167382
2104	30803,586491	62575,056068	2104	29974,683462	59548,545279
2105	30853,032153	62573,811393	2105	30010,975798	59514,152454
2106	30895,792689	62548,932881	2106	30047,268133	59479,759630
2107	30928,457813	62516,820142	2107	30083,560468	59445,366805
2108	30950,388553	62559,592728	2108	30123,464711	59415,283970
2109	30997,805051	62566,718220	2109	30163,674437	59385,565661
2110	31037,492237	62537,450233	2110	30203,663151	59355,561493
2111	31077,370038	62508,361322	2111	30242,546987	59324,128274
2112	31113,855911	62476,209266	2112	30281,430824	59292,695055
2113	31159,387724	62486,012456	2113	30320,314660	59261,261835
2114	31208,583862	62486,469078	2114	30361,140356	59232,676246
2115	31253,657804	62470,143745	2115	30404,602092	59207,956264
2116	31286,469148	62433,120781	2116	30448,063827	59183,236281
2117	31324,723494	62404,051139	2117	30491,525563	59158,516299
2118	31367,212933	62426,698767	2118	30534,987299	59133,796317
2119	31405,079799	62455,349254	2119	30578,449035	59109,076335
2120	31453,038093	62454,674763	2120	30619,839153	59081,353260
2121	31496,579729	62431,889525	2121	30656,402437	59047,372241
2122	31545,015260	62430,117119	2122	30690,996670	59011,271839

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
2123	31594,304030	62423,097645	2123	30725,590904	58975,171437
2124	31643,359832	62419,116289	2124	30760,185138	58939,071035
2125	31689,490393	62402,038575	2125	30794,779371	58902,970634
2126	31722,443127	62370,083423	2126	30829,373605	58866,870232
2127	31770,131478	62357,718882	2127	30867,284359	58835,393091
2128	31817,928656	62344,856082	2128	30912,567453	58814,193058
2129	31853,548667	62313,745336	2129	30956,699227	58790,809588
2130	31891,786352	62284,650334	2130	30999,772844	58765,419363
2131	31934,605707	62261,675201	2131	31042,846461	58740,029139
2132	31972,423987	62230,881659	2132	31085,920078	58714,638914
2133	32002,309136	62192,856218	2133	31121,260115	58680,356880
2134	32039,954230	62170,339452	2134	31155,992546	58644,586026
2135	32087,605315	62164,743153	2135	31191,286807	58609,200931
2136	32127,392548	62136,581607	2136	31225,872893	58573,092724
2137	32169,303461	62110,405238	2137	31260,458980	58536,984517
2138	32209,559304	62081,827969	2138	31295,045066	58500,876310
2139	32230,619190	62038,826499	2139	31329,631153	58464,768102
2140	32206,524743	61997,420860	2140	31365,821727	58430,738763
2141	32166,397193	61969,649620	2141	31409,514965	58406,430309
2142	32208,696875	61947,334788	2142	31453,208203	58382,121854
2143	32246,659835	61914,966458	2143	31496,901441	58357,813400
2144	32278,212183	61876,228986	2144	31540,594679	58333,504946
2145	32303,275876	61833,113139	2145	31583,359300	58307,623582
2146	32326,658746	61789,369124	2146	31625,750322	58281,109412
2147	32354,753692	61748,146861	2147	31671,201810	58261,688780
2148	32372,581170	61701,580938	2148	31719,576164	58249,042759
2149	32387,693845	61654,126734	2149	31767,950519	58236,396739
2150	32402,901736	61606,565193	2150	31816,324873	58223,750719
2151	32409,097709	61557,081637	2151	31864,699228	58211,104698
2152	32413,960939	61508,051233	2152	31913,073582	58198,458678
2153	32442,355016	61467,573764	2153	31961,447937	58185,812658
2154	32479,181299	61433,786626	2154	32009,839013	58173,233484

COORDINATE SYSTEM:	Barbados_1938_Barbados_Grid
WKID:	21292

INLAND BOUNDARY			OFFSHORE BOUNDARY		
Nº	LON (º)	LAT (º)	Nº	LON (º)	LAT (º)
2155	32509,457904	61394,088058	2155	32058,470040	58161,613534
2156	32536,224197	61351,910027	2156	32107,101066	58149,993585
2157	32553,080163	61304,988022	2157	32155,732093	58138,373635
2158	32557,828228	61255,362359	2158	32204,363120	58126,753685
2159	32550,175737	61206,098819	2159	32252,994147	58115,133736
2160	32530,592684	61160,241213	2160	32301,625174	58103,513786
2161	32500,229057	61120,678693	2161	32350,256201	58091,893836
2162	32518,880755	61079,227890	2162	32398,859974	58080,160894
2163	32534,462245	61031,961771	2163	32447,441130	58068,334174
2164	32547,863013	60985,076956	2164	32494,166146	58050,789355
2165	32548,886369	60936,537894	2165	32540,431403	58031,828183
2166	32545,010420	60887,973271	2166	32586,696660	58012,867012
2167	32533,852685	60839,528241	2167	32632,961350	57993,904470
2168	32526,188652	60790,285785	2168	32679,117978	57974,680379
2169	32507,474900	60745,055809	2169	32725,390145	57955,739013
2170	32520,821593	60698,181375	2170	32771,800151	57937,134947
2171	32551,340593	60660,102386	2171	32818,210158	57918,530880
2172	32587,100794	60626,422299			
2173	32620,709040	60591,303451			
2174	32666,021112	60595,688526			
2175	32714,900751	60588,112681			
2176	32754,209911	60558,101769			
2177	32774,300047	60512,893796			
2178	32813,128695	60485,537510			
2179	32850,096265	60452,803063			
2180	32892,440211	60429,718044			
2181	32937,975073	60411,358224			
2182	32978,996918	60412,158712			
2183	33018,751184	60439,194066			
2184	33040,181652	60483,769045			
2185	33080,407326	60512,566061			

ANNEX 2. BASELINE STUDIES AND RISK ASSESSMENTS DEVELOPED BY THE CZMU

REPORT	CONTENTS
Circulation Water Quality & Sedimentation Study. Phase 1 Report	A review of previous works completed concerning water quality, terrestrial loads, and circulation in Holetown, Bridgetown and Consett Bay
Circulation Water Quality and Sedimentation Study. Phase 3. Model Calibration, Verification and Clean-up Scenarios	Model calibration/validation and potential clean-up scenarios to reduce contaminant loadings to the receiving coastal waters
Circulation Water Quality and Sedimentation Study. Phase 4. Summary Report	Summary of the work completed during the CWQS study, including data assembly and review, field monitoring programs, groundwater assessment, numerical modelling activities, and the assessment of clean-up scenarios
CRMP Ecosystem-Based Adaptation Pilot Project. Water Quality and Reef Information Report	Summary of the initial findings from the first campaign for the EBA and analysis of the results and the historical quality measurements
Ecosystem-Based Adaptation Pilot Project. Phase 1. Report	Summary of the technical studies completed during the first year of the EBA pilot project, which analyses the feasibility of reef restoration as an NbS to mitigate the impacts of Climate Change
Ecosystem-Based Adaptation Pilot Project. Coral Nursery – Final Report	Description of the Coral Nursery Pilot project carried out within the EBA project
Geotechnical surveys Investigation. Field Study Report	Results of the data collection and field investigations completed in this part of the CRMP study, which include: geological maps, cliff undercut surveys, downhole camera and optical televiewer surveys, instrumentation installation and monitoring records, and laboratory testing results.
Geotechnical surveys Investigation. Assessment Report	Results of the data interpretation, analysis and geotechnical modelling carried out to assess the stability of the slopes and cliffs within the coastal zone
CRMP Nearshore Wave Study. Phase 1. Report	Review of previously recorded wave data and past hindcasts in the vicinity of the Barbados coastline
CRMP Nearshore Wave Study. Phase 3a. Report	Review of past data, collection of new data, and development of a long-term data collection program as well as the development of a numerical model to produce wave climates for different locations around the island
CRMP Nearshore Wave Study. Phase 3b. Report	
CRMP Shoreline Change Study. Phase 1. Data Preparation Progress Memorandum	Summary of the ongoing data preparation for the shoreline change analysis, including the sources of historical imagery, steps involved in generating ortho-photographs for the coast of Barbados
CRMP Shoreline Change Study. Phase 2. Report on Expansion and Improvements to the Beach Profile Monitoring Program	A review of the existing beach monitoring program and new recommendations for future improvements
CRMP Shoreline Change Study. Phase 3. Report on the QA/QC Process	Analysis of the shoreline changes for different time periods of historic aerial imagery, classification of the coastal zones based on shoreline trends and providing information for decisions about future monitoring
RMP Shoreline Change Study. Phase 4. Report on Training	Final recommendations on coastal monitoring
Sediment Transport Study. Final Report	Literature review about the sediment budget along the Barbados coastline, Data about sediment samples from beaches around Barbados and results of an encapsulated sediment budget model that formulates the balance between supply and loss of sediment for individual beaches under different SLR scenarios
Update of the System of Indicators of Disaster Risk and Risk Management to Barbados	Results for Barbados for the indicators DDI (Disaster Deficit Index), LDI (Local Disaster Index), PVI (Prevalent Vulnerability Index) and RMI (Risk Management Index)
National Hazard Mapping Risk Atlas	Maps to illustrate the areas that are exposed to the different hazards identified in Barbados, at specific return period levels
National Coastal Risk Information and Planning Platform. Final Hazard Report	Development of hazard data (wind, earthquakes, landslides, storm surge, coastal erosion, flooding due to rainfall, tsunami and oil spills) for Barbados
National Coastal Risk Information and Planning Platform. Final Vulnerability Report	Analysis of the exposure and susceptibility of socioeconomic and environmental items to the identified hazards in Barbados
National Coastal Risk Information and Planning Platform. Revised Draft Risk Report	Calculating financial damage (referred to as risk) resulting from the assessed hazards in previous reports. Risk is computed for multiple hazards at various return periods for a range of assets

Table Annex 2.1. Baselines studies and risk assessments developed by the CZMU during last years.

ANNEX 3. CLIMATE CHANGE TRENDS AND PROJECTIONS

HISTORICAL TREND	FUTURE PROJECTION
Temperatures • Mean temperature has increased at 0.1ºC/decade • Maximum and minimum temperatures show an upward (linear) trend. Reanalysed records (1901-2015) suggest +0.094ºC/decade for maximum temperatures and +0.10ºC/decade for minimum temperatures. • Daily temperature range has decreased slightly. • Maximum and minimum temperature extremes near Barbados have increased at 0.1-0.3 ºC/decade over 1961-2010. • Frequency of warm days and warm nights have shown statistically significant increases. • Frequency of cool days and nights have declined across the Caribbean by approximately 1.8% and 2.6% respectively over the 1961-2010 period.	Temperatures • Minimum, maximum and mean temperatures increase irrespective of the climatic scenario through the end of the century. These temperature increases occur across all seasons of the year. • The projected mean temperature increase from selected RCP climatic scenarios in the GCMs are: • 0.56-0.68°C for the 2020s; • 0.71-0.96°C for the 2030s, • 0.85 – 1.59°C for the 2050s and • 0.78-2.82°C for 2081-2100. • RCMs suggest increases in mean temperature of up to 0.89°C by the 2050s
Rainfall • Significant year-to-year variability due to the influence of phenomena like the El Nino Southern Oscillation (ENSO). • An upward trend in mean is observed at 0.197 mm/year over Barbados though a strong decadal signal is also evident. • Two long-term stations in Barbados suggest no discernible change in consecutive dry days and frequency of days above 10 mm rainfall in recent past but slightly increase in very wet days (R95p). Trends diverge for max 1-day and max 5-day rainfall. • A 2014 study suggests that for 1986-2010, Barbados shows an increase in total precipitation as well as an increase in the daily rainfall intensity index although both are not considered statistically significant.	Rainfall • Rainfall shows a slight decrease across all scenarios through to the end of the century. • The mean annual precipitation is projected from GCMs to have decreases of 3 – 5% for 2020s, 3– 6% for 2030s, 2 – 14% for 2050s and 4 – 25% for the end of century. • This drying is projected to occur in both the wet season (August to November) by up to 11% and the dry seasons (Dec. to Mar.) up to 18% by mid-century (2046-2065) from GCM data. • One RCM projects modest declines of up to 4% by the 2050s which overlaps with projections from GCMs. • Two RCMs predict little discernible change in consecutive dry days and frequency of days above 10 mm rainfall. These RCMs also predict small increases in the number of very wet days, the maximum 1-day precipitation and maximum 5-day precipitation. • A detailed analysis of rainfall intensity (Acclimatise, 2016) for Barbados showed significant uncertainty with respect to future trends with changes of -70% to +45% possible in the next 50 years.
Sea Levels* • Historical trends show a regional rate of increase of 0.18 ± 0.01 mm/year between 1950 and 2010. • Higher rate of increase in later years: up to 3.2 mm/year between 1993 and 2010. • Caribbean Sea level changes are similar to the overall global mean.	Sea Levels* • The combined range for a projected rise over all GCM scenarios spans 0.26 to 0.82 m by 2100 relative to 1986-2005 levels. The range is 0.17 to 0.38 m for 2046 – 2065. • It is suggested that gravitational and geophysical factors will lead to the region experiencing a greater rise in sea levels than most global areas. • Sea-level rise over the northern Caribbean may exceed the global average by 25%. • Other recent studies suggest an upper limit for the Caribbean of up to 1.5 m for the most pessimistic future climatic scenario (RCP8.5).
Hurricanes • Increase in frequency and duration of Atlantic hurricanes since 1995. • Increase in Category 4 and 5 hurricanes and in rainfall intensity, associated peak wind intensities, and mean rainfall for the same period.	Hurricanes • No change or slight decrease in the frequency of hurricanes. • An 80% increase in the frequency of Saffir-Simpson category 4 and 5 Atlantic hurricanes over the next 80 years using a future compromise or average climatic scenario (A1B). • Shift toward stronger storms by the end of the century as measured by maximum wind speed increases of +2 to +11%. • +20% to +30% increase in rainfall rates for the model hurricane's inner core, with a smaller increase (~10%) at radii of 200 km or larger.

Table Annex 3.1. Climate change and projections for Barbados at a glance. (Source: Baird, 2017)

ANNEX 4. SAMPLE HAZARD MAPS

Storm surge

The information on the hazard maps shows the flooded region (coastal surge flooding or backshore flooding for specific areas) for different return period events, and also provides an indication of the wave height on top of the crest, as well as the inland propagation distance. NCRIPP flooding maps are prepared for a sea level rise scenario where the mean sea level has reached 0.6 m, or a 0.25 m increase relative to the present.

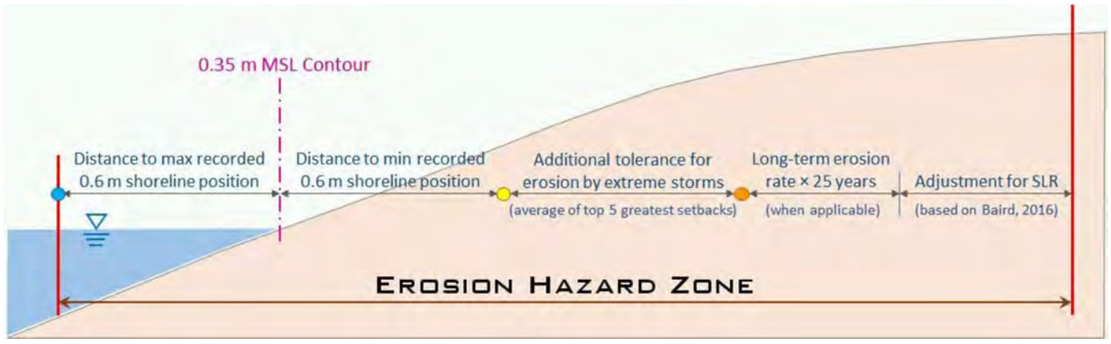
There are two important factors that will impact the flooding extent due to storm surge that are not considered in this simulation approach: walls and buildings. Walls and buildings will impact where water can flow as water propagates inland, or as water returns to the sea. In some instances, the buildings and walls may be very effective at blocking flow, and in other instances, they may have minimal impacts. The influence of these structures and whether they improve or exacerbate the flood situation would need to be defined on a case by case basis when a detailed local flood assessment was being completed.

Shoreline erosion – Beaches

Baird (2016) predicted that under IPCC (2013) least optimistic RPC8.5 scenario, and with the current alongshore and onshore sand supply rates, most beaches in Barbados would lose 20% to 50% of their existing sand volumes by 2100 if no mitigation measures are implemented.

The impact was predicted to reduce under more moderate IPCC (2013) scenarios approximately proportional to the SLR value. Model predictions indicated that beaches on the southwest and west coasts of Barbados are the most susceptible to SLR due to the manmade structures along the densely populated shoreline.

Erosion Hazard Zone at each survey station was then defined as the zone between the most seaward position of the 0.6 m LD shoreline (i.e. the Blue Point) and the most landward position of the 0.6 m LD shoreline plus the average of the top 5 greatest setbacks (i.e., the Orange Point). This was considered to reasonably cover short-term shoreline fluctuations and the impact of future sea level rise for the 50-year plan.



Summary of Various Elements Defining the Erosion Hazard Zone. (Source: Baird, 2017).

The beach erosion hazard assessment relies heavily on historical data to understand how beaches respond to storms within the context of the natural conditions of each beach. There are many beaches that do not have recorded profile data, which necessitates professional judgment to define the erosion hazard. The numerical modelling completed by Baird for the CRMP work (Baird, 2016) provided insight into beach response in Barbados and sea level rise impacts. Local knowledge of beaches in Barbados and the common underlying cobble layer was important to finalizing an approach for undertaking this study.

The erosion hazard zone was defined based on interpolation of recent historical erosion/accretion trends obtained from profile survey data. While this is believed to be a reasonable approach, the results are expected to be more reliable for beaches located in the proximity of profile survey stations (that are less impacted by the interpolation process). Furthermore, our analysis did not explicitly consider the impact of very strong storms that could damage the structures that presently limit beach erosion potential. As mentioned before, without accurate subsurface information it is impossible to know the exact response of a beach to a very severe storm and how the underlying cobble beach could also be changed.

The analysis did not include an assessment of the condition of coastal wall and other defences that would limit the beach erosion in most developed areas of the coast. The assumption is that these walls, revetments or other structures would be maintained (or rebuilt) to “hold the line” against long term erosion trends. The trimmed hazard zones reflect our knowledge of local structures and how erosion may be limited but were not based on structural assessments.

Shoreline erosion - cliffs

Estimating erosion rates based on incremental air photo information provides a disjointed snapshot view of an overall slow geological process. For all cliff types, actual change in cliff morphology and shoreline geometry generally occurs as a series of step changes. It is likely these changes are only associated with significant “impact” events such as major storms, which can trigger changes in cliff stability such as increasing the undercut depth to where it might reach a critical joint, or where serious inundation occurs into a low stability cliff situation due to overtopping of “protection” provided by sand beaches or fallen blocks.

Once wave information was defined, statistical means and interpolation of historical erosion rates were then extrapolated for periods of 10 years, 25 years, 50 years, 100-years and 500 years, as listed in Table A.1.

Cliff type	Erosion Rate Case 1 m/10 years	Case 2 m/25 years	Case 3 m/50 years	Case 4 m/100 years	Case 5 m/500 years
Type A	0.1	0.25	0.50	0.70	1.40
Type B	1.00	2.20	4.00	6.00	12.50
Type D	2.50	5.30	10.00	15.00	30.00
Type E1	3.20	6.80	13.00	19.00	38.00
Type C	3.80	8.10	15.00	23.00	45.00
Type E2/E3	5.80	12.50	23.50	35.00	70.00

Table A.1. Summary of Cliff Erosion Rates for each case. (Source: Baird, 2017).

Case 1: Very limited erosion occurs over a 10-year time span for the stronger Type B and Type A cliffs. The Type D, Type C and Type E cliffs also have limited erosion but as storms affect these weaker cliffs more, their erosion rates are still perceptible.

It is critical to reiterate that for slopes that fail instantaneously with large volume rather than in small increments, any given 10-year period could include large shoreline change due to a block failure of the Type A or Type B cliffs, or a landslide within a Type D2 or Type E2 cliff zone, due to basal failure.

The erosion rates provided are average rates that cannot represent these one-off events. Rate relationships over a longer duration will tend to greater accuracy, but again are subject to uncertainty of individual one-off events.

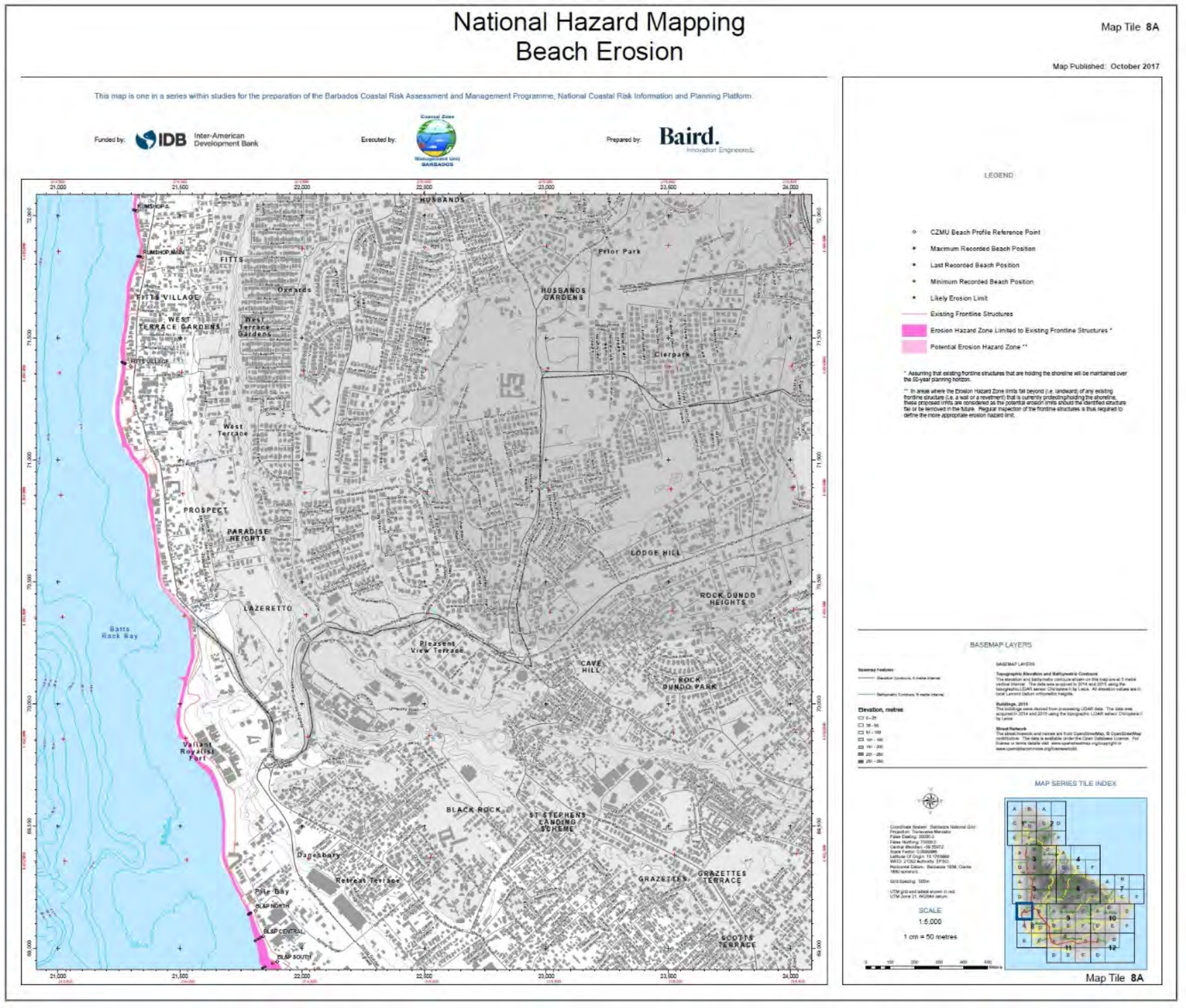
Case 2: In a 25-year period, greater erosion is predicted, in some instances increasing the setback stability point significantly from the 10-year point. Care should be utilized in selection of what might be an appropriate period for design.

Case 3: The 50-year record defines precisely the base time interval data used for calibration of all of the regression relationship equations.

Case 4: Although the 50-year erosion rate measurement data were previously linearly extrapolated out to represent a 100-year frequency period, the increasing frequency of larger hurricane events occurring in a 100-year period based on recurrence of more recent high energy events than in the past, potentially greater recession rates might occur in the future.

Case 5: The 500-year period, which mirrors the 1% exceedance 475-year period used in earthquake seismicity likely reflects a reasonable snapshot geologically of the time over which real cliff erosion at a map scale might be determinable.

Sample maps


National Hazard Mapping
Beach Erosion
Map Tile 8A
Map Published: October 2017
This map is one in a series within studies for the preparation of the Barbados Coastal Risk Assessment and Management Programme, National Coastal Risk Information and Planning Platform.
Funded by: IDB Inter-American Development Bank
Executed by:
Prepared by: Baird. Innovation Engineered.
LEGEND
CZMU Beach Profile Reference Point
Maximum Recorded Beach Position
Last Recorded Beach Position
Minimum Recorded Beach Position
Likely Erosion Limit
Existing Frontline Structures
Erosion Hazard Zone Limited to Existing Frontline Structures *
Potential Erosion Hazard Zone **
* Assuming that existing frontline structures that are holding the shoreline will be maintained over the 50-year planning horizon.
** In areas where the Erosion Hazard Zone limits fall beyond (i.e. landward) of any existing frontline structure (i.e. a wall or a revetment) that is currently protecting/holding the shoreline, these proposed limits are considered as the potential erosion limits should the identified structure fail or be removed in the future. Regular inspection of the frontline structures is thus required to define the more appropriate erosion hazard limit.
BASEMAP LAYERS
MAP SERIES TILE INDEX
SCALE
1:5,000
1 cm = 50 metres
Map Tile 8A
HUSBANDS
Prior Park
HUSBANDS GARDENS
Clerpark
FITTS
Dreads
FITTS VILLAGE
WEST TERRACE GARDENS
West Terrace Gardens
West Terrace
PROSPECT
PARADISE HEIGHTS
LODGE HILL
ROCK DUNDO HEIGHTS
LAZERETTO
Batts Rock Bay
Pleasant View Terrace
CAVE HILL
ROCK DUNDO PARK
Vellard Royal(s) Fort
BLACK ROCK
ST STEPHENS LANDING SCHEME
Dagesbury
Retreat Terrace
GRAZETTES
GRAZETTES TERRACE
Pile Bay
BLEP NORTH
BLEP CENTRAL
BLEP SOUTH
SCOTTS TERRACE

National Hazard Mapping
Seismic - Estimated Site Classes

Map Tile **4E**

Map Published: **October 2017**

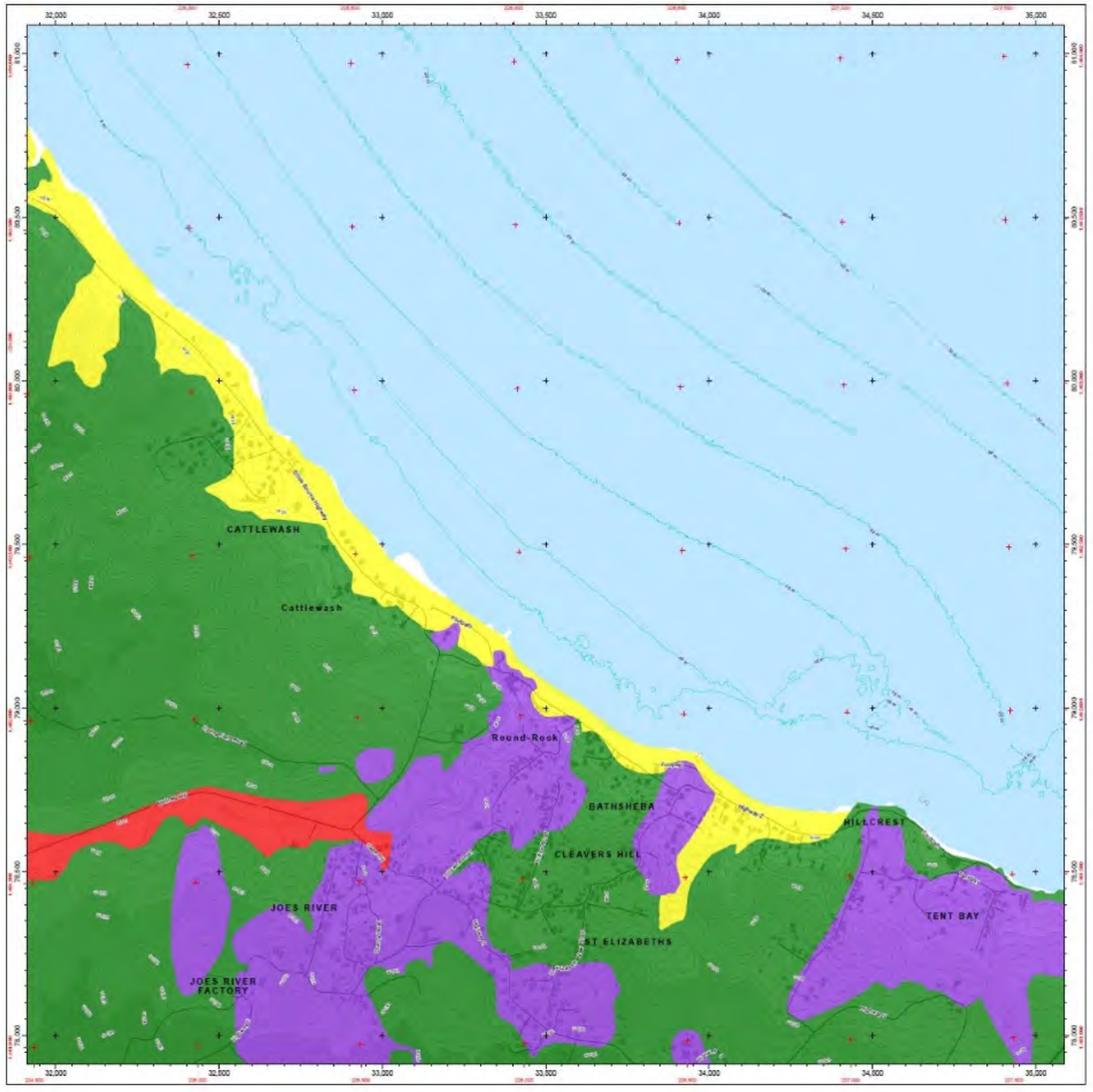
This map is one in a series within studies for the preparation of the Barbados Coastal Risk Assessment and Management Programme, National Coastal Risk Information and Planning Platform.

Funded by: IDB Inter-American Development Bank

Executed by: Coastal Zone Management Unit BARBADOS

Prepared by: Baird. Innovation Engineered.

Geotechnical Analysis by: Golder Associates



LEGEND

Soil Site Class	Horizonal Peak Ground Acceleration PGA_m (g)	0.2 second Spectral Accelerations S_{ms} (g)	1 second Spectral Accelerations S_{m1} (g)
B - Rock	0.69	1.50	0.64
C - Very dense soil and soft rock	0.69	1.50	0.83
D - Stiff soil	0.69	1.50	0.86
E - Soft clay soil	0.62	1.35	1.54

NOTE
1. Site class based on ASCE 7-10 (2011) with Golder interpretation of geologic units from Poole et al. (1979/1980) and Speed (1997, 2012)

REFERENCES
1. ASCE 7-10 (2011)
2. IBC (2015)
3. POOLE, E.G., BARKER, L.H., AND PAYNE, P. (1981)
4. SALAZAR, W., BROWN, L. AND MANNETTE, G. (2013)
5 SPEED, R.C. (1997, 2012)

BASEMAP LAYERS

Basemap Features
Elevation Contours, 5 metre interval
Bathymetry Contours, 5 metre interval

Elevation, metres
0 - 25
26 - 50
51 - 100
101 - 150
151 - 200
201 - 250
251 - 350

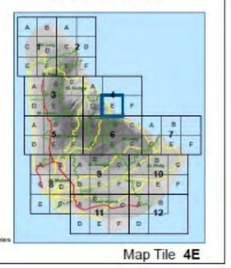
BASEMAP LAYERS

Topographic Elevation and Bathymetric Contours
The elevation and bathymetry contours shown on this map are at 5 metre vertical interval. The data was acquired in 2014 and 2015 using the topographic LiDAR sensor Chiroptera II by Leica. All elevation values are in local Lamont Datum orthometric heights.

Buildings, 2015
The buildings were derived from processing LiDAR data. The data was acquired in 2014 and 2015 using the topographic LiDAR sensor Chiroptera II by Leica.

Street Network
The street linework and names are from OpenStreetMap, © OpenStreetMap contributors. The data is available under the Open Database Licence. For licenses or terms details visit www.openstreetmap.org/copyright or www.opendatacommons.org/licenses/odbl.

MAP SERIES TILE INDEX



Coordinate System: Barbados National Grid
Projection: Transverse Mercator
False Easting: 30000.0
False Northing: 75000.0
Central Meridian: -59.55972
Scale Factor: 0.9999995
Latitude Of Origin: 13.1793889
WKID: 21262 Authority: EPSG
Horizontal Datum: Barbados 1938, Clarke 1880 spheroid.

Grid Spacing: 500m

UTM grid and labels shown in red
UTM Zone 21, WGS84 datum

SCALE
1:5,000
1 cm = 50 metres

Map Tile **4E**

National Hazard Mapping
Slope Risk Classification - Fully Saturated Condition

Map Tile **4A**

Map Published: **October 2017**

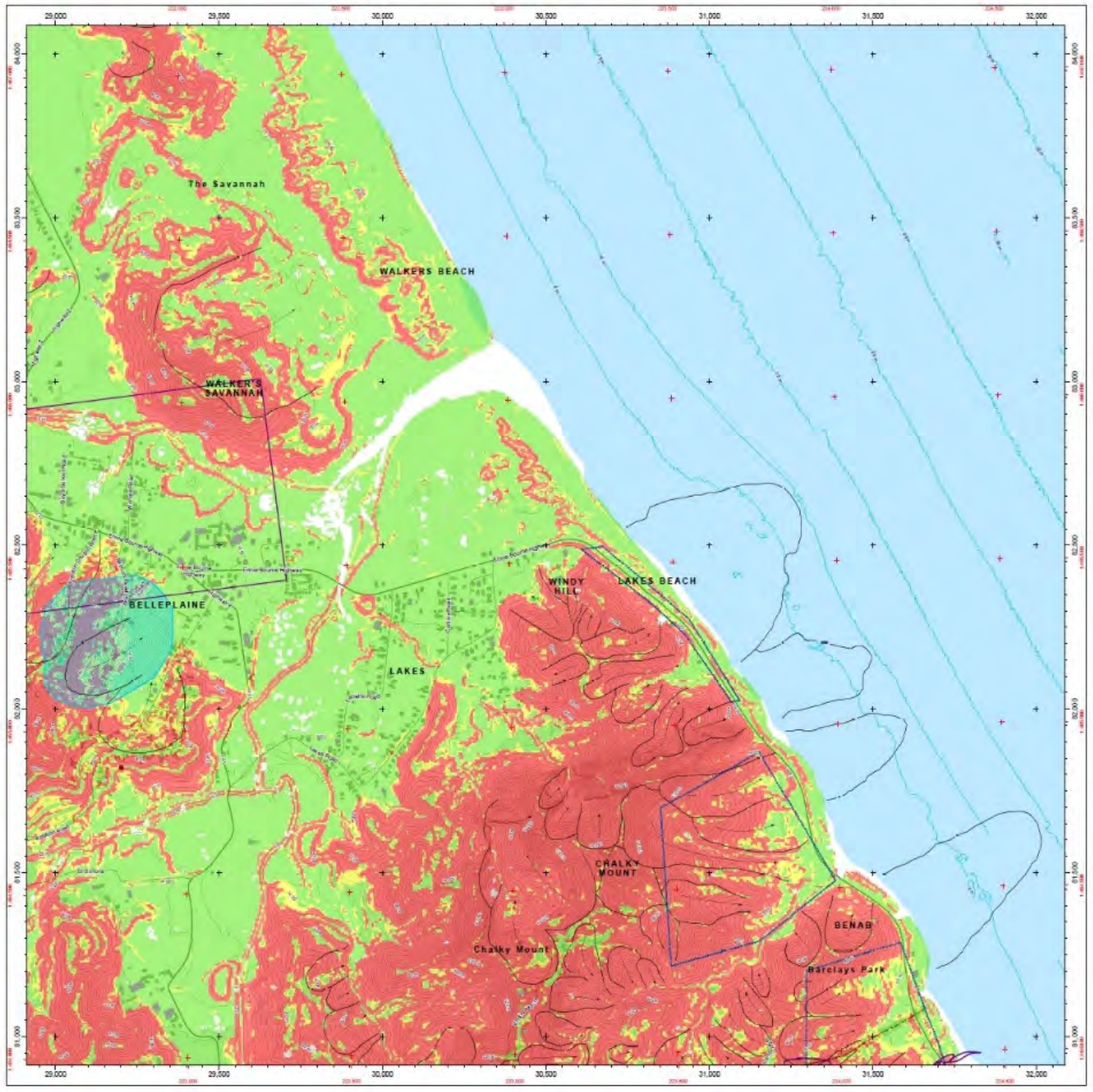
This map is one in a series within studies for the preparation of the Barbados Coastal Risk Assessment and Management Programme, National Coastal Risk Information and Planning Platform.

Funded by: IDB Inter-American Development Bank

Executed by: Coastal Zone Management Unit BARBADOS

Prepared by: Baird. Innovation Engineered.

Geotechnical Analysis by: Golder Associates



LEGEND

CDRG RECORD FAILURE LOCATIONS

ROAD DAMAGE LOCATIONS

Road_Damage_Locations_Golder

Road Damage Locations - GOLDER (2016)?

Road Crack - Uncategorized

Road Crack - Minor

Road Crack - Moderate

Road Crack - Major

Slope/dist_Failure_Approximate_Locations

Arrow

Dashed

Solid

Sandstone/Limestone

APPROXIMATE CORAL CAP

ESCARPMENT / LIMESTONE BOUNDARY

Discontinuity

LAND SLIP

Approximate Locations of Previous Failures

SETTLEMENT AT RISK OF LANDSLIDES

UNSTABLE AREAS

FIELD INTERPRETATIONS - GOLDER (2016)?

BACK SCARP

FRONT LOBE, DEBRIS/MUDFLOW

RISK CLASS	FACTOR OF SAFETY	PROBABILITY OF FAILURE	STABILITY STATE	ANTICIPATED IMPACTS
HIGH	< 1.0	> 50%	MARGINALLY UNSTABLE TO UNSTABLE	LONG-TERM CREEP, EXCESSIVE MOVEMENT, FAILURE
MEDIUM	1.0 to 1.3	15% to 50%	MARGINALLY STABLE TO GENERALLY STABLE	LONG-TERM CREEP MOVEMENT
LOW	> 1.3	< 15%	GENERALLY STABLE TO STABLE	MINOR TO NONE

REFERENCES AND NOTES:

1. FROM CRMP GEOTECHNICAL SURVEYS INVESTIGATION ET FIELD STUDY REPORT, DATED SEPTEMBER 2016. MAPPING CARRIED OUT IN LESS DETAIL OUTSIDE OF THE 1 KM STRIP ALONG THE COAST.
2. FROM MARSHALL, 1998. ENVIRONMENTAL HAZARDS IN BARBADOS: PERCEPTION AND RESPONSE II. IN THE SCOTLAND DISTRICT AND THE WEST COAST CARIBBEAN. GEOGRAPHY, VOL 7, P 23-35.

BASEMAP LAYERS

Basemap Features

Elevation Contours, 5 metre Interval

Bathymetry Contours, 5 metre Interval

Elevation, metres

0 - 25

26 - 50

51 - 100

101 - 150

151 - 200

201 - 250

251 - 350

BASEMAP LAYERS

Topographic Elevation and Bathymetric Contours
The elevation and bathymetry contours shown on this map are at 5 metre vertical interval. The data was acquired in 2014 and 2015 using the topographic LiDAR sensor Chiroptera II by Leica. All elevation values are in local Lamont Datum orthometric heights.

Buildings, 2015
The buildings were derived from processing LiDAR data. The data was acquired in 2014 and 2015 using the topographic LiDAR sensor Chiroptera II by Leica.

Street Network
The street (network and names are from OpenStreetMap. © OpenStreetMap contributors. The data is available under the Open Database License. For licence or terms details visit: www.openstreetmap.org/copyright or www.opendatacommons.org/licenses/odbl.

MAP SERIES TILE INDEX

Coordinate System: Barbados National Grid
Projection: Transverse Mercator
False Easting: 30000.0
False Northing: 75000.0
Central Meridian: -59.55972
Scale Factor: 0.9996000
Latitude Of Origin: 13.1713600
WKID: 21292 Authority: EPSG
Horizontal Datum: Barbados 1938, Clarke 1880 spheroid
Grid Spacing: 500m
UTM grid and values shown in red.
UTM Zone 21, WGS84 datum.

SCALE
1:5,000
1 cm = 50 metres

0 100 200 300 400 500 Metres

Map Tile **4A**

National Hazard Mapping
Inland Flooding

Map Tile **5A**

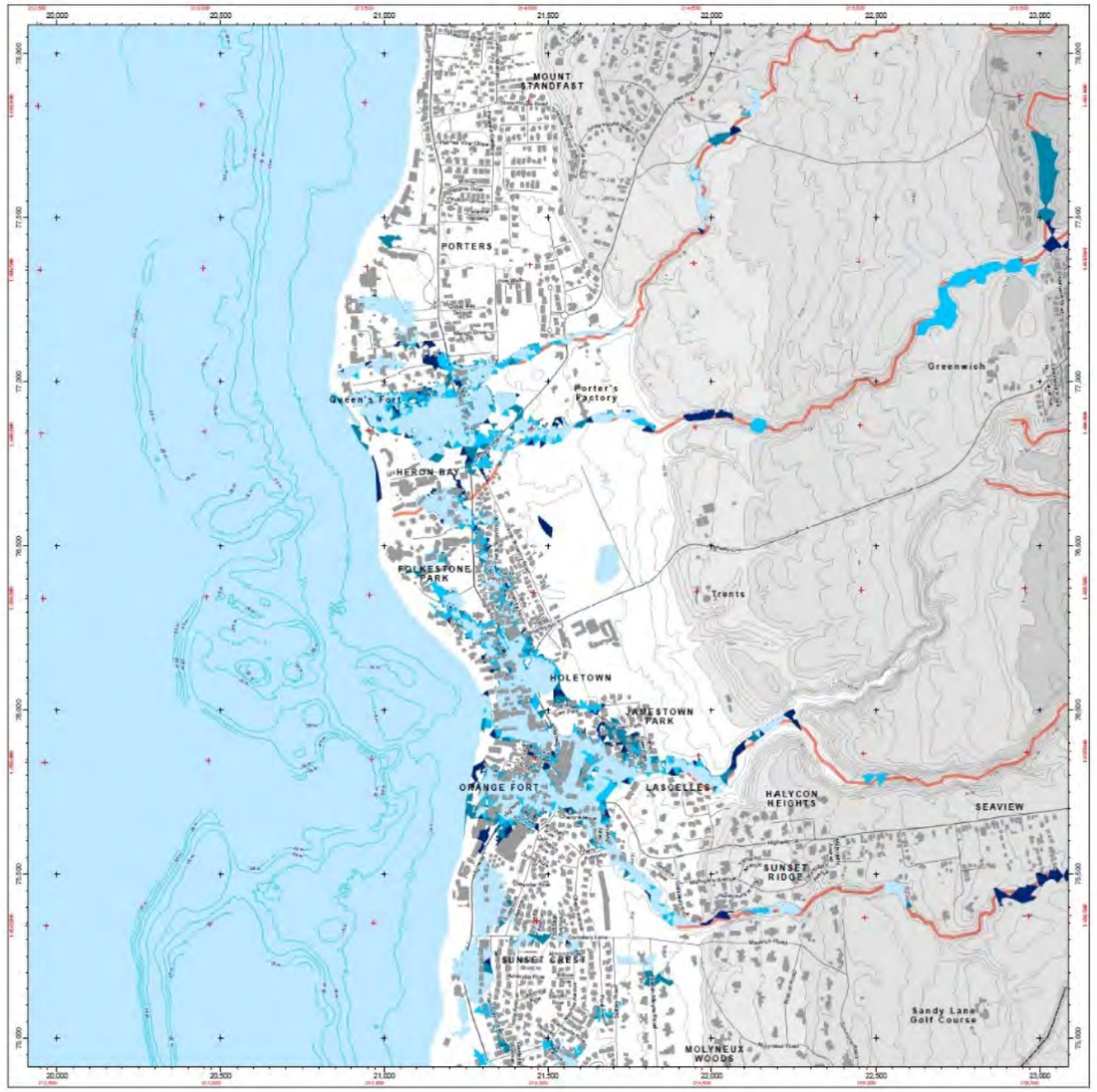
Map Published: October 2017

This map is one in a series within studies for the preparation of the Barbados Coastal Risk Assessment and Management Programme, National Coastal Risk Information and Planning Platform.

Funded by: IDB Inter-American Development Bank

Executed by: Coastal Zone Management Unit BARBADOS

Prepared by: Baird. Innovation Engineered.



LEGEND

Rainfall Induced Flooding

Inland flooding may occur throughout Barbados, but is common near the coast and in flatter low-lying regions. Flooding was determined based on an island-wide hydrologic model developed with SWAT, and 2 tab-dimensional model using MIKE21 Flexible Mesh. This flood assessment focused on regional flooding, rather than small scale ponding and swales. Two dimensional modelling was undertaken with grid cells in the range of 10 to 50 m in size, and local drainage infrastructure was not included in the broad-scale modelling effort. Mapped flood depths were derived from assessing the difference between water surface elevations from the MIKE21 model, and topography from the 1 m DEM from the LiDAR data set (Baird, 2015). The flooding depicted in these maps is representative of regions with significant flood potential, however, local variability due to small scale drainage patterns will exist.

Limitations. The island-wide scale of the modelling exercise did not allow for simulation of detailed smaller scale flow paths. Calibration and validation data are extremely limited or completely absent in many regions. The model was primarily calibrated through assessing model performance on the west coast, and using similar methodologies elsewhere (with local topography, rainfall and soil data). Simulations were based on bare-earth topography, which did not include buildings and walls, and represent topography from 2015.

Inland Drainage Hazard - Major Drainage Pathways

Gullies in Barbados present flood hazards as well as top of slope hazards. Gullies were included in the SWAT model but were not modelled to represent flow depths. Instead, gullies have been assigned an "Inland Drainage Hazard" classification, and a 10 m offset has been assigned to delineate these regions. The hazard due to being at the top of a gully may extend beyond 10 m and needs to be assessed on a case by case basis.

Annual Exceedance Probability

Annual Exceedance Probability (AEP) is the annual probability that a specific hazard level will be exceeded in any given year. For return periods over 10 years, the AEP is well approximated by the reciprocal of the return period. E.g. AEP of 0.1 is close to a 10 year return period.

- Area inundated by a 1:10 annual exceedance probability/AEP flood
- Additional area inundated by a 1:25 AEP flood
- Additional area inundated by a 1:50 AEP flood
- Additional area inundated by a 1:100 AEP flood
- Major Drainage Pathways

BASEMAP LAYERS

Elevation, metres

MAP SERIES TILE INDEX

SCALE

1:5,000

1 cm = 50 metres

Map Tile **5A**

National Hazard Mapping
Storm Surge Induced Runup and Overtopping

Map Tile **8F**

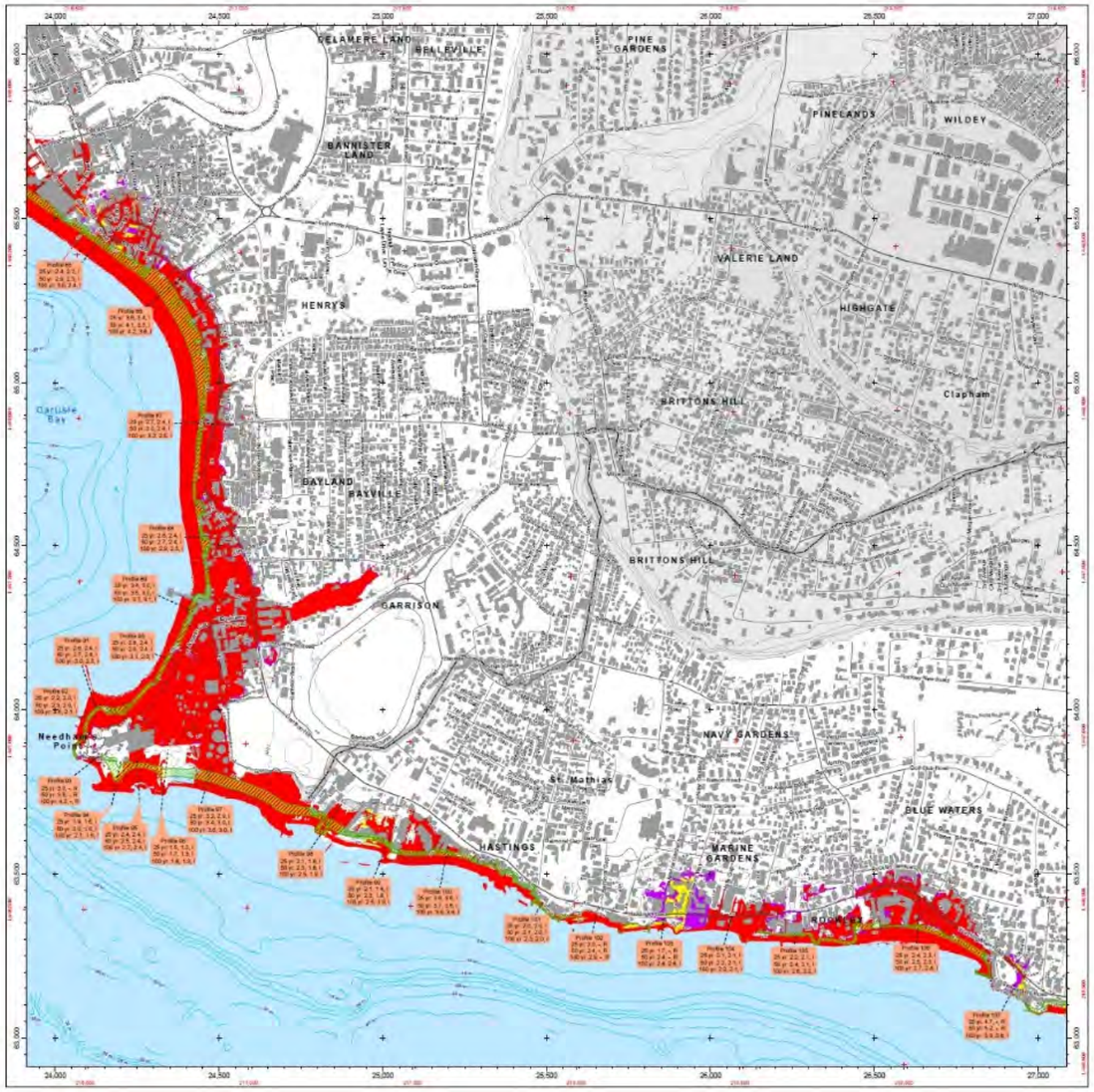
Map Published: October 2017

This map is one in a series within studies for the preparation of the Barbados Coastal Risk Assessment and Management Programme, National Coastal Risk Information and Planning Platform.

Funded by: IDB Inter-American Development Bank

Executed by: Coastal Zone Management Unit BARBADOS

Prepared by: Baird. Innovation Engineered.



LEGEND

Coastal Flooding due to Storm Surge

Coastal flooding is a complex process that is influenced by the nearshore wave conditions, water depth, beach slope, and presence of beach berms, coastal structures, (promenades/boardwalks, seal walls, buildings, etc. The wave runup and wave overtopping elevations depicted on the maps represent the estimated water surface elevation on the beach crest for a particular return period storm event. The distance an overtopping wave will travel inland will depend on the volume of the wave, local topographic variations, constructions, and roughness elements. Wave runup and flood elevations may vary by +/- 0.3 m or more locally.

Return Period is a term used to define the maximum condition that would be expected to occur, on average, every 'Y' years. For exampe a 10 year return period could be assessed in historica data by extracting the maximum level from each decade for an appropriatery long period of time.

AEP or Annual Exceedance Probability is the annual probability that a specific hazard level will be exceeded in any given year. For return periods over 10 years, the AEP is ales approximated by the reciprocal of the return period. E.g. AEP of 0.1 is close to a 10 year return period.

Data boxes are associated with each profile location along the coast and provide two elevation values (m LD) and an indication of the flooding type for three return periods. The first elevation value is either: (a) the maximum runup level on the shore; or (b) the 2% highest wave crest passing over the beach crest. If the runup does not exceed the beach crest, the data box contains an "R" for runup. If there are waves over the beach crest, the data box contains an "I" for inundation. If inundation is taking place, the second elevation value lists the expected ponded water surface elevation. If only runup is occurring (denoted "R"), then a second value is not provided.

Simulations were undertaken to deploi the 25, 50, 100 and the 150 year events. The 100 and 150 year events were similar in runup and overtopping magnitude such that the values were often close to equal and occasionaly reversed. The highest of the two values was adopted to represent the 100 year event. The 150 year event should be considered to be similar, yet slightly higher.

Limitations: Wave runup and overtopping were calculated based on data from the 2015 LIDAR survey and represent conditions at that time. Changes from these profiles will impact wave runup and overtopping. Wave runup elevations are based on a 2% exceedance; infrequent waves could exceed these elevations. Wave runup and overtopping elevations may vary substantially between profiles due to differences in wave and shoreline conditions.

Severe Spray Hazard

A severe spray hazard exists on sections of the east coast, where deep water allows large waves to impact cliffs. Very high spray, sometimes mixed with rubble or boulders can result in localized regions where setbacks of 100 to 200 m may be required. Site specific assessments should be undertaken for development in these regions.

Maximum Ponding

- 25-Year Return Period
- 50-Year Return Period
- 100/150 Year Return Periods

Hazard Mapping Features

- Potential Wave Impact Zone
- Shoreline Profile

BASEMAP LAYERS

Basemap Features

- Elevation Contours, 5-metre interval
- Bathymetry Contours, 5-metre interval

Elevation, metres

1 – 25
26 – 50
51 – 100
101 – 150
151 – 200
201 – 250
251 – 300

Buildings, 2015
The buildings were derived from processing LiDAR data. The data was acquired in 2014 and 2015 using the topographic LiDAR sensor Chiroptera II by Leica.

Topographic Elevation and Bathymetric Contours
The elevation and bathymetry contours shown on this map are at 5 metre vertical interval. The data was acquired in 2014 and 2015 using the topographic LiDAR sensor Chiroptera II by Leica. All elevation values are in local Lamont Datum orthometric heights.

Street Network
The street linework and names are from OpenStreetMap, © OpenStreetMap contributors. The data is available under the Open Database License. For license or terms details visit: www.openstreetmap.org/copyright or www.opendatacommons.org/licenses/odbl

MAP SERIES TILE INDEX



Coordinate System: Barbados National Grid
Projection: Transverse Mercator
False Easting: 30000.0
False Northing: 75000.0
Central Meridian: -59.55972
Scale Factor: 0.9999995
Latitude Of Origin: 13.1793889
WKID: 31293 Authority: EPSG
Horizontal Datum: Barbados 1938, Clarke 1880 spheroid

Grid Spacing: 500m

UTM grid and labels shown in red.
UTM Zone 21, WGS84 datum.

SCALE
1:5,000
1 cm = 50 metres

Map Tile **8F**

National Hazard Mapping
Tsunami Flood Hazard for Maximum Runup for 2017

Map Tile **8C**

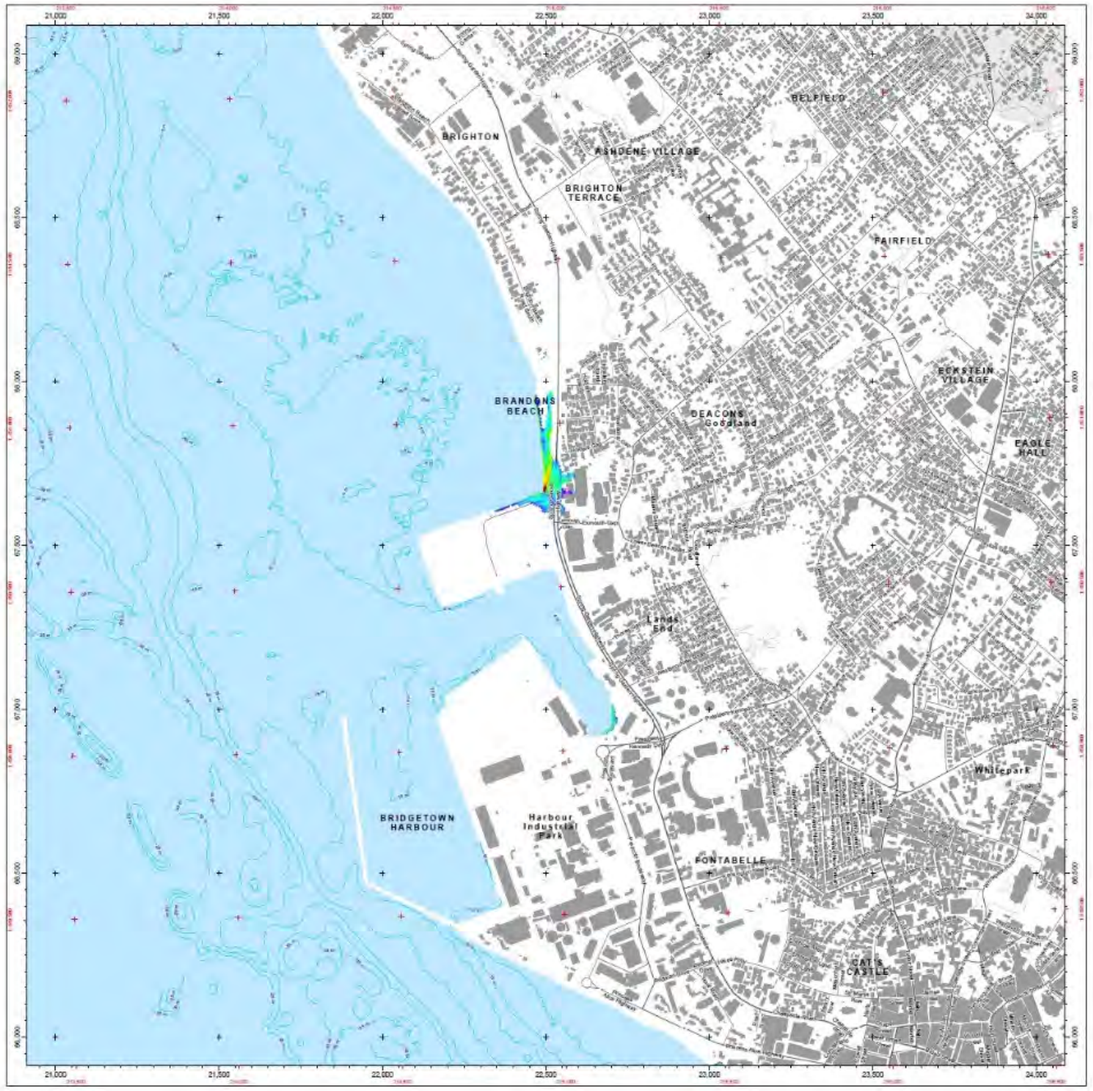
Map Published: **October 2017**

This map is one in a series within studies for the preparation of the Barbados Coastal Risk Assessement and Management Programme, National Coastal Risk Information and Planning Platform.

Funded by: IDB Inter-American Development Bank

Executed by: Coastal Zone Management Unit BARBADOS

Prepared by: Baird. Innovation Engineered.



LEGEND

Tsunami propagation was simulated with the MIKE21 Flexible Mesh Hydrodynamic Model. The model domain included topographic and bathymetric detail to Barbados from the 2015 LiDAR study. The domain also included the tsunami source regions to the north and east of Barbados.

The 100 year event was deemed to be representd by the historical events of 1839 and 1963. These events were megathrust earthquakes located north of Barbados, to the east of the Lesser Antilles. An estimate of the fault displacement was completed for each of these events. Two variations on each of these events (seafloor displacement area and height) were also simulated, for a total of six simulations. These six events were orientated at a high tide level (0.6 m Lament Datum) to represent present conditions (MSL + 0.35 m) and future sea level rise conditions (MSL + 0.85 m).

Results consist of maximum tsunami surface elevation for three hours of simulation, including the arrival of the waves that produce the greatest flooding. For each of the groups of six simulations, four of the simulations resulted in wave runup that did not over the beach berm and resulted in no inland flooding. Two events had very localized overtopping of the beaches and resulted in some inundation. These plots show the maximum inundation from all six events, which aligns with one particular simulation.

Overall dimensions and location of future seismic seafloor displacements are highly uncertain and these results should be considered as indicative conditions for a 100 year event. Limits and depths indicated on these maps are derived from six possible events from countless highly variable possibilities. Runup and inundation beyond the 100-year event is also possible and would be much worse than the values shown here.

Maximum Runup Elevation at 0.85m High Tide (metres)

- 0.01 - 0.1
- 0.11 - 0.2
- 0.21 - 0.3
- 0.31 - 0.4
- 0.41 - 0.5
- 0.51 - 0.6
- 0.61 - 0.7
- 0.71 - 0.8
- 0.81 - 0.9
- 0.91 - 1.0
- 1.01 - 1.1
- 1.11 - 1.2
- 1.21 - 1.3
- 1.31 - 1.4
- 1.41 - 1.5
- 1.51 - 2.0

BASEMAP LAYERS

Basemap Features
- Elevation Contours, 5 metre interval
- Bathymetry Contours, 5 metre interval

Elevation, metres
- 0 - 25
- 26 - 50
- 51 - 100
- 101 - 150
- 151 - 200
- 201 - 250
- 251 - 300

BASEMAP LAYERS

Topographic Elevation and Bathymetric Contours
The elevation and bathymetry contours shown on this map are at 5 metre vertical interval. The data was acquired in 2014 and 2015 using the topographic LiDAR sensor Chiroptera II be Leica. All elevation values are in local Lamont Datum orthometric heights.

Buildings, 2015
The buildings were derived from processing LiDAR data. The data was acquired in 2014 and 2015 using the topographic LiDAR sensor Chiroptera II by Leica.

Street Network
The street linework and names are from OpenStreetMap, © OpenStreetMap contributors. The data is available under the Open Database License. For licenses or terms details visit www.openstreetmap.org/copyright or www.opendatacommons.org/licenses/odbl

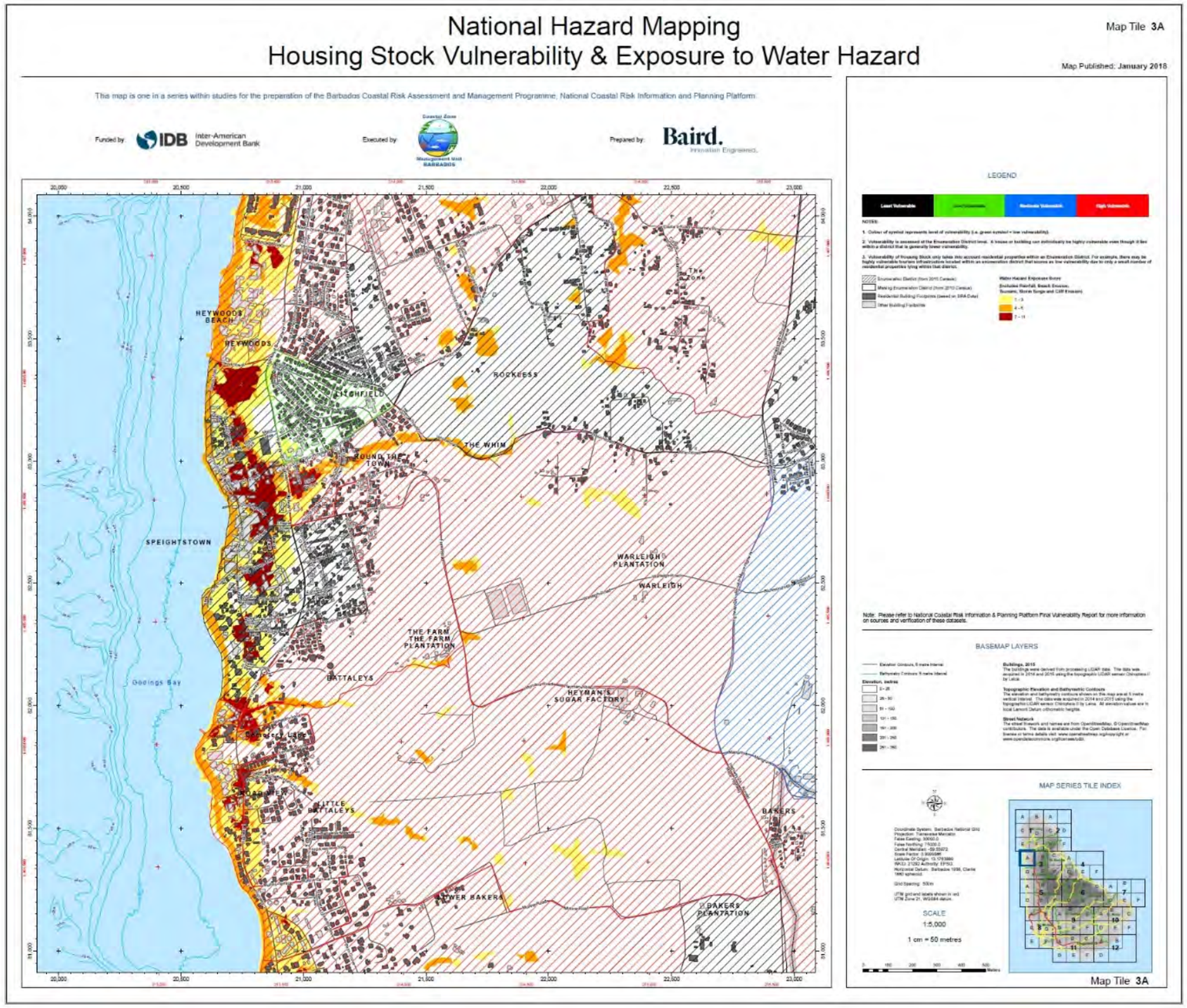
MAP SERIES TILE INDEX

Coordinate System: Barbados National Grid
Projection: Transverse Mercator
False Easting: 500000.0
False Northing: 100000.0
Central Meridian: -59.55972
Scale Factor: 0.9999995
Latitude Of Origin: 13.1713889
WKID: 31292 Authority: EPSG
Horizontal Datum: Barbados 1938, Clarke 1880 spheroid
Grid Spacing: 500m
UTM grid and labels shown in red.
UTM Zone 21, WGS84 datum

SCALE
1:5,000
1 cm = 50 metres

Map Tile **8C**

ANNEX 5. SAMPLE VULNERABILITY MAP



ANNEX 6. SOCIAL IMPACT ASSESSMENT AND GENDER ANALYSIS

1. The SIA will investigate socio-economic developmental opportunities and risks related to the execution of the project; and inform possible mitigation measures to safeguard against any risks identified, as well as other measures to support positive social impacts. It will be conducted in a highly participatory, gender-inclusive manner engaging the communities, particularly with representatives of women and men and vulnerable groups such as children, youth, elderly, persons with disabilities (PWDs) etc.

2. The methodology for the SIA shall include, but is not be limited to, the following:

(a) Review of secondary data including reports, studies, gender assessments, poverty assessments, census reports, labour force surveys, and relevant policy documents such as legislation, regulations, standards and policies in the areas of gender and social development including vulnerable groups of women, youth, PWDs and human trafficking victims.

(b) Collection of primary data through participatory consultations with all categories of stakeholders in order to introduce the project, facilitate feedback, and gauge perception of the project in order to gain and/or strengthen buy-in. Interviews, focus groups and other appropriate differential participatory methodologies may be employed for state and non-state stakeholders directly impacted by the works such as Community-Based Organisations, Non-Governmental Organisations, vulnerable groups (to include elderly, children, youth, men, women, PWDs, and indigenous peoples), private sector entities and relevant public agencies. Where applicable, focus groups may be convened for youth, PWDs, males and females, respectively. Facilitation of participation through the provision of transportation and child care as well as appropriate timing should be ensured. Data should be disaggregated by sex, age groups, disability status and race/ethnicity where feasible.

(c) Execution of site visit exercises to verify, update and fill gaps using community maps, transect walks, snowballing, as well as photographic documentation, and other appropriate participatory approaches.

3. The scope of work shall examine and report on the following, and related developmental issues:

(a) Describe the project areas including demographic, economic, topographical and sociocultural data which should be disaggregated by sex, age groups, minority or special needs groups (such as PWDs, youth, immigrants, and informal settlers):

(i) total population of the project areas (Parish communities/villages);

(ii) population density of the project areas (Parish communities/villages);

(iii) number of households by sex of household head;

(iv) labour force participation, employment and occupation;

(v) crime and violence; and

(vi) prevalence of poverty.

(b) Investigate the governance and management structure in the appropriate sector (institution) of Government in Barbados, including staff ratios by occupation and sex), equality in recruitment, workplace policies conducive for women, occupational health and safety.

(c) Assess the different social as well as household activities of men and women, and vulnerable youth, PWDs in project areas.

(d) Assess economic activities or potential future economic activity by sex for the project areas and need for areas for vendors, sanitation facilities, parking, illumination needs and other basic facilities necessary to be covered in the design of the project infrastructure. This assessment should address competing users of the proposed infrastructure including social service providers, commercial sector operators; and private citizens.

(e) Analyse the local labour force and the potential of engaging communities, especially abovementioned vulnerable groups, in the construction and maintenance and resilience building phases of the project. Give recommendations on training needs and legal requirements from a procurement perspective. Identify the number of men, women and other vulnerable groups identified who will benefit from employment during project implementation and subsequent operation.

(f) Propose project components (initiatives) necessary to facilitate the access and participation of youth, women and PWDs in the economic and social benefits of the proposed project. The institutional partners necessary for the success of the project components (initiatives) and the budget to implement them must be clearly identified.

(g) Assess accessibility of the project areas in keeping with universal design standards required for use by PWDs, and seek direct feedback from PWDs regarding the requirements, to inform the design of the proposed infrastructure.

(h) Identify the effects of the project on time use in the household disaggregated by sex; and how men and women would use the time savings differently. Differentiate the time use benefits for public and private sectors as well as for householders.

(i) Identify any deficiencies in transport arrangements that hinder men, women, indigenous peoples and relevant vulnerable groups from fully accessing services and markets. The assessment should examine:

(i) different travel patterns of women and men;

(ii) who pays for the commercial, household and other transportation, disaggregated by sex;

(iii) how the travel pricing structure would change due to the project, i.e. cost implications for consumers (if possible, disaggregated by sex); and

(iv) expected performance/service of existing transport networks, and the potential needs of the population in beneficiary communities and/or the project areas during works and post-completion of works, disaggregated by sex and vulnerable groups identified.

(j) Identify any activities related to transactional and commercial sex in the project areas and analyse both the potential effects of the construction and operational phases of the project.

(k) Evaluate public illumination needs and the potential for preventing crime, including gender-based violence and sexual assault. Identify "hot spots" together with the police and the communities engaging women, men, youth and PWDs as they have different perspectives and advice on the placement of street lights and necessary preventative measures.

(l) Determine potential social and economic dislocation in the project areas and whether resettlement/replacement is necessary. Identify any possible effects of this on the livelihoods and culture of people in the project areas. Identify possible social and gender concerns taking into account the distribution of male and female-headed households, distribution of land titles by sex, and any other vulnerable group. Identify any possible options to avoid resettlement as well as appropriate gender-responsive resettlement (possible distribution of land titles to women) and mitigation measures.

(m) Describe the potential impacts of the project at its various stages (preparation, construction, and operation) on the social and economic contexts in the immediate surrounding communities. Identify any issues pertaining to the design of the project which may have social impacts including gender, livelihood or other dimensions.

(n) Make specific recommendations with regard to the project design options and identify measures required not only to mitigate any significant negative impacts, and enhance the potential social and gender benefits in the project areas. This process shall:

(i) Discuss the adequacy of proposed mitigation measures overall, and specific measures to enhance gender equality and equitable inclusion of vulnerable groups and any other relevant social benefits; as well as the adequacy of project design to meet the needs of the relevant stakeholders.

(ii) Consider measures such as public education and, training opportunities for vulnerable groups to take part in project activities, workers code of conduct and grievance mechanisms; and reform of workplace, human resources and customer service policies.

(iii) Define Community Participatory Mechanisms (CPMs) by identifying appropriate mechanisms to engage women, men and vulnerable groups in the decision-making of the project in a gender-balanced way; and appropriate gender-sensitive public education communication strategies for providing information on project activities to stakeholders and for receiving timely feedback (pre-project, during implementation and post-implementation). The CPM design must ensure conducive meeting times and facilitate participation through the provision of transportation, child care, and other supportive measures.

(iv) Estimate the cost of the measures and justify their suitability.

(v) Prepare a detailed monitoring and evaluation plan for tracking the key relevant project results and the implementation of the mitigating and benefit-supporting measures. Identify gender-responsive outputs and outcomes of the project activities to facilitate gender-responsive results monitoring and evaluation.

(vi) Develop a Gender Action Plan containing relevant gender and social inclusion actions, indicators, timelines and budget. (o) Analyse and outline the key SIA findings regarding: (i) social and gender benefits arising from the project and measures to maximise the benefits; and (ii) social and gender risks and measures to mitigate the risks for beneficiaries including the sub-groups requiring focussed attention. The key SIA findings including measures such as universal design standards required for use by PWDs, areas for vendors, sanitation facilities, parking, public illumination, and other basic facilities must be discussed with the engineers on the team for consideration in the design of the proposed project infrastructure.

(p) Convene a stakeholders' validation workshop, including community groups, representatives of vulnerable population groups (women, elderly, youth, indigenous people and persons with disabilities), and relevant Barbados government agencies, to discuss the findings of the consultancy and to seek consensus and clarification on issues from participants for incorporation in the Draft Final and Final Reports. As part of the stakeholders' validation workshop conduct gender sensitisation training to report on the findings of the gender analysis.

ANNEX 7. DRAFT TERMS OF REFERENCE CLIMATE RISK AND VULNERABILITY ASSESSMENTS

1. BACKGROUND

1.01. A Climate Risk and Vulnerability Assessment (CRVA) will be conducted on the project components as part of the design process to ensure that they are strengthened against climate risks (to develop depending on the exact project details and requirements).

2. OBJECTIVES

2.01 The objectives of the CRVA are to (i) identify and evaluate the potential effects of climate change on the project on the project area and (ii) recommend resilience measures to address the identified risks and vulnerabilities and minimise impacts. This should include consultation with stakeholders to get a better understanding of the nature of the climate risk and adaptation issues, especially the historical experience of climate related hazards, the response and to agree on the scope.

3. METHODOLOGY

3.01 The consultants are expected to develop a database, if one does not already exist, that would include, inter-alia, the following data and information:

(a) Background information on the project; and

(b) Locational characteristics of the project area geographic scope.

4. SCOPE OF SERVICES

4.01 The consultants will be required to perform the following tasks:

(a) Identification and description of project components

(b) Hazard Identification and Characterisation

(i) Summarise the key current and expected future climate hazards relevant in the context of the project, and of the associated potential climate-related risks/implications for the Project, that should be addressed in the CRVA, during the construction and operational phases; and

(ii) Establish a climate baseline for the relevant climate variables and establish a climate baseline;

(iii) Undertake an in-depth assessment, combining an analysis of historical events and present day conditions in order to establish a climate baseline, with an analysis of future conditions (mid-century as well as the design life of the investment) using scenario-based methodologies. Climate variables could include the following: (aa) sea level and wave action; (bb) storm surges (cc) peak rainfall events; (dd) temperatures; (ee) profiles of past extreme weather events; and (ff) wind speed.

(c) Assessment of Exposure

4.02 The consultant will (i) assess the exposure of project components that could be exposed to the hazards identified above and the extent of this exposure. This should include preparation of hazard maps showing the spatially distributed expected exposure levels for different frequencies (i.e. 50-yr, 100-yr and 150-yr return periods) and for different hazard types (extreme precipitation, flooding, landslides, sea level rise, etc.).

(d) Vulnerability Assessment

4.03 The consultant will establish climate change scenarios and assess the relationship between the changes in the climate parameters agreed on in (b) and the impacts on project components. The assessment of vulnerabilities considers in detail how the project components, and communities would be vulnerable to the identified hazards according to different climate scenarios, as well as non-climate factors.

(e) Risk assessment

4.04 The consultant will conduct a risk assessment (a quantitative expression of the vulnerability assessment: the consequences of the hazards, in economic and social impact terms, on project components.

(f) Adaptation Assessment

4.05 The consultant shall identify the most appropriate adaptation measures that could be incorporated into the Project in order to address the vulnerabilities and risks identified. This may include structural, technological and behavioural measures.

5. REPORTING REQUIREMENTS

5.01 The consultants will report to the CZMU's Project Manager. The Technical Proposal of the selected consultant shall outline a work plan and approach to the assignment, the scope and methodology, the tasks and responsibilities and a time schedule for the completion of the assignment. The following reports, one hard copy each, along with an electronic copy either by electronic mail, on CD ROM or flash drive, shall be submitted to the CZMU at the times indicated below.

(a) Inception Report within three weeks of commencement of the assignment;

(b) Draft report on completion of the risk assessment;

(c) Final report on the CRVA specifying the recommended design changes to take account of climate risks, including an analysis of structural and non-structural measures.

6. TIMING AND QUALIFICATIONS

6.01 Duration: circa 30-40 working days.

6.02 The consultancy shall be conducted by a team of three experts, who shall have the following competencies:

(a) Climate Change Specialist: Responsible for identifying the climate change parameters to be assessed; collection of relevant local historical climate data and climate change projections; identify the probabilities of specific climate change occurrences; conduct field investigations with local stakeholders to identify existing vulnerabilities. In consultation with other team members, contribute to the identification of adaptation options, including their costs and benefits and prioritisation. The consultant is expected to have at least five years' work experience in the area of climate change impacts adaptation and mitigation. Knowledge of the Climate Change Adaptation context in the Caribbean region would be a plus.

(b) Engineer: Civil Engineer will lead the characterisation and technical assessment of project infrastructure and operations in the energy sector; conduct interviews with relevant organisations and stakeholders; and undertake site visits to determine the existing infrastructure conditions and proposals for rehabilitation. The specialist will assist in the preparation of cost estimates for capital and recurrent costs for the recommended resilience measures.

(c) Economist: The Economist should have at least 10 years of experience and a graduate degree or equivalent. Experience should include economic analysis of development projects and sector strategies based on economic analyses. Experience with incorporating climate change concerns into economic analysis as well as multi criteria analysis will also be required.

ANNEX 8. STANDARD FORMS FOR COASTAL RESEARCH

- Draft standard form A: Application for consent to conduct marine scientific research

Application for consent to conduct
Marine scientific research

Date: _____

1. General Information

1.1 Cruise name and/or number:	
1.2 Sponsoring institution(s):	
Name:	
Address:	
Name of Director:	
1.3 Scientist in charge of the project:	
Name:	
Country:	
Affiliation:	
Address:	
Telephone:	
Fax:	
Email:	
Website (for CV and photo):	

1.4 Entity(ies)/Participant(s) from coastal State involved in the planning of the project:	
Name:	
Affiliation:	
Address:	
Telephone:	
Fax:	
Email:	
Website (for CV and photo):	

2. Description of Project

2.1 Nature and objectives of the project:

2.2 If designated as part of a larger scale project, then provide the name of the project and the organization responsible for coordinating the project:

2.3 Relevant previous or future research projects:
2.4 Previous publications relating to the project:

3. Geographical Areas

3.1 Indicate geographical areas in which the project is to be conducted (with reference in latitude and longitude, including coordinates of cruise track/way points)

3.2 Attach chart(s) at an appropriate scale (1 page, high-resolution) showing the geographical areas of the intended work and, as far as practicable, the location and depth of sampling stations, the tracks of survey lines, and the locations of installations and equipment.

4. Methods and means to be used

4.1 Particulars of vessel:	
Name:	
Type/Class:	
Nationality (Flag State):	
Identification Number (IMO/Lloyds No.):	
Website for diagram & specifications:	
Owner:	
Operator:	
Overall length (meters):	
Maximum draught (meters):	
Displacement/Gross tonnage:	
Propulsion:	
Cruising & maximum speed:	
Call sign:	
INMARSAT number and method and capability of communication (including emergency frequencies):	
Name of master:	
Number of crew:	
Number of scientists on board:	
Relevant documents required by international conventions and regulations:	
Other relevant information:	
4.2 Particulars of aircraft:	
Name:	
Make/model:	
Nationality (Flag state):	
Website for diagram & specifications:	

4.4 Other craft in the project, including its use:

4.5 Particulars of methods and scientific instruments		
Types of samples and measurements:	Methods to be used:	Instruments to be used:

4.6 Indicate nature and quantity of substances to be released into the marine environment:

4.7 Indicate whether drilling will be carried out. If yes, please specify:

4.8 Indicate whether explosives will be used. If yes, please specify type and trade name, chemical content, depth of trade class and stowage, size, depth of detonation, frequency of detonation, and position in latitude and longitude:

5. Installations and Equipment

Details of installations and equipment (including dates of laying, servicing, method and anticipated timeframe for recovery, as far as possible exact locations and depth, and measurements):

6. Dates

6.1 Expected dates of first entry into and final departure from the research area by the research vessel and/or other platforms:

6.2 Indicate if multiple entries are expected:

7. Port calls

7.1 Dates and names of intended ports of call:

7.2 Any special logistical requirements at ports of call:

7.3 Name/address/telephone of shipping agent (if available):

8. Participation of the representative of the coastal State

8.1 Modalities of the participation of the representative of the coastal State in the research project:

8.2 Proposed dates and ports for embarkation/disembarkation:

9. Access to data, samples and research results

9.1 Expected dates of submission to coastal State of preliminary report, which should include the expected dates of submission of the data and research results:

9.2 Anticipated dates of submission to the coastal State of the final report:

9.3 Proposed means for access by coastal State to data (including format) and samples:

9.4 Proposed means to provide coastal State with assessment of data, samples and research results:

9.5 Proposed means to provide assistance in assessment or interpretation of data, samples and research results:

9.6 Proposed means of making results internationally available:

10. Other permits submitted

10.1 Indicate other types of coastal state permits anticipated for this research (received or pending):

11. List of supporting documentation

11.1 List of attachments, such as additional forms required by the coastal State, etc.:

Signature:

Contact information of the focal point:
Name:
Country:
Affiliation:
Address:
Telephone:
Fax:
Email:

- Draft standard form B: Consent to conduct marine scientific research

Consent to conduct marine scientific research

(Complimentary opening)

....and has the honour to refer to (request document from Embassy) dated _____ regarding the proposed marine scientific research of (chief scientist). The Ministry is pleased to advise that approval has been given for the marine scientific research project (reference number of project) proposed in the (Territorial Sea/ Exclusive Economic Zone/Continental Shelf) of (coastal State) from (dates) to (dates) inclusive, subject to the conditions being met as specified below.

- Participation of (name and details of coastal State participant(s)).
- Notifications regarding entry into and departure from the (Territorial Sea/ Exclusive Economic Zone/Continental Shelf), port arrivals and departures, and daily position reports, should be transmitted to (provide channels through which such notifications are to be transmitted).
- Provision of preliminary report(s) within the time frame provided on application _____
- Access to all data and samples derived from the marine scientific research project, including provision of data to participant(s).
- Provision of data which may be copied and samples which may be divided and copies of reports prepared, or alternatively details of where such data and reports can be obtained will be submitted to _____ in a form acceptable to (coastal State) as soon as possible but preferably no later than a 12-month period after the conclusion of the proposed research programme. The information will be treated as public information and may be made available via the internet unless another arrangement is reached with the (coastal State) government.
- Assessment of data, samples and research results /or provision of assistance in such assessment or interpretation.
- Compliance with the attached guidelines (safety, acoustics, map of protected areas, list of relevant endangered species under CITES, etc.).
- Changes to the authorized research programme shall be directed to _____ (name, phone, email of Marine Scientific Research Office or focal point).
- Removal of the scientific research installations or equipment once the research is completed.
- Final report will be provided within a reasonable time-frame.

(Complimentary close)

Date

Diplomatic Seal

ANNEX 9. BASIC SOCIOECONOMIC ASSESSMENTS TO SUPPORT COASTAL DEVELOPMENT PLANNING

A9.1. Introduction

A9.1.1. Socio-economic Conditions

Islands, such as Barbados, which include both land and sea interfaces, influence the fabric and design of the economies and welfare of the communities which depend, directly or indirectly, on the exploitation of the natural resources present on the island. This means that there are interrelationships between environmental and socioeconomic conditions prevailing in the both land and sea space. On one hand, socioeconomic conditions are usually affected by the natural environment with its various ecosystems which provide a continuous supply of goods including fish, oil, gas, minerals, salt, construction materials, and services including shoreline protection, sustaining bio-diversity, water quality maintenance, transportation, recreation and tourism. The socioeconomic structures on islands may affect, positively or negatively, the environment and its ecosystems by various human activities being conducted. This, in return, means that the stability of both the natural environment and the community welfare on islands are highly associated.

However, current growth and consumption patterns as well as unplanned development activities are placing increasing pressure on island ecosystems, causing a wide range of problems. Globally, it was estimated that, about two-thirds of the world's population live in coastal areas, and within three decades, 75 per cent of the world population will reside in coastal areas. These problems range between environmental degradation, biodiversity loss and deforestation, leading ultimately to the breakdown of socioeconomic systems. Such a pressure on coastal areas poses increasing threats to coastal ecosystems as they exceed the carrying capacity of these areas and leads usually to degradation of their resources and environmental quality in general (UNEP). This accordingly, emphasizes the need for sustainable development on islands. According to sustainable development, economic growth and environmental protection are viewed as mutually comparable activities and not conflicting ones. This in turn requires that various human activities must be integrated within a coherent setting of land-use planning policies, addressing problems of environmental carrying capacity. They also should be planned and developed within the limits of the local socioeconomic and natural carrying capacities.

A9.1.2. Objective of the Guide

Basically, the underlying purpose of this Guide is to provide conceptual and practical guidelines on how to conduct a reliable assessment of prevailing socioeconomic conditions for developmental proposal applications, in consistent format. It should be noted that the proposed consistent data collection and presentation format is intended to enable clear monitoring and evaluation to support State of the Coast reporting in the coming years and for improved data on socio-economic factors to be easily updated which in turn, may help the update of land use policies in the future.

A9.2. What is a Socio-economic Assessment?

A9.2.1. Definition and Purpose

The socio-economic environment refers to a wide range of diverse aspects and variables relating to or involving a combination of social and economic factors. These in general, can be categorized into several categories including, economic, demographic, public services, fiscal and social. The social aspects may, for instance, involve community island life as well as social and cultural attitude and values. Community services may meanwhile be concerned with housing and requirements for public services such as water, sanitation, communications, police and fire protection facilities, solid waste disposal as well as health and educational services. Demographic aspects may include population growth structures, distribution and density. Similarly, economic factors may include general characteristics, structures and changes various economic activities and employment.

A socioeconomic assessment is a way to learn about the social, cultural, economic and political conditions of stakeholders including individuals, groups, communities and organizations. The socioeconomic “situational analysis” is intended to:

- Assess the prevailing socioeconomic conditions. This includes provision of a baseline study and characterizing the existing state. This will assist in identifying the main areas of concern.
- Analyze the impacts of the prevailing environmental conditions on the socioeconomic structure of the proposed development area.
- Develop a set of guidelines for establishing viable communities.

Accordingly, the following section is concerned with listing all possible socioeconomic impacts and the indicators used to estimate their magnitude. This is followed by a general discussion of the methodology usually employed in conducting a socioeconomic analysis. Based on this methodology, an operational work plan is provided for the actual implementation of such socioeconomic analysis to be then used for insertion within future State of the Coast reports.

A9.2.2. Possible Socioeconomic Impacts

Generally, it should be stated that socioeconomic conditions are usually hard to identify and assess, as they are related to the human beings and their characteristics, which usually differ widely within the same community and from one community to another. Furthermore, as socioeconomic assessment deals with dynamic variables, no comprehensive list of areas of concern could be developed to fit socioeconomic assessment in all cases. However, there is a number of broad sets of socioeconomic impacts could be developed including economic impacts, demography; employment, health, and community resources including political, social, economic and cultural conditions (See Table 2.1).

Impact area	Indicators
Economic conditions	• Economic structure • Income levels • Job opportunities
Community structure, institution and infrastructure	• Health and social services in study area, including health, workforce, law enforcement, fire protection, water supply, wastewater treatment facilities, solidwaste collection and disposal, and utilities. • Transportation systems in study area, including highway, rail, air, and motorway • Tourism and recreational opportunities in the study site • Tax levels and patterns in the study area, including land, sales, and income taxes • Institutional structure • Community cohesion, including organized community groups • Social orders including community attitudes, lifestyle and history of the community • Distinct settlements of ethnic groups
Demographic conditions	• General trends in population size for study site • Migration trends in the study area • Population characteristics in the study area including distribution by age, gender, ethnic groups, educational level and family size • poverty and wealth distribution
Employment	• Employment composition • Unemployment rate • Availability of job opportunities and their nature
Gender	• Gender distribution • Employment structure • Role of women
Community resources	• Land use patterns and controls for study site • Land values in the study area • Housing characteristics in the study area, including types of housing and occupancy levels and age and condition of housing • Areas of unique significance

Table Annex 9.1: Indicators for socioeconomic impacts

A9.2.3. The Questions to Answer

The following questions may be used to help support CZMU to help coordinate the collection of information by other agencies. The questions refer to a "location" which is a loose term that may be used to relate to a specific geographic location (ICZM Plan Sub-Area), a sector or a new policy, plan or development proposal.

Economic Impacts:

- What are the main characteristics of the locations economic structure and how does it contribute to Barbados' overall economic income?
- How does such an economic structure affect or be affected by the environmental quality of the location?
- How would local business be affected by rapid growth resulting from the development of the location?

Community structure, institutions, and infrastructure

- How are the locations communities organized, both formally and informally?
- What are the employment and economic dimensions of each social grouping?
- What are the existing economic, social, or cultural inequities among groups, if any, and what are their causes?
- What experience do various groups have with induced change?
- What changes in these variables may be caused by alternative scenarios for socio-economic development?
- What factors influence the daily lives of potentially affected members of the community?
- How stable is the pattern of residence?
- Do people in different groups feel that they currently have a satisfying way of life?
- What attitudes do people have toward risk, health, safety, and toward alternative scenarios for socio-economic development?

- How available are community services and infrastructure? And how will their provision and availability be affected in the future (i.e.: by climate change?).

Demography

- What are the demographic characteristics of the community? And to what extent are they affected by the prevailing environmental conditions?
- What is the current structure and organization of the population? Is it stable or changing?
- Are there ethnic, economic, or social group distinctions within this population?
- What are the patterns of poverty and wealth, and income distribution among the population?

Employment

- What is the existing employment composition?
- What is the magnitude and composition of the unemployed?
- What are the types and characteristics of primary and secondary job opportunities that are expected to be created?
- Are there seasonal changes, or other kinds of influx and outflow?

Gender

- What is the existing gender distribution of the population?
- What is the existing gender structure of employment and unemployment?
- What are the social and economic roles played by women in the community?
- What is the role of women, if any, in the existing decision making system?
- How are power and authority distributed in the community, both formally and informally?
- Who are the relevant stakeholders? What are their interests?
- How do they organize and exercise power within the community and at the regional and national levels?

Community Resources

- How do people use the land, whether urban or rural? Are there conflicts between these different land uses?
- How do they use the natural environment (land and reef area)?
- Are there culturally valued neighbourhoods, shopping areas, recreational areas, or gathering places?
- Are there culturally valued patterns of social formal and/or informal groups?
- Are there valued historic places, archaeological sites, or historical artifacts?

A9.3. Recommended Approach

For a socioeconomic "profile" to be organized and conducted properly, it should be systematic, and have minimum bias, and allow for consistent comparison and reasoned judgment. For all this to be accomplished, carefully planned, very precise and logical work methodologies are usually developed. The approach consists of three main sections as shown in Figure 3.1.

A9.3.1. Location Profiling

The first section aims to provide a comprehensive profile for the location and develop criteria for socioeconomic assessment. This could be attained through develop a thorough background about both coastal areas considerations and socioeconomic assessment.

A9.3.2. Conducting New Assessments

The second section deals with conducting the island socioeconomic assessment, which begins with the identification of main issues at the location and followed by identification by of main positive and negative socioeconomic aspects.

Listing Impacts

Criteria for socioeconomic assessment should be firstly developed. The development of such criteria should be based on the list of socioeconomic impacts and indicators. However, the specific features of each location should be carefully taken into account in listing all possible impacts areas. The socioeconomic assessment should identify all possible impacts. In order to take account of all possible impacts, there is a number of "Impact identification" approaches (methods) including:

- Checklists.
- Matrices
- Networks
- Overlays and geographical information systems (GIS)

Each of the above-mentioned methods has their own advantages and disadvantages. However, the suitable method should be carefully selected. The choice of impact identification methods depends upon the type of impacts being considered, the nature of the likely impacts and the experience of the staff.

Scoping of Impacts

As the number of potential impacts on any location is usually large, socioeconomic impacts should be scoped to focus on the most important impacts, both direct, and indirect. Scoping is carried out by identifying and assigning priority to socioeconomic impacts that might be examined within the context of the socioeconomic assessment.

Scoping must be carried out in consultation with the affected groups and through the public participation process, should be based on discussions of an agreed policy, goal, vision or scenario for the future. Parameters to consider may include:

- Number of people potentially affected;

- Duration of potential impacts;
- Values of benefits and costs to affected groups;
- Potential for reversibility or mitigation;
- Likelihood of subsequent impacts;
- Relevance to decisions;
- Uncertainties over probable effects;
- Controversy.

A9.3.3. Provide Guidelines

Field Surveys

It should be borne in mind that the implementation of the socioeconomic study involves a number of field work activities, which include field surveys to acquire data and information from primary sources. This data and information is mainly concerned with personal opinions, which cannot be obtained from secondary sources such as perceptions and opinions of the individuals about their concerns and future perspectives of the island. They will also be utilized in the verification of data and information obtained from secondary sources.

Depending upon the objective of the field survey, the techniques of data collection should be determined. Generally, there is a wide range of techniques for data and information collection from primary sources including personal interview, telephone interview and mailed questionnaire. This means that the procedures and output of these techniques should be reliable and well-adopted to the case in hand.

Considerable amounts of fieldwork with different population groups would require careful consideration of the right approaches; which include for example, social surveys, questionnaires, interviews, use of available statistics, the Delphi technique. This would require recognition and understanding of the relationships of peoples' perceptions, their realities and the structures within which they exist. The ultimate objective is not only to obtain the required data and information but also to get them involved in the assessment process. This means that the objectives of the field survey should be clearly identified, which is the first step of conducting a successful field survey.

Questionnaires

Concerning the questionnaire forms to be employed in such field surveys, they should be developed carefully taking into account a number of considerations which may include the following:

- The questions should be easily understood by the all individuals of the sample whatever their educational and cultural levels.
- The questions should be formulated to be accurately and clearly answered. This can be done through minimizing the open answer questions.
- The questions should be ordered so that the difficult and sensitive questions come later.
- The sensitive questions should be asked indirectly and their answers should be verified.

In order to ensure that the questionnaire is properly designed a pilot survey should be conducted with a feedback on the quality of questions, especially the difficult ones to understand ones. The pilot survey will include a number of questions, at the end of the primarily questionnaire to assess the reaction of those interviewed.

The outcome of this pilot survey will assist to review the questionnaire, and make adjustments, where needed. At this stage, the final questionnaire form will be ready and can be used to collect data and information. The form of survey to be conducted will depend upon direct interviews with the people in order to ensure high rate of response. It also helps to ensure the seriousness of the answers given by the interviewees. Moreover, the sensitivity of some questions and the need for clear, sharp and explicit answers to some questions compel the need for personal interview approach.

Also, as a result of the impossibility of investigating all the islands population, sampling methods will be useful to acquire data and information to save time, effort and fund. To ensure the representative of the sample, the sampling should be random. This will ensure that different socioeconomic groups are included in the sample. The best representativeness of the sample for the population can be considered as a function of sample size and sampling method. This means that the pre-determination of the sample size is meaningless. So the decision of the sample size should be taken during the carrying out of the survey, taking into account time, effort and fund limitations.

Involving Community Leaders

It should be noted that the involvement of communities' leader is of great importance to ensure the contacts with the target sample. Since the most socioeconomic aspects of the environment, and their magnitudes, exist largely in people's minds, interaction with affected communities and groups is essential. There are many methods of interacting with people and groups to learn about their society. A systematic interview program, working with group leaders and participant observation (in which the analyst lives as part of the community while studying how it works) are among the methods that can be employed. Still, the choice of methods will necessarily reflect not only available time and funds, but also reflect the kind of community affected.

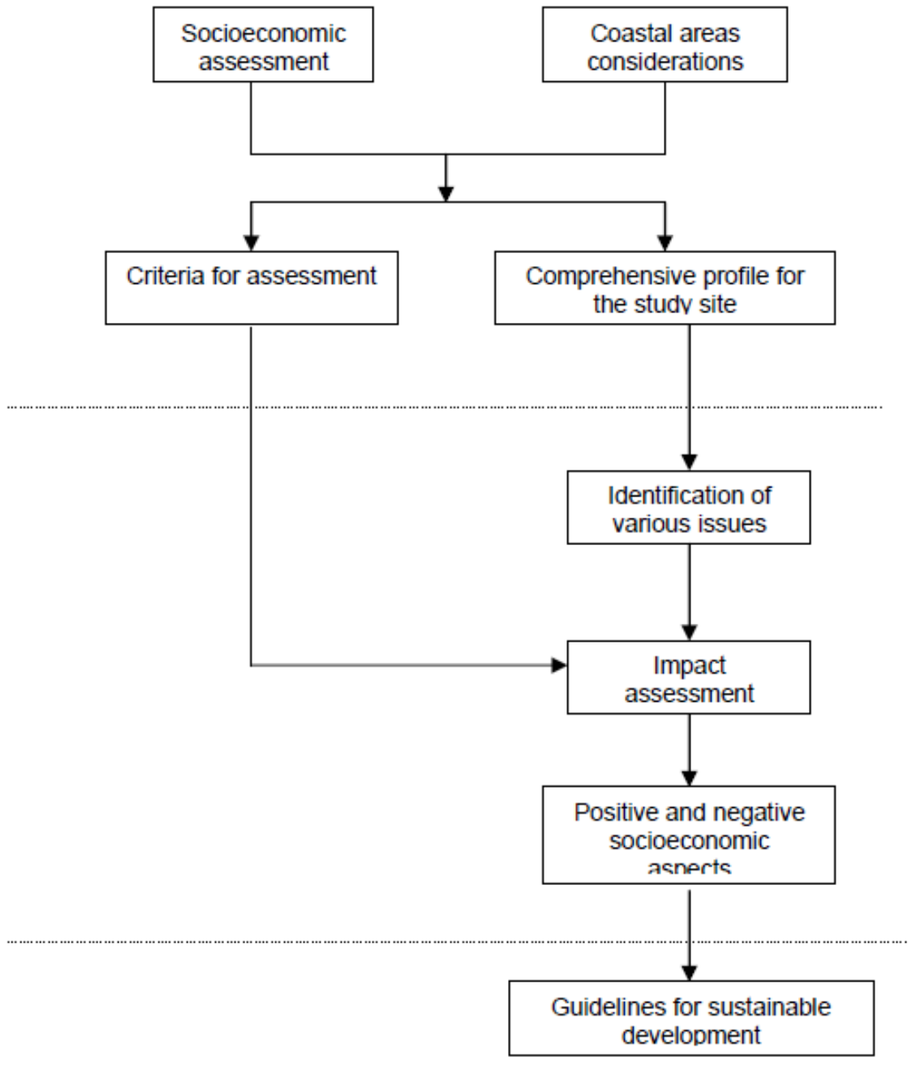


Figure Annex 9.1: Methodology for a Socioeconomic Study

A9.4. Work plan:

Based on the methodology presented above, a work plan for the socioeconomic study of any location should be developed to support future State of the Coast reporting. This work plan needs to include the following tasks and activities (Figure 4.1):

A9.4.1. Develop baseline conditions

This section can be considered as a preparatory work which includes the following steps:

Data and information collection from secondary sources

Materials; including statistics, research work, study reports, that may provide data and information about conditions in the island, have to be reviewed. This includes available data and information about various socioeconomic aspects, environmental quality and previous as well as current development schemes. It should be noted that various socioeconomic aspects of the location, have to be considered comprehensively without any bias towards any of the aspect.

As Census data is relatively inexpensive and highly reliable, Census represents one of the main secondary sources of data and information. Nevertheless, there should be certain problems that are generally associated with the use of data collected from secondary sources in general and census data in particular. These problems generally are related to:

- Changes in classification way of data and definitions of variables.
- Changes in boundaries of administrative units.

Therefore, these two issues should be taken into account in dealing with data from secondary sources

Develop a comprehensive profile

Depending upon the data and information that are collected from secondary sources, a comprehensive profile could be developed. The comprehensive profile should cover the following items:

- Boundaries of the island
- Past and present
    1. Demographic structure.
    2. The economic structure.
    3. Social structure.
    4. Infrastructure provision.
- Development schemes in the island, past, present and future.

Usually, such a comprehensive profile is of great importance for the following steps of the study as it highlights the character and the main features of the island.

Develop a set of criteria for assessment

A comprehensive list of all possible socioeconomic impacts and indicators should be developed, based on the provisional list described before in the Guide. Thereafter, these impacts should be scoped to focus on the most important impacts to be dealt with within the context of the socioeconomic assessment.

A9.4.2. Field work

The field work (if required or deemed necessary) would involve the following steps:

Identify required data and information

After scoping, the data and information from secondary sources about the location and the previous development schemes should be reviewed to identify the gap of information to be collected from primary sources.

Conducting field surveys

After the identification of gaps in the required data and information, field surveys would be planned. This would require also the identification of the target population and sampling techniques.

A9.4.2.1. Designing a questionnaire form

Such a questionnaire will have to be designed in such a way that takes into account the type of people to be covered by the survey, in terms of educational status, culture, and attitude. This aspect is very important in order to end up with the right answers needed for this research work and avoid any possible biases.

A9.4.2.2. Pilot survey and feedback

In order to ensure the effectiveness and adequacy of the designed questionnaire forms, pilot survey would be conducted. The main objectives of conducting these pilot surveys is to fine tune them to attain their objectives most effectively.

A9.4.3. Data analysis and socioeconomic assessment

This section of the socioeconomic study will include the socioeconomic assessment of the island depending upon the analysis of the data and information collected from primary and secondary sources.

Data entry and verification

Dealing with large amount of data requires a systematic approach for data coding, tabulating and entry. It should be noted that, before data entry, the collected data should be verified. Such verification could be carried out for all collected data or for the random sample of the data. This depends usually on the quality of the procedures of data collection.

Data analysis

Analysis will involve standard statistical analysis of the data and information collected. The analysis should be based upon the criteria developed before.

Socioeconomic impacts assessment and identification of main areas of concern

One of the main objectives of socioeconomic assessment is to identify various socioeconomic positive and negative impacts. The socioeconomic impacts assessment should highlights possible relationships between assessed socioeconomic variables and the environmental quality in the island. Such an assessment could guide the following step of the work. Also, the areas of concern (issues and opportunities) of socioeconomic structure of the location have to be identified.

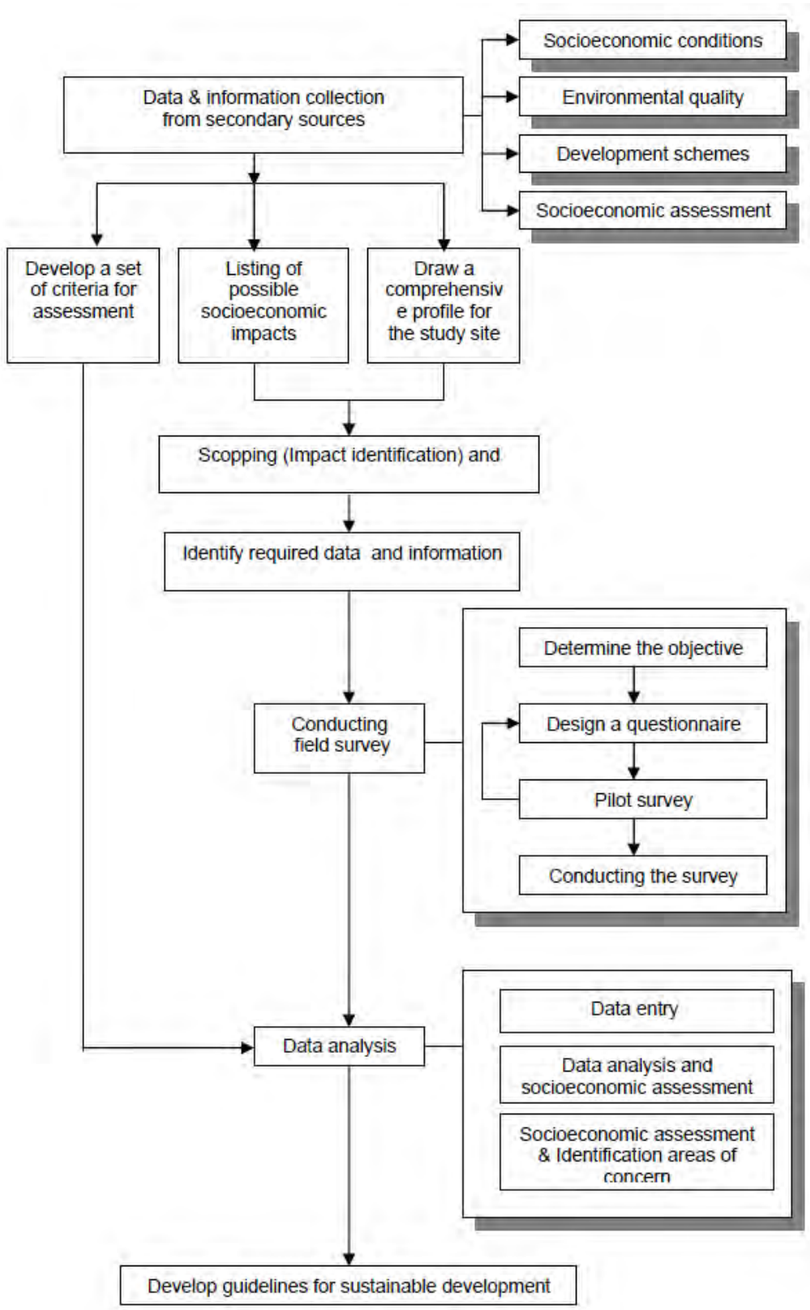


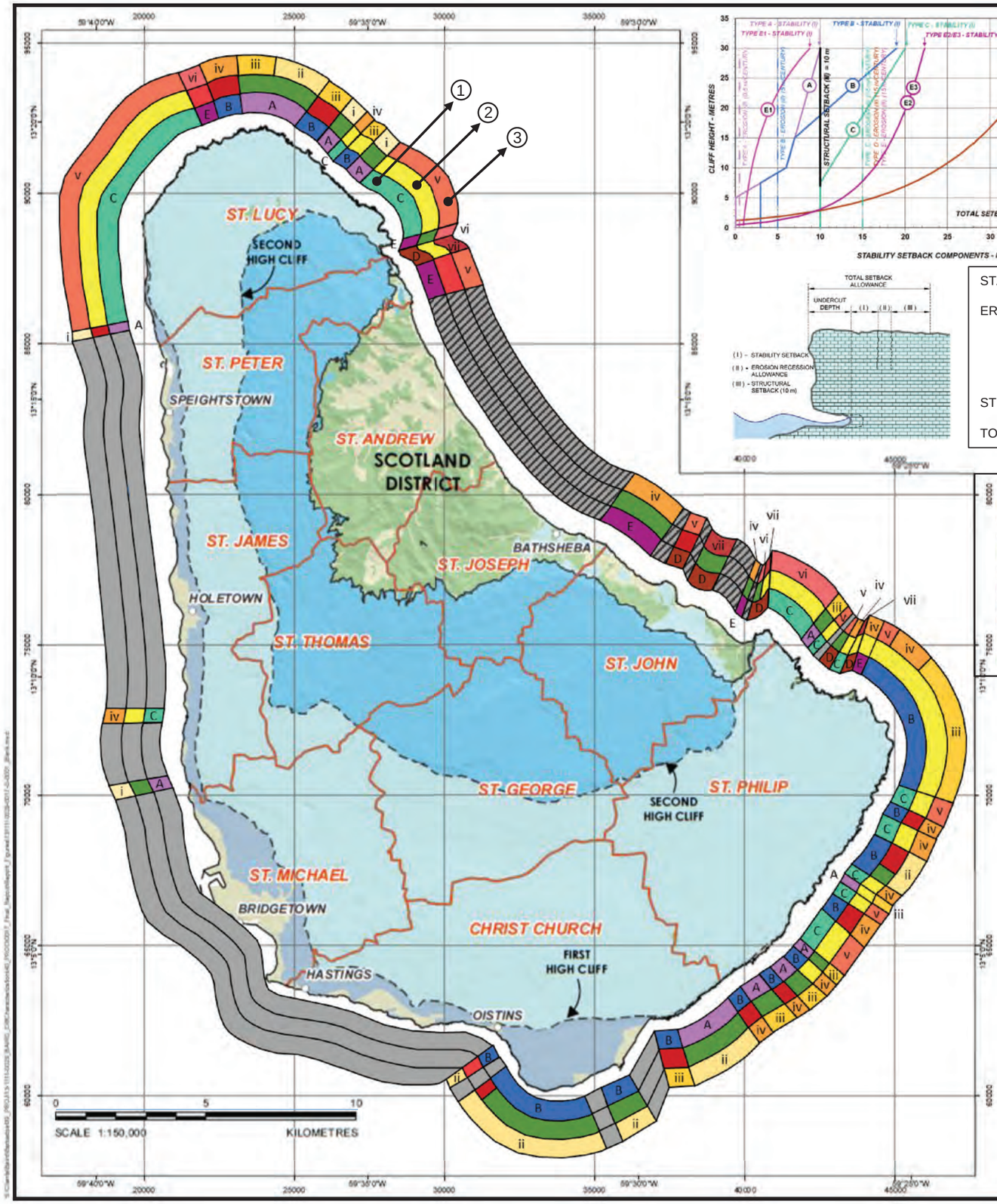
Figure Annex 9.2: Proposed WorkPlan of a Socioeconomic study

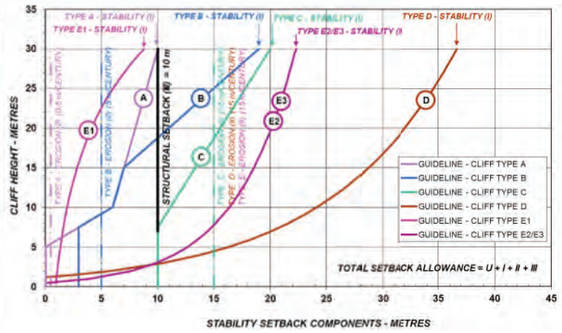
ANNEX 10. COASTAL CLIFF CLASSIFICATION, SETBACK AND RISK FROM GSI STUDY

This Annex provides information extracted from the Geotechnical Survey Investigation (GSI) study (Golder Associates 2017), including:

- First, a set of maps including (i) a national map that represents the coastal cliff classification, setback and risk along the coast of Barbados; and (ii) the Coastal Cliff Classification Map Series 003 (extracted from Appendix R of GSI report) with local scale maps showing the extent of cliff setbacks.
- Finally, the guidelines for development in cliff areas around the island (extracted from section 6.9 of the GSI report).

A10.1. Maps: coastal cliff classification, setback and risk.





SETBACK CATEGORY	TOTAL SETBACK (m) (I + II + III)
i	18.0
ii	20.0
iii	25.0
iv	35.0
v	45.0
vi	55.0
vii	65.0

STABILITY SETBACK (I): UDEC ANALYSES RESULTS

EROSION RATES (II):
TYPE A: 0.5 m in 100 years
TYPE B: 5 m in 100 years
TYPE C: 15 m in 100 years
TYPE D: 15 m in 100 years
TYPE E: 15 m in 100 years

STRUCTURAL SETBACK (III): 10 m FOR ALL CLIFFS

TOTAL SETBACK = U + I + II + III

LEGEND
PARISH BOUNDARY
GEOLOGY
FIRST AND SECOND HIGH CLIFF
QUATERNARY SEDIMENTS
PLEISTOCENE LIMESTONE
CORAL ROCK - UPPER REEF TERRACES
CORAL ROCK - MIDDLE REEF TERRACES
CORAL ROCK - LOWER REEF TERRACES
TERTIARY FORMATIONS
MUDSTONES, SHALES, SANDSTONES, CHALK

TYPE A CLIFFS		
UNDERCUT DEPTH	HIGH STRENGTH	LOW STRENGTH
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE B CLIFFS		
UNDERCUT DEPTH	HIGH STRENGTH	LOW STRENGTH
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE C CLIFFS		
CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE D CLIFFS	
CLIFF TYPE	CLIFF DESCRIPTION
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	D1 CLIFFS OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS	
CLIFF TYPE	CLIFF DESCRIPTION
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

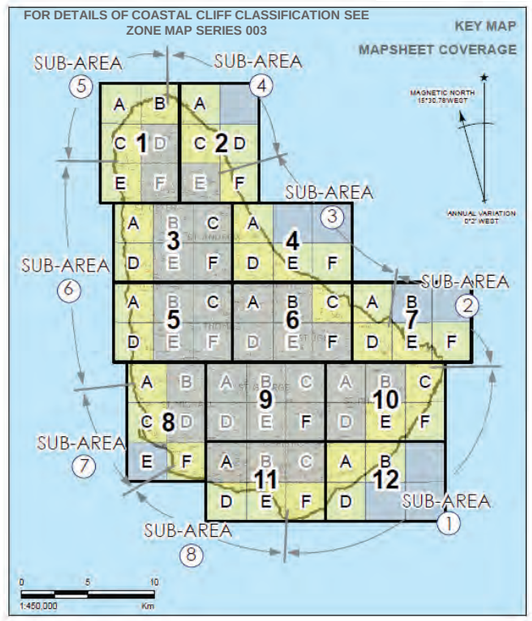
NOT CLASSIFIED
NO CLIFFS IN THIS AREA; SEE NOTE 8.

RISK CLASS	PROBABILITY OF FAILURE	MIN FoS
Very High	>50%	<1.0
High	30-50%	1.1
Medium	8-30%	1.3
Low	<8%	>1.5

REFER TO SCOTLAND DISTRICT MAP SERIES

① Morphology
② Risk
③ Total Setback

FOR DETAILS OF COASTAL CLIFF CLASSIFICATION SEE ZONE MAP SERIES 003



REFERENCE(S) AND NOTE(S)

1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS).
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015.
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015.
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAP PROJECTION: BARBADOS NATIONAL GRID 1938.

CLIENT
Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

PROJECT
GEOTECHNICAL SURVEYS INVESTIGATION (GSI) ASSESSMENT REPORT
COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE
CLIFF AREAS - GENERAL COASTAL CLIFF CLASSIFICATION, SETBACK AND RISK

CONSULTANT
Golder Associates

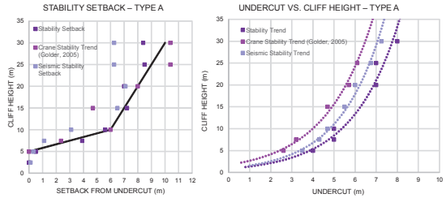
YYYY-MM-DD	MARCH 2017
DESIGNED	CGE/PR
PREPARED	AB
REVIEWED	TGC
APPROVED	TGC

PROJECT NO. 1311110029 | CONTROL | REV. | FIGURE 34

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 26mm

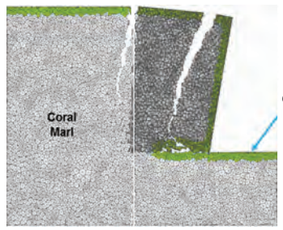
TYPE A

TYPE A STABILITY SETBACK AND RISK ASSESSMENT



PROBABILITY OF FAILURE					
CLIFF HEIGHT	UNDERCUT DEPTH (m)				
	A0	A1	A2	A3	
	<1 m	1-2 m	2-4 m	4-7 m	>7 m
2.5 m	35%	>90%	>90%	>90%	>90%
5 m	<1%	10%	>90%	>90%	>90%
7.5 m	<1%	<1%	67%	>90%	>90%
10 m	<1%	<1%	21%	>90%	>90%
15 m	<1%	<1%	3%	>90%	>90%
20 m	<1%	<1%	<1%	27%	>90%
25 m	<1%	<1%	<1%	7%	>90%
30 m	<1%	<1%	<1%	3%	72%

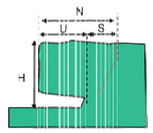
RISK CLASS RANKING					
CLIFF HEIGHT	UNDERCUT DEPTH (m)				
	A0	A1	A2	A3	
	<1 m	1-2 m	2-4 m	4-7 m	>7 m
2.5 m	HIGH	VERY HIGH	VERY HIGH	VERY HIGH	VERY HIGH
5 m	LOW	MEDIUM	VERY HIGH	VERY HIGH	VERY HIGH
7.5 m	LOW	LOW	VERY HIGH	VERY HIGH	VERY HIGH
10 m	LOW	LOW	MEDIUM	VERY HIGH	VERY HIGH
15 m	LOW	LOW	LOW	VERY HIGH	VERY HIGH
20 m	LOW	LOW	LOW	MEDIUM	VERY HIGH
25 m	LOW	LOW	LOW	LOW	VERY HIGH
30 m	LOW	LOW	LOW	LOW	VERY HIGH



Competent Limestone	
$M_i \approx \sigma_c/\sigma_t$	40.8
Friction Angle	29.9°
Cohesion (MPa)	4.12

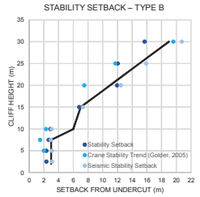
Coral Marl	
$M_i \approx \sigma_c/\sigma_t$	24.5
Friction Angle	22.2°
Cohesion (MPa)	2.06

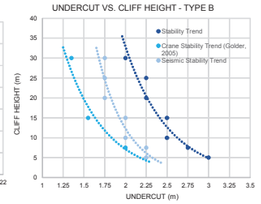
H – Height
U – Undercut
S – Stability Setback from Undercut (I)
N – Notch Setback



TYPE B

TYPE B STABILITY SETBACK AND RISK ASSESSMENT



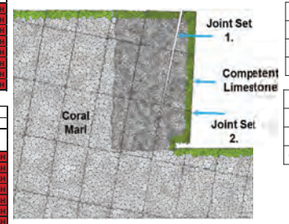


PROBABILITY OF FAILURE					
CLIFF HEIGHT	UNDERCUT DEPTH (m)				
	B0	B1	B2	B3	
	<1 m	1-2 m	2-4 m	4-7 m	>7 m
2.5 m	3%	41%	>90%	>90%	>90%
5 m	4%	59%	>90%	>90%	>90%
7.5 m	6%	81%	>90%	>90%	>90%
10 m	9%	>90%	>90%	>90%	>90%
15 m	15%	>90%	>90%	>90%	>90%
20 m	22%	>90%	>90%	>90%	>90%
25 m	27%	>90%	>90%	>90%	>90%
30 m	26%	>90%	>90%	>90%	>90%

RISK CLASS RANKING					
CLIFF HEIGHT	UNDERCUT DEPTH (m)				
	B0	B1	B2	B3	
	<1 m	1-2 m	2-4 m	4-7 m	>7 m
2.5 m	LOW	HIGH	VERY HIGH	VERY HIGH	VERY HIGH
5 m	LOW	VERY HIGH	VERY HIGH	VERY HIGH	VERY HIGH
7.5 m	LOW	VERY HIGH	VERY HIGH	VERY HIGH	VERY HIGH
10 m	MEDIUM	VERY HIGH	VERY HIGH	VERY HIGH	VERY HIGH
15 m	MEDIUM	VERY HIGH	VERY HIGH	VERY HIGH	VERY HIGH
20 m	MEDIUM	VERY HIGH	VERY HIGH	VERY HIGH	VERY HIGH
25 m	MEDIUM	VERY HIGH	VERY HIGH	VERY HIGH	VERY HIGH
30 m	MEDIUM	VERY HIGH	VERY HIGH	VERY HIGH	VERY HIGH

PROBABILITY OF FAILURE					
CLIFF HEIGHT	UNDERCUT DEPTH (m)				
	<0.5 m	0.5-1 m	1-1.5 m	1.5-2 m	>2 m
2.5 m	<1%	3%	12%	41%	>90%
5 m	<1%	4%	18%	59%	>90%
7.5 m	<1%	6%	25%	81%	>90%
10 m	1%	9%	35%	>90%	>90%
15 m	3%	15%	55%	>90%	>90%
20 m	5%	22%	72%	>90%	>90%
25 m	7%	27%	78%	>90%	>90%
30 m	7%	26%	76%	>90%	>90%

RISK CLASS RANKING					
CLIFF HEIGHT	UNDERCUT DEPTH (m)				
	<0.5 m	0.5-1 m	1-1.5 m	1.5-2 m	>2 m
2.5 m	LOW	LOW	MEDIUM	HIGH	VERY HIGH
5 m	LOW	LOW	MEDIUM	VERY HIGH	VERY HIGH
7.5 m	LOW	LOW	MEDIUM	VERY HIGH	VERY HIGH
10 m	LOW	MEDIUM	HIGH	VERY HIGH	VERY HIGH
15 m	LOW	MEDIUM	VERY HIGH	VERY HIGH	VERY HIGH
20 m	LOW	MEDIUM	VERY HIGH	VERY HIGH	VERY HIGH
25 m	LOW	MEDIUM	VERY HIGH	VERY HIGH	VERY HIGH
30 m	LOW	MEDIUM	VERY HIGH	VERY HIGH	VERY HIGH

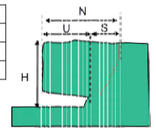


Competent Limestone	
$M_i \approx \sigma_c/\sigma_t$	40.8
Friction Angle	29.9°
Cohesion (MPa)	4.12

Coral Marl	
$M_i \approx \sigma_c/\sigma_t$	24.5
Friction Angle	22.2°
Cohesion (MPa)	2.06

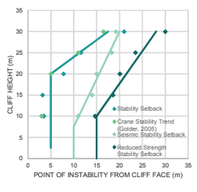
Joint Sets:
1. 80° ~ 5 m spacing
2. 10° ~ 8 m spacing

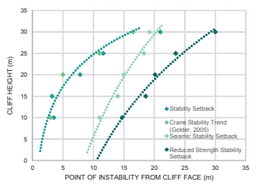
H – Height
U – Undercut
S – Stability Setback from Undercut (I)
N – Notch Setback



TYPE C

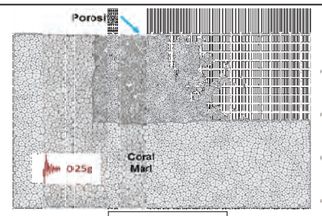
TYPE C STABILITY SETBACK AND RISK ASSESSMENT



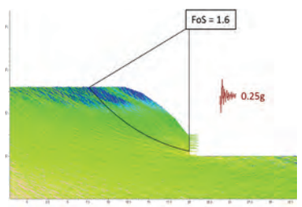


PROBABILITY OF FAILURE					
CLIFF HEIGHT	POINT OF INSTABILITY FROM CLIFF FACE (m)				
	<5 m	5-10 m	10-15 m	15-20 m	20-25 m
2.5 m	21%	14%	9%	6%	5%
5 m	18%	12%	8%	6%	4%
7.5 m	17%	12%	7%	5%	4%
10 m	17%	12%	7%	5%	4%
15 m	27%	17%	9%	6%	4%
20 m	68%	35%	15%	8%	5%
25 m	>90%	>90%	30%	13%	7%
30 m	>90%	>90%	80%	25%	10%

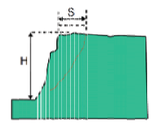
RISK CLASS RANKING					
CLIFF HEIGHT	POINT OF INSTABILITY FROM CLIFF FACE (m)				
	<5 m	5-10 m	10-15 m	15-20 m	20-25 m
2.5 m	MEDIUM	MEDIUM	MEDIUM	LOW	LOW
5 m	MEDIUM	MEDIUM	MEDIUM	LOW	LOW
7.5 m	MEDIUM	MEDIUM	LOW	LOW	LOW
10 m	MEDIUM	MEDIUM	LOW	LOW	LOW
15 m	MEDIUM	MEDIUM	MEDIUM	LOW	LOW
20 m	VERY HIGH	HIGH	MEDIUM	MEDIUM	LOW
25 m	VERY HIGH	VERY HIGH	HIGH	MEDIUM	LOW
30 m	VERY HIGH	VERY HIGH	VERY HIGH	MEDIUM	MEDIUM



Coral Marl	
$M_i \approx \sigma_c/\sigma_t$	24.5
Friction Angle	22.2°
Cohesion (MPa)	0.206

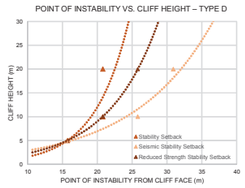


H – Height
S – Stability Setback from Cliff Edge (I)



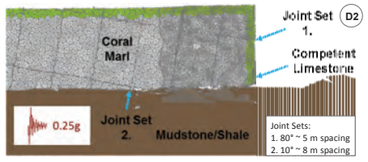
TYPE D

TYPE D STABILITY SETBACK AND RISK ASSESSMENT



PROBABILITY OF FAILURE					
CLIFF HEIGHT	POINT OF INSTABILITY FROM CLIFF FACE (m)				
	<15 m	15-20 m	20-25 m	25-30 m	>30 m
2.5 m	<1%	<1%	<1%	<1%	<1%
5 m	33%	<1%	<1%	<1%	<1%
7.5 m	>90%	12%	<1%	<1%	<1%
10 m	>90%	43%	2%	<1%	<1%
15 m	>90%	>90%	13%	2%	1%
20 m	>90%	>90%	32%	9%	5%
25 m	>90%	>90%	51%	19%	12%
30 m	>90%	>90%	67%	29%	20%

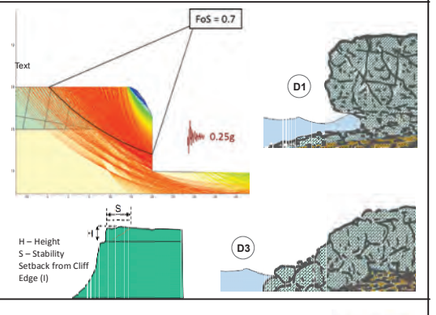
RISK CLASS RANKING					
CLIFF HEIGHT	POINT OF INSTABILITY FROM CLIFF FACE (m)				
	<15 m	15-20 m	20-25 m	25-30 m	>30 m
2.5 m	LOW	LOW	LOW	LOW	LOW
5 m	HIGH	LOW	LOW	LOW	LOW
7.5 m	VERY HIGH	MEDIUM	LOW	LOW	LOW
10 m	VERY HIGH	HIGH	LOW	LOW	LOW
15 m	VERY HIGH	VERY HIGH	MEDIUM	LOW	LOW
20 m	VERY HIGH	VERY HIGH	HIGH	MEDIUM	LOW
25 m	VERY HIGH	VERY HIGH	VERY HIGH	MEDIUM	MEDIUM
30 m	VERY HIGH	VERY HIGH	VERY HIGH	MEDIUM	MEDIUM



Competent Limestone	
$M_i \approx \sigma_c/\sigma_t$	40.8
Friction Angle	29.9°
Cohesion (MPa)	4.12

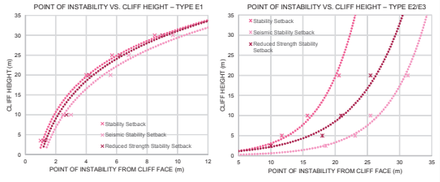
Coral Marl	
$M_i \approx \sigma_c/\sigma_t$	24.5
Friction Angle	22.2°
Cohesion (MPa)	2.06

Mudstone/Shale	
$M_i \approx \sigma_c/\sigma_t$	0.0
Friction Angle	18.0°
Cohesion (MPa)	0.005



TYPE E

TYPE E STABILITY SETBACK AND RISK ASSESSMENT

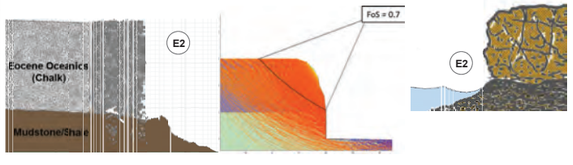


PROBABILITY OF FAILURE - E1					
CLIFF HEIGHT	POINT OF INSTABILITY FROM CLIFF FACE (m)				
	<1 m	1-3 m	3-5 m	5-7 m	>7 m
3.5 m	1%	<1%	<1%	<1%	<1%
5 m	2%	<1%	<1%	<1%	<1%
7.5 m	7%	<1%	<1%	<1%	<1%
10 m	26%	<1%	<1%	<1%	<1%
15 m	>90%	22%	<1%	<1%	<1%
20 m	>90%	>90%	7%	<1%	<1%
25 m	>90%	>90%	>90%	9%	<1%
30 m	>90%	>90%	>90%	>90%	16%

PROBABILITY OF FAILURE - E2/E3					
CLIFF HEIGHT	POINT OF INSTABILITY FROM CLIFF FACE (m)				
	<15 m	15-20 m	20-25 m	25-30 m	>30 m
2.5 m	12%	7%	3%	1%	1%
5 m	20%	11%	4%	2%	1%
7.5 m	33%	17%	6%	3%	2%
10 m	51%	26%	9%	4%	2%
15 m	>90%	52%	16%	6%	4%
20 m	>90%	88%	25%	9%	6%
25 m	>90%	>90%	34%	12%	8%
30 m	>90%	>90%	41%	14%	9%

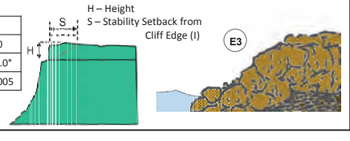
RISK CLASS RANKING - E1					
CLIFF HEIGHT	POINT OF INSTABILITY FROM CLIFF FACE (m)				
	<1 m	1-3 m	3-5 m	5-7 m	>7 m
3.5 m	LOW	LOW	LOW	LOW	LOW
5 m	LOW	LOW	LOW	LOW	LOW
7.5 m	LOW	LOW	LOW	LOW	LOW
10 m	MEDIUM	LOW	LOW	LOW	LOW
15 m	VERY HIGH	MEDIUM	LOW	LOW	LOW
20 m	VERY HIGH	VERY HIGH	LOW	LOW	LOW
25 m	VERY HIGH	VERY HIGH	VERY HIGH	MEDIUM	LOW
30 m	VERY HIGH	VERY HIGH	VERY HIGH	VERY HIGH	MEDIUM

RISK CLASS RANKING - E2/E3					
CLIFF HEIGHT	POINT OF INSTABILITY FROM CLIFF FACE (m)				
	<15 m	15-20 m	20-25 m	25-30 m	>30 m
2.5 m	MEDIUM	LOW	LOW	LOW	LOW
5 m	MEDIUM	MEDIUM	LOW	LOW	LOW
7.5 m	HIGH	MEDIUM	LOW	LOW	LOW
10 m	VERY HIGH	MEDIUM	MEDIUM	LOW	LOW
15 m	VERY HIGH	VERY HIGH	MEDIUM	LOW	LOW
20 m	VERY HIGH	VERY HIGH	MEDIUM	MEDIUM	LOW
25 m	VERY HIGH	VERY HIGH	HIGH	MEDIUM	MEDIUM
30 m	VERY HIGH	VERY HIGH	HIGH	MEDIUM	MEDIUM



Eocene Oceanics (Chalk)	
$M_i \approx \sigma_c/\sigma_t$	10.2
Friction Angle	37.0°
Cohesion (MPa)	0.028

Mudstone/Shale	
$M_i \approx \sigma_c/\sigma_t$	0.0
Friction Angle	18.0°
Cohesion (MPa)	0.005



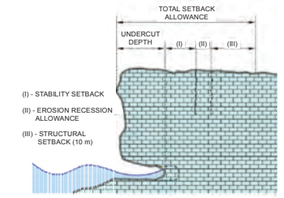
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

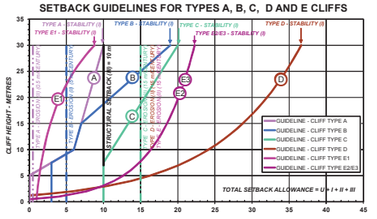
RISK CLASS	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS				
	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	**FORBIDDEN** — SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	**CONDITIONAL**
MEDIUM	8-30%	1.3	MINOR CRACKING		
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	**ALLOWABLE**

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

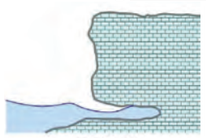


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



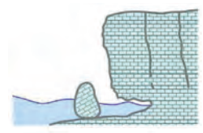
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



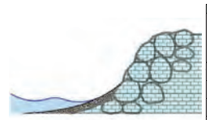
TYPE A - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



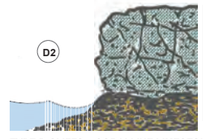
TYPE B - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



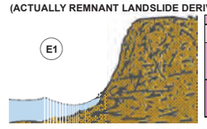
TYPE C - CLIFFS		
VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

NOT CLASSIFIED *

REFER TO SCOTLAND DISTRICT MAP SERIES

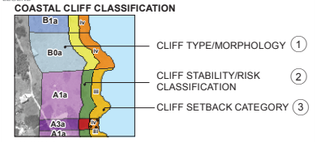
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS				
SETBACK CATEGORY				TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES		ARCUATE OVERHANGS	
i	i		i	18.0
ii	ii		ii	20.0
iii	iii		iii	25.0
iv	iv		iv	35.0
v	v		v	45.0
vi	vi		vi	55.0
vii	vii		vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

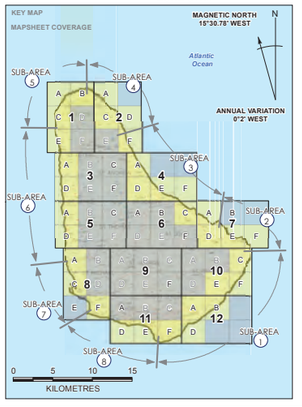
LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]



PROGRAM **GEOTECHNICAL SURVEYS INVESTIGATION (GSI)**
COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE **CLIFF AREAS -**
COMPOSITE RISK CLASSIFICATION REFERENCE SHEET

REFERENCE(S) AND NOTE(S):

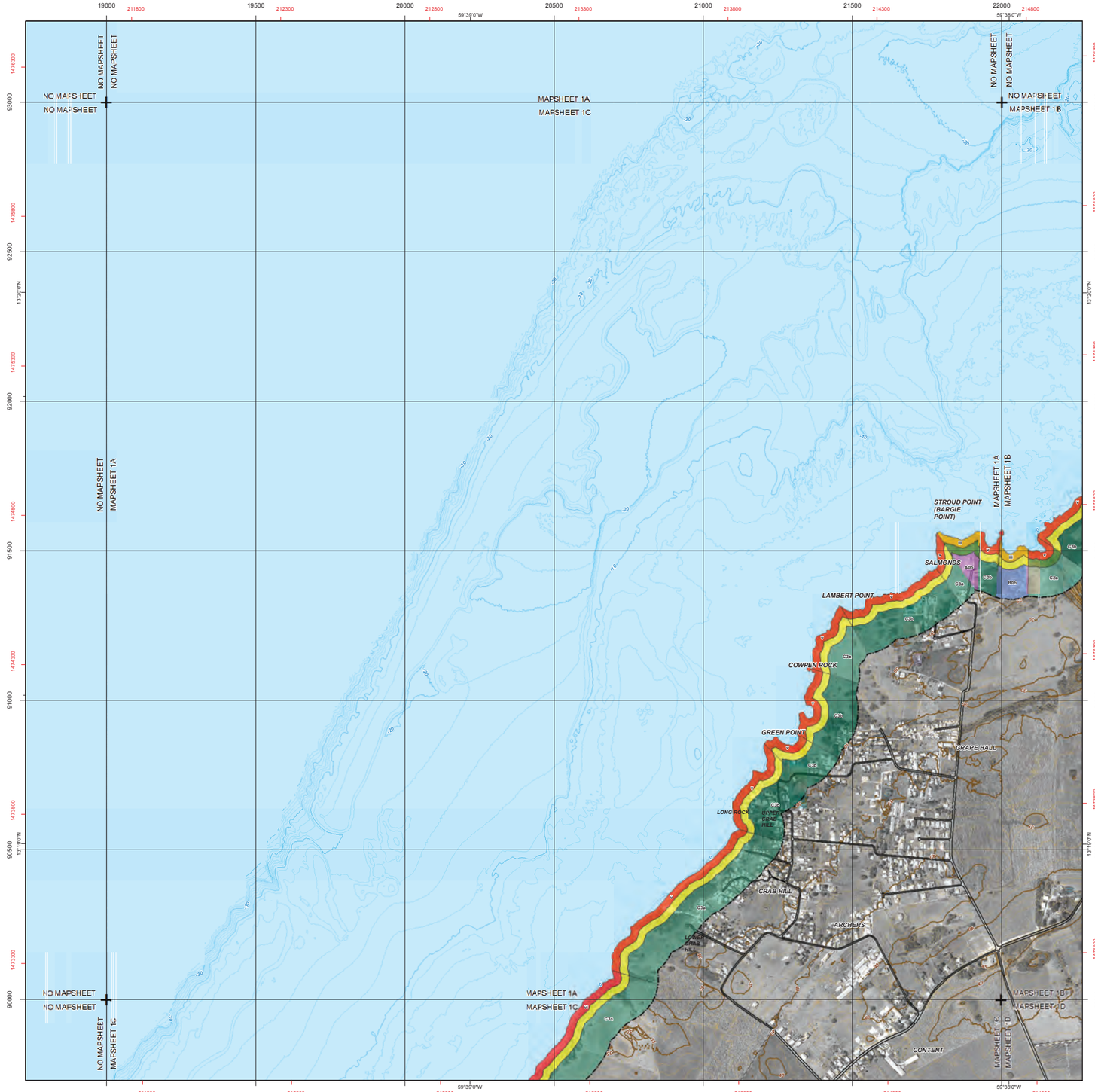
1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	01	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird
Golder Associates

S:\Coastal\Deliverables_Reports\Final_GSI\Appendices\Appendix_C\Cliff_Line_Mapping\TYPE\[TYPE_SHEETS.dwg]Layout1, 2017-03-23 08:55:11, Warren.Page.pdf



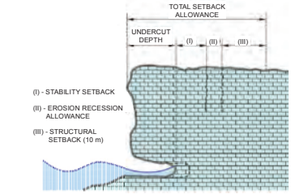
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

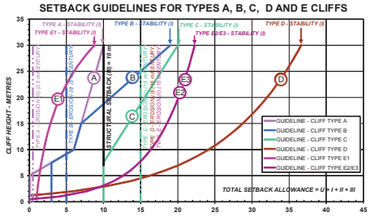
RISK CLASS	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS: FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	**FORBIDDEN**	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	**CONDITIONAL**	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	**ALLOWABLE**	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

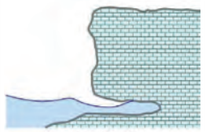


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



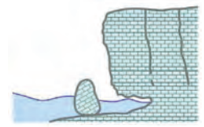
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



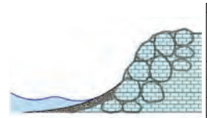
TYPE A - CLIFFS: AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



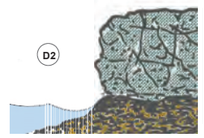
TYPE B - CLIFFS: AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



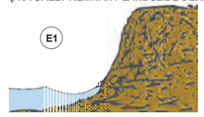
TYPE C - CLIFFS: VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

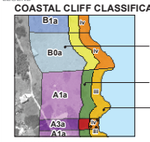
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS: SETBACK CATEGORY — COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	TOTAL SETBACK (U + I + II + III) (m)
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

LEGEND

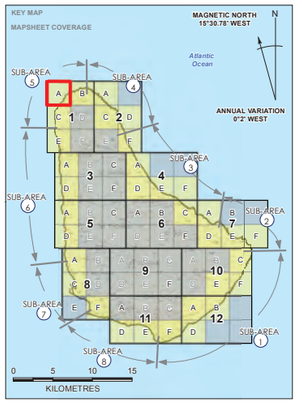
COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]

KEY MAP



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI) COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 5 - SHEET 1A

REFERENCE(S) AND NOTE(S):

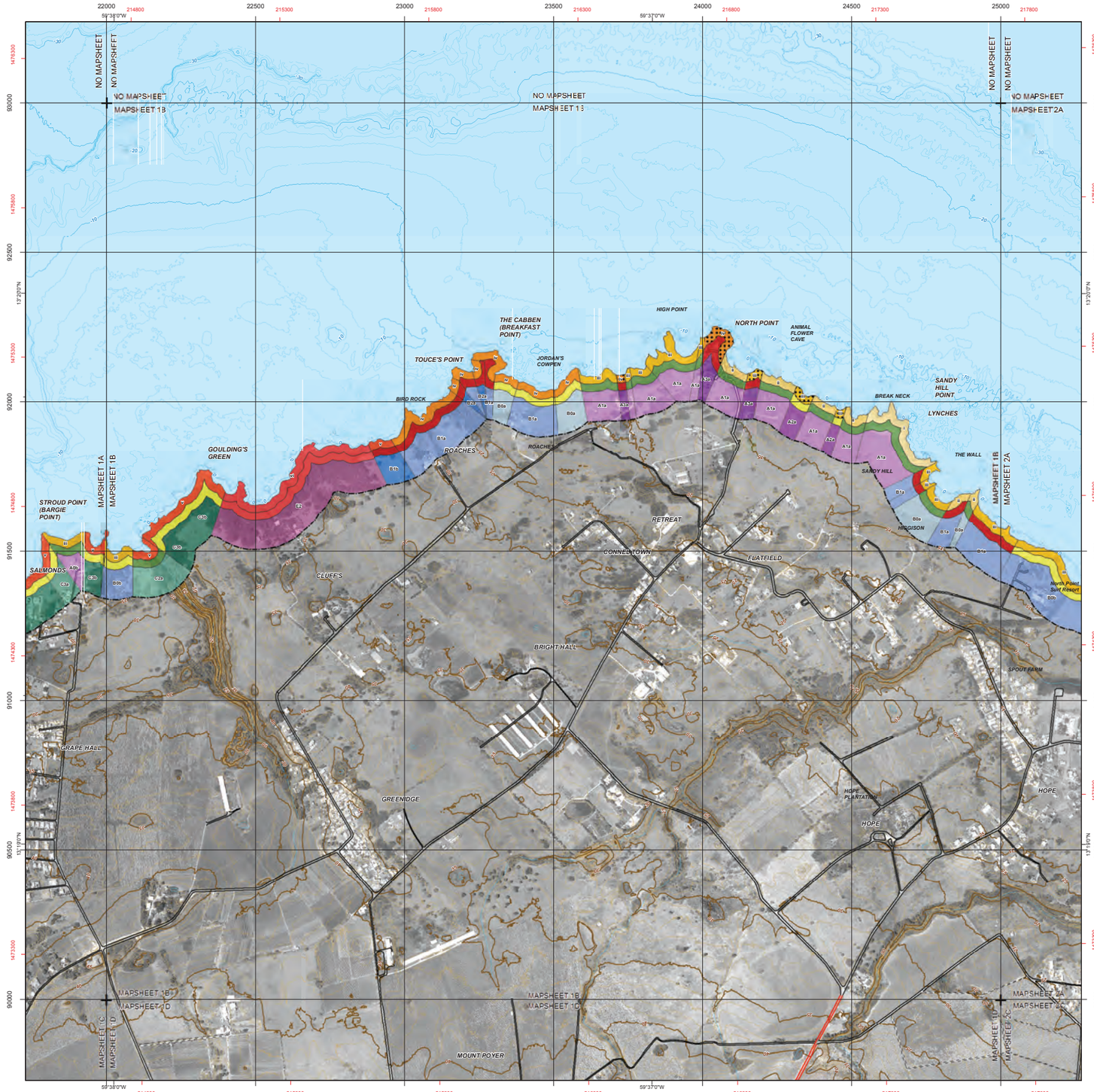
1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	1A	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird

Golder Associates



Map Projection and 500-metre Grid: Barbados National Grid 1938
Supplementary 500-metre Grid Labels: Universal Transverse Mercator, Zone 21

Magnetic North Declination: 15°30.78' W, Annual Variation 0°2' W, 09-01-2015

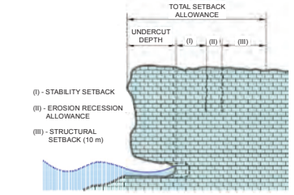
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

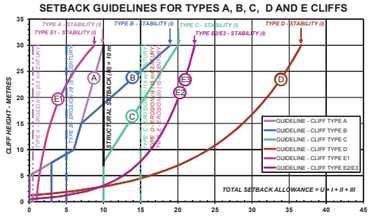
RISK CLASS	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS					
	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	**FORBIDDEN**	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	**CONDITIONAL**	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	**ALLOWABLE**	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

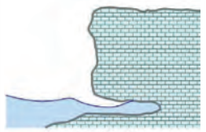


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



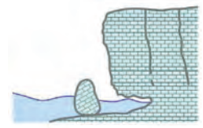
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



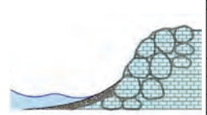
TYPE A - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



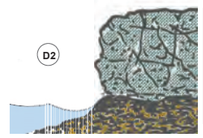
TYPE B - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



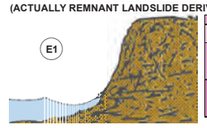
TYPE C - CLIFFS		
VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS			
SETBACK CATEGORY			TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

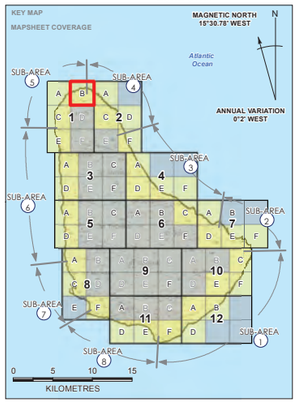
LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY
- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]

KEY MAP
MAPSHEET COVERAGE



PROGRAM
GEOTECHNICAL SURVEYS INVESTIGATION (GSI)
COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE
COASTAL CLIFF CLASSIFICATION - SUB-AREA 4 / 5 - SHEET 1B

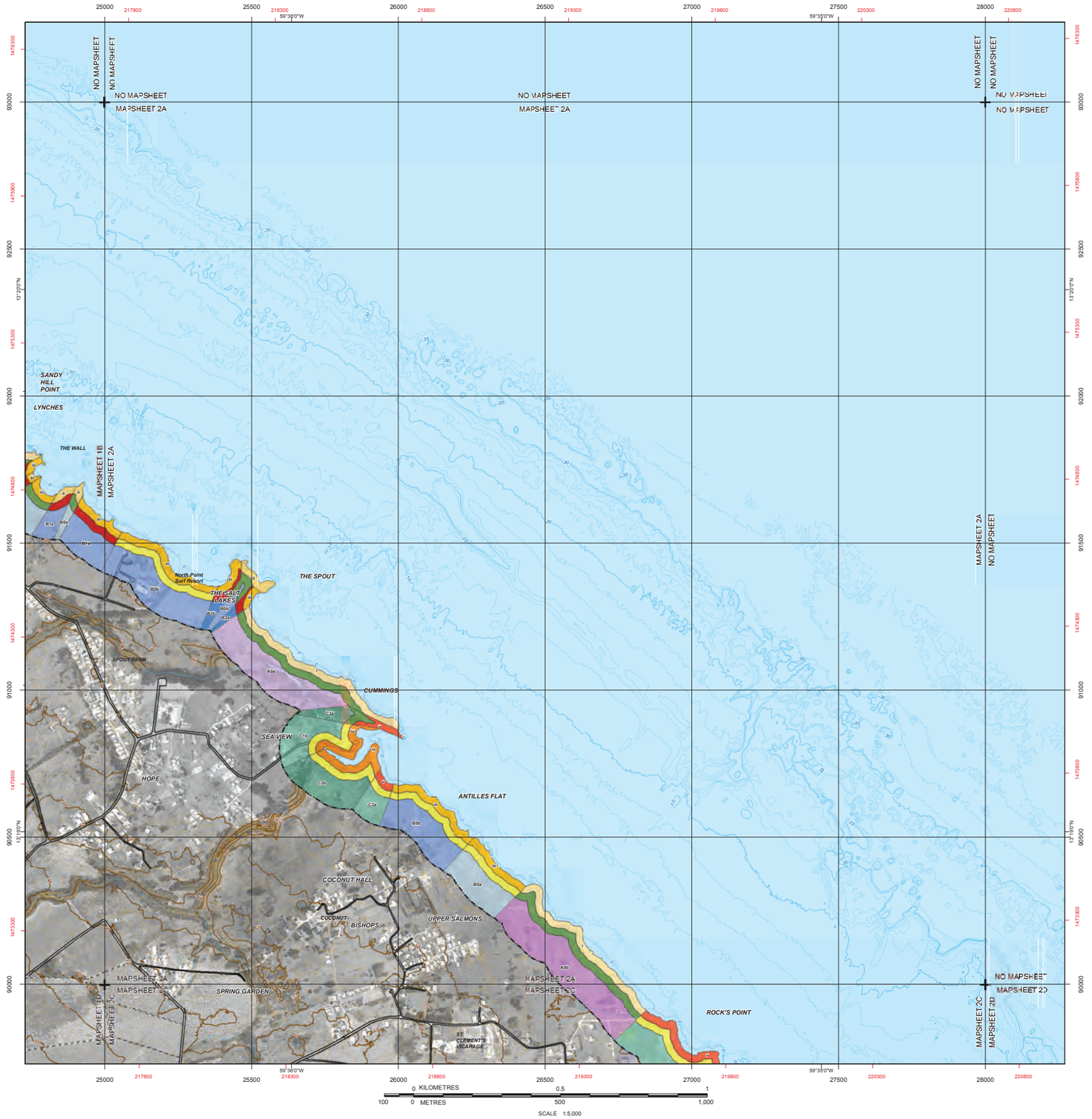
REFERENCE(S) AND NOTE(S):
1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	1B	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird | Golder Associates

S:\Data\Barbados\Mxd\B_2016\13-1111\003_GA\01_GA\Finals\Sheet1B_PROGRAM_Coastal_Zone_Mapping_20170302\GA-13-1111-003-GA01_GA-Sheet1B-Fig.mxd



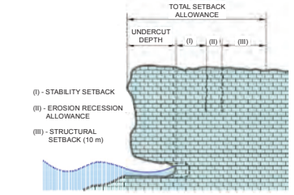
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

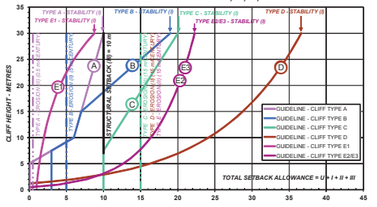
RISK CLASS	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS					
	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	FOR CONTINUED USE		FOR NEW OR FUTURE DEVELOPMENT
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	FORBIDDEN	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	CONDITIONAL	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	ALLOWABLE	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

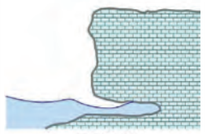


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



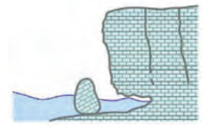
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



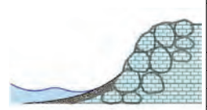
TYPE A - CLIFFS		
UNDERCUT DEPTH \ AVERAGE UCS (MPa)	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



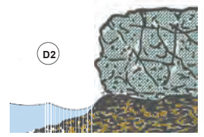
TYPE B - CLIFFS		
UNDERCUT DEPTH \ AVERAGE UCS (MPa)	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



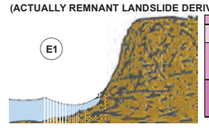
TYPE C - CLIFFS		
CLIFF HEIGHT \ VUGGINESS	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

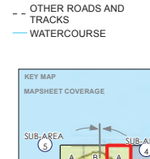
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS			
SETBACK CATEGORY			TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

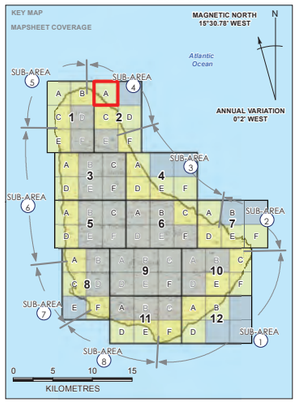
LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI) COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 4 - SHEET 2A

REFERENCE(S) AND NOTE(S)

1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	2A	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird

Golder Associates

© Coastal Zone Management Unit, Barbados



Map Projection and 500-metre Grid: Barbados National Grid 1938
Supplementary 500-metre Grid Labels: Universal Transverse Mercator, Zone 21

Magnetic North Declination: 15°30.78' W, Annual Variation 0°2' W, 09-01-2015

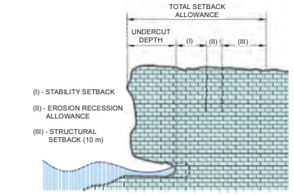
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

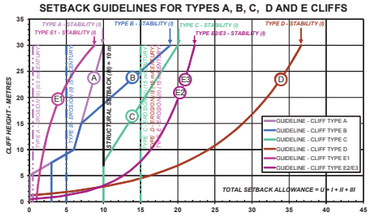
RISK CLASS	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS					
	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	FORBIDDEN	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	CONDITIONAL	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	ALLOWABLE	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

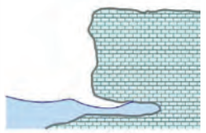


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



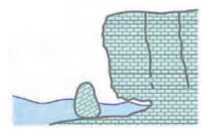
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



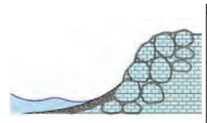
TYPE A - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



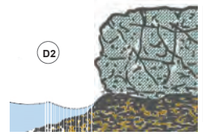
TYPE B - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



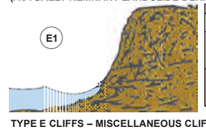
TYPE C - CLIFFS		
VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

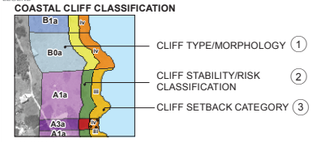
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS			
SETBACK CATEGORY			TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY
- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]

KEY MAP



PROGRAM
GEOTECHNICAL SURVEYS INVESTIGATION (GSI) COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE
COASTAL CLIFF CLASSIFICATION - SUB-AREA 4 - SHEET 2C

REFERENCE(S) AND NOTE(S)
1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

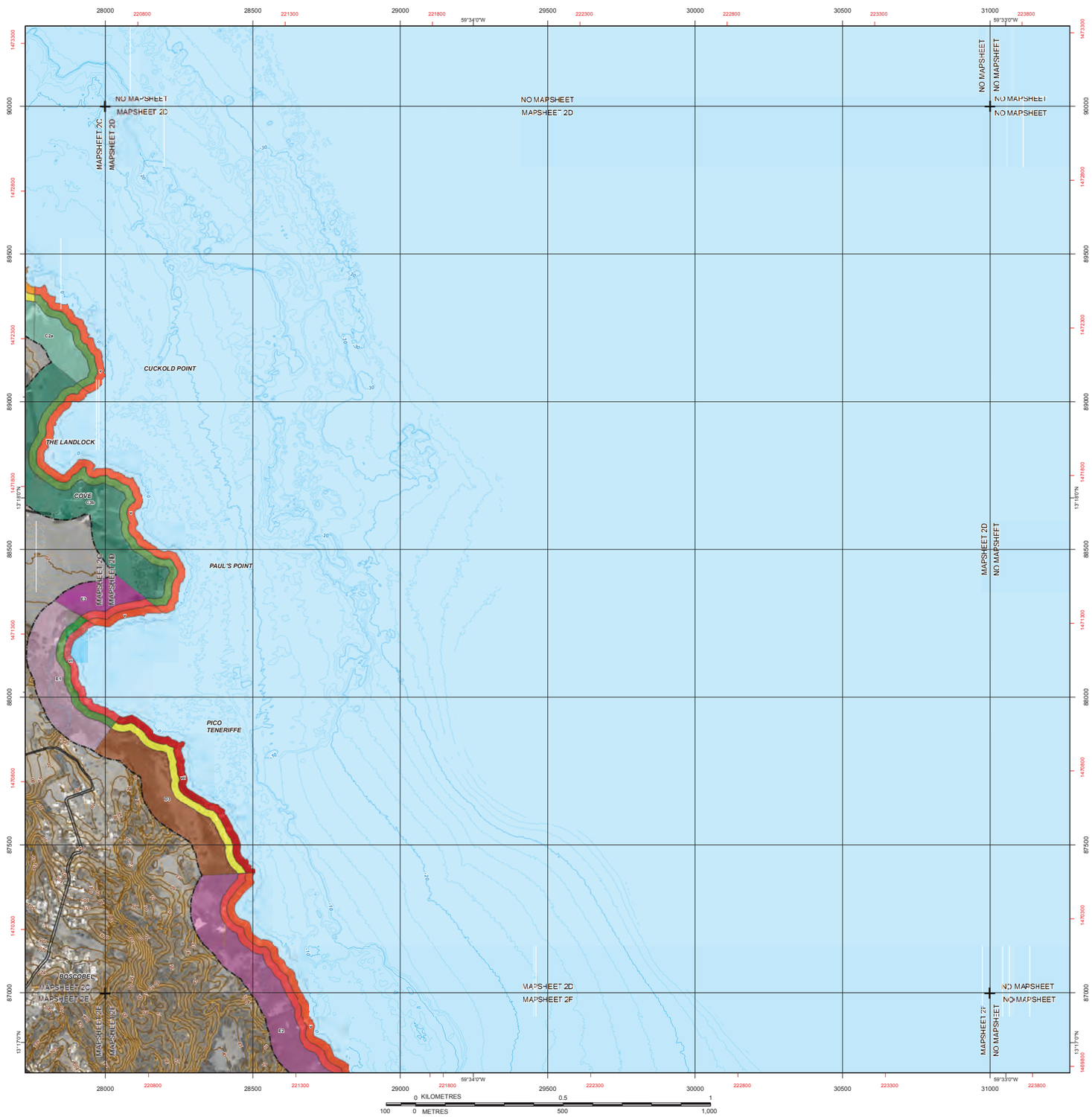
MAP SERIES	MAPSHEET	DATE
003	2C	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird

Golder Associates

S:\Coastal\Data\arcinfo_ARCGIS 11\mxd\gsi_2016\02_GSI\Classification\gsi_PROGRAM_Coastal_Zone_Mapping_20170328-0154-0301_CliffClassification.mxd



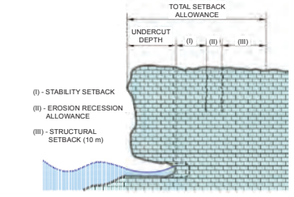
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

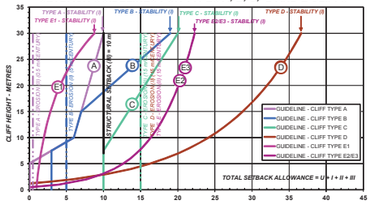
RISK CLASS	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS				
	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	**FORBIDDEN** — SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	**CONDITIONAL**
MEDIUM	8-30%	1.3	MINOR CRACKING		
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	**ALLOWABLE**

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

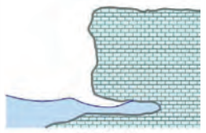


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



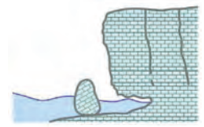
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



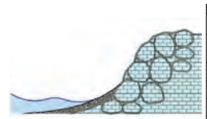
TYPE A - CLIFFS		
UNDERCUT DEPTH \ AVERAGE UCS (MPa)	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



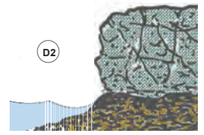
TYPE B - CLIFFS		
UNDERCUT DEPTH \ AVERAGE UCS (MPa)	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



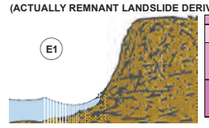
TYPE C - CLIFFS		
CLIFF HEIGHT \ VUGGINESS	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

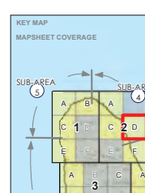
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS			
SETBACK CATEGORY			TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY
- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI)
COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 4 - SHEET 2D

REFERENCE(S) AND NOTE(S):
1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	2D	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird | Golder Associates



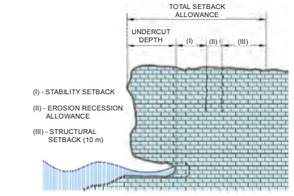
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

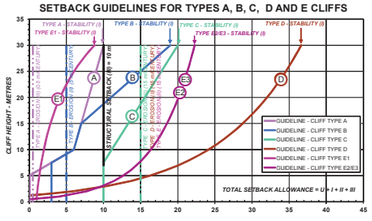
RISK CLASS	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS: FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	FORBIDDEN	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	CONDITIONAL	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	ALLOWABLE	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

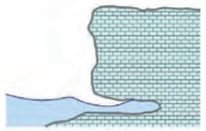


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



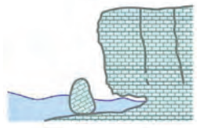
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



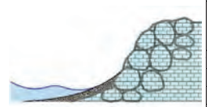
TYPE A - CLIFFS: UNDERCUT DEPTH \ AVERAGE UCS (MPa)	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



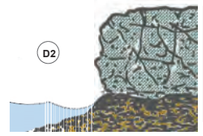
TYPE B - CLIFFS: UNDERCUT DEPTH \ AVERAGE UCS (MPa)	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



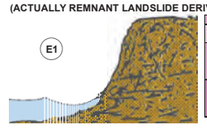
TYPE C - CLIFFS: CLIFF HEIGHT \ VUGGINESS	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

REFER TO SCOTLAND DISTRICT MAP SERIES

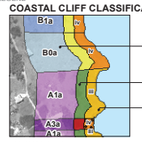
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS: SETBACK CATEGORY — COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	TOTAL SETBACK (U + I + II + III) (m)
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

LEGEND

COASTAL CLIFF CLASSIFICATION



- CLIFF TYPE/MORPHOLOGY (1)
- CLIFF STABILITY/RISK CLASSIFICATION (2)
- CLIFF SETBACK CATEGORY (3)

TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]

KEY MAP



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI) COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 3 - SHEET 2F

REFERENCE(S) AND NOTE(S):

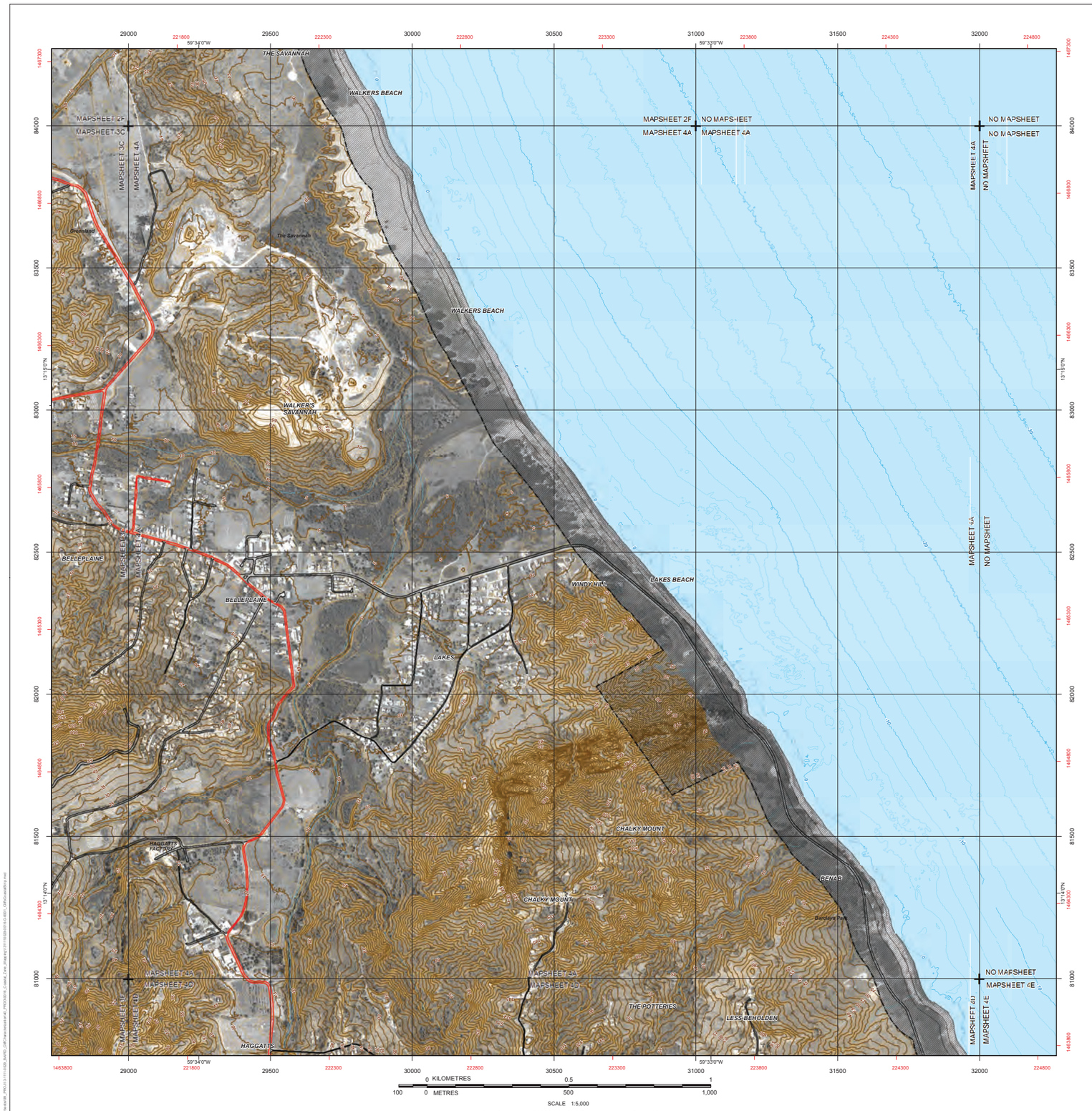
1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDYREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	2F	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird

Golder Associates



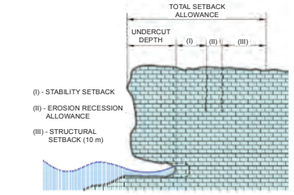
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

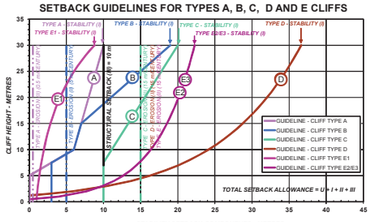
RISK CLASS	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS: FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	FORBIDDEN	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	CONDITIONAL	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	ALLOWABLE	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

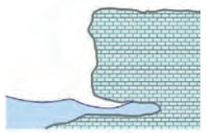


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



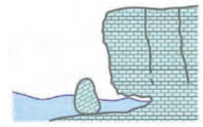
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



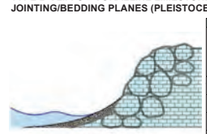
TYPE A - CLIFFS: AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



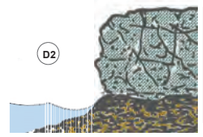
TYPE B - CLIFFS: AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



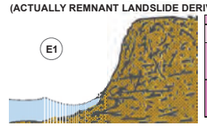
TYPE C - CLIFFS: VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

REFER TO SCOTLAND DISTRICT MAP SERIES

(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS: SETBACK CATEGORY — COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	TOTAL SETBACK (U + I + II + III) (m)
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

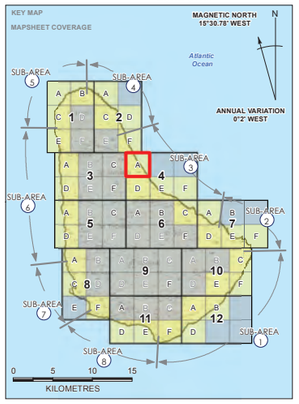
LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY
- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]

KEY MAP



REFERENCE(S) AND NOTE(S)

1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI)
COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 3 - SHEET 4A

MAP SERIES	MAPSHEET	DATE
003	4A	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird
Golder Associates

© Coastal Zone Management Unit, Barbados



Map Projection and 500-metre Grid: Barbados National Grid 1938
Supplementary 500-metre Grid Labels: Universal Transverse Mercator, Zone 21

Magnetic North Declination: 15°30.78' W, Annual Variation 0°2' W, 09-01-2015

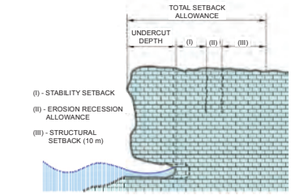
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

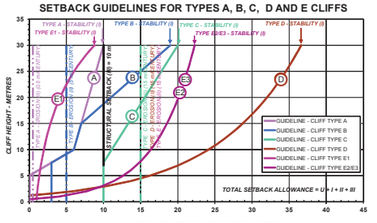
RISK CLASS	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS					
	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	**FORBIDDEN**	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	**CONDITIONAL**	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	**ALLOWABLE**	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

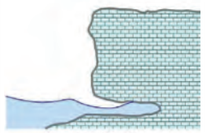


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



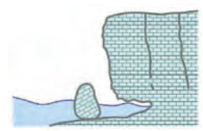
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



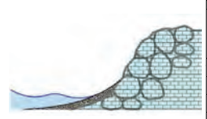
TYPE A - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



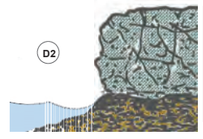
TYPE B - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



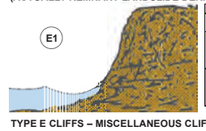
TYPE C - CLIFFS		
VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

REFER TO SCOTLAND DISTRICT MAP SERIES

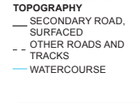
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS			
SETBACK CATEGORY			TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

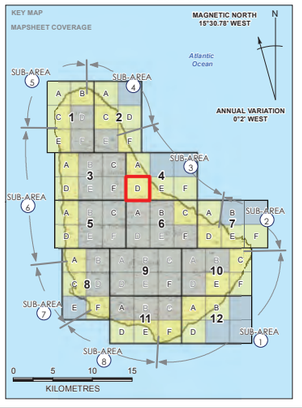
LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY
- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]

KEY MAP



PROGRAM **GEOTECHNICAL SURVEYS INVESTIGATION (GSI)**
COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 3 - SHEET 4D

REFERENCE(S) AND NOTE(S):
1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDRYN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017.

MAP SERIES	MAPSHEET	DATE
003	4D	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird

Golder Associates

S:\Cadd\Arcmap\Arcmap\B_CRC\GSI 111\003_SHEET_4D\Projects\arcmap\B_PROGS\B_Coastal_Zone_Mapping\111003gsi111c003_4D01_CliffClassification.mxd



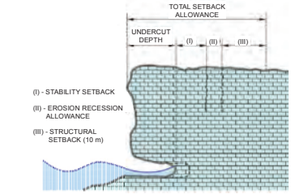
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

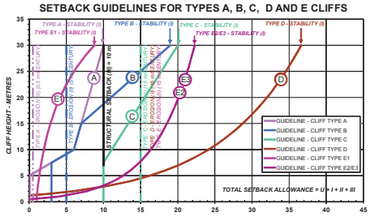
RISK CLASS	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS					
	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	FOR CONTINUED USE		FOR NEW OR FUTURE DEVELOPMENT
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	FORBIDDEN	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	CONDITIONAL	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	ALLOWABLE	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

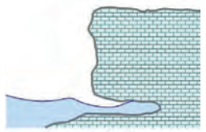


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



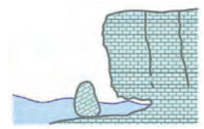
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



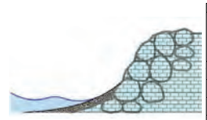
TYPE A - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



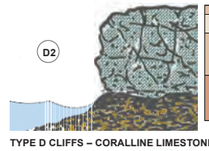
TYPE B - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



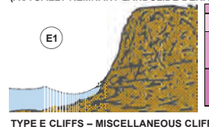
TYPE C - CLIFFS		
VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

REFER TO SCOTLAND DISTRICT MAP SERIES

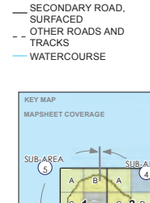
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS			
SETBACK CATEGORY			TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

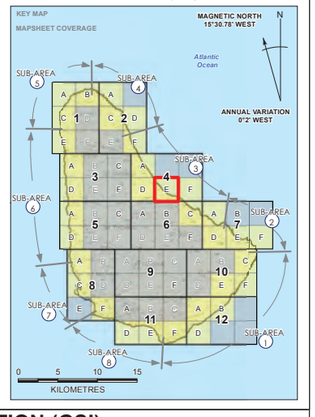
LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI) COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 3 - SHEET 4E

REFERENCE(S) AND NOTE(S)

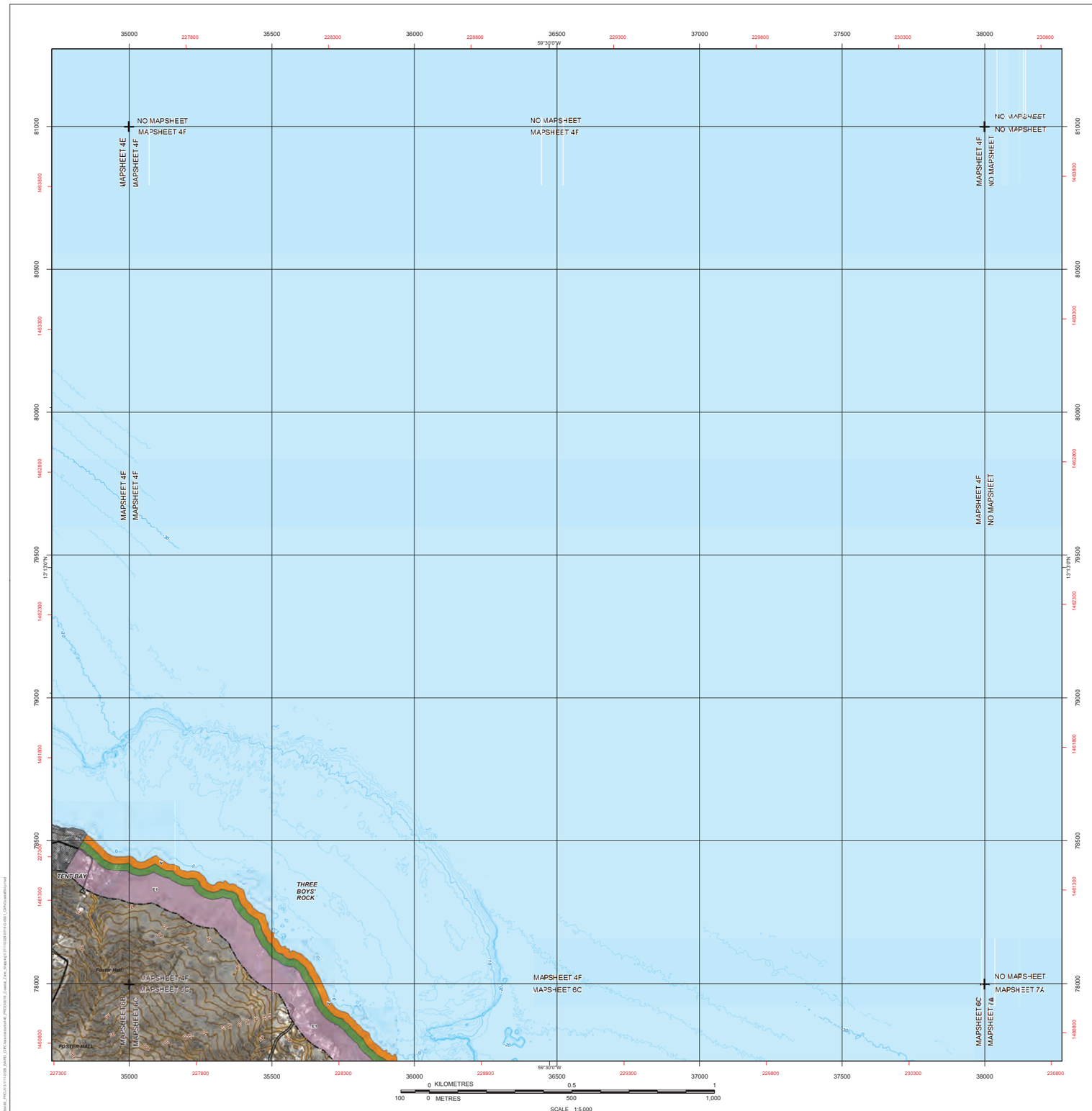
1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	4E	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird
Golder Associates

G:\Data\Data\Data\Data\Wk_PROJ\13-1111\03_GIS\03_GIS\Mxds\Mxds\Wk_PROJ\GSI_Coastal_Zone_Mapping\13-1111(03)-GIS-001_CRMCoastalSheet.mxd



0 KILOMETRES 0.5 1
100 0 METRES 500 1,000

SCALE 1:5,000

Map Projection and 500-metre Grid: Barbados National Grid 1938
Supplementary 500-metre Grid Labels: Universal Transverse Mercator, Zone 21

Magnetic North Declination: 15°30.78' W, Annual Variation 0°2' W, 09-01-2015

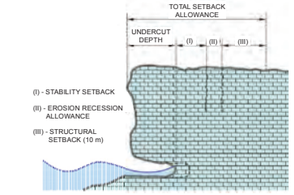
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

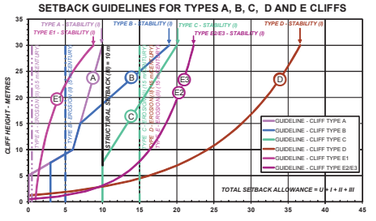
RISK CLASS	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS					
	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	**FORBIDDEN**	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	**CONDITIONAL**	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	**ALLOWABLE**	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

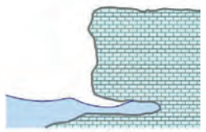


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



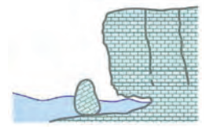
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



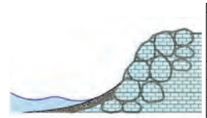
TYPE A - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



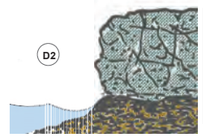
TYPE B - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



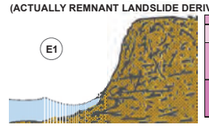
TYPE C - CLIFFS		
VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

REFER TO SCOTLAND DISTRICT MAP SERIES

(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS			
SETBACK CATEGORY			TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

LEGEND

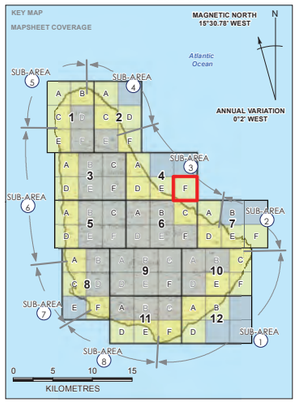
COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]

KEY MAP



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI)
COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 3 - SHEET 4F

REFERENCE(S) AND NOTE(S):

1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017.

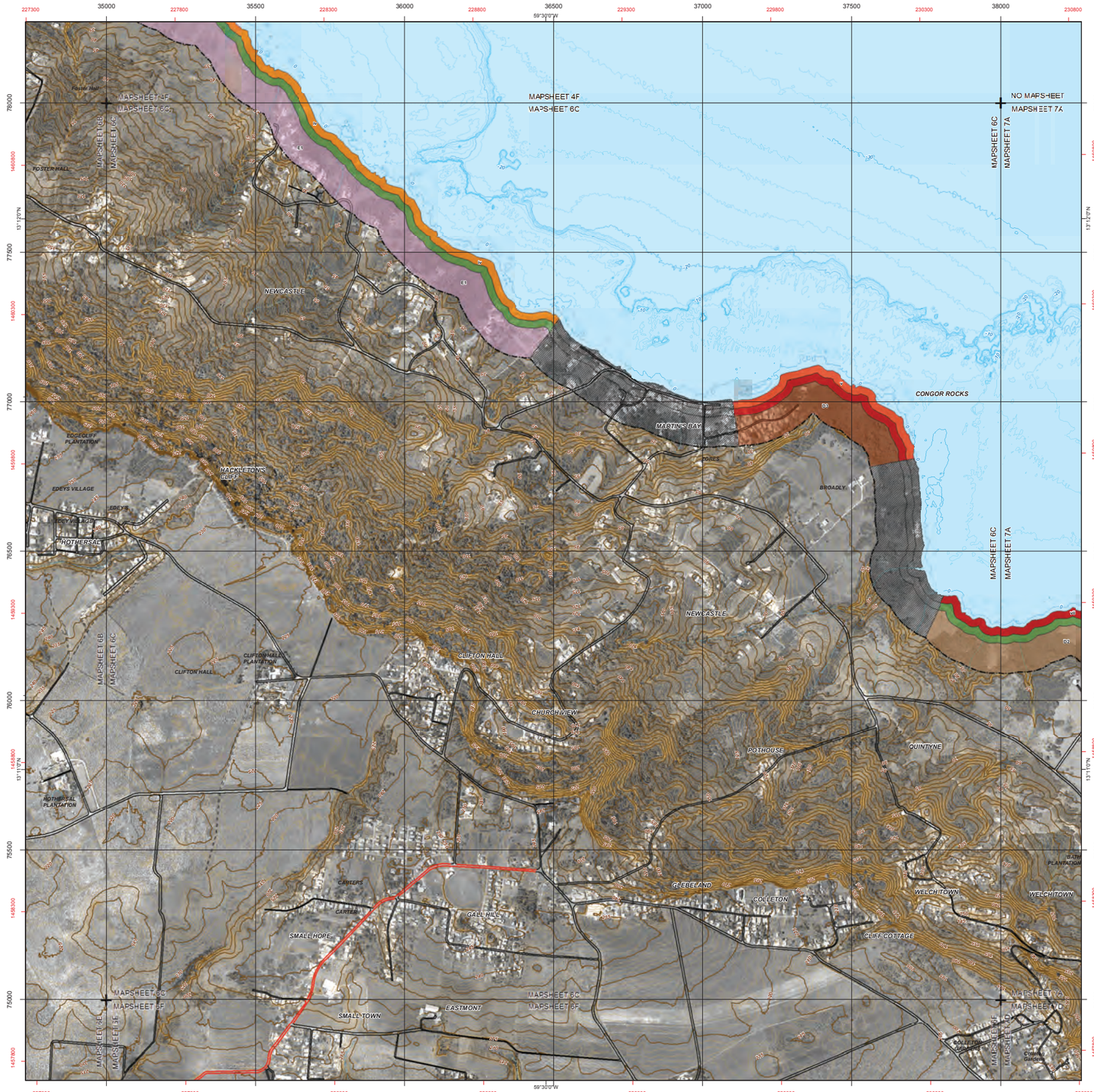
MAP SERIES	MAPSHEET	DATE
003	4F	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird

Golder Associates

S:\Clients\Barbados\Work\R_PROJ\13-1111\GIS_DATA\assessment_PROJ\GSI_Coastal_Zone_Mapping\2017\03\GSI-CCRA-003_CliffClassification.mxd



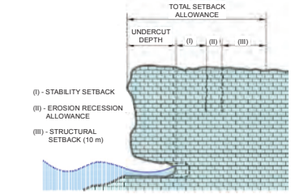
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

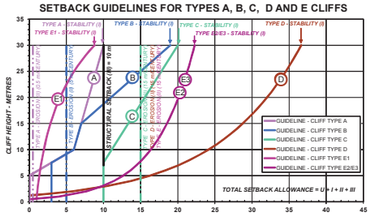
RISK CLASS	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS: FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	FORBIDDEN	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	CONDITIONAL	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	ALLOWABLE	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

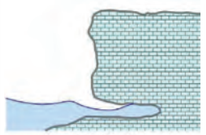


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



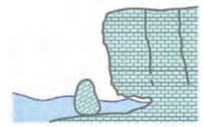
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



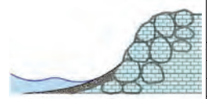
TYPE A - CLIFFS	AVERAGE UCS (MPa)	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
UNDERCUT DEPTH			
<1 m		A0a	A0b
1 to 2 m		A1a	A1b
2 to 4 m		A2a	A2b
4 to 7 m		A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



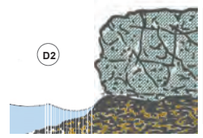
TYPE B - CLIFFS	AVERAGE UCS (MPa)	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
UNDERCUT DEPTH			
<1 m		B0a	B0b
1 to 2 m		B1a	B1b
2 to 4 m		B2a	B2b
4 to 7 m		B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



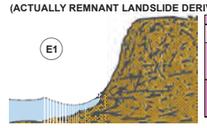
TYPE C - CLIFFS	VUGGINESS	MINOR VOIDS	MAJOR VOIDS
CLIFF HEIGHT			
1 to 2 m		C0a	C0b
2 to 5 m		C1a	C1b
5 to 10 m		C2a	C2b
>10 m		C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

REFER TO SCOTLAND DISTRICT MAP SERIES

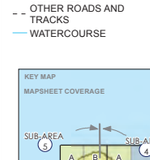
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS				
SETBACK CATEGORY				TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES		ARCUATE OVERHANGS	
i	i		i	18.0
ii	ii		ii	20.0
iii	iii		iii	25.0
iv	iv		iv	35.0
v	v		v	45.0
vi	vi		vi	55.0
vii	vii		vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

LEGEND

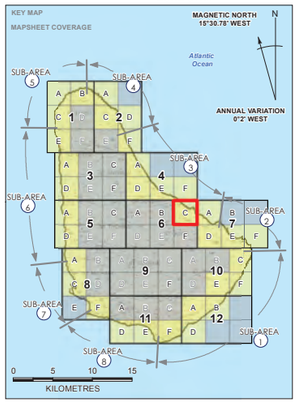
COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]

KEY MAP



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI) COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 3 - SHEET 6C

REFERENCE(S) AND NOTE(S):

1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

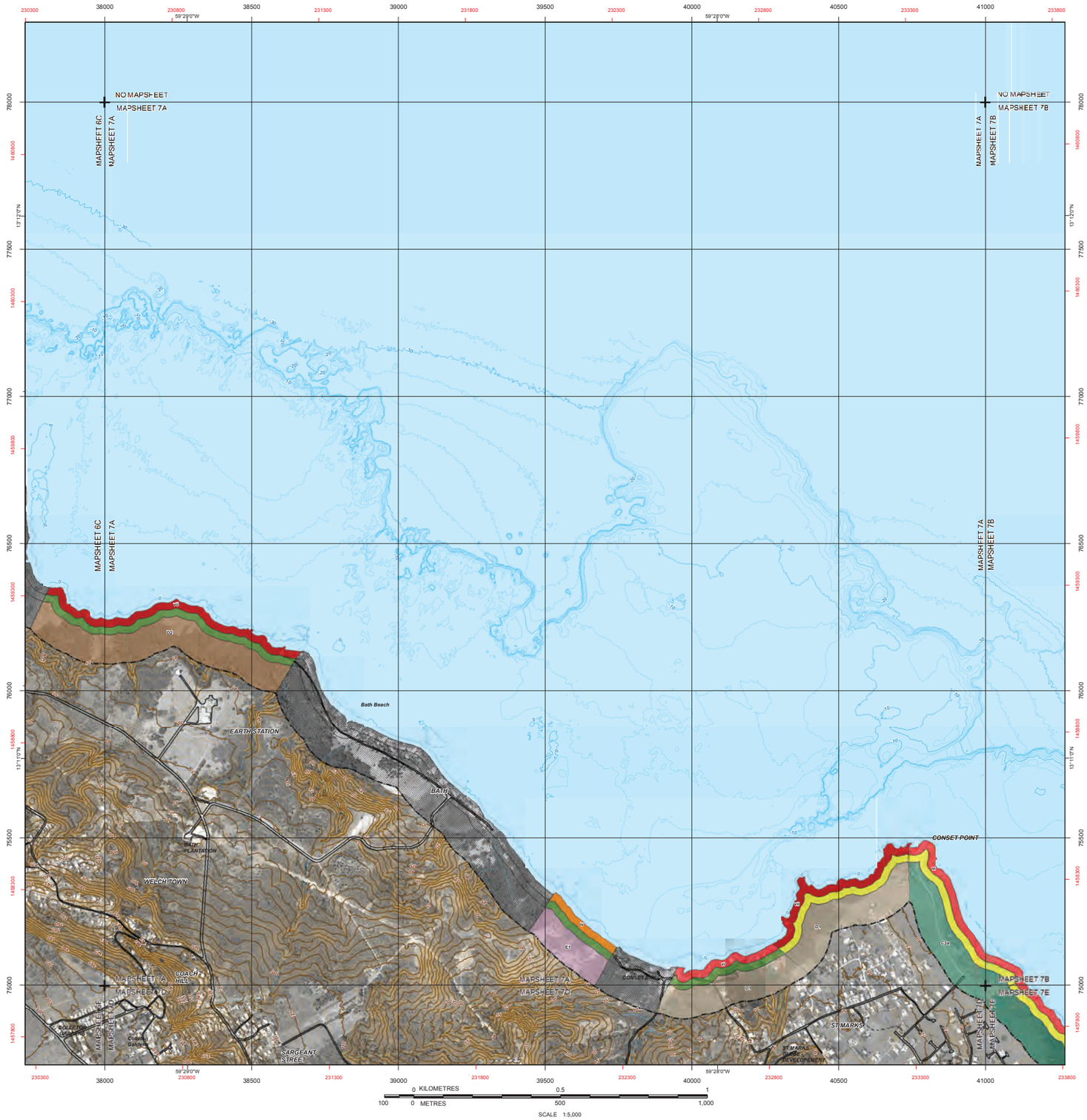
MAP SERIES	MAPSHEET	DATE
003	6C	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird

Golder Associates

S:\Cartel\Barbados\GIS_PROJECTS\COZO_GIS\Classification\MXD\BDS_CoastalClassification_Sheet6C_20170313.mxd



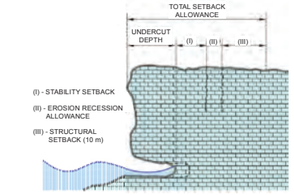
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

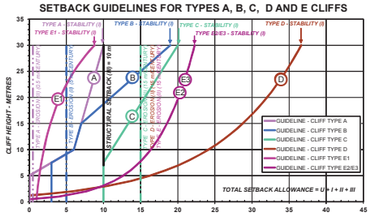
RISK CLASS	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS					
	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	**FORBIDDEN**	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	**CONDITIONAL**	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	**ALLOWABLE**	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

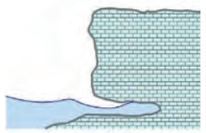


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



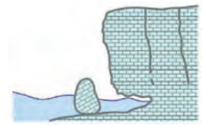
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



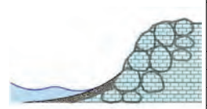
TYPE A - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



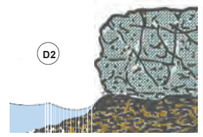
TYPE B - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



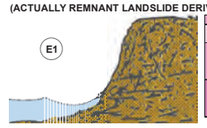
TYPE C - CLIFFS		
VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

REFER TO SCOTLAND DISTRICT MAP SERIES

(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS			
SETBACK CATEGORY			TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

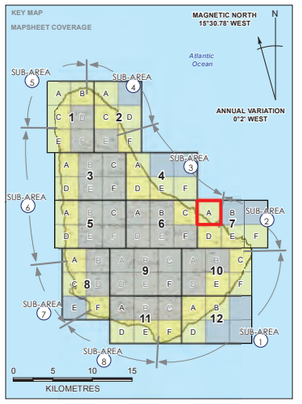
LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI) COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 3 - SHEET 7A

REFERENCE(S) AND NOTE(S)

1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	7A	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird

Golder Associates

© Government of Barbados and Golder Associates



Map Projection and 500-metre Grid: Barbados National Grid 1938
Supplementary 500-metre Grid Labels: Universal Transverse Mercator, Zone 21

Magnetic North Declination: 15°30.78' W, Annual Variation 0°2' W, 09-01-2015

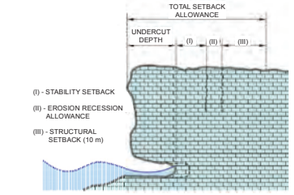
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

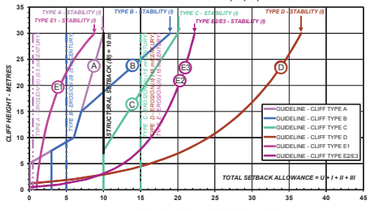
RISK CLASS	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS: FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	FORBIDDEN	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	CONDITIONAL	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	ALLOWABLE	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

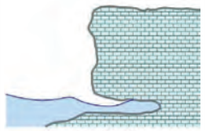


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



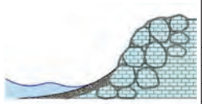
TYPE A - CLIFFS: AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



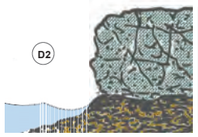
TYPE B - CLIFFS: AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



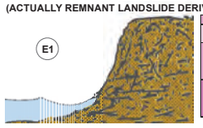
TYPE C - CLIFFS: VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

REFER TO SCOTLAND DISTRICT MAP SERIES

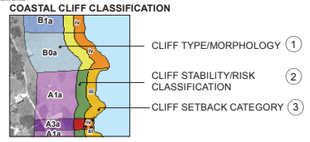
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS: SETBACK CATEGORY — COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	TOTAL SETBACK (U + I + II + III) (m)
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY
- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI) COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 3 - SHEET 7D

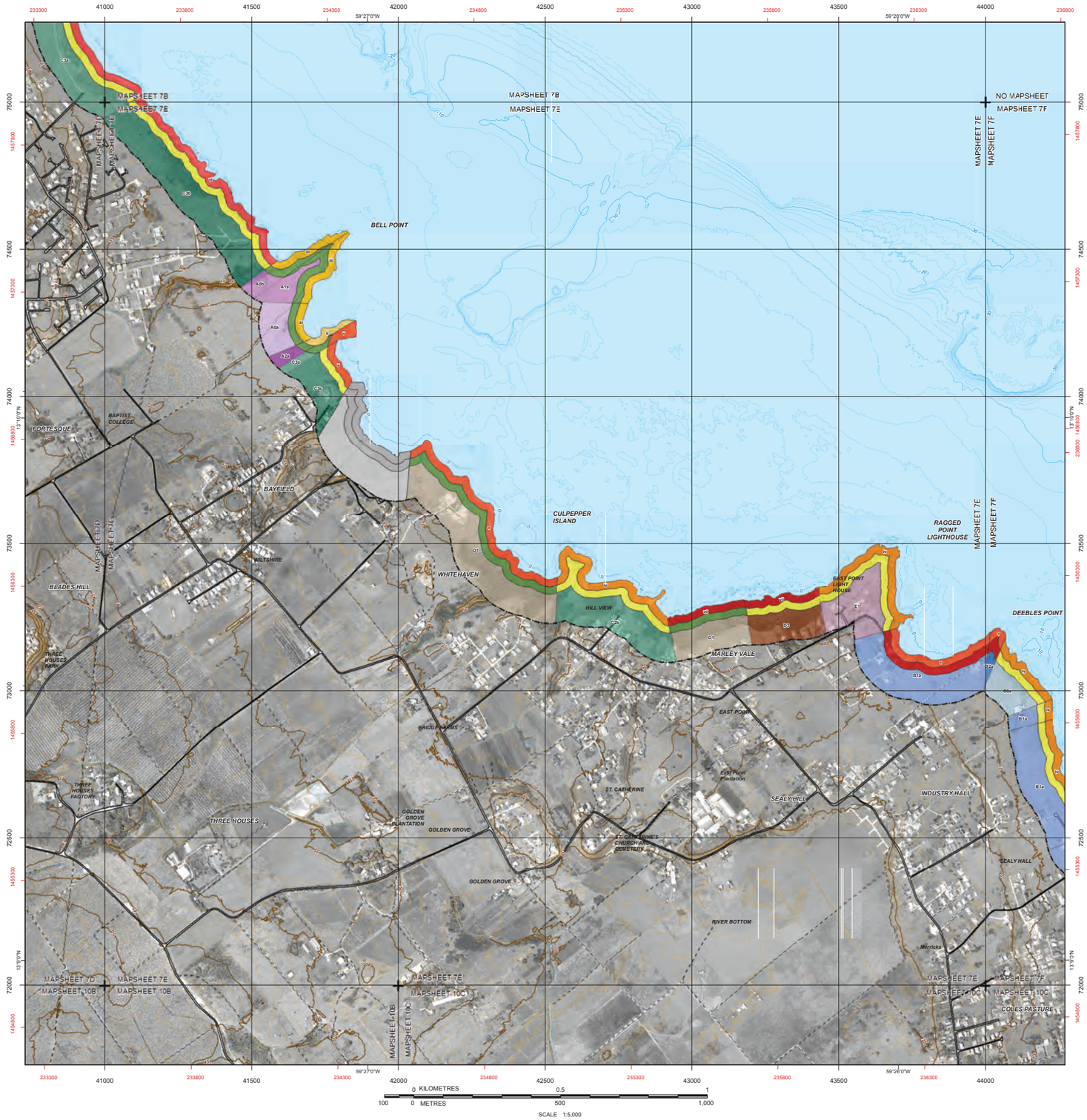
REFERENCE(S) AND NOTE(S):
1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDRYN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	7D	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird | Golder Associates

© Coastal Zone Management Unit, Barbados, 2017



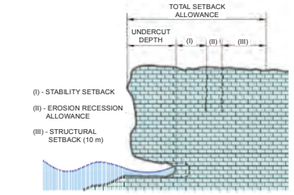
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

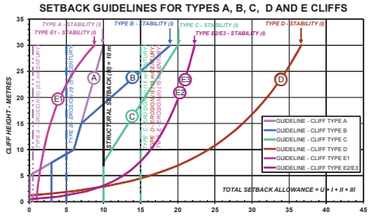
RISK CLASS	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS: FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	FORBIDDEN	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	CONDITIONAL	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	ALLOWABLE	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

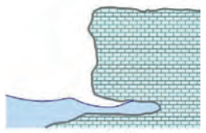


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



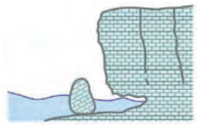
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



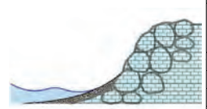
TYPE A - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



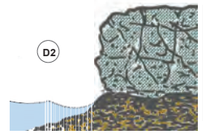
TYPE B - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



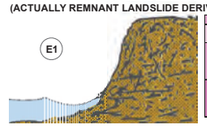
TYPE C - CLIFFS		
VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

NOT CLASSIFIED *

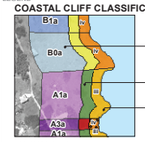
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS			
SETBACK CATEGORY			TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI) COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 2 - SHEET 7E

REFERENCE(S) AND NOTE(S):

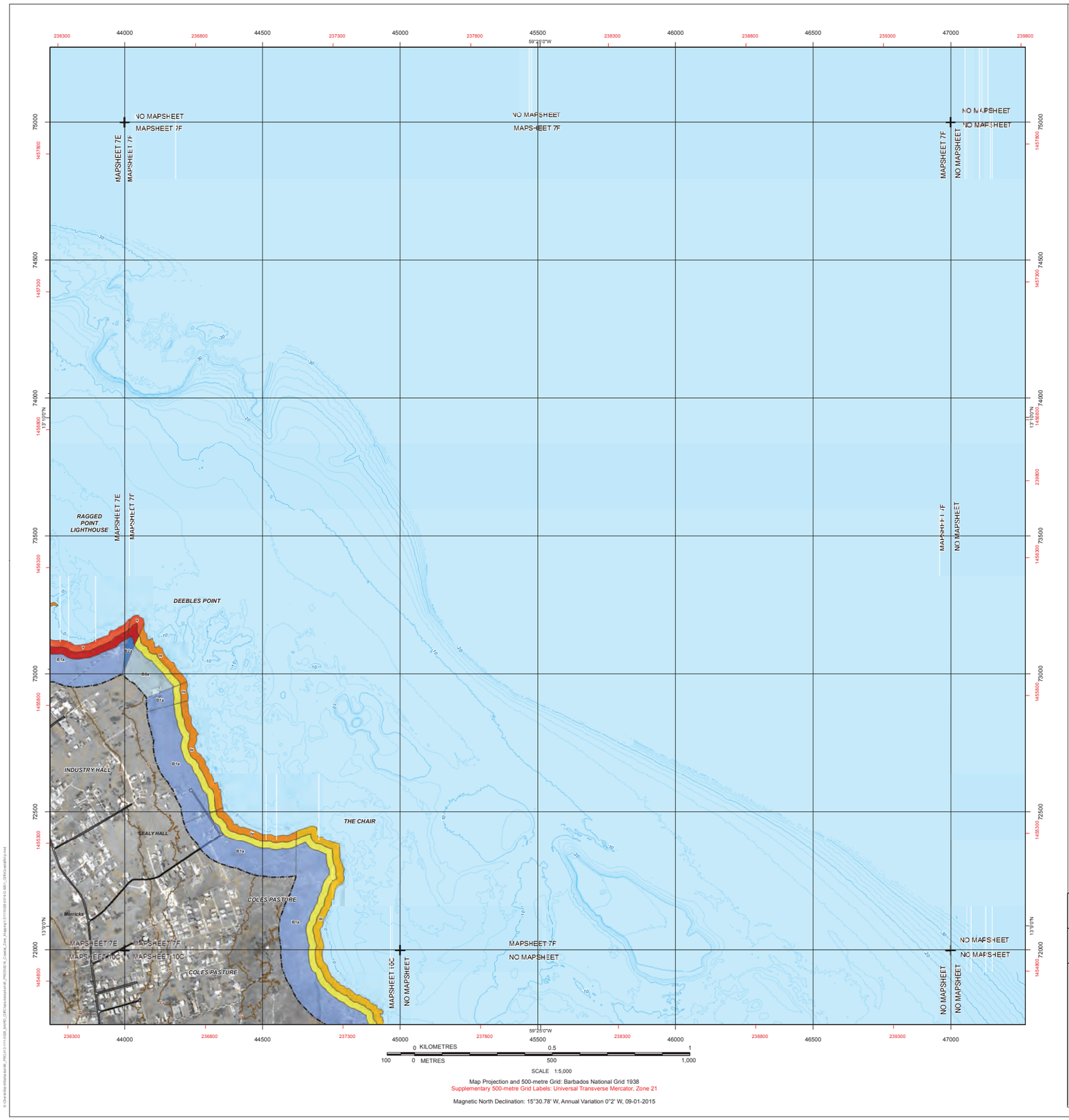
1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	7E	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird | Golder Associates

© Coastal Zone Management Unit, 2016 | J:\Projects\1114\1114-2016_2245_CZMU\reports\final_PROGRAM_Coastal_Zone_Mapping\111411422016-0161_CZMU\coastal\final.mxd



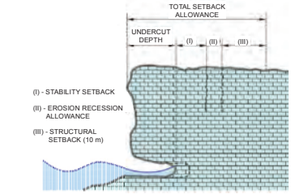
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

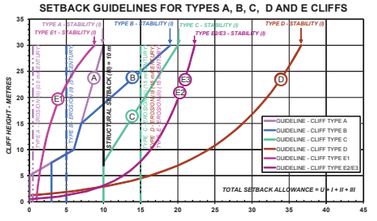
RISK CLASS	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS: FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	FORBIDDEN	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	CONDITIONAL	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	ALLOWABLE	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

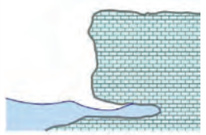


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



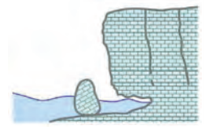
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



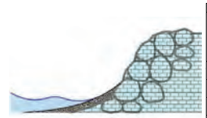
TYPE A - CLIFFS: UNDERCUT DEPTH \ AVERAGE UCS (MPa)	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



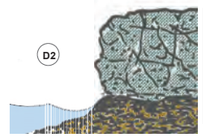
TYPE B - CLIFFS: UNDERCUT DEPTH \ AVERAGE UCS (MPa)	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



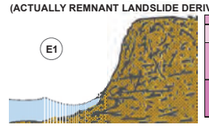
TYPE C - CLIFFS: CLIFF HEIGHT \ VUGGINESS	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

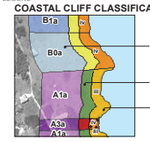
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS: SETBACK CATEGORY — COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	TOTAL SETBACK (U + I + II + III) (m)
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]

KEY MAP



REFERENCE(S) AND NOTE(S):

1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI)
COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 2 - SHEET 7F

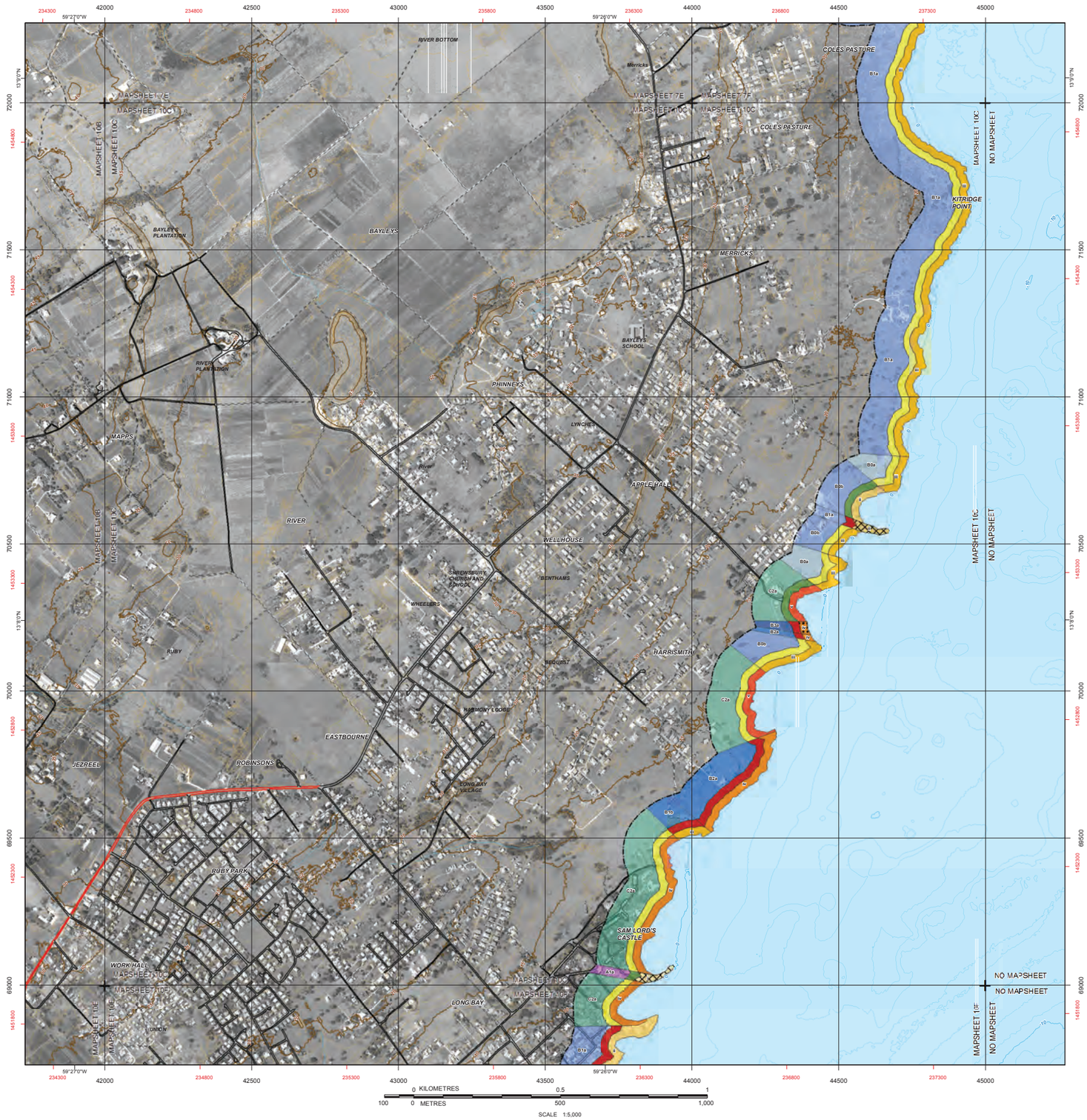
MAP SERIES	MAPSHEET	DATE
003	7F	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird

Golder Associates

S:\Data\Data\Data\GIS_PROJ\13-1111\GIS_DATA\Coastal\Data_PRODUCTS_Coastal_Zone_Mapping\7F\1111g13-01-001_CRSCoastalMap.mxd



Map Projection and 500-metre Grid: Barbados National Grid 1938
Supplementary 500-metre Grid Labels: Universal Transverse Mercator, Zone 21

Magnetic North Declination: 15°30.78' W, Annual Variation 0°2' W, 09-01-2015

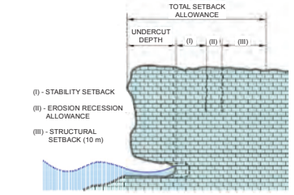
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

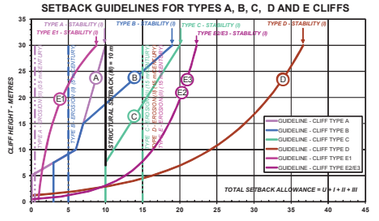
RISK CLASS	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS					
	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	**FORBIDDEN**	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	**CONDITIONAL**	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	**ALLOWABLE**	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

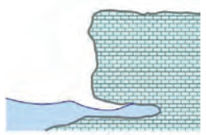


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



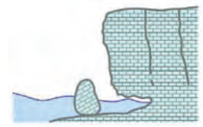
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



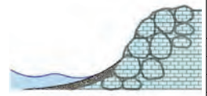
TYPE A - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



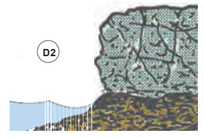
TYPE B - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



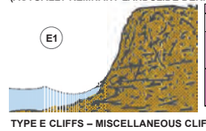
TYPE C - CLIFFS		
VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

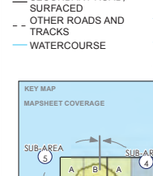
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS			
SETBACK CATEGORY			TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI)
COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 1 - SHEET 10C

REFERENCE(S) AND NOTE(S):

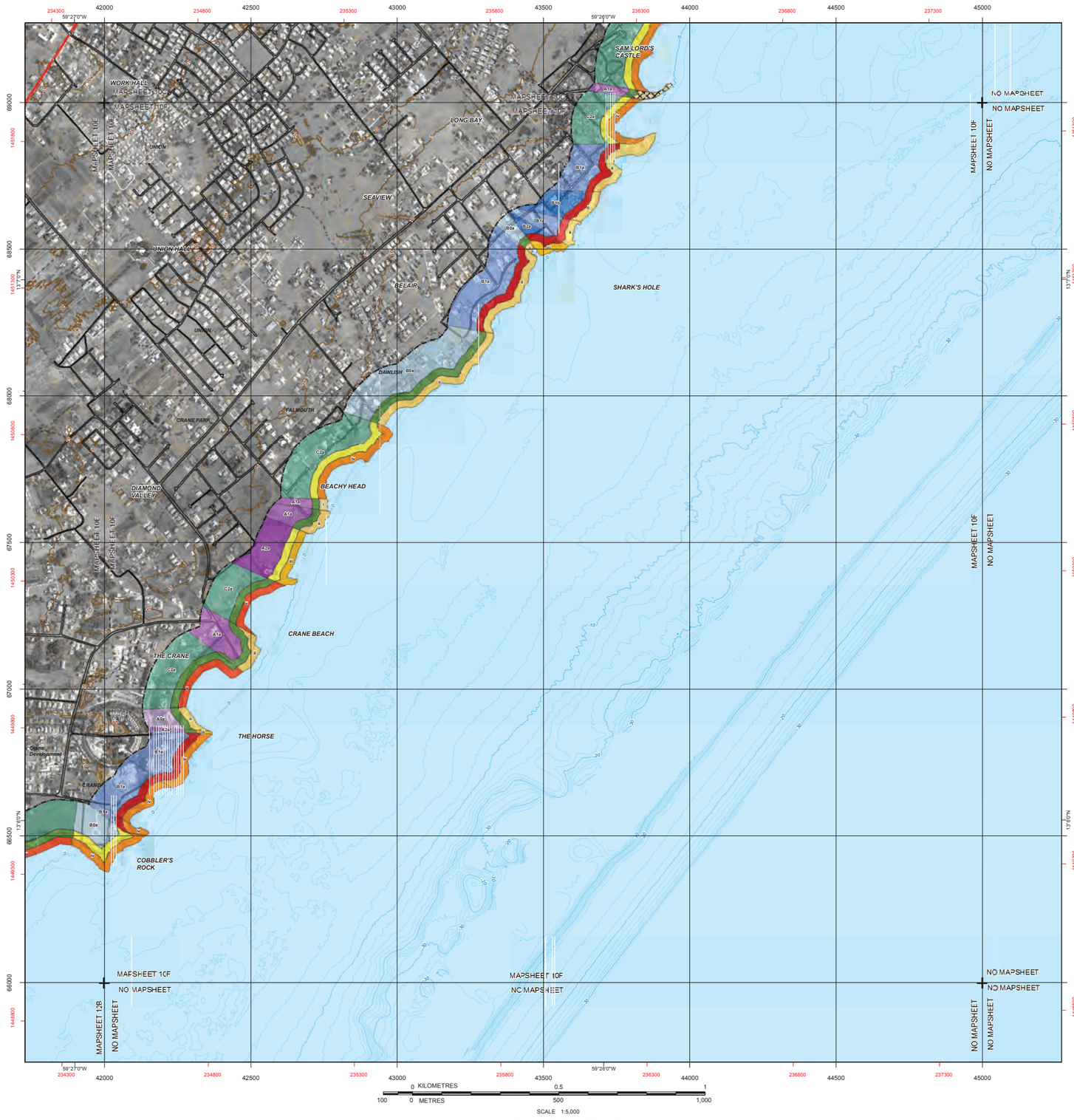
1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	10C	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird

Golder Associates



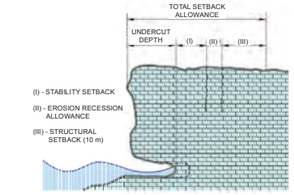
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

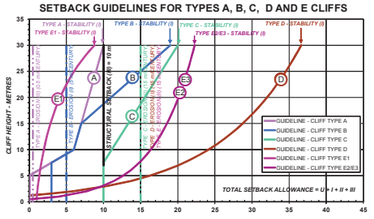
RISK CLASS	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS					
	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	FOR CONTINUED USE		FOR NEW OR FUTURE DEVELOPMENT
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	FORBIDDEN	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	CONDITIONAL	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	ALLOWABLE	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

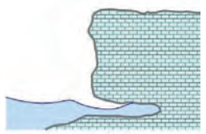


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



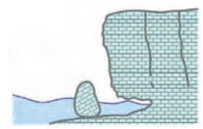
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



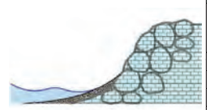
TYPE A - CLIFFS		
UNDERCUT DEPTH \ AVERAGE UCS (MPa)	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



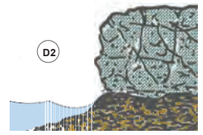
TYPE B - CLIFFS		
UNDERCUT DEPTH \ AVERAGE UCS (MPa)	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



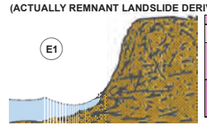
TYPE C - CLIFFS		
CLIFF HEIGHT \ VUGGINESS	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

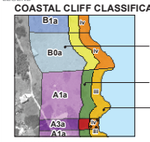
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS			
SETBACK CATEGORY			TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

LEGEND

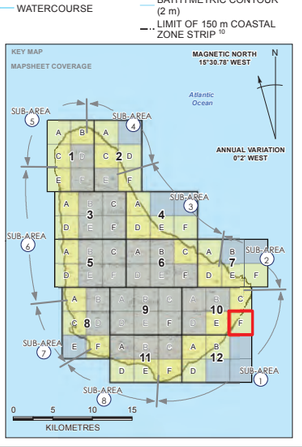
COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]

KEY MAP



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI)
COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 1 - SHEET 10F

REFERENCE(S) AND NOTE(S):

1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDRYN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	10F	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird | Golder Associates

© Coastal Zone Management Unit, Barbados, 2017



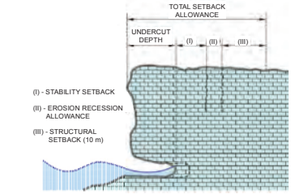
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

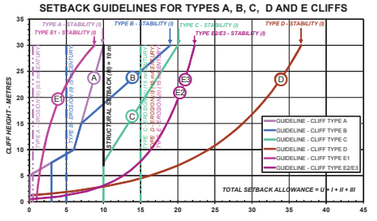
RISK CLASS	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS					
	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	**FORBIDDEN**	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	**CONDITIONAL**	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	**ALLOWABLE**	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

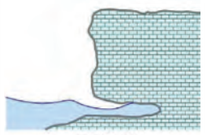


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



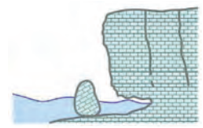
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



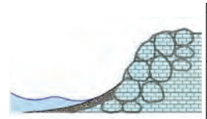
TYPE A - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



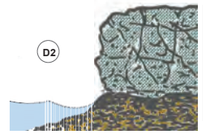
TYPE B - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



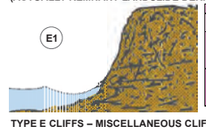
TYPE C - CLIFFS		
VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

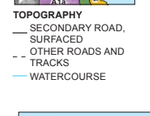
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS			
SETBACK CATEGORY			TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

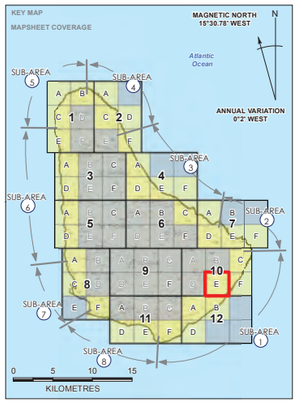
NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY
- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI) COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 1 - SHEET 10E

REFERENCE(S) AND NOTE(S)

1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

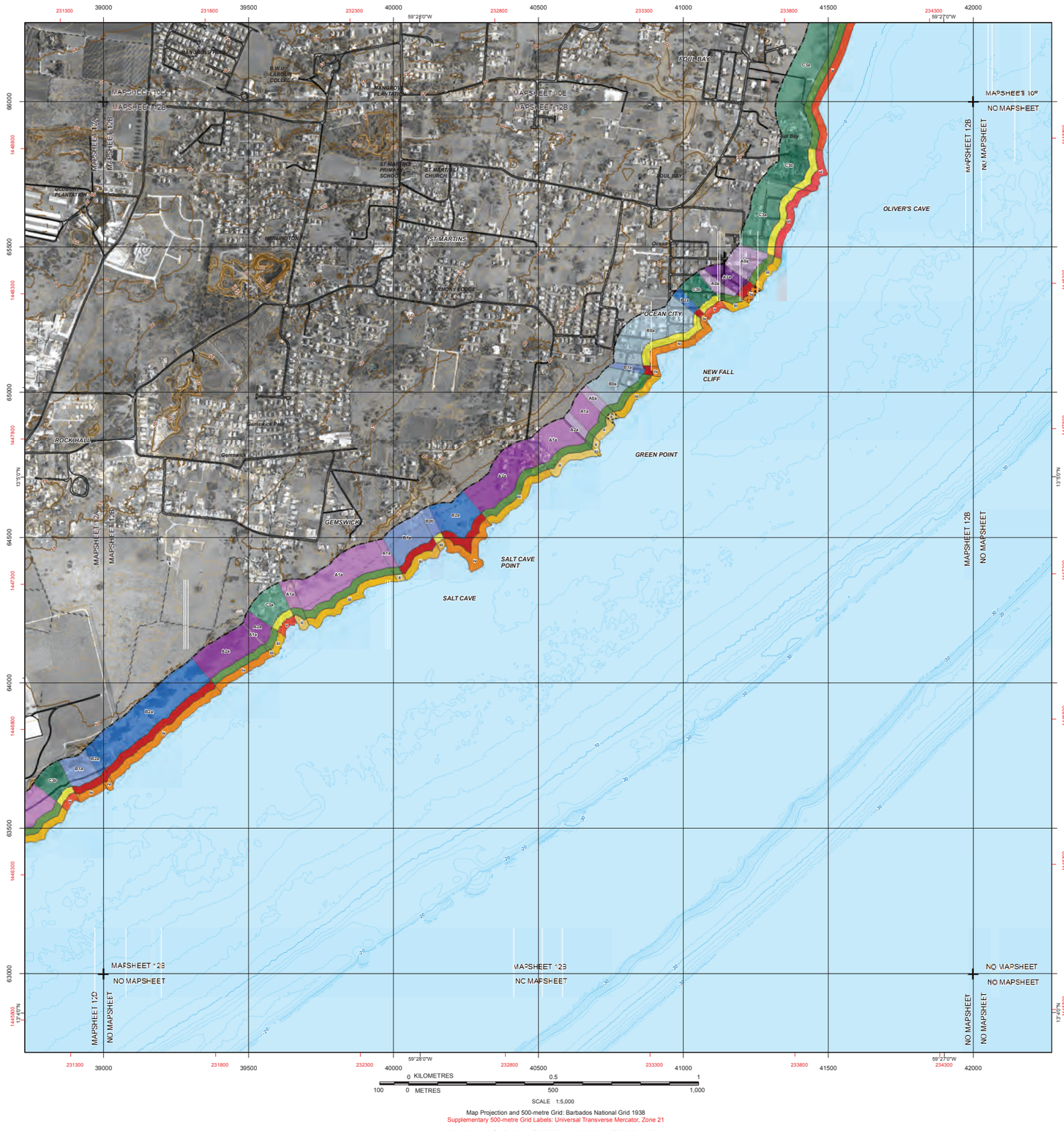
MAP SERIES	MAPSHEET	DATE
003	10E	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird

Golder Associates

© Crown Copyright reserved. (Reproduced with permission of the Director of Surveys, Barbados)



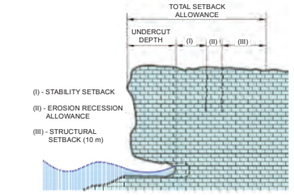
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

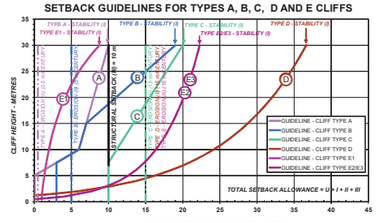
RISK CLASS	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS					
	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	**FORBIDDEN**	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	**CONDITIONAL**	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	**ALLOWABLE**	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

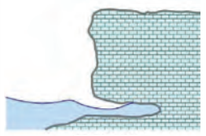


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



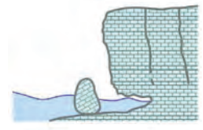
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



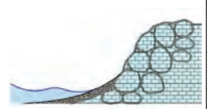
TYPE A - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



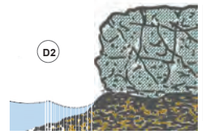
TYPE B - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



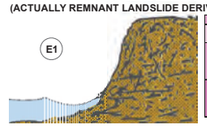
TYPE C - CLIFFS		
VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

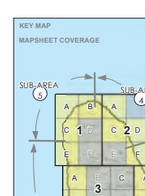
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS			
SETBACK CATEGORY			TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

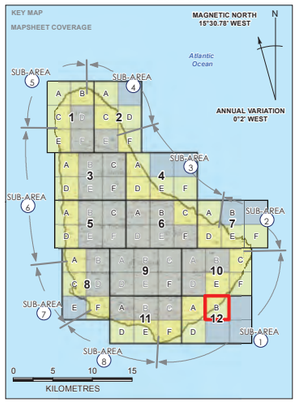
LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI)
COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 1 - SHEET 12B

REFERENCE(S) AND NOTE(S):

1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

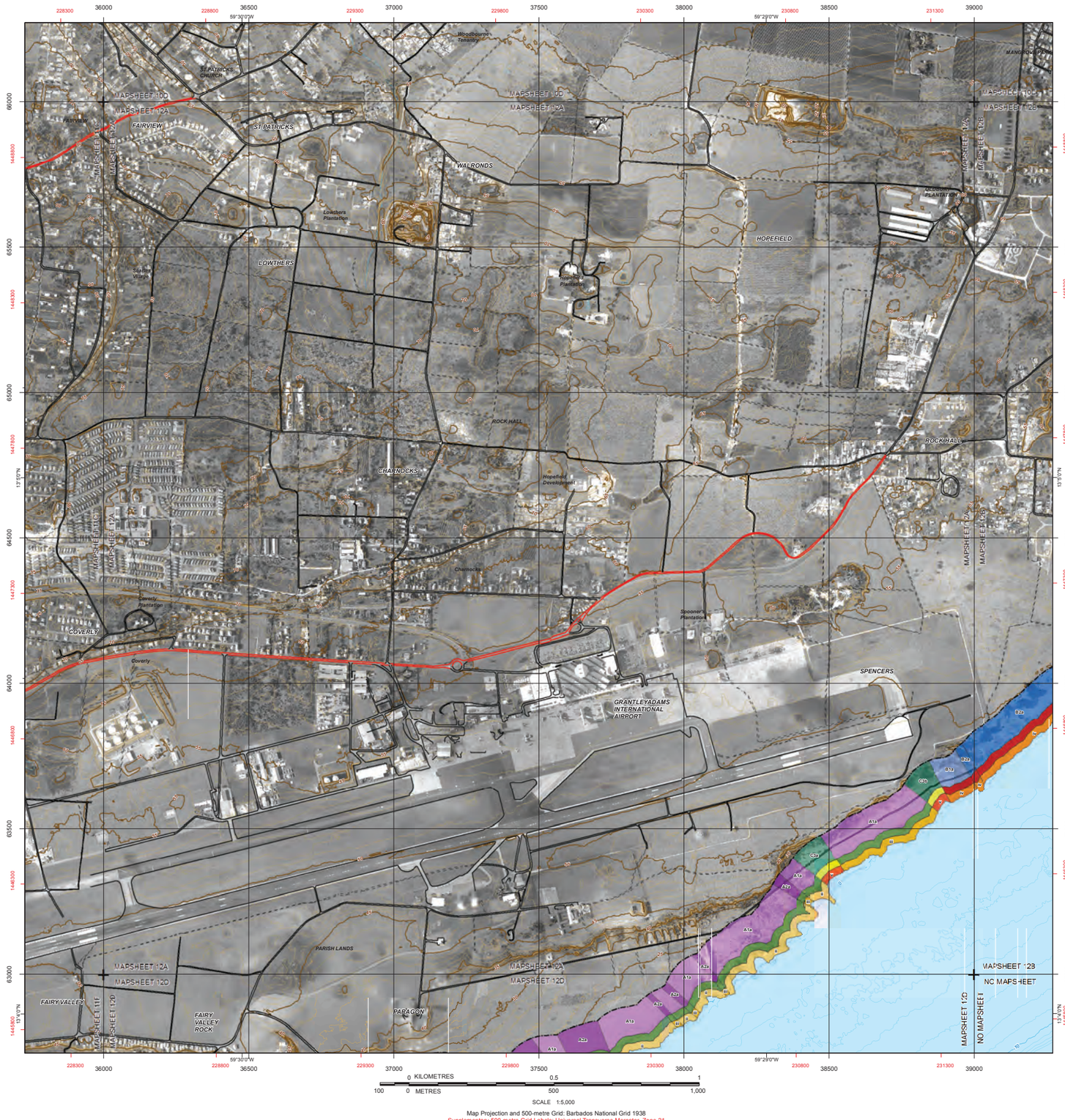
MAP SERIES	MAPSHEET	DATE
003	12B	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird

Golder Associates

© Coastal Zone Management Unit, Barbados, 2017



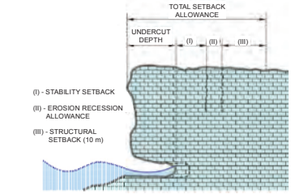
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

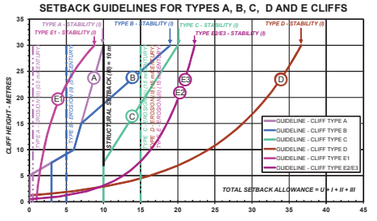
RISK CLASS	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS					
	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	FOR CONTINUED USE		FOR NEW OR FUTURE DEVELOPMENT
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	FORBIDDEN	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	CONDITIONAL	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	ALLOWABLE	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

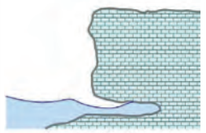


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



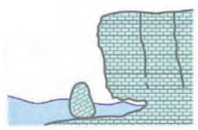
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



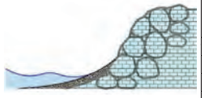
TYPE A - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



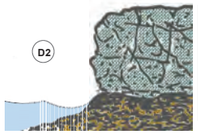
TYPE B - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



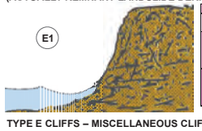
TYPE C - CLIFFS		
VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

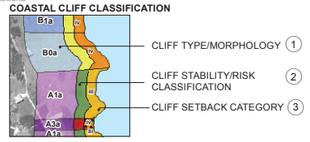
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS			
SETBACK CATEGORY			TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

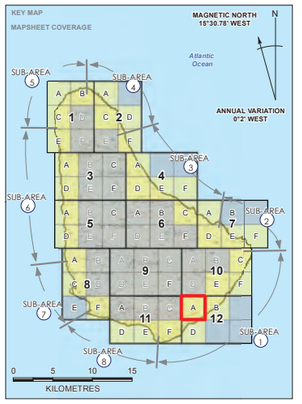
NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY
- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI) COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 1 - SHEET 12A

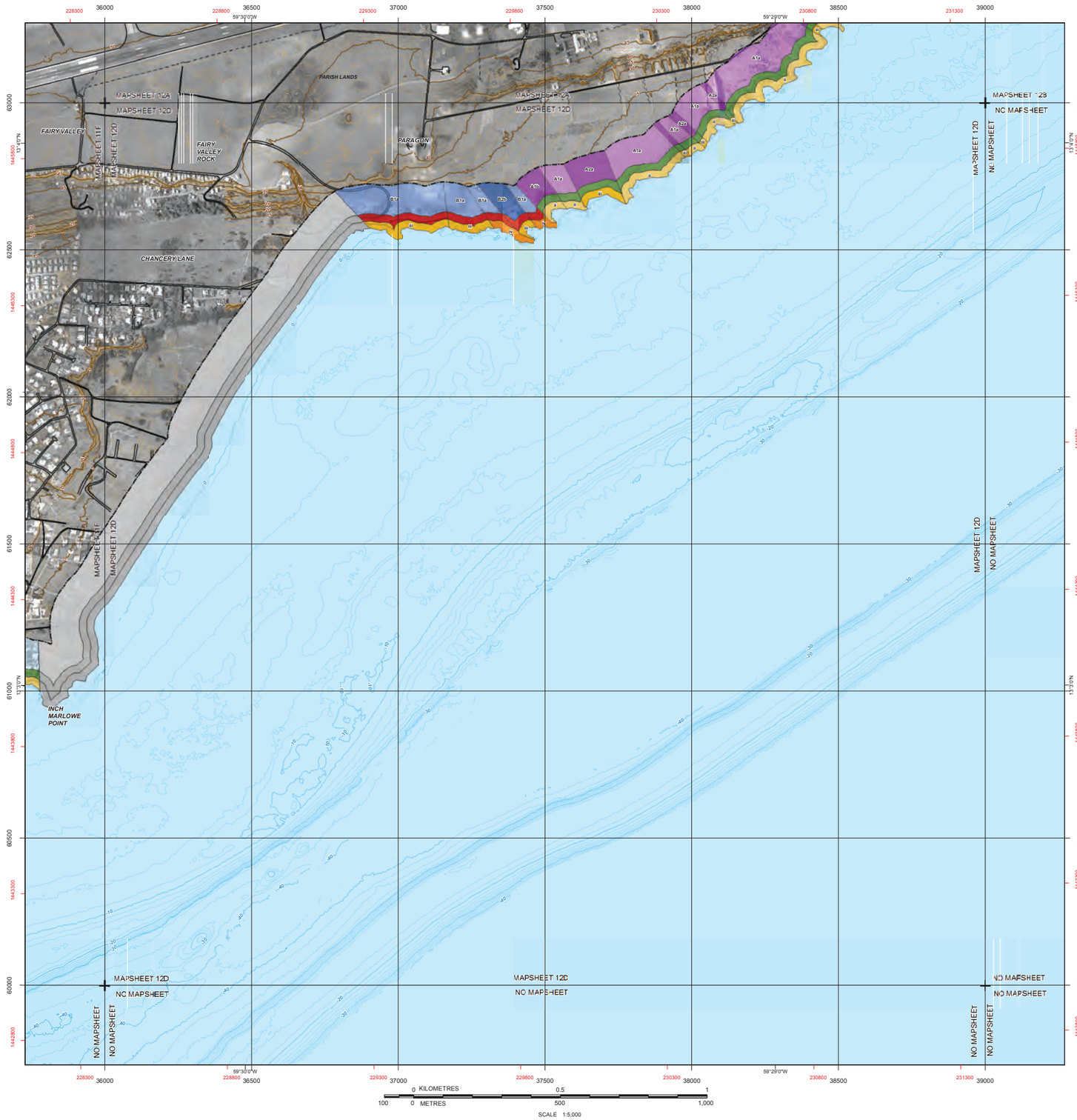
REFERENCE(S) AND NOTE(S):
1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDRYN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	12A	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird

Golder Associates



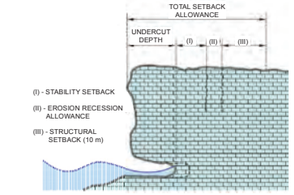
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

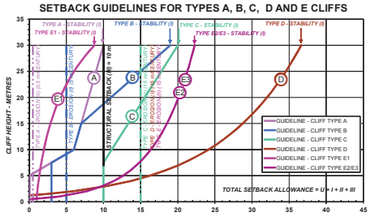
RISK CLASS	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS					
	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	FOR CONTINUED USE		FOR NEW OR FUTURE DEVELOPMENT
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	FORBIDDEN	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	CONDITIONAL	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	ALLOWABLE	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

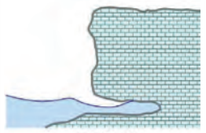


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



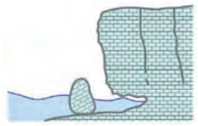
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



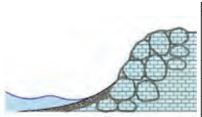
TYPE A - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



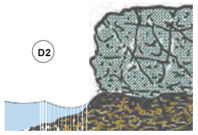
TYPE B - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



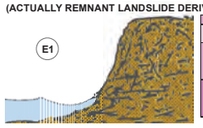
TYPE C - CLIFFS		
VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

NOT CLASSIFIED *

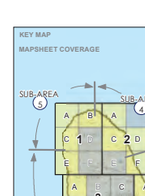
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS				
SETBACK CATEGORY				TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES		ARCUATE OVERHANGS	
i	i	i	i	18.0
ii	ii	ii	ii	20.0
iii	iii	iii	iii	25.0
iv	iv	iv	iv	35.0
v	v	v	v	45.0
vi	vi	vi	vi	55.0
vii	vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

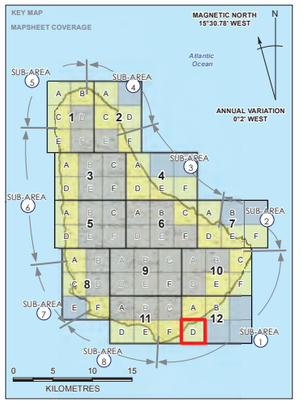
LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI)
COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 1 - SHEET 12D

REFERENCE(S) AND NOTE(S)

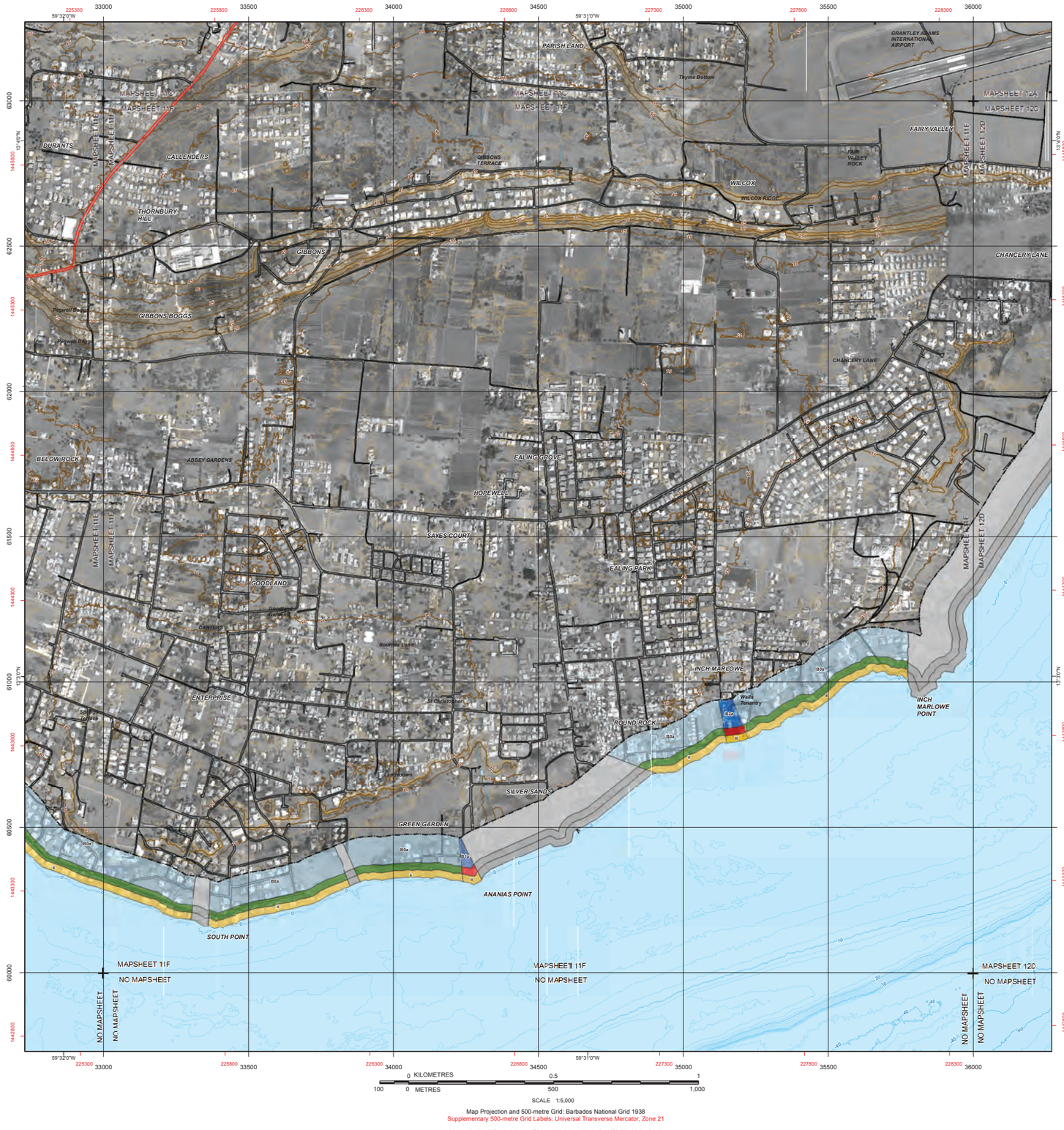
1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA. GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	12D	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird

Golder Associates



Map Projection and 500-metre Grid: Barbados National Grid 1938
Supplementary 500-metre Grid Labels: Universal Transverse Mercator, Zone 21

Magnetic North Declination: 15°30.78' W, Annual Variation 0°2' W, 09-01-2015

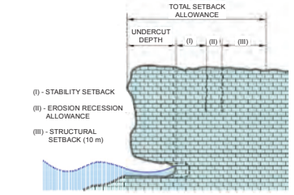
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

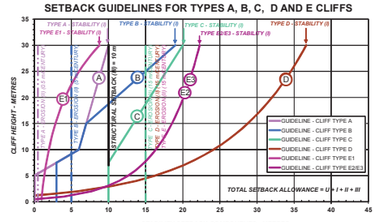
RISK CLASS	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS: FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	FORBIDDEN	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	CONDITIONAL	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	ALLOWABLE	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

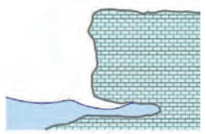


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



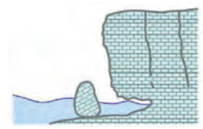
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



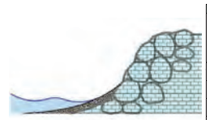
UNDERCUT DEPTH \ AVERAGE UCS (MPa)	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



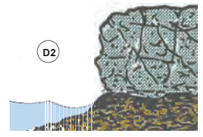
UNDERCUT DEPTH \ AVERAGE UCS (MPa)	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



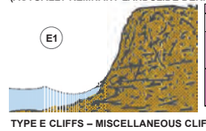
CLIFF HEIGHT \ VUGGINESS	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

NOT CLASSIFIED [9]

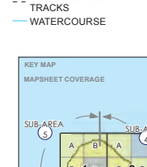
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS			
SETBACK CATEGORY			TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI) COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 1 - SHEET 11F

REFERENCE(S) AND NOTE(S):

1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA. GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO CLIFF DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	11F	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird

Golder Associates

S:\Data\Data\Data\GIS_PROJECTS\003_BARD_CZM\mxd\mxd\GSI_PROGRAM\GSI_Coastal_Zone_Mapping\11F\003-gsi-11f-final-assessment.mxd



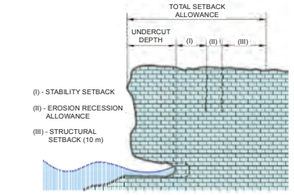
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

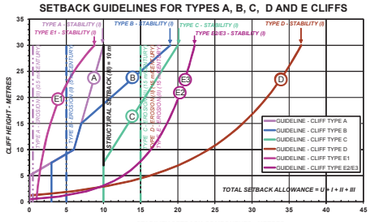
RISK CLASS	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS: FOR CONTINUED USE		FOR NEW OR FUTURE DEVELOPMENT
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	FORBIDDEN	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	CONDITIONAL	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	ALLOWABLE	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

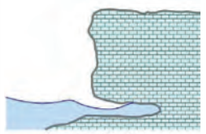


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



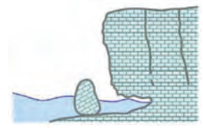
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



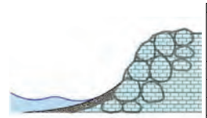
TYPE A - CLIFFS: AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



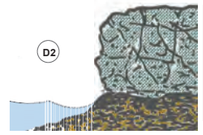
TYPE B - CLIFFS: AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



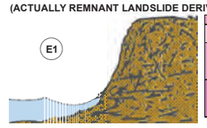
TYPE C - CLIFFS: VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

NOT CLASSIFIED *

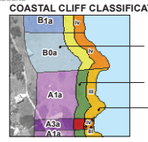
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS: SETBACK CATEGORY — COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	TOTAL SETBACK (U + I + II + III) (m)
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

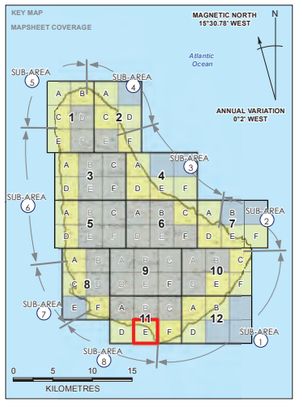
NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY
- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI)
COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 8 - SHEET 11E

REFERENCE(S) AND NOTE(S):
1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	11E	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird
Golder Associates



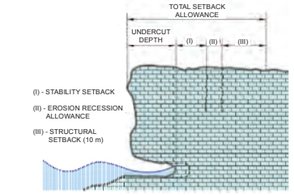
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

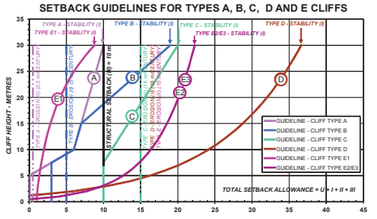
RISK CLASS	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS: FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	FORBIDDEN	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	CONDITIONAL	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	ALLOWABLE	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

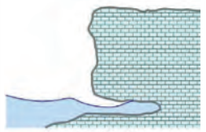


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



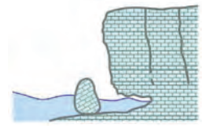
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



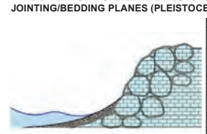
TYPE A - CLIFFS: AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



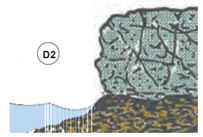
TYPE B - CLIFFS: AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



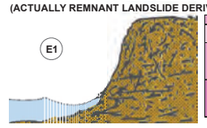
TYPE C - CLIFFS: VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

NOT CLASSIFIED [8]

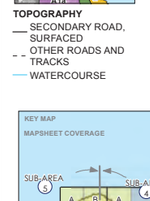
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS: SETBACK CATEGORY — COMMON CLIFFS	PROMONTARIES	ARCUATE OVERHANGS	TOTAL SETBACK (U + I + II + III) (m)
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

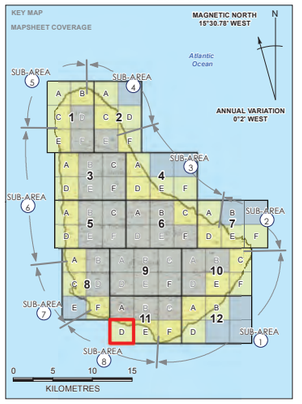
LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI) COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 8 - SHEET 11D

REFERENCE(S) AND NOTE(S)

1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	11D	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird | Golder Associates

© Crown and Baird and Golder Associates Ltd. (2016). [2017] Coastal Zone Management Unit. All rights reserved.



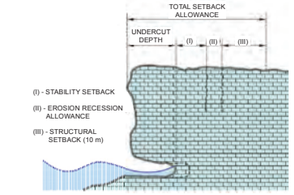
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

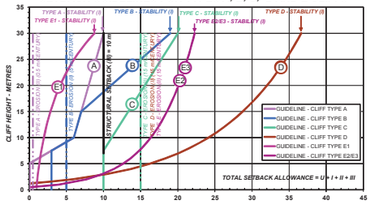
RISK CLASS	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS					
	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	**FORBIDDEN**	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	**CONDITIONAL**	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	**ALLOWABLE**	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

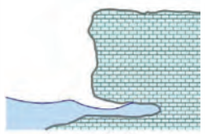


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



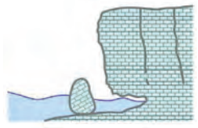
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



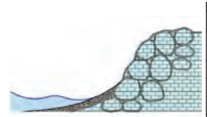
TYPE A - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



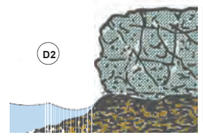
TYPE B - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



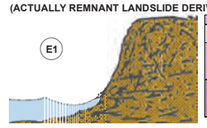
TYPE C - CLIFFS		
VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

NOT CLASSIFIED [9]

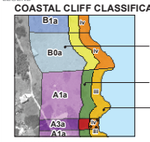
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS			
SETBACK CATEGORY			TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]

KEY MAP



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI) COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 8 - SHEET 8F

REFERENCE(S) AND NOTE(S):

1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA. GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO CLIFF CLASSIFICATION SYSTEM. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	8F	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird | Golder Associates

© Crown Copyright Reserved. [WORK IN PROGRESS_DRAFT_DATA]\mxd\GSI_Coastal_Zone_Mapping_20170502\GSI-003_CZMCoastalSlip.mxd



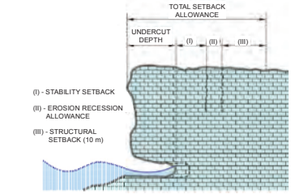
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

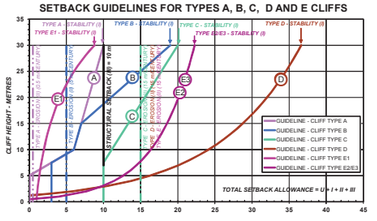
RISK CLASS	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS: FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	FORBIDDEN	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	CONDITIONAL	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	ALLOWABLE	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

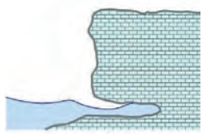


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



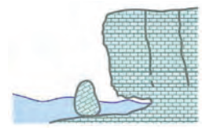
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



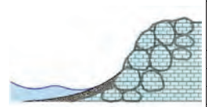
TYPE A - CLIFFS: AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



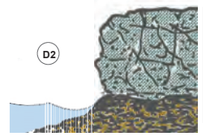
TYPE B - CLIFFS: AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



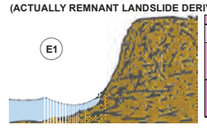
TYPE C - CLIFFS: VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

NOT CLASSIFIED [9]

(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS: SETBACK CATEGORY — COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	TOTAL SETBACK (U + I + II + III) (m)
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

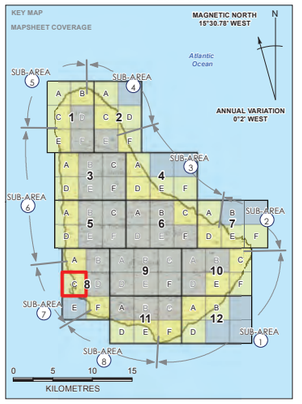
LEGEND

COASTAL CLIFF CLASSIFICATION

TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]

KEY MAP



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI) COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 7 - SHEET 8C

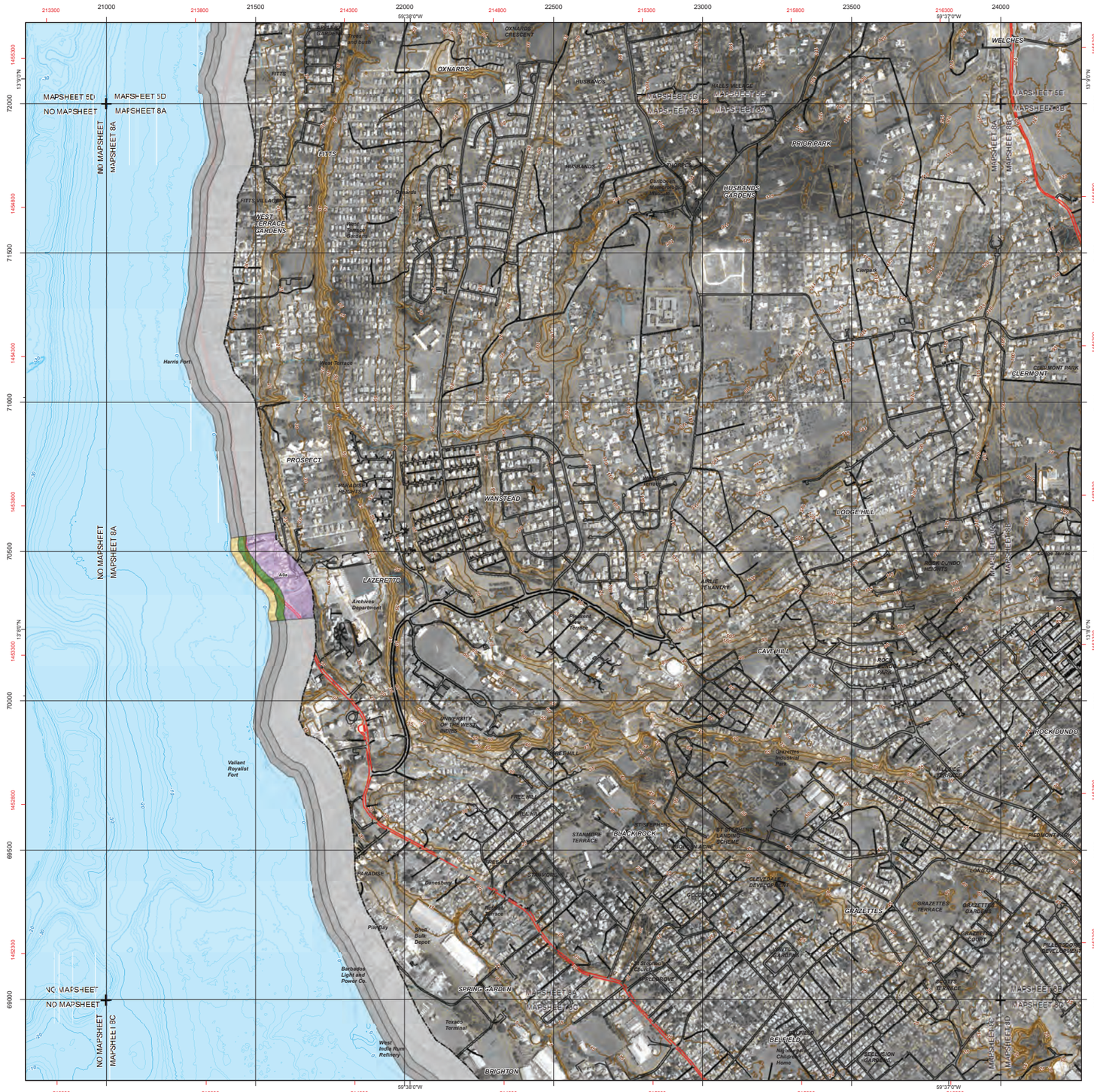
REFERENCE(S) AND NOTE(S):

1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	8C	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird | Golder Associates



Map Projection and 500-metre Grid: Barbados National Grid 1938
Supplementary 500-metre Grid Labels: Universal Transverse Mercator, Zone 21

Magnetic North Declination: 15°30.78' W, Annual Variation 0°2' W, 09-01-2015

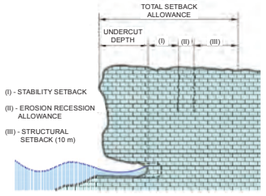
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

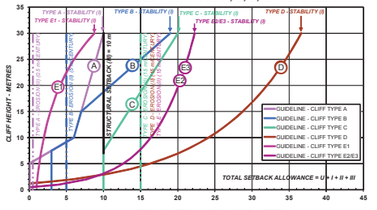
RISK CLASS	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS					
	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	**FORBIDDEN**	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	**CONDITIONAL**	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	**ALLOWABLE**	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

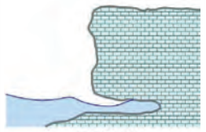


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



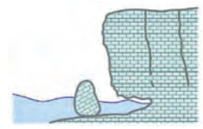
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



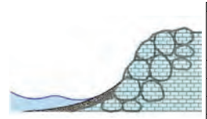
TYPE A - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



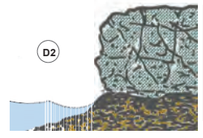
TYPE B - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



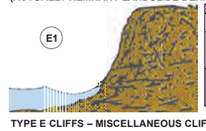
TYPE C - CLIFFS		
VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

NOT CLASSIFIED [9]

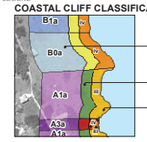
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS			
SETBACK CATEGORY			TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

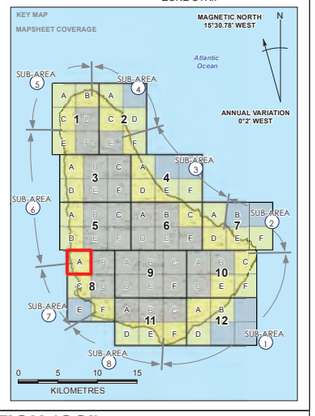
LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI) COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 6 / 7 - SHEET 8A

REFERENCE(S) AND NOTE(S):

1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	8A	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird

Golder Associates



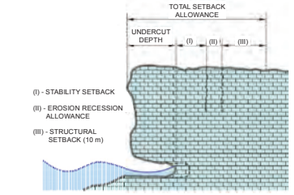
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

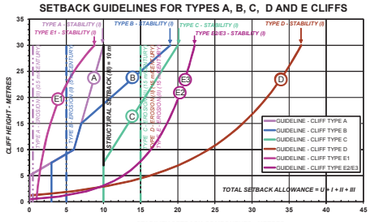
RISK CLASS	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS					
	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	**FORBIDDEN**	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	**CONDITIONAL**	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	**ALLOWABLE**	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

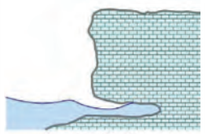


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



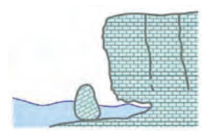
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



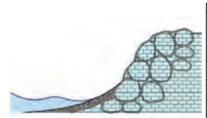
TYPE A - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



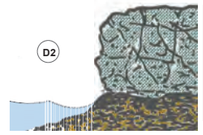
TYPE B - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



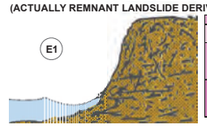
TYPE C - CLIFFS		
VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

NOT CLASSIFIED [9]

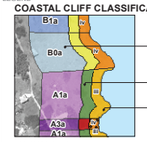
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS			
SETBACK CATEGORY			TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

LEGEND

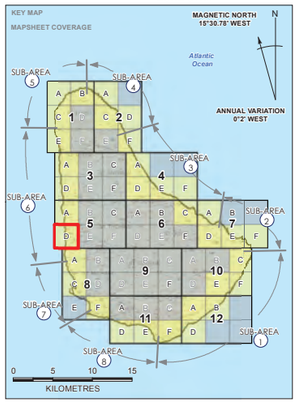
COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]

KEY MAP



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI) COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 6 - SHEET 5D

REFERENCE(S) AND NOTE(S):

1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDRYN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	5D	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird

Golder Associates

© G:\Jobs\Barbados\09_PROJECTS\1115\GSI_RAMP_CliffClassification\[5D]\2016_Coastal_Zone_Mapping(13115GSI2016-01-08).CliffClassification.mxd



Map Projection and 500-metre Grid: Barbados National Grid 1938
Supplementary 500-metre Grid Labels: Universal Transverse Mercator, Zone 21

Magnetic North Declination: 15°30.78' W, Annual Variation 0°2' W, 09-01-2015

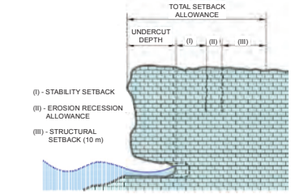
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

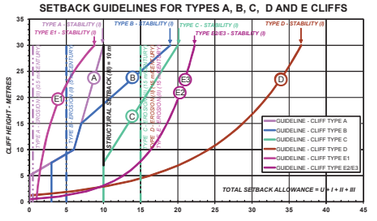
RISK CLASS	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS					
	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	**FORBIDDEN**	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	**CONDITIONAL**	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	**ALLOWABLE**	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

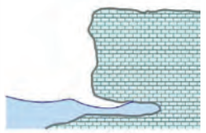


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



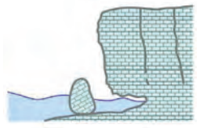
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



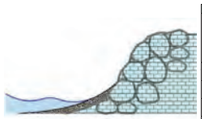
TYPE A - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



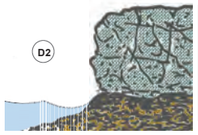
TYPE B - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



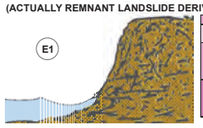
TYPE C - CLIFFS		
VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

NOT CLASSIFIED [4]

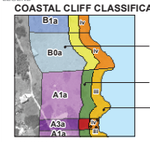
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS			
SETBACK CATEGORY			TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

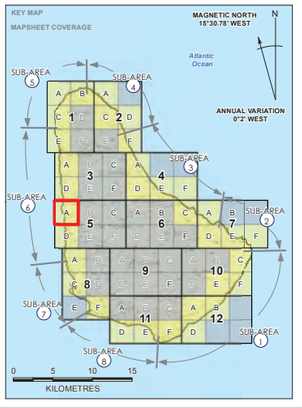
LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI)
COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 6 - SHEET 5A

REFERENCE(S) AND NOTE(S)

1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDRYN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S)
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	5A	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird
Golder Associates



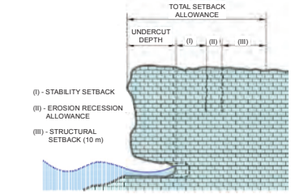
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

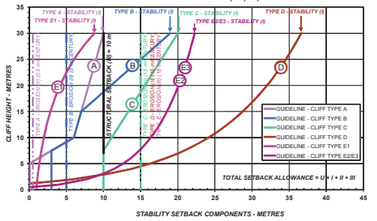
RISK CLASS	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS: FOR CONTINUED USE		FOR NEW OR FUTURE DEVELOPMENT
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	FORBIDDEN	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	CONDITIONAL	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	ALLOWABLE	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

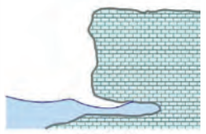


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



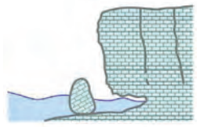
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



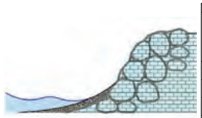
TYPE A - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



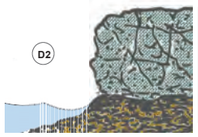
TYPE B - CLIFFS		
AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



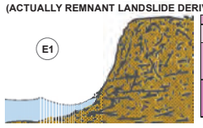
TYPE C - CLIFFS		
VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

NOT CLASSIFIED [9]

(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS			
SETBACK CATEGORY			TOTAL SETBACK (U + I + II + III) (m)
COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

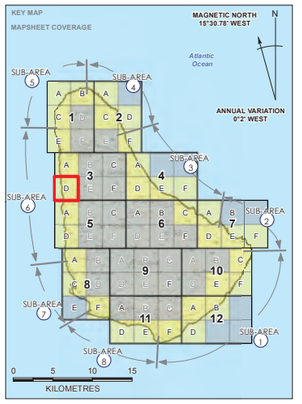
NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

LEGEND

COASTAL CLIFF CLASSIFICATION

TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI)
COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 6 - SHEET 3D

REFERENCE(S) AND NOTE(S):

1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	3D	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird

Golder Associates



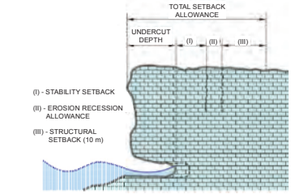
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

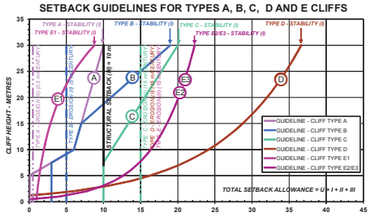
RISK CLASS	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS: FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	FORBIDDEN	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	CONDITIONAL	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	ALLOWABLE	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

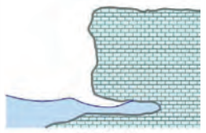


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



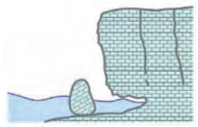
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



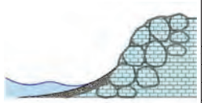
TYPE A - CLIFFS: AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



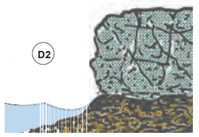
TYPE B - CLIFFS: AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



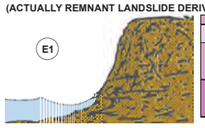
TYPE C - CLIFFS: VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

NOT CLASSIFIED [4]

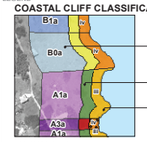
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS: SETBACK CATEGORY — COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	TOTAL SETBACK (U + I + II + III) (m)
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]

KEY MAP



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI) COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 6 - SHEET 3A

REFERENCE(S) AND NOTE(S):

1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

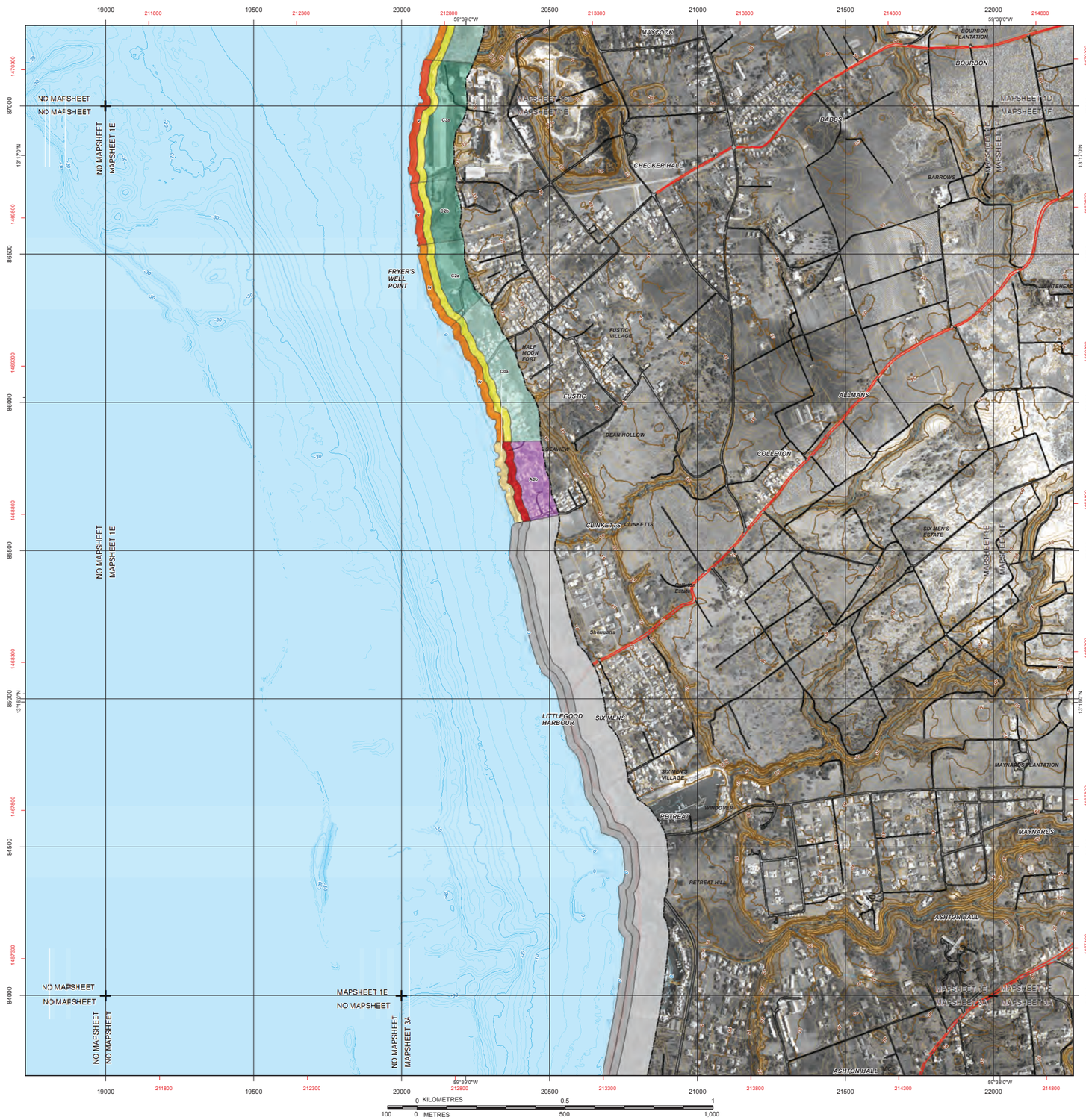
MAP SERIES	MAPSHEET	DATE
003	3A	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird

Golder Associates

© Coastal Zone Management Unit, 2017 | 2017-03-03 | 2017_CZMU Sprints\Arcmap_PROJECTS_Coastal_Zone_Mapping\11111\GSI\2016-0365_CZMU Coastal Risk.mxd



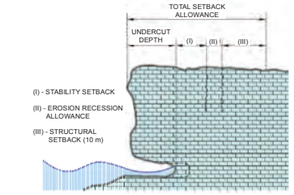
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

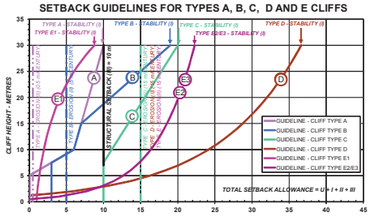
RISK CLASS	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS: FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	FORBIDDEN	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	CONDITIONAL	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	ALLOWABLE	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

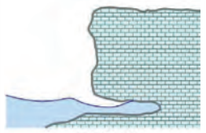


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



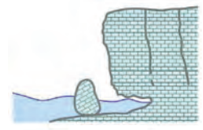
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



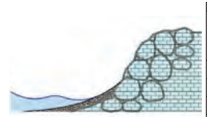
TYPE A - CLIFFS: AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



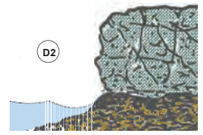
TYPE B - CLIFFS: AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



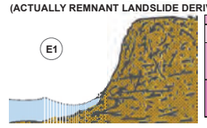
TYPE C - CLIFFS: VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

NOT CLASSIFIED [4]

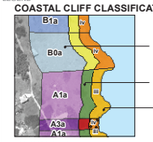
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS: SETBACK CATEGORY — COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	TOTAL SETBACK (U + I + II + III) (m)
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

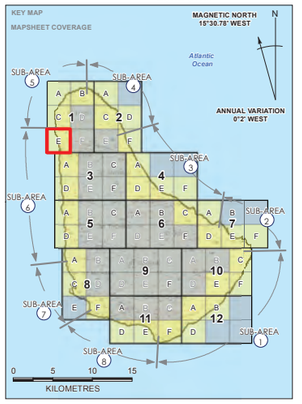
LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY
- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]

KEY MAP



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI)
COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 6 - SHEET 1E

REFERENCE(S) AND NOTE(S)

1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA. GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017

MAP SERIES	MAPSHEET	DATE
003	1E	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird

Golder Associates



Map Projection and 500-metre Grid: Barbados National Grid 1938
Supplementary 500-metre Grid Labels: Universal Transverse Mercator, Zone 21

Magnetic North Declination: 15°30.78' W, Annual Variation 0°2' W, 09-01-2015

© Coastal Zone Management Unit

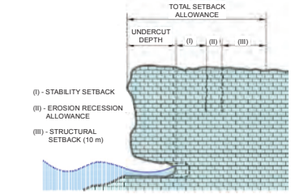
LEGEND

(2) COASTAL CLIFF RISK CLASSIFICATION

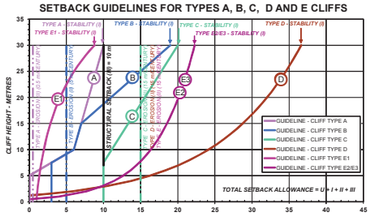
RISK CLASS	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS: FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	FORBIDDEN	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVANT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	CONDITIONAL	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	ALLOWABLE	

NOTE(S): 1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

SETBACK GUIDELINE SCHEMATIC

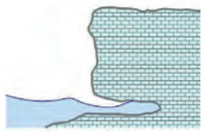


SETBACK GUIDELINES FOR TYPES A, B, C, D AND E CLIFFS



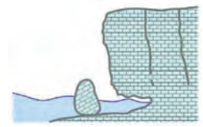
NOTE(S): SETBACK GUIDELINES CHART FOR TWO DIMENSIONAL GEOMETRY ONLY. FOR THREE DIMENSIONAL STRUCTURES, SITE SPECIFIC EVALUATION MANDATORY.

(1) TYPICAL MORPHOLOGY



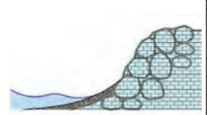
TYPE A - CLIFFS: AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	A0a	A0b
1 to 2 m	A1a	A1b
2 to 4 m	A2a	A2b
4 to 7 m	A3a	A3b

TYPE A CLIFFS – MASSIVE OR LAYERED CORALLINE LIMESTONE, DEVOID OF SIGNIFICANT JOINTING OR VOIDS (PLEISTOCENE AGE)



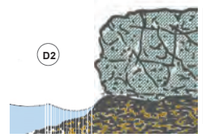
TYPE B - CLIFFS: AVERAGE UCS (MPa) / UNDERCUT DEPTH	HIGH STRENGTH >15 MPa	LOW STRENGTH <15 MPa
<1 m	B0a	B0b
1 to 2 m	B1a	B1b
2 to 4 m	B2a	B2b
4 to 7 m	B3a	B3b

TYPE B CLIFFS – CORALLINE LIMESTONE CONTAINING WELL DEVELOPED JOINTING/BEDDING PLANES (PLEISTOCENE AGE)



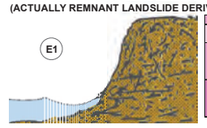
TYPE C - CLIFFS: VUGGINESS / CLIFF HEIGHT	MINOR VOIDS	MAJOR VOIDS
1 to 2 m	C0a	C0b
2 to 5 m	C1a	C1b
5 to 10 m	C2a	C2b
>10 m	C3a	C3b

TYPE C CLIFFS – REEFAL, VUGGY, OPEN STRUCTURED, OFTEN RUBBLY CORALLINE LIMESTONE, CONTAINING SIGNIFICANT VOIDS (PLEISTOCENE AGE)



TYPE D - CLIFFS	
D1	TRANSLATED LIMESTONE BLOCK(S)
D2	TRANSLATED LIMESTONE BLOCK(S) OVER OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
D3	BROKEN TRANSLATED LIMESTONE OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE D CLIFFS – CORALLINE LIMESTONE PSEUDO-CLIFFS (ACTUALLY REMNANT LANDSLIDE DERIVED LIMESTONE DEBRIS)



TYPE E - CLIFFS	
E1	IN-PLACE EOCENE STRATA
E2	STRATA OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS"
E3	BROKEN ROCKY DEBRIS OVERLYING OCEANICS OR OTHER SCOTLAND DISTRICT "ROCKS" (BOULDER BLOCKS)

TYPE E CLIFFS – MISCELLANEOUS CLIFF FORMATIONS IN EOCENE ROCK UNITS

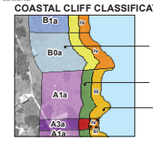
(3) MINIMUM SETBACK LIMITS AND CATEGORY

SUGGESTED MINIMUM ALLOWABLE SETBACK LIMITS: SETBACK CATEGORY — COMMON CLIFFS	PROMENTARIES	ARCUATE OVERHANGS	TOTAL SETBACK (U + I + II + III) (m)
i	i	i	18.0
ii	ii	ii	20.0
iii	iii	iii	25.0
iv	iv	iv	35.0
v	v	v	45.0
vi	vi	vi	55.0
vii	vii	vii	65.0

NOTE(S): SETBACKS MEASURED FROM CREST OF CURRENT CLIFF. ALLOWABLE REDUCTIONS IN SETBACK DISTANCES POSSIBLE WITH SITE SPECIFIC GEOTECHNICAL ASSESSMENT.

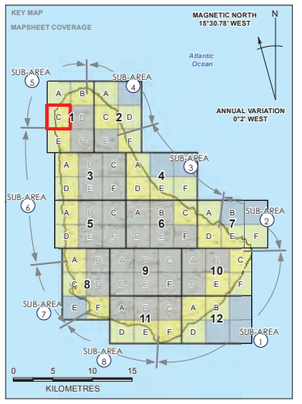
LEGEND

COASTAL CLIFF CLASSIFICATION



TOPOGRAPHY

- SECONDARY ROAD, SURFACED
- OTHER ROADS AND TRACKS
- WATERCOURSE
- CONTOUR (5 m)
- CONTOUR (1 m)
- BATHYMETRIC CONTOUR (10 m)
- BATHYMETRIC CONTOUR (2 m)
- LIMIT OF 150 m COASTAL ZONE STRIP [10]



PROGRAM

GEOTECHNICAL SURVEYS INVESTIGATION (GSI) COASTAL RISK ASSESSMENT AND MANAGEMENT PROGRAM

TITLE

COASTAL CLIFF CLASSIFICATION - SUB-AREA 5 - SHEET 1C

REFERENCE(S) AND NOTE(S)

1. CLIFF TYPES - GENERAL CHARACTERISTICS (SEE GEOTECHNICAL SURVEYS INVESTIGATION 6.7 FIELD STUDY REPORT DATED SEPTEMBER 2016 FOR DETAILS)
2. CLIFF HEIGHTS MEASURED AT SOME LOCATIONS IN THE FIELD. ALL OTHER LOCATIONS ESTIMATED THEN CHECKED FROM LIDAR AND DRONE SURVEY INFORMATION.
3. CLIFF RISK AND SETBACK CRITERIA APPLY AT THE CLIFF EDGE. LANDSLIDE RISK ZONINGS APPLY FOR FULL 150 M STRIP.
4. CLIFF UNDERCUT DEPTHS ESTIMATED IN FIELD, FROM DRONE SURVEY AND/OR OFFSHORE PHOTOGRAPHS.
5. COASTLINES FEATURING CLIFFS TYPES (A, B, C, D, E) ARE OF VARYING ELEVATIONS AND GENERALLY LACK ANY BEACH.
6. CONTOURS - 1 m AND 5 m ELEVATION ON LAND AND 2 m BATHYMETRY GENERATED BY GOLDER ASSOCIATES FROM LIDAR DATA COLLECTED AND PROCESSED BY PELYDREN, SEPTEMBER 2014 TO JANUARY 2015
7. LIDAR IMAGERY COLLECTED/PROCESSED BY PELYDRYN SEPTEMBER 2014 TO JANUARY 2015
8. NO CLIFFS IN THIS AREA; GEOTECHNICAL SURVEYS AND INVESTIGATION (GSI) MAPPING NOT CARRIED OUT - SHORELINE NOT CLASSIFIED ACCORDING TO GSI DESIGNATIONS. SHORELINE CONSISTS OF EITHER BEACH (REFER TO BAIRD MAPPING FOR SHORELINE CLASSIFICATION) OR MAN-MADE STRUCTURE(S).
9. ASSESSMENT OF COASTAL ZONE STRIP AREA EXTENDED TO 400 m INLAND JUST NORTH OF BENAB.
10. WHERE TYPES D AND E CLIFFS ARE PRESENT IN SCOTLAND DISTRICT, SLOPE RISK CLASSIFICATION FOR SOILS WITHIN THE 150 m COASTAL ZONE STRIP MUST ALSO BE CONSIDERED.
11. MAPS TO BE READ IN CONJUNCTION WITH GEOTECHNICAL SURVEYS INVESTIGATION 6.8, FINAL ASSESSMENT REPORT DATED MARCH 2017.

MAP SERIES	MAPSHEET	DATE
003	1C	MARCH, 2017

Coastal Zone Management Unit
8th Floor Warrens Tower
Warrens, St. Michael
Barbados
www.coastal.gov.bb

Baird
Golder Associates

A10.2. Guidelines for development

The following is intended to update and enhance the existing recommendations and form a new set of guidelines to be used to help review applications for future development and continued land use within the 150 m coastal zone strip within the Cliff areas around the island. These guidelines are based on the risk zoning presented in detail (at 1:5,000 scale) on the Map Series 003 and as summarized on the first figure of this Annex.

The guidelines for development and use within the coastal strip (summarized in the tables within the legend of these figures and the detailed Map Series 003) are discussed in the following sub-sections. The table of Guidelines for Development and Use shown on the following figure provides a summary of these guidelines and is also included as an inset on figures on each individual map sheet of the Map Series 003.

RISK CLASS	PROBABILITY OF FAILURE AND USAGE GUIDELINES WITHIN TOTAL SETBACK LIMITS					
	PROBABILITY OF FAILURE	MIN FoS	CLIFF STABILITY	FOR CONTINUED USE	FOR NEW OR FUTURE DEVELOPMENT	
VERY HIGH	>50%	<1.0	UNSTABLE AND REGRESSING	**NOT PERMITTED** (POSSIBLE ONLY AFTER SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING, DESIGN, AND IMPLEMENTATION OF ENGINEERING CONTROL MEASURES EXECUTED)	**FORBIDDEN**	SITE SPECIFIC GEOTECHNICAL INVESTIGATION[1], MOVEMENT MONITORING AND DESIGN AND IMPLEMENTATION OF ENGINEERING CONTORL MEASURES REQUIRED. THE SCOPE AND SCALE OF THESE REQUIREMENTS DEPENDS ON THE RISK CLASS, THE TYPE OF PROPOSED DEVELOPMENT AND THE NATURE OF THE SITE CONDITIONS. EVALUATION MUST BE CARRIED OUT BY A QUALIFIED GEOTECHNICAL SPECIALIST WITH RELEVENT EXPERIENCE WHO IS A REGISTERED PROFESSIONAL ENGINEER.
HIGH	30-50%	1.1	SIGNIFICANT CRACKING	**CAUTION** - SITE SPECIFIC ASSESSMENT, MOVEMENT MONITORING AND POSSIBLY ENGINEERING CONTROL MEASURES REQUIRED	**CONDITIONAL**	
MEDIUM	8-30%	1.3	MINOR CRACKING			
LOW	<8%	>1.5	STABLE	**ALLOWED** - AFTER VISUAL INSPECTION	**ALLOWABLE**	

NOTE(S):
1. GUIDELINES FOR TYPE(S) OF GEOTECHNICAL INVESTIGATION AND MONITORING REQUIRED TO ASSESS LOCAL STABILITY ARE PROVIDED IN SECTION 6.9 OF THE FINAL ASSESSMENT REPORT (GOLDER, 2017). THESE REQUIREMENTS FOR INVESTIGATION TO EVALUATE STABILITY ARE OVER AND ABOVE THE CURRENT STATE OF PRACTICE FOR FOUNDATION DESIGN FOR TYPICAL DEVELOPMENTS OR STRUCTURES.

In general, all new development should be located behind the minimum recommended total setback limits. Any development or structures (existing or proposed) that may encroach into the total setback limit will require specific evaluation to ensure that the loading from the structure(s) do not adversely affect the stability of the cliffs. All existing structures located within the total setback limits may incur restrictions on future use (including possibly eviction) depending on risk level and outcome of site specific geotechnical investigation and assessment as discussed below.

A10.2.1. Low Risk Areas

From a cliff stability perspective, areas within the coastal strip that are classified as low risk are generally considered to be stable. Future development and continued use of currently occupied properties should not be restricted (subject to adherence to the minimum recommended total setback requirements) and geotechnical investigations and/or monitoring are generally not anticipated to be necessary for locations outside of the total setback limits. For existing structures located within the total setback limits in low risk areas, continued use may be allowable, depending on proximity to cliff face, local conditions and subject to satisfactory inspections. New development within the total setback limits in low risk areas would generally be allowable subject to geotechnical investigations (i.e. in addition to typical requirements as part of the current state of practice for foundation design for developments or structures) and assessment and monitoring by a qualified geotechnical specialist with proper structural design, if required.

A10.2.2. Medium Risk Areas

Areas within the coastal strip that are classified as medium risk are also generally considered to be stable from an overall stability perspective. New development and continued use of currently occupied properties should not necessarily be restricted (subject to adherence to the minimum recommended total setback requirements) however, caution is advised. Evidence and signs of incipient instability observed in certain parts of medium risk areas suggests that confirming stability and refining risk with respect to the extent and/or location of any existing or proposed development is required. For cases where existing structures are located, or new development is proposed to be located, within the recommended total setback allowance, geotechnical investigations (i.e. additional to typical requirements as part of the current state of practice for foundation design for developments or structures), assessment and monitoring by a qualified geotechnical specialist will be required. The scope of the investigation and assessment required (plus requirements for additional structural and/or remedial design measures) will be dependent on the scale of the existing or proposed development, and in particular on the location relative to the recommended total setback limit.

A10.2.3. High Risk Areas

Areas within the coastal strip that are classified as high risk are generally considered to be only marginally stable.

All existing structures and any proposed new development should be located beyond the recommended total setback limits. In high risk areas, existing buildings and infrastructure that are located within the minimum recommended total setback limits may be at high risk if cliff recession has created marginally stable overhangs or open joints in areas where joint controlled blocks are evident. For these situations and for cases where any new development is proposed to encroach into the recommended total setback limit, inspection, investigation and evaluation by a qualified geotechnical specialist is required. Evaluation should include a detailed assessment of each of the components for calculating/refining the minimum total setback requirement, including:

- Undercut (U) – refinement should be based on detailed survey of actual cliff and notch geometry at the site;
- Stability Component (I) – refinement should be based on detailed site specific investigation, sampling and laboratory testing followed by numerical analysis using actual cliff geometry (3D analysis may be required, depending on site geometry);
- Recession Component (II) – refinement should be based on assessment of actual recession/erosion rates at site, including consideration of shoreline protection, if any, typical wave climate and energy, and available long-term monitoring information (if any); and,
- Structural Component (III) – refinement should be based on actual site and structure conditions including cliff height, cliff type as well as building load(s) and foundation type(s) and depth(s).

Depending on the outcome, new development may not be permitted and, for existing structures, restrictions on continued land use, implementation of remedial measures, monitoring, or possibly eviction, may be mandatory. Ground movement and tension crack monitoring of identified features will be required for any continued use of existing structures and for any proposed new development. Such mandatory monitoring should be carried out to establish ground movement rates on an annual basis. Approval(s) for new development in these areas (within the total setback limits) would be dependent on the outcome of detailed investigation, assessment and monitoring and be subject to review by a qualified geotechnical specialist. However, in general, new development may be limited to only lightly loaded, low-level or single-storey building structures.

As a minimum requirement, all geotechnical investigations should be carried out by a qualified geotechnical specialist and the minimum investigation requirements to assess stability (in addition to that carried out as part of the current state of practice for foundation design for typical developments or structures) should include the following tasks:

- Detailed survey of topography and cliff geometry;
- Detailed cliff mapping followed by drillhole investigation to confirm cliff types and rockmass competence and variability, and presence or absence of unidentified deep undercuts, adverse jointing influence, blowholes, caves or adverse vuggy porosity;
- Laboratory testing of undisturbed samples of cap, face and internal fabric (direct tensile and Brazilian and uniaxial strength tests) to establish rock properties;
- Determination of Building Footprint and Loadings;
- Calculation of appropriate stability, recession and structural setbacks based on regression equations; and,
- Check comparison of results against the 1:5,000 scale setback maps in Appendices J and R and update as required.

Prior to approval for new development, the results of the detailed geotechnical investigation and assessment in the context of the scale of the proposed development should be reviewed by a qualified geotechnical professional.

A10.2.4. Very High Risk Areas

Areas within the coastal strip that are classified as very high risk are generally considered to be unstable within the total setback limits. Future development should therefore not be permitted within the setback zone as defined in these areas. The continued use of existing structures and infrastructure within the setback zone in these areas is also not permitted. The urgency and requirements for abandonment of existing infrastructure, design and implementation of remedial measures, and/or eviction from existing residential developments within the total setback limits however would need to be evaluated on a case-by-case basis. Mandatory evaluation must include a detailed re-assessment of each of the components involved in determining the minimum total setback required (as per the requirements outlined in previous section for the High Risk Areas).

In all areas where existing development is present, and where it is proposed that such development remain in place, a regular program of inspection, crack monitoring and structure movement monitoring should be immediately implemented. The results of such a program would then be used to identify and prioritize the requirements for abandonment, eviction, or implementation of remedial measures.

A10.2.5. Areas behind Total Setback Limit

In terms of the above discussions, the ‘setback limit’ or ‘setback strip’ applies to the Total Setback Distance and not just the Stability Setback (I) discussed under stability analysis. The stability setback constitutes just one portion of the Total Setback. The Total Setback is the combined value of the Undercut Depth (U) as well as the setbacks compiled from: (I) the Stability Setback Component calculated from the line of best fit for each cliff type; (II) the Recession Allowance Component; and, (III) the Structural Setback Width.

Ongoing and future use of cliff areas outside of the defined Total Setback distance, as far as the 150 m boundary, is permissible without remediation. However, if new development is proposed to be located close to the Total Setback boundary in any areas designated as high to very high risk (as explained in Section 6.7), it is advisable that the new development be subjected to site specific investigations (over and above that required as part of the current state of practice for typical foundation design). This additional, site specific investigation would be necessary to check that the proposed structure(s), foundation load(s), construction methods, etc. will not destabilize the cliff zone conditions or in any way adversely extend the pre-defined Total Setback distance father inland.

ANNEX 11. TIERED APPROACH TOWARDS ADDRESSING EMERGING ISSUES IN THE CZMA

A tiered approach to identifying and addressing emerging challenges (as directed by members of the Planning and Development Board) may include the following:

Analysing and applying approaches to identify possible emerging challenges

- Scan methods (enhanced by deep-analytics tools) to provide early detection of even weak signals or patterns.
- Undertake trend-analysis methods to better quantify data and review additional analytic tools for assessing unstructured data.
- Consider using future scenarios that use quantitative, qualitative, and unstructured data to fuel real-time and dynamic scenario imaging as data feeds are used to refine and weight potential outcomes.
- Adopt the use of crowdsourcing and analytics to detect and predict emerging challenges, particularly for hazardous natural or human-caused areas of concern.

Organizing and screening emerging challenges for further review

- Apply selected screening-level versions of the mature tools now available for each of the three main sustainability pillars (society/environment/economy)'.

Analyse the sustainability challenges of identified emerging issues

- Screening-level results should be used to help rank/order the importance or significance of emerging challenges taking place on the coast for further analysis. The most likely scenarios from the future methods should be subjected to a more detailed set of assessments for each of the three pillars as more refined data become available.
- Devise a systems-based indicator analysis of likely scenarios from the futures methods which could be used to further clarify which projects would benefit most from more refined sustainability assessments. *(NB: the sustainability-assessment tools and approaches will be informed and guided by emerging related issues that are identified and may include environmental-impact assessments, social impact assessments, benefit-cost analyses (BCAs), risk assessments, resilience and adaptation assessments, segmentation analyses, and collaborative problem-solving already in place for the ESIA process in Barbados).*

Communication of findings and recommendations

Social-media platforms and analytics present new and effective forums to engage and communicate with Barbadian stakeholders, allowing for the use of analytic approaches to provide rapid analysis and categorization of stakeholder input and to provide transparency to stakeholders on how CZMU uses this information in its decision-making. This approach presents an opportunity to derive a substantial increase in value from stakeholder processes that are planned for GOB and CZMU. Additional value could be created in the use of advanced IT capabilities in the following:

- Benchmarking the potential effects of newly identified emerging issues in the regulated community and other stakeholders.
- Mapping the effects of newly identified emerging issues in demographic or stakeholder categories.
- Setting priorities for action on newly identified emerging issues multiple stakeholder categories.
- Identifying the socially influential stakeholders to spearhead the communication of emerging issues to a broader citizenry.
- Assessing stakeholder preferences for sustainable and resilient products and technologies through analysis of social-media data.

In this instance, CZMU should develop its current IT capabilities to assess emerging issues by involving all relevant stakeholders, possibly through the use of a range of social analytic tools (see Section E4 "Information Needs and Data Management"). This could involve the incorporation of insights from a broad array of stakeholders which, upon evaluation, could markedly improve CZMU's understanding of a new issue's importance and also, the speed with which it is emerging. The insights could also improve the evidence base for the CZMU's decision-making process and increase the likelihood of stakeholder acceptance of difficult decisions.

To enhance post-decision assessment of its activities, the GOB (under the leadership of the CZMU) should identify, track, and address unintended consequences of new emerging issues. A searchable database of the lessons learned should be created and possibly linked to NCRIPP to determine the implications of the emerging issue for coastal hazards and risks (see Section E4 "Information Needs and Data Management").

Not only would that provide additional evidence-based support capabilities for future decision-making, but the data could feed advanced cognitive analytics that could be used to test proposed decisions against known unintended cause–effect scenarios developed from past decisions.

Finally, it is clear that more accurate and earlier prediction of emerging issues related to environmental settings would enhance the ability to incorporate resilience strategies into any new (required) infrastructure design. Incorporation of resilience in the context of sustainability would have implications for the design and planning of projects (particularly urban infrastructure projects) that include and integrate new emerging issues into their design. Currently, this remains a challenge to accomplish as no comprehensive tool for quantifying resilience is available.

Made by the Minister this 13th day of January, 2022.

K. D. M. HUMPHREY

Minister responsible for Martime Affairs

BARBADOS

The Official Gazette Part A 13th January, 2022

Statutory Instrument

S.I. 2022 No. 4

Small Business Development Act

CAP. 318C

DECLARATION OF APPROVED SMALL BUSINESS (HOPEWELL DISTILLERY INC.) ORDER, 2022

The Minister, in exercise of the powers conferred on him by section 4 of the *Small Business Development Act*, makes the following Order:

1. This Order may be cited as the *Declaration of Approved Small Business (Hopewell Distillery Inc.) Order, 2022*.

2. For the purposes of the *Small Business Development Act*, Cap. 318C, Hopewell Distillery Inc., a company incorporated under the *Companies Act*, Cap. 308 as Company No. 45883 and located at Hopewell in the parish of Saint Thomas, is declared to be an approved small business.

3. Hopewell Distillery Inc. is granted the following incentives in respect of its business:

(a) the payment of corporation tax at a rate of 15 per cent on the profits of the business;

(b) exemption from import duty on raw materials and plant and equipment imported for use in the business;

(c) exemption from withholding tax on dividends and interest earned on any investment in an approved small business or in any fund approved for investment in small businesses;

(d) exemption from the payment of stamp duty under the *Stamp Duty Act*, Cap. 91 on all documents related to the business, where the registration of those documents is required by law; and

(e) a deduction of corporation tax of an amount equal to 20 per cent of the actual expenditure incurred in respect of the use of technology, market research and any other activity that is, in the opinion of the Revenue Commissioner, directly related to the development of the business.

Made by the Minister this 12th day of January, 2022.

K. D. SYMMONDS

Minister responsible for Business Development