Jamaica Disaster Vulnerability Reduction Project (DVRP)

TERMS OF REFERENCE

Consultancy Firm to Understanding Risk - Microzonation Studies

Port Maria – St Mary; Morant Bay – St Thomas; Alligator Pond – Manchester; Black River – St Elizabeth; Ocho Rios – St Ann, Savanna-la-mar- Westmoreland; Portland Cottage – Clarendon and Manchioneal - Portland

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1 GENERAL INFORMATION

Beneficiary Country: Jamaica

Contracting Authority: Jamaica Social Investment Fund

The Jamaica Social Investment Fund (JSIF) is the Implementing Entity for the project and is a limited liability company incorporated under The Company's Act of Jamaica. It was established in 1996 as a component of the Government of Jamaica's (GoJ's) national poverty alleviation strategy. The Fund was designed primarily to channel resources to small-scaled community-based projects. This is done with the use of an Operations Manual that acts as a guide to ensure transparency, accountability and efficiency in project implementation.

The operations of the JSIF were initially funded by a loan negotiated between the GoJ and the World Bank. Though the Fund was initially established as a temporary organization with an initial lifespan of four (4) years, it has been in operation for over 18 years and presently has agreements that will continue until 2020.

The mandate of the JSIF

The Jamaica Social Investment Fund (JSIF) mobilizes resources and channels these to community-based socio-economic infrastructure and social services projects. Through a national partnership between central and local government, communities and private and public organizations, the JSIF addresses the immediate demands of communities in a manner that is quick, efficient, effective, transparent and non-partisan.

A number of partners will work alongside JSIF in implementing the project components. These include the National Environment and Planning Agency (NEPA), Office of Disaster Preparedness and Emergency Management (ODPEM), Jamaica Fire Brigade (JFB), National Works Agency (NWA), Earthquake Unit (EQU) of the University of the University of the West Indies (UWI) and the Ministry of Education, Youth and Information (MOE). On this consultancy, JSIF will collaborate closely with the Office of Disaster Preparedness & Emergency Management, the national office responsible for disaster management in Jamaica.

2 BACKGROUND

In addition to climate risks, Jamaica is vulnerable to earthquakes. Earthquakes cannot be prevented, however, the level of damage to the built environment and loss of lives can be reduced by adequately integrating earthquake information in the design of infrastructure and buildings. Seismic microzonation studies provide the expected level of shaking for a local site and the associated seismic risks such as liquefaction susceptibility. Micro zonation studies are of significant value and is a critical step in earthquake risk mitigation.

Jamaica's exposure to earthquakes can be attributed to the country's geographical location in a seismotectonic zone within an active plate margin. Jamaica and its coastal waters lie within the seismically active Caribbean plate, crossed by an active east-west trending fault on the southern boundaries of the Gonave microplate. The western trend of the Enriquillo-Plantain Garden Fault Zone that triggered the 2010 Haitian earthquake and a number of active smaller Northeast South-West (NE-SW) trending faults occurring all over Jamaica contribute to the high seismic vulnerability and the active network of fault lines in the eastern region of the island are to be noted in particular. This seismic profile contributes to unstable geophysical characteristics. The eastern section of the island is where over 50 percent of the country's population resides. This exposure is heightened because of the small size of the country and earthquake activity in one area can have serious and adverse effects island wide. Additionally, coastal areas are mainly located on flat lands typified by alluvial soils which amplify seismic waves, making these areas significantly exposed to the effects of earthquakes.

In order to address these challenges capacity needs to be built for earthquake resilience across all sectors of Jamaica's economy. Currently, this capacity is constrained by various factors such as inadequate microzonation studies and the resultant over- or under-designing of structures and low levels of preparedness in some areas for this hazard.

In order to protect these investments and safeguard lives it is necessary to widen the range of hazards studied so that the design and sustainability of infrastructure and preparedness measures consider the probability and effects of seismic hazards.

To this end, it is necessary to understand the local site of effects of the earthquake hazard, especially for areas located on alluvial soils for various coastal towns island wide and use

these as reference points for similar surrounding locations and integrate the findings in disaster risk reduction effort of the country.

3 PROJECT DESCRIPTION

3.1 Project Objectives

In response to the challenges posed by earthquake and other hazards, the Government of Jamaica, on July 1, 2016, signed a loan agreement for the Jamaica Disaster Vulnerability Reduction Project (JDVRP), funded by the World Bank. The project development objective is to enhance Jamaica's resilience to disaster and climate risk. The achievement of the objective will be measured using the following key indicators:

i. Improved risk identification: Use of risk information for investment planning in the built and non-built environment (Number of Plans)
ii. Reduction in vulnerability: Population benefitting from improved critical facilities and infrastructure (Number of People)

The outputs of this consultancy are reflected in indicator i), improved risk identification.

The project implementing entity is the Jamaica Social Investment Fund (JSIF)

3.2 Project Components

The Project will finance four components, which will be implemented over a six-year period ending 2022. This consultancy falls within **Component 1: Technical Assistance for Improved Disaster and Climate Resilience which** includes improving the generation and collection of targeted hazard and risk information, its analysis and use in monitoring systems and decision making. In order to improve the ability of Government officials to generate and use hazard and risk information for decision making and policy development, this component will finance the following activities: (i) equipment and facilities to strengthen the seismic monitoring network; (ii) the establishment of a National Risk Information Platform and Coastal Risk Atlas; (iii) multi-hazard risk assessments for coastal areas, including ecosystems-based analyses and microzonation studies; and (iv) a training program to support the implementation of the National Building Code. In addition, this component will finance workshops to promote public awareness raising relating to climate and disaster risk management. The summary of the other project components are:

- **Component 2: Risk Reduction -** This includes the retrofitting or construction of key assets given that the infrastructure sector is one of the most severely impacted after a major disaster event. To reduce Jamaica's physical vulnerability to adverse natural events, this component will finance structural mitigation measures.
- **Component 3: Contingent Emergency Response. -** The proposed operation will include a contingent 'zero component', which in the event of a disaster caused by a natural hazard would enable the Government to quickly reallocate Project funds to disaster response and recovery purposes under streamlined procedures.

- **Component 4: Project Administration -** This component will finance costs associated with program management, including Project related audits, monitoring, mid-term and end-of-project evaluation, equipment and training to strengthen the Project Implementation Unit (PIU), as well as individual Consultants, motor vehicle and operating costs.

3.3 RATIONALE FOR PROJECT SITES

There are 8 locations to be targeted for this study, six of which were the subject of previous multi-hazard assessments for which microzonation studies were not completed. The remaining two are new locations for which coastal assessments will be completed under this project.

New Sites for Multi-hazard Studies (Including micro-zonation studies)	Sites with Previous multi-hazard Studies (Excluding micro-zonation studies
1. Alligator Pond – Manchester 2. Port Maria – St Mary	1. Morant Bay – St Thomas 2. Ocho Rios – St Ann 3. Black River – St Elizabeth 4. Savanna-la-mar – Westmoreland 5. Manchioneal – Portland 6. Portland Cottage - Clarendon

Completing the studies for the target locations will assist in achieving result indicator i) of the PDO, that is, improved risk identification: Use of risk information for investment planning in the built and non-built environment. While the majority of sites fall within the built environment, a few fall within the non-built environment. There are also several reasons these sites were selected (See Annex for Rationale).

1. **Completion of the multi-hazard perspective of the sites** – Previous studies that included storm surge and flooding were completed for six of the eight sites. Earthquake hazard was not comprehensively addressed in these studies (Portland Cottage, Manchioneal, Black River, Ocho Rios, Savanna-la-Mar and Morant Bay) and so the aim is to complete the multi-hazard profile by incorporating the earthquake hazard for the six sites.

2. **High exposure of assets in density urban areas** – Most of Jamaica's urban areas are expanding. However, the full range of hazard information to make local investments decisions, moreso earthquake risk information is not available. The micro-zonation studies will be of significant value to investment decisions in a number of parish capitals and major towns. These include the parish capitals of Port Maria – St Mary; Morant Bay – St Thomas; Savanna-la-mar- Westmoreland and Black River – St Elizabeth. Ocho Rios – St Ann is the third largest resort area in Jamaica and Alligator Pond – Manchester is a fishing village but is also a key location for south Coast Resort Area and is also a growth centre under the national growth strategy.

3. **Proximity to major fault lines** – The most active fault zones, as demarcated by the Earthquake Unit are:

    a. **Enriquillo-Plantain Garden (PG) Fault zone, St Thomas** – This fault zone is important for the **Manchioneal** community. Historical evidence based on the two major earthquakes (1907 and 1692) to have affected Jamaica, suggests that this area was significantly affected during both events. Additionally, the Enriquillo Plantain Garden Fault Zone (EPG) fault systems straddles the countries of the Dominican Republic, Haiti and Jamaica. Experts agree that it is a very hazardous fault system.
    b. **Rio Minho Crawle Rive Fault Zone, Clarendon** – This fault zone is located in the upper reaches of Clarendon and like Manchioneal is a low density area, however, it is in the second most active zone in the island and is in close **proximity Portland Cottage** and Vere Plains. Given the lithology of this area and the alluvium nature of the soil, any activity along this fault line will have impacts on Portland Cottage and surrounding communities located on the Vere Plain.
    c. **South Coast Fault Zone** located in central Jamaica – The South Coast fault zone (SCFZ) cuts across the alluvium-covered Vere Plain of south-central Jamaica and closely parallels the southern coast of southwestern Jamaica, where it creates prominent cliffs as it crosscuts the NNW-oriented ranges that occur to the north. This is among the four major fault zones in the country. Because it cuts across the Vere plains which occupy the

southern half of the parish of Clarendon, it means a high degree of exposure for assets located on the Vere plain which includes:

i. **The port at Rocky Point**
ii. **The LNG plant located in Old Harbour Bay**
iii. **Proposed development off the coast of Clarendon and St Catherine including the logistics hub**
iv. **The proposed New Town at Hayes, Clarendon,**
v. **Several proposed housing projects along the Vere Plain by the National Housing Trust**
vi. **Proposed May Pen-Williamsfield corridor of Highway 2000**
vii. Proposed 200 MW Natural Gas Fired Power generation station at Jamalco

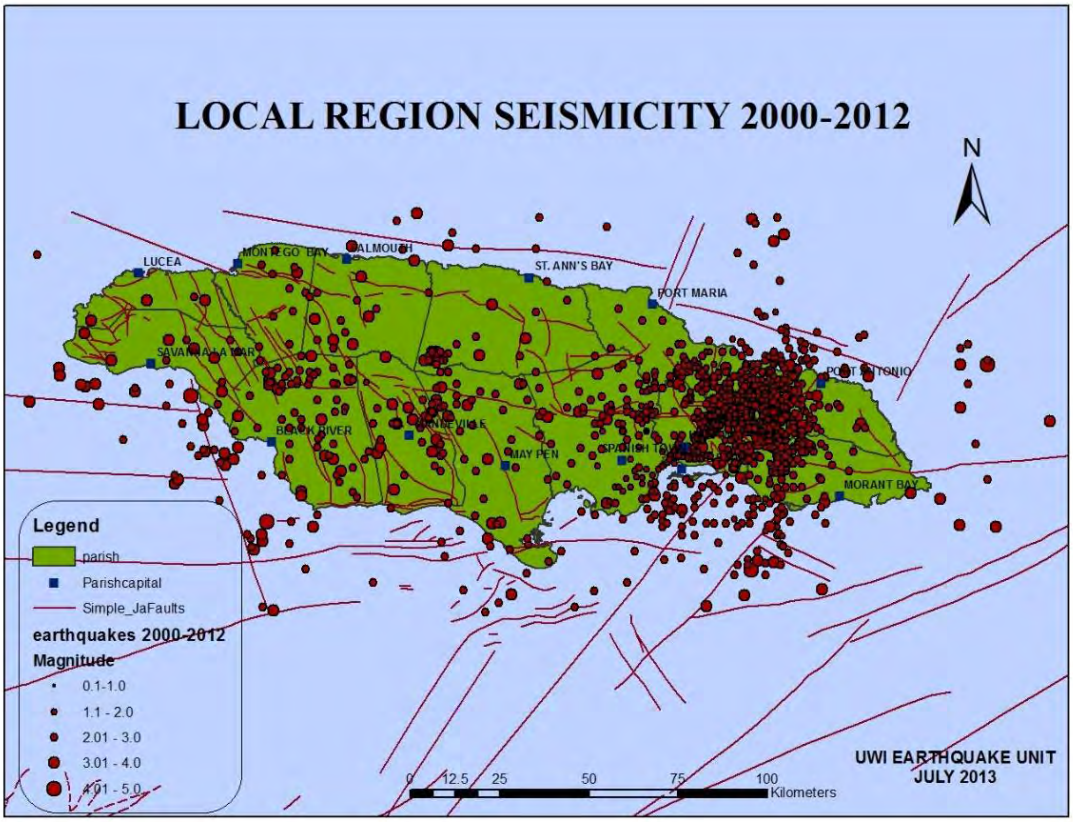
d. The Vere Plains which is home to several sprawling communities that are that are neighbouring to Portland Cottage. The aggregated population of these communities is approximately 100 000, representing about 40% of the population of the parish.

4. **Historical Impacts** – The 1692 Port Royal and 1907 earthquakes have been well documented and not only were these specific areas impacted but the entire eastern block including Manchioneal were affected.

   The 1957 Montego Bay earthquake is much less known, and this quake rattled the entre island but moreso western Jamaica. This is evidence that western Jamaica is vulnerable to seismic activity, however, less research on the seismicity of western and north-western sections of Jamaica has been carried out in contrast to the east. The proposed microzonation studies will provide insights on the seismicity of areas such as **Black River and Savanna-la-mar** that were also affected. This information will be useful in guiding urban expansion for these areas, including guiding any investments in infrastructure that may be proposed.

5. **High Periodicity of Alluvial Soils on which Sites are located** – All the target sites are located in the coastal zone on geology characterized as alluvium or lower coastal group. These geological formations comprise interbedded lenses of gravels, sands, silts and clays. Large Boulders, organic soil and peat may be present at depth.

   Deep alluvial soils influence the performance of land, infrastructure, and buildings during strong earthquakes in two ways. As seismic waves propagate through the alluvial soils, from the base rock towards the ground surface, the alluvial soils significantly modify the characteristics of ground shaking. They amplify the shaking and seismic forces for some structures, while for others they reduce or de-amplify the shaking.



Source: Earthquake Unit, University of the West Indies

4 PURPOSE OF CONSULTANCY

The consultancy will be executed under **Component 1** of the project and its purpose to improve risk identification by broadening to scope of hazard information available for decision-makers to use in development and investment decisions in coastal areas.

4.1 SPECIFIC OBJECTIVES

The Consultant shall undertake microzonation studies of the eight target locations to facilitate their use in development decisions, emergency response and hazard risk reduction. The microzonation studies are critical to improving the capacity of local authorities, policymakers and developers to harmonize spatial development and hazard mitigation by providing hazard data for decision-making.

4.2 SCOPE OF WORK

The Consultant shall conduct microzonation studies for the eight project sites in Annex A. The assessments shall cover the entire project boundaries as identified in the annex. The Consultant shall perform the following tasks:

4.2.1 Task 1 – General

The Consultant will:

- Consult available literature to understand the challenges with the availability and use of seismic risk information in Jamaica and also identify pre-existing data that maybe useful to the micro-zonation studies.
- Develop knowledge of the DVRP project, specifically project objectives, components, stakeholders, activities target groups
- Prepare quarterly progress reports and attend progress review meetings

4.2.2 Task 2 – Conduct Microzonation Studies

In undertaking the tasks, the Consultant is expected to:

i. Review Historical seismic data of the targeted locations. The Consultant is expected to work closely with the Earthquake Unit, University of the West Indies Jamaica to identify available datasets and understand the data gaps that exist.
ii. Undertake a Geological desk study prior to any field investigation to understand local geology, landslide potential and presence of any other hazards.
iii. Use H/V points at approximately 500 m separation (or any other methodology delivering similar quality or better results) incorporating other geophysical technique (such as electrical resistivity and seismic refraction) and carry out ground investigation and field tests to determine the following for each of the targeted sites:
    a. Fundamental period
    b. Frequency
    c. Liquefaction potential
    d. Depth to bedrock
    e. Shear wave velocity

iv. Use supporting geophysical techniques such as Seismic refraction or electrical resistivity to determine stratigraphic boundaries (depth or thickness of each subsurface layer, water table)
v. Evaluate the ground motion parameters to study topographic and site response amplification effects to develop seismic microzonation maps.
vi. Location of boreholes or well in each location will provide additional information for sampling locations. Where borehole data exists, these should be incorporated; otherwise borehole tests should be completed.
vii. Produce GIS data layers depicting frequency and period maps. Meta-data must be included for these maps
viii. Incorporating all applicable seismological, geological, geotechnical and hydrogeological mapping and their relationship that will provide a picture of levels of hazard distribution relevant to urban planning, engineering and architectural designs
ix. Create simple maps that will incorporate the interpretation of the findings from the microzonation studies and identify the implication for various end-users including preparing a list of recommendations for property owners, developers, local authorities, disaster risk management professionals and other key stakeholders based on the findings from the Microzonation studies
x. Present the draft and final reports/findings to a set of stakeholders to be agreed by the client and the Technical Review Committee
xi. Prepare a comprehensive report documenting methodology and findings from the micro-zonaton studies

5 DELIVERABLES

The Consultant will be required to submit the following deliverables to the JSIF via the ODPEM:

i. An inception report after contract signing clearly outlining proposed methodology, detailed work plan and specific limitations or constraints to completion of work, if any.
ii. A Technical report in soft copy and 2 hard copies discussing in detail the findings/results of the microzonation studies. The report should incorporate:
    a. An estimation of the ground motion parameters using the historical seismicity and recorded earthquake motion data including the location of potential sources, magnitude, mechanism, epicentral distances.
    b. Site characterization using geological, geomorphological, geophysical and geotechnical data. [3] Assessment of the local site effects which includes site amplification, predominant frequency, liquefaction hazard,

landslides, tsunami etc. [4] Preparation of the seismic microzonation maps based on liquefaction, site amplification, predominant frequency, liquefaction hazard, landslides, tsunami etc.

c. hazard profile of the communities/town

iii. Microzonation maps for each of the target location in GIS shapefile format with associated attribute data and metadata based on the standards stipulated by the National Spatial Data Management Division (NSDMD), Jamaica.

iv. Final consultancy report outlining lessons learnt, challenges, unintended outcomes (if any) and a summary of key deliverables/outputs from the consultancy.

6 TYPE OF CONSULTANCY

The Consultant shall be a Firm or Academic Consortium with the professional experience and experience to satisfy the requirements of the project.

6.1 DURATION OF CONSULTANCY

The duration of this consultancy is eighteen (18) months.

7 QUALIFICATIONS & EXPERIENCE

The Consultant must show its capability to complete the works by showing a complement of staff or Consultants with the qualifications and past relevant experience (or previous work) that will provide the caliber of work expected. The team should consist of the following minimum skills and experience as listed in the table below.

Position	Minimum Qualification	Minimum Experience in Related Work
Geologist	MSc Geophysics, or MSc. Seismic Engineering OR related field	10 years

Geo-technical Engineer	MSc. Engineering Geology OR related field	8 years
Seismologist	MSc. Seismic Engineering OR related field	10 years

8 PAYMENT SCHEDULE

The Consultant will be paid according to the following payment schedule, once deliverables have been submitted, reviewed and accepted:

Deliverable	**Due date**	**Payment**
Inception report/technical proposal clearly outlining proposed methodology, detailed work plan and specific limitations or constraints to completion of work, if any	7 days after contract signing	10%
Progress Report outlining results of tests and assessments completed	6 months after contract signing	20%
Micro-zonation Studies: • Well-structured and well-written technical reports detailing the methodology and findings of the studies. The reports must include the map outputs and the recommendations and must be delivered in 2 hard copies and soft copy • GIS Shapefiles – All shapefiles from each of the hazard assessments in ESRI GIS shapefile format with associated meta data		
Draft 1 Micro-zonation Reports	15 months after contract signing	40%

Draft 2 Microzonation Reports	2 months after Draft 1 has been reviewed and approved	
Final Reports	One month after Draft 2 ha been reviewed and approved	20%
Final Consultancy Report	20 days after contract completion	10%

9 PROJECT MANAGEMENT /REPORTING ARRANGEMENTS

The Consultant will be interfacing with several stakeholders nationally and locally to adequately fulfil the objectives of the ToR. Prior to project start, the Consultant will be invited to participate in an inception meeting to be held with JSIF, ODPEM and the Earthquake Unit.

On contractual or other matters, the Consultant will report to the Managing Director, JSIF, or designate. The Consultant should request problem solving meetings as soon as there is any indication of a variation in the scope of work, or changes in the timeline. No variations are to be made to the agreed time or cost without the prior approval of JSIF.

A project manager/team lead should be identified by the Consultant who will interface with the Senior Director Mitigation Planning and Research Division at the ODPEM for day-to-day matters such as technical matters relating to the methodology, outputs and technical guidance.

9.1 Submission and Approval of Outputs

All deliverables are to be submitted to the ODPEM who will lead a Committee to review the deliverables and provide comments. The ODPEM will also collaborate closely with the Earthquake Unit and other technical experts to review the related outputs.

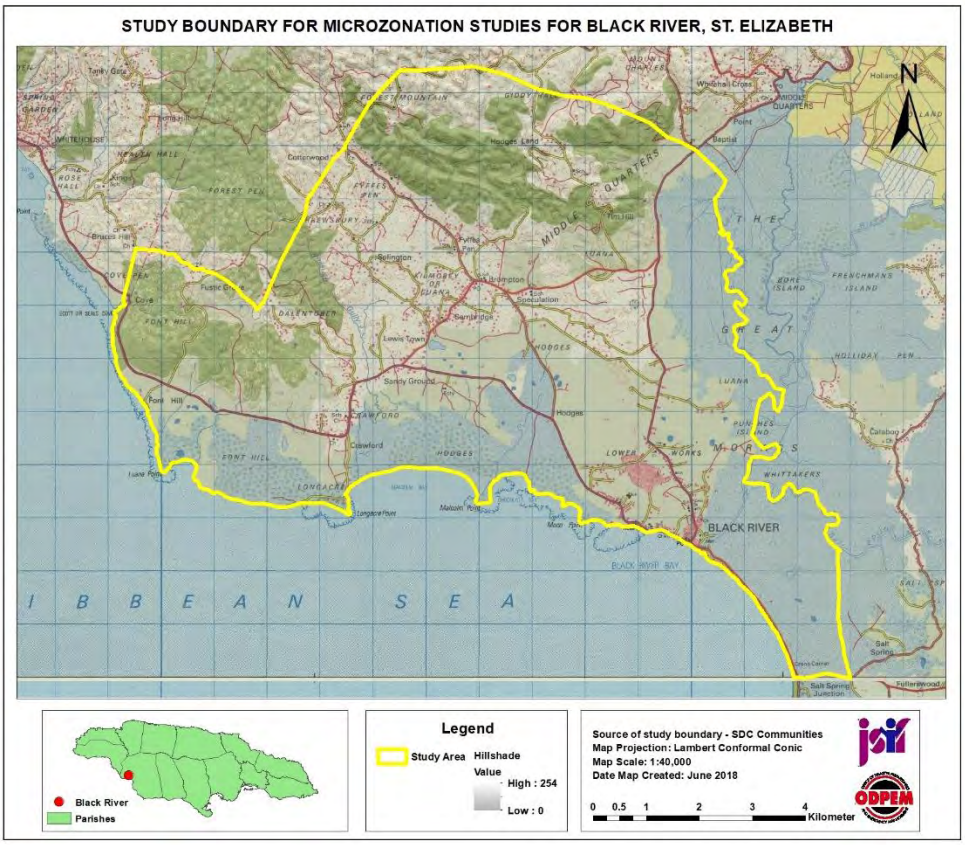
9.2 Support to be provided to the Consultant

ODPEM will:

- Provide venue for any sensitization or training to be done, where the ODPEM's headquarters is logistically appropriate as venue
- Appoint a focal point who will interface with the Consultant during the execution of the assignment
- Share stakeholder contact information for key stakeholders such as the Earthquake Unit, University of the West Indies, who will be integral in monitoring the implementation of activities and review and approval of outputs under this consultancy.

10 ANNEX

10.1 LOCATION /SITE BOUNDARIES




STUDY BOUNDARY FOR MICROZONATION STUDIES FOR MANCHIONEAL, PORTLAND
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Kensington
Christmas Island
Ecclesdown
PROVIDENCE
BETTYS HOPE
MANCHIONEAL
DISTRICT
SPRING VALLEY
Reach
Muirton
Nettle Point
Shaipnose Point
Grange Hill
GRANGE
Dillon
Packi River
Happy Grove
HECTORS RIVER
BIG LEVEL
MOUNTAINS
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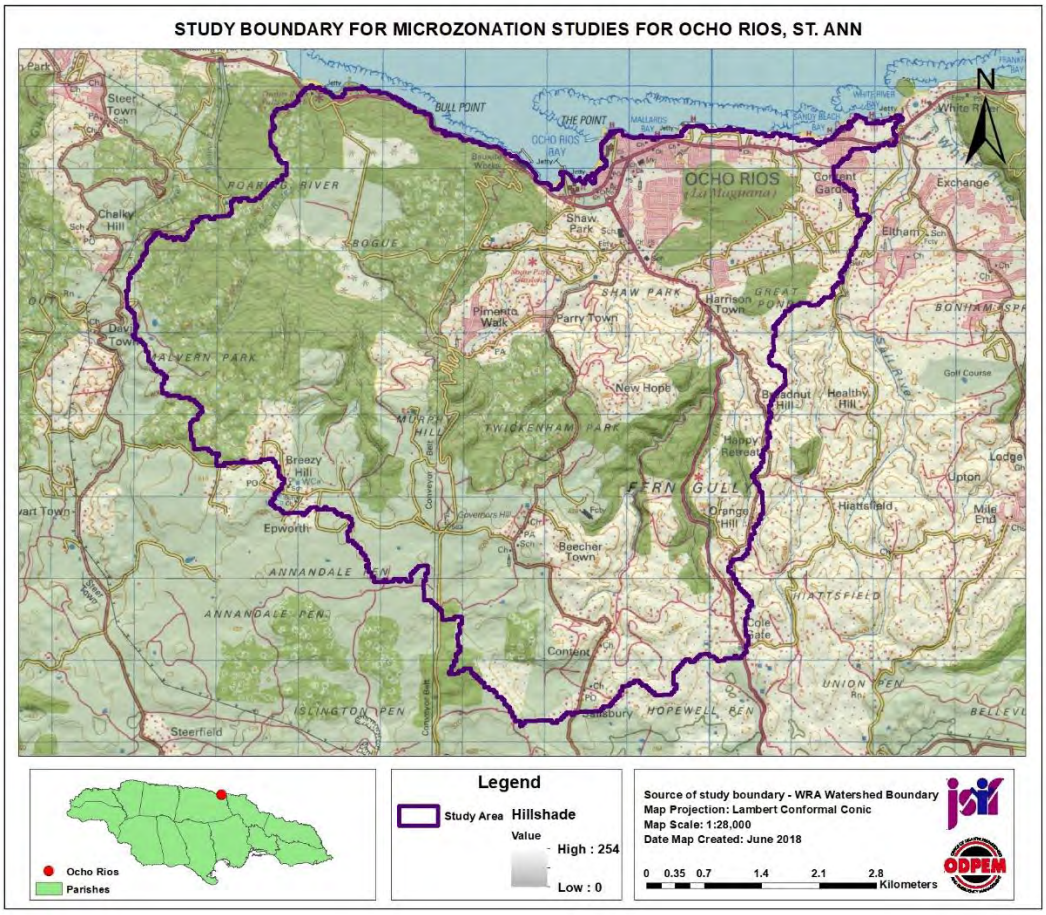
STUDY BOUNDARY FOR MICROZONATION STUDIES FOR OCHO RIOS, ST. ANN
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OCHO RIOS
Steer Town
Chalky Hill
ROARING RIVER
BOGUE
Shaw Park
SHAW PARK
Pimento Walk
Parry Town
Harrison Town
Exchange
Eltham
Content Gardens
DAVYS
DAVYS Town
HALVERN PARK
New Hope
Healthy Hill
TWICKENHAM PARK
Happy Retreat
FERN GULLY
Orange Hill
Hiattsfield
Upton
Lodge
Mile End
Golf Course
Breezy Hill
Epworth
Beecher Town
ANNANDALE
HIATTSFIELD
Content
UNION PEN
HOPEWELL PEN
ISLINGTON PEN
Steerfield
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Hillshade
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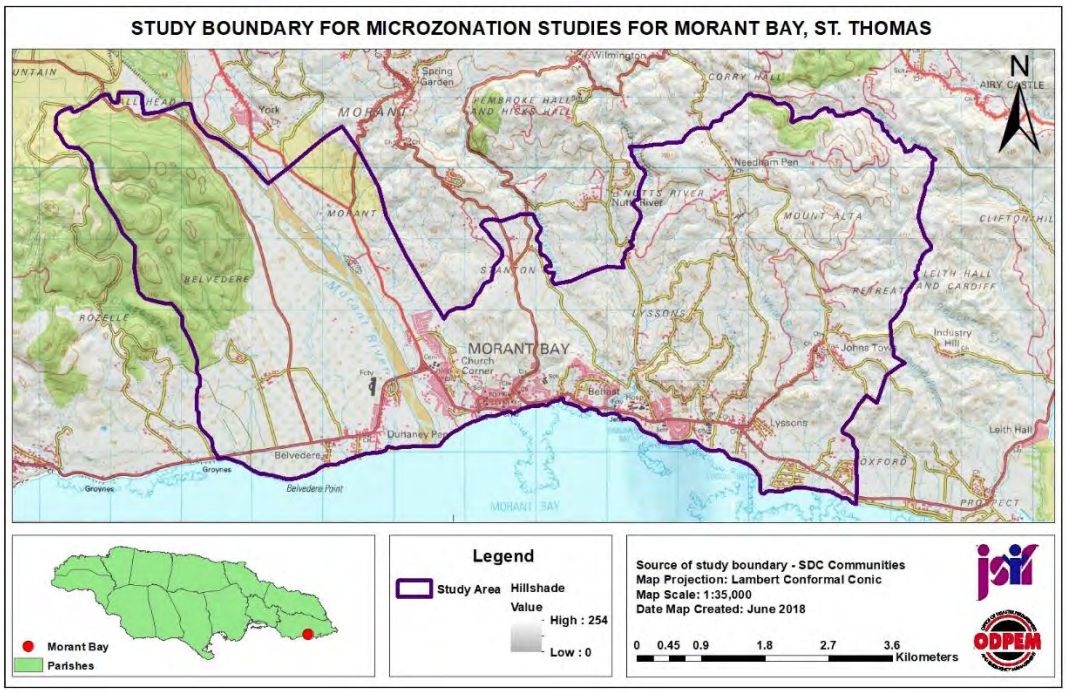
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York
MORANT
PEMBROKE HALL AND HIGH HALL
CORRY HALL
AIRY CASTLE
Needham Pen
MOUNT ALTA
CLIFTON HILL
LEITH HALL AND CARDIFF
RETREAT
BELVEDERE
ROZELLE
LYSSONS
Industry Hill
Johns Town
MORANT BAY
Church Corner
Belmont
Duntaney Pen
Belvedere
Groynes
Belvedere Point
Lyssons
Leith Hall
OXFORD
PROSPECT
Legend
Study Area
Hillshade
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Parishes
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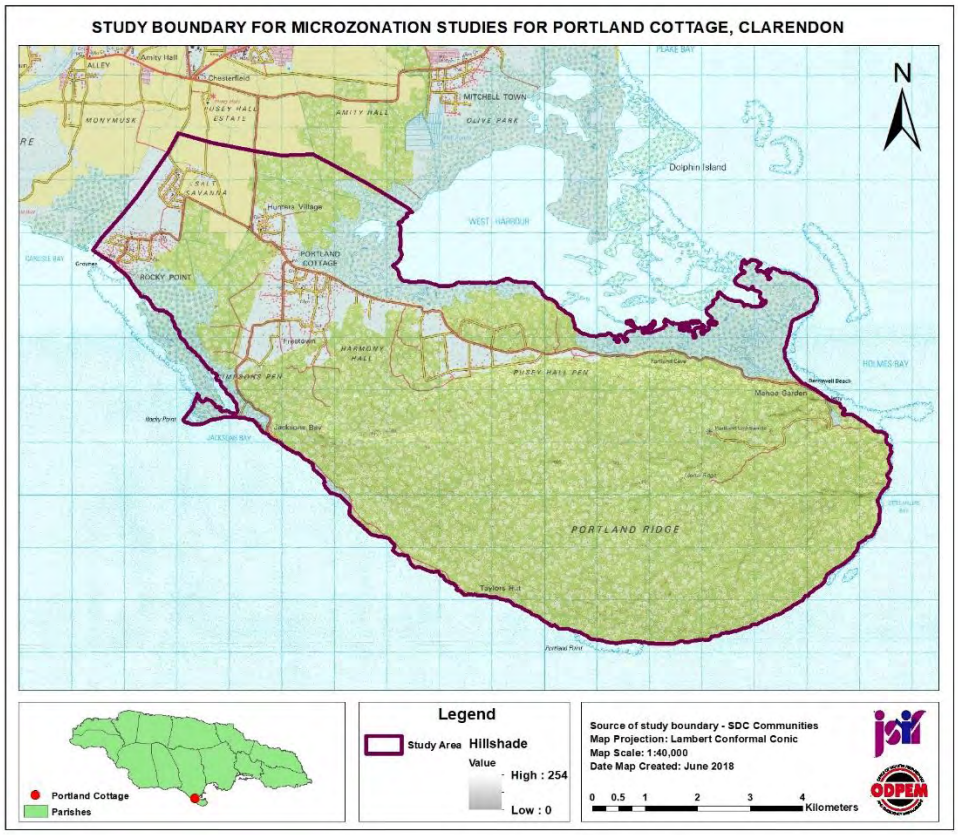
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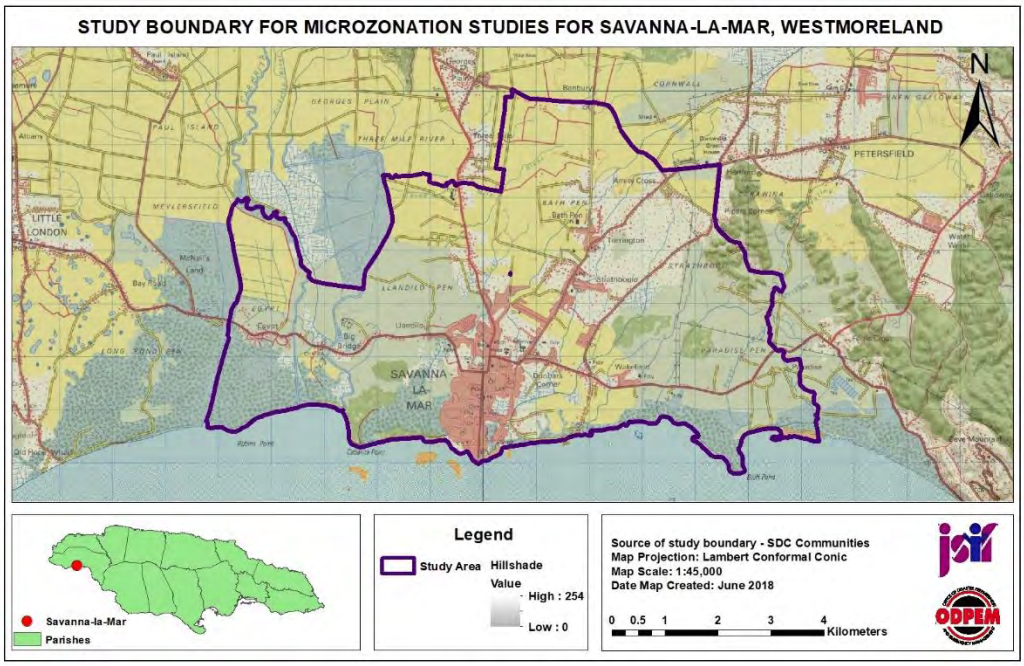
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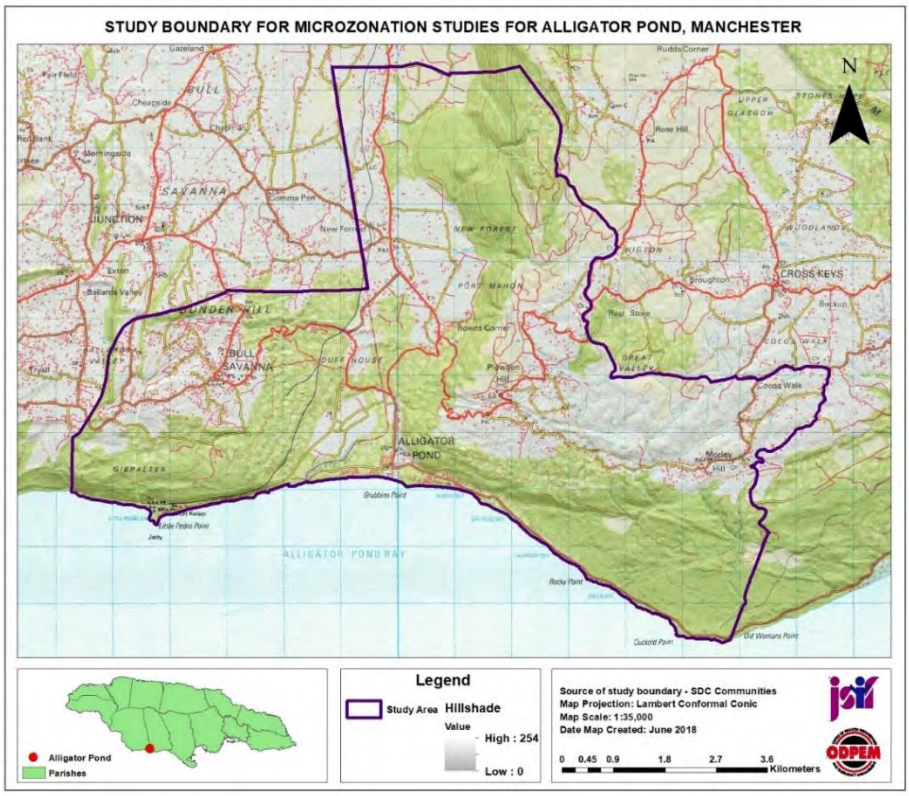
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CROSS KEYS
Alligator Pond
Parishes
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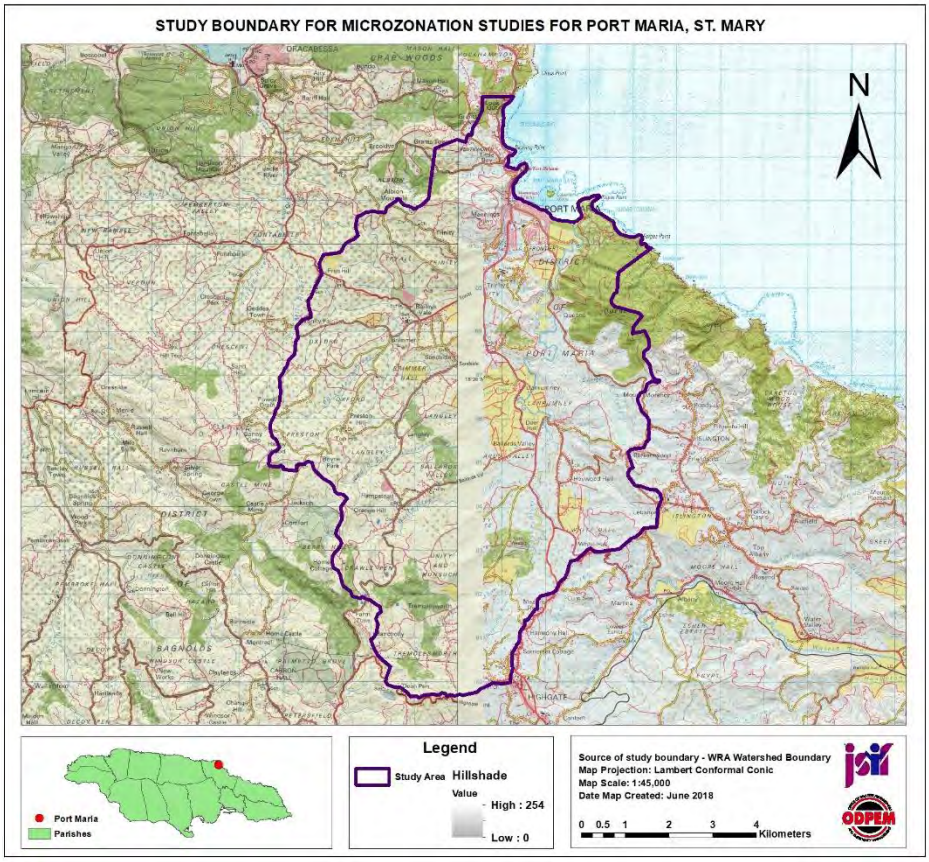
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Port Maria
Parishes
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