



## Technical Assistance for Increasing Resilience of the Education System to Climate Change in Saint Lucia and Antigua & Barbuda

### Technical Assessment and Technology Options Report

Submitted to

Climate Technology Centre and Network  
United Nations Industrial Development Organization

By



**ECMC**

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## Executive Summary

This Technical Assessment and Technology Options (TATO) report is one of the main deliverables of the consultancy for *Increasing resilience of the education system to climate change in Saint Lucia and Antigua & Barbuda*. The need for this report is a consequence of the high vulnerability of Saint Lucia and, Antigua and Barbuda to climate-related shocks. The impacts of these shocks on the education sectors of these countries are likely to increase unless efforts are made to improve their capacity to anticipate, prepare, adapt and become more resilient to such events. This report focuses on twelve schools in Saint Lucia, which are located throughout the country. The buildings, which comprise eleven (infant, primary and combined) schools and one secondary school, have been equally categorized into two zones – the north and south.

The TATO report follows up to another critical deliverable – the Rapid Climate Vulnerability Report which ranked the schools based on their susceptibility to climate hazards and the adaptive capacity of the immediate community and the schools. This ranking was used in establishing the overall ranking of the schools after the physical condition assessment was undertaken.

The main aspect of the TATO report is findings of the condition assessment of the schools, which were influential in determining the technology interventions and mitigation measures to address the issue of resilience of the school buildings and structures. The schools were found to be in generally good condition, with seven obtaining a rating of “Good”. Three schools (Vieux Fort Primary, Balata Combined, and Desruisseaux Combined) were rated as being in “Poor” condition. The condition assessment, which was conducted by ECMC, suggests that there are significant cases of structural deficiency, deferred maintenance as well as non-compliance with the OECS Building Code and international best practices. The key stakeholders advised on several occasions that a formal maintenance plan for the schools was non-existent and that emergency repair was usually the type of maintenance strategy which prevailed.

The mitigation measures and technology interventions proposed, range from basic repairs to cracks and repainting of the buildings, to significant structural retrofit and reconstruction of the entire roofing structure of the school buildings. The susceptibility of some of the schools to the drought hazard has resulted in recommendations to increase storage capacity for potable water at many of the schools and the introduction of rainwater harvesting (together with the use of a first-flush system) in all the schools. Technology options proposed include the use of roof and ground mounted solar panels and photovoltaic systems matching the current limit of 25 megawatts.

Accessibility to and within the schools’ compounds is a major issue to be addressed. Improvement to the access to the Balata, Ave Maria, Desruisseaux, and Saltibus schools was identified as mitigation measures and were included in the work packages developed for each school. Access to ground floors for the differently-able was found to be another critical mitigation measure.

Twelve work packages comprising interventions to increase the schools’ resilience and functioning as emergency shelters were developed. The estimated cost of the work packages ranged from circa USD474,000.00 to USD1,200,000.00 (excluding design and project management cost). The total cost of the twelve packages (inclusive of all cost) is estimated at USD11,826,061. To ensure that disaster risk resilience features prominently in the curriculum of the schools, the work packages include an allowance of USD3,200.00 for each school for this aspect. The issue of fire safety issues at the schools, addressed by the Saint Lucia Fire Service, resulted in the inclusion of fire detection and alarm systems as well as fire suppression and safety measures as part of the interventions for all the schools.



The computation of the cost-effectiveness of the interventions proved to be a major challenge, as the information on the size of the beneficiary community was not readily available. The best options was to use the schools' populations as the direct beneficiary group; another option was to factor the number of students in each school by the national average household size, thereby giving rise to a combined direct and in-direct total beneficiaries. Notwithstanding the option used, when the cost-effectiveness ratio was combined with the overall ranking of the schools and the physical condition rating, Balata Combined was ranked to be the school most worthy of attention.

To address a critical concern of the stakeholders, a maintenance and sustainability framework was developed and included as part of the TATO report. The framework recommends that as per best practice, maintenance budgets should be around one per cent of the building/asset's replacement value.



## Document Information

<b>Document permissions:</b>	Confidential - Client and its funding agencies
<b>Project number:</b>	20501
<b>Project name</b>	Increasing Resilience of the Education System to Climate Change in Antigua and Barbuda
<b>Report Title:</b>	Technical Assessment and Technology Options Report
<b>Report number</b>	20501.110-01
<b>Version number:</b>	<b>V01Draft</b>
<b>Client:</b>	United Nations Industrial Development Organization

## Document History

Version No.	Date	Description	Distributed to	
			Name	Position
V01Draft	August 9, 2021	Technical Assessment and Technology Options Report	Ramiro Salinas	Liaison for Latin America and the Caribbean
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## Acronyms Used

BCA	Building Condition Assessment
CMU	Concrete Masonry Units
CTCN	Climate Technology Centre and Network
CVA	Climate Vulnerability Assessment
DRR	Disaster Risk Reduction
ECMC	Engineering, Construction & Management Consultation Limited
ESIA	Environmental and Social Impact Assessment
HVAC	Heating, Ventilation, and Air Conditioning
MSP	Maintenance and Sustainability Plan
MSSP	Model School Safety Programme
NDE	National Designated Entity
OECS	Organization of Eastern Caribbean States
RCM	Renewable Cycles for Maintenance
SIDS	Small Island Development States
SMP	Strategic Management Plan
TATO	Technical Assessment and Technology Options
TOR	Terms of Reference
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
USD	United States Dollar



## The Consulting Team

This report was prepared by ECMC (the Consultant) with input from a team of experts listed below:

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## 1.0 Introduction

The vulnerability of Saint Lucia and Antigua & Barbuda to climate-related shocks is likely to increase unless their education sectors improve their capacity to anticipate, prepare, adapt, and become more resilient to such events. Some of the public schools designated as emergency shelters in these two Small Island Development States (SIDS) are considered insufficient in terms of structural condition to withstand a Category 5 Hurricane as well as ensuring minimum disruption to the populations' education system. Therefore, there is a need for a new approach to increase the resilience of those schools as emergency shelters for the communities. This situation has resulted in the consultancy for a technical assessment to establish possible options for retrofitting the schools to improve their resilience to climate change.

This report presents Deliverable 4.1 – *“A Technical Assessment and Technology Options Report for Schools Upgrading to Improve Climate Change Resilience and Sustainable Functioning and Subsistence of Schools”*. This Technical Assessment and Technology Options (TATO) Report is specific to Saint Lucia as was initially mandated by the Terms of Reference; however, due to a variation to the consultancy consequent to a request from Antigua and Barbuda, the report also outlines the process involved in assisting that country in adopting the methods utilized in Saint Lucia to replicate the exercise for 28 selected schools.

### 1.1 Background

The Climate Technology Centre and Network (CTCN) is the operational arm of the United Nations Framework Convention on Climate Change (UNFCCC) Technology Mechanism and hosted by the United Nations Environment Programme (UNEP) in collaboration with the United Nations Industrial Development Organization (UNIDO) and supported by eleven partner institutions with expertise in climate technologies.

The mission of the CTCN is to promote accelerated deployment and transfer of climate technologies at the request of developing countries for energy-efficient, low-carbon, and climate-resilient development. The requests for Technical Assistance were submitted to the CTCN by the National Designated Entity (NDE) of Antigua and Barbuda and Saint Lucia.

It is our understanding that the main aim of the CTCN technical assistance/consultancy assignment is to enable the two SIDS to strategically assess the climate risk and the related negative impacts to the educational system. The intention is to also appraise improvement measures that will allow both governments to remove technology barriers and deploy specific adaptation technology solutions in preparation of a project proposal to be submitted to the Adaptation Fund.

### 1.2 Context

Like the other Eastern Caribbean countries, Saint Lucia and Antigua and Barbuda, are exposed to various natural hazards, including the five referenced in this consultancy – hurricanes, droughts, floods, sea-level rise, and landslides. Although these hazards affect the countries to a varying degree, almost all have compromised countries poverty reduction strategies, hindered development gains, and negatively impacted various sectors, particularly the educational systems. The severe effects of these hazards have been magnified by the impact of climate change. The 2013 Christmas Trough and 2010 Tropical Storm Tomas are two critical examples of extreme rainfall in Saint Lucia.

Low-lying countries and low-lying sections of Saint Lucia and Antigua and Barbuda, have been shown to be particularly vulnerable to the sea level rise in addition to the usual storm surge during storms



and hurricanes throughout June to December. These hazards, pose significant risks to public safety and health as well as assets, and natural resources.

In the context of this consultancy, Saint Lucia and Antigua & Barbuda are Small Island Development State (SIDS), that are highly at risk from climate change, mainly due to their location along the north Atlantic hurricane corridor. Over the last twenty years, Saint Lucia has been struck by two hurricanes and nine tropical storms, and Antigua and Barbuda, three and five tropical storms<sup>1</sup>. In both of these countries, there is a heavy economic reliance on tourism and agriculture, which are both climate-sensitive sectors.

### **1.3 Purpose**

The purpose of this report is to, present the methodologies and processes involved in developing resilience improvement packages, showing options for upgrading, retrofitting or replacement, for each of twelve selected schools. These packages are aimed at increasing the schools' resilience and function as an emergency shelter.

This TATO report for the schools has a particular bias towards upgrading for mitigating climate hazards; however, emphasis is also placed on the adaptive capacity of the schools and their immediate communities, so as to ensure sustainable functioning and subsistence of the schools. Therefore, the report also highlights how the schools were assessed and rated to establish those most in need of resilience actions, retrofit, and preventative maintenance measures. The method of establishing the cost of the mitigation action and computing cost-effectiveness, in terms of the size of the beneficiary communities are also presented in the report.

Outside of addressing the impacts of climate change, adoption of maintenance strategies is considered extremely important for the sustainable operations and longevity of the physical schools' plant. In this regard, the report also presents actions which are particularly relevant to the cyclical maintenance of the schools.

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<sup>1</sup> Storm CARIB- Caribbean Hurricane Network; [https://stormcarib.com/climatology/TAPA\\_all\\_isl.htm](https://stormcarib.com/climatology/TAPA_all_isl.htm)



## 2.0 General Description of the Twelve Schools

### 2.1 Location

The 12 school sites are located throughout Saint Lucia, from Corinth in the north (Gros Islet) to Vieux Fort at the southern tip of the Island. The schools and surrounding communities are located in areas varying from very flat to moderately sloping. The schools vary in elevation from 3.5 to 5.0 metres at the Ave Maria Schools to 278 to 280 metres at the Saltibus Combined School.

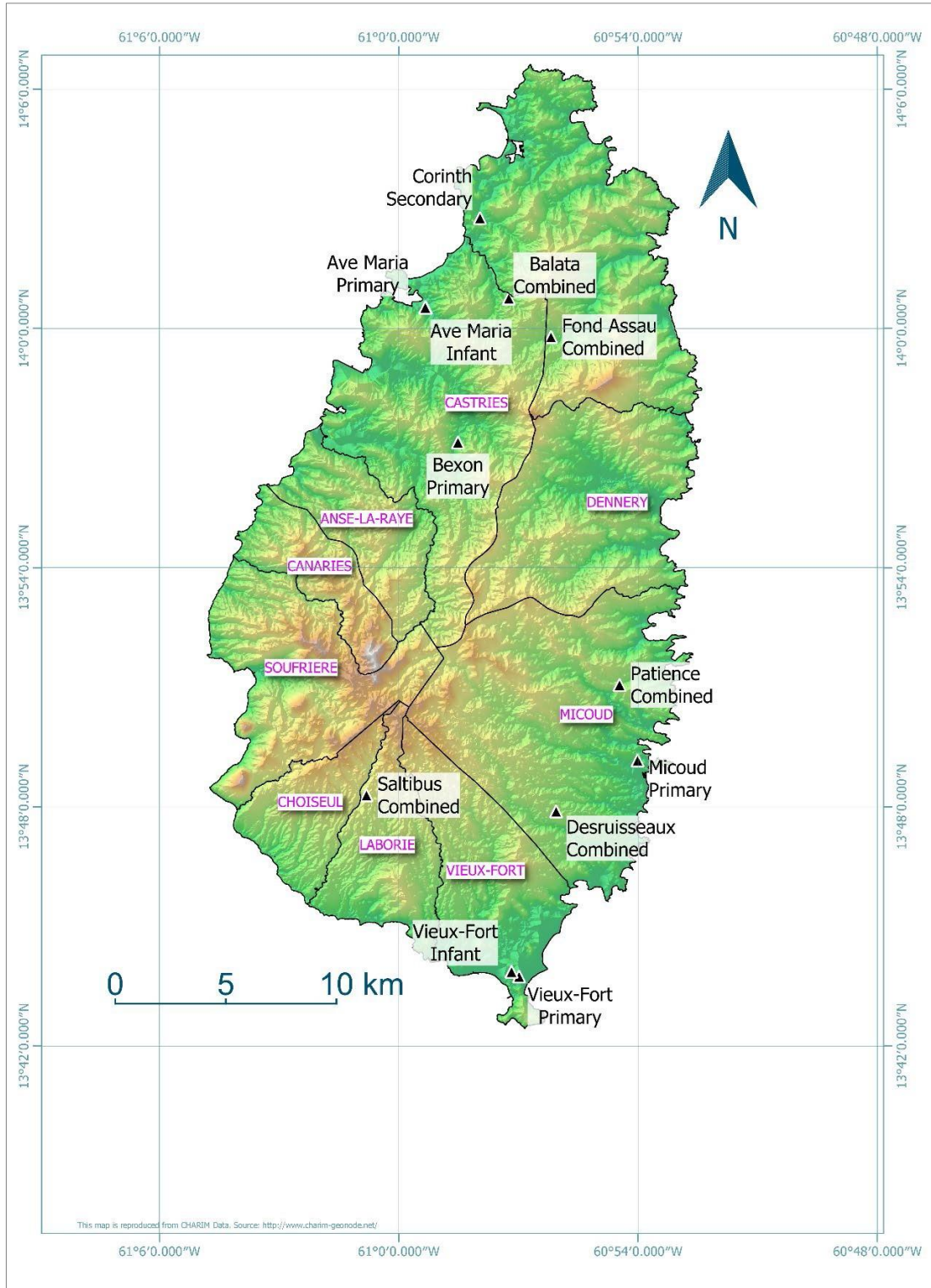
Apart from the Ave Maria (Infant and Primary), and Corinth Secondary schools, which can be considered to be on the western flanks of the Island, the other nine schools are either inland or on the east coast. While those on the eastern flanks would be more exposed to saline conditions and greater exposure to windstorms, those on the west appeared to be sheltered from the easterly saline conditions and direct impacts of the hurricanes. The two at the highest elevations, Desruisseaux and Saltibus, are more exposed to the impacts of hurricanes and high wind storms. Table 1 provides information on the geographic location of the 12 schools.

**Table 1 – Geographic Location of the 12 Schools in Saint Lucia**

School	Latitude	Longitude
Ave Maria Infant (AMI)	14° 0'31.28"N	60°59'18.93"W
Ave Maria Primary (AMP)	14° 0'31.72"N	60°59'20.00"W
Balata Combined (BC)	14° 0'45.28"N	60°57'14.30"W
Bexon Primary (BP)	13°57'8.60"N	60°58'30.85"W
Corinth Secondary (CS)	14° 2'46.30"N	60°57'57.71"W
Desruisseaux Combined (DC)	13°47'53.19"N	60°56'3.15"W
Fond Assau Combined (FAC)	13°59'47.27"N	60°56'10.91"W
Micoud Primary (MP)	13°49'9.90"N	60°54'0.60"W
Patience Combined (PC)	13°51'3.47"N	60°54'27.74"W
Saltibus Combined (SC)	13°48'17.50"N	61° 0'48.48"W
Vieux-Fort Infant (VFI)	13°43'51.76"N	60°57'10.26"W
Vieux-Fort Primary (VFP)	13°43'44.77"N	60°56'58.91"W

Source: Google Earth

The map in Figure 1 shows the location of the 12 schools throughout Saint Lucia.



**Figure 1 – Overview map of the 12 schools in Saint Lucia**  
(note that the Ave Maria schools are located very close together in Castries and appear as one point)  
*Source: HR Wallingford produced using data from ECMC Ltd and CHARIM GEONODE*



## 2.2 Description

The descriptions of the sites provide information on their: relative locations within the communities, topography of the grounds; elevations, proximity to water courses, playgrounds and emergency services. Information on the type of community (rural, urban or sub-urban) and school occupation is also described to provide an insight into the size of the school and its capacity as an emergency shelter.

### ***Ave Maria Infant and Primary Schools***

Both of these schools are located within one fenced compound in the central business district of Castries about three city blocks away from the Central Fire Station. Photographs 1 and 2 show the Infant and Primary schools respectively.

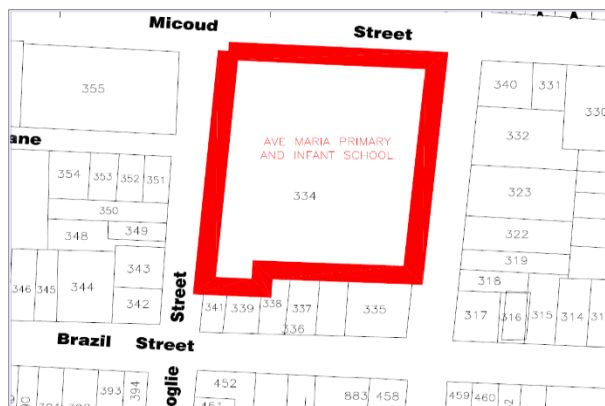


**Photo. 1** – Ave Maria Infant School



**Photo. 2** – Ave Maria Primary School

The site is flat and occupies the major portion of a city block, on 3,000 m<sup>2</sup> of land. The location plan and aerial view of the school are presented in Figure 2. The compound comprises six school buildings enclosing a playground, void of any vegetation. The property has exits on all the three streets which are contiguous to the northern, eastern, and western boundaries. Both schools are identified as emergency shelters and are two of five schools which are considered as being located in the centre of Castries. The total population of the two Schools is 498 students.



**Figure 2** – Location Plan and Aerial Photo of Ave Maria Infant and Primary Schools



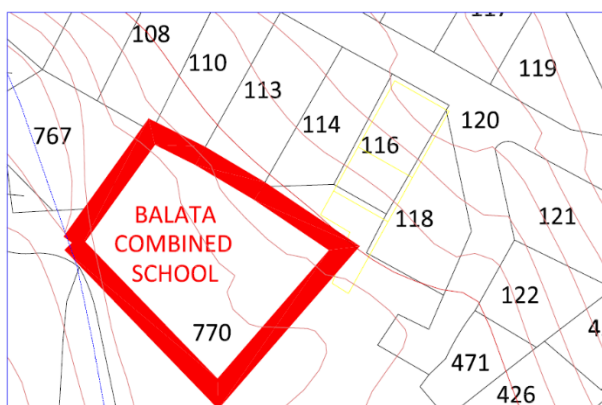
### **Balata Combined School**

The school (shown in Photograph 3) is nestled within the Balata community, which is in the district of Castries and in the central north of Saint Lucia. The location plan and aerial view of the school are presented in Figure 3.

The compound is at the end of an ill-defined cul-de-sac, accessed by a narrow road with inadequate geometric design. The road reduces to a community footpath after passing the school, and there are no other vehicular accesses to the site. There is minimal space available for vehicular turning. A ravine flows to the western side of the school and is in close proximity to the school's north-western boundary. The compound is flat and school operations accommodated within an "L" shaped building with access to a playground on the opposite side of the access road. The school compound occupies about 1,880 m<sup>2</sup>. It is used as an emergency shelter and has a population of 378 students.



**Photo. 3 – Balata Combined School**



**Figure 3 – Location Plan and Aerial Photo of Balata Combined School**

### **Bexon Primary School**

This school is located in the centre of the Island. It is considered to be between the Cul De Sac and Mabouya Valleys and sits within a low lying plain which is known to flood. Photograph 4 shows the Bexon Primary School. Vehicular access is off an extended track which does not facilitate easy manoeuvrability of emergency and other vehicles. The location plan and aerial view of the school are presented in Figure 4.

The pedestrian access across the school's eastern boundary crosses the Cul De Sac River off the



**Photo. 4 – Bexon Primary School**



Castries-Vieux Fort Highway. The closest emergency vehicles (fire and ambulance) are located in the Castries and Dennery areas which are about 16 km to the north and south respectively. The school compound occupies 2,117 m<sup>2</sup>. It is located near a community playground and is zoned as an emergency

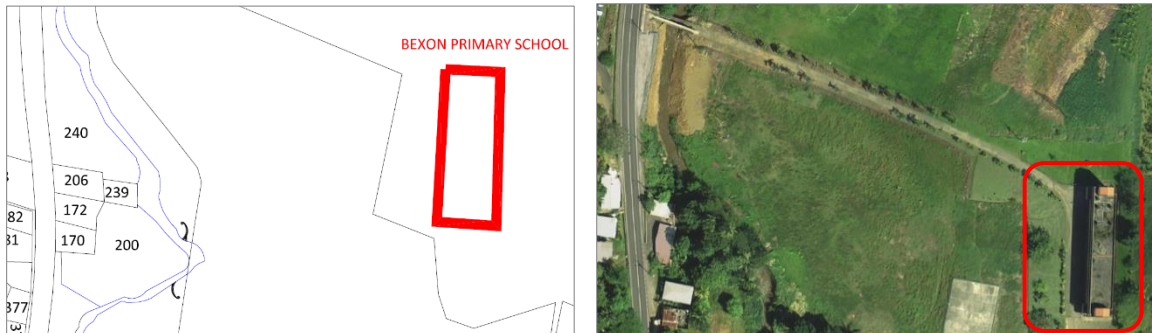


Figure 4 – Location Plan and Aerial Photo of Bexon Primary School

shelter. It has a population of 136 students.

#### **Corinth Secondary School**

This school (shown in Photograph 5) is located in the northern section of the Island and is accessed off a major secondary road which runs in an easterly direction from the Grand Riviere Junction off the Castries-Gros Islet Highway. The location plan and aerial view of the school are presented in Figure 6. It is within a densely populated residential area, which is quickly becoming sub-urban. It is one of the largest schools in the Gros-Islet area and the compound occupies 8,130 m<sup>2</sup> of land adjacent to a community playground. The La Brelotte River flows near its north-eastern boundary and the school site is known to have experienced issues with drainage and flooding of the northern side of the compound. Emergency services (police and fire) are available about 8 km to the north and the school is designated as an emergency shelter. It has a population of 706 students.



Photo. 5 – Corinth Secondary School

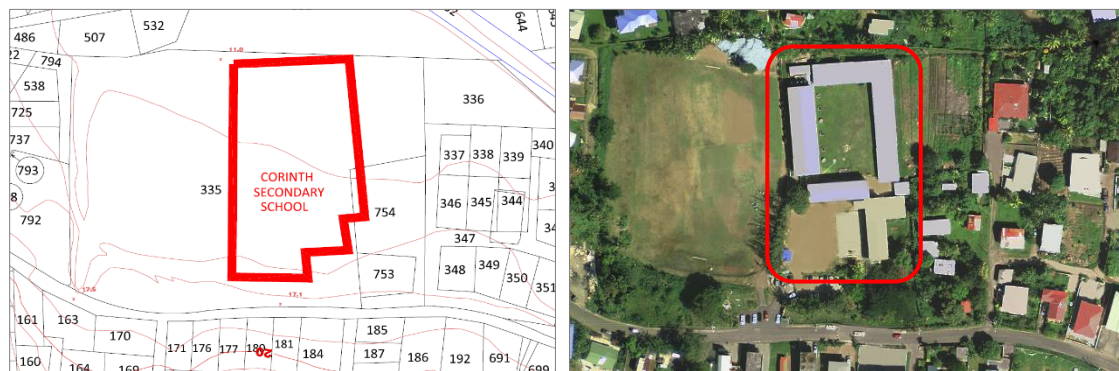


Figure 5 – Location Plan and Aerial Photo of Corinth Secondary

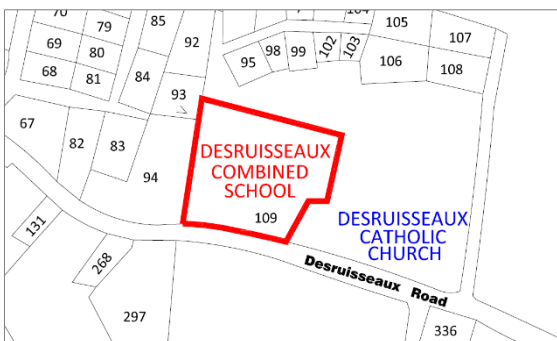


### **Desruisseaux Combined School**

The Desruisseaux Combined school is located in the south of the island in the Quarter of Micoud. The location plan and aerial view of the school are presented in Figure 7. It is accessed directly off the Desruisseaux main road. The Church and the playground are on the eastern boundary of the school. The site is generally gently sloping from south to north, at a high elevation of 133 m above sea level. It has a population of 230 pupils.



**Photo. 6 – Desruisseaux Combined**



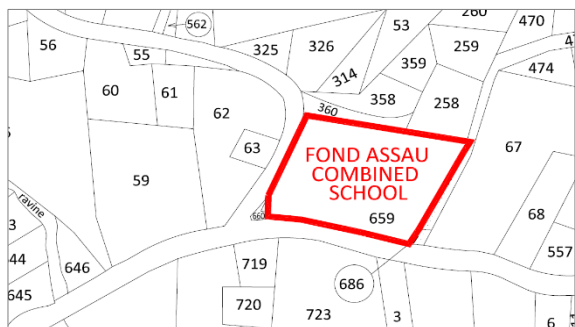
**Figure 6 – Location Plan and Aerial Photo of Desruisseaux Combined School**

### **Fond Assau Combined School**

The school is located in Babonneau, a community in the northeast of Saint Lucia. The location plan and aerial view of the school are presented in Figure 8. The school is accessed off the main Fond Assau road and is about 2 km downhill from the Babonneau main road. It is a sloping site which has been benched to build three school blocks, one of which was recently constructed. The entire compound measures about 3,932 m<sup>2</sup>. The school's population is 130 pupils.



**Photo. 7 – Fond Assau Combined School**



**Figure 7 – Location Plan and Aerial Photo of Fond Assau Combined School**

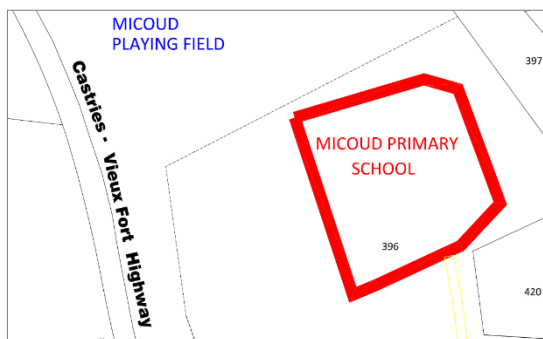


### **Micoud Primary School**

Micoud Primary School is located on the southeast of Saint Lucia and is accessed off the Castries-Vieux Fort Highway. The location plan and aerial view of the school are presented in Figure 9. The main access to the school is narrow and below standard. There are four buildings within the compound, one of which was recently constructed. The compound is gently sloping from north to south and measures about 5,090 m<sup>2</sup>. It has 385 students.



**Photo. 8** – Micoud Primary School



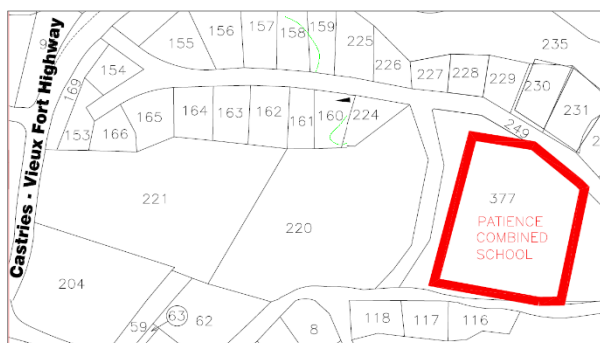
**Figure 8** – Location Plan and Aerial Photo of Micoud Primary School

### **Patience Combined School**

This school is located in the district of Praslin, north of Micoud. The location plan and aerial view of the school are presented in Figure 9. It is east of the Castries-Vieux Fort Highway and has a view of the Atlantic coastline. It is accessed off a paved secondary road and comprises four buildings, one of which was built recently. The compound measures 5,250 m<sup>2</sup>. The school has 253 pupils and is a designated emergency shelter.



**Photo. 9** – Patience Combined School



**Figure 9** – Location plan and aerial photo of Patience Combined School



### **Saltibus Combined School**

The Saltibus Combined School is at an elevation of 282 m above sea level. It is located along an extended spur, which is about 10 - 12 km off the Laborie-Choiseul Highway. The location plan and aerial view of the school are presented in Figure 11. The School appears to straddle the Laborie - Choiseul boundary. The immediate area is characterized by steep terrain and the only available access road to the school runs along the spur, where it ends some 12 - 13 km inland. The property area is 2,188 m<sup>2</sup> and is adjacent to a community playground. It is identified as an emergency shelter and has a student population of 106.



**Photo. 10** – Saltibus Combined School



**Figure 10** – Location Plan and Aerial Photo of Saltibus Combined School

### **Vieux Fort Infant and Primary Schools**

These two schools are located in the suburban locality of the town of Vieux Fort. The location plan and aerial views of the schools are presented in Figure 12. The Infant School is accessed directly off Clarke Street which is the main road into the town centre. The Primary School is further east, where the town's urbanization appears to be expanding. Photographs 11 and 12 show the infant and primary schools respectively.



**Photo. 11** – Vieux Fort Infant



**Photo. 12** – Vieux Fort Primary



Both schools are on extremely flat grounds but the primary school is much more exposed to the trade winds and coastal inundation. The Infant School occupies 2,922 m<sup>2</sup> of land while the primary school is 7,120 m<sup>2</sup>. The Infant School has a population of 167 students, and the primary school, 205 students.



Figure 11 – Location Plan and Aerial Photos of Vieux Fort Infant and Primary schools



### 3.0 Methodology and Approach

The methodology and approach adopted was influenced by the number of schools, the spread of their locations, and more importantly the time frames for the deliverables. Some of the initial deliverables required preliminary cost estimates for proposed interventions. The following sections describes the approach adopted.

#### 3.1 Inspection Strategy

To facilitate an efficient and optimal process, the inspection strategy involved dividing the Island into two zones; north and south as explained in Figure 13. The inspection team for each zone comprised two engineers and two technicians; however, for expediency purposes and due to the allotted time offered by the principal, the Corinth Secondary school was inspected by a larger team.

The strategy was to schedule one inspection per school, except in cases where a return visit was necessary to reconcile measurements or take additional photographs. Additionally, where the defects were significant, additional visits were made to expand the investigation and to evaluate specific conditions which were observed from previous visits. Regarding the fire safety component, the mechanical engineer coordinated visits with officers of the Saint Lucia Fire Services. These visits were conducted on the basis of three schools per day.

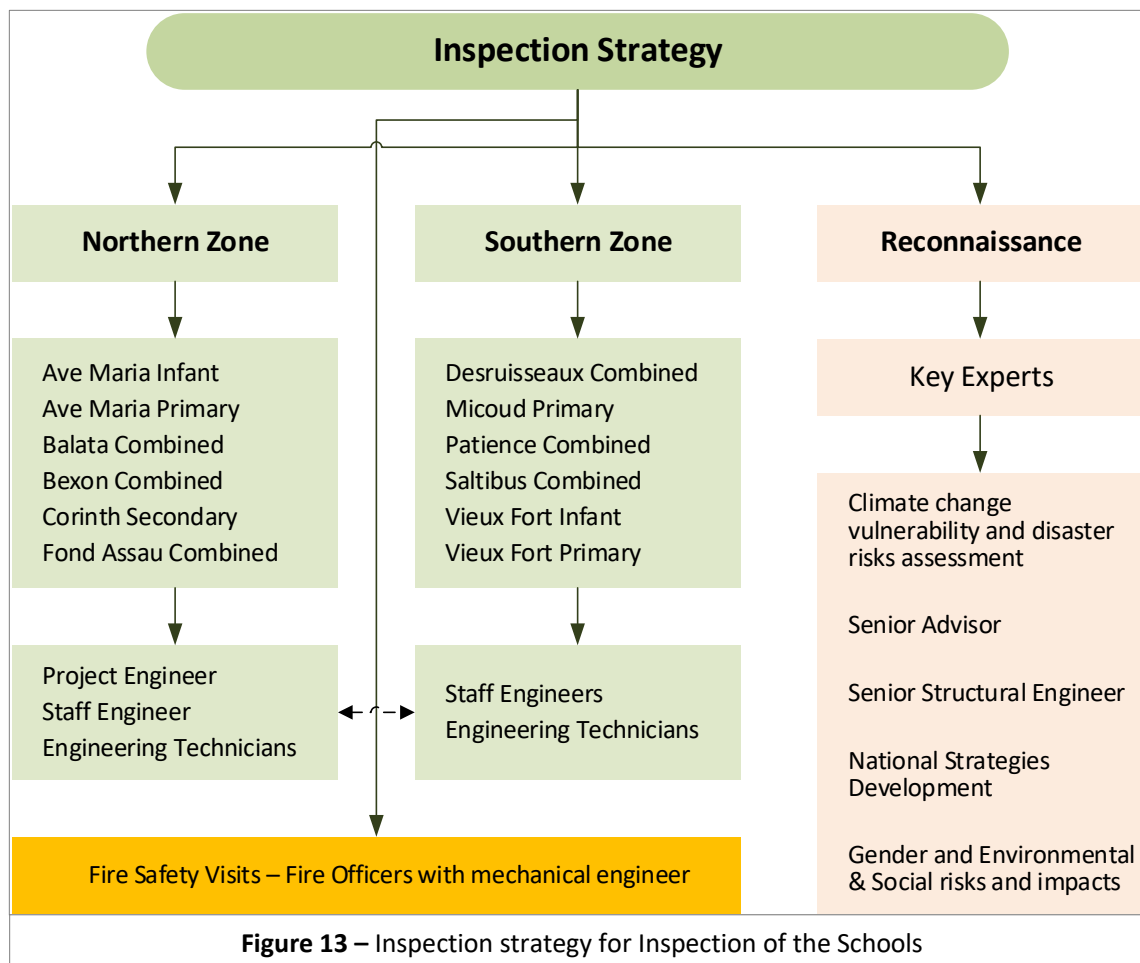


Figure 13 – Inspection strategy for Inspection of the Schools



### 3.2 Inspection Schedule

With the problem of periodic closure of schools due to the Coronavirus Pandemic, a tight inspection schedule had to be developed and maintained. A pilot inspection was conducted on August 27, 2020, when an engineer and a technician inspected the Balata Combined School. The inspection and completion of specially designed assessment forms were followed by a presentation to the remainder of the ECMC team of inspectors.

The assessment of the 12 schools was performed over a period of about 49 hours by five engineers and five technicians. The schedule which was maintained is highlighted in Table 2. Also included are the days when the reconnaissance visits and rapid inspections were conducted. The initial reconnaissance team included two engineers performing the rapid assessment, which facilitated the estimation of initial preliminary costing of anticipated mitigation works.

Although the civil/structural engineers and technicians performed some rudimentary inspections on the issues of fire safety, the team's mechanical engineer, with the specific role for these investigations made separate visits. As mentioned earlier, these visits were conducted in collaboration with the Saint Lucia Fire Service. The adopted schedule is also highlighted in Table 2.

**Table 2 – Technical Inspection Schedule**

Dates in 2020	Schools	Times	Personnel
August 27	Balata Combined	9:30 a.m. – 12:00 p.m.	1 Eng.; 1 Tech.
September 4	Vieux Fort Primary	8:00 a.m. – 1:00 p.m.	3 Engs.; 1 Tech.
September 4	Fond Assau Combined	1:00 p.m. – 4:00 p.m.	2 Engs.; 2 Techs.
September 4,	Vieux Fort Infant	2:00 p.m. – 5:00 p.m.	3 Engs.; 1 Tech.
September 9	Micoud Primary	8:00 a.m. – 1:00 p.m.	3 Engs.; 1 Tech.
September 9	Ave Marie Infant and Primary	9:30 a.m. – 2:30 p.m.	2 Engs.; 2 Techs.
September 9	Patience Combined	2:00 p.m. – 5:00 p.m.	3 Engs.; 1 Tech.
September 11	Desruisseaux Combined	8:00 a.m. – 12:00 p.m.	3 Engs.; 1 Tech.
September 14	Saltibus Combined	8:30 a.m. – 1:00 p.m.	3 Engs.; 1 Tech.
September 14	Bexon Primary	9:00 a.m. – 1:30 p.m.	2 Engs.; 2 Techs.
September 16	Corinth Secondary	9:00 a.m. – 1:30 p.m.	4 Engs.; 1 Tech.
<b>Fire Safety Visits</b>			
November 23, 2020			
To January 6, 2021	All Twelve Schools		



### 3.3 Sites Reconnaissance

ECMC’s key experts visited the selected schools and conducted in-depth site reconnaissance to obtain a clearer appreciation of the locations as well as the environmental and topographic conditions which would contribute to the climate change impacts. Population centres and concentrations in proximity to the schools and the communities being served by the schools were also noted.

School Principals or their representatives were also engaged to obtain information on priority issues and their assessment of adaptive capacities at a school, community, Ministry, and national level. Plant maintenance schedules and prominent concerns were discussed assist in developing a discernible pattern of the schools’ needs over the years of existence or years of management by the incumbent principal.

The consulting team was unable to schedule the two Ave Maria schools at the time of reconnaissance visits, primarily because the officers in charge were unavailable. The reconnaissance team was also unable to hold discussions with the principal of the Corinth Secondary and Saltibus Combined schools; however, these key stakeholders were interviewed individually at later occasions. The reconnaissance visits which lasted the whole day, took place on two days September 2020; the schedule adopted is presented in Table 3.

**Table 3 – Schedule of Sites Reconnaissance Visits**

Dates in 2020	Schools
September 8	<ul style="list-style-type: none"><li>– Balata Combined,</li><li>– Fond Assau Combined,</li><li>– Corinth Secondary,</li><li>– Bexon Primary,</li></ul>
September 11	<ul style="list-style-type: none"><li>– Micoud Primary,</li><li>– Patience Combined,</li><li>– Saltibus Combined,</li><li>– Vieux Fort Infant and Primary</li></ul>

Additionally, to facilitate a quick evaluation of the physical conditions to determine climate factors and impacts, a rapid condition assessment of the school plant was performed by the engineers on the reconnaissance team. The team (Civil/Structural Engineer) undertook a concise yet instructive investigation of the conditions of each of the schools, to determine the appropriate mitigation and general preventative maintenance requirements of the buildings and the grounds. This investigation of the physical/structural defects facilitated the preparation of very preliminary cost estimates for the works likely to be undertaken under each school. Thus, the preliminary condition assessment was necessary as *Deliverable 3.2: Brief School Profile* required that “preliminary cost estimations, be included in the profile.

Understanding the vulnerability in a spatial context was expected to enable the stakeholders to properly assess climate change vulnerability for each of the schools. This tailored approach allowed for individual improvement measures to be identified and prioritized on a case-by-case basis.



### 3.4 Technical Inspections

The drawings for some of the schools assisted the technical inspections. Where drawings were available, these became part of the tools and resources used at the school sites. The conditions of the schools' plant and the surrounding grounds were observed through detailed, and, in some cases, intrusive inspections.

The scope of the inspections included:

- Compiling the component inventory and verifying the inventory for refurbished and existing structures, wherever possible.
- Identifying the exposure classification in the immediate proximity of each component.
- Visually inspecting building structural elements and components to assess their condition using a standard condition rating system outlined in Section 5.3.
- Reporting the condition of each building structural element and component, and the extent over which that condition applies.
- Rating the overall condition of the building or structure.
- Identifying buildings, structures, and/or elements which warrant detailed and further inspection due to severe deterioration of critical structural elements.
- Identifying elements which require closer condition monitoring and observation, whether during the consultancy or in the future.
- Capturing a photographic record of the buildings and structures, and any deficient or non-standard elements.
- Identifying maintenance requirements and/or deficient maintenance practices.
- Identifying deficiencies which are a direct result of the quality of the workmanship
- Capturing where deficiencies are a result of construction detailing or engineering design.

These observations were recorded on both still photography (in Appendix 1) and Building Condition Assessment (BCA) forms (in Appendix 2) designed specifically for the consultancy. The forms, their summary descriptions, and some of the condition ratings used are identified in Tables 4 and 5.

**Table 4 – Condition Assessment Forms**

Building Condition Assessment	Summary Description
Building and Inspection data	<ul style="list-style-type: none"><li>• General information on the school's construction, age/year of construction and remodeling or major retrofitting; design codes used, building size, geographic location, building dimensions, number of storeys, and risk category</li><li>• Construction data on the main structural elements – roofs, walls, columns, floor and ceilings, windows and skylights, and external doors</li><li>• Overall building condition assessment rating</li></ul>



Building Condition Assessment	Summary Description
Hazards and Building Integrity	<ul style="list-style-type: none"> <li>On site assessment of the five hazards identified for assessment on the project</li> <li>Information on building and structural integrity, architectural components, water supply, and wastewater systems, and mechanical and electrical systems.</li> </ul>
Fire Safety & Code Compliance	<ul style="list-style-type: none"> <li>Information on means of exit, fire control, fire alarm, emergency lighting, fire resistance, provisions for handicap/accessibility.</li> </ul>

To establish the relative building conditions, several indices and ratings were used. Three BCA forms and indices were used to assess the various conditions, building elements, structural integrity, code compliance, and fire safety situations. Some of these indices are identified in Table 5.

**Table 5 – Condition Indices**

Building Condition Assessment	Rating Criteria
Overall building condition assessment	Excellent - 5, Good - 4, Fair/Average - 3, Poor - 2, Very Poor - 1
Hazards	No Hazard, Low, Average, High
Building Integrity	<ul style="list-style-type: none"> <li>Low = Major damage and no repairs; Average = Moderate damage and building only partially repaired; High = Minor or no damage, or building fully repaired.</li> <li>Low = Current safety standards not applied; Average = Current safety standards partially applied; High = Current safety standards fully applied.</li> <li>Low = No evidence of engineered building records, or built according to an old design standard; Average = Built according to previous design standards and no retrofit work to a current standard; High = Built according to a current standard.</li> </ul>
Fire Safety & Code Compliance	Good, Fair and Unsatisfactory



## 4.0 Descriptions of Existing Conditions

The schools' plant and surrounding grounds were found to be in various levels of physical conditions. The visual walkthrough took note of building elements and systems that were conspicuous and easily discernible. Reports of the observed conditions are addressed below.

### 4.1 Structural Systems

The structural systems varied throughout the schools, with some sites having as many as three different types. However, the structural systems observed could be categorized as follows:

- Concrete masonry units (CMU) with infill reinforced concrete columns and ring beams;
- Reinforced concrete structural frame with infill CMUs;
- All timber framing and cladding;
- Structural steel frames with infill CMUs.

The roofs as part of the structural system also varied and included, concrete solid slabs, trusses spanning the width of the buildings, and rafters as part of a gable or hip roof. The floors also varied, with the buildings having reinforced concrete solid slabs, precast aerated concrete planks, and timber boards.

As expected, structural systems are frequently concealed and, in some cases, inaccessible. Therefore, ECMC's teams were mandated to identify the structural system as a primary function when starting the assessments. Consequently, it was important to identify every structural system existent in the school plant. The information gathered on the structural systems, façades, flooring, and roof systems is presented in Tables 6 and 7.

While the observations suggest the existence of several defects, Table 6 highlights ten of the most significant defects which may require some level of retrofit being undertaken to the building element of a structural system on the whole.

**Table 6 – Most Significant Structural Defects**

Number	Significant Defects
1	Severe and excessive cracking of beams, columns, and slabs (Bexon Combined)
2	Termite infected and poor-quality construction of roof truss (Balata Combined)
3	Heavily corroded sheets, steel purlins, and steel roof members (Vieux Fort Primary)
4	Poorly constructed, corroded, and sagging roof members (Desrousseaux Combined)
5	Leaking roof suggesting existence of cracks in the slab (Bexon Combined)
6	Flooding inundation during extreme rainfall events (Vieux Fort Primary)
7	Cracks in, and excessive vibration of first floor (Desrousseaux Combined)
8	Corroded roof members and wet rot of timber at eaves of buildings (Vieux Fort Primary)
9	Cracks in wall, floor slabs, and first floor beams suggesting settlement (Fond Assau Combined)
10	Effect of roots from huge tree cracking walls and staircase (Desrousseaux Combined)



**Table 7 – Building Structural Components**

Schools	Structural Systems	Walls	Floor	Roof
Ave Maria Infant	<ul style="list-style-type: none"> <li>Structural Steel with infill CMU's</li> <li>Reinforced concrete frame</li> </ul>	CMUs	<ul style="list-style-type: none"> <li>Aerated concrete slabs</li> <li>Solid slabs</li> </ul>	<ul style="list-style-type: none"> <li>Structural steel</li> <li>Large span roof truss</li> </ul>
Ave Maria Primary	Reinforced concrete frame	CMUs	<ul style="list-style-type: none"> <li>Solid slabs</li> </ul>	<ul style="list-style-type: none"> <li>Structural steel</li> <li>Large span roof truss</li> </ul>
Balata Combined	<ul style="list-style-type: none"> <li>Reinforced concrete frame</li> <li>Timber frame and floor</li> </ul>	CMUs & Timber	Solid concrete slab and Timber floor	<ul style="list-style-type: none"> <li>Large span roof truss</li> <li>Timber rafters</li> </ul>
Bexon Primary	Reinforced concrete frame	CMUs	Solid concrete slab	Concrete flat roof
Corinth Secondary	<ul style="list-style-type: none"> <li>Structural Steel with infill CMU's</li> <li>Reinforced concrete frame</li> </ul>	CMUs	Solid concrete slab	<ul style="list-style-type: none"> <li>Concrete flat roof</li> <li>Large span roof truss</li> </ul>
Desruisseaux Combined	<ul style="list-style-type: none"> <li>Structural Steel with infill CMU's</li> <li>Reinforced concrete frame</li> </ul>	CMUs	Solid concrete slab	<ul style="list-style-type: none"> <li>Large span roof truss</li> <li>Structural steel</li> </ul>
Fond Assau Combined	<ul style="list-style-type: none"> <li>Reinforced concrete frame</li> <li>Timber frame walls</li> </ul>	CMUs & timber walls	CMUs and timber	<ul style="list-style-type: none"> <li>Concrete flat roofs</li> <li>Timber rafters</li> </ul>
Micoud Primary	<ul style="list-style-type: none"> <li>Structural Steel with infill CMU's</li> <li>Reinforced concrete frame</li> </ul>	CMUs	<ul style="list-style-type: none"> <li>Concrete solid slab</li> <li>Steel joists &amp; solid slab</li> </ul>	<ul style="list-style-type: none"> <li>Large span roof truss</li> <li>Structural steel</li> <li>Concrete flat roof</li> </ul>
Patience Combined	<ul style="list-style-type: none"> <li>Structural Steel with infill CMU's</li> <li>Reinforced concrete frame</li> </ul>	CMUs	<ul style="list-style-type: none"> <li>Concrete solid slab</li> <li>Steel joists &amp; solid slab</li> </ul>	<ul style="list-style-type: none"> <li>Structural steel</li> <li>Large span roof truss</li> </ul>
Saltibus Combined	Reinforced concrete frame with CMUs	CMUs	Solid concrete slab	Large span roof truss
Vieux-Fort Infant	<ul style="list-style-type: none"> <li>Reinforced concrete frame</li> <li>Timber frame walls</li> </ul>	CMUs & timber walls	Steel joists with concrete slabs	Large span roof truss
Vieux-Fort Primary	Structural steel with CMUs	CMUs	Concrete slab on grade	Structural steel



## 4.2 Non-structural Components

Observations were made of the type, condition, and adequacy of the interior finishes, fixtures, windows, and doors. Although the windows and doors are considered nonstructural under this report, these elements are critical to a buildings' performance during a hurricane or high wind event, thus, particular emphasis was placed on the inspection of those two elements.

Doors and windows were inspected for both functionality and effectiveness to remain shut and withstand the forces of hurricanes and high wind storms. The thickness of glass and locking mechanisms of the windows were extensive scrutinised. Doors were also checked for the locking and the number of deadbolt connections. The thickness of the door width and its type was also investigated and recorded.

Also important was the issue of accessibility. A Tier I Visual Survey was performed to determine if the buildings were in compliance with the OECs Building Code Seventh Edition 2016. No measurements were taken as part of the screening as it was not an in-depth survey.

Visual inspection of the partitions for any defects, discolouration, and functionality, when moveable, was also performed. The condition of floor screeds and tiles featured prominently during the inspections. The ceilings were also observed and watermarks where noticed were recorded both on paper and through still photography.

Although not associated with climate impacts, conditions of the services were also observed. Inspections of the plumbing fixtures, supply lines, and electrical infrastructure was also conducted. Of particular interest was the compliance of the electrical wiring with the statutory regulations, which require institutional buildings to be inspected and re-certified every three years. Discussions during the inspections suggest that the regulation was not being met.

To facilitate an appreciation of the non-structural defects observed during the inspections, Table 8, provides a listing of ten observations considered the most significant non-structural defects. These are not listed in any order of rating or priority.

**Table 8 – Most Significant Non-structural Defects**

No.	Significant Defects
1	Windows were generally inadequate to withstand hurricane-force winds
2	Doors were not considered to be hurricane impact resistant
3	Ceilings were showing signs of existing roof leaks
4	Collapsed and patched-up ceilings (Vieux Fort Primary)
5	Mal-functioning partitions (Desruisseaux Combined)
6	Extensive cracking in floor screed (Bexon Combined)
7	Water tank supporting structure structurally unsound (Balata Combined)
8	Inadequate ingress and egress point to a number of schools
9	Inadequate capacity of potable and rainwater water storage for disaster conditions
10	Electrical wiring in poor state and plant needing to be recertified



### **4.3 Life Safety and Fire Protection**

Observations were made of the type, condition, and adequacy of fire alarm systems, smoke detectors, or any other life safety and fire protection systems present at the schools. The school sites were visited by the mechanical experts and fire officers from the Saint Lucia Fire Service Department. Descriptions of the findings are presented in this Section of the TATO report and the fire reports are attached as Appendix 3.

#### **4.3.1 Mechanical and Electrical Systems**

None of the schools visited had generators or alternative sources of energy and it is recommended that 15 kVA generators or photovoltaic systems be installed at each of the schools. In most of the schools, the electrical equipment, power lines, outlets, cables, and ducts are in fair condition with instances of corroded and broken outlets, exposed wires, and the possibility of water seepage into electrical components.

Electrical panels in the Vieux Fort and Micoud Primary schools are outdated and require replacement. There is a serious electrical issue in the Saltibus Combined School as it was reported that the main electrical panel trips, whenever it rains.

The schools generally have good levels of lighting except in the Micoud and Vieux Fort Primary schools. In general, there are occurrences of broken lights, damaged switches, and bulbs that need to be replaced. However, in the Balata Combined School, the light fixtures are deteriorated and need to be replaced. The HVAC units are all in good condition and require only routine servicing except for a unit in the Vieux Fort Primary School and one in the Balata Combined School that may need to be replaced soon due to corrosion of the condenser and a non-functional isolator respectively.

#### **4.3.2 Fire Safety**

In most schools, there are no fire alarms, exit signage, smoke detectors, emergency lighting, or provisions made for the handicapped. Smoke detectors and fire alarms exist in the Vieux Fort Infant and Micoud Primary schools. The only schools with exit signage were the Vieux Fort Infant, Corinth Secondary, and Ave Maria Infant.

Two schools – Patience and Fond Assau Combined – have fire hose reels. All schools have fire extinguishers; however, more are required in some schools; some need to be serviced and some installed in safer and more accessible locations.

The majority of the blocks in all schools are constructed with concrete, masonry blocks, and steel with most steel members encased in concrete providing a level of fire resistance. The timber buildings have no fire resistance protection.

The floor layout and means of exit for all schools are generally adequate with classrooms in most schools having at least two exits. No doors in any of the schools have panic bars and most schools do not have any provisions for the handicapped. In a few schools, there are ramps mostly to access areas on the ground floor.



## **5.0 Condition Assessment**

For the purposes of this assignment, Condition Assessment is considered to be a periodic inspection, measurement, and interpretation of the performance of a specific building element or the building as a whole so as to determine the need for preventative or retrofit action against climate change and other hazards. The condition, which is considered as the state of the building as a whole or an element (structural or non-structural) at a particular time, is measured through the use of a grading index.

Under this consultancy, the TOR is specific as to the parameters for ranking the twelve schools under consideration. However, as the condition assessment is particularly focused on the physical condition of the building and constituent elements, it is necessary to note that the final ranking of the twelve schools was based on consideration of several conditions, including the adaptive capacity of the communities in the immediate vicinity of the schools, as a result of climate impacts.

### **5.1 Conditions Considered**

To undertake the condition assessment and to ensure that the schools which are most affected by the climate hazards, and exacerbated by the physical state of the buildings, obtain prominence, the following factors were considered:

1. The following five climate hazards (mandated by the TOR and addressed in Deliverable 2.1 – Rapid Climate Vulnerability Assessment):
  - a. Hurricanes,
  - b. Droughts,
  - c. Floods,
  - d. Sea-Level rise, and
  - e. Landslides.
2. The physical condition of the school as an asset
3. Building Code and statutory requirements
  - a. Building configuration,
  - b. Earthquake events,
  - c. Fire Safety.
4. Adaptive Capacity assessment (addressed in Deliverable 2.1 – Rapid Climate Vulnerability Assessment)

Both the climatic hazard and adaptive capacity conditions have been addressed and rated in the Rapid Climate Vulnerability Assessment (CVA). The other two were addressed during the detailed inspections of the schools undertaken by ECMC's engineering and technical team. The assessment for those conditions is captured in the BCA forms for each of the schools (these forms are attached as Appendix 2).



## 5.2 Condition Index

A condition index matrix (Table 9) was adopted to facilitate a summary assessment of the condition of the critical buildings, structures, and infrastructure. Based on the observed conditions, the structures, and infrastructure, the assessed condition index is an effort to present the overall state of the building or infrastructure.

**Table 9 - Condition Index Matrix<sup>2</sup>**

Status	Rating	Condition of Building Asset	Summary Description of Condition
<b>Excellent</b>	5	5.00 – No Defects	Free of defects with little or no deterioration evident
		4.50 – As-new condition and appearance	
<b>Good</b>	4	4.00 – Minor defects	Free of defects affecting structural performance, integrity, and durability
		3.75 – Superficial wear and tear	
		3.50 – Some deterioration to finishes	Deterioration of a minor nature in the protective coating and/or parent material is evident
		3.25 – Major maintenance not required	
<b>Fair/ Average</b>	3	3.00 – Significant defects are evident	Defects affecting the durability/ serviceability which may require monitoring and/or remedial action
		2.75 – Worn finishes require maintenance	
		2.50 – Services are functional but need attention	Elements show marked and advancing deterioration including loss of section. Intervention is normally required
		2.25 – Deferred maintenance work exists	
<b>Poor</b>	2	2.0 – Badly deteriorated	Defects affecting the performance and structural integrity which require immediate intervention including an inspection by a structural engineer. Signs of overstressing or evidence that elements are acting differently to their intended design mode or function
		1.8 – Potential structural problems	
		1.6 – Inferior appearance	
		1.4 – Major defects	
		1.2 – Components fail frequently	
<b>Very Poor</b>	1	NA	Structural integrity is severely compromised and the building must be removed from service until a structural engineer has inspected the structure and recommended the remedial action
		– Building has failed	
		– Not operational or viable	
		– Unfit for occupancy or normal use	

The summary description provides an opportunity to define the condition of the building or element in a single sentence; however, the rating number is the parameter used to produce a physical assessment of the school buildings and associated structures.

<sup>2</sup> Adopted from Maintenance Management Framework – Policy for the maintenance of Queensland Government buildings, Revised Second Edition Queensland Department of Housing and Public Works December 2017



### 5.3 Physical Condition Rating of Schools

Based on the inspections conducted and the observations made, the condition rating was developed by ECMC's teams of engineers and technicians. Although the assessment can be considered qualitative, the assessors were instructed to produce the rating through collaboration among the team members. Table 10 was also used as to provide guidance to the assessors.

**Table 10 – Refined Condition Index**

Condition Status	Rating Range
Poor	1.2 to 2.0
Fair/Average	2.25 to 3.0
Good	3.25 to 4.0
Excellent	4.5 to 5.0

Table 11 indicates that seven of the 12 schools scored rating of good 3.5 – 4.0, while three were considered poor – rating of 2.0. Table 12 provides rating of the schools as per the hazard assessment and adaptive capacity. It shows that the Vieux Fort Primary is the most affected with a hazard rating of 3.6 and Corinth Secondary with the lowest at 1.8. Three schools show low adaptive capacity an Corinth has the highest at 5.0

**Table 11 – Condition Rating of Schools**

Status	Maximum Rating	Schools/Region											
		AMI	AMP	BC	BP	CS	FAC	PC	MP	DC	VFP	VFI	SC
Excellent	5												
Good	4	4.0	4.0			4.0	4.0	3.75				3.5	4.0
Fair/Average	3				3.0				3.0				
Poor	2			2.0						2.0	2.0		
Very poor	1												

**Table 12 – Hazard and Adaptive Capacity Rating of Schools<sup>3</sup>**

Status	Schools/Region											
	AMI	AMP	BC	BP	CS	FAC	PC	MP	DC	VFP	VFI	SC
Average Hazard	2.6	2.6	2.6	2.2	1.8	2.8	2.4	2.2	1.8	3.6	2.0	3.0
Adaptive Capacity <sup>4</sup>	4.0	4.0	2.0	2.0	5.0	3.0	3.0	3.0	2.0	3.0	3.0	3.0

<sup>3</sup> Information taken from the Rapid CVA - Increasing Resilience of the Education System to Climate Change in Saint Lucia and Antigua and Barbuda

<sup>4</sup> Quantifying the ranking: - High = 5; Medium = 3; Low = 1

Overall Adaptive Capacity – Average of all five parameters: - High = 4.0 to 5.0; Medium = < 4.0 and ≥ 2.5 and Low: < 2.5



## 5.4 Combined Condition Rating

The combined rating as shown in Table 13 was necessary to establish an overall ranking for the schools. The following procedure was used to develop the combined ranking, giving rise to a priority list of the schools requiring retrofitting for both impacts of climate change and the physical condition of the assets or properties:

- The Hazard rating is the direct value calculated from the hazard matrix in the Rapid CVA;<sup>5</sup>
- The Physical Condition and Adaptive Capacity rating are the inverse values of the calculated rating as the index is the reverse of the one used for the CVA ranking;
- The total rating is the summation of the three levels - Hazard, Physical Condition, and Adaptive Capacity;
- The top-ranked school for assistance has the highest total score.

**Table 13 – Combined Condition Rating**

School	Rating			Overall Ranking	
	Average Hazard	Inverse of			Total Score
		Physical Condition	Adaptive Capacity		
Vieux Fort Primary	3.6	0.50	0.33	4.43	1
Balata Combined	2.6	0.50	0.50	3.60	2
Saltibus Combined	3.0	0.25	0.33	3.58	3
Ave Maria Infant	2.6	0.25	0.25	3.10	4
Ave Maria Primary	2.6	0.25	0.25	3.10	4
Patience Combined	2.4	0.27	0.33	3.00	6
Bexon Primary	2.2	0.50	0.20	2.90	7
Micoud Primary	2.2	0.33	0.33	2.86	8
Desruisseaux Combined	1.8	0.50	0.33	2.63	9
Vieux Fort Infant	2.0	0.29	0.33	2.62	10
Fond Assau Combined	2.0	0.25	0.33	2.58	11
Corinth Secondary	1.8	0.25	0.33	2.38	12

The resultant ranking of the combined condition assessments suggests that Vieux Fort Primary is the top-ranked school requiring retrofitting followed by Balata Combined then Saltibus Combined. These results are similar to the findings of the CVA, which indicated that Vieux Fort Primary was the most susceptible followed by Saltibus Combined and Balata Combined.

<sup>5</sup> Ibid 2



## **6.0 Corrective Measures and Technical Interventions**

The observations made during the site inspections of the twelve schools and the review of the MSSP<sup>6</sup> toolkit led to the development of a set of mitigation measures, which could be adopted and implemented in retrofitting the school buildings and compounds, to create assets that are more resilient to climate change. These mitigation measures and technical interventions are considered as detailed work tasks or activities, being subsets of broader interventions.

These summary interventions were all identified in the BCA forms and are the resultant Level 1 action of the detailed condition assessment of each of the schools. The following twelve broad interventions were developed in the forms:

1. Structural Retrofitting of; both structural and non-structural elements, and the whole structure;
2. Retrofit and Repairs to Roof Structure;
3. Retrofit and Repairs of Door and Window Systems to Withstand Hurricane-force Winds;
4. Internal and Superficial Works;
5. External Works;
6. Water Storage, Plumbing, and Accessories;
7. Electrical Energy Improvement;
8. Air Conditioning Systems;
9. Information Technology;
10. Fire Protection;
11. Disability Accessibility;
12. Access to Site.

Subtasks or mitigation measures were then identified for each of those summary interventions. The number of those tasks vary from three to twelve and are highlighted in the combined matrix of mitigation measures in Appendix 4. Every effort has been made to define the mitigation measures with sufficient detail so that work activities can be easily identified and adequate resources allowed when priced as part of the work package for each school.

To facilitate an appreciation of the approach adopted, Table 14 presents the twelve summary or Level 1 interventions, the subtask or Level 2 measures and the mitigation measures or Level 3 activities, which are then used for establishing the scope of works and associated costing for specified interventions for each school. The last (sample mitigation measures) column of the Table provides one of the several measures for each Level 2 subtask, which are reflected in the mitigation matrix attached in Appendix 3.

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<sup>6</sup> The Caribbean Disaster Emergency Management Agency; Model School Safety Programme for Caribbean Schools Toolkit – a publication of the Caribbean Disaster Emergency Management Agency; 2014



**Table 14 – Mitigation Measures and Options**

Interventions			Sample Mitigation Measures
No.	Summary – Level 1	Subtask – Level 2	Mitigation Measures – Level 3
1	Structural Retrofitting of both Elements and the Whole Structure		Undertake detailed structural condition assessment of Bexon school before zoning as a disaster shelter
2	Retrofit and Repairs to Roof Structure		Install additional fasteners at every trough at the eaves, hips, ridges, and edges of gable roofs for the resistance of hurricane-force winds
3	Retrofit and Repairs of Door and Window Systems to Withstand Hurricane-force Winds		Install 150 mm concrete surround having minimum cube strength of 21 MPa at 28 days to all windows to ensure adequate anchorage
4	Internal and Superficial Works		Replace all termite infested timber and undertake termite treatment of buildings and compound
5	External Works	Structural	Improve access to school entrance - roadway and gate
		Environmental	Improve and introduce drainage of the school compound
6	Water Storage, Plumbing, and Accessories	Potable Water	Procurement and installation of additional potable water storage tanks
		Rainwater Harvesting	Allow for supply and installation of rainwater harvesting system with pump and first flush system
		Plumbing and fixture	Re-plumbing of buildings to facilitate dual water use - potable and rainwater harvesting
7	Electrical Energy Improvement	Alternative	Allow for supply and installation of the solar photovoltaic system as an alternative power supply
		Stand-by Generation	Allow for supply and installation of a generator
		Electrical Wiring & Lighting Systems	Improve electrical systems, inspection, and re-certification
8	Air Conditioning Systems		Increase capacity of system - cooling generating systems
9	Information Technology		Communication & Security - complete rewiring required
10	Fire Protection	Detection & Alarm	Procure and install smoke detectors
		Suppression	Install fire extinguishers at strategic locations throughout school
		Safety	Install illuminated exit signs at strategic points
11	Disability Accessibility		All ground floor classrooms to be made wheel-chair accessible
12	Access to Site		Improve existing ingress and egress to the site



## **7.0 Estimated Cost of Work Packages**

The preparation of the cost impact of the proposed interventions and resultant work packages is a major deliverable of this report. Therefore, it was considered important to describe the methodology adopted and the unit costs which were used to develop the cost estimates for the work packages for each of the twelve schools.

### **7.1 Methodology**

Once the appropriate interventions and mitigation measures were determined (as defined in the mitigation matrix - Appendix 4), work packages were prepared for each of the schools. The packages were developed in the form of bills of quantities<sup>7</sup>, listing the different Level 3 mitigation measures under the twelve Level 1 Interventions.

With the mitigation measures listed, different units were used to estimate the quantities, which were based on on-site measurements, information from as-built or design drawings, and in some cases, from photographs taken at the various school sites. In cases where quantities could not be established, or the extent of the works could not be estimated, provisional sums were included in the document.

The following is the information contained in the packages for each school:

- The task number AMI-15 represents the fifteenth task under the Ave Maria infant School;
- Once all tasks are ascribed a quantity and a unit price, the total cost is calculated using a formula;
- The cost of all tasks taken to collection, to produce a base cost;
- As it is anticipated that there will be some level of demolition, thus, an allowance of 3 per cent of the base cost was used;
- Using industry standards and construction data from previous projects, an allowance of 7.5 per cent of the base cost was allowed for preliminaries. This cost usually comprise supervision, transportation of workers, insurance, performance security, hoarding, personal protective equipment, testing of materials, etc.;
- An allowance of 20 per cent was made for contingencies. Best practice suggests that for works of a retrofit or repair nature, the contingency should be increased to as high as 20 per cent;
- Allowing a provisional sum for including Disaster Risk Reduction (DRR) Education at the school level through the integration of relevant topics and themes in regular classroom teaching and engaging students in DRR community outreach initiatives through co and extra-curricular activities;
- Allowing a provisional sum for any recommendations made under the ESIA;
- All the cost is then summed, Value Added Tax (VAT) calculated and included.

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<sup>7</sup> The bill of quantities is the document defining and describing the quality and quantity of works required to be undertaken to effectively implement the interventions and mitigation measures specified for each school.



## 7.2 Unit Construction Cost

The unit construction cost is based on industry data and information on works of a similar nature which were undertaken within the last two years. Where unit costs were considered dated, an allowance for inflation was used to develop a current rate. Where possible, unit costs were calculated using anticipated labour cost added to quotations received for the equipment or materials.

It should be noted that the unit cost and provisional sums are based on broad parameters, very preliminary conceptual designs and construction methodologies. Detailed designs will have to be undertaken before the works are implemented as part of any agreed works programme. Table 15 shows the format of a typical work package.

**Table 15 – Format of Typical Work Package**

Task No.	Interventions/Improvements	Unit	Quantity	Unit Rate	Total
AMI-15 <sup>8</sup>	<p><b>Lighting System</b></p> <p>Improve the lighting in all areas based on the international standard for light levels.</p> <p>Install emergency lighting with battery power packs; includes 4 signs and 5 lights</p> <p style="text-align: right;"><b>Base Cost</b></p> <p>Allowance for Demolition of works to be repaired (3% of Base Cost)</p> <p>Allowance for preliminaries (7.5% of Base Cost)</p> <p style="text-align: right;"><b>Sub-total</b></p> <p>Allow 20% contingencies due to the nature of repairs and retrofit works</p> <p style="text-align: right;"><b>Total</b></p> <p>Plus Value Added Tax (12.5% of Total)</p> <p><b>Total Construction cost of repairs and retrofit works for School</b></p>	<p>m<sup>2</sup></p> <p>nr</p>			

## 7.3 Indicative Cost

The indicative cost of the interventions and mitigation measures have been developed for each of the twelve schools and presented in Appendix 5 – Schools Works Packages. Using the methodology outlined in Section 7.1 and including an allowance for engineering design and project administration, the total cost of the interventions and mitigation measures is estimated at **USD11,826,061** as summarized in Table 16.

<sup>8</sup> AMI – Ave Maria Infant



**Table 16 - Indicative Costs of Retrofit Work Packages**

School	Costs in USD*					
	Base Cost	Demolition of Defective Works	Prelims	Contingency	Value Added Tax	Total
Ave Maria Infant	317,831	9,535	23,837	70,241	52,680	474,124
Ave Maria Primary	372,373	11,171	27,928	82,294	61,721	555,488
Balata Combined	466,214	13,986	34,966	103,033	77,275	695,474
Bexon Primary	572,938	17,188	42,970	126,619	94,965	854,681
Corinth Secondary	812,138	24,364	60,910	179,483	134,612	1,211,507
Fond Assau Combined	431,873	12,956	32,390	95,444	71,583	644,247
Piatience Combined	415,474	12,464	31,161	91,820	68,865	619,783
Micoud Primary	636,568	19,097	47,743	140,682	105,511	949,601
Desruisseaux Combined	1,052,295	31,569	78,922	232,557	174,418	1,569,761
Vieux Fort Primary	774,490	23,235	58,087	171,162	128,372	1,155,345
Vieux Fort Infant	437,270	13,118	32,795	96,637	72,477	652,297
Saltibus Combined	344,546	10,336	25,841	76,145	57,109	513,977
<b>Base Cost</b>	<b>6,634,011</b>	<b>199,020</b>	<b>497,551</b>	<b>1,466,116</b>	<b>1,099,587</b>	<b>9,896,286</b>
Allow 15% detailed engineering design and supervision	995,102	29,853	74,633	219,917	164,938	1,484,443
Allow 10% of engineering fees as reimbursable cost	99,510	2,985	7,463	21,992	16,494	148,444
Project Administration cost - 3% of base cost	199,020	5,971	14,927	43,983	32,988	296,889
<b>Total</b>	<b>7,927,643</b>	<b>237,829</b>	<b>594,573</b>	<b>1,752,009</b>	<b>1,314,007</b>	<b>11,826,061</b>

\*Figures are rounded-off



## 7.4 Cost-effectiveness of Interventions

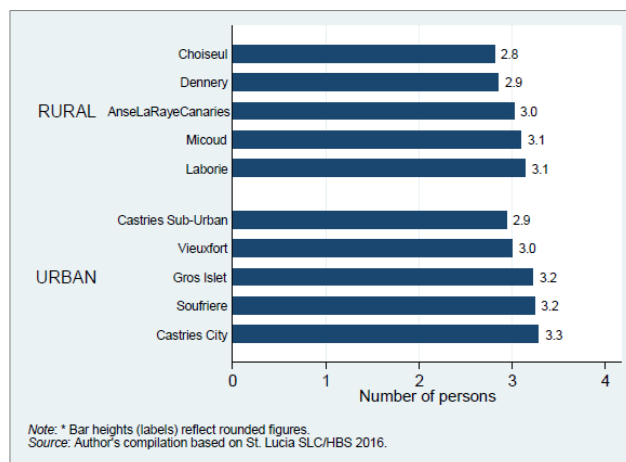
The twelve schools are located throughout the Island, within urban, suburban, and rural settings as indicated in Table 17. This posed a challenge in establishing the size of the beneficiary communities and groups, particularly for those in the urban settings and the suburban, to a lesser extent. Another challenge was with the secondary school, which would normally have students and teachers from all parts of the Island.

**Table 17 – Locations of the Schools by Type of Neighbourhood**

Urban	Sub-urban	Rural
Ave Maria Infant	Corinth Secondary	Desruisseaux Combined
Ave Maria Primary	Balata Combined	Fond Assau Combined
Vieux Fort Infant	Bexon Combined	Patience Combined
Vieux Fort Primary	Micoud Primary	Saltibus Combined

Although it may be argued that Desruisseaux Combined could be considered to be in a suburban setting, for the purposes of this report and to establish the size of the beneficiary community/group, it has been classified as rural. While Bexon Combined is accessed via a secondary road within rural surroundings, its relative position to the Castries - Vieux Fort main road and pedestrian access, influenced its zoning as being within a suburban setting.

Data for the size of the beneficiary groups for the twelve schools were not readily unavailable. However, given the objective of the exercise was to establish the cost-effectiveness of the retrofit measures, a method was developed to estimate the size of the beneficiary groups. The method involved factoring the population of each school by the average household size in the community in which the school is located (Table 18). In that regard, the average household size information presented in Figure 13<sup>9</sup> was used.



**Figure 13 – Average household size, by locality and district**

<sup>9</sup> Kairi Consultants Limited; Saint Lucia National Report of Living Conditions 2016 - Final Report; OECS Commission; Enhanced Country Poverty Assessment Project



**Table 18 – Calculation of Size of Beneficiary Group**

School	Average Household Size <sup>10</sup>	School Population	Size of Beneficiary Group
Ave Maria Infant	3.3	402	1327
Ave Maria Primary	3.3	529	1746
Balata Combined	2.9	274	795
Bexon Primary	2.9	152	441
Corinth Secondary	3.2	765	2448
Fond Assau Combined	3.2	142	454
Patience Combined	3.1	289	896
Micoud Primary	3.1	424	1314
Desruisseaux Combined	3.1	250	775
Vieux Fort Primary	3.0	226	678
Vieux Fort Infant	3.0	197	591
Saltibus Combined	2.8	126	353

The Corinth Secondary School posed an issue in that while it is within the Gros Islet region and has an average household size of 3.2, precise information on the demographic spread of the students was not readily available.

Thus, in the absence of exact data on the size of the beneficiary community or groups per school, another important assumption was made that each student came from a separate household. It was the view that the likelihood of siblings from the same household attending the infant primary and combined schools, was much higher than for the secondary school. Therefore, relative to each school, the cost-effectiveness metric can be considered an acceptable basis for comparison and level of benefits to the communities.

Another approach was to use information on household population size from the 2010 National Census. Table 19, provides data on households for some of the communities in which the twelve schools are located. Noteworthy is that the information does not provide information on beneficiaries or households in specific relation to the schools.

<sup>10</sup> Ibid Pg. 90



**Table 19 – Households per Community<sup>11</sup>**

Location	Private Household	Total Population
Balata (Babonneau)	514	1,434
Balata (Castries North)	23	84
Corinth	744	1,937
Corinth Estate	66	175
Fond Assau/Babonneau	295	581
Patience	196	586
Saltibus	160	469
Castries Central	2,809	7,274
Bexon	582	1,553
Micoud Village	819	2,407
Desrissageux	565	1,633
Vieux-Fort Town	468	1,429
Westhall Group/The Mangue	74	250

The cost-effectiveness of the interventions was calculated by dividing the total cost (of the interventions) for each school by the estimated size of its beneficiary group. Based on this formula, the school with the lowest cost-effective ratio is Ave Maria Primary, while Desrissageux Combined has the highest. Table 20 provides the average cost-effectiveness for each of the schools, based on two sets of sizes for the beneficiary groups.

Due to the large variability in cost-effectiveness of the interventions (most likely caused by the intrinsic inaccuracies in the calculation and data for the size of the beneficiary group), a third approach was considered. In this approach, the size of the direct beneficiary group (student population) was used to calculate the cost-effectiveness and is presented in Table 21. The results from this approach again suggest that the lowest cost-effectiveness is for Ave Maria Primary, and Desrissageux Combined, the highest.

<sup>11</sup> 2010 Population and Housing Census Preliminary Report (Updated April 2011) Table 16: Estimated Population by Constituency and Settlements

: <https://www.stats.gov.lc/wp-content/uploads/2016/12/StLuciaPreliminaryCensusReport2010.pdf>



**Table 20 – Cost-effectiveness per Direct & In-direct Beneficiaries**

School	Size of Beneficiary Group		Cost of Mitigation	Cost-effectiveness (Cost per person - Based on:)		
	Census Data	School Population		Census Data	School Population	Average
Ave Maria Infant	7,274	1,327	566,578	78	427	252
Ave Maria Primary	7,274	1,746	663,808	91	380	236
Balata Combined	1,518	795	831,092	547	1,046	797
Bexon Primary	1,553	441	1,021,343	658	2,317	1,487
Corinth Secondary	2,112	2,448	1,447,751	685	591	638
Fond Assau Combined	581	454	769,875	1,325	1,694	1,510
Patience Combined	586	896	740,641	1,264	827	1,045
Micoud Primary	2,407	1,314	1,134,773	471	863	667
Desruisseaux Combined	1,633	775	1,875,865	1,149	2,420	1,785
Vieux Fort Primary	1,679	678	1,380,637	822	2,036	1,429
Vieux Fort Infant	1,679	591	779,495	464	1,319	892
Saltibus Combined	469	353	614,203	1,310	1,741	1,525

**Table 21 – Cost-effectiveness per Direct Beneficiary**

School	Student Population	Mitigation Cost (USD)	Cost Effectiveness (USD)
Ave Maria Infant	402	566,578	1,409
Ave Maria Primary	529	663,808	1,255
Balata Combined	274	831,092	3,033
Bexon Primary	152	1,021,343	6,719
Corinth Secondary	765	1,447,751	1,892
Fond Assau Combined	142	769,875	5,422
Piatience Combined	289	740,641	2,563
Micoud Primary	424	1,134,773	2,676
Desruisseaux Combined	250	1,875,865	7,503
Vieux Fort Primary	226	1,380,637	6,109
Vieux Fort Infant	197	779,495	3,957
Saltibus Combined	126	614,203	4,875



The three graphs in Figure 14 provides a broad analysis of the cost-effectiveness of the interventions in relation to the building's condition and overall ranking. Balata Combined, the school ranked second in requiring retrofitting, has a low condition rating and a cost-effectiveness below the average for the twelve schools. However, the Vieux Fort Primary as the third-ranked school has a low condition rating but a cost-effectiveness which is above the average. Interestingly, Saltibus Combined which is ranked first has a high condition rating and an above-average cost-effectiveness. Thus, if the cost-effectiveness metric is included in the ranking of the schools, Balata Combined, is the most deserving of immediate resiliency upgrading.

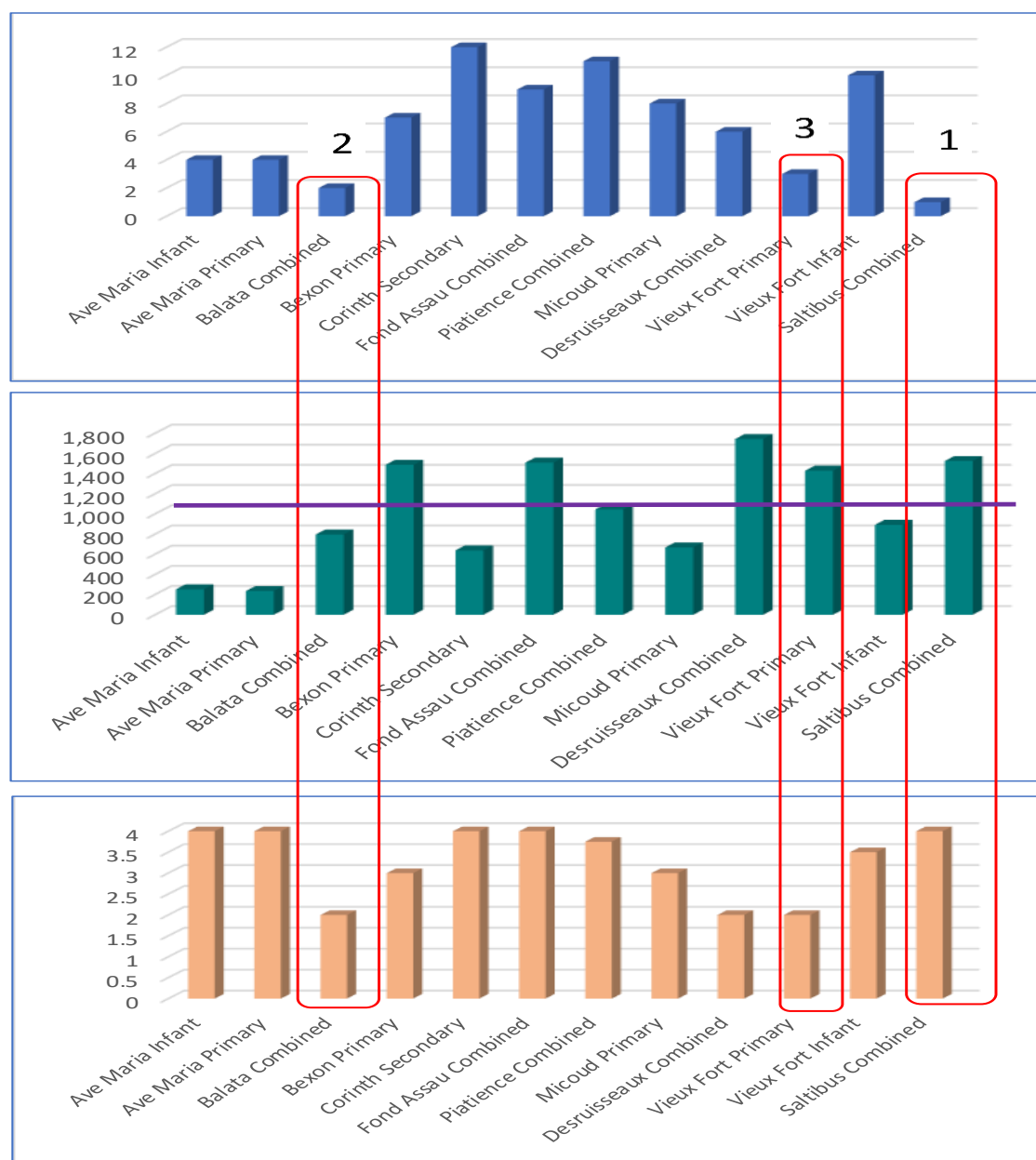


Figure 14Top – Combination of Ranking Metrics  
Overall ranking of schools; Middle – Cost-effectiveness; Bottom – Condition rating



## 7.5 Maintenance and Sustainability Needs

The inspections of the schools suggest significant and several cases of lack of maintenance. Thus, in addition to addressing the issues of retrofitting to create resilient buildings for climate change impacts, the physical condition assessments included evaluation of the defects which are related to deficient maintenance. Therefore, this section of the report addresses matters related to possible maintenance and sustainability but does not make reference to any cost estimates, except for a broad recommendation on funds to be allocated towards maintenance.

A *Maintenance Management Manual for Education Facilities* was prepared (in 2014) under the Basic Education Enhancement Project. This document appears to be prescriptive on the procedures, organization structures and qualifications of personnel to be involved in maintenance management of the schools. However, the Manual did not address issues of minimum budgets and is deficient on the checklist which would normally be a major part of a maintenance manual. It is also silent on the issue of sustainability.

### 7.5.1 Maintenance and Sustainability

Maintenance management is considered as the effective and efficient planning and execution of activities performed to properly maintain the asset and a direct means of ensuring sustainability. Maintenance and sustainability which span many diverse functions is a key component of strategic property management.

#### Types of Maintenance

To place the issue of maintenance of the schools in the proper context, Table 22 defines the seven main types of building maintenance. This definition and consequential categorisation would assist maintenance officers in adopting a more focused approach when utilising any maintenance sustainability plan.

**Table 22 – Types of Building Maintenance**

Planned Maintenance	Maintenance performed as per predetermined plan;
Unplanned Maintenance	Ad hoc maintenance performed with no pre-determined plan;
Preventive Maintenance	Maintenance performed at predetermined intervals, or as prescribed by manufacturers and intended to reduce the probability of failure;
Corrective Maintenance	Performed as a result of a failure and intended to restore full or partial use of asset;
Emergency Maintenance	Maintenance performed immediately to avoid serious consequences;
Conditioned-based Maintenance	Preventive maintenance resulting from the condition of an item or asset known from continuous monitoring;
Scheduled Maintenance	Preventive maintenance performed to a predetermined interval of time, number of operations, or mileage.

In determining maintenance priority areas, the effects of deferred action need to be appreciated, not simply from the perspective of a worsening problem, but also based on the relationship that maintenance needs increase with age; however, government budgets tend to decrease. The



relative importance of the building element to the structure, facility or equipment must be first considered. In this regard, Figure 15 illustrates a decision-based type of maintenance.

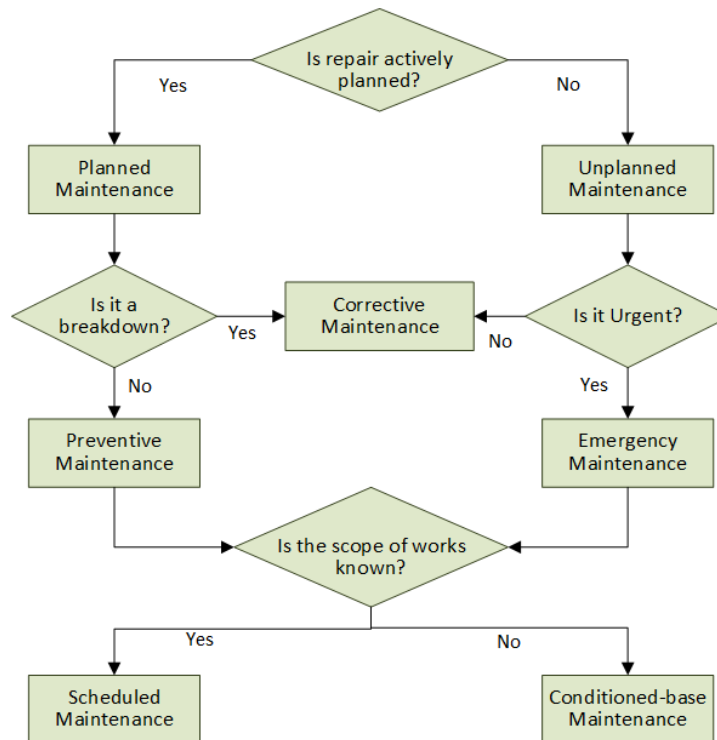


Figure 15 – Decision-Based Type of Maintenance

## Sustainability

Sustainability defines the existence of humans and nature in productive harmony to meet the requirements of present and future generations. In the context of maintenance, sustainability is considered as the application of corrective measures that would extend, or ensure a service life of the asset matching the original design life. Achieving this objective could be extremely difficult, particularly if deferred maintenance is significant, as is the case for several of the twelve schools.

Sustainability is facilitated through an integrated synergistic approach at the design stages, where the assets lifecycle is given due consideration; however, it cannot be said that this principle was adopted for all the twelve schools. As part of any Maintenance and Sustainability Plan (MSP), the optimal synergy of cost, environmental, societal and human benefits should be the primary aim of the designer, while designing for the intended function of the infrastructure. Therefore, as part of the MSP, sustainable design and maintenance should follow the basic tenets of:

1. Optimizing the potential of the site on which the asset is being built or exist;
2. Whenever possible, optimize non-renewable energy consumption;
3. Protect and conserve water through rainwater harvesting;
4. Enhance environmental quality while at the same time mindful of maintenance cost;



5. Utilize innovative measures to optimize operations and maintenance practices (within budget constraints).

Regarding long-term maintenance and retrofitting, it may be possible to utilise the concept of “passive survivability”. This would ensure that the facility or the asset could maintain life support conditions for its occupants and users if natural disasters interrupt access to critical resources such as utilities. Some of the critical passive design features which could form part of the long-term interventions of the MSP include: introducing cooling load avoidance strategies, increased natural ventilation, daylighting, and passive solar gain through the use of canopies. Essentially, sustainability has to be a major principle in any design brief, provided to the designers of schools.

### Maintenance Factors

Concerning the MSP being proposed, the following three factors affect the schools’ physical plant and eventually result in some level of erosion of the original standards to which the assets would have been constructed or installed:

1. **Climatic Conditions** – the impact may vary depending on the specific location and orientation of the asset, with the external facades and exposed elements sustaining the greatest severity of damage.
2. **Occupant usage** – wear and tear and damaged caused through use of the asset.
3. **Changing standards** – where the condition may not be worsening but maintenance may be required more frequently than is functionally required – like a change in colour scheme.

Even more important insofar as changing standards is concerned, is a widening gap between the standards demanded by current building codes and that produced at the design stage. This scenario was clearly evident in some of the schools inspected. Therefore, the applicable intervention, as is being proposed for some of the schools, is considered retrofitting for improvement or modernising and is depicted in Figure 16.

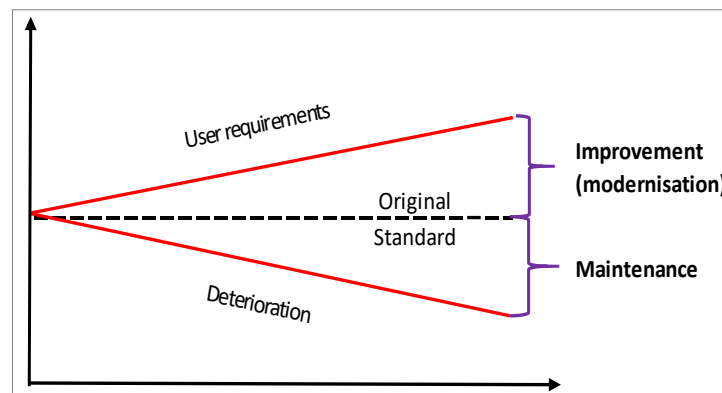


Figure 16 – Relation of Time to Maintenance Requirements

Adapted from Lee’s Building Maintenance Management



## **Strategic Maintenance Planning**

Strategic Maintenance Plan (SMP) is considered a structured process which will assist in ascertaining the future requirements for maintaining the schools. While the formulation of an SMP is not one of the deliverables of this Consultancy, it is important to point towards a framework that would assist in the development and preparation of such a plan. In this regard, the remaining life of the schools would assist the owners in determining the most appropriate planning horizon for their SMP. Based on the inspection, most of the schools appear to have remaining useful lives of over 20 years.

Any such SMP should evolve from the Government's overall policy and strategy initiatives, as it would have direct implications for the availability of funds. Notwithstanding, in the development of a SMP, the Ministry of Education (as immediate owners and management) will need to focus on the:

- Government's/Ministry's long-term plans for the specific school;
- Current condition of the schools' physical plant;
- Backlog or deferred maintenance on the schools;
- Disaster planning and climate change issues which require annual attention.

## **Developing the Strategic Maintenance Plan**

To facilitate the development of a workable and effective SMP, some essential tools are being recommended. These include renewal cycles for maintenance charts for buildings (discussed below), a maintenance checklist (Appendix 6A) and an Indicative Maintenance Plan-Framework (Appendix 6B).



### 7.5.2 Renewal Cycles for Maintenance

A sample of the building elements which will require maintenance over time is presented in the Renewal Cycles for Maintenance (RCM) chart illustrated in Figure 17. The suggested periods in the RCM Chart are realistic and were developed from appropriate literature, standards, and real-life examples. However, adjustments would be necessary, based on the micro-climate conditions prevailing at the specific asset sites. For example, maintenance officials should expect a different regime for an asset constructed on or near the coast, as opposed to those in the centre of the country.

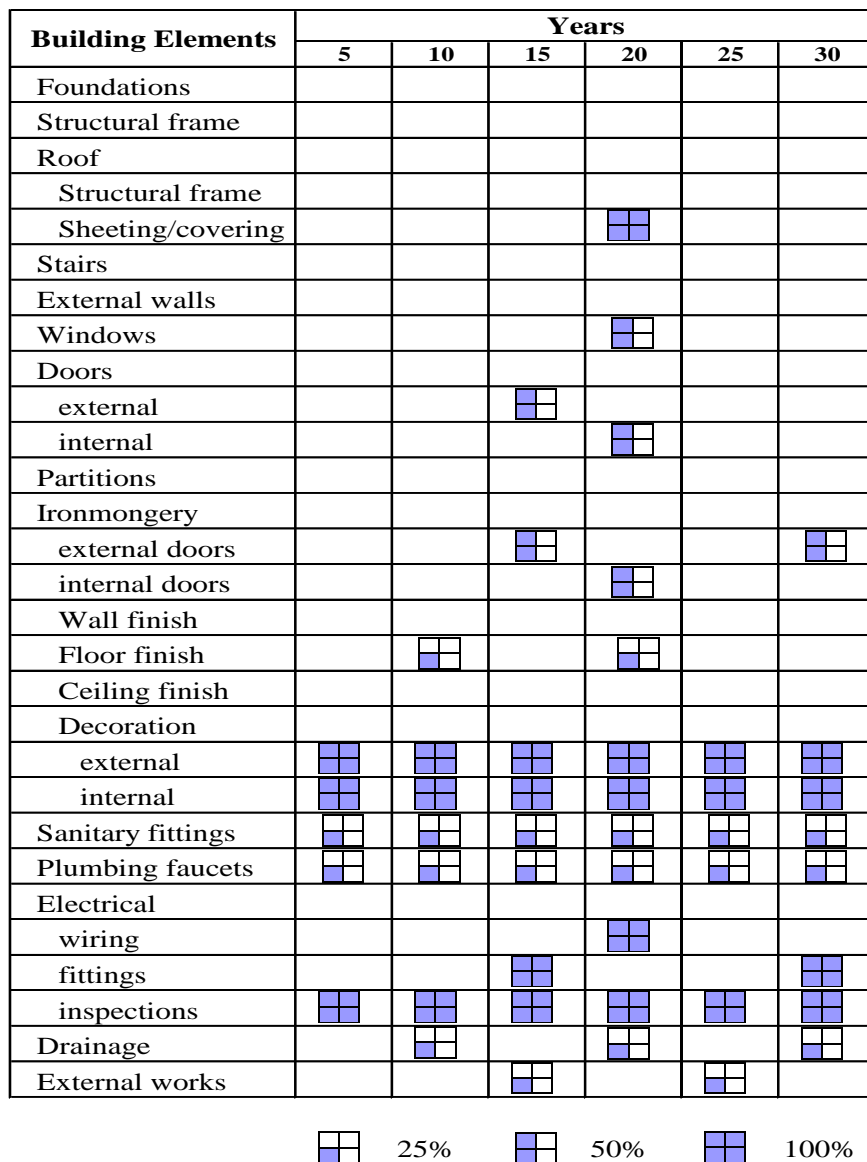


Figure 17 – Renewal Cycles for Maintenance



### 7.5.3 Implementing Maintenance Programmes

The approach to be used in implementing an MSP should involve two broad categories of activities, namely:

- Routine inspections of the building elements, external works, and other assets;
- Condition surveys/assessments.

#### Routine Inspections

The following are guidelines and the safe practices for conducting any type of routine inspections. The inspector must:

- i. Prior to any inspections, acquaint him/herself with the findings of any previous reports.
- ii. Approach the exercise by beginning on the exterior of the asset from roof to foundation and from general to specific.
- iii. Always inspect the worst elements or section(s) first.
- iv. Observe the surroundings and identify any nearby trees which could affect the building asset during a hurricane by damaging its roofing structure.
- v. Always review one façade at a time.
- vi. Use torch lights to inspect above ceilings and roof members.
- vii. Thoroughly inspect all doors and windows and associated ironmongery.
- viii. Inspect grounds, looking for cracks in the soil and check for drainage adequacy, specifically check whether all surface run-off moves away from the building(s).
- ix. Always perform inspections with a team of at least two persons, one of whom should be undertaking the close inspections and the other taking notes.
- x. Always conduct a general condition survey, and if necessary, a detailed condition survey after the “all clear” for a disaster has been given.

#### Condition Surveys/Assessments

The most appropriate method for achieving coherent and effective maintenance is through the collection of comprehensive data on the condition of the building<sup>12</sup>. Condition surveys will provide school managers with a snapshot of the state of the building, facility, and external works to be maintained. Additionally, condition surveys provide management with an opportunity to consider the effectiveness of previous maintenance programmes.

The following three methods of condition surveys/assessment are recommended implementing schools’ maintenance programmes:

- i. *A General Condition Survey* – essentially a visual inspection, which is a cursory inspection of the main elements of the building/asset, most likely annually and under the supervision of suitably qualified personnel; documentation of the deterioration is encouraged.

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<sup>12</sup> Wordsworth 2001; Chanter and Swallow 1996



- ii. *Routine Condition Survey* – continuous regular observations while walking around the building or asset, documentation of the deterioration is encouraged.
- iii. *Detailed Condition Survey or Audit* – thorough and structured inspection of the building or asset by suitably qualified personnel at least once every five years; documentation of the deterioration is encouraged.

A Detailed Condition Survey should also be conducted after any major disaster has affected the asset.

Table 23 provides some guidelines to determine the frequency of conducting the condition surveys. Asset managers must note that these are only guidelines and could be adapted when necessary.

**Table 23 - Guidelines to Determine Frequency of Conducting Condition Surveys**

Building/Assets	Type of Condition Survey to be conducted after:		
	Year 1	Years 2 - 4	Year 5
Assets with extensive engineering services or subject to severe environmental factors or near the end of the life cycle	Detailed	Routine General	Detailed
Assets with minor engineering services and experience normal wear and tear	Detailed	Routine General	General Detailed

#### 7.5.4 The Maintenance and Sustainability Schedule

A broad format for a maintenance and sustainability schedule – an organized process to achieve the objective of extending the service life of the schools – is depicted in Table 24.

**Table 24 – Format for Maintenance and Sustainability Schedule**

Sub-Project	Action	Responsible Agency	Time Frame			Anticipated Outcome
			Short Term	Medium Term	Long Term	

A typical schedule (presented in Appendix 7), has been developed from the findings of the condition surveys for the schools and is also based on information of the maintenance practices and deficiencies observed and communicated by school principals/managers, stakeholders, and other beneficiaries. The typical schedule provides information on the maintenance needs of the schools in a similar format to the matrix in Table 24. The schedule outlines the immediate, medium-term, and long-term interventions necessary to facilitate the sustainability of the assets which were inspected.



The schedule anticipates that the Ministry of Education is the entity responsible for the suggested maintenance and indicates the expected outcome insofar as the service life of the school buildings are concerned.

- The short-term interventions are associated with works which are urgently required to restore the structural integrity or code-specified serviceability requirements.
- Medium-term; however, is also necessary maintenance but represents a defect which is not currently affecting the issues associated with structural integrity. The medium and long-term interventions are more associated with sustainability aspects of this MSP.
- The long-term efforts are associated with retrofitting works or defects which are expected to worsen with time and have a significant effect on the assets service life.

The schedule does not reflect all the items identified in the work packages and merely provides an example to be adopted by the schools' principals/managers, maintenance officers, and the Ministry of Education.

#### **7.5.5 Maintenance Costs**

The work packages developed for each school is based on the climate hazards assessment, the schools' adaptive capacity rating, recommendations made under the DRR framework and the ESIA, and the physical condition assessments of the schools' plant. Therefore, works associated with deferred maintenance are included in these packages.

The maintenance budget represents the incremental financial resources over a desired period. It also provides information on the level of funding required to keep the facility in acceptable shape and reduce the life cycle cost. Best practice recommends that at least 1% of the replacement cost (new) of the school be budgeted for maintenance.



## **8.0 Conclusion and Overall Rank**

This TATO report should be read in conjunction with the Rapid CVA, as the conclusion of the latter document was used to establish the overall ranking of the twelve schools. The evaluation of the twelve schools after the condition assessments by ECMC's teams concluded that while Vieux Fort Primary, Saltibus and Balata ranked first second and third respectively, under the climate hazard assessments, there was a slight change when the overall ranking was determined. Vieux Fort Primary remained first but Balata ranked second.

The condition assessments of the schools suggested that the buildings were generally in good condition, with seven being rated as having an overall "Good" and three with a rating of "Poor". These three schools were Vieux Fort Primary, Balata Combined, and Desruisseaux Combined. Despite the poor condition of the Desruisseaux Combined school, its ranking of 11<sup>th</sup> under the climate hazard assessment influenced its overall ranking of 9<sup>th</sup>.

It is understood that all the schools are designated emergency shelters. In that regard, the condition of the Bexon Primary School warrants a detailed condition assessment as part of the work package. ECMC is of the view that this school building has failed under serviceability limit states and needs remedial works if it has to maintain its status as a shelter. Efforts at obtaining the structural report which identified the basis for the existing retrofit to the structural members proved futile. Therefore, this TATO report is unable to conclude whether the structure has also failed under ultimate limit state conditions.

The CVA, adaptive capacity and, physical conditions of the schools, led to several technology and retrofit options being proposed as mitigation measures. Compliance with the OECS Building Code requirements, international best practice, and recommendations from the Model Safe School Programme toolkit, influenced the interventions proposed. Retrofit of roofs, installation of impact-resistant windows, and the use of hurricane shutters are some of the major measures which were warranted. Susceptibility to some of the climate hazards warranted the use of rainwater harvesting, installation of solar pumps, and the inclusion of stand-by generators. Vehicular and pedestrian accessibility were found to be an absolute necessity in all of the schools.

The main outcome of the TATO report is the twelve work packages, with the estimated cost of the interventions ranging from about USD474,000 to USD1,200,000 (excluding design and project management cost). The total cost of the twelve packages inclusive of design and project management cost plus VAT) is estimated as USD11,826,061. To ensure that disaster risk resilience features prominently in the curriculum of the schools, an allowance was included in the work packages. The request to address the fire safety issues at the schools necessitated the involvement of the Saint Lucia Fire Service and the inclusion of fire safety devices (fire detection and alarm; suppression and other safety measures) as part of the interventions for all the schools.

It was extremely difficult to determine the size of the direct and indirect beneficiary community or group. Several options were explored, but none were considered satisfactory to allow the use of this metric as a measure to rank the schools. Nonetheless, when combined with the overall ranking of the schools and the physical condition rating, Balata Combined was considered the school most worthy of attention.

Based on the significant deferred maintenance observed and the discussions with the key stakeholders, it appears that the schools are not implementing any maintenance plans. Emergency repairs appeared to be the main approach to maintenance of the physical plant. In this regard, a maintenance and sustainability framework has been included as part of the TATO report. The framework recommends that as per best practice; maintenance budgets should be around one per cent of the building/asset's replacement value.



## Appendix 1 – Photographic Albums of Schools’ Condition



## **Appendix 2 - Building Condition Assessment Forms**



### **Appendix 3 - Fire Reports**



## **Appendix 4 - Combined Matrix of Mitigation Measures**



## **Appendix 5 - Schools Works Packages**



## **Appendix 6A - Renewal Cycles for Maintenance Charts for Buildings - Maintenance Checklist**



## **Appendix 6B - Indicative Maintenance Plan - Framework**



## **Appendix 7 – Maintenance and Sustainability Schedule (A Typical Schedule)**