Schedule F

Standard Specification

Site Works and Civil Balance of Plant

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1. General

1.1.1.1 This document shall be read as part of a complete Specifications package including *LUCELEC* documents and other technical appendices:

- *Energy Storage System* Request for Proposal (RFP)
- *Battery Energy Storage System* Specification
- *Power Conversion System* Specification
- Power Transformer Specification
- *Energy Management System* Specifications
- Electrical Balance of Plant and Installation Specifications
- Site Works and Civil Balance of Plant Specifications
- Containerized Building Specification
- Packaging and Shipping Requirements

1.1.1.2 Following definitions will be used for this Specification:

a.) ***Balance of Plant*** or ***BOP*** – electrical and site works for the entire facility, excluding the *ESS* equipment and *EMS*

b.) ***Battery Energy Storage System*** or ***BESS*** – A lithium-ion electrochemical storage device capable of delivering or absorbing electrical energy at its *DC Bus*

c.) ***Battery Management System*** or ***BMS*** – the control and monitoring system for the *BESS* designed to manage all internal bank functions and internal protection. The *BMS* shall communicate with the *PCS* and *EMS*

d.) ***Battery Module***- An assembly of rechargeable battery cells with a convenient mechanical arrangement and a degree of protection

e.) ***Battery Rack*** – a free standing assembly of battery modules, integrated as part of an overall *BESS*

f.) ***Calendar Life*** – The expected number of calendar years that the battery is expected to last independent of charge and discharge cycles

g.) ***Contract*** – The agreement resulting from this RFP process

h.) ***Contractor***– the successful *Proponent* with whom the *LUCELEC* may enter into a *Contract*

i.) ***Current Transformer*** or ***CT*** - an instrument transformer used to step down a measured current for metering, control or protection purposes

j.) ***DC Bus*** – the direct current connection between the *PCS* and *BESS* capable of carrying rated system power

k.) ***Depth of Discharge*** or ***DOD*** – the ratio of the amount of energy discharged from the *BESS* to the maximum dischargeable energy capacity of the *BESS*

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l.) ***End of Life*** or ***EOL*** – the defined remaining *BESS* capacity as a percentage of the amount of initial *BESS* capacity at which the *BESS* system becomes not functional as initially designed

m.) ***Energy Storage System*** or *ESS* – - consists of a *Battery Energy Storage System (BESS)* and a *Power Conversion System (PCS)*

n.) ***Energy Management System*** or *EMS* – the *Contractor* supplied power plant control system that communicates to the *PCS* and coordinates plant functions

o.) ***Factory Acceptance Testing*** or *FAT* – performance testing of all equipment at the factory to ensure it meets the specifications and requirements prior to shipment to site

p.) ***Factory Integration Testing*** or ***FIT*** - performance testing at the factory of an integrated system, consisting of the *ESS, PCS* and *EMS* to ensure interface between components is functional prior to shipment to site

q.) ***Input/Output*** or ***I/O –*** refers to the input or output signals associated with a control system or component of the control system such as a programmable logic controller.

r.) ***Inspection and Test Plan*** or ***ITP*** – the plan for managing the quality control and assurance of a particular the construction work providing information on the requirements, overview of the method(s) to be used, responsibilities of relevant parties, and documentary evidence to be provided to verify compliance

s.) ***Human Machine Interface*** or ***HMI*** – A user interface that serves as the main point of interaction between an operator of the battery plant and the settings, functions and commands associated with the plant

t.) ***Low Voltage Bus*** – the alternating current connection between the *PCS* inverter and the step-up transformer

u.) ***LUCELEC –*** St. Lucia Electricity Services Ltd.

v.) ***LUCELEC's Representative*** – The person appointed by the *LUCELEC* who has responsibility for managing the *Contract* and, unless *Contractor* is expressly advised otherwise, *LUCELEC's Representative* (1) has full authority to act on behalf of and bind the *LUCELEC*, and (2) may, in writing, delegate any or all of his or her authority to any other person

w.) ***Power Conversion System*** or *PCS* – The Battery *PCS* is the power interface from the battery system to the AC electrical grid

x.) ***Proponent*** or ***Tenderer***– Each company receiving this *Request for Proposal*

y.) ***Proposal*** – Documents submitted by *Proponents* in response to this *RFP*

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z.) ***Potential Transformer*** or ***PT*** - also known as a Voltage Transformer, an instrument transformer used to step down the main connection voltage for metering, control or protection purposes

aa.) ***Programmable Logic Controller*** or ***PLC*** – A ruggedized industrial computer on which the core logic of the control system resides

bb.) ***Primary Frequency Response*** or ***PFR –*** The first stage of frequency control in response to a disturbance on the power system frequency. Traditionally provided by fast acting governor systems.

cc.) ***Request for Proposal*** or ***RFP –*** This Request for Proposal including all attached and referenced documents and subsequent addenda

dd.) ***Remote terminal unit*** or ***RTU -*** A controller that interfaces with a physical system or sub-system of the plant and transmits information to the SCADA network.

ee.) ***Supervisory Control and Data Acquisition System*** or ***SCADA*** – the plant Supervisory Control and Data Acquisition system supplied by *LUCELEC*

ff.) ***SCADA Network*** – the communications network that facilitates the communication between *PLCs* and other networked components within the *BESS*

gg.) ***Site Acceptance Testing*** or ***SAT*** – performance testing of all installed equipment at site to ensure it meets the specifications and requirements and that there was no damage during shipment or installation

hh.) ***State of Charge*** or *SOC* – the ratio of present dischargeable energy storage capacity to maximum dischargeable energy storage capacity expressed either in percentage or MWh

ii.) ***Subcontractor –*** Any firm/individual that the *Contractor* may contract with to perform a portion or all of the *Work* and for which the *Contractor* assumes liability

jj.) ***System Control Center*** or ***SCC*** – The *LUCELEC* control center that dictates power system commands to distributed generators through the *LUCELEC SCADA*

kk.) ***Uninterruptible Power Supply*** or ***UPS*** - an electrical apparatus that provides emergency power to a load when the input power source or mains power fails.

ll.) ***Work*** or ***Supply –*** All or any part of the services and obligations required to be performed under the *Contract*.

1.1.1.3 This Specification is for the supply of all labour, materials, and services required for the design, engineering, supply, packaging, site preparation and construction of the balance of plant for the *LUCELEC ESS* facility.

1.1.1.4 The work called for is subject to the purchase order documents. They include the Specification, the general conditions of contract, any specific conditions, and any other attachments, all of which form an integral part of the contract. The *Contractor* shall be responsible for and be

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governed by all requirements therein. **Any exceptions to this Specification shall be stated in writing by the *Contractor* and a suitable alternative can be priced as an option.**

1.1.1.5 The supplied equipment shall be designed for continuous operation, and all components shall be of a robust, industrially proven design.

1.1.1.6 The *Contractor* supply shall include all components and accessories as required for the proper and safe operation of the complete system.

1.1.1.7 Compliance with this Specification does not relieve the *Contractor* of the responsibility to provide safe and reliable equipment. The *Contractor* shall have overall responsibility for the safety of the *ESS* design. Any areas of the *ESS* that pose a risk to the environment, personnel, or *LUCELEC*'s assets are to be clearly communicated to *LUCELEC* and its *Representative.*

2. Codes and Regulations

2.1. General Standards

2.1.1.1 The design, fabrication and testing of the works shall be in accordance with the latest revisions of relevant standards issued by the following regulatory agencies and institutes:

BSI	British Standard Institute
ASNI	American National Standards Institute
ASTM	ASTM International

2.1.1.2 Statutes and regulations:

- The ISO standards and Codes of practice
- The British standard and Code of practice
- St-Lucia National standard
- OECS Building Code Grenada, St. Vincent & the Grenadines, St. Lucia, Montserrat, latest version (National Building Code)

2.2. Specific Standards

2.2.1.1 In addition to the general standards listed above, the latest version of the following specific standards shall apply to the design, testing and manufacturing:

- BS 4482 - Steel Wire for the Reinforcement of Concrete Products
- BS 4483 – Steel fabric for the reinforcement of concrete

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- BS 4449 – Specifications for hot rolled steel bars for the reinforcement of concrete
- BS 1192 – Collaborative production of Architectural, engineering and construction information – Code of practice
- BS 1377-1 - Soils for civil engineering purpose - Part 1: General requirements and sample production
- BS 1377-2 - Soils for civil engineering purpose – Part 2: Classification test
- BS 1377-3: Soils for civil engineering purpose – Part 3: Chemical and electro-chemical test
- BS 1377-4: Soils for civil engineering purpose – Part 4: Compaction related test
- BS 1377-5: Soils for civil engineering purpose – Part 5: Compressibility, permeability and durability tests
- BS 1377-6: Soils for civil engineering purpose – Part 6: Consolidation and permeability test in hydraulic cells and with pore pressure measurement
- BS 1377-7 Soils for civil engineering purpose – Part 7: Shear Strength tests (total stress)
- BS 1377-8: Soils for civil engineering purpose – Part 8: Shear Strength test (effective stress)
- BS 1377-9: Soils for civil engineering purpose – Part 9: In situ test
- ISO 14688-1: Identification and classification of soil – Part 1: Identification and description
- ISO 14688-1: Identification and classification of soil – Part 2: Principle for soil classification
- ISO 17025: General requirements for the competence of testing and calibration laboratories
- BS 1722-10: Specification for anti-intruder fences in chain link and welded mesh
- BS 197-1: Cement – Part1: composition, specifications and conformity criteria for common cements
- BS 6021: Earthworks
- BS 720: Hot Dip galvanized coating on iron and steel
- BS 8110-1: Structural use of concrete - Code of practice for design and construction
- BS 10293: Steel Casting for general engineering uses
- ASTM D2922: Standard Test methods for Density of Soil and Soil Aggregate in place by nuclear method

2.2.2 *Other Reference Documents*

- TECSOLgeo – Geotechnical Assessment report – Survey site: La Tourney (Saint-Lucia), REF:IG62717

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- ECMC Ltd. – Hydrologic and Hydraulic Study for Construction of a 3MW Solar farm at La Tourney Hill, Vieux Fort, Saint-Lucia. Project No. 17301, September 4, 2017.
- *LUCELEC* – Section 2 Design Criteria

3. Site Information

3.1. Location

3.1.1.1 The *Energy Storage System (ESS)* will be installed next to the 7A and 7B La Tourney solar PV plant close to the Vieux Fort Substation. Two underground distribution lines, at 11 kV, shown in Pink and Red in Figure 1, will be used to connect the battery directly to the substation.

Figure 1: Location of the ESS Site and Incoming Feeders from the VFSS

3.2. Site Access

3.2.1.1 The site access, for equipment and personnel, shall be from the east access road. Extension of the existing road is required to access the *ESS* site. The proposed access route is outlined in *Schedule J – Reference Reports and Drawings*.

3.3. Site Layout

3.3.1.1 The *ESS* will be installed beside the existing solar PV. The site location is at the following coordinates 13°44’16” N, and 60°57’41” W. Underground cables are already installed to connect the new switching station to the Vieux Fort and Pierrot Substations.

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3.3.1.2 A proposed site layout is included in drawing H366562-00000-220-260-0001.

3.3.1.3 The site layout is to be treated as indicative. The *Contractor* should propose its preferred layout based on the *ESS* technology selected and the required clearances, as well as necessary truck and crane access.

3.4. Information Available

3.4.1 *Geotechnical Report*

3.4.1.1 Information regarding Geotechnical data are available in Schedule J.

3.4.2 *Topographical information*

3.4.2.1 Available topographical condition is provided by *LUCELEC* and available in Schedule J.

3.4.3 *Hydrological information*

3.4.3.1 Site hydrological information and ditch sizing are provided by LUCELEC and available in Schedule J.

4. Summary of Work

The Site Works and Civil *Balance of Plant* scope of work includes site preparation and drainage, access road, ESS container foundations and site security.

4.1. Materials and Work Included

4.1.1 *Design*

The Site Works and Civil *Balance of Plant* scope of work as a minimum consists of preliminary and detailed engineering for the design of the following civil elements:

4.1.1.1 Platform Design

- Final grading design for the site considering operational requirements, layout and geotechnical characteristics, the final grading includes the gravel pad structure and landscaped areas.
- New access road to ESS site will be designed considering pedestrian and vehicle safety and vehicles requirements, access is next to the La Tourney Cemetery and also leads to the 7A and 7B solar plant.
- Drainage will be designed to minimize water accumulation and impact to receiving environment.

4.1.1.2 Road Design

- Site roads geometry shall be designed to meet traffic needs with required width and radius, also considering proper drainage with minimal cross fall.
- Road structure typical cross section based on the underlying materials and bearing capacity.

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- Drainage shall be provided to maintain current site flows via culverts and minimizing impact to receiving environment.

4.1.2 *Construction*

4.1.2.1 The Site Works and Civil *Balance of Plant* scope of work includes the preparation and construction of all earthworks, sub-base layers and drainage facilities for the new access road, the ESS site, and the site security, more specifically the following activities are part of the scope of works:

- Clearing and grubbing
- Excavation
- Backfill and Grading
- Drainage
- Surface drainage
- Oil water containment (if necessary)
- Fencing
- Trenching
- Concrete duct bank work
- Asphalt pavement
- *BESS* and *PCS* container foundations
- Switchgear foundation
- Power transformer foundations
- Foundations for any other major equipment

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4.1.2.2 The Civil *Balance of Plant* scope of supply includes but is not limited to the items identified in Table 1.

Table 1: Civil Balance of Plant Scope of Supply

Item	Qty	Deliverable Brief Description
		ENGINEERING
1.	1 Lot	The *Contractor* is to provide detail engineering drawings for construction and documentation on scope of supply. All following the Design Criteria proposed in the document. Deliverables: Civil/Structural • HSE management plan • Construction drawings • Design Reports – Including required calculations to support the design • Relative shop drawing • As-built Drawings
		SITE WORK
2.	1 lot	Design and Construction of civil works required for the installation of the proposed equipment as per drawings and specifications. Including: • Clearing and grubbing • Excavation • Backfill and Grading • Drainage • Surface drainage • Culvert • Oil water containment (if necessary) • Fencing • Trenching • Concrete duct bank work • Asphalt pavement
		STRUCTURE AND FOUNDATION
3.	1 lot	Design and construction for the foundation and structural work of the proposed equipment as per drawing and specifications. Including: • *BESS* and *PCS* container foundations • Switchgear foundation • Power transformer foundations • Foundations for any other major equipment

4.2. Works Excluded

4.2.1.1 The contractor shall be responsible for providing the completed works, except as listed below:

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- Any work to be carried out within the existing Solar PV station.

4.3. Battery Limits

4.3.1.1 Battery limits for the Site works and Civil *Balance of Plant* are:

- At the intersection with the access road and the *ESS* site.
- The *ESS* site.

4.4. Site Establishment

4.4.1.1 Site establishment shall include the mobilization of all plant labour and equipment as required for the execution of works as detailed within this Scope of Work and associated drawings and specifications.

4.4.1.2 Site establishment shall also include all works associated with the supply, erection and maintenance of the *Contractor*'s site office, crib and amenities for their employees and *Subcontractors*, including the provision for connections to the utilities and other services as required, as well as the preparation of a lay-down/compound areas and storage facilities and workshops which are clear of the current accesses and the proposed development.

4.4.2 *Access Roads*

4.4.2.1 The *Contractor* shall ensure that the size of the materials, equipment, and all other supplies required for the contract are such that they can be transported or move freely and safely on all routes and access to the work areas.

4.4.2.2 Access for large loads may be restricted to specific roads or access routes. *LUCELEC* or its *Representative* shall be consulted prior to delivery or movement of such loads on site to confirm approved access roads.

4.5. Health, Safety and Environment

4.5.1.1 The *Contractor* shall develop, implement, and maintain a Health, Safety and Environment (HSE) Management System specially relating to all the *Contractor*'s activities on site.

4.5.1.2 Health and Safety Management shall include plans, processes and procedures to identify and control risk and workplace situations to ensure the healthy, safety and well-being of all persons entering the *Contractor*'s work site.

4.5.1.3 Issues to be addressed include site access control, traffic control, safe work methods, deep excavations, contaminants spills and confined spaces.

4.5.1.4 The HSE Plan shall specifically incorporate the *Contractor*'s Site Health Safety and Security Plan and Site Environmental Management Plan. It shall be consistent with and satisfy the requirements of all relevant statutory and project regulations, policies, procedures and codes of practice.

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4.6. Construction Permits

4.6.1.1 All required construction permits and environmental permits for the Site are the responsibility of *Contractor.* Construction will commence after these permits have been obtained.

4.6.1.2 The works shall be in full compliance with all statuary requirements complete with all required certification and accreditation.

5. Design Criteria

5.1. References

5.1.1 *Safety in Design*

5.1.1.1 Safety in design establishes a process that aims to eliminate or minimize Occupational Health and Safety (OHS) hazards and risks by encouraging key decision makers to consider safety over the life cycle of the project.

5.1.1.2 The *Contractor*'s Designers and Engineers have an obligation to ensure the Project does not adversely affect the health and safety of personnel during the construction and operational phases. Risks and hazards must be identified and controlled as early as possible in the design process to ensure they are addressed efficiently. The safety of personnel and equipment is of paramount importance to all stakeholders and will be reflected in the civil design. The Project civil design will comply with all relevant legal and regulatory requirements.

5.1.2 *Topographic Survey*

5.1.2.1 A final survey of the area is to be conducted using a Global Position System (GPS). The survey will include the original ground for the proposed roadway, site layout, and ditch areas based on the proposed site layout. Including features such as watercourses, existing intersections, edge of pavement, and utilities.

5.1.2.2 All survey dimensions will be in metric units and are based on the NAD83 UTM Zone 20 system.

5.2. Standard Units

5.2.1.1 The International System of Units (SI units and prefixes) will be used for all design calculations and on all drawings.

5.3. Earthquake loading

5.3.1.1 The earthquake loading for station equipment foundations and building is define as USA Uniform building Code Zone 3.

5.4. Site Development

Site development refers to the construction of civil infrastructure to support the erection and operation of the facility.

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5.4.1 *Environmental Protection*

5.4.1.1 The new installations shall be constructed in a manner that will minimize the impact on the environment.

5.4.1.2 During road and platform construction, care will need to be taken to minimize the effects on the local environment. The construction of silt traps and the use of anti-erosion techniques must be employed to prevent the excessive runoff of silt for the construction into the local drainage systems.

5.4.1.3 Riprap will be placed at locations where the speed of the water might create erosion and will be sized to resist the water speed and prevent erosion. Runoff water of the site shall be free of sediment during and after construction.

5.4.1.4 Localized depressions containing standing water will be drained through pumping and/or trenching operations during construction. Water quality will be addressed to determine if there are any issues and applicable disposal procedures required during the drainage process due to possible contamination.

5.4.1.5 All disturbed areas beyond limits of work to be restored to original conditions or better.

5.4.1.6 A containment system for the transformer is to be installed as required per the applicable codes/standards.

5.4.1.7 The *Contractor*'s Environmental Management practices must be in alignment with *LUCELEC* Environmental Policy Statement.

5.4.2 *Clearing and Grubbing*

5.4.2.1 The extent of the Project's facilities and road to be cleared of trees and other vegetation as shown on the plans. The identified areas will be rough graded and perimeter ditches will be installed prior to other construction activity. Topsoil, root mats and other organic matter will be removed from all areas where required.

5.4.2.2 All topsoil will be identified, stripped and stored in dedicated areas for later use. Topsoil stockpiles shall not exceed 2 m in height.

5.4.3 *Earthworks and Levelling*

5.4.3.1 Earth moving activities are required to obtain the required design elevations of the ground surface. Earthworks shall be carried out in accordance with BS 6031 and the following general guidelines.

5.4.3.2 Use native materials from site excavations to shape the site and balance cuts and fills as much as is practical.

5.4.3.3 Place and compact fill materials on prepared subgrade to provide adequate bearing capacities, as required for specific infrastructure construction. All utilities shall be decommissioned and removed before commencement of earthwork activities.

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5.4.3.4 Water must be diverted away from excavations, so it does not saturate the slopes.

5.4.3.5 If pipes are in the vicinity of the slopes, erosion control measures shall be in place as mitigation for eventual leaks.

5.4.3.6 No loads, including excavated material, traffic of vehicles or heavy machinery shall be allowed near the crest of the slopes (equal distance to the height of the excavation) if the slope supporting solutions did not take such loads into account.

5.4.3.7 No excavation shall be carried out near existing structures without a proper design to secure such structures.

5.4.3.8 No worker shall enter excavations deeper than 4 feet or approach the side of an excavation to a distance equal to the depth of an unsupported excavation.

5.4.3.9 Safe means for entering and exiting excavations shall be in place, where workers are to access the excavations.

5.4.3.10 Dust control measures shall be in place.

5.4.3.11 Protect the environmental sensitive areas, as applicable and including wetlands, floodplains, water courses, and other sensitive areas.

5.4.3.12 Site grading shall produce a usable and easily maintainable ground surface not subject to flooding or erosion. Initial rough grading and final site grading are to adhere to the following:

- Provide final grades that ensure suitable pedestrian and vehicular access to buildings and permit adequate drainage of the site,
- Ensure new grades merge smoothly with existing grades without causing low areas, which can result in water ponding.

5.4.4 *Sloped Embankments*

5.4.4.1 Slopes may be modelled at 3H:1V as standard for the soil's geotechnical conditions.

5.5. Roads, Platforms and Parking Areas

5.5.1 *Roads*

5.5.1.1 Roads and parking lots shall be graded with slopes varying from 1% to 3%, directing water to the water collection system (ditch).

5.5.1.2 Access road will be subjected to occasional traffic by security, maintenance, and/or firefighting vehicles.

5.5.1.3 Unless noted otherwise in technical documents, the roads located on the site shall be designed using the following guidelines as shown in Table 2 below.

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Table 2: Road Dimension Table

Criteria	Access Road
Overall Width	6 m
Lane Width	1 at 3.5 m
Shoulder	1.25 m
Type of Surfacing after Construction Period	Macadam
Side Slope	3:1
Cross Slope	1-3%

5.5.2 *Design Vehicle*

5.5.2.1 Geometrical design of pavements shall be designed to withstand the loading and sizing of the design vehicle, for the project the design vehicle will be the construction equipment required to carry out the civil construction and delivery of the electrical equipment as well as the maintenance vehicles required and emergency response plan requirements (i.e., fire fighting truck).

5.5.3 *Design Speed*

5.5.3.1 The design speed shall be 30 km/h.

5.5.3.2 The posted speed limit shall be 10 km/h.

5.5.4 *Signage*

5.5.4.1 Traffic control signs to be provided as indicated in the traffic design drawings to assure a safe movement on site.

5.5.4.2 Direction and informational signs to be provided for both vehicle and pedestrian traffic, such as parking areas, restricted areas, shipping and receiving.

5.5.4.3 Primary identification signs area to be free-standing and cited per applicable legal regulations and standards.

5.5.4.4 Provide security signs at the site and along the site property boundaries.

5.5.4.5 Signs are to be free-standing, fence mounted or wall-mounted, per the application.

5.5.4.6 Signs are to be lighted, if determined necessary.

5.5.5 *Minimum Clearances*

5.5.5.1 Overhead power lines horizontal and vertical clearances shall be in accordance with local standard and regulation.

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5.5.5.2 A minimum horizontal distance of 3 m shall be provided between buildings and road edges. When this requirement is not met, safety features shall be put in place (i.e.: bollards, jersey barriers, etc.).

5.5.6 *Emergency Services*

5.5.6.1 Emergency service vehicle access areas shall be provided adjacent to all main egress points.

5.5.6.2 Sufficient space shall be provided to allow two (2) conventional Emergency Medical Service vehicles to park with doors open and with clearance to unload and load a stretcher.

5.5.6.3 Clear space shall be provided adjacent to all fire hydrants and fire department connection points to allow parking and operation fire fighting vehicles.

5.5.7 *Parking*

5.5.7.1 Parking spaces for cars and pickup trucks will be designed per the minimum requirement as per Table 3 below.

Table 3: Parking Stall Spacing Requirements

Angle of Parking[1]	Minimum dimensions of parking space
75 to 90 degrees	2.80 m wide by 6.10 m long; or 3.1 m wide by 5.50 m long
50 to 74 degrees	
Less than 50 degrees	
Parallel	2.80 m wide by 7.00 m long; by 2.20 m high[2,]

Notes:
1. The angle of parking must be measured between the centerline of the parking space and the centerline of the parking aisle or parking driveway.

2. Width must be increased by 3.10 m if long dimension is immediately adjacent to a fence or wall.

5.5.8 *Drainage Areas*

5.5.8.1 Slopes for gravel surfaces shall be at a preferred minimum gradient of 1.0% towards ditches to drain any surface water away from the roadways and structures.

5.5.9 *Guardrails, Posts and Bollards*

5.5.9.1 Guardrails shall be installed where delineation of the roadway is required in hazardous areas such as adjacent to steep banks, culvert crossing, and other vulnerable installations.

5.5.9.2 Provide guardrails where a 3.0 m or more drop-offs exist at the edge of a road.

5.5.9.3 Guardrails or safety barriers shall be installed where horizontal distance from roadside to an obstruction, or a slope steeper than: 1V:2H, is less than 1.0 m.

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5.5.9.4 Provide discontinuous openings in berms for drainage, with openings smaller than half the blade width of vehicles constructing or maintaining the berms.

5.5.9.5 Steel bollards to be provided at building entrances and around hazard areas such as and transformers.

5.5.9.6 Bollards will be filled with concrete.

5.5.9.7 Bollards to be painted and reflectorized for clear visibility.

5.5.10 *Fence and Gates*

5.5.10.1 Fences and gates requirements shall be shown on the layout and shall be provided as shown on technical documents for security purposes and to prevent human and animal intrusion.

5.5.10.2 Fences located near roadside shall be built to protect electrical equipment from potential road crash.

5.6. Stormwater Management

5.6.1 *General Considerations*

5.6.1.1 Design overall site drainage, including open drains (ditches, culverts and inlet structures, where applicable, to convey the storm water peak flow runoff.

5.6.1.2 Where possible and practical, surface drains will be incorporated within the road right-of-way (road and ditch section).

5.6.1.3 All site grading, roads, and open drains will be designed to provide a continuous overland flow route to respective stormwater detention ponds.

5.6.1.4 Surface runoff from areas within the site shall be handled as follows:

- Runoff from the *ESS* area shall be conveyed to the drainage ditches by sloping the tributary surface areas,
- Areas draining away from buildings will slope away from buildings towards ditches with grades for land slopes ranging from 1% to 3%.

5.6.2 *Quantity Control*

5.6.2.1 Design storms shall be determined from the historical rainfall intensities from the Hydrologic and Hydraulic study by ECMC Ltd from 2017.

5.6.3 *Culverts*

5.6.3.1 Peak flows conveyed towards culverts will be modelled and the hydraulic analysis to be determine the backwater.

5.6.3.2 Culvert capacity shall be calculated using appropriate nomographs with inlet or outlet control for each culvert with the corresponding flow from the hydrological report.

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5.6.3.3 Calculated design flow shall be increased by a factor of 1.2, to allow for reduced culvert areas due to silting.

5.6.3.4 Where installation of multiple culverts is required, the minimum space between culverts will be 300 mm for 400 mm to 600 mm diameter culverts; half diameter for 675 mm to 1800 mm diameter culverts; and 900 mm for 1950 mm to 3000 mm diameter culverts.

5.6.3.5 Design criteria for culverts are summarized in Table 4.

Table 4: Design Criteria for Culverts

Culvert Design Criteria	
Minimum slope of culvert	0.1%
Maximum slope of culvert	5.0%
Minimum size of culvert	600 mm
Headwater depth/Pipe dia/ (HW/D)	1
Minimum cover	Per manufacturer's recommendations based on each loading case
Minimum velocity	1 m/s

5.6.4 *Ditches*

5.6.4.1 Drainage ditches shall be designed with a trapezoidal cross-sectional shape.

5.6.4.2 Ditches will be sized using Manning's equations expressed as follows and ditch capacity shall be for a 25-year event.

$$Q = A*R^{0.67}*S^{0.5}/n$$

Where:

Q = capacity (m^3/s)

A = Cross sectional area of flow (m^3)

R = hydraulic radius (m)

S = Slope (m/m)

n = coefficient of roughness (unit less) = 0.013

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5.6.4.3 The ditches are graded with a minimum slope of 0.3%. The bottom of the ditches is at least 0.3 m lower than the infrastructures line of roads to collect water from the foundations.

5.6.4.4 Ditches are at least 2 m wide at the bottom and have minimum 2H:1V slopes, or as per geotechnical study, whichever is the most stringent.

5.6.4.5 Ditches are stabilized using topsoil and seeding and / or erosion blanket, riprap, whichever is the most stringent.

5.6.4.6 Design criteria for ditches is summarized in Table 5.

Table 5: Design Criteria for Ditches

Ditches Design Criteria	
Minimum slope of ditch	0.3 %
Maximum slope of ditch	5.0 %
Minimum depth of ditch	600 mm
Maximum depth of ditch (invert to top of highest bank)	1200 mm
Minimum bottom width	1000 mm
Maximum side slope (soil)	3H:1V

5.6.5 *Ditch Protection*

5.6.5.1 Riprap will be provided at erosion susceptible locations of the interceptor drainage system, including open drain sections subject to high velocities (1.5 m/s to 4.0 m/s), sections of super critical flow, ditch outlets, storm sewers outfalls, and culverts. Open drains conveying uncontaminated surface water may be grass-lined with erosion tolerant native grasses.

5.6.5.2 Energy dissipaters will be used where the flow velocities exceed the acceptable maximum.

5.6.6 *Geotextile*

5.6.6.1 Synthetic geotextile material shall be placed beneath all riprap installations and ditches when constructed in fill.

5.6.6.2 This material shall also be placed in conjunction with earth or granular covered synthetic liners to provide protection of the liner material.

5.6.6.3 The geotextile shall be selected based on specific applications for strength, permeability, thickness, porosity and roughness properties necessary to satisfy the specific requirements.

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5.6.6.4 The geotextile shall be installed in accordance with the manufacturer's methods and procedures.

5.6.7 *Riprap*

5.6.7.1 Riprap shall be placed at all culvert inlets and outlets, discharge locations to existing ground and transition locations from blankets to native soils.

5.6.7.2 Riprap shall be placed at the confluence of main ditches where lateral ditches intersect main ditches and in the ditch bottom.

5.6.7.3 Riprap shall be placed on the substation slope in order to prevent long term erosion.

5.6.7.4 Riprap must be underlain by a non-woven geotextile.

5.6.7.5 Riprap size shall be determined by soil and flow conditions.

5.6.8 *Erosion and Sediment Control*

5.6.8.1 Sediment control methods or devices shall be provided around and on the plant site to minimize sediment transport off the site.

5.6.8.2 Sediment Controls shall:

- Minimize the size of disturbed areas,
- Prevent runoff from off-site areas from flowing across disturbed areas,
- Reduce speed of runoff flowing across the site,
- Remove sediments from on-site runoff before it leaves the site,
- Meet or exceed local requirements for sediment and erosion control plans,
- Rehabilitate temporary construction facilities to avoid future erosion problems.

5.6.9 *Dewatering*

5.6.9.1 Dewatering installation, if required by site conditions, will be designed by the contractor in accordance with the recommendation in the geotechnical study.

5.7. Concrete

5.7.1 *General*

5.7.1.1 Concrete structure shall be designed in accordance with BS 8110 and *LUCELEC* site condition in the *LUCELEC* Design Criteria and the OECS Building Code Grenada, St. Vincent & the Grenadines, St. Lucia, Montserrat, latest version (National Building Code).

5.7.1.2 Concrete structures will be designed with due consideration given to location and spacing of expansion joints, control joints and construction joints. Construction joint locations, if not indicated on the drawings shall be approved by the *Contractor*'s Engineer prior to construction.

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5.7.2 *Dead Loads*

5.7.2.1 Dead loads will include the weight of all fixed structural elements and all permanent equipment. Equipment loads shall be as supplied by the equipment manufacturer and shall be certified prior to issuing drawings for construction.

5.7.2.2 The minimum design dead loads shall be in accordance the BS 8110 and the OECS Building Code.

5.7.3 *Cement*

5.7.3.1 Cement shall conform to BS 197.

5.7.4 *Concrete Strength*

5.7.4.1 The minimum 28 days compressive strength shall be 30 MPa. Higher compressive strength could be used if required.

5.7.4.2 Classes of exposure C1 and S1, Geotechnical report does not provide information on this but believe that this might be the case based on experience.

5.7.4.3 Lean concrete compressive strength shall be 15 MPa.

5.7.5 *Reinforcing Steel*

5.7.5.1 Reinforcing steel shall be in accordance with BS 4449, BS 4482, or BS 4483, as appropriate and the *LUCELEC* Design Criteria.

6. Site Work

6.1. General Requirements

6.1.1 *Set out Works*

6.1.1.1 The work shall be set out using the coordinates and corresponding datum required for project drawings and documents. All set out works shall be approved before start of excavation, filling or construction works.

6.1.2 *Protection of Existing Works*

6.1.2.1 The *Contractor* shall conduct, jointly with *LUCELEC*, a condition survey of existing aboveground and underground services and facilities on site and adjacent areas which may be affected by the work, by inspecting available existing plans, if necessary, by hand excavation before start commencement of works. The *Contractor* shall protect all such facilities from damage while the work is in progress.

6.1.2.2 The *Contractor* shall protect the existing services and facilities from damage or interference during site preparation. Methods of protections are presented in the drawings, other methods proposed by the *Contractor* shall be approved by *LUCELEC*.

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6.1.2.3 A certificate must be obtained from *LUCELEC* confirming that services have been cut-off and/or made safe, and it shall specify any services or other facilities adjacent to site and shall include related safety aspects and measures which must be maintained during implementation of work.

6.1.2.4 In the event where drainage paths during construction will be blocked, temporary or permanent alternate routing during construction shall be installed and the drainage path shall be restored upon completion of works.

6.1.2.5 If services or facilities are accidentally damaged or cut, the damage shall be repaired by the *Contractor* at *LUCELEC* satisfaction.

6.1.2.6 Any protection measure such as temporary supports, bridging, shoring and safety barriers shall be approved prior to work commencement.

6.1.3 *Water Control*

6.1.3.1 A temporary drainage system shall be implemented to control runoff from stormwater events to allow works to proceed in a dry condition. Proposed systems shall be approved by *LUCELEC* before commencing work.

6.1.3.2 The dry condition shall be always maintained continuously under all conditions and until completion of works or when work is able to withstand effects of water. Furthermore, damp earth shall not enter or contaminate the various components of the works. Subgrades will be protected from softening, undermining, washout and damage by rain or water accumulation.

6.1.3.3 If ponding of water occurs and water saturation results in softening, loss of bearing strength, heave or settlement or any other effect of a detrimental nature of the soil strata then the suspected strata shall be excavated, removed, and replaced with specified fill material compacted to equal that of adjacent material.

6.1.3.4 When ponding of water occurs at the bottom of an excavation, the *Contractor* is responsible for dewatering with required equipment (i.e., dewatering power pumps, piping system) and discharge water to an approve location by *LUCELEC*. All dewatering equipment including temporary electrical supply shall be removed upon completion of dewatering activities.

6.1.3.5 The *Contractor* shall provide and maintain slopes, crowns and ditches on all excavations and grades to always ensure satisfactory surface drainage.

6.1.4 *Dust Control*

6.1.4.1 The dust from site preparation work shall be controlled to prevent the spread of dust to existing facilities at site. The dust shall be controlled by the *Contractor* by installing and maintaining a dust control system plan for cleaning, sweeping and sprinkling with water or other means as frequently as necessary.

6.1.4.2 The *Contractor* shall perform the following activities:

- Maintain access in a clean condition,
- Apply water with equipment approved by *LUCELEC*,

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- Apply water with distributors equipped with spray system that will ensure uniform application and with means of shut-off,
- Adjust the application rate to eliminate dust and maintain the integrity of the site,
- Maintain access and routes in a clean condition. Immediately clean pavement surfaces if requested to do so by *LUCELEC* by sweeping and washing. Haul routes require continuous cleaning,
- Always keep municipal roads clean.

6.2. Clearing, Grubbing and Stripping

6.2.1 *Description*

6.2.1.1 The work to be performed under this section consists of supplying all labour, materials and equipment and performing all the work necessary for site clearing, grubbing and stripping, as indicated in this Specification.

6.2.1.2 Site clearing shall include the following:

- Removal of all vegetation or other hazardous obstacles,
- Removal of all surface boulders, debris, and rubbish,
- Removal of any abandoned underground electrical cables, pipes, pipelines, drainage and wells,
- Removal of existing infrastructure identified to be demolished within limits of construction.

6.2.1.3 Vegetation clearing shall be carried over the full extent of the works, which includes the following:

- Platform area,
- Access road,
- Drain alignments,
- Areas set aside for the establishment of the site as shown on the drawings or as directed.

6.2.2 *Definitions*

6.2.2.1 Clearing and Grubbing

- Clearing and grubbing shall consist of the removal from the site of:
  - Waste such as rubbish dumps and sawdust piles resting on or protruding from the ground surface.
  - Obstructions such as asphalt paving, concrete edgings, foundations, fences and disused structures, but not underground obstructions such as drainage pipes and service conduits (which, where required, shall be indicated on drawings and specifications).

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6.2.2.2 *Topsoil*

- Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles. Friable and pervious, topsoil is distinguishable from the underlying subsoil by having a black or a darker shade of brown, gray, or red than underlying subsoil.

6.2.3 *Execution*

6.2.3.1 *Preparation*

- Confirm, transfer, establish, protect and maintain benchmarks and survey control points from disturbance during construction.
- Locate and clearly flag trees and vegetation to remain or to be relocated.
- Stake out any existing buried lines, cables, structures, sterile zones and underground structure.

6.2.3.2 *Clearing and Grubbing*

- Vegetation, fences, or any other items not within the areas specified in the section above shall not be removed and where necessary as agreed with *LUCELEC* shall be protected particularly in areas adjacent to works.
- All depressions and holes below grade level or sloped surfaces because of grubbing operations shall be filled and compacted with soils and materials in accordance with the requirements set within this specification.
- Disturbed areas surrounding the designated clearing areas shall be cleaned of debris and restored as directed by *LUCELEC*.
- Disposal location shall be selected by *LUCELEC.*

6.2.3.3 *Topsoil Stripping*

- Upon completion of all clearing operations, the topsoil shall be removed in areas to be either filled or excavated to a minimum depth stablished in the design drawings, to ensure that all vegetation and soft spots are removed. Removed topsoil shall not be used as structural fill material.
- The stripping of topsoil is conducted to provide a stable base for the works and preparation of subgrade for fill placement as per the requirements set out in this specification. The stripping depth may vary depending on site conditions as shown on the drawings or as directed by *LUCELEC.*
- Suitable materials recovered shall be placed in stockpiles at agreed locations, away from the edge of excavations. They shall be placed well clear from other stockpiled materials to limit intermixing with non-usable soils to be used in future construction activities as required.

6.2.3.4 *Cleaning and Protection*

- Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris and legally dispose of them at a location specified by *LUCELEC.*

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- Existing landforms and vegetation shall be preserved wherever possible to facilitate the integration of the site with the natural surrounding environment.

6.3. Excavation

6.3.1 *Description*

6.3.1.1 The work to be performed under this Section consists of the supply of all labour, materials, equipment and supervision and the performance of all the work necessary for excavating, hauling, and stockpiling or disposing of overburden, as shown on the construction drawings, as indicated in this Specification, and as required by *LUCELEC* or its *Representative*.

6.3.2 *Definitions*

6.3.2.1 **Grading:** cutting, filling, and moving of earth prior to the construction grading and finishing grading work.

6.3.2.2 **Backfill**: Natural material or controlled low-strength material used to fill an excavation.

6.3.2.3 **Excavation:** Removal of material encountered above elevations, lines, and dimensions indicated.

6.3.2.4 **Authorized additional excavation:** Excavation below elevations or beyond indicated lines and dimensions as directed by *LUCELEC*.

6.3.2.5 **Unauthorized excavation:** Excavation below specified elevations or beyond indicated lines and approved dimensions without instructions from *LUCELEC.*

6.3.2.6 **Fill:** Soil Materials used to raise existing grades.

6.3.2.7 **Utilities:** Underground pipes, conduits, culverts, ducts, and cables, as well as underground services within buildings.

6.3.3 *General Requirements*

6.3.3.1 The geotechnical report is provided for information only. The *Contractor* shall be responsible for any interpretation or conclusions drawn from the data and for carrying out any additional investigation, which it considers necessary to either verify the data provided or provide additional data. The *Contractor* shall submit details of additional testing it intends to undertake to *LUCELEC* for approval prior to proceeding with connected works/activities.

6.3.3.2 The *Contractor* shall conduct a joint survey with *LUCELEC* or its *Representative* to establish existing site conditions adjacent or near excavation areas at least 2 weeks prior to commencement of work. The *Contractor* shall submit a copy of the survey report to *LUCELEC*.

6.3.3.3 The *Contractor* shall make all excavation as required by this specification. After excavation, the exposed soil shall be inspected.

6.3.3.4 The *Contractor* shall control water flow into excavations by suitable means.

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6.3.3.5 Batters for permanent excavations will be indicated on the drawings. If the material in the batter is found to be unstable, the batter shall be flattened to a stable slope as directed and approved by *LUCELEC*. When the depth of the excavation exceeds 1.2 m, the sidewalls shall be sloped or shored.

6.3.3.6 Temporary slopes shall be cut back to a minimum ratio of two horizontal to one vertical (2:1), or as directed by *LUCELEC*. Existing adjacent structures and footings shall be located outside of 2:1 projection from the base of the excavation cuts.

6.3.3.7 The *Contractor* shall be fully responsible for maintaining the stability of the shoring systems (if any) and/or cut slopes. The *Contractor* shall assume full responsibility for:

- The safety of the personnel,
- Maintaining all excavated faces and cuts in a safe and stable condition,
- Complying with the requirements of the Geotechnical Investigation Report, along with international, local laws and regulations until final acceptance of work.

6.3.3.8 The *Contractor* shall respect all the general requirements as always specified in this document during the excavation operations. The *Contractor* shall be aware of underground utilities, services and structures that may impact excavation works.

6.3.3.9 The earthmoving equipment shall be directed in pre-determined routes to minimize damage to natural subsoil structure of exposed formations.

6.3.4 *Treatment of Excavation Subgrade*

6.3.4.1 The *Contractor* shall rework the stripped or excavated surface areas until the required compaction and material requirements are achieved.

6.3.4.2 Where exposed in-situ material is suitable for use, but additional preparation is required then one of the following shall be adopted:

- When one layer requires treatment, the *Contractor* shall scarify the exposed soil to a depth of 150 mm and compact it to at least 95% of maximum dry density as per the requirements set out in this specification,
- If additional material must be imported to obtain the specified layer thickness, then the in-situ material in that layer shall be scarified, the imported material placed and mixed, and combined material compacted to the required levels,
- Where natural aggregates in in-situ material exceeds the maximum size specified for the layer then heavy grid rolling shall be done to reduce the aggregates to an acceptable size.

6.3.5 *Safety Plan*

6.3.5.1 Prior to commencement of excavation works, the *Contractor* shall submit an excavation safety plan for review and approval by *LUCELEC*. The plan shall indicate:

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- The methods, systems, techniques to be used to ensure that the excavation sidewalls shall be properly guarded to protect personnel and surrounding facilities and structures,
- The methods shall include but not be limited to shoring, strutting, protective barriers, steps, temporary fences, guardrails, demarcations, signage, barricades, lights,
- These systems/methods shall be properly always maintained and remain in good condition during the construction period,
- These systems shall be removed when they are no longer required as approved by *LUCELEC.*

6.3.6 *Stockpile of Excavated Materials*

6.3.6.1 Excavated material shall be stockpiled and the following shall apply:

- Be placed in an organized manner, at approved locations by *LUCELEC,*
- Shall be protected from contamination with unsuitable materials or other materials that might impact the quality of the material and make it unsuitable for use,
- Shall not obstruct drainage or other construction activities in the vicinity of excavation.

6.3.6.2 Excavated material shall not be left even temporarily outside of designated storage area as it might interfere with other construction operations. Unsuitable excavated material for use as fill, shall be stockpiled adjacent to the site as directed by *LUCELEC*.

6.4. Backfill and Grading

6.4.1 *Description*

6.4.1.1 The work to be performed under this section consists of the supply of all labour, materials, equipment and supervision and the performance of all the work necessary for supplying, transporting and placing fill materials as shown on the construction drawings and as indicated in this Specification.

6.4.1.2 The process includes the following:

- The preparation of all project areas where fill or embankments will be constructed,
- The preparation, selection and supply of materials,
- The formation, compaction and trimming of the fills.

6.4.1.3 All fills shall be made to the slopes, dimensions and elevations shown on the drawings. Prior to start of fill operations, the existing ground or "as stripped" subgrade surface shall be assessed, tested, and prepared.

6.4.1.4 Fills shall be constructed with suitable specified material in accordance with this specification. Unless otherwise authorized, all suitable materials obtained from excavation that meet the technical specifications for fill materials shall be placed before any material that is borrowed from off-site sources.

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6.4.1.5 Fills shall be constructed in layers, the thickness of which shall be compatible with the compaction efficiency of the equipment used as approved, generally 300 mm. In the case where the full depth of the compacted layer has not achieved, it may be instructed that additional compaction effort shall be conducted or the thickness of fill layers shall be reduced as directed by *LUCELEC*.

6.4.1.6 QA/QC and test results must be provided prior to works commencing of subsequent layers.

6.4.2 *Fill Material*

6.4.2.1 Fill material shall be obtained from naturally occurring material on site or from recognized local borrow areas in accordance with the material specification required.

6.4.2.2 Suitable Materials

Materials excavated from the site or imported from outside that are:

- In conformance with the standards and specifications in this document,
- The *Contractor* to submit test results of material to confirm suitability.

6.4.2.3 Unsuitable Materials

Materials shall be classified as unsuitable if the materials do not meet conformance requirements due to the following:

- Peat, logs, and perishable materials,
- Contaminated materials or materials susceptible to spontaneous combustion,
- Materials with undefined properties, or materials that cannot be proven by testing,
- Building debris and domestic and industrial wastes,
- Materials having a moisture content greater than the maximum specified,
- Soils and rocks susceptible to deterioration/change of their properties,
- Gypsum and dredged materials,
- Materials containing chlorides, sulphates or other chemicals greater than the maximum specified.

6.4.2.4 General Granular Fill

- Granular fill shall be classified as well-graded, hard granular material free from clay and other deleterious substances. The grading of material shall be as per Table 6 when tested per requirements set out in BS1377.

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Table 6: Granular Fill

Sieve Size (mm)	Percentage Passing by Mass
40	100
19	80
0.075	0-8

- Material and other properties shall be as listed in Table 7 and Table 8.

Table 7: Material Properties for Structural Fill

Element	Value
Uniformity Coefficient: D60/D10	≥ 10
Friction Angle, φ	≥ 42°
Elastic Modulus, E (Plate Load Test)	≥ 100
Minimum CBR	≥ 30
Plasticity Index	≤ 6

Table 8: Other Properties for General Fill

Element	Value
Sulphate Content	≤ 2%
Soluble Salts	≤ 5%
Gypsum	≤ 5%

6.4.3 *Stockpiling*

6.4.3.1 The *Contractor* shall prepare a layout plan describing the size, maximum height, shapes of the stockpiles and the minimum distances between stockpiles within a designated stockpile for approval by *LUCELEC* prior to stockpiling work. Rough sketches shall be provided for easy of explanation by the *Contractor.*

6.4.3.2 Stockpiles shall be placed on surfaces which have been cleared. The foundations for stockpiles shall be suitably prepared to prevent loss of materials into the foundations or contamination of materials. The prepared surface for any stockpile shall extend at least 6 m beyond the limits of the stockpile.

6.4.3.3 Stockpile fill material in sufficient quantities to meet project schedules.

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6.4.3.4 Stockpiling sites to be level, well drained, and of adequate bearing capacity and stability to support stockpiled materials and handling equipment.

6.4.3.5 Separate different fill material far enough apart to prevent intermixing.

6.4.3.6 Do not use intermixed or contaminated materials. Remove and dispose of rejected materials as directed by *LUCELEC* or its *Representative* within 48 hours of rejection.

6.4.3.7 In storage areas, the materials shall be placed in uniform layers of maximum 3.0 m thickness. The stockpiling of materials shall be done to prevent any surface water accumulation and prevent slope erosion.

6.4.3.8 Uniformly spot-dump fill material delivered to stockpile in trucks and build up stockpile as specified.

6.4.4 *Execution*

6.4.4.1 General Fill

- Place, spread, and compact the fill in accordance following specifications and drawings.
- Prior to fill placement, the ground to be filled shall be tested for *LUCELEC*'s inspection and approval. The *Contractor* shall scarify and re-compact the upper 150 mm of existing soil to the specified density before placing fill.
- Fill material shall be placed in horizontal layers not greater than 300 mm loose lifts over the full width of the cross-section. Each layer shall be spread evenly and mixed during the spreading to increase material and moisture uniformity.
- Each layer shall be compacted. An appropriate type of compacting equipment shall be used as approved by *LUCELEC* to compact the fill to the specified density. The compaction shall be achieved in parallel paths with an overlap of the adjacent trip by not less than 600 mm. Compaction shall be continuous over the entire area and the equipment shall make sufficient passes to obtain the desired density and finish uniformly.
- The slopes shall be compacted until they are stable, and no loose soil is present. The *Contractor* shall compact the slopes by an over-building and cutting back method approved by *LUCELEC.*

6.4.4.2 Sub-base and Base Layer

- Place material on roads and gravel surface areas in accordance with thicknesses indicated on the project drawings.
- Place and spread the material in loose lifts of 200 mm thickness. The material shall be rolled with a self-propelled approved vibratory equipment. The rolling shall start at the edges of the layers. The roller shall run back and forth along the edge until the shoulder and coarse material are bound firmly together. After the sides are rolled, the rolling shall advance gradually toward the center, parallel with the roadway's centerline, uniformly lapping each preceding track at a minimum of 400 mm and thoroughly covering the entire surface with the rear wheel. The rolling shall continue until the specified density is

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achieved and the entire surface is well keyed and does not creep or wave ahead of the roller.

6.4.4.3 Small Areas

- In the event where, small and confined areas are present, then compaction shall be done using a hand compactor to achieve desired density. Hand compacted fill shall be placed in loose lifts not exceeding 150 mm thickness.
- When the required density is not obtained in any layer or portion of fill, then the area shall be re-worked until the material meets the specified density.

6.4.4.4 Compaction Requirements

- Unless noted otherwise on the drawings, the materials shall be compacted at a moisture content of ±2 percent of the optimum moisture content and to at least 95 percent of the maximum dry density.

Table 9: Compaction Requirements

Location	Minimum Dry Density in %
General Fill	95
Subgrade	95
Sub- base & Base	100

- The maximum dry density and optimum moisture content for all materials shall be determined per the requirements set out in BS 1377. Corrections to adjust the laboratory maximum dry density and optimum moisture content for soils with oversize particles shall be made in accordance with British Standard.

6.4.5 *Final Grading*

6.4.5.1 Description

- Grading refers to cutting, filling, and moving of earth prior to the construction grading and finished grading work. Rough grading shall be carried out according to the following guidelines:
  - Grading shall be done in accordance with the elevation indicated on drawings. Tolerance as per BS 1031.
  - The subgrade shall be smooth and compact free of irregular surface changes comply with compaction requirements.
  - Ensure all features such as culverts, piping under subgrade level are installed.
  - The *Contractor* shall provide a smooth transition between adjacent existing grades and new grades.

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- All dewatering, unsuitable materials and soft spots shall be processed as mentioned in BS 1031.

6.5. Riprap

6.5.1 *Description*

6.5.1.1 The work to be performed under this Section consists of supplying all labour, materials and equipment and performing all the work necessary for the sampling, quality testing, supplying and placing of approved stone as a protective covering along the side slopes and bases of river channels, on slopes around culvert inlets and outlets and on embankments, or such other places as may be indicated on the plans or designated by *LUCELEC* in the field, as indicated in this Specification.

6.5.2 *Sampling*

6.5.2.1 The *Contractor* shall submit a sampling plan and method of execution to *LUCELEC* for approval prior to commencement of the work.

6.5.2.2 Rock soundness tests shall be performed for all rock types in 5 kg ± 300 g test samples of rock fragments, reasonably uniform in size and cubic in shape, and weighing, after sampling, approximately 100 g each. The samples shall be obtained from rock samples that are representative of the total rock mass, as noted in BS 1377.

6.5.2.3 Samples undergoing soundness testing shall be sawed into slabs as indicated in BS 1377. The thickness of the slabs and the size of the sawed fragments shall be such that the samples weigh approximately 100 g. The samples shall further be reduced in size by sawing the slabs into cubic blocks. The cubes shall undergo five cycles of soundness testing in accordance with BS 1377.

6.5.3 *Construction Methods*

6.5.3.1 Preparation of Bed

- The ground surface shall be excavated and neatly shaped to the lines as shown on the plans or as staked by *LUCELEC* in the field prior to the placing of any riprap. The supply and installation of any geotextile, granular filter, and/or bedding material shown on the plans shall be according to their respective specifications.

6.5.3.2 Placing of Stone Riprap

- The stone riprap shall be dumped or placed in such a manner that the larger stones are uniformly distributed, the smaller rocks serve to fill the spaces between the larger stones, and that excessive segregation of the various stone sizes does not occur. Sufficient placing and leveling shall be done to produce a firmly bedded neat and uniform surface conforming to the thickness, shape, and dimensions shown on the drawings.
- When hand placing, use larger stones for lower courses and as headers for subsequent courses. Stagger vertical joints and fill voids with rock spalls or cobbles. Finish surface evenly, free of large openings and neat in appearance.

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6.6. Fencing

6.6.1 *General*

6.6.1.1 Description

- This Section specifies the requirements for the supply of labour, materials, equipment, tools and supervision for the installation of chain link security fences and gates, as indicated in this specification.
- Where specifications may conflict with drawings, the drawings shall supersede.
- The fence shall be erected plump and true to line, with changes in slope made gradually where possible, in accordance with the highest standards of workmanship.

6.6.1.2 Fences

- Fence to be design as per *LUCELEC* Design Criteria. The existing fence along side the main road shall be provided with a 1 m reinforced concrete upstand that is to act as a crash barrier and shall protect the substation material.

6.6.2 *Materials*

6.6.2.1 General Material and Installation Requirements

- All fence materials incorporated shall be new and in accordance with the requirements of the specifications and drawings. All fittings shall be of sufficient strength to ensure the integrity of the fence. Contractor to follow BS 1722 for material requirements and fence installations.

6.6.2.2 Concrete

- Concrete strength shall test at 30 MPA after 28 days of curing.
- Concrete installation and other requirement as detailed in this specification.

6.6.2.3 Gates

- All gates shall be installed as per the drawings with the fabric on the outside. They shall swing to the outside of the fence. The hinges shall be adjusted so the gates swing level, 50 mm over the sill. Gap tolerance around the gate frame and man door is 55 mm.

6.6.2.4 Signs

6.6.2.4.1 Danger Signs

- All signs shall be placed 1,500 mm above ground level.
- The following sign requirements and spacing is for 300 x 450 mm signs. Different sign requirements and spacing will be specified by the *Contractor*'s Engineer if the sign size changes.
- A sign shall be placed on every gate. If there is a walking wicket, the sign should be placed on it.
- At least one sign shall be placed on every side of a switchyard.

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- There shall be no more than 30 m of fence between signs.
- The signs shall be tied to the fence with the same wire clips used for tying the fabric to the posts. The ends shall be tightly twisted to prevent hand removal.

6.7. Trenching

6.7.1 *Description*

6.7.1.1 The work to be performed under this Section consists of supplying all labour, materials and equipment and performing all the works necessary for excavation, trenching, disposal of excess or unsuitable excavated material, dewatering, shoring, foundations, bedding, backfilling and compaction required for the installation of underground works, as indicated in this Specification.

6.7.2 *Existing Buried Utilities and Structures*

6.7.2.1 Confirm locations of buried utilities by careful test excavation and non-destructive methods where applicable.

6.7.2.2 Size, depth and location of existing utilities and structures where indicated are for guidance only, completeness and accuracy are not guaranteed.

6.7.2.3 Maintain and protect from damage, water, sewer, gas, electric and other utilities and structures encountered.

6.7.2.4 Where utility lines or structures exist in area of excavation, not identified in construction drawings, obtain direction from *LUCELEC.*

6.7.2.5 Record location of maintained, rerouted and abandoned underground lines.

6.7.2.6 Locate existing building sewer and water services, utility manhole drains and catch basin leads within the site as applicable.

6.7.3 *Execution*

6.7.3.1 Excavate to lines, grades, elevations and dimensions as indicated in the drawings.

6.7.3.2 Remove obstructions encountered during excavation.

6.7.3.3 Excavation must not interfere with normal 45° splay of bearing from bottom of any footing or pavement subgrade and must not interfere with the bearing capacity of adjacent foundations.

6.7.3.4 For trench excavation, unless otherwise authorized by *LUCELEC* in writing, do not excavate more than 30 m of trench in advance of installation operations and do not leave open more than 15 m at end of day's operation.

6.7.3.5 Keep excavated and stockpiled material at a safe distance away from the edge of the trench as directed by *LUCELEC*. Examples of unsuitable areas include, but are not limited to, the following:

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- In the flood plain,
- On the edge of an embankment creating slope stability issues,
- Locations impeding sight lines of the travelling public through or around the site,
- Restrict vehicle operations directly adjacent to open trenches.

6.7.3.6 Dispose of surplus and unsuitable excavated material off-site or as directed by *LUCELEC.*

6.7.3.7 Do not obstruct flow of surface drainage or natural watercourses.

6.7.3.8 Earth bottoms of excavations to be undisturbed soil, level, free form loose, soft or organic matter.

6.7.3.9 Notify *LUCELEC* when bottom of excavation is reached.

6.7.3.10 Obtain *LUCELEC* approval of completed excavation.

6.7.3.11 Where required due to unauthorized over-excavation, correct with granular base, compact to density not less than 95% Standard Proctor maximum dry density in accordance with BS 1377.

6.7.3.12 Hand trim, make firm and remove loose material and debris from excavations. Where material at bottom of excavation is disturbed, compact foundation soil to a density at least equal to undisturbed soil.

6.7.4 *Dewatering*

6.7.4.1 Keep excavations free of water while work is in progress.

6.7.4.2 Protect open excavations against flooding and damage due to surface runoff.

6.7.4.3 Dispose of water in accordance with local regulations in a manner not detrimental to public and private property, or portion of Work completed or under construction. Provide and maintain temporary drainage ditches and other diversions outside of excavation limits.

6.7.4.4 The *Contractor* shall ensure that the point of discharge from surface water pumped from any excavation is a minimum 25 m from the edge of a watercourse.

6.7.5 *Stockpiling*

6.7.5.1 Stockpile fill materials in areas designated by the *Contractor*'s Engineer.

6.7.5.2 Stockpile granular materials in manner to prevent segregation.

6.7.5.3 Protect fill materials from contamination.

6.7.5.4 Implement sufficient erosion and sediment control measures to prevent sediment release off construction boundaries and into water bodies.

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6.7.6 *Compaction*

6.7.6.1 Compaction in trenches according to the following:

Table 10: Trench Compaction Standard

Location	Compaction % of Standard Proctor
Bedding material – all piping	90
Filter material – sub-drains	95
Trench backfill – all piping	95
Adjacent to and under structures – manholes and catch basins	95

6.7.7 *Backfilling*

6.7.7.1 Do not proceed with backfilling operations until completion of the following:

- Inspection, testing, approval and recording locations of underground utilities,
- Inspection and sign-off are completed by the *Contractor*,
- *LUCELEC* or its *Representative* has inspected and approved installations.

6.7.7.2 The *Contractor* shall backfill the excavated areas with the specified type of backfill material to an elevation in accordance with the drawings, this Specification and as directed by the *Contractor*'s Engineer.

6.7.7.3 Place backfill materials in uniform layers that do not exceed 150 mm compacted thicknesses up to grades indicated. Compact each layer before placing the succeeding layer.

6.7.7.4 Backfill around underground installations:

- Place bedding and surround material as specified,
- Do not backfill around or over cast-in-place concrete within 48 hours after placing of concrete,
- Place layers simultaneously on both sides of installed work to equalize loading. Difference not to exceed 300 mm.

6.7.8 *Restoration*

6.7.8.1 Upon completion of Work, remove waste materials and debris, trim slopes, and correct defects as directed by *LUCELEC,* including, but not limited to:

- Clean and reinstate areas affected by work,
- Reinstate pavement structures and asphalt as required,
- Reinstate grassed areas with topsoil and hydroseed as required,

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- Protect newly graded areas from traffic and erosion and maintain free of trash or debris.

6.7.9 *Inspection and Testing*

6.7.10 *Requirements*

6.7.10.1 Inspection and testing of soil per the requirements and standards set in this specification shall be the responsibility of the *Contractor*. The *Contractor* shall hire an independent qualified geotechnical engineering consultant with testing laboratory capability to perform required testing and inspection. The selected independent geotechnical engineer shall be approved by *LUCELEC*. *LUCELEC* may also conduct independent testing and inspection any of the materials or portions of works.

6.7.10.2 The inspections and tests shall be conducted by the geotechnical engineer in a timely manner to avoid delay in construction operations. Where non-conforming conditions are detected, the *Contractor* and *LUCELEC* shall be informed, and the geotechnical engineer shall advise them on recommendations that are deemed necessary based on the subsurface conditions encountered.

6.7.10.3 The tests shall be repeated if the source of material used for fill changes. Enough tests shall be performed to establish representative average and range of properties. The test shall establish the following properties:

- Natural Water Content,
- Maximum Dry Density and Optimum Moisture Content,
- Particle size distribution, including hydrometer analysis where fraction passing 75micron sieve exceeds 15%,
- Plasticity Index,
- Liquid Limit,
- Angle of Internal Friction,
- Maximum salt and organic matter content.

6.7.10.4 Field density tests shall be performed in accordance with BS 1774.

6.7.10.5 Nuclear density tests may be performed in accordance with ASTM D2922.

6.7.10.6 In areas or circumstances where the above field density tests procedures appear not practical, contractor shall present to the engineer a substitution method for approbation.

6.7.10.7 The *Contractor* shall submit all inspection, test results and documents required by the specifications as indicated herein to *LUCELEC* in a timely manner:

- Written records of all inspections/observations and tests made shall be prepared. All records shall be maintained and made readily accessible and available at the jobsite to *LUCELEC*,

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- Written logs fully describing all work inspected and monitored each day shall be prepared. Daily field logs shall be submitted to *LUCELEC* verifying that the work is being performed as per design documents and geotechnical report. As a minimum, daily field logs shall contain the following:
  - The results of all density tests performed,
  - Type of field density test,
  - Areas inspected and results,
  - Weather conditions,
  - Time spent on the jobsite,
  - An overview and summary of the earthwork,
  - Other geotechnical related activities performed for the day,
  - Any discrepancies noted,
  - Location coordinates and elevations shall be provided for each location tested or inspected,
- The results of all laboratory tests shall be submitted to *LUCELEC* no later than two (2) days from test assignment by the *Contractor*,
- All work and documentation performed, shall be signed and certified by the *Contractor*,
- As required by *LUCELEC* on a periodic or after the completion of earthworks operations, the *Contractor* is responsible to prepare a complete report documenting the results of all field density tests, observations, and inspection performed during the construction, and shall certify that all performed earthworks conform to the requirements of this specification and geotechnical report.

6.7.10.8 Field density tests shall be made for each lift of fill material placed and at the following minimum frequencies:

- Mass & Sub-base Fill - A minimum of three field density tests shall be performed on every 1,000 m^2 of each layer of compacted fill,
- Road Embankments - A minimum of two (2) field density tests per 100 m length of each layer of compacted fill shall be conducted.

6.8. Trenching for Electrical Cables and Utilities

6.8.1 *General*

6.8.1.1 Cable trench shall be fabricated from a non-metal dielectric material and shall be nonporous. The trench shall be self-supporting and equipped with easy access covers.

6.8.2 *Materials*

6.8.2.1 Trench system shall be concrete heavy-duty trench.

6.8.2.2 The design shall be H-20 Heavy Traffic Rated.

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6.8.2.3 Fiber and steel reinforced concrete components shall not be flammable.

6.8.2.4 Concrete shall be in accordance with the technical requirements this specification.

6.8.2.5 Concrete reinforcement shall be in accordance with the technical requirements this specification.

6.8.3 *Backfilling and Compaction for Electrical Cables and Utilities*

6.8.3.1 Place concrete around conduits or utilities. Conduits shall have a minimum of 75 mm concrete encasement and a minimum burial depth to top of conduit of 600 mm where traffic can occur and 450 mm otherwise. Do not place other backfill material over or around concrete within 24 hours of concrete placement.

6.8.3.2 Place sand bedding/cover/backfill around cables and utilities. Unless indicated otherwise on the drawings, direct buried cables shall have a minimum of 75 mm thickness of sand cover below and 150 mm above. Cable separation shall be in accordance with *Schedule E: Electrical Balance of Plant.* The minimum distance from the invert of a ditch to the top of a cable or conduit shall be not less than 1,000 mm.

6.8.3.3 Sand backfill requiring compaction shall be placed in layers not exceeding 200 mm loose thickness and compacted to 95% Standard Maximum Dry Density using hand-operated power tampers.

6.8.3.4 Impervious fill material shall be placed in uniform layers not exceeding 300 mm in thickness for the full width of the trench and each layer shall be compacted to 95% of the standard maximum dry density before a subsequent layer is placed.

6.8.3.5 Impervious fill for cable trench backfill placed within 300 mm of the top of the cable cover sand shall not contain any particles larger than 50 mm.

6.8.4 *Access Covers*

6.8.4.1 All access covers for the precast cable trench shall conform to the following specifications unless otherwise specified by the *Contractor*'s Engineer.

6.8.4.2 Covers shall be fabricated from a non-metal dielectric material and shall be nonporous.

6.8.4.3 Unless otherwise specified, all covers shall be capable of H-20 loading conditions 14,500 kg (32,000 lbs) per axle. Lids capable of H-40 loading 29,000 kg (64,000 lbs) shall also be supplied for locations where heavy load road crossings are specified on the drawings.

6.8.4.4 No channel cover, regardless of the H-20 0r H-40 load rating shall exceed 100kg (220lbs).

6.8.4.5 H-40 load rated lids shall be different in colour as compared to H-20 rated lids for easy site identification. Preference for colour – high visibility orange; AzkoNobel International Paint Ltd. – International Orange D260 or similar.

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6.9. Concrete Precast and Cast-In-Place

6.9.1.1 Concrete installation and testing shall be as per *LUCELEC Design Criteria.*

7. As Built Drawings

7.1. General

7.1.1.1 As-built drawings and certificates shall be submitted to *LUCELEC* as pre-requisite to Practical Completion.

7.1.1.2 During the execution, the *Contractor* must maintain at their office on site one (1) copy of contract drawings marked in red, showing all changes made to the work. These drawings must be always available during normal working hours for inspection by *LUCELEC* or its *Representative.*

7.1.1.3 The *Contractor* shall be responsible for sealing all issue for construction or final drawings with an APESL (Association of Professional Engineers of St. Lucia) seal.

7.1.1.4 All Drawings shall be supplied in PDF and AutoCAD files (preferred AutoCad 2010 files if possible).

7.1.1.5 Three paper copies and an electronic copy of the following documentation will be provided:

- Installation and Commissioning Report
- Issue for Construction and As Built Drawing Package.

7.1.1.6 Paper copies of any Documentation shall be printed on, and/or electronic copies of any Documentation shall be formatted for, standard sized paper, which is limited to the following dimensions:

- Letter: 8 ½ x 11",
- Drawings: A1 or 11 x 17".

7.2. As-Built Drawings

7.2.1.1 As built documentation shall be provided to *LUCELEC* and as a minimum shall show the “as-built” locations and dimensions of:

- Earthworks limits,
  - Road cross sections at 10 m intervals including road centreline,
  - Platforms on a grid at a spacing of approximately 5m x 5m,
- Drainage including ditches and pipe culverts with inlet levels,
- Field data from site verification surveys.

7.3. Certificates

7.3.1.1 The following certificates shall be submitted to *LUCELEC:*

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- Certified copies of all documents submitted to and approved by all statutory authorities and/or independent certifiers,
- Originals of all test/certifications/compliance certificates and *Inspection Test Plan (ITP's).*

END OF SECTION

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