The contents of this document were compiled following the hosting of a symposium for Engineers and Architects (Jan. 2007) and a number of other training activities for industry stakeholders under the CQA Project. The principal reference documents are the Grenada Building Guidelines, 1999, and the Guidelines for Hurricane-Resistant Re-Roofing of Small Buildings, Government of Grenada Disaster Assessment and Recommendation Committee, 2004. The objectives of the document are to facilitate further training of local Building inspectors, and to provide a guide for the CQA checks to be carried out on residential construction projects under the CQA Mechanism for Grenada.
CHECKING OF PLANS AND INSPECTION OF CONSTRUCTION

1 Location Plan

1.1 Roads: the name and location of nearest road and road junctions should be shown.

1.2 Fixed Points: such as bridges, rivers and nearby structures should be shown.

2 Site Plan

2.1 Boundaries: should be shown, along with distances of building from adjacent boundaries – to enable setting out of the building.

* The Building Inspector should verify that the construction is within the required setbacks from the site boundaries, and is in accordance with the approved plans.

2.2 Access Roads: and driveway should be shown.

* Roadways/driveways should not be less than 8ft. wide
* The top soil should be removed and replaced by a minimum of 6" of compacted, granular material.
* Concrete slabs should have a minimum thickness of 4", with welded wire mesh (A142 or equivalent) placed 1" below the slab surface.

2.3 Stormwater & Sanitary Drainage: must be shown; contours or spot levels are required to determine grades.

3 Floor Plan

3.1 Building Shape: undesirable shapes raise warning flags; such building plans should be checked more carefully.

Long narrow buildings should be avoided by limiting the length to three times the width. Rectangular buildings with well inter-connected walls are desirable.

3.2 Dimensions of spaces: critical dimensions should be given.

3.3 Window & Door Openings: as well as distances from corners and distances between adjacent openings should be shown.

* Openings should be located a minimum of 15" from corners.
* The total width of the openings should not exceed 1/2 the length of the wall between consecutive cross walls.
* The horizontal distance between two openings should not be less than 1/2 the height of the shorter opening.

3.4 Exterior Doors: all exterior (hinged) doors should open outwards. Kitchens should have an exterior door which opens outwards.

3.5 Block Walls: thickness should be shown.

3.6 Materials of Construction: should be indicated.
4 Foundation Plan

4.1 Foundation Type: *all exterior walls and interior load bearing walls should be supported on reinforced concrete strip footings.*

4.2 Subsoils: *where feasible, subsoil bearing capacity should be given.*

4.3 Foundation Depth(s): *should be shown provisionally on the pre-construction drawing which should include the following note: “The foundations should generally be located on a layer of soil or rock with good bearing characteristics.”*

4.4 Foundation Sizes: *should be shown.*

5 Sections/Elevations

5.1 Internal Bracing Walls: *4” internal structural bracing walls are inadequate – 6” thick walls should be used.*

5.2 Roof Heights and Pitch: *should be shown; pitch should be between 25° and 35°.*

5.3 Openings: *position and heights should be shown.*

5.4 Floors: *heights above ground should be shown.*

* The finished surface of the floor should be located a minimum of 12” above finished ground level. On a sloping site, the floor should be at least 12” above the ground at any point.

5.5 Materials of Construction: *should be indicated.*

6 Structural Plans

6.1 General:

6.1.1 Strength of Concrete: *should be shown.*

* Concrete to substructure should have a minimum compressive cube strength of 3,000 psi at 28 days, while concrete to superstructure should have a minimum compressive cube strength of 3,750 psi at 28 days.

6.1.2 Reinforcement: *details should be given for all structural elements. Reinforcement should comprise deformed high yield steel bars, with the exception of 3/8” mild steel used for stirrups. It is advisable to use galvanized reinforcing steel to avoid corrosion.*

* All bars should be suitably cranked at the ends.

6.1.3 Cover to Reinforcement: *should be shown for various structural elements.*

* Reinforcement steel (reasonably free of rust) should be positioned within formwork by spacer blocks or plastic spacers to enable correct concrete cover to the steel.

* Minimum concrete covers are for:

- Slabs: 1”
- Beams/Columns: 1-1/2”
- Surfaces in contact with earth: 3”
6.1.4 **Laps and Continuity:** lap lengths and dimensions should be shown.

* Minimum lap lengths for steel reinforcement are for:

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Lap Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8&quot; dia. bars</td>
<td>1'-6&quot;</td>
</tr>
<tr>
<td>1/2&quot; dia. bars</td>
<td>2'-0&quot;</td>
</tr>
<tr>
<td>5/8&quot; dia. bars</td>
<td>2'-6&quot;</td>
</tr>
</tbody>
</table>

6.1.5 **Reinforcement Yield Strengths:** should be shown on the drawings. In accordance with BS 4449:1997 minimum yield strengths should be:

- For deformed high yield bars ('Y' bars): 460 N/mm² (60,000 psi)
- For plain round mild steel bars ('R' bars): 250 N/mm² (33,000 psi)

6.1.6 **Formwork:** the appropriate structural drawings should include the following note:

> “The formwork into which concrete is to be poured shall be strongly constructed of straight timber so braced that no movement or deformation is caused by the wet concrete and normal construction loads”.

* The Building Inspector should verify that the formwork is properly constructed and braced; with close fitting joints to prevent loss of fine aggregate, cement or water through leakage.

* The Building Inspector should verify that forms have been thoroughly cleaned to remove sawdust, bits of wood, wire and other debris, prior to placing of concrete.

6.1.7 **Curing:**

* The Building Inspector should guide the small builder by notifying that, for proper curing, the poured concrete must be kept moist by wetting over the first three days after pouring.

If propriety curing compounds are to be used, the manufacturer’s instructions should be included on the appropriate drawings.

6.2 **Foundations:**

6.2.1 **Foundation Depth(s):** should be shown provisionally on the pre-construction drawing which should include the following note:

> “The foundations should generally be located on a layer of soil or rock with good bearing characteristics”.

* It may be desirable for the Building Inspector to seek the assistance of a qualified Engineer in determining the appropriate level for the foundation.

* Excavations for foundations in rock should be carried out to a minimum depth of 2” to 4” to provide a key for the foundations.

* The Building Inspector should ensure that foundation footings cannot be eroded by storm water, or if near the sea, by high seas or storm surge effects.

6.2.2 **Foundation Sizes:** foundation thickness should be not less than 9”; and its width not less than 24” or a min. of 3 times the width of the wall immediately supported by it.

Separate reinforced concrete columns should be supported by square footings not less than 2'-0" square and 12” thick.
6.2.3 **Foundation Reinforcement:** for strip footings, the minimum reinforcement should comprise 2 No. 1/2” dia. bars placed longitudinally, and 1/2” dia. bars placed transversely at 12” centers. For column footings, the minimum reinforcement should comprise 1/2 “dia. bars at 6” centers in both directions. [Fig. D-3] [Fig. D-2]

6.3 **Beams and Columns:**

6.3.1 **Sizes of Beams & Columns:** the minimum sizes prescribed in the Guidelines relate principally to earthquake resistance and fire protection.

6.3.2 When buildings are to be constructed on steep sites, reinforced concrete beams should be constructed to reduce the un-braced heights of columns to not more than 10 feet. [C- 3.4.1(c)] [Fig. C-6]

6.3.3 **Column Size & Reinforcement:** columns should have minimum dimensions of 8” x 8”; the minimum column reinforcement should be 4 No. 1/2 “dia. bars with 3/8” dia. stirrups (links).

*Note that Fig. D-7 of the Guidelines indicates, in error, use of 1/4” dia. links.*

* The Building Inspector should verify that column link ends are adequately anchored.

6.3.4 The spacing of columns should not exceed 16 feet for masonry walls. [C-3.2.2(a)]

6.3.5 **Column at Door Jamb:** A filled core column or poured concrete column should be placed full height to the ring beam at each door jamb. [D- 3.6 (c)]

6.3.6 **Suspended Beams:** these should be carefully detailed.

* The Building Inspector should verify that beam link ends are adequately anchored; that there is no lapping of bars at/near mid-span of beams; and that there is continuity of column-beam reinforcement.

6.3.7 **Cantilever Beams:** these should be carefully detailed.

* The Building Inspector should verify that cantilever tension reinforcement is adequately anchored (1.5 times the cantilever length).

*Note that Figs. D-13 and D-14 of the Guidelines indicate, in error, use of 5/16” dia. links; these should properly be 3/8” dia. links.*

6.3.8 **Suspended Stairs:** these should be carefully detailed.

* The Building Inspector should verify that exterior stairs to grade are provided with adequate foundations.

When spans exceed 12 ft. in suspended/cantilever beams and suspended stairs, the Building Inspector should verify that a qualified Engineer has been consulted. [D- 4.4 (d)]

6.3.9 **Stripping of Formwork:** the side formwork may be removed from the fresh concrete in 24 hours; the bottom forms and props for suspended beams shall remain in place for not less than 14 days. [D- 2.8]
6.4 Concrete Floors:

6.4.1 **Base Preparation for Slabs on Grade:** care should be exercised in the removal of all unsuitable soils within the building perimeter.

Concrete floors should be supported on not less than 8” of well compacted marl, gravel or approved granular material

Where fills greater than 3 feet are required, the floor should be constructed as a suspended reinforced concrete slab.

6.4.2 **Floor Geometry:** concrete floors on grade must be a minimum of 4” thick.

Edge details should be carefully shown on the drawings.

6.4.3 **Floor Elevation:** As a protection against flooding, the finished surface of the floor should be located a minimum of 12” above finished ground level. On a sloping site, the floor should be at least 12” above the ground at any point.

6.4.4 **Reinforcement of Slabs on Grade:**

* Concrete slabs on grade should be reinforced with welded wire mesh (A142 or equivalent 6” mesh) placed 1” below the slab surface. Minimum laps in the mesh should be 6”.

* Spacers should be used to ensure proper (1”) cover to the mesh reinforcement.

Welded wire mesh shipped from the factory in rolls should be discouraged; the use of mesh provided in flat sheets should be encouraged.

6.4.5 **Reinforcement of Suspended Floors:** these should be carefully detailed. The drawings should include a slab reinforcement plan.

When spans exceed 12 ft. in suspended floor slabs, the Building Inspector should verify that a qualified Engineer has been consulted.

6.4.6 **Openings in Slabs:** structural drawings should show reinforcement arrangement and details.

* These should comprise 1/2” dia. bars, minimum 48” in length, placed at the top and bottom of the slab, at the four corners of the opening, and oriented at 45° to the sides of the opening.

6.4.7 **Services:** the appropriate structural drawings should include the following note:

“All concealed pipes and conduits for services must be so arranged that the required concrete cover to the reinforcement is maintained”.

6.5 Concrete Block Walls:

6.5.1 **Strength:** this should be specified for the blocks and for the mortar.

The appropriate structural drawings should include the following note:

All hollow concrete blocks shall conform to the compulsory Grenada National Standard GDS 6: 1992 “Specification for Hollow Concrete Blocks”.

6.5.2 **Internal Bracing Walls:** 4” internal structural bracing walls are inadequate – 6” thick walls should be used. The maximum length of an un-braced wall should be 25 ft.
6.5.3 **Block Laying:**

* All walls should be tied to columns or to reinforced corners every three courses. 

The appropriate structural drawings should include the following note:

“Horizontal and vertical mortar joints should be an average thickness of 1/2” and must be properly filled with mortar”.

6.5.4 **Block Wall Reinforcement:** Block wall reinforcement details, including details for wall openings, should be shown on the structural drawings.

6.5.5 **Vertical Reinforcement:** Minimum vertical reinforcement is as follows:

* 3 No. 1/2” dia. bars at corners, tied with 1/4” links every third course. 
* 4 No. 1/2” dia. bars at junctions tied with 1/4” links every third course. 
* 2 No. 1/2” dia. bars at jambs of doors and windows. 
* Throughout the block walls, 1/2” dia. bars spaced as follows:

<table>
<thead>
<tr>
<th>Block Size</th>
<th>Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>4” blocks</td>
<td>48”</td>
</tr>
<tr>
<td>6” blocks</td>
<td>32”</td>
</tr>
<tr>
<td>8” blocks</td>
<td>24”</td>
</tr>
</tbody>
</table>

6.5.6 **Horizontal Reinforcement:**

* This should comprise “Brickforce” (or equivalent) every third course.

6.5.7 **Block Cores:** reinforced block cores for 6” and 8” blocks should be filled with 1:2:4 nominal mix concrete, every three courses. Reinforced block cores for 4” blocks should be filled with grout or fine aggregate concrete.

* Concreting should be stopped 1-1/2” below the top of the block to form a key at joints. 
* The Building Inspector should verify that vertical wall reinforcement is securely anchored in the wall footing below and the ring beam above.

6.5.8 **Lintels:** reinforced concrete lintels must span all window and door openings, extended beyond the jambs not less than 8”.

* Lintels should be 8” deep, with 4 No. 5/8” dia. bars and 1/4” dia. links at 9” centers.

When lintel spans exceed 8 ft. the Building Inspector should verify that a qualified Engineer has been consulted.

6.6 **Ring Beam:** all walls should be finished at the top by a reinforced concrete ring beam no less than 8” in depth (and preferably 9”).

* The minimum ring beam reinforcement should be:

  For an 8” thick wall: 4 No. 1/2” dia. bars with 1/4” dia. links at 9” centers. 
  For an 6” thick wall: 2 No. 1/2” dia. bars with 1/4” dia. links at 9” centers. 

Consideration should be given to use of 3/8” dia. links in place of 1/4” dia. links. 

* The Building Inspector should verify that there is adequate ring beam/rafter connection.
6.7 Roof:

6.7.1 Materials: the timber used for roof construction shall be well seasoned, straight, sound and pressure treated to resist termites. [D-5.1 (c)]

6.7.2 Timber Roof Frames:

* The frame should comprise minimum 2” x 6” rafters at maximum 24” centers, with minimum 2” x 8” ridge board and hip rafters (where applicable).

* Eaves should have a maximum projection of 18”.

* The preferred method of connection of the rafters to the ring beam is by use of patented galvanized steel straps used with nails or screws supplied for use with these products. Reinforcing rods bent around notched rafters is not the preferred method.

* Timber to timber (rfter to ridge board) connections should be made stronger with patented galvanized steel straps used with nails or screws supplied for use with these products.

* The roof frame can be strengthened further by use of 2” x 6” timber collars fixed to alternate pairs of common rafters with 2 No. 1/2” dia. zinc plated bolts and washers. [Fig.C-10 (D)]

6.7.3 Plywood sheathing: where plywood (or groove-and-tongue) sheathing is used in exposed rafter construction, connection or fixing details should be carefully shown on the drawings.

6.7.4 Purlins: the drawings should include a roof plan showing arrangement and fixing details for timber purlins or laths.

* Purlins should be fixed at a maximum spacing of 36” generally, and 18” at the eaves, verge and ridge.

* Where timber sheathing is employed, purlins should be fixed through the sheathing into the rafters. [C-3.4.2(b)]

6.7.5 Roof Cladding: the drawings should include a roof plan showing thickness, profile and fixing details for the roof sheeting.

The appropriate structural drawings should include the following note:

All corrugated galvanized and aluzinc coated steel sheets shall conform to the compulsory Grenada National Standard GDS 78: 2005 “Specification for Corrugated Galvanized and Aluminium and Zinc (Aluzinc) Coated Steel Sheets for Roofing and General Purposes”.

* Sheeting thickness should be shown in decimal fractions of millimeters or inches, in addition to gauge measurements.

* Sheeting should be fixed to the purlins at 12” centers generally, and at 6” centers at the eaves, verge and ridge.
6.7.6 **Gable Walls:** where employed, gable wall reinforcement details should be shown on the structural drawings.

* Vertical reinforcement should comprise 3/8" dia. bars at 24" centers fixed in the ring beam below and minimum 6" x 6" reinforced concrete capping beam above.

Roof details can be found at the “Guidelines for Hurricane-Resistant Re-Roofing of Small Buildings”, Government of Grenada Disaster Assessment and Recommendation Committee, 2004.

6.7.7 **Suspended Roof Slabs:** these should be carefully detailed. The drawings should include a slab reinforcement plan.

When spans exceed 12 ft. in suspended roof slabs, or when supported differently to that shown in Table D-2, the Building Inspector should verify that a qualified Engineer has been consulted.

7 **Plumbing, Sanitation & Water Supply**

7.1 **Plumbing & Sanitation:**

* The Building Inspector should ensure that the plumbing workmanship is sound, that sewer and potable water lines are not laid in the same trench, and the possibility of cross connections between water and waste lines is avoided.

* The Building Inspector should verify that all waste pipes are trapped and vented in accordance with the provisions of the Guidelines.

* The Building Inspector should verify that septic tanks are constructed in strict compliance with the approved drawings (where required, in collaboration with the Environmental Health Department of the Ministry of Health), and that septic tanks and disposal systems are located a minimum of 10 feet from any dwelling house or property line.

7.2 **Water Supply:** construction details for a water storage cistern should be shown on the drawings; washout valve(s) should be included to facilitate cleaning of the cistern.

When water storage cisterns exceed the dimensions of that shown in the Guidelines (Fig. H-4), the Building Inspector should verify that a qualified Engineer has been consulted.

8 **Final Inspection**

* The Building Inspector should conduct the final inspection with the Builder present, and should verify that the building has been constructed in accordance with the approved plans. The inspection should include all elements of the house including building structure and roof, electricity, sewage disposal, water supply and drainage.

If the final inspection shows that the building construction is satisfactory, and the necessary Certificate has been issued by the Electrical Inspector in respect of the electrical works, and upon application therefor, the Authority shall issue a Certificate of Occupancy for the building.
9 Safety & Health

* The Building Inspector should be aware of the provisions of Section J of the Guidelines *Precautions During Building Construction*, and ensure that builders comply with the provisions where applicable. Particular attention should be paid to the following on site:

- Wearing of eye/face, head, hearing, hand, toe and respiratory protective gear by workers;
- Safe erection, use and maintenance of scaffolds, ramps and ladders;
- Sanitation and general cleanliness;
- Electricity lines, cords and other potential hazards;
- Excavations, 5 feet or more in depth, where workers are employed; and
- Storage of construction materials, in particular hazardous materials.