GENERAL BUILDING CONSIDERATIONS FOR

BUILDING BACK BETTER

Prepared by
the Building & Development Services Department of
The Grand Bahama Port Authority

version 1.0

Introduction

On September 2nd, 2019, Hurricane Dorian landed on the island of Grand Bahama impacting the island for two days. A number of structures were impacted as a result of record-breaking surge events. In response to the natural disaster the Building Department engaged immediately in conducting assessments, meeting with engineers, architects, contractors and sub-contractors in the construction industry, and tapping into the expertise of the Global Network of Engineers Without Borders.

As a result of the above interactions, basic recommendations were collated to provide considerations for the construction industry and residents seeking to build back better, safer and stronger. The recommendations are not intended to be all inclusive, but cover a gamut of elements for structural, mechanical, electrical and plumbing considerations in rebuilding.

Cognizant that some of the recommendations have not been mandated by law, the recommendations are offered for the consideration of residential and commercial development to make improvements where possible with the mind frame that the increased intensity and frequency of storms are possible. Thus, all elements that can be impacted by wind and water must be considered. To this end, the recommendations will also be shared at the national level to further the discussion on strengthening the Bahamas Building Code as well as the Grand Bahama Port Authority, Building and Sanitary Code (2010).

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GENERAL BUILDING & STRUCTURAL CONSIDERATIONS FOR REBUILDING

A. Retrofitting Methods for Flooding (per ASCE 24-14 or the most widely adopted standards for the industry)

There are ***six retrofitting methods*** for you to consider as you think about how to protect your home from flooding:

1. **Elevation** – Raising your home so that the lowest floor or lowest horizontal member is at or above the regulated flood level. You can accomplish this in several ways.

   Elevating a home to prevent floodwaters from reaching living areas is an effective retrofitting method. The goal of the elevation process is to raise the lowest floor to or above the Design flood elevation (**DFE**). You can do this by elevating the entire home, including the floor, or by leaving the home in its existing position and constructing a new raised floor within the home. The method used depends largely on construction type, foundation type, and flooding conditions.

   Method #1: Elevating on Continuous Foundation Walls (see Fig. 1 & 2 below)

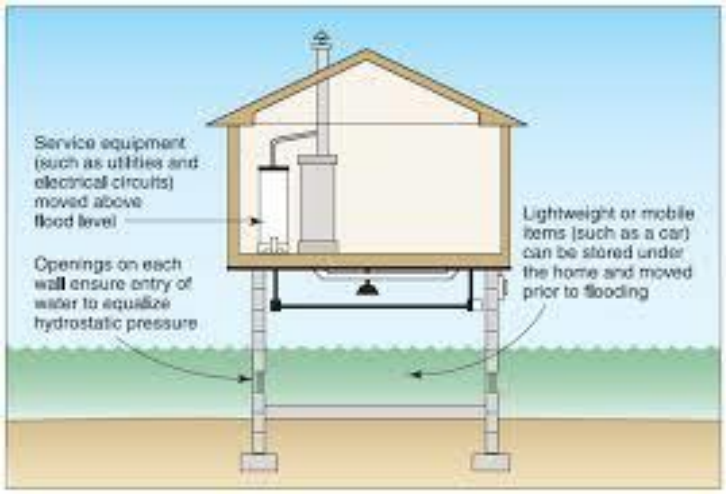
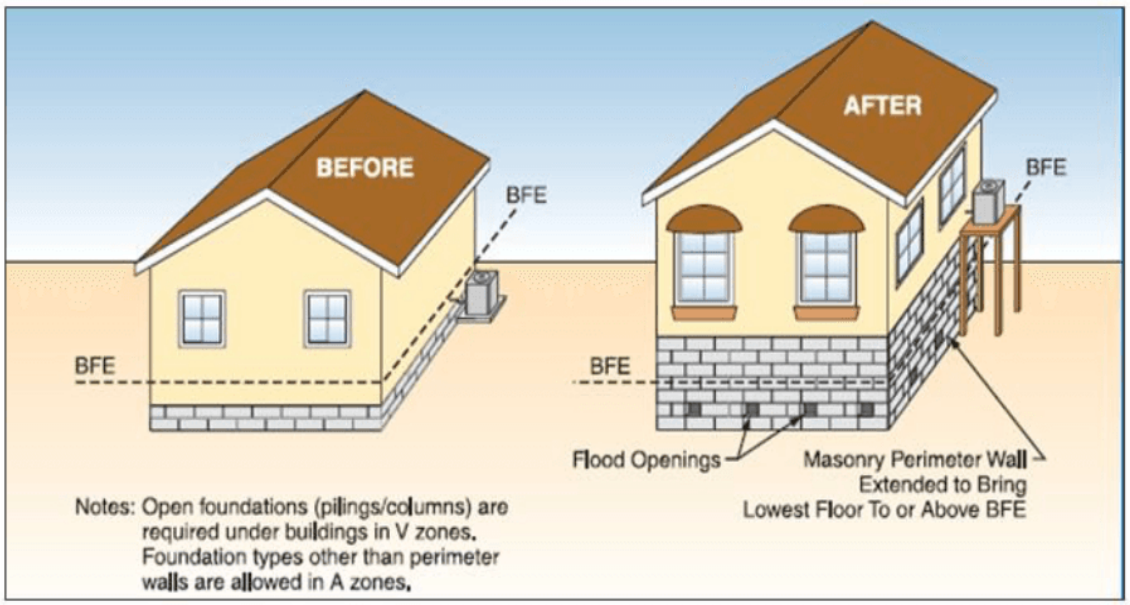


   Figure 1. Typical cross-section of home elevated on continuous foundation walls.



FEMA Substantial Improvement/Substantial Damage Desk Reference, Figure 6-1

Figure 2. Before (left) and after (right) photos of a retrofitted home elevated on extended continuous foundation walls.

Method #2: Elevating on Open Foundations [Piers (or columns), Posts, Piles]

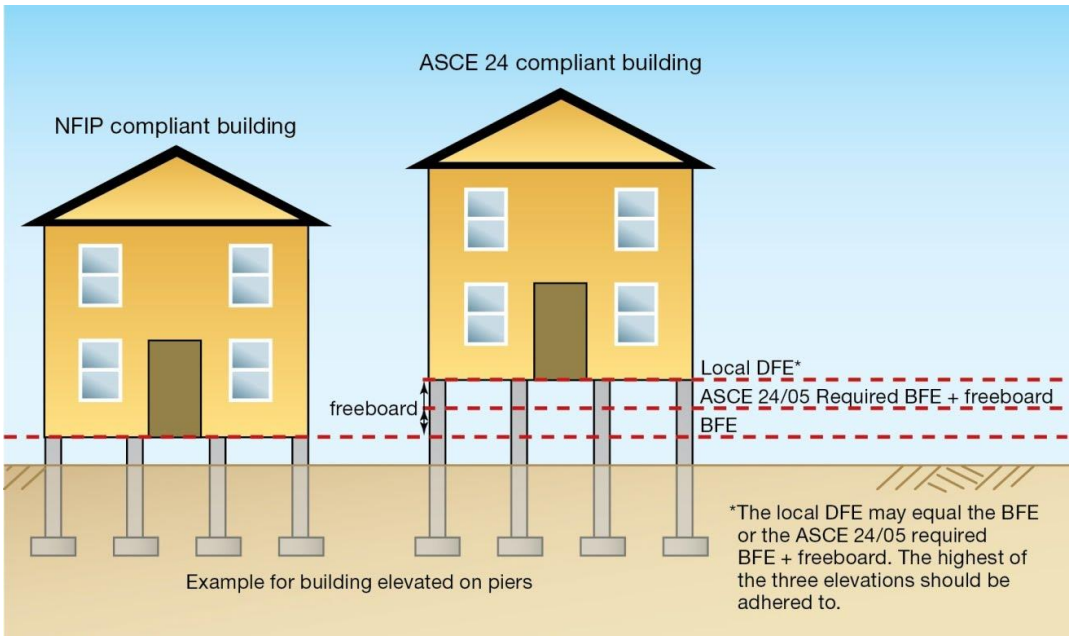


Figure 3. Home elevated on reinforced concrete piers.

Figure 4. Example of a Home elevated on reinforced concrete piers / stilts that survived Hurricane Dorian.

Methods #3 and #4: Elevating by Extending the Walls of the Home or Moving the Living Space to an Upper Floor.

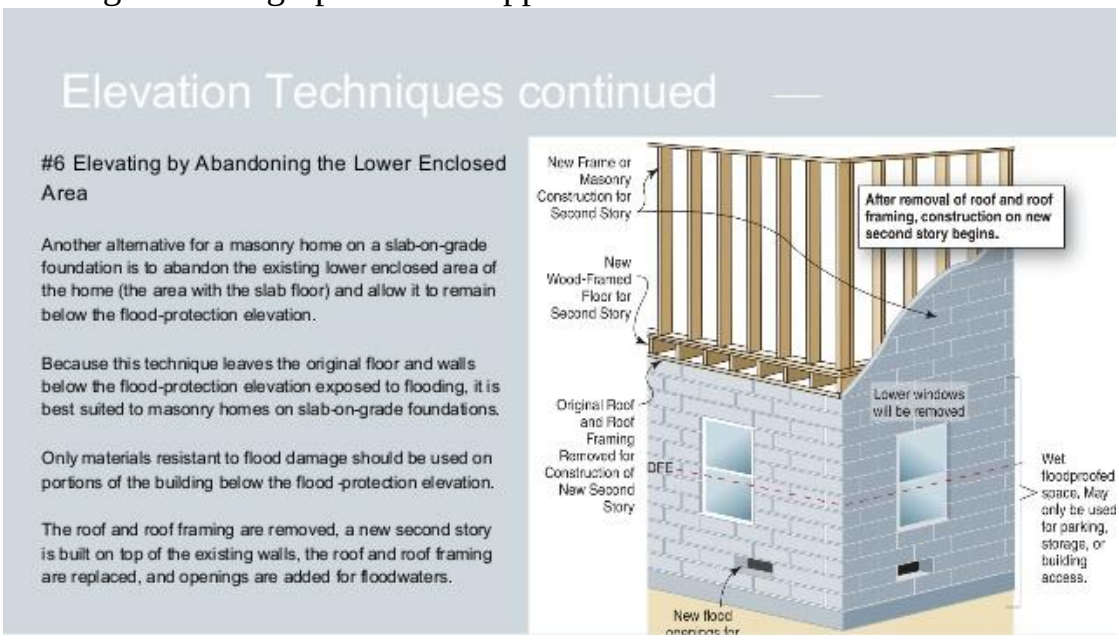


Figure 6. Home elevated by adding a new second story over an abandoned lower floor.

2. **Relocation** – Moving your home to higher ground where it will reduce the exposure to flooding.
3. **Demolition** – Tearing down your damaged home and either rebuilding on the same property or buying or building a home elsewhere.
4. **Wet Floodproofing** – Making portions of your home resistant to flood damage and allowing water to enter during flooding.

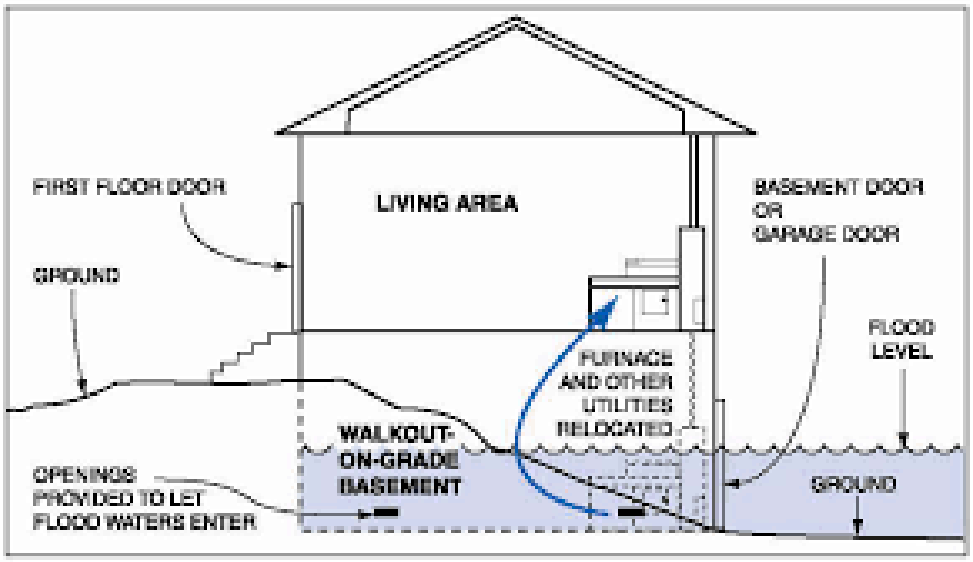


Figure 7. A home with a wet floodproofed enclosure. Note: Interior grade must be at or above the exterior grade along the entire length of the lowest side to prevent being a basement. *** Base flood elevation (BFE).**

5. **Dry Floodproofing** – Sealing your home to prevent floodwaters from entering.
6. **Barrier Systems** – Building a floodwall or levee around your home to restrain floodwaters.

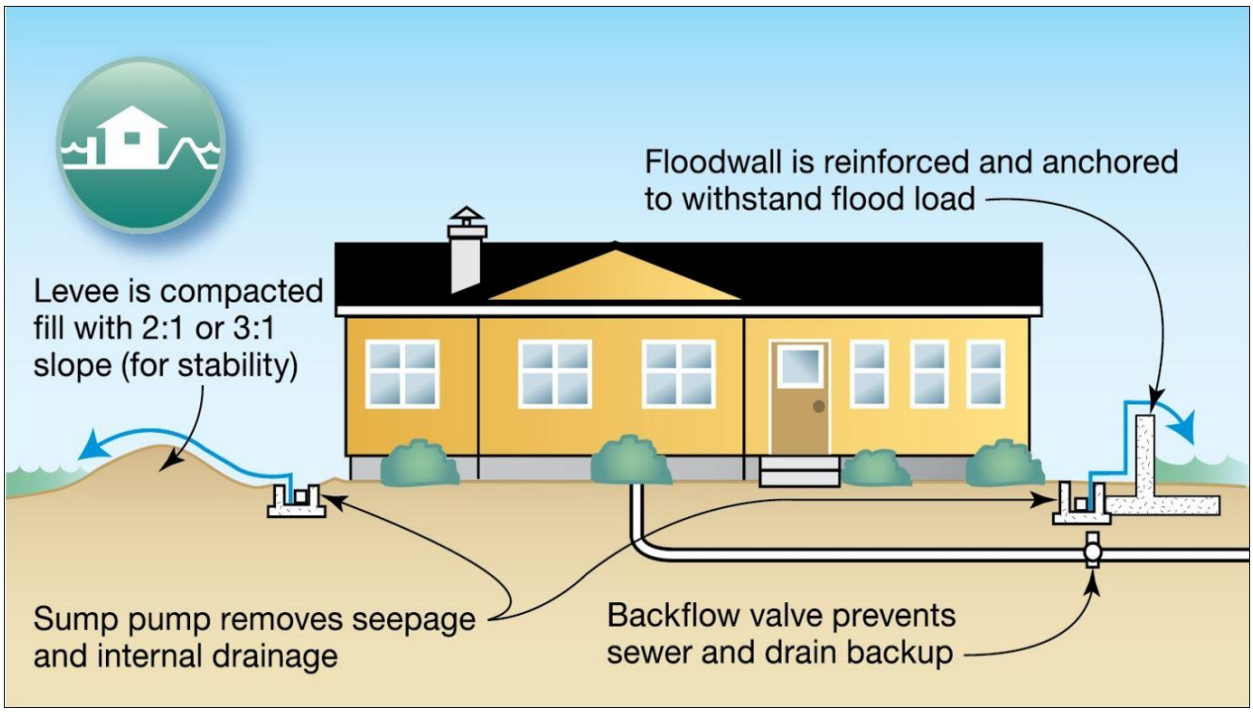


Figure 8b. Levee & Flood wall protection example.

Figure 8c. Levee & Flood wall protection example.

Table 1. Flood Damage-Resistant Materials

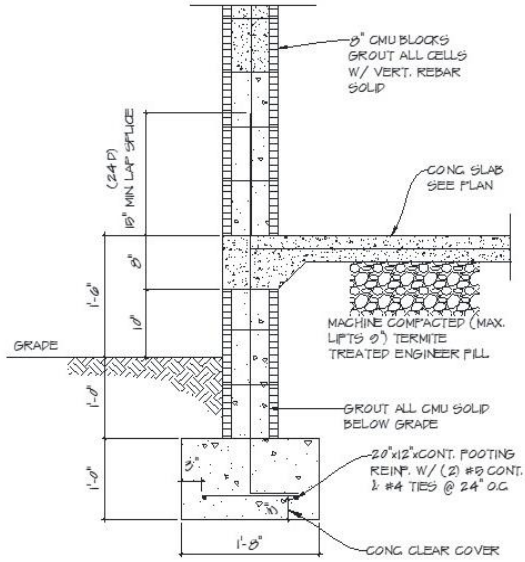
Material Type	Acceptable	Unacceptable
Structural Flooring Materials	• Concrete • Naturally decay-resistant lumber • Pressure-treated plywood	• Engineered wood or laminate flooring • Oriented-strand board (OSB)
Finish Flooring Materials	• Clay tile • Ceramic or porcelain tile • Terrazzo tile • Vinyl tile or sheets	• Engineered wood or laminate flooring • Carpeting • Wood flooring
Structural Wall and Ceiling Materials	• Brick face, concrete, or concrete block • Cement board / fiber cement board • Pressure-treated plywood • Solid, standard structural lumber (2x4) • Non-paper-faced gypsum board	• Fiberglass insulation • Paper-faced gypsum board • OSB
Finish Wall and Ceiling Materials	• Glass blocks • Metal cabinets or doors • Latex paint	• Wood cabinets and doors • Non-latex paint • Particleboard cabinets and doors • Wallpaper

B. <u>Retrofitting Methods for building damage repairs</u>

1. For new or re-build construction, pay attention to building shapes and make use of smaller more compact buildings or buildings without excessively large surface areas for better wind resistant.

2. For Insulated Concrete Form (I.C.F.) construction, wall thickness with inner concrete core to be equal to or greater than six (6) inches with adequate rebar splicing for Flood Prone areas.

3. Floor fill material below slab-on-grade to be installed in well-compacted layers (max. 9” lifts) to prevent floor from falling below its original elevation when fill material becomes saturated under intense rain and/or flooding conditions.



8" CMU WALL & SLAB, CONT. / SPREAD FOOTING

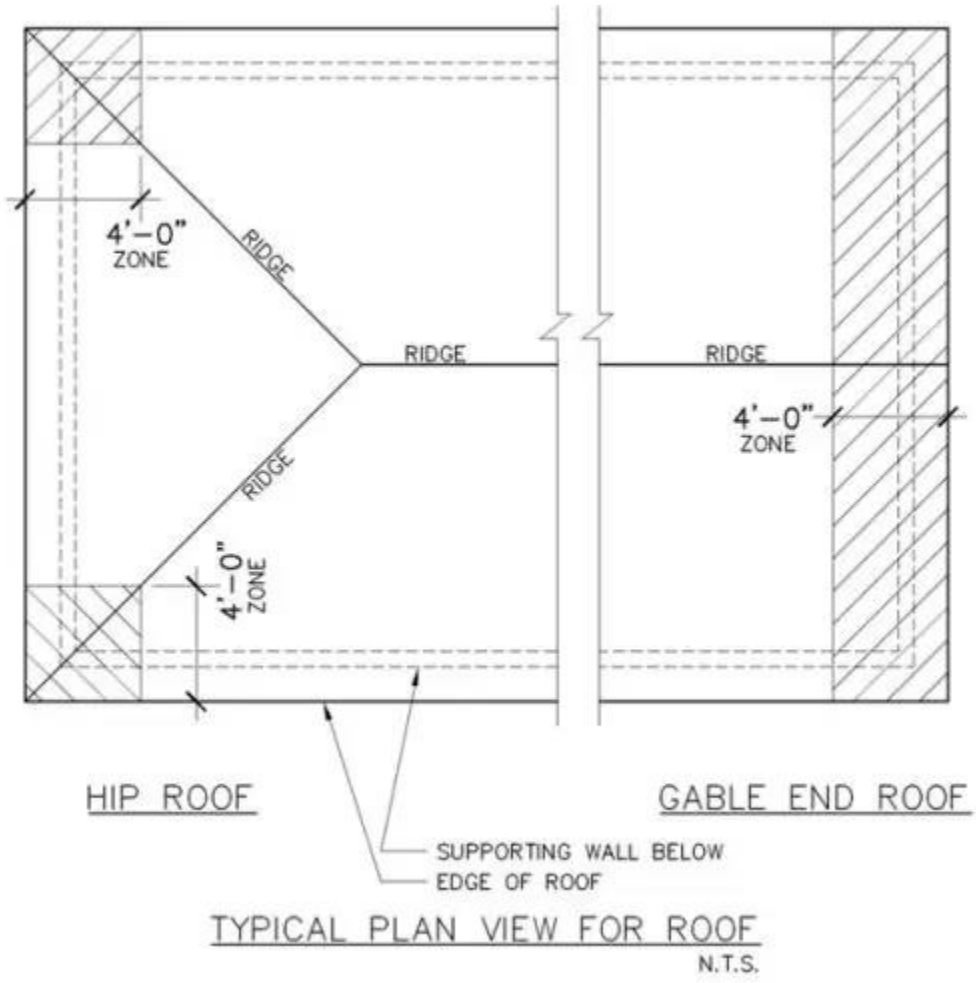
4. Grout 8” CMU block cells below grade with concrete.

5. Add reinforcement (rebars) to 8” CMU block cells with concrete below and above grade level at exterior building stem-walls at maximum 32” on center between Tie-Columns and anchor rebars into Foundation Footings and Tie-Beams. This will strengthen exterior walls and prevent masonry wall collapse during flooding or extremely high velocity wind conditions. Minimum Rebar Splice 24 x Bar Diameter. (Recommend 48 x Bar Diameter in areas subject to levels exceeding 3 ft and extremely turbulent storm surges).

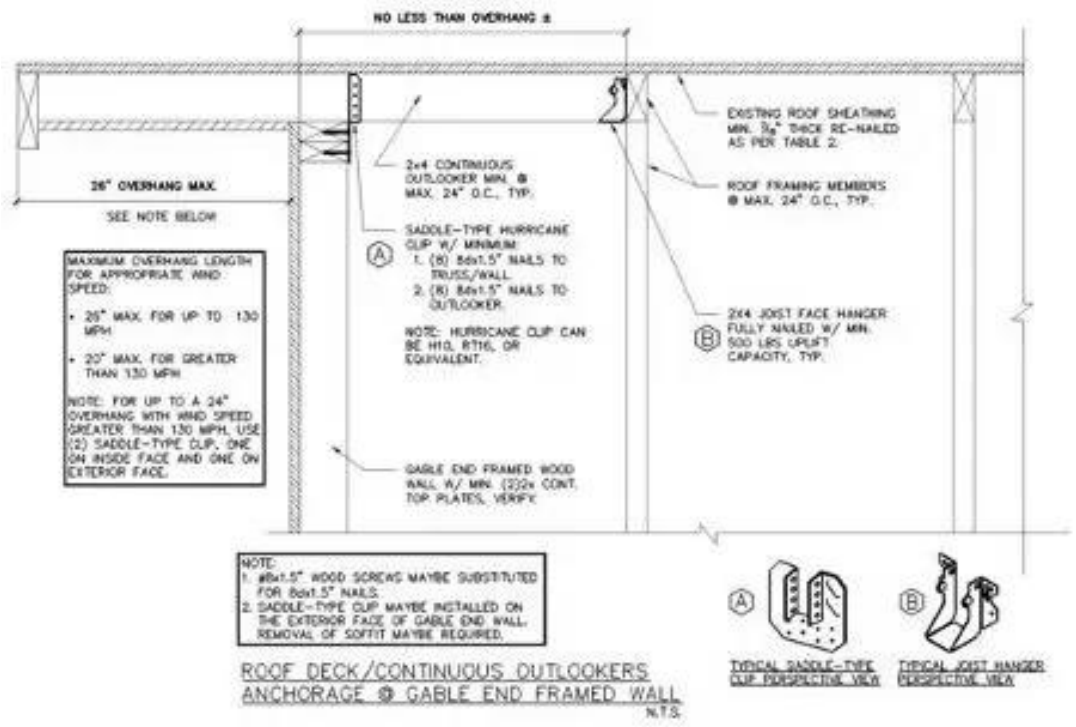
6. Include attic access in roof space with a pull-down ladder, and comfortable sitting/sleeping space.

7. Consider escape hatch in roof attic spaces and ensure that the hatch is adequately sealed against moisture penetration.

8. Avoid Gable-End roof designs as they are more susceptible to wind failures. If Gable-End roofs are unavoidable, ensure that they are adequately braced and strapped to prevent or minimize wind failures. Gable-end walls are best constructed of reinforced masonry material.



TYPICAL PLAN VIEW FOR ROOF
N.T.S.



9. Roof framing to have adequate hurricane strapping, girder-truss bolting, web bracing and roof top fastening. Recommend deck to be secured with either ring-shank nails or screws, especially along eaves edge and ridges of roofs.

10. Recommend using (peel-n-seal) roof membrane/moisture barrier verses felt paper.

11. Consider escape hatch in roof attic spaces and ensure that the hatch is adequately sealed against moisture penetration.

12. Finish roof covering to be installed per manufacturer's specifications.

13. Install hurricane impact resistant windows and patio doors or hurricane shutters for high velocity wind protection.

14. Ensure that replaced windows and doors are adequately sealed during installation.

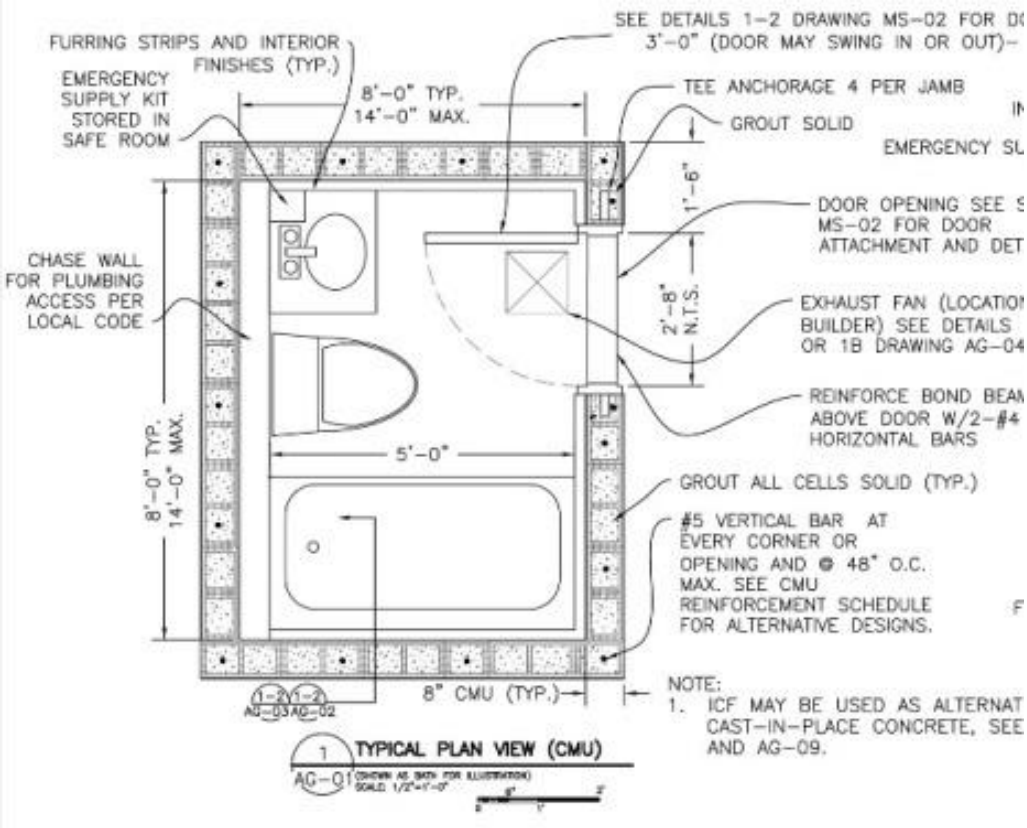
15. Avoid use of vinyl soffits without adequate base supports.

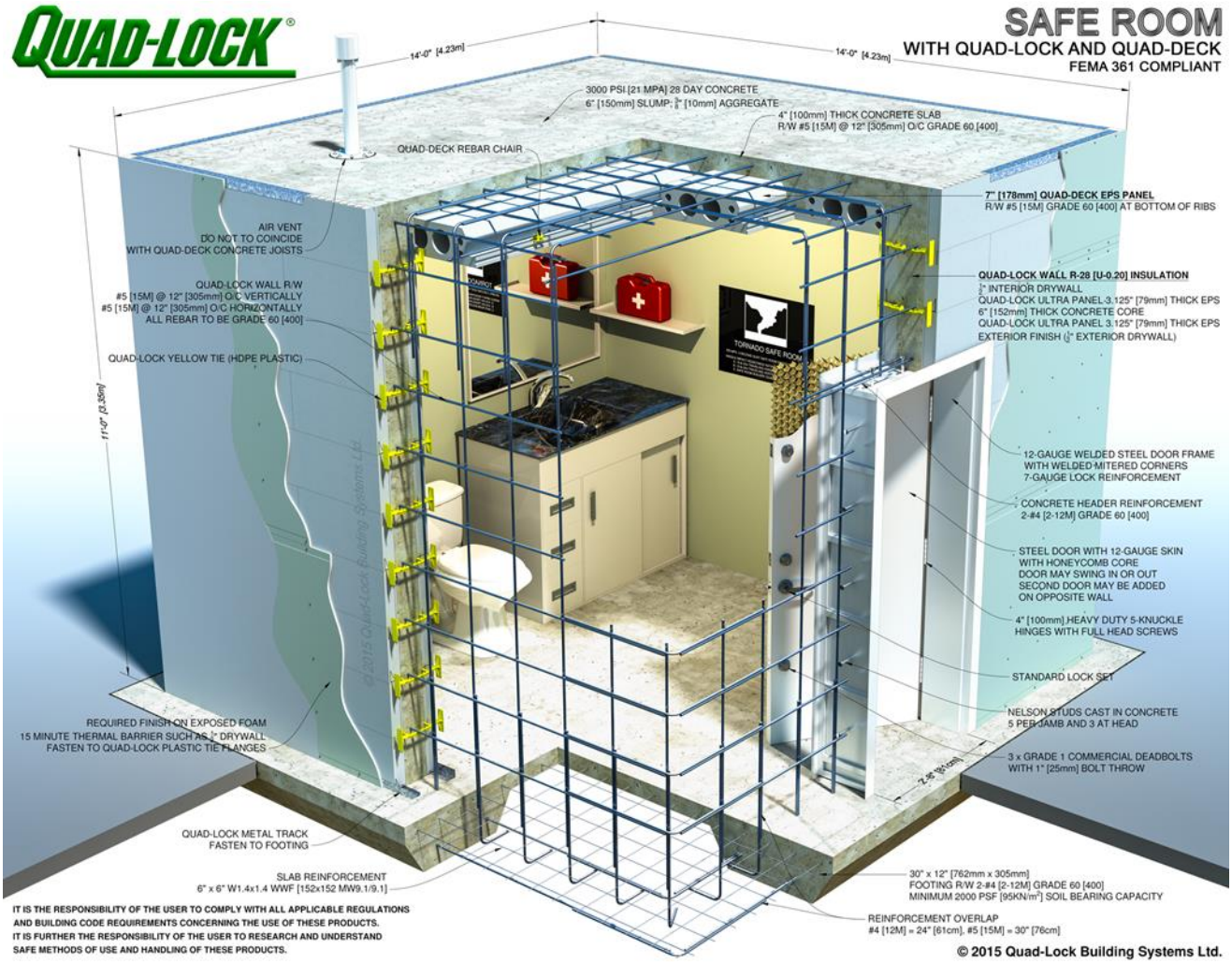
16. For interior building material replacement, use materials recommended in **Table 1** Flood Damage-Resistant Materials to reduce time for future mold remediation.

17. Where light-guage steel is used for interior or exterior wall framing, ensure that they are installed to manufacturer's specs, adequately braced and material use suited for saline conditions.

18. Apply corrosion resistant treatment to reinforcement in saline environments. Ensure reinforcement is provided with adequate concrete clear cover as per design or engineering specifications.

19. Consider adding a Safe Room by modifying existing space such as Bathroom or Closet to retrofit.




QUAD-LOCK®
SAFE ROOM
WITH QUAD-LOCK AND QUAD-DECK
FEMA 361 COMPLIANT
14'-0" [4.23m]
14'-0" [4.23m]
11'-0" [3.35m]
3000 PSI [21 MPA] 28 DAY CONCRETE
6" [150mm] SLUMP; ⅜" [10mm] AGGREGATE
4" [100mm] THICK CONCRETE SLAB
R/W #5 [15M] @ 12" [305mm] O/C GRADE 60 [400]
QUAD-DECK REBAR CHAIR
AIR VENT
DO NOT TO COINCIDE
WITH QUAD-DECK CONCRETE JOISTS
QUAD-LOCK WALL R/W
#5 [15M] @ 12" [305mm] O/C VERTICALLY
#5 [15M] @ 12" [305mm] O/C HORIZONTALLY
ALL REBAR TO BE GRADE 60 [400]
QUAD-LOCK YELLOW TIE (HDPE PLASTIC)
REQUIRED FINISH ON EXPOSED FOAM
15 MINUTE THERMAL BARRIER SUCH AS ½" DRYWALL
FASTEN TO QUAD-LOCK PLASTIC TIE FLANGES
QUAD-LOCK METAL TRACK
FASTEN TO FOOTING
SLAB REINFORCEMENT
6" x 6" W1.4x1.4 WWF [152x152 MW9.1/9.1]
7" [178mm] QUAD-DECK EPS PANEL
R/W #5 [15M] GRADE 60 [400] AT BOTTOM OF RIBS
QUAD-LOCK WALL R-28 [U-0.20] INSULATION
½" INTERIOR DRYWALL
QUAD-LOCK ULTRA PANEL 3.125" [79mm] THICK EPS
6" [152mm] THICK CONCRETE CORE
QUAD-LOCK ULTRA PANEL 3.125" [79mm] THICK EPS
EXTERIOR FINISH (½" EXTERIOR DRYWALL)
12-GAUGE WELDED STEEL DOOR FRAME
WITH WELDED MITERED CORNERS
7-GAUGE LOCK REINFORCEMENT
CONCRETE HEADER REINFORCEMENT
2-#4 [2-12M] GRADE 60 [400]
STEEL DOOR WITH 12-GAUGE SKIN
WITH HONEYCOMB CORE
DOOR MAY SWING IN OR OUT
SECOND DOOR MAY BE ADDED
ON OPPOSITE WALL
4" [100mm] HEAVY DUTY 5-KNUCKLE
HINGES WITH FULL HEAD SCREWS
STANDARD LOCK SET
NELSON STUDS CAST IN CONCRETE
5 PER JAMB AND 3 AT HEAD
3 x GRADE 1 COMMERCIAL DEADBOLTS
WITH 1" [25mm] BOLT THROW
2'-6" [81cm]
30" x 12" [762mm x 305mm]
FOOTING R/W 2-#4 [2-12M] GRADE 60 [400]
MINIMUM 2000 PSF [95KN/m²] SOIL BEARING CAPACITY
REINFORCEMENT OVERLAP
#4 [12M] = 24" [61cm], #5 [15M] = 30" [76cm]
IT IS THE RESPONSIBILITY OF THE USER TO COMPLY WITH ALL APPLICABLE REGULATIONS
AND BUILDING CODE REQUIREMENTS CONCERNING THE USE OF THESE PRODUCTS.
IT IS FURTHER THE RESPONSIBILITY OF THE USER TO RESEARCH AND UNDERSTAND
SAFE METHODS OF USE AND HANDLING OF THESE PRODUCTS.
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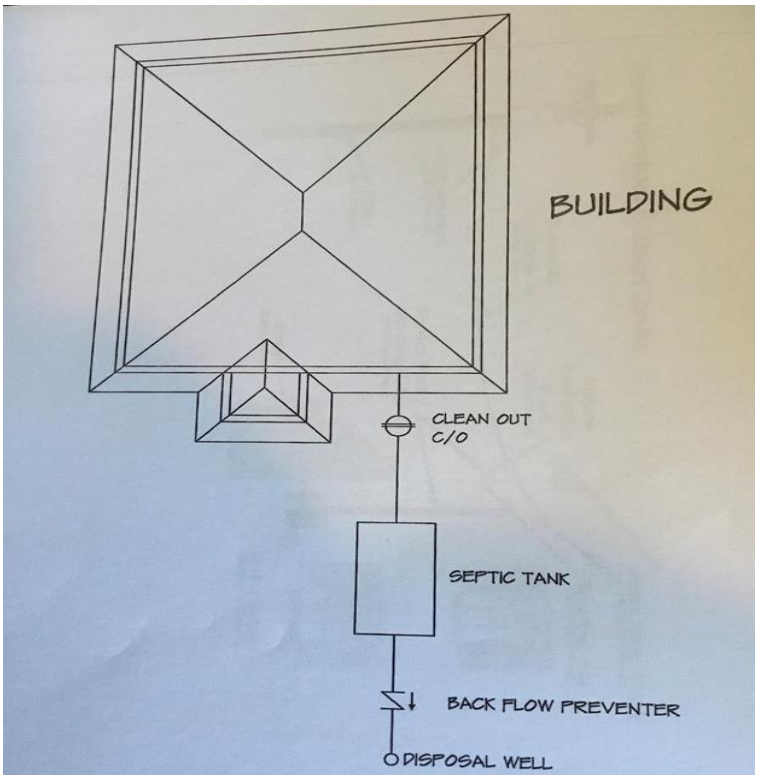
PLUMBING CONSIDERATIONS FOR REBUILDING

The following are recommendations to assist in the plumbing system for consideration:-

(1) Dwelling homes and businesses should be designed with the option to accommodate water reservoir/holding tanks, which can be used as a reserved method for water usage after hurricanes in event the Grand Bahama Utility Company, (GBUC), encounter malfunction of their equipment.

(2) Installation of backflow preventer devices to connect at the discharge pipe of the septic tank and disposal well which will prevent water from entering back into the septic tank and in turn through the plumbing fixtures in the building.

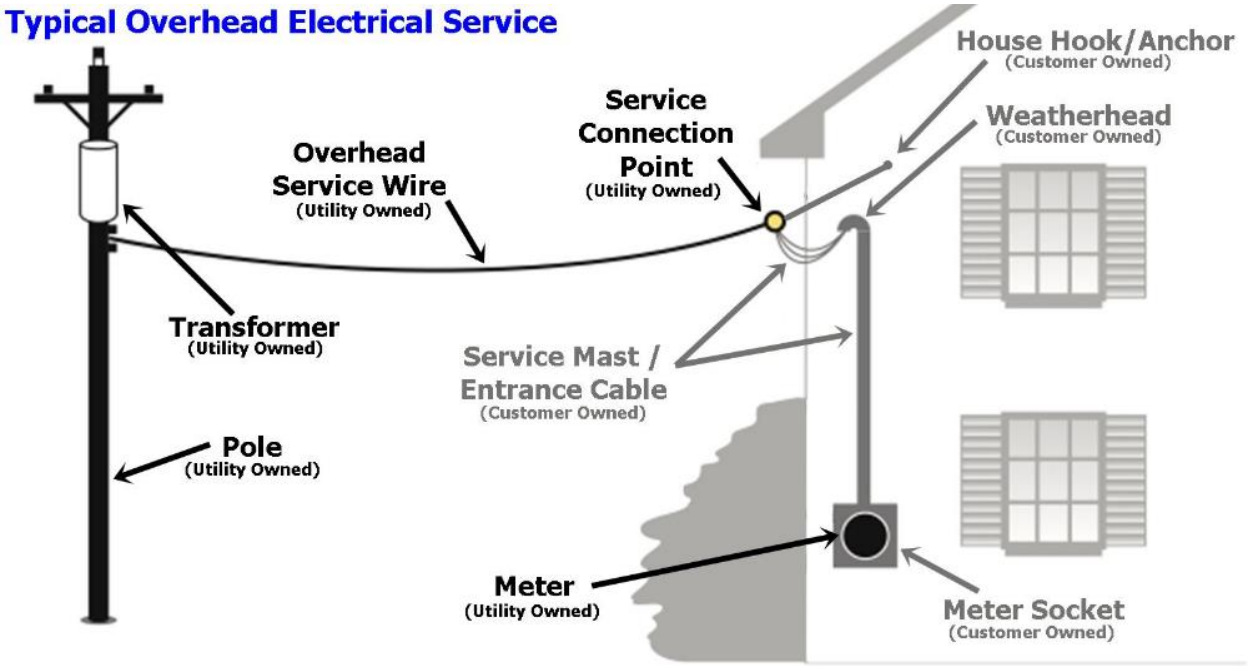
(3) All domestic water wells should be properly case and sealed off to avoid contaminating of the fresh water lens.



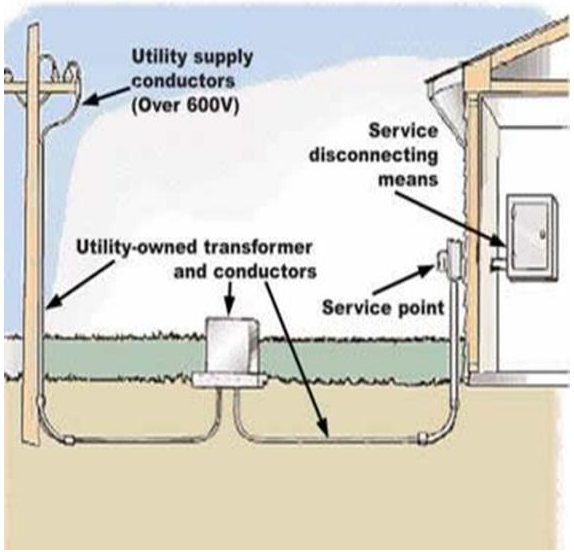
Back Flow Preventer Diagram

ELECTRICAL CONSIDERATIONS FOR REBUILDING

Typical Service to Residence



Basic Underground Service



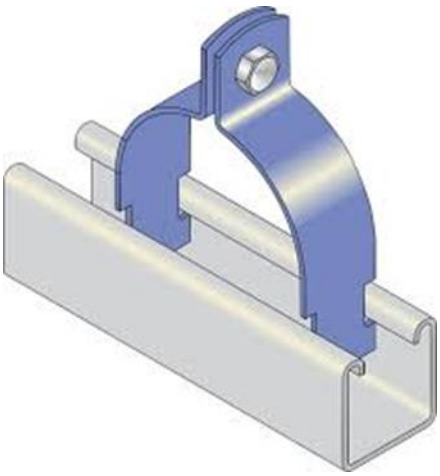
Considerations:

1. Underground services can be vulnerable to flood waters

- The need to drain services conductor (Pipe)
- Possibility of changing service equipment due to being damaged by debris (When mounted on boundary walls)
- May have to change conductors if damaged

2. Overhead services can be vulnerable to high winds

- Service mast (pipe) bend/pulled down
- Strap mast using Unistrut straps (angle iron/u-bar)



3. If possible, install electrical conduits (pipes) within a building (home) overhead instead of underground, including the pipe coming from the disconnect to the breaker panel box.

If having to deal with flood waters this will eliminate the need to have standing water removed from conduits.

4. Continue with the use of Copper conductors (wires) verses Aluminum conductors.

- Copper is a better conductor of electricity
- Doesn't contracts (expands) like aluminum

5. Use anti-seize lubricant on all wire terminations in the service equipment.

Note:

- All electrical boxes, panel boards, meter cans, disconnects, and equipment, must be accessible at all times.
- Meter Cans, plugs and switches must be accessible for use

MECHANICAL CONSIDERATIONS FOR REBUILDING

1) Install all exterior mechanical equipment and structures above the recommended flood level.

2) Ensure all mechanical equipment i.e. air conditioning condensing units, LP gas storage tanks, and generators are securely fastened to the structures on which they sit.

3) Install mechanical equipment in a way that will prevent them from coming into contact with trees and other vegetation.

4) Specify paints and coatings that would protect mechanical equipment from the Marine Environment (Salt Spray).

5) The practice of installing elevator mechanical equipment below the ground floor should be reconsidered, and as an alternative install the mechanical equipment on the roof instead.

6) Install and seal electrical service underground. Meter can be located above recommended flood level.

Examples of elevated Condenser Units


SAMSUNG
SAMSUNG

Examples of elevated Generator

REFERENCES & SOURCES:

FEMA 3-93: Non-Residential Floodproofing for Buildings Located in Special Flood Hazard Areas in Accordance with National Flood Insurance Program

FEMA P-55: Coastal Construction Manual

FEMA 102: Floodproofing for Non-Residential Structures

FEMA 259: Engineering Principles and Practices of Retrofitting Floodprone Residential Structures

FEMA FL-RA1: Dry Floodproofing Operational Considerations

gov

ASCE 24-14: Flood Resistant Design

ASCE 7-10: Minimum Design Loads for Buildings and Other Structures