APPENDIX A: Construction Standards (FNSBC 15.04.110)

A. No person *shall* construct or substantially improve any *structure* within a *special flood hazard area* that is not in compliance with this section.

B. **General Construction Standards**. All *new construction* or *substantial improvements* to a *structure shall* be constructed using methods and practices that minimize *flood* damage and comply with the following standards:

1. *Structures shall* be constructed with electrical, heating, ventilation, plumbing and air conditioning equipment and other service facilities that are designed or located so as to prevent water from entering or accumulating within the components during conditions of *flooding*.

2. Fuel storage tanks and other liquid storage tanks *shall* be secured to prevent disturbance by floodwater. Buried tanks *shall* be secured to a concrete base slab of sufficient volume to prevent flotation or otherwise adequately secured. Both fill and vent pipes *shall* extend at least one foot above the *base flood elevation*.

3. On-site waste disposal systems *shall* be designed to minimize or eliminate infiltration of floodwaters into the systems and discharges from the systems into floodwaters and *shall* be located to avoid impairment to them or contamination to them during *flooding*.

4. All *new construction* and *substantial improvements* (including the placement of prefabricated buildings and *manufactured homes*) *shall* be designed (or modified) and adequately anchored to prevent flotation, collapse or lateral movement of the *structure* resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy.

5. All *new construction* and *substantial improvements* below the *base flood elevation shall* be constructed with materials resistant to *flood* damage.

6. New and replacement water supply systems *shall* be designed to minimize or eliminate infiltration of *flood* waters into the systems.

C. **Residential *Structures***. All *new construction* of and *substantial improvements* to residential *structures shall* have:

1. The *lowest floor* (including basement) elevated to or above the *base flood elevation*; and

2. Other fully enclosed areas below the *lowest floor*, such as crawl spaces, that are subject to *flooding*, and that are usable solely for the parking of vehicles, building access, or limited storage, *shall* be designed to automatically equalize hydrostatic *flood* forces on exterior walls by allowing for the entry and exit of floodwaters. Designs for meeting this requirement must either be certified by a registered professional engineer or architect or must meet or exceed the following criteria:

a. A minimum of two openings having a total net area of not less than one square inch for every square foot of enclosed area subject to *flooding shall* be provided.

b. The bottom of all openings *shall* be no higher than one foot above grade.

c. Openings *shall* be equipped with screens, louvers, valves, or other coverings or devices; provided, that they permit the automatic entry and exit of floodwaters.

D. **Nonresidential *Structures***.

1. All *new construction* of and *substantial improvements* to nonresidential *structures shall* have either:

a. The *lowest floor* (including basement) elevated to or above the *base flood elevation*; or

b. Together with attendant utility and sanitary facilities, be designed so that below the *base flood* level the *structure* is watertight with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads and effects of buoyancy.

2. Where a nonresidential *structure* is intended to be made watertight below the *base flood* level:

a. A registered professional engineer or architect *shall* develop and/or review structural designs, specifications, and plans for the construction, and *shall* certify that the design and methods of construction are in accordance with accepted standards of practice for meeting the applicable provisions of subsection (D)(1) of this section; and

b. A record of such certificates which includes the specific elevation (in relation to mean sea level) to which such *structures* are floodproofed *shall* be maintained by the department of community planning.

3. Other fully enclosed areas below the *lowest floor* that are usable solely for parking of vehicles, building access or storage in an area other than a basement and which are subject to *flooding shall* comply with the requirements of subsection (C)(2) of this section.

E. ***Accessory Structures***. *Accessory structures shall* be constructed and placed on the building site so as to offer minimum resistance to the flow of floodwaters, and *shall* be anchored to prevent flotation which *may* result in damage to other *structures*. Services utilities such as electrical and heating equipment *shall* be elevated or floodproofed.

F. ***Recreational Vehicles***. In a *special flood hazard area*, a *recreational vehicle* must be licensed and titled as a *recreational vehicle* or park model (not as a permanent residence) and ready for highway use (i.e., on its wheels or jacking system, have no attached deck, porch or shed, and have quick-disconnect sewage, water and electrical connectors) or be on the site for fewer than 180 consecutive days. *Recreational vehicles* that do not meet these conditions must obtain a permit and meet the elevation and anchoring requirements for *manufactured homes*.

G. ***Critical Facilities***. The following additional standards apply to *critical facilities*:

1. Construction of new *critical facilities shall* be, to the extent possible, located outside the limits of the *special flood hazard area*. Construction of new *critical facilities shall* be permissible within the *special flood hazard area* if no feasible alternative site is available.

2. *Critical facilities* constructed within the *special flood hazard area shall* have the *lowest floor* elevated three feet above the *base flood elevation* or to the height of the 500-year *flood*, whichever is higher.

3. Access to and from the *critical facility should* be protected to the height utilized above.

4. *Floodproofing* and sealing measures must be taken to ensure that toxic substances will not be displaced by or released into floodwaters.

5. Access routes elevated to or above the level of the *base flood elevation shall* be provided to all *critical facilities* to the extent possible.

Standards for Manufactured Homes (FNSBC 15.04.120)

A. ***Manufactured homes*** that are placed or *substantially improved* within a *special flood hazard area* on any of the following sites must be elevated on a permanent foundation such that the *lowest floor* of the *manufactured home* is elevated to or above the *base flood elevation* and be securely anchored to an adequately anchored foundation system to resist flotation, collapse and lateral movement:

1. Outside of a *manufactured home park or subdivision*;

2. In a manufactured home;

3. In an expansion to an *existing manufactured home park or subdivision*; or

4. In an *existing manufactured home park or subdivision* on which a *manufactured home* has incurred *substantial damage* as the result of a *flood*.

B. ***Manufactured homes*** to be placed or *substantially improved* on sites in an *existing manufactured home park or subdivision* within the *special flood hazard area* that are not subject to the provisions of subsection (A) of this section must be elevated so that either:

1. The *lowest floor* of the *manufactured home* is at or above the *base flood elevation*; or

2. The *manufactured home* chassis is supported by reinforced piers or other foundation elements of at least equivalent strength that are no less than 36 inches in height above grade and is securely anchored to an adequately anchored foundation system to resist flotation, collapse, and lateral movement.

APPENDIX B: EC Building Diagrams

The following diagrams illustrate various types of buildings. Compare the features of the building being certified with the features shown in the diagrams and select the diagram most applicable. Enter the diagram number in Item A7, the square footage of crawlspace or enclosure(s) and the area of flood openings in square inches in Items A8.a–c, the square footage of attached garage and the area of flood openings in square inches in Items A9.a–c, and the elevations in Items C2.a–h.

In A zones, the floor elevation is taken at the top finished surface of the floor indicated; in V zones, the floor elevation is taken at the bottom of the lowest horizontal structural member (see drawing in instructions for Section C).

DIAGRAM 1A

All slab-on-grade single- and multiple-floor buildings (other than split-level) and high-rise buildings, either detached or row type (e.g., townhouses); with or without attached garage.

Distinguishing Feature – The bottom floor is at or above ground level (grade) on at least 1 side.*

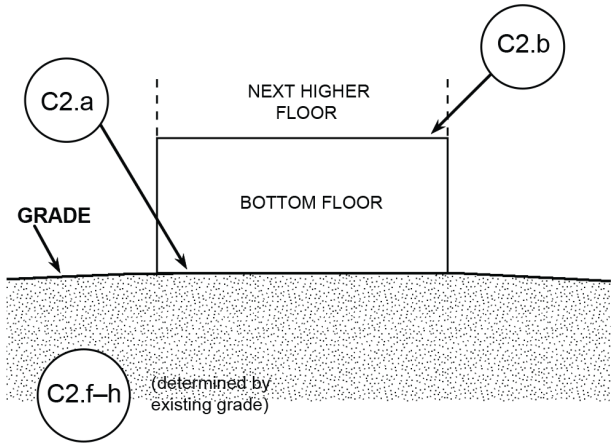


DIAGRAM 1B

All raised-slab-on-grade or slab-on-stem-wall-with-fill single- and multiple-floor buildings (other than split-level), either detached or row type (e.g., townhouses); with or without attached garage.

Distinguishing Feature – The bottom floor is at or above ground level (grade) on at least 1 side.*

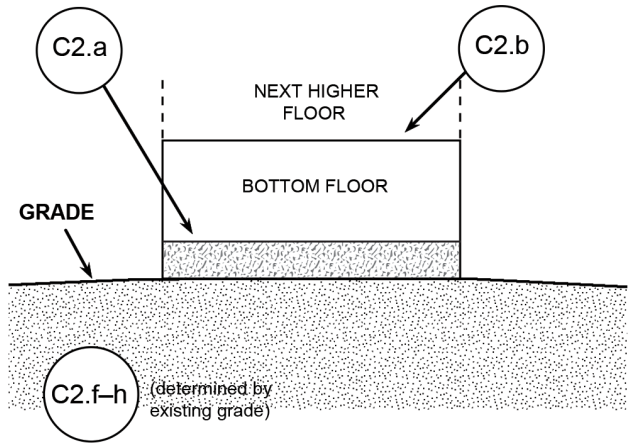


DIAGRAM 2A

All single- and multiple-floor buildings with basement (other than split-level) and high-rise buildings with basement, either detached or row type (e.g., townhouses); with or without attached garage.

Distinguishing Feature – The bottom floor (basement or underground garage) is below ground level (grade) on all sides.*

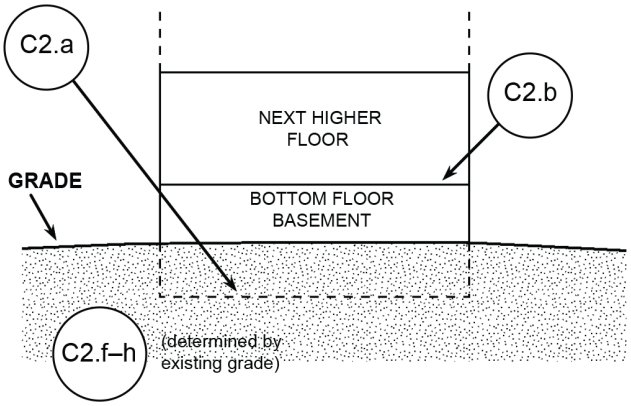
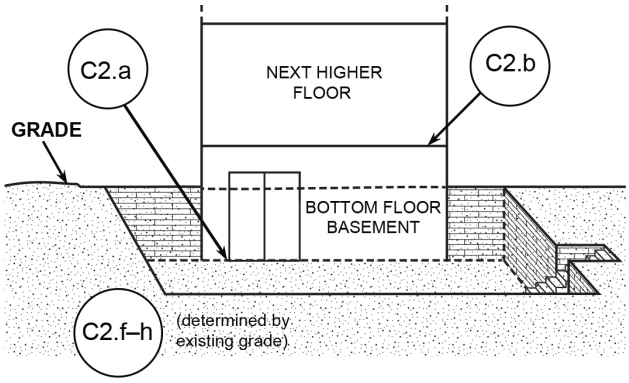


DIAGRAM 2B

All single- and multiple-floor buildings with basement (other than split-level) and high-rise buildings with basement, either detached or row type (e.g., townhouses); with or without attached garage.

Distinguishing Feature – The bottom floor (basement or underground garage) is below ground level (grade) on all sides; most of the height of the walls is below ground level on all sides; and the door and area of egress are also below ground level on all sides.*



* A floor that is below ground level (grade) on all sides is considered a basement even if the floor is used for living purposes, or as an office, garage, workshop, etc.

Building Diagrams

DIAGRAM 3

All split-level buildings that are slab-on-grade, either detached or row type (e.g., townhouses); with or without attached garage.

Distinguishing Feature – The bottom floor (excluding garage) is at or above ground level (grade) on at least 1 side.*

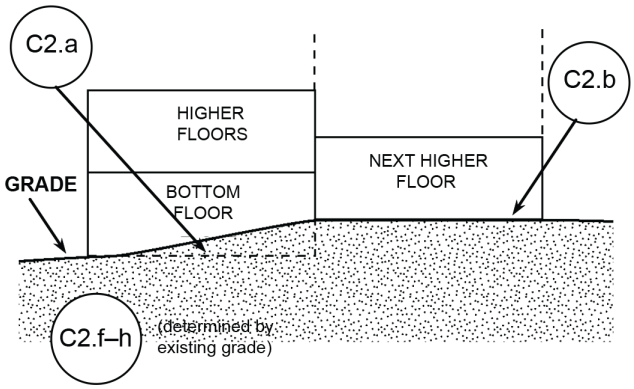


DIAGRAM 4

All split-level buildings (other than slab-on-grade), either detached or row type (e.g., townhouses); with or without attached garage.

Distinguishing Feature – The bottom floor (basement or underground garage) is below ground level (grade) on all sides.*

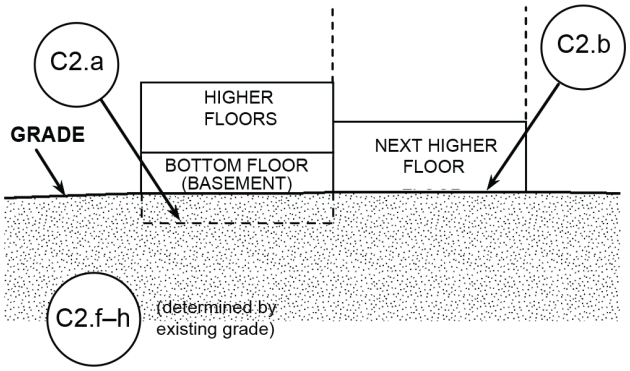


DIAGRAM 5

All buildings elevated on piers, posts, piles, columns, or parallel shear walls. No obstructions below the elevated floor.

Distinguishing Feature – For all zones, the area below the elevated floor is open, with no obstruction to flow of floodwaters (open lattice work and/or insect screening is permissible).

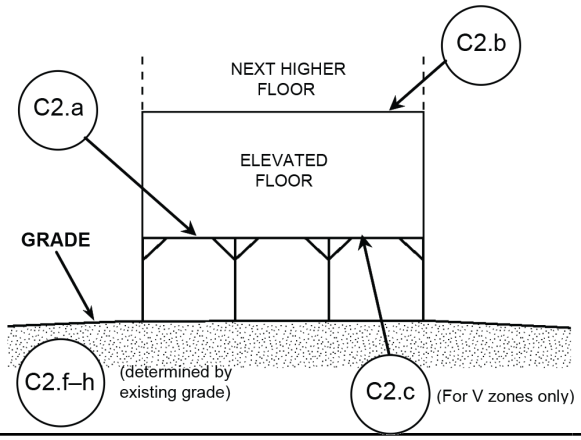
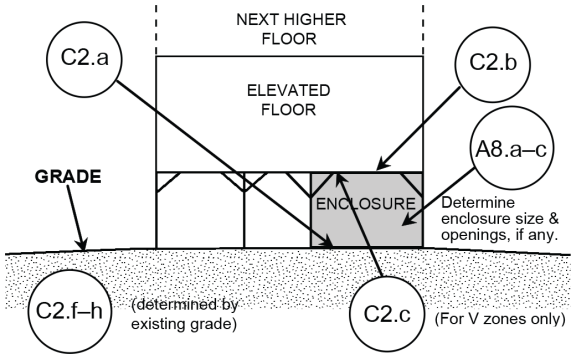


DIAGRAM 6

All buildings elevated on piers, posts, piles, columns, or parallel shear walls with full or partial enclosure below the elevated floor.

Distinguishing Feature – For all zones, the area below the elevated floor is enclosed, either partially or fully. In A Zones, the partially or fully enclosed area below the elevated floor is with or without openings** present in the walls of the enclosure. Indicate information about enclosure size and openings in Section A – Property Information.



* A floor that is below ground level (grade) on all sides is considered a basement even if the floor is used for living purposes, or as an office, garage, workshop, etc.

** An "opening" is a permanent opening that allows for the free passage of water automatically in both directions without human intervention. Under the NFIP, a minimum of 2 openings is required for enclosures or crawlspaces. The openings shall provide a total net area of not less than 1 square inch for every square foot of area enclosed, excluding any bars, louvers, or other covers of the opening. Alternatively, an Individual Engineered Flood Openings Certification or an Evaluation Report issued by the International Code Council Evaluation Service (ICC ES) must be submitted to document that the design of the openings will allow for the automatic equalization of hydrostatic flood forces on exterior walls. A window, a door, or a garage door is not considered an opening; openings may be installed in doors. Openings shall be on at least 2 sides of the enclosed area. If a building has more than 1 enclosed area, each area must have openings to allow floodwater to directly enter. The bottom of the openings must be no higher than 1.0 foot above the higher of the exterior or interior grade or floor immediately below the opening. For more guidance on openings, see NFIP Technical Bulletin 1.

Building Diagrams

DIAGRAM 7

All buildings elevated on full-story foundation walls with a partially or fully enclosed area below the elevated floor. This includes walkout levels, where at least 1 side is at or above grade. The principal use of this building is located in the elevated floors of the building.

Distinguishing Feature – For all zones, the area below the elevated floor is enclosed, either partially or fully. In A Zones, the partially or fully enclosed area below the elevated floor is with or without openings** present in the walls of the enclosure. Indicate information about enclosure size and openings in Section A – Property Information.

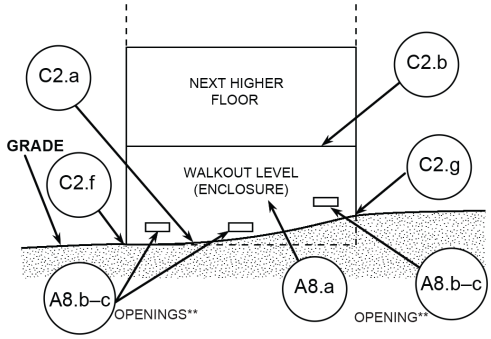


DIAGRAM 8

All buildings elevated on a crawlspace with the floor of the crawlspace at or above grade on at least 1 side, with or without an attached garage.

Distinguishing Feature – For all zones, the area below the first floor is enclosed by solid or partial perimeter walls. In all A zones, the crawlspace is with or without openings** present in the walls of the crawlspace. Indicate information about crawlspace size and openings in Section A – Property Information.

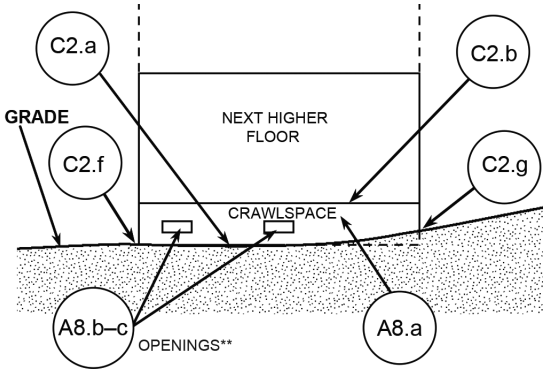
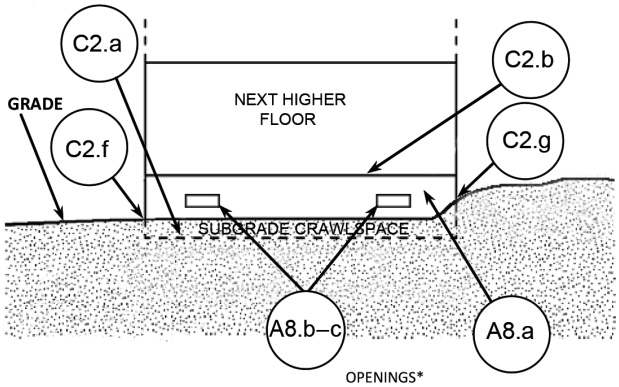


DIAGRAM 9

All buildings (other than split-level) elevated on a sub-grade crawlspace, with or without attached garage.

Distinguishing Feature – The bottom (crawlspace) floor is below ground level (grade) on all sides.* (If the distance from the crawlspace floor to the top of the next higher floor is more than 5 feet, or the crawlspace floor is more than 2 feet below the grade [LAG] on all sides, use Diagram 2A or 2B.)



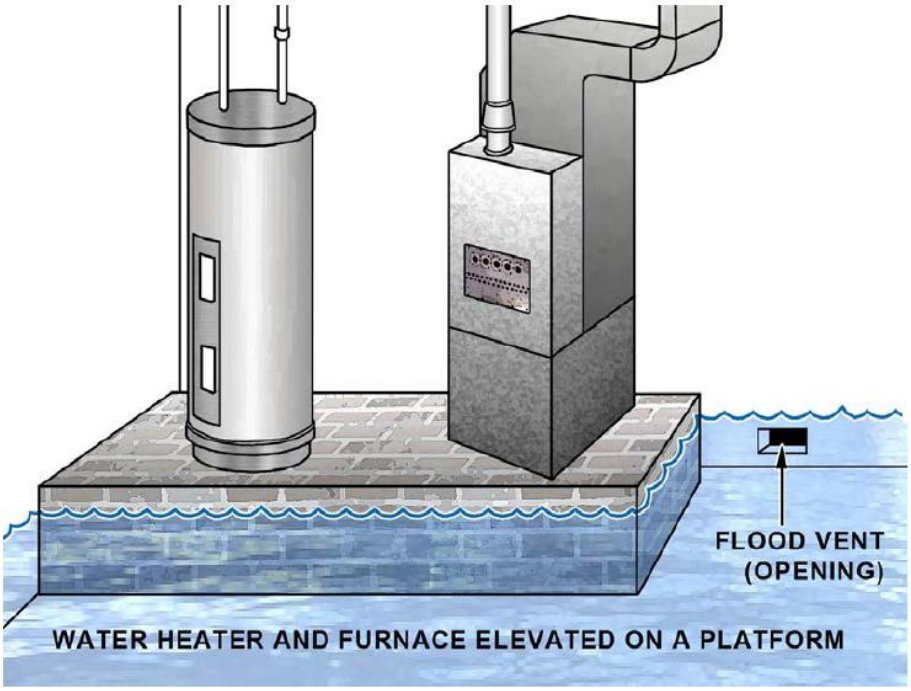
* A floor that is below ground level (grade) on all sides is considered a basement even if the floor is used for living purposes, or as an office, garage, workshop, etc.

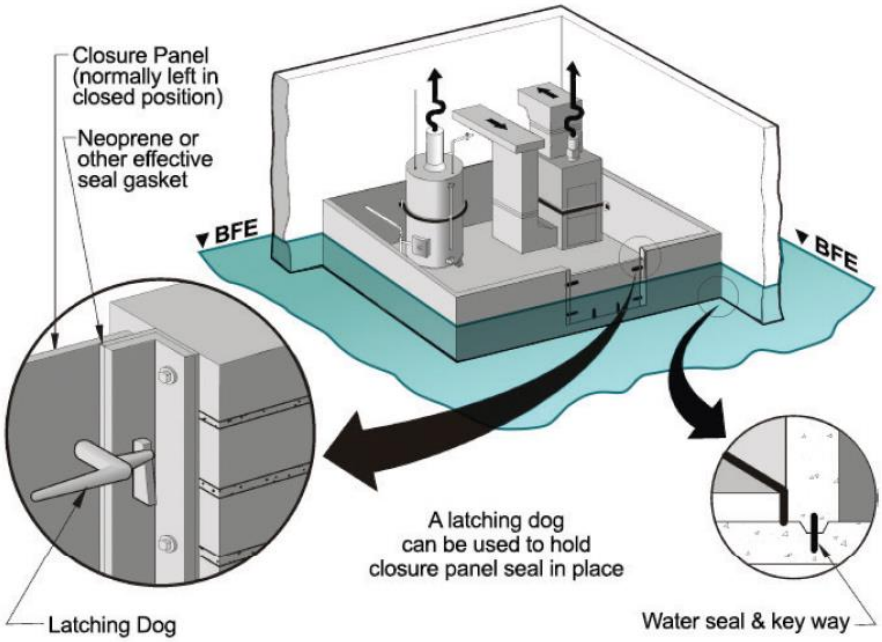
** An "opening" is a permanent opening that allows for the free passage of water automatically in both directions without human intervention. Under the NFIP, a minimum of 2 openings is required for enclosures or crawlspaces. The openings shall provide a total net area of not less than 1 square inch for every square foot of area enclosed, excluding any bars, louvers, or other covers of the opening. Alternatively, an Individual Engineered Flood Openings Certification or an Evaluation Report issued by the International Code Council Evaluation Service (ICC ES) must be submitted to document that the design of the openings will allow for the automatic equalization of hydrostatic flood forces on exterior walls. A window, a door, or a garage door is not considered an opening; openings may be installed in doors. Openings shall be on at least 2 sides of the enclosed area. If a building has more than 1 enclosed area, each area must have openings to allow floodwater to directly enter. The bottom of the openings must be no higher than 1.0 foot above the higher of the exterior or interior grade or floor immediately below the opening. For more guidance on openings, see NFIP Technical Bulletin 1.

APPENDIX C: Utilities in the Special Flood Hazard Area

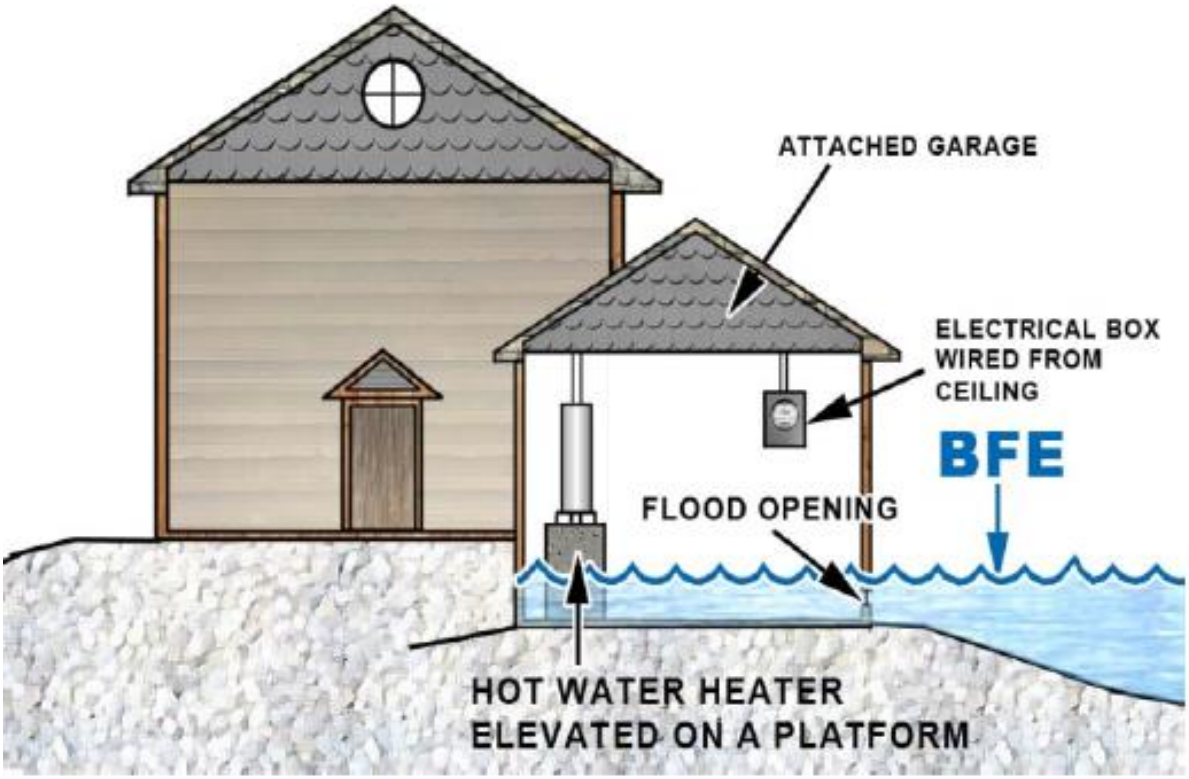
Utilities include, but are not limited to water heaters, furnaces, electrical boxes, plumbing, gas lines, air conditioning, etc.

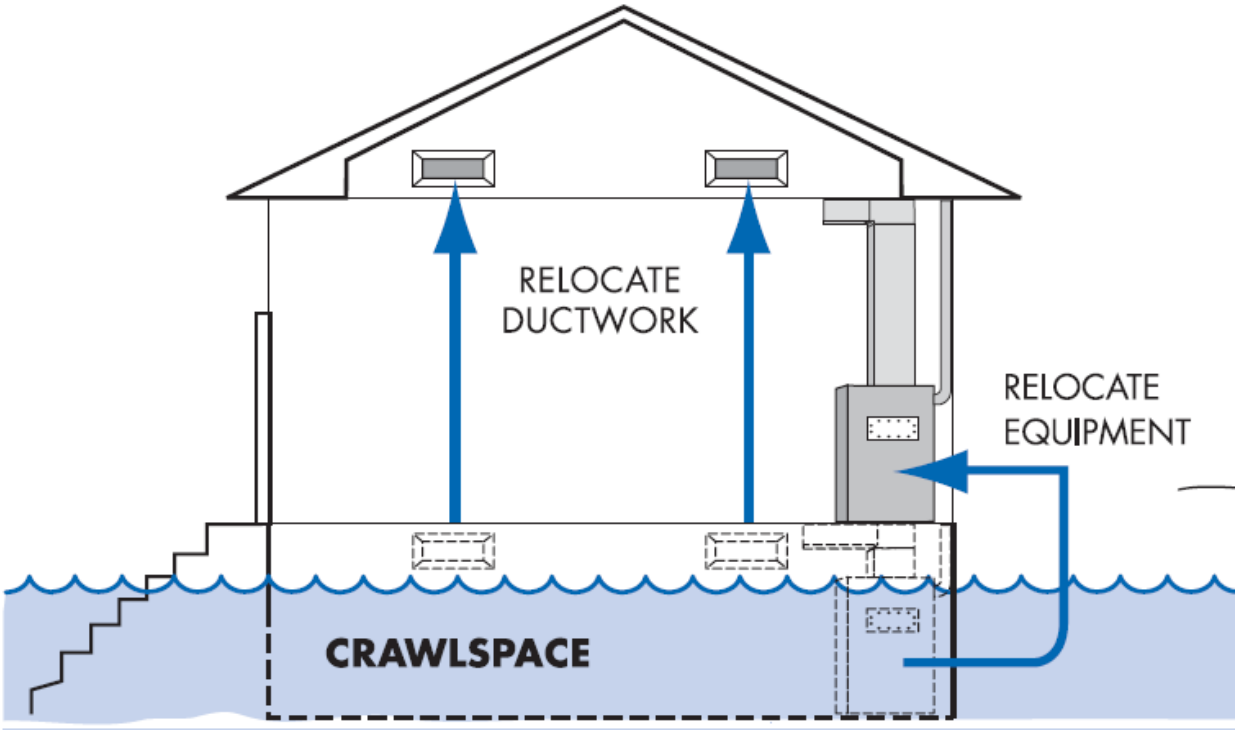
Inside



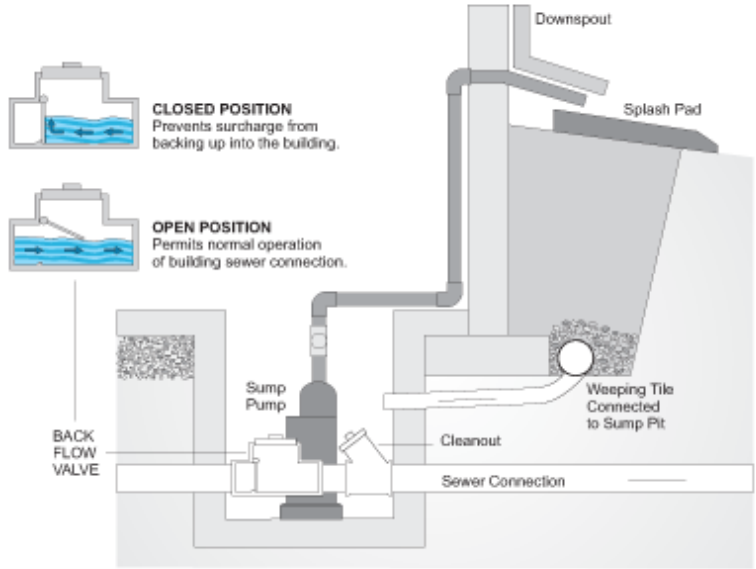


Detail of Floodproofed Building Utilities


ATTACHED GARAGE
ELECTRICAL BOX
WIRED FROM
CEILING
BFE
FLOOD OPENING
HOT WATER HEATER
ELEVATED ON A PLATFORM

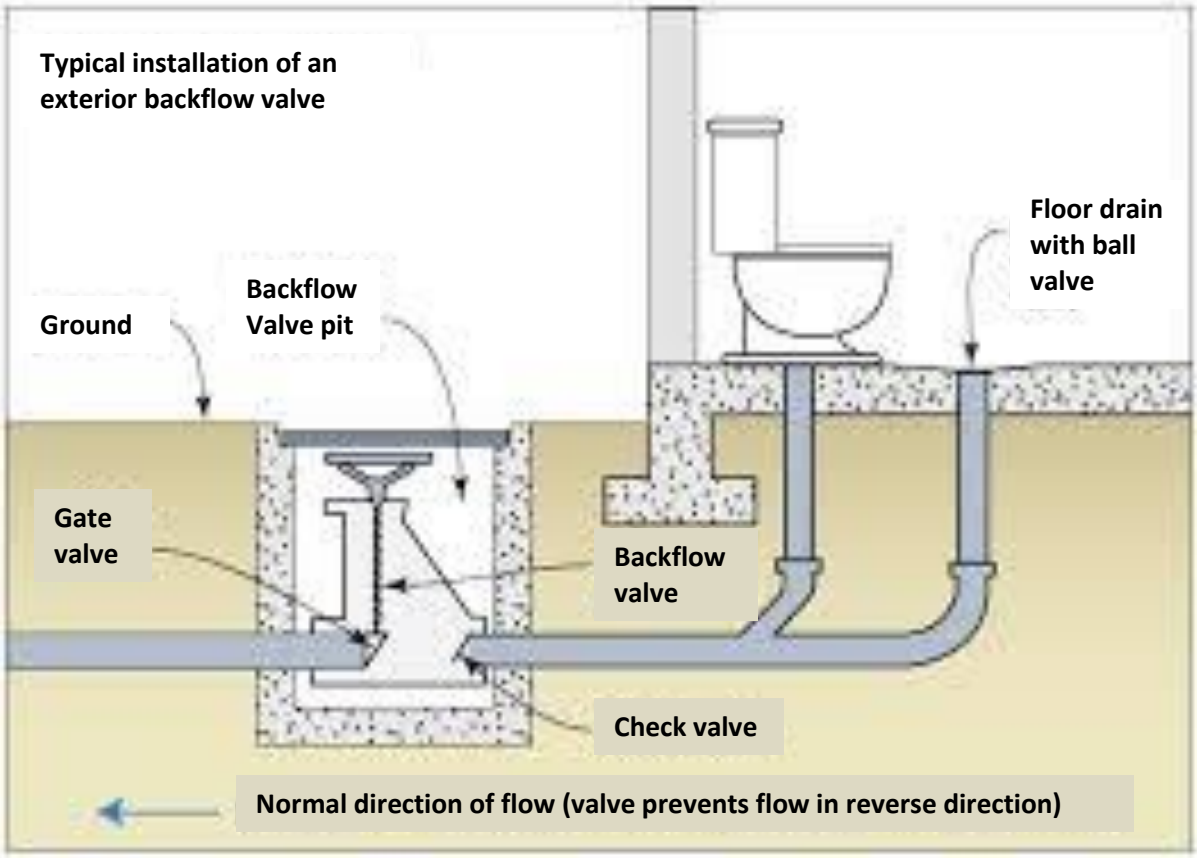

RELOCATE
DUCTWORK
RELOCATE
EQUIPMENT
CRAWLSPACE

Back Flow Valves and Sump Pumps Diagrams

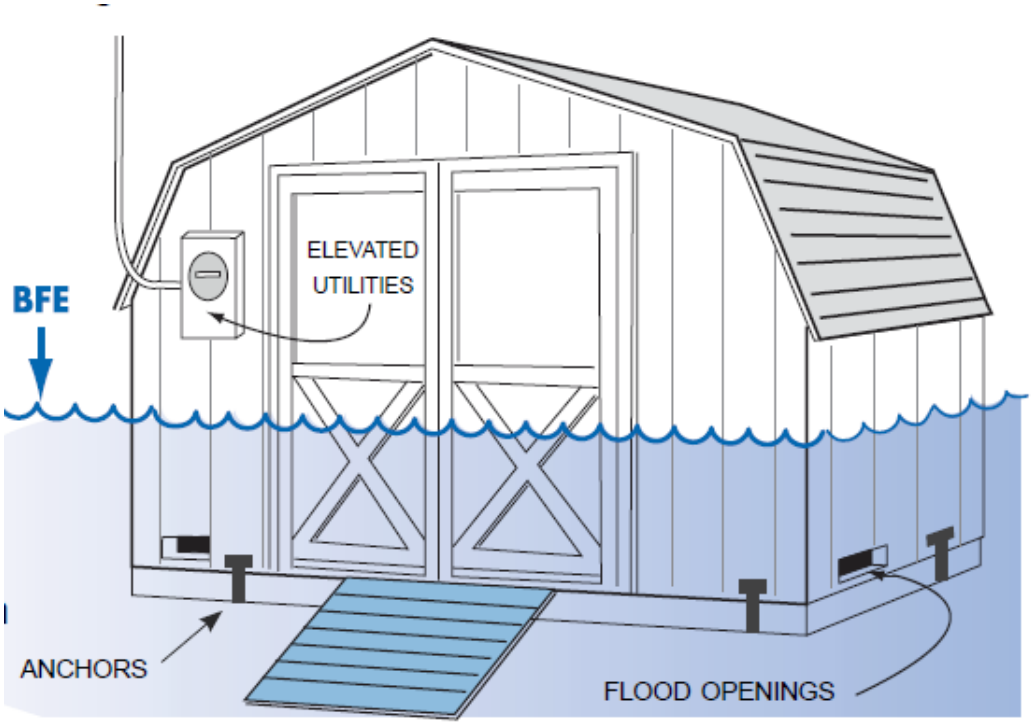


BACK FLOW VALVES AND SUMP PUMPS ARE EFFECTIVE MEANS OF AVOIDING BASEMENT FLOODING

In existing homes experiencing basement flooding due to sewer backup, an effective prevention strategy is to install a sump pump and a back flow valve. This type of installation must normally be approved by the municipality and it is recommended to have the work performed by a qualified plumbing contractor.



Outside on an Accessory Structure Diagram



APPENDIX D: Outside Tanks in the Special Flood Hazard Area

Tanks include, but are not limited to fuel tanks, propane tanks, water tanks, sewage holding tanks, etc.

Above Ground

At Ground Level:

A fuel tank located above ground but below the Design Flood Elevation (DFE) must be secured against flotation and lateral movement. This requirement applies as well to portable fuel tanks such as propane tanks.

In A Zones, that are not subject to velocity flows, the following techniques can be used:

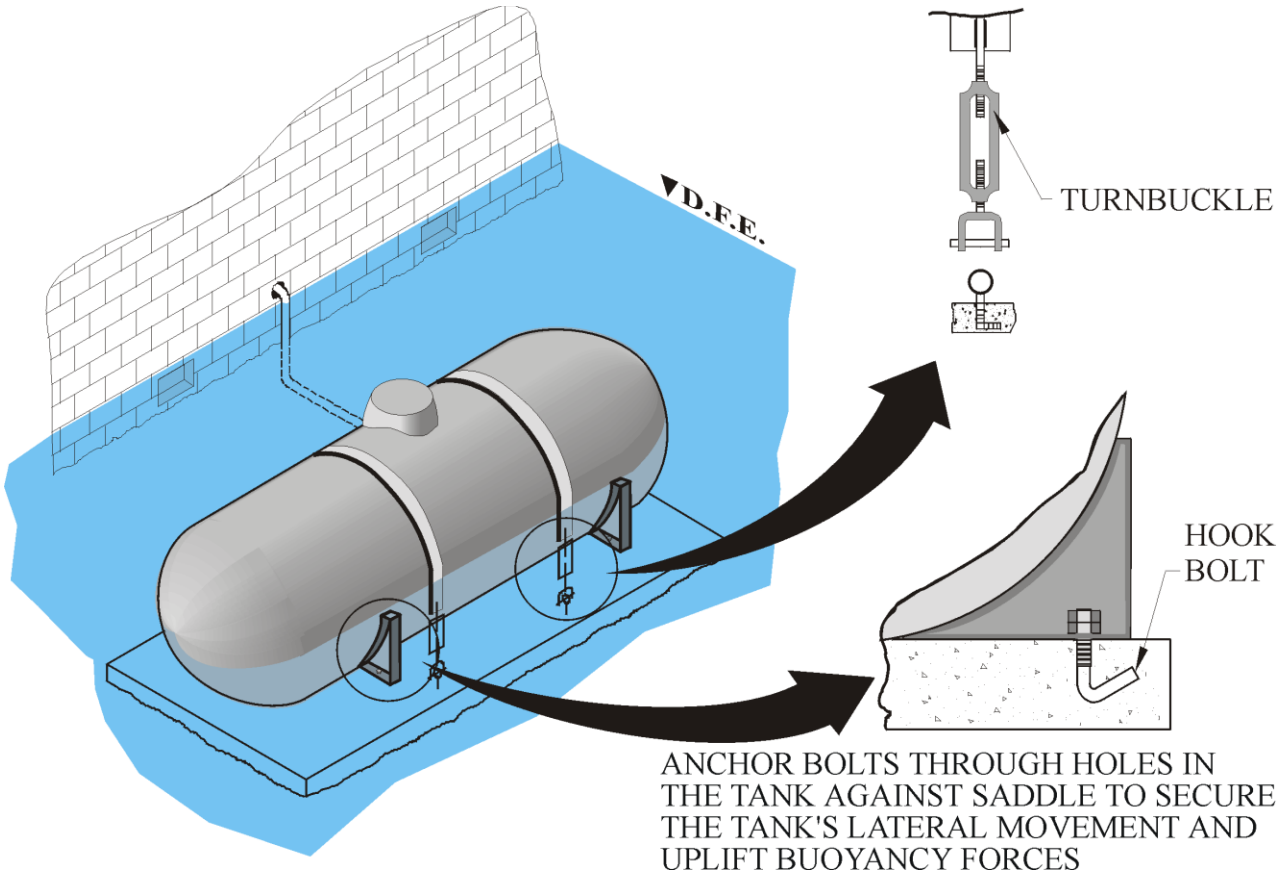
Mounting and strapping a tank onto a concrete slab or strapping a tank onto concrete counterweights on both sides of the tank. The anchoring straps are typically connected to anchor bolts by turnbuckles that are installed when the concrete is poured. Please refer to the supplier's data when selecting the strap locations for anchoring tanks because a tank can rupture when buoyancy forces are too great. In most applications, brackets are designed to withstand the weight of the tank only. Buoyancy forces can exceed the weight of the tank and cause the brackets to fail. A structural engineer or manufacturer's literature should be used to verify that the bracket used to hold the tank can withstand buoyancy forces.

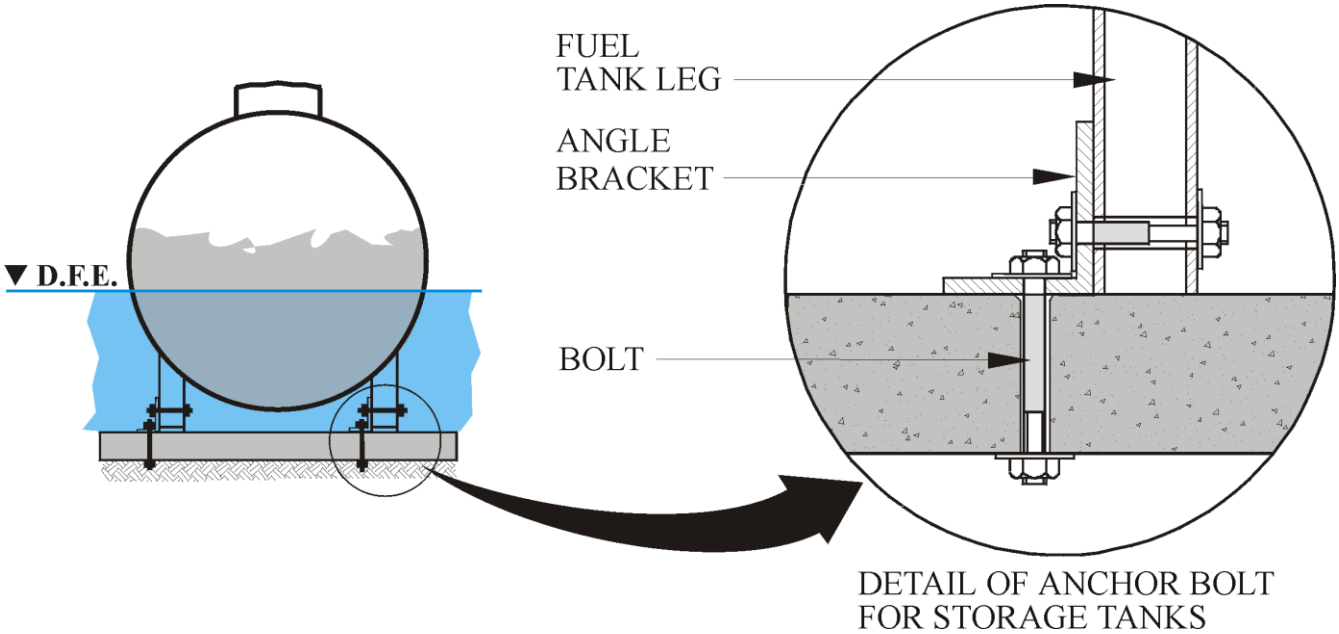
Strapping a tank to earth augers. The augers and strapping mechanism must be strong enough to withstand the buoyancy force expected during inundation and the lateral forces expected with wind and water. Earth augers are readily available from many manufacturers.

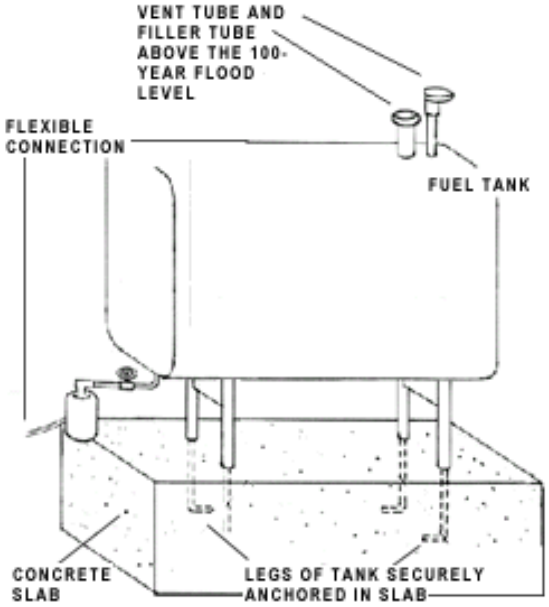
It is important to note that the performance of an auger depends upon the type of soil into which it is embedded. For example, an auger has a greater holding strength in clay soil than in sandy soil. Therefore, if the soil conditions are unknown or if the anchors selected cannot withstand anticipated loads, larger-sized or additional anchors should be used. Generally, the total holding strength of an anchoring system can be increased by increasing the number of augers, the size of the augers, or both. Earth augers and anchoring components are readily available from many manufacturers.

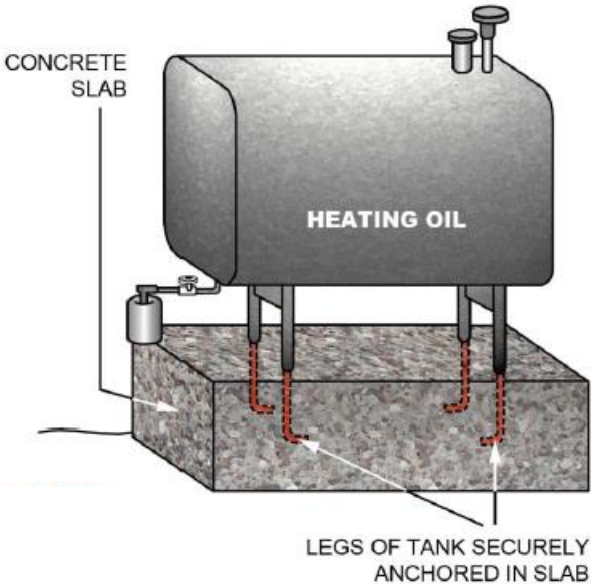
Because of environmental concerns, underground storage tanks are not recommended. Elevated storage tanks are also problematic because of concerns about impact damage during flooding. Therefore, for elevated tanks, additional protection must be applied against debris impact and the forces of velocity flow. The following technique can be used to prevent damage from debris impact and the forces of velocity flow:

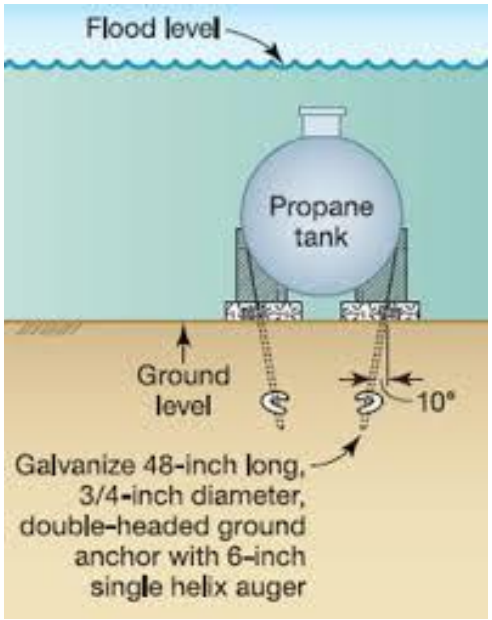
- Protective walls can be constructed around the tank to protect it from debris impact and the forces of velocity flow. The walls must be higher than the DFE, but they do not have to be watertight. Furthermore, there must be drainage holes at the base of the walls for rain water to drain.
- Concrete guard posts can be constructed around the tank to protect it from debris impact.

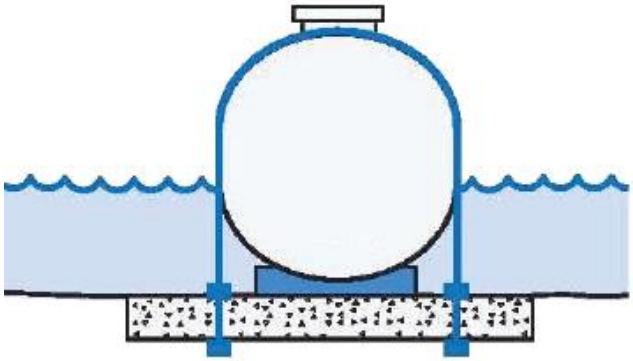

D.F.E.
TURNBUCKLE
HOOK
BOLT
ANCHOR BOLTS THROUGH HOLES IN
THE TANK AGAINST SADDLE TO SECURE
THE TANK'S LATERAL MOVEMENT AND
UPLIFT BUOYANCY FORCES


D.F.E.
FUEL
TANK LEG
ANGLE
BRACKET
BOLT
DETAIL OF ANCHOR BOLT
FOR STORAGE TANKS

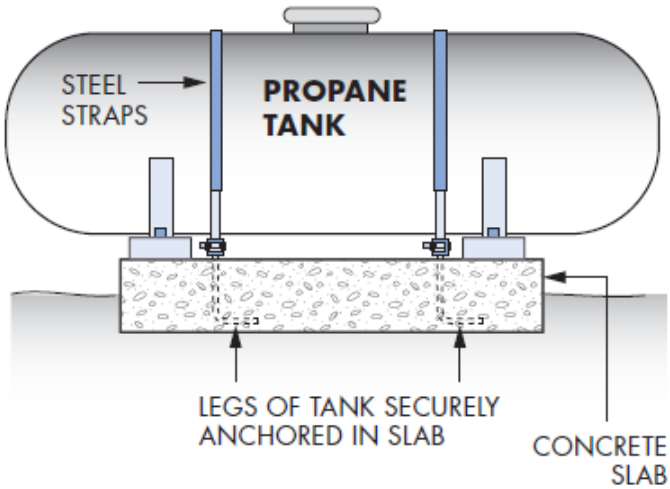








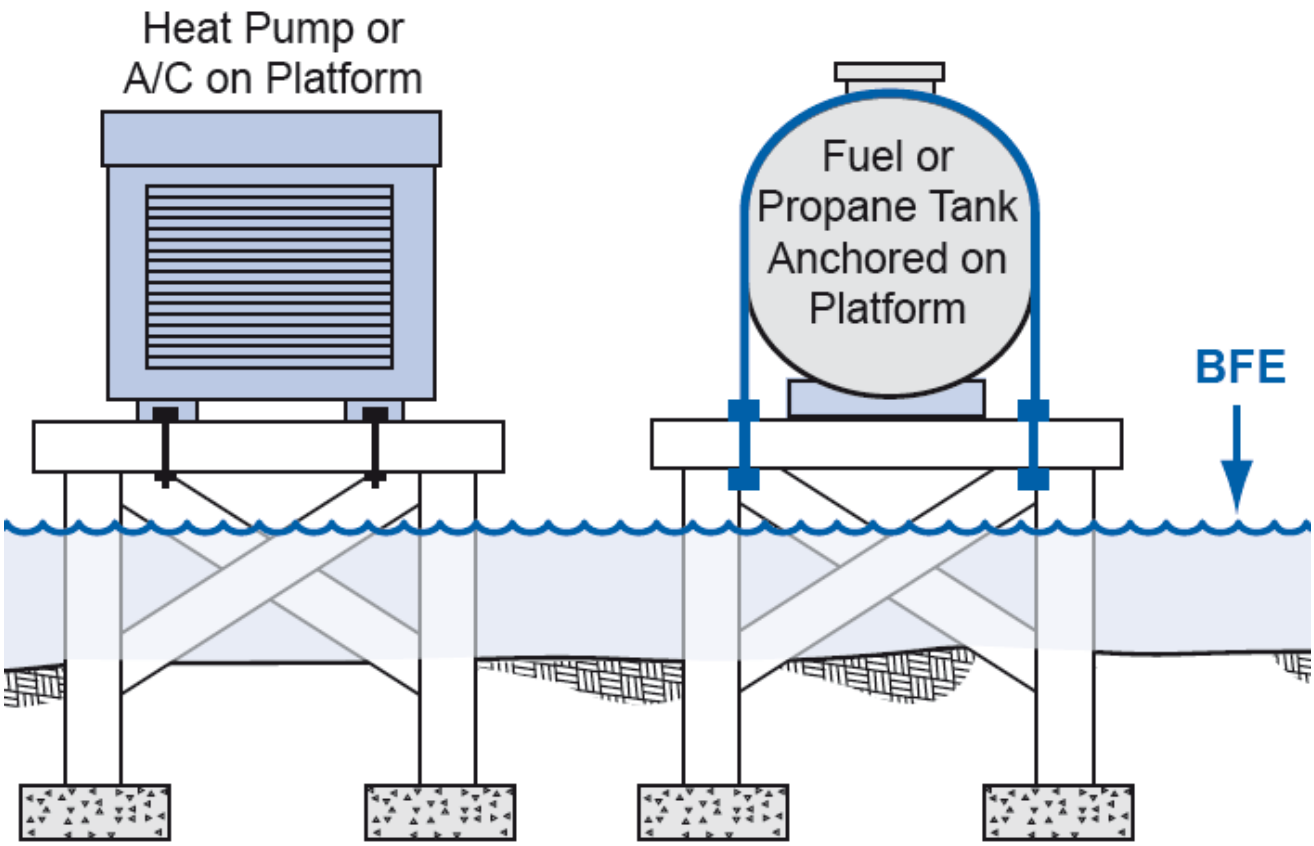
FUEL OR PROPANE TANK ANCHORED TO PREVENT FLOTATION



Elevated:

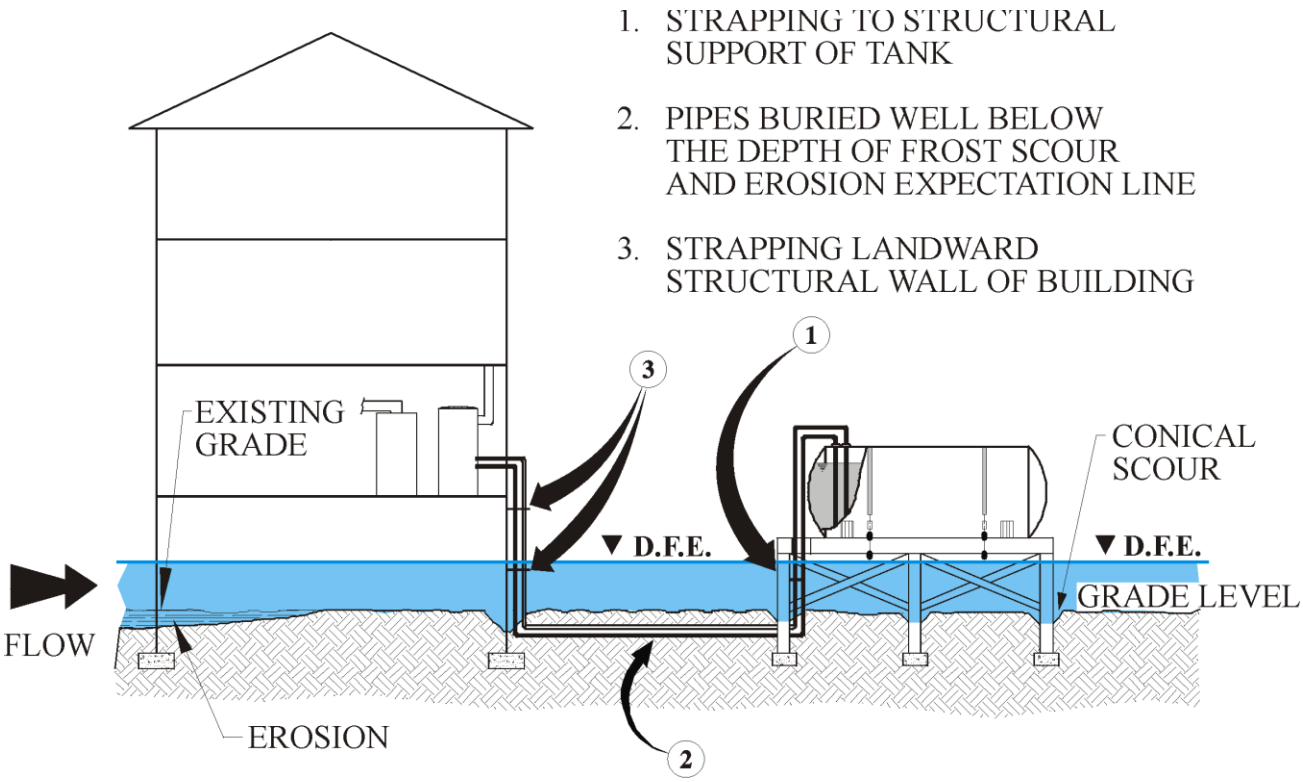
The following outlines some considerations when protecting fuel systems:

- The tank should be anchored to the platform with straps, which would constrain the tank in wind, earthquake, and other applicable forces.
- In velocity flow areas, the platform should be supported by posts or columns that are adequately designed for all loads including flood and wind loads.
- The posts or columns should have deep concrete footings embedded below expected erosion and scour lines.
- The piles, posts, or columns should be cross-braced to withstand the forces of velocity flow, wave action, wind, and earthquakes; cross-bracing should be parallel to the direction of flow to allow for free flow of debris.
- In non-velocity flow floodplains, elevation can also be achieved by using compacted fill to raise the level of the ground above the DFE and by strapping the tank onto a concrete slab at the top of the raised ground.



Component Protection

Where it is not possible to elevate the whole length of a fuel line above the DFE, the pipe can be protected by strapping it to the landward downstream side of the vertical structural member



Below Ground

An underground tank surrounded by floodwaters or saturated soil will be subjected to buoyancy forces that could push the tank upward. Such movement of a tank may cause a rupture and/or separation of the connecting pipes. The effects of buoyancy and/or those of velocity flow can move a tank from its location, break it open, and cause fuel leakage into floodwaters. Such leakage creates the risk of fire, explosion, water supply contamination, and possible health and environmental hazards which would delay cleanup and repair work necessary to occupy the building.

There are precautions that can be taken prior to and during the underground tank installation process including placing wet cement in the hole just before the tank is lowered into place. This ensures that the tank feet are surrounded and covered and when the concrete cures, it will be harder for the tank to float out of the hole if water rises above the fuel level in the tank. Another option, recommended by FEMA, involves securing the tank in place with ground anchors and metal straps.

Component Protection

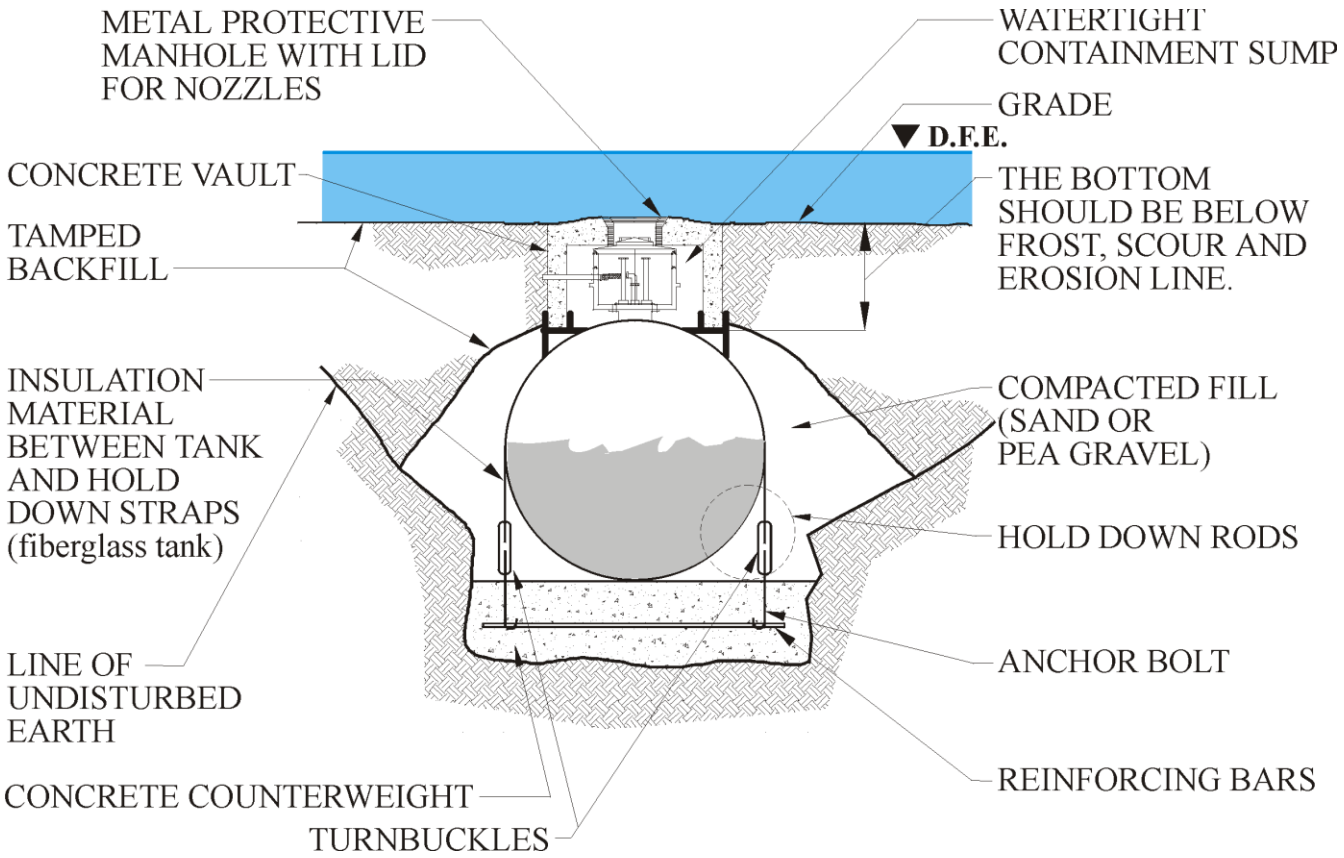
If a fuel tank must be located below the Design Flood Elevation (DFE) in an SFHA, it must be protected against the forces of buoyancy, velocity flow, and debris impact. This can be achieved by the following methods:

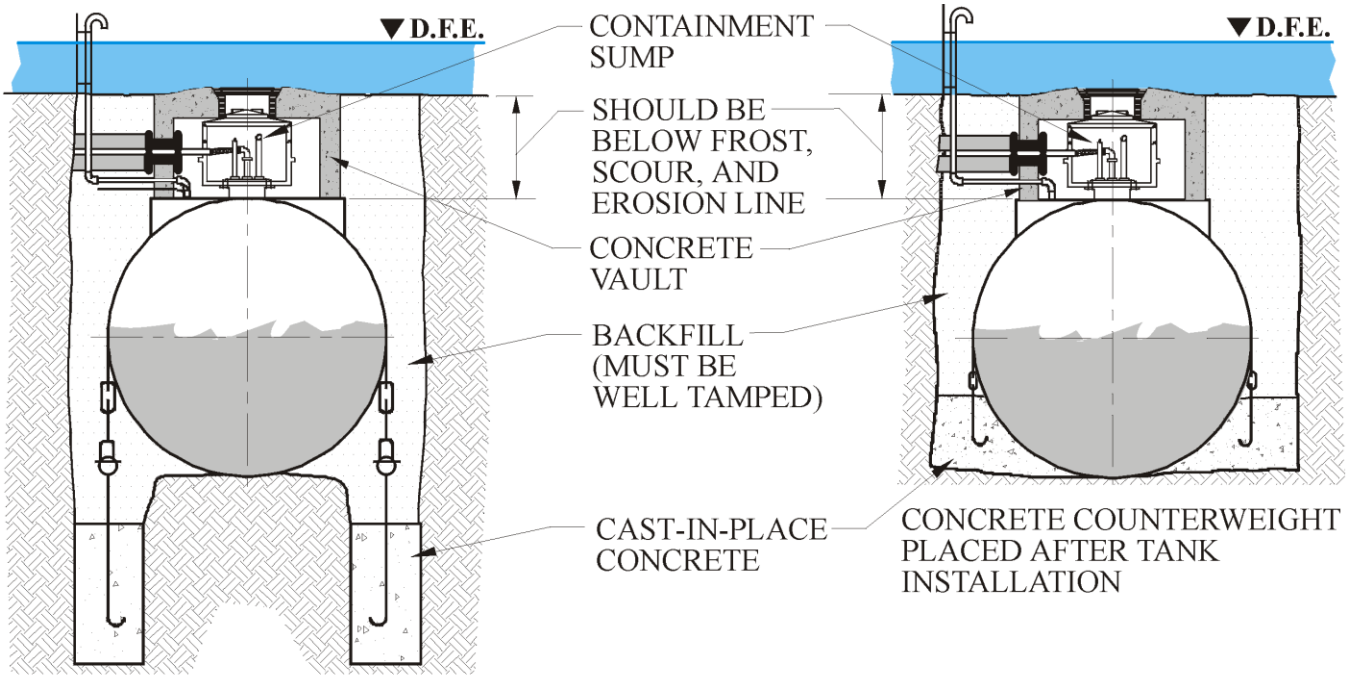
Anchoring Tanks Below Ground

1. A fuel tank located below ground in a flood-prone area can be anchored to a counterweight in order to counteract the buoyancy force that is exerted by saturated soil during a flood.
One effective method is to anchor the fuel tank to a concrete slab with (non-corrosive) hold-down straps. The straps must also be engineered to bear the tensile stress applied by the buoyancy force. The maximum buoyancy force is equal to the weight of floodwaters which would be required to fill the tank minus the weight of the tank.

2. An alternative design technique involves strapping the tank to concrete counterweights on opposite sides of the tank. The use of this technique is ideal for existing tanks servicing substantially improved structures. Note that the tank in this example is sitting in the concrete anchor, not on it.

3. Another technique for countering the buoyancy force is by anchoring the tank using earth augers. The holding strength of an auger is a function of its diameter and the type of soil into which the auger is embedded. The use of straps attached to augers is often well suited to an existing tank that services a substantially improved structure. In order to use this system without the risk of failure, proper soil conditions must exist. Always refer to a geotechnical engineer or other knowledgeable professional when designing auger anchors to combat buoyancy forces. Please refer to the tank manufacturers' literature to determine the proper configuration for the straps.





CONCRETE COUNTERWEIGHT PLACED PRIOR TO TANK INSTALLATION

APPENDIX E: Substantial Damage / Improvement Cost List

Items included in calculating cost of the project.

Items to be included

- All structural elements, including:
  - Spread or continuous foundation footings and pilings
  - Monolithic or other types of concrete slabs
  - Bearing walls, tie beams and trusses
  - Floors and ceilings
  - Attached decks and porches
  - Interior partition walls
  - Exterior wall finishes (brick, stucco, siding) including painting and moldings
  - Windows and doors
  - Reshingling or retiling a roof
  - Hardware
- All interior finishing elements, including:
  - Tiling, linoleum, stone, or carpet over subflooring
  - Bathroom tiling and fixtures
  - Wall finishes (drywall, painting, stucco, plaster, paneling, marble, etc.)
  - Kitchen, utility and bathroom cabinets
  - Built-in bookcases, cabinets, and furniture
  - Hardware
- All utility and service equipment, including:
  - HVAC equipment
  - Plumbing and electrical services
  - Light fixtures and ceiling fans
  - Security systems
  - Built-in kitchen appliances
  - Central vacuum systems
  - Water filtration, conditioning, or recirculation systems
- Cost to demolish storm-damaged building components
- Labor and other costs associated with moving or altering undamaged building components to accommodate improvement or additions
- Overhead and profits

Items to be excluded

- Plans and specifications
- Survey costs
- Permit fees
- Post-storm debris removal and clean up

- Outside improvement, including:
    - Landscaping
    - Sidewalks
    - Fences
    - Yard lights
    - Swimming pools
    - Screened pool enclosures
    - Landscape irrigation systems
- Detached structures (including garages, sheds and gazebos)

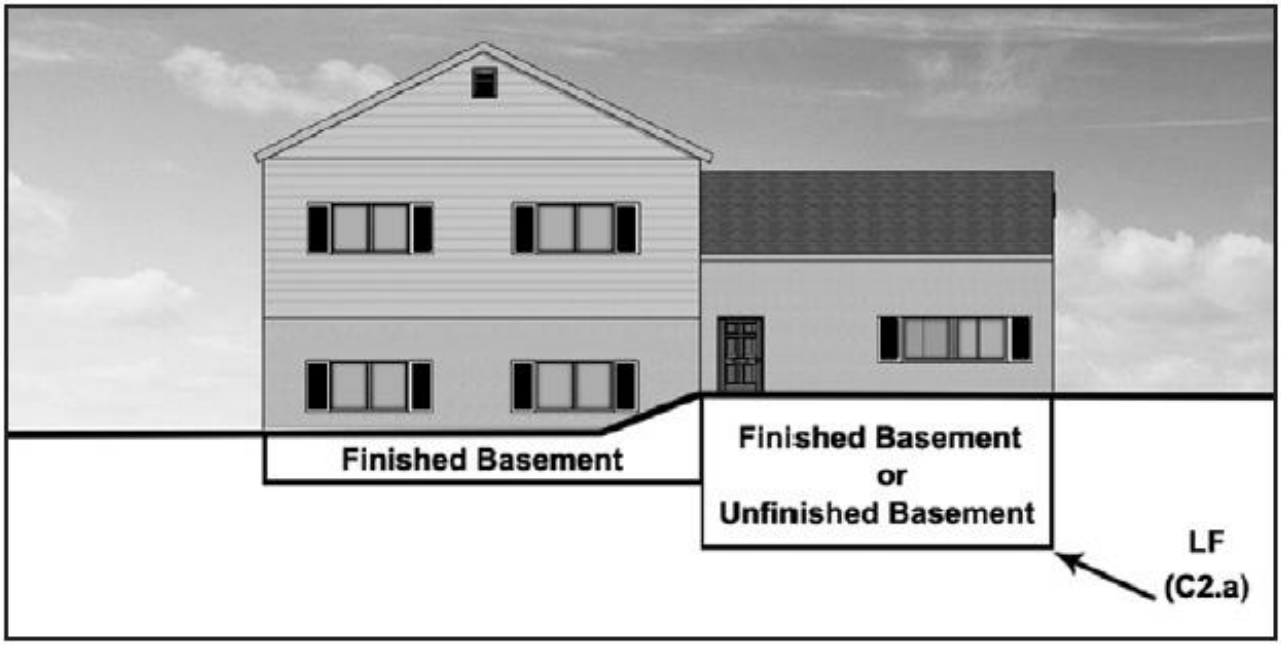
Acceptable estimates of market value can be obtained from these sources:

- An independent appraisal by a professional appraiser. The appraisal must exclude the value of the land and not use the "income capitalization approach" which bases value on the use of the property, not the structure.
- Detailed estimates of the structure's actual cash value – the replacement cost for a building, minus a depreciation percentage based on age and condition. For most situations, the building's actual cash value should approximate its market value.
- Property values used for tax assessment purposes with an adjustment recommended by the tax appraiser to reflect current market conditions (adjusted assessed value).
- The value of buildings taken from NFIP claims data (usually actual cash value).
- Qualified estimates based on sound professional judgment made by the staff of the local building department or tax assessor's office.

APPENDIX F: Crawlspaces & Permanent Flood Openings

Basements

A **basement** is more than four feet in height beneath the Base Flood Elevation; more than two feet beneath natural grade; and has no permanent flood openings. Basements are **NOT** allowed in the Special Flood Hazard Area (Flood Zones A, AE, A1-99, AO, AH, AR, AE Regulatory Floodway)



Crawlspaces

A **crawlspace** is no more than four feet in height beneath the Base Flood Elevation; no more than two feet beneath natural grade; and has permanent flood openings on a minimum of two walls.

Height is measured from the interior grade of crawlspace to the top of crawlspace foundation wall.

All utilities are required to be above the Base Flood Elevation or designed so that floodwaters cannot enter or accumulate within the system components during flood conditions. If not elevated, then utilities have to be floodproofed, sealed and anchored and documentation is required.

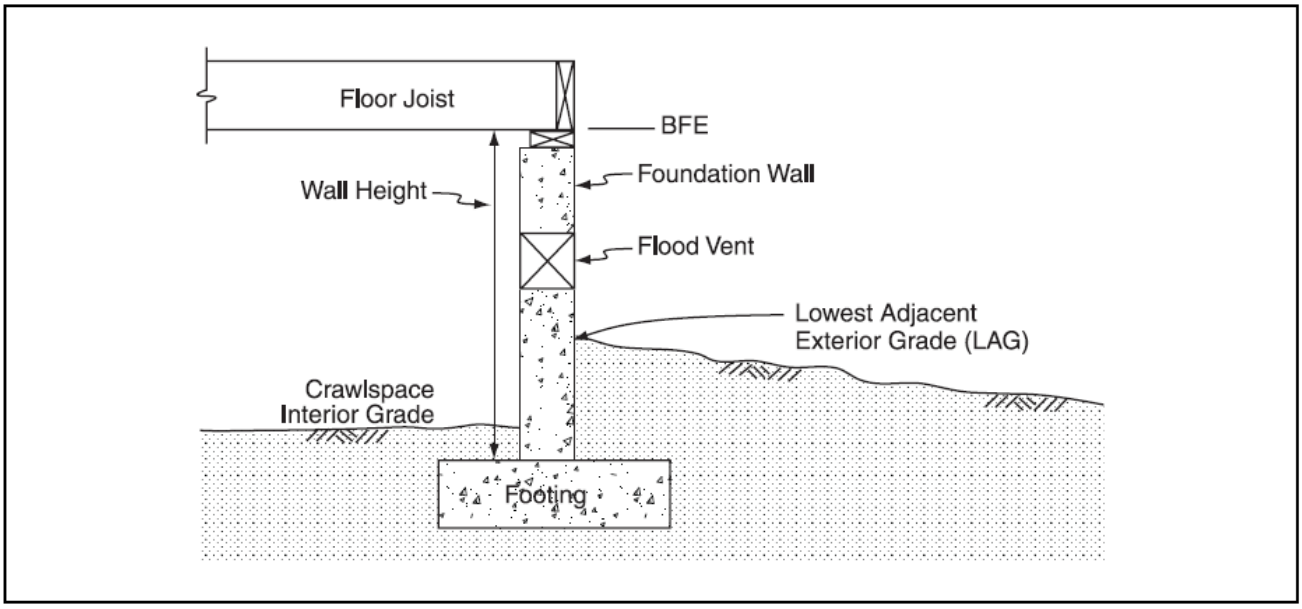


Figure 2 Below-grade crawlspace construction.

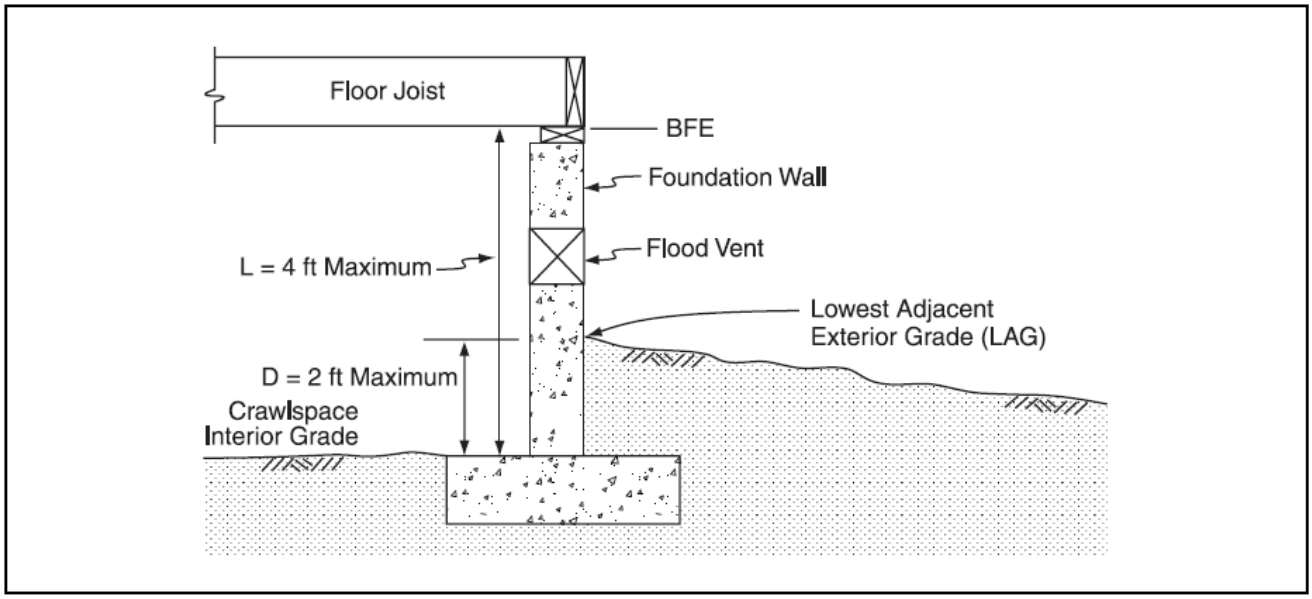


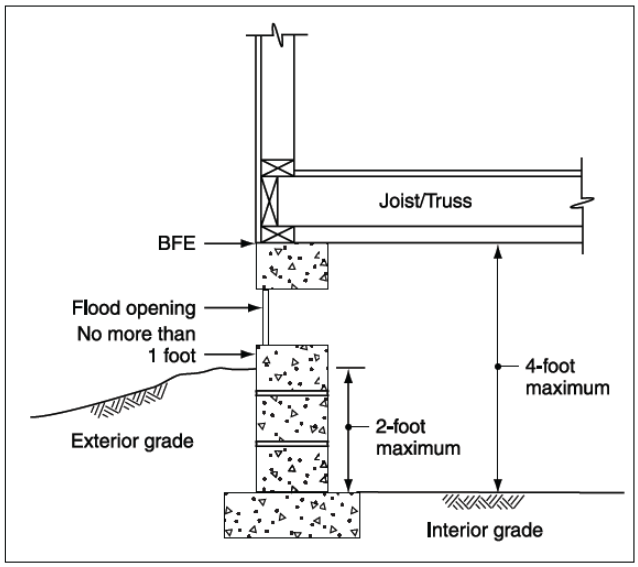
Figure 3 Requirements regarding below-grade crawlspace construction.

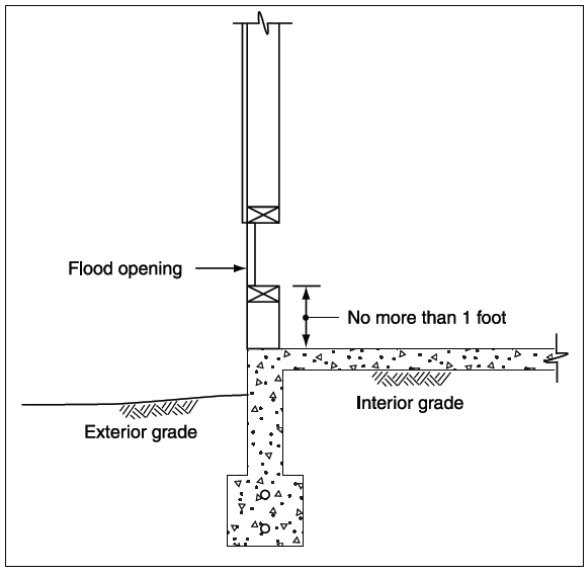
Permanent Flood Openings

Permanent Flood Openings are required on a minimum of two walls.

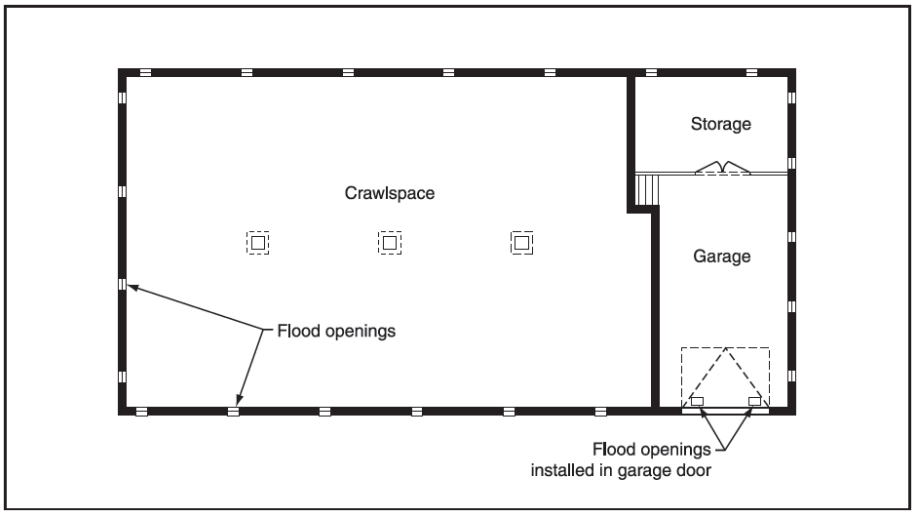
For every one square foot of space above the crawlspace, one square inch of opening is required.

Openings cannot be more than one foot above lowest adjacent exterior grade or interior grade.

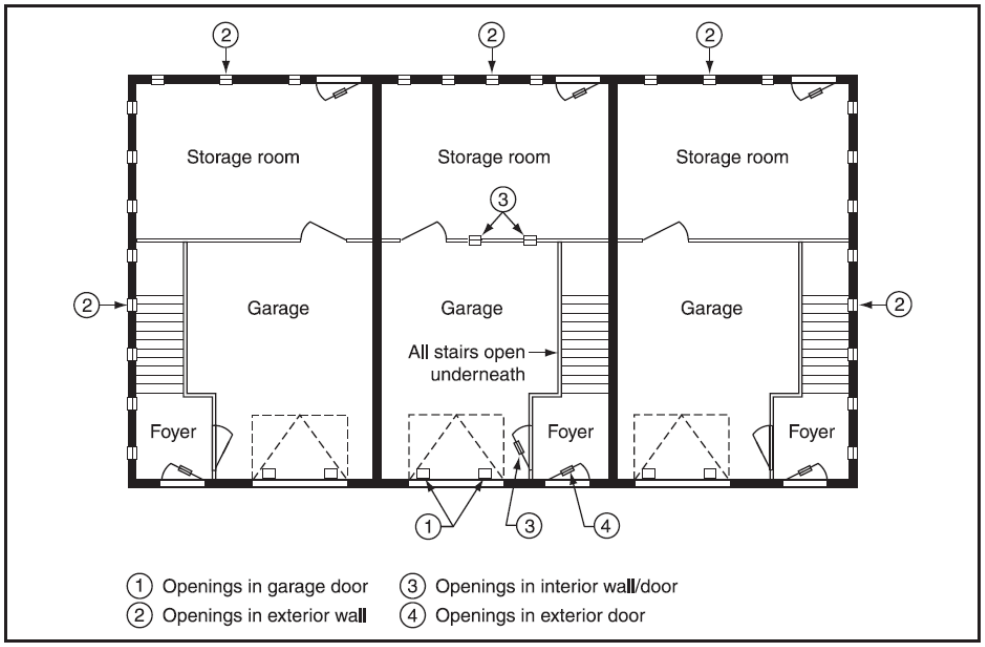




Flood Opening Locations

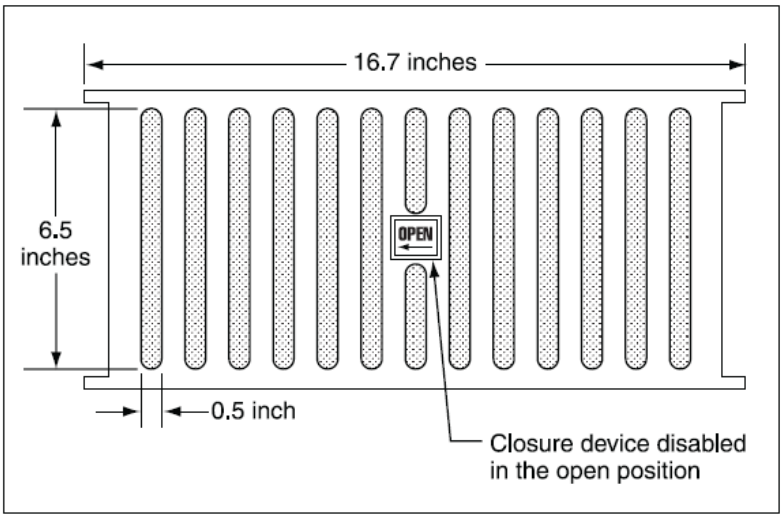


Single Unit



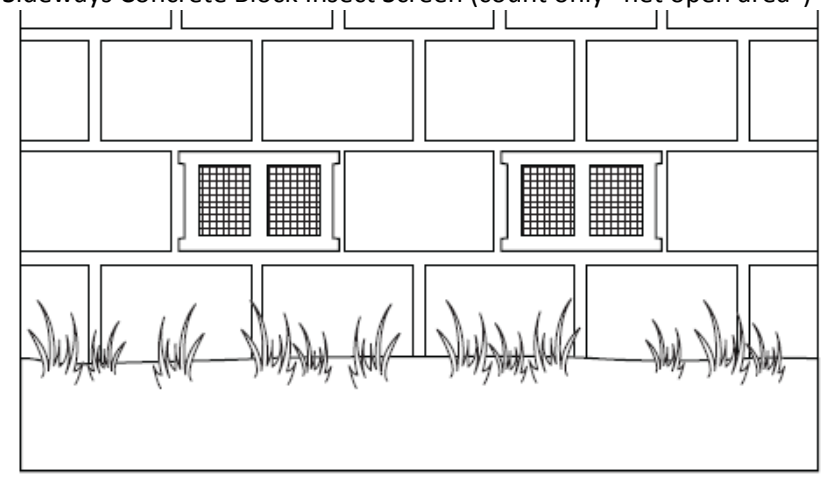
Multiple Units

Flood Opening Examples

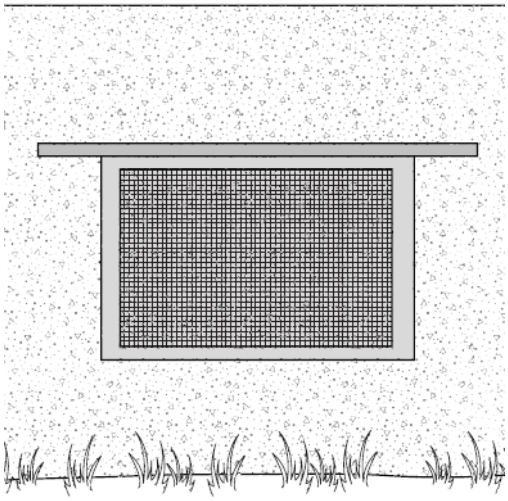


6.5 X .5 = 3.25 X 12.5 = 40.625 inches of opening

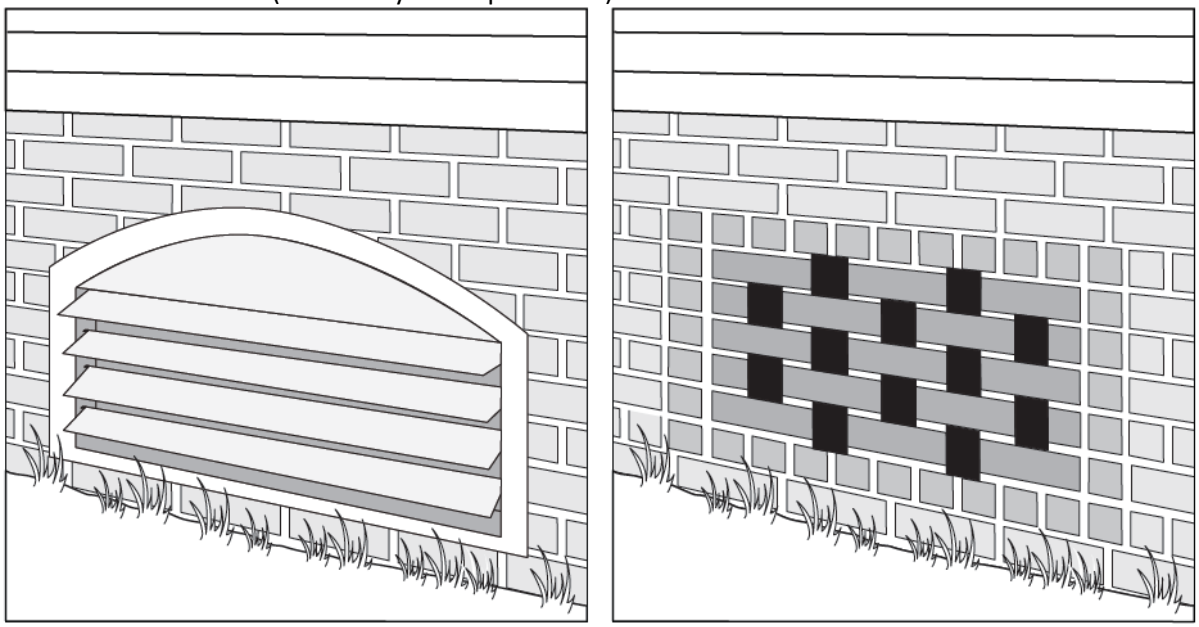
Sideways Concrete Block Insect Screen (count only “net open area”)

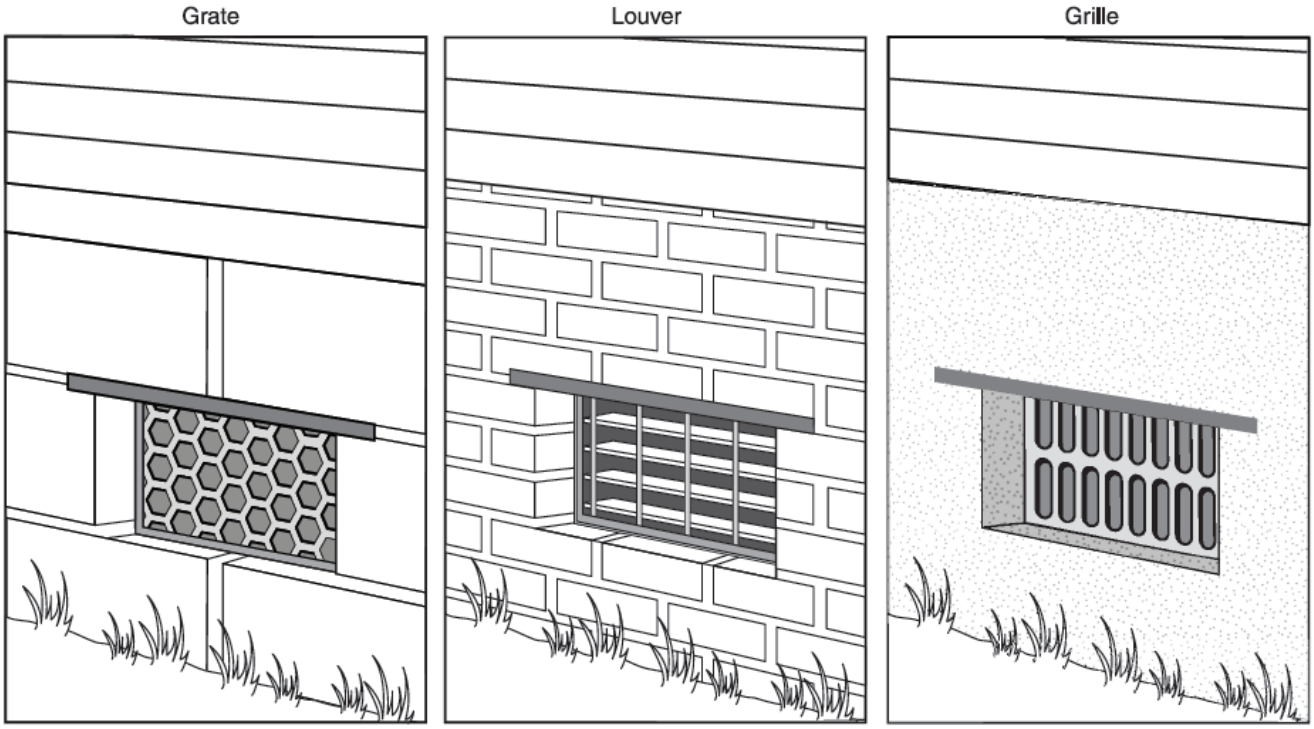


Wood Frame in Concrete Insect Screen (count only “net open area”)



Decorative Treatments (count only “net open area”)





An insulated cover may be used from first snowfall to spring breakup with signed documentation and surprise onsite inspections verifying removal between spring breakup and first snowfall for these types of openings.

Permanent flood openings cannot be blocked during flood season!