



Unit 2

Reducing Risks from Flooding

Objectives: At the end of this unit, participants will be able to:

- 1. List and describe low-cost mitigation steps the homeowner can take to protect the home from flooding.*
- 2. Define floodproofing.*
- 3. List three things an insurance policy purchased through the National Flood Insurance Program covers.*
- 4. Identify six measures that reduce risks from flooding in severe cases.*

INTRODUCTION

Out of all the natural hazards that occur in the U.S., flooding occurs most often; at least 90% of disasters in the U.S. are floods. Most of the flooding that occurs in the U.S. is either **riverine** or **ocean** flooding, although flooding also occurs around lakes and ponds and in isolated areas where storm drainage systems are not adequate.

Riverine flooding, as its name implies, occurs when rivers and streams overflow their banks. Riverine floodwaters can move quite rapidly, as in a flash flood, or very slowly, as they often do where the land is gently sloping or flat. The primary causes of riverine flooding are rainfall and melting snow (and sometimes a combination of both).

Ocean flooding, which is caused by storm surge and wave action, affects primarily coastal areas, especially those along the beachfront, but it can also affect

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areas around bays, and it can back up along rivers and streams that empty into bays. Ocean flooding is most dangerous, and causes the most severe damage, where large waves are driven inland by wind. These wind-driven waves occur primarily along the open coast, where they can destroy houses, wash away protective dunes, and erode the soil, often so much that the ground surface is lowered several feet. But they can also move

inland where the land is flat and there are no large dunes or other obstacles to break them. In these areas the level of damage can rival that along the open coast.

If you have experienced flooding in your home, or if there's a chance you might, **now is the best time to think about floodproofing your home.** You can do many things now that will protect your property in the future.

Many floodproofing measures are quite simple, cost effective, and easy to put in place. By floodproofing, you can make the next flood easier on you and your wallet. If you aren't sure whether your house is at risk from flooding, check with your local floodplain manager, building official, city engineer, or planning and zoning administrator. They can tell you whether you are in a flood hazard area. Also, they usually can tell you how to protect yourself and your house and property from flooding.

Steps You Can Take...

There is a wide range of flood protection measures for buildings that can eliminate or reduce the risk of future flood damage. In severe cases, a building can be relocated out the floodplain area or elevated above the projected flood levels. In less severe cases, which we will focus on first, there are a number of relatively inexpensive flood mitigation techniques that can be used to protect specific elements of a building.

Before we begin with the protection measures, definitions to some terms you will see repeatedly throughout this section are listed below:

One-hundred-year flood—This term is simply a convenient way to express probability. For example, the flood that has a 1-percent probability (1 in 100) of being equaled or exceeded in any year is referred to as the 100-year flood. It should not be interpreted to mean a flood that happens exactly once every 100 years. Nor does it imply that once a 100-year flood occurs, there is little risk of another 100-year flood occurring in the near future. To the contrary, changes in climatic conditions, such as those caused by El Niño, often result in “clusters” of floods that occur over relatively short times at the same location.

For most homeowners, the value of these terms is that they indicate relative frequencies and sizes. On the average, over a long period, a 100-year flood is expected to occur less often than a 50-year flood and more often than a 500-year flood. The 100-year flood is particularly important for homeowners because it is the basis of the National Flood Insurance Program (NFIP) rates and regulatory floodplain requirements. (See NFIP, #8, page 2-7.) In the NFIP, the 100-year flood is referred to as the “*base flood*” and the 100-year flood elevation as the “*base flood elevation*” or *BFE*.

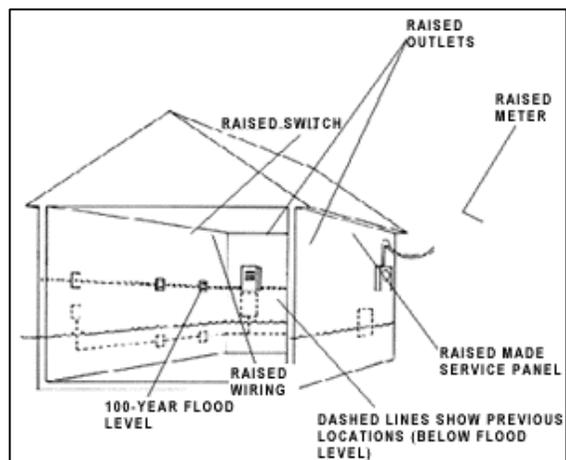
This unit provides examples of the range of flood loss reduction techniques that are available. The following are low-cost mitigation measures you can take to protect yourself, your home, and your property from losses:

1. ***Move valuables and appliances out of the basement of your home or business if it is prone to flooding.*** By doing so, you increase the chance that your belongings will be safe and sound when a flood event occurs. Relocate washer and dryer to a floor with at least a 12-inch safety margin above the base flood elevation or BFE to protect them from flooding.

Should you decide to elevate your washer and dryer, do so on a concrete blocks or a wooden platform (pressure-treated lumber) supported by concrete blocks to at least a 12-foot safety margin above the BFE, or the highest known flood level. Make certain that washers and dryers are secure and will not vibrate off the blocks or platform during use. A 1- or 2-foot waterproof floodwall around appliances will protect them from shallow flooding.

2. ***Elevate or relocate the main breaker or fuse box and the utility meters above the anticipated flood level in your home or business, so that floodwater won't damage your utilities.***

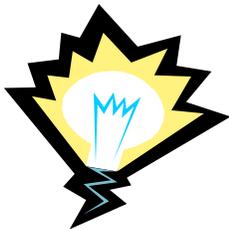
Electrical system components, including service panels (fuse and circuit breaker boxes), meters, switches, and outlets, are easily damaged by flood water. If they are inundated for even short periods, they will probably have to be replaced. Another serious problem is the potential for fires caused by short circuits in flooded systems. Raising electrical system components helps you avoid those problems. Also, having an undamaged, operating electrical system after a flood will help you clean up, make repairs, and return to your home with fewer delays.



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The surest way to protect your valuable electrical system is to keep it from getting wet. All outlets, switches, light sockets and junction boxes, as well as the main breaker or fuse box and electric motors, should be out of danger of getting wet. Make sure each circuit is labeled so you know which circuit controls which outlet and switch.

Elevate electric panel to a recommended minimum 12-foot safety margin above the base flood elevation or the highest known flood level if you are outside of any known flood zone. All components of the electrical system, including the wiring, should be raised at least 1 foot above the 100-year flood level. In an existing house, this work will require the removal of some interior wall sheathing (drywall, for example). If you are repairing a flood-damaged house or building a new house, elevating the electrical system will be easier.



It's a good idea to run wires overhead. If a wire has to run into the zones that could get wet it is best to use a wire rated for underground use. No wire should end in the flood zone and all junctions should be in approved junction boxes. If a wire has to terminate below the 100-year flood level it should be specially marked in the panel box and turned off at the time of a flood warning.

Note:

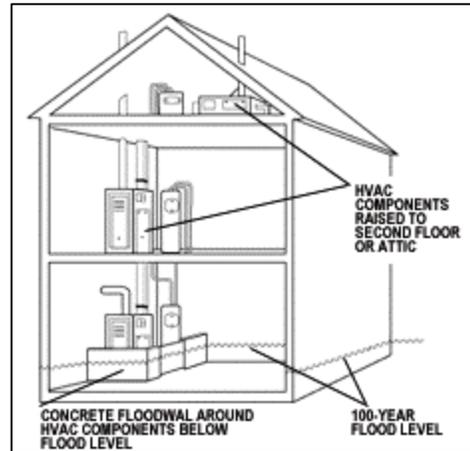
- All relevant permits must be obtained before work begins, and all work must conform to state and local building codes.
- Electrical system modifications must be done by a licensed contractor, who will ensure that the work is done correctly and according to all applicable codes. This is important for your safety.
- Your contractor should check with the local power company about the maximum height that the electric meter can be raised.
- If your house is equipped with an old-style fuse box or low-amperage service, you may want to consider upgrading to a modern circuit breaker system and higher-amperage service, especially if you have large appliances or other electrical equipment that draws a lot of power.

Raising the electrical service panel, meter, and all of the outlets, switches, and wiring in a 1,000-square-foot, single-floor house will cost about \$1,500 to \$2,000. If this work is performed during the repair of a damaged house or construction of a new house, the cost may be much lower.

3. ***Elevate electric baseboard heaters.*** If your 100-year-flood elevation is 12 inches or less above your floor level, you can protect your electric baseboard heater system by elevating it above the floodwaters. Use

waterproof wall construction techniques for the wall area below the baseboard units.

4. ***Elevate or relocate a water heater or heating plant.*** Heating, ventilating, and cooling (HVAC) equipment, such as a furnace or hot water heater, can be damaged extensively if it is inundated by floodwaters. The amount of damage will depend partly on the depth of flooding and the amount of time the equipment remains under water. Often, the damage is so great that the only solution is replacement.



In floodprone houses, a good way to protect HVAC equipment is to move it from the basement or lower level of the house to an upper floor or even to the attic. When relocating or raising the water heater, be sure it will be at least 12 feet above the 100-year flood level. Consult your local building department for details. A water heater can be put anywhere near a hot water pipe.

A less desirable method is to leave the equipment where it is and build a concrete or masonry block floodwall around it. Both of these methods require the skills of a professional contractor. Relocation can involve plumbing and electrical changes, and floodwalls must be adequately designed and constructed so that they are strong enough and high enough to provide the necessary level of protection.

If the existing ductwork for your furnace is below the 100-year flood level (e.g. inside a slab or crawlspace beneath the home) it should be relocated so that it distributes heat from above and runs free and clear of floodwaters. Your local building department can help you determine your 100-year flood level. An updraft furnace located in a basement can be replaced with a downdraft furnace on a floor above the flood protection level. If you are replacing your furnace, ask your supplier for information on a downdraft system.

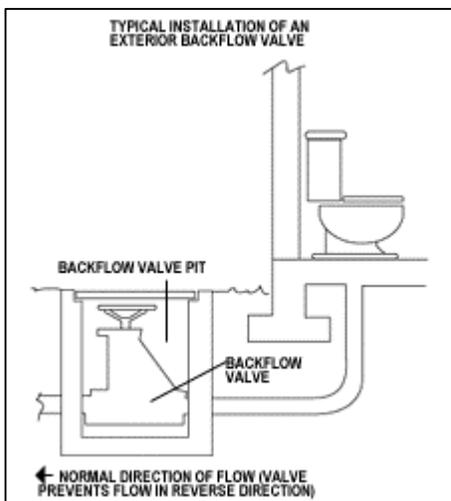
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Note:

- Changes to the plumbing, electrical system, and ventilating ductwork in your house must be done by a licensed contractor, who will ensure that the work is done correctly and according to all applicable codes. This is important for your safety.
- If you are having your existing furnace or hot water heater repaired or replaced, consider having it relocated at the same time. It will probably be cheaper to combine these projects than to carry them out at different times.
- Similarly, if you have decided to raise your HVAC equipment, consider upgrading to a more energy-efficient unit at the same time. Upgrading can not only save you money on your heating and cooling bills, it may also make you eligible for a rebate from your utility companies.
- If you decide to protect your HVAC equipment with a floodwall, remember that you will need enough space in the enclosed area for system repairs and routine maintenance. Also, depending on its height, the wall may have to be equipped with an opening that provides access to the enclosed area. Any opening will have to be equipped with a gate that can be closed to prevent flood waters from entering.

Having your furnace and hot water heater moved to a higher floor or to the attic will cost about \$ 1,500. The cost of a floodwall will depend partly on its height and length. A 3-foot-high wall with a perimeter length of 35 feet would cost about \$1,000.

5. **Elevate an air conditioning compressor or heat pump.** To protect an air conditioning compressor or heat pump, elevate it to at least a 12-foot safety margin above the 100-year flood level on a base of masonry, concrete, or pressure treated lumber. Keep service lines above the 100-year flood level. If your new air conditioner or heat pump will be outside, install it on a platform above your flood protection level.



6. **Install sewer backflow valves.** In some floodprone areas, flooding can cause sewage from sanitary sewer lines to back up into houses through drainpipes. These backups not only cause damage that is difficult to repair but also create health hazards.

A good way to protect your house from sewage backups is to install backflow valves, which are designed to block drainpipes temporarily and prevent flow into the house. Backflow valves are available in a variety of designs that range from the simple to the complex. The figure shows a gate valve, one of the more complex designs. It provides a

strong seal, but must be operated by hand. So the effectiveness of a gate valve will depend on how much warning you have of impending flooding. Among the simpler valves are flap or check valves, which open to allow flow out of the house but close when the flow reverses. These valves operate automatically but do not provide as strong a seal as a gate valve.

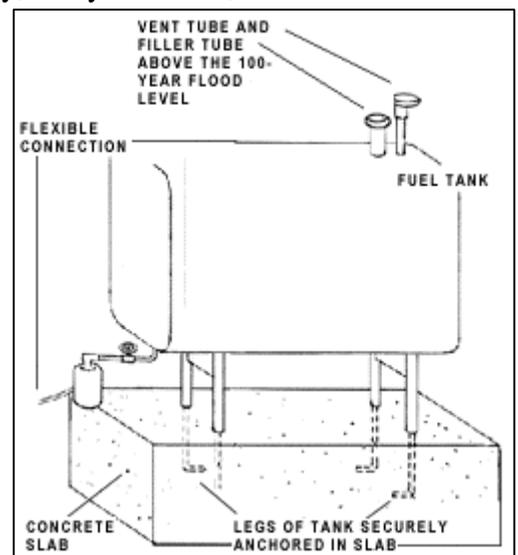
NOTE:

- Changes to the plumbing in your house must be done by a licensed plumber or contractor, who will ensure that the work is done correctly and according to all applicable codes. This is important for your safety.
- Some valves incorporate the advantages of both flap and gate valves into a single design. Your plumber or contractor can advise you on the relative advantages and disadvantages of the various types of backflow valves.
- Valves should be installed on all pipes that leave the house or that are connected to equipment that is below the potential flood level. So valves may be needed on washing machine drain lines, laundry sinks, fuel oil lines, rain downspouts, and sump pumps, as well as sewer/septic connections.
- If you have a sump pump, it may be connected to underground drain lines, which may be difficult to seal off.

Having a plumber or contractor install one backflow valve will cost you about \$525 for a combined gate/flap valve or about \$375 for a flap valve. These figures include the cost of excavation and back-filling.

7. **Anchor a fuel tank.** Unanchored fuel tanks can be easily moved by flood waters; they can tip over or float. Escaping fuel may result in spills and fires. These tanks pose serious threats not only to you, your family, and your house, but also to public safety and the environment. An unanchored tank outside your house can be driven into your walls, and it can be swept downstream, where it can damage other houses. When an unanchored tank in your basement is moved by flood waters, the supply line can tear free and your basement can be contaminated by oil. Even a buried tank can be pushed to the surface by the buoyant effect of soil saturated by water.

To prevent this, anchor your fuel tank. One way to anchor a tank is to attach it to a large concrete slab whose weight is great enough to resist the force of flood waters. This method can be used for all tanks, both inside and outside your house. You can also anchor an outside tank by running straps over it and attaching them to ground anchors. Use non-corrosive metal structural supports and



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fasteners or pressure treated wood structural supports and fasteners or pressure treated wood structural supports. The type of anchorage will vary depending on the size of the tank and the structure it is being attached to. Keep the fuel tank topped off to increase the tank's weight and reduce its tendency to float.

Anchoring a 1,000-gallon fuel tank to a concrete base will cost you about \$300 to \$500. Using straps and ground anchors will cost about \$300.

NOTE:

- If you prefer not to do this work yourself, you can have a handyman or contractor anchor your tank.
- Check with the fuel tank manufacturer for recommendation on anchoring.
- Be sure all work done conforms to state and local building codes.
- For rented tanks, check with the fuel supplier before making any modifications to the tank.
- Extend all filling and ventilation tubes above the 100-year flood level so that flood waters cannot enter the tank.

8. ***Buy flood insurance to cover the value of your home and its contents.*** Not only will insurance give you greater peace of mind, but it will also greatly speed your recovery if a flood occurs.

Even if you have floodproofed your house, you still need insurance to protect you from unexpected events, such as a flood that rises higher than your flood protection level. If you have insurance, find out whether you have the right kinds of coverage, and whether you have adequate coverage. Homeowners' policies do not cover damage caused by floods, so you will need to purchase a separate policy under the **National Flood Insurance Program (NFIP)**, the federal government's principal administrative mechanism for reducing flood damage. Established by Congress in 1968, the NFIP is administered by the Federal Emergency Management Agency (FEMA). The NFIP insures buildings and their contents in flood-prone areas where conventional insurance had, prior to the NFIP, been generally unavailable.

An NFIP policy covers:

- ✓ Damage to your building or contents caused by a general condition of surface water flooding (up to the amount of your coverage)

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- ✓ Costs for moving and storing your contents for up to 45 days (up to the amount of the minimum deductible)
- ✓ Expenses for removing debris left by the flood.

An NFIP policy does ***not*** cover:

- ✓ Damage caused by high groundwater, sewer backup, subsurface flows, wind-driven rain, or local drainage problems that are not considered a “general condition of flooding”
- ✓ Property located outside an insurable building, including fences, outdoor swimming pools, driveways, docks, floodwalls, crops in the field, and landscaping
- ✓ Vehicles, trailers on wheels, and boats
- ✓ Paneling, carpeting, furniture, and contents in the finished portion of a basement or underneath an elevated building
- ✓ Animals
- ✓ Money, valuable papers, and land values
- ✓ Living expenses and lost income



The NFIP provides federally backed insurance coverage for any building in a community that is participating in the program. Almost every type of walled and roofed building can be insured. It does not matter whether the building is in or out of the floodplain. A mobile (manufactured) home affixed to a permanent site and properly anchored can also be insured. You can get coverage on the building as well as for contents.

Types of Coverage:

- **Building Coverage.** Insurance can be purchased for the building, including walls, floors, insulation, wall-to-wall carpeting, furnace, and other items permanently attached to the structure. (Permanent items include anything that would not fall out if you were to turn the building upside down.) Up to 10 percent of the policy value for building coverage may apply to a detached garage or carport on the same lot.

If you buy insurance for 80 percent or more of the replacement value of your house, you will be reimbursed for the replacement value of damage to your house—no depreciation will apply. If your coverage is for less than 80

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percent, you will be reimbursed for the actual cash value of the damage—replacement value minus depreciation.

- **Contents Coverage.** Contents coverage insures your personal property. Renters as well as owners may purchase contents coverage. Although you can get contents coverage without having a building that can be insured under the NFIP. Contents coverage will pay some of the costs of moving and storing contents in a safe place when a flood threatens.
- **Basements.** Building coverage is recommended to cover walls, floor, furnace, and other structural components of a basement. However, the NFIP does not cover finished portions of a basement (carpets, wallboard) or its contents. Damage to the basement foundation is a major problem during floods, so this coverage can be very important even though it does not cover the finished portions (carpets, wallpaper) of basements. Some private companies sell coverage for water damage caused by sewer backup or sump pump failure—items that are not covered by the NFIP.

NFIP flood insurance is sold through private insurance agents and companies. All policies offer identical coverage and rates. Newer or substantially improved houses are charged flood insurance rates according to their elevation in relation to the expected flood level. Older houses, which are “grandfathered” in, qualify for a flat, subsidized rate. Houses outside floodplains that are identified on Flood Insurance Rate Maps (FIRMS) often pay lower rates. You can check your property’s location on a FIRM at your building department or ask an insurance agent.

A few private insurance companies sell their own flood insurance policies, although the coverage and rates are different from the NFIP’s. Some mobile home insurance covers flood losses. Unlike the NFIP, private insurance varies from company to company, so check around to compare their coverage and rates.

If you are located in a floodplain shown on a Flood Insurance Rate Map, you must buy flood insurance coverage as a condition of having a mortgage or home improvement loan from a federally regulated lender or as a condition for getting federal disaster assistance. In some cases, private insurance will satisfy this requirement, but generally the lender or disaster assistance agency will ask you to get an NFIP policy.

Flood Insurance Facts

Myth: My standard homeowners' insurance will cover me if my house is damaged or destroyed in a flood.

FACT: Homeowners' insurance does not cover flood damage. Federal flood insurance, purchased through your insurance agent or company, is the only guaranteed flood insurance coverage available for your home.

Myth: Federal disaster aid, available during and after a flood, will reimburse me for losses. Therefore, I don't need to buy flood insurance for my home and belongings.

FACT: Federal Emergency Management Agency disaster aid is only available during Presidentially declared disasters. Federal aid may often be in the form of an SBA loan that you must pay back with interest. Flood insurance policies pay claims whether or not a disaster is declared.

Myth: I live outside the floodplain, so I don't need to buy flood insurance.

FACT: More than 25 percent of the National Flood Insurance Program's (NFIP) claims are for structures outside identified flood plains. Floods can occur anywhere. An area that is near a levee or a dam is at

risk of levee or dam breakage. People who face even moderate flood risks should get insurance, which can be purchased for as little as \$80 per year.

Myth: I can't buy flood insurance because my home has been flooded previously.

FACT: If your community is participating in the NFIP, it doesn't matter that your home has been flooded before. You may still buy flood insurance.

Myth: If people don't want to purchase flood insurance, it's their own business. It doesn't really affect me.

FACT: When people do not buy flood insurance, you pay more for federal and state disaster relief. Flood insurance is one of the best ways to keep disaster relief costs down for all taxpayers.

Myth: Flood insurance is only available for homeowners.

FACT: Flood insurance is available to protect homes, condominiums and nonresidential buildings including farm and commercial structures in participating communities. Contents coverage also is available, so coverage is available to renters as well.

Myth: If they predict a flood in the near future, it's too late for me to purchase insurance.

FACT: You can purchase flood insurance anytime in a participating community. However, there is a 30-day waiting period after you have applied and paid the premium before the policy is in effect. The policy will not, however, cover a loss in progress.



**DON'T
WAIT!**

Buy flood

insurance protection before the next flood is threatening. Call your insurance agent for information on rates and coverage.

**For Flood Insurance
Information Call
1-800-427-4661**

MORE STEPS TO REDUCE FLOOD DAMAGE

You may need to decide if you will be better off living in a different location, away from areas that flood. Ask your building official about government agencies that sometimes purchase property for open space or flood protection in areas that flood—you may qualify.

If you are sure that you will repair or rebuild your house in the floodprone area, choose the mitigation measures that are best for your home or property. Each homeowner's situation needs to be looked at individually.

There are 6 basic mitigation steps or types of floodproofing described below.

Please note: These measures will be for more severe cases and will be more costly.

1. Elevation

One of the most common retrofitting methods is elevating a house to a required or desired Flood Protection Elevation (FPE). When a house is properly elevated, the living area will be above all but the most severe floods (such as the 500-year flood). Most types of houses can be raised so that the lowest floor is above the FPE, including wood frame, brick, slab-on-grade, crawlspace, or homes with basements. This is an extremely reliable flood proofing method and requires little human intervention to prepare for a flood event.

If you had foundation damage from a flood, you may need to raise the house to repair it. It will be easier and cheaper to elevate the house at that time. Several elevation techniques are available. In general, they involve (1) lifting the house and building a new, or extending the existing, foundation below it or (2) leaving the house in place and either building an elevated floor within the house or adding a new upper story.

An elevated building will need a new foundation. The contractor will jack up the house and set it on a temporary framework call cribbing while the new foundation is built underneath. The foundations of an elevated building may be columns, piers, pilings, or raised foundation walls. The elevated building will usually look better and have added protection if fill dirt is placed around the new foundation. But check with your building department before adding fill dirt. It may not be allowed in all areas of your community.

The floor elevation height should be set at a recommended safety margin above the 100-year-flood level. Some buildings may be elevated over 9 feet above their existing floor levels. In such an extreme case the new lower level would probably be used as a garage. In all cases, a new entry stair and front porch is built to meet the new height. Elevating a home requires use of

professional plumbers/electricians, house movers, contractors, and structural engineers to help you design your new foundation and obtain a permit from your building department. Because the new foundation will be in the floodwaters, it is extremely important that it be structurally designed to withstand lateral (sideways) forces such as fast flowing currents and the impact of water-borne debris.

Basic Steps in Elevating a Building:

- Have appropriate professionals disconnect all utilities.
- Hire a professional house mover to disconnect your house from the existing foundation, jack it up to the new height and provide a temporary foundation.
- Have the utilities temporarily reconnected so the house is livable while foundation work is done.
- Build a temporary access stair to meet the new height.
- Build a new, permanent foundation.
- Have the house mover lower the house onto the new foundation and connect the anchor bolts.
- Have the utilities permanently reconnected.
- Build a new, permanent access stair and landing.



There are other variations of this technique. Also, there are numerous contractors throughout the United States who are qualified to undertake elevating your house above the flood level. Elevation or relocation are the only reasonable ways to protect your home if it is subject to coastal flooding or to deep flooding (flooding more than 6 feet deep). Elevation and relocation are also the most dependable measures for floodproofing your home.

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Case Study - Winter Floods 1997

Herb and Lark Lozoff and their children of Forestville, California, lost everything when floods in 1995 swept through their home. The most painful loss was the destruction of personal family items, including irreplaceable photographs. The recovery was long, and the family vowed to do whatever was necessary to ensure it didn't happen again. With the help of their community, the Lozoff's elevated their house above the flood level and strengthened it against earthquakes. It didn't take long for their efforts to pay off -- the floods of December and January surged into their yard and ground-level garage. But their house stayed safe and dry above the roaring waters. Herb Lozoff said: "We had 7 feet of water in the house in '95. We raised it up almost 11 feet and didn't get a drop of water in the house. This was a little bit less than the flood of '95, a few feet less. But it wasn't even close. We were a good 5 feet above the highest water."

Lark Lozoff said, "It was just the best thing we ever did. Paying that price one time, you can get the house up and it won't happen again."

ADVANTAGES AND DISADVANTAGES OF ELEVATION

ADVANTAGES	DISADVANTAGES
<ul style="list-style-type: none"> ▪ Elevation to or above the BFE allows a substantially damaged or substantially improved house to be brought into compliance with your community's floodplain management ordinance or law. ▪ Elevation reduces the flood risk to the house and its contents. ▪ Except where a lower floor is used for storage, elevation eliminates the need to move vulnerable contents to areas above the water level during flooding. ▪ Elevation often reduces flood insurance premiums. ▪ Elevation techniques are well known, and qualified contractors are often readily available. ▪ Elevation does not require the additional land that may be needed for the construction of floodwalls or levees. ▪ Elevation reduces the physical, financial, and emotional strain that accompanies floods. 	<ul style="list-style-type: none"> ▪ Cost may be prohibitive. ▪ The appearance of the house may be adversely affected. ▪ Access to the house must not be occupied during a flood. ▪ The house must not be occupied during a flood. ▪ Unless special measures are taken, elevation is not appropriate in areas with high velocity flows, waves, fast-moving ice or debris, or erosion. ▪ Additional costs are likely if the house must be brought into compliance with current code requirements for plumbing, electrical, and energy systems. ▪ Potential wind and earthquake loads must be considered.

Table 2.1

2. Relocation

Moving a building out of the flood-prone area is the surest way to protect it from flood damage. Most houses and smaller commercial buildings in good condition can be moved, and it is usually no problem to find contractors experienced in moving buildings. You will have to purchase a new lot unless your present lot is large and has a good spot on higher ground for your house. Relocation and elevation are the only reasonable choices for protecting a house that is subject to deep flooding (flooding more than 6 feet deep) or to coastal flooding.

To relocate a building, it is detached from the original foundation, placed on a heavy-duty truck bed, transported to the new site and set on a conventional foundation. The house is installed on the new foundation and all utility lines are connected. Relocation is particularly appropriate in areas where the flood hazard is severe, such as where flood conditions are characterized by one or more of the following:

- Deep water
- Short warning time
- High flow velocity
- Long duration
- High rates of rise and fall
- Wave action
- High debris potential

Relocation is also appropriate for homeowners who want to be free of worries about damage from future floods that may exceed a selected FPE.

Unless there is a hidden structural defect, most homes and small commercial buildings in good structural condition can be moved with no more damage than occasional slight cracks in the plaster or wallboard joints. Single story frame houses over a crawlspace or basement are easiest to relocate. Multi-story, slab-on-grade, and brick buildings can also be moved.

Moving a house is a complex operation that requires a professional house mover. Although similar to *elevation*, relocation requires additional steps that usually make it more expensive. Before you choose a house mover, obtain bids from several companies and contractors. Before choosing the lowest bid be certain the contractor or mover has the experience and resources to complete the project at the quoted price. Be certain that they have liability insurance to cover the move.

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Construction Steps Involved in Building Relocation

- Locate a new building site.
- Check the transportation route to the new location. Is it clear and adequate to move the house?
- On the building site, construct a new perimeter and interior foundation that coordinates with the existing house.
- Install new utilities to stubbed-in locations in the foundation. Disconnect, elevate and move the house to the new location.
- Lower and anchor the building onto the new foundation.
- Connect the new utilities.

Let's take a look at the advantages and disadvantages of relocating a building.

ADVANTAGES AND DISADVANTAGES OF RELOCATION

ADVANTAGES	DISADVANTAGES
<ul style="list-style-type: none"> ▪ Relocation allows a substantially damaged or substantially improved house to be brought into compliance with your community's floodplain management ordinance or law. ▪ Relocation significantly reduces flood risk to the house and its contents. ▪ Relocation can either eliminate the need to purchase flood insurance or reduce the amount of the premium. ▪ Relocation techniques are well known, and qualified contractors are often readily available. ▪ Relocation reduces the physical, financial, and emotional strain that accompanies flood events. 	<ul style="list-style-type: none"> ▪ Cost may be prohibitive. ▪ A new site (preferably outside the flood hazard area) must be located and purchased. ▪ Disposition of the flood-prone lot must be addressed. ▪ Additional costs are likely if the house must be brought into compliance with current code requirements for plumbing, electrical, and energy systems.

Table 2.2

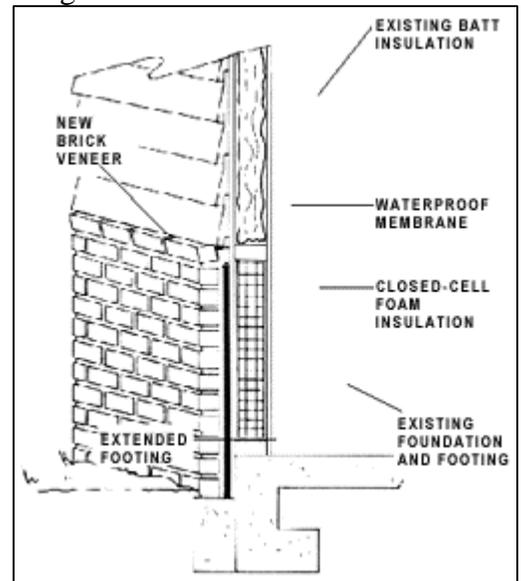
3. Floodwalls

Floodwalls, berms, and levees all work to keep floodwaters from reaching your house. They are built to at least the height of the flood protection level in your area. Floodwalls are usually made of concrete. Berms are simply small levees, usually built from fill dirt.



Floodwalls, berms, and levees can either surround the building (ring levee) or connect to high ground. They can also be built up against a building's foundation walls. A sump and pump will be needed to pump out water that seeps under the walls. Floodwalls, levees or berms may not be allowed in your area if they could create a drainage problem on your neighbor's property. Check with your building department before you build.

Floodwalls of all types work best in places where flooding is less than 3 feet deep. If floodwaters near your house develop swift currents, earthen levees and berms cannot be used—they may wash away. Floodwalls and berms may not be appropriate for homes with basements.



- ◆ An **exterior floodwall** can protect a window well or stair against low level flash flooding. Walls should be supported by and securely tied to a footing so that they will not be undercut by scouring. It is important to understand the flood situation you are working with and your soil conditions in order to properly evaluate if a floodwall is the right solution for you. Floodwalls are not effective when the ground becomes saturated.

Construct a watertight masonry floodwall around the perimeter of the opening. The wall should not exceed 3 feet in height and must be constructed of properly reinforced poured concrete or sufficient masonry units to prevent failure under the flood conditions. Install proper footing and anchor to existing walls. Install a watertight, spring-loaded steel access door and watertight gaskets on sides and bottom of frame at any necessary opening. Be sure all work conforms to State and local building codes.

- ◆ An **interior floodwall** can be built to accommodate low levels of flooding. The wall must enclose the utilities and be built 1 foot above the 100-year flood elevation. The wall must be constructed of either concrete blocks or poured concrete and reinforced with steel rods in order to be able to resist the pressure of the floodwaters. It is important to anchor the new wall into the existing basement wall and floor so that it is not pushed around by the floodwaters. For best protection, do not install gates that open **into** the enclosure.

Unit 2: Reducing Risks from Flooding

Even in areas where floodwaters are less than 2 feet deep, a house can be severely damaged if water reaches the interior. The damage to walls and floors can be expensive to repair, and the house may be uninhabitable while repairs are underway.

To protect a house from shallow flooding, add a **waterproof veneer** to the exterior walls sealing all openings, including doors, to prevent the entry of water. As shown in the figure, the veneer can consist of a layer of brick backed by a waterproof membrane. Before the veneer is applied, the siding is removed and replaced with exterior grade plywood sheathing. If necessary, the existing foundation footing is extended to support the brick. Also, because the wall will be exposed to flood water, changes are made to the interior walls as well so that they will resist moisture damage. In the area below the flood level, standard batt insulation is replaced with washable closed-cell foam insulation, and any wood blocking added inside the wall cavity is made of exterior grade lumber.



Tips

Keep these points in mind when you have a waterproof veneer added to the exterior walls of your house:

- Adding a waterproof veneer is appropriate in areas where the flood depth is less than 2 feet. When flood depths exceed 2 feet, the pressure on waterproofed walls increases greatly, usually beyond the strength of the walls. If greater flood depths are expected, consult with a licensed civil or structural engineer before using this method.
- Changes to the foundation of your house must be done by a licensed contractor, who will ensure that the work is done correctly and according to all applicable codes. This is important for your safety.
- If your house is being remodeled or repaired, consider having the veneer added as part of the remodeling or repair work. It will probably be cheaper to combine these projects than to carry them out separately.
- If your house has brick walls, you can still use this method. The new brick veneer and waterproof membrane are added over the existing brick.
- If your house is flooded by groundwater entering through the floor, this method will not be effective.

Estimated Cost. If you have a contractor add a waterproof brick veneer to your house, you can expect to pay about \$10 per square foot of exterior wall. For example, a 3-foot-high brick veneer on a house measuring 60 feet by 30 feet would cover about 540 square feet and would cost about \$5,400. This figure does not include the cost of sealing doors and other openings or extending the foundation.

The advantages and disadvantages of adding levees and floodwalls are listed on the next page.

ADVANTAGES AND DISADVANTAGES OF LEVEES AND FLOODWALLS

ADVANTAGES	DISADVANTAGES
<ul style="list-style-type: none"> ▪ The house and the area around it will be protected from inundation, and no significant changes to the house will be required. ▪ Floodwaters cannot reach the house or other structures in the protected area and therefore will not cause damage through inundation, hydrodynamic pressure, erosion, scour, or debris impact. ▪ Building levees and floodwalls is usually less expensive than elevating or relocating a house. ▪ The house <u>can</u> be occupied during construction of levees and floodwalls. ▪ Levees and floodwalls reduce the flood risk to the house and its contents. ▪ Levees and floodwalls reduce the physical, financial, and emotional strain that accompanies flood events. 	<ul style="list-style-type: none"> ▪ Levees and floodwalls may not be used to bring a substantially damaged or substantially improved house into compliance with your community’s floodplain management ordinance or law. ▪ Cost may be prohibitive. ▪ Periodic maintenance is required. ▪ Human intervention and adequate warning time are required to close any openings in a levee or floodwall. ▪ If a levee or floodwall fails or is overtopped by floodwaters, the effect on the house will be the same as if there were no protection at all. ▪ An interior drainage system must be provided. ▪ Local drainage can be affected, possibly creating or worsening flood problems for others. ▪ The house must not be occupied during a flood. ▪ Access to the house may be restricted. ▪ Levees and floodwalls do not reduce flood insurance rates. ▪ Floodplain management requirements may make levees and floodwalls violations of codes and/or regulations. ▪ A large area may be required for construction, especially for levees. ▪ Hydrostatic pressure on below-ground portions of a house may still be a problem, so levees and floodwalls are not good retrofitting methods for houses with basements.

Table 2.3



4. *Dry floodproofing*

Dry floodproofing means sealing a building to keep floodwaters out. All areas below the flood protection level are made watertight. Walls are coated with plastic or rubberized sheeting or special waterproofing compounds. Openings such as doors, windows, sewer lines, and vents are closed permanently, or they are temporarily sealed with removable shields or sandbags.

Dry floodproofing can only be done if the walls of your house are strong enough to hold back the floodwaters without collapsing. For this reason, dry floodproofing is not recommended if your flood protection level is more than 2 or 3 feet above ground level. Dry floodproofing is generally *not* appropriate for houses with basements or crawl spaces. Successful dry floodproofing involves the following:

- sealing the exterior walls of the house
- covering openings below the flood level
- protecting the interior of the house from seepage
- protecting service equipment (utility systems, heating and cooling systems and large appliances) outside the house



5. *Wet floodproofing*

Wet floodproofing means modifying a building so that floodwaters will cause only minimal damage to the building and contents. Building materials below the flood protection level are replaced with materials that are resistant to water. Floodwaters are allowed into the building to counteract the pressure of the water on the outside of the walls.

You should furnish areas that have been wetproofed with light, portable furniture that can be easily and quickly moved before a flood. Objects that are difficult to move quickly, such as furnaces, water heaters, appliances, and bookcases, are either put permanently on platforms or reinstalled upstairs.

Wet floodproofing has one advantage over the other four floodproofing types: even the smallest efforts will significantly reduce flood damage the next time. Simply moving furniture and electrical appliances out of areas that will flood can save thousands of dollars. If you decide not to use one of the other four floodproofing measures described above, you should use wet floodproofing measures as you repair and rebuild.

Successful wet floodproofing involves the following:

- ensuring that flood waters enter and exit the house
- ensuring that flood waters inside the house rise and fall at the same rate as flood waters outside
- protecting the areas of the house that are below the flood level from damage caused by contact with flood waters
- protecting service equipment inside and outside the house
- relocating any materials stored below the Flood Protection Level (FPE)

6. *Demolition*

Demolition is another mitigation method that can be practical and effective. Demolition is used in the following instances:

- If a floodprone house has been severely damaged because of flooding or any other cause.
- If an undamaged house, deteriorated over time, is not worth retrofitting with any of the other methods described in this chapter.

If you choose the demolition method, you will tear down your damaged house and either rebuild properly on the same property or move outside the floodplain. It involves disconnecting and capping utility lines at the damaged house, tearing the house down, removing debris and otherwise restoring the old site and building or buying a new house. The most important considerations involve how badly your house has been damaged and your options for building or buying a new house.

Basic Steps in Demolition of Buildings:

- Have utility company turn off all services to the house.
- Have demolition contractor disconnect the utility lines. If you do not plan to rebuild on the same site, the contractor will cap the lines permanently or remove them according to utility company requirements.
- Have environmental hazards, such as asbestos, abated in accordance with Federal, state and local requirements.

Unit 2: Reducing Risks from Flooding

- Demolition contractor will push down the house with bulldozer and then dispose of resulting debris.
- Have old site restored including demolishing or removing the house and any pavement (driveway or patio), grading areas disturbed by the demolition, and stabilizing the site with grass.
- Have aboveground and underground tanks drained or removed, or anchored to resist flotation.
- Utilizing the services of a qualified geotechnical or environmental engineering firm, have soil tested around an underground tank to determine whether leakage has occurred.
- Have contaminated soil cleaned if there has been leakage from the tank.

ADVANTAGES AND DISADVANTAGES OF DEMOLITIONS

<ul style="list-style-type: none"> ▪ Demolition greatly reduces or eliminates the potential for damage from floods, earthquakes, high winds and other hazards. ▪ Tearing down a house is an easy process. ▪ If a disaster has caused extensive damage to the interior and exterior of your house or left it structurally unsound, tearing it down and starting over may be easier than making all of the necessary repairs. ▪ Demolition techniques are well known, and qualified contractors are often readily available. ▪ Demolition reduces the physical, financial, and emotional strain that accompanies flood and other hazard events. 	<ul style="list-style-type: none"> ▪ Demolition is disruptive to occupants. ▪ Cost may be prohibitive. ▪ You will need to purchase a house elsewhere or rebuild somewhere on the existing property. ▪ If you are not rebuilding on the old site, the site must be restored to the requirements of local regulations. ▪ Old property inside the regulatory floodplain may be difficult to sell because of restrictions on its use.
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Table 2.4

Permit. You or your design professional or contractor must check with local officials regarding permitting requirements for the necessary work. All permits for demolition, including disconnecting and capping utilities and disposing of debris; new construction; and restoration of the old site should be obtained before the demolition process begins.

BUILDING PERMIT

Once you've determined the repairs and floodproofing measures you are going to take, local codes generally require that you get a building permit. Before you make repairs or alterations to your home or property, make sure your plans are reviewed and OK'ed by your building department. You may also need to get the OK of your homeowners' association or mortgage holder before you make repairs or alterations to your home or property.

If you are just replacing items such as carpeting or wallboard, you will probably not need a permit—but should check with your local building department before you proceed. You will usually have to get a permit for electrical work and repairs of structural damage, such as broken walls.

Most local and state building codes require that a building that is substantially damaged be treated as a new building. A new residential building must be so that its lowest floor is at or above the flood protection level. In other words, if your house is substantially damaged, you will have no choice but to elevate or relocate your house in order to meet local building codes.

Failure to follow the local building code can result in an order to stop reconstruction, a fine, higher flood insurance rates, denial of flood insurance, or all of the above.

**Before you begin the work, make sure you'll do
it right.
Contact you local building official!!**



Unit Review

Circle the correct response. Answers may be found on page A1.

1. The reason for purchasing flood insurance under the National Flood Insurance Program (NFIP) is:
 - a) An NFIP policy covers damage to paneling, carpeting and furniture in a basement.
 - b) NFIP policies are sold through private insurance agents and companies.
 - c) NFIP policy covers damage to your home or contents caused by surface water flooding, something homeowners' insurance policies do not cover.
 - d) An NFIP policy covers water damage caused by sewer back-up or sump pump failure.

2. What can you do about wires that terminate below the 100-year flood level?
 - a) Make sure the wire is specially marked in the panel box and turned off at the time of a flood warning.
 - b) Leave it where it is and repair the damages after the flood event.
 - c) Have a qualified electrician move all wiring well above the 100-year flood level, out of danger of getting wet.
 - d) No wires end in the flood zone.

3. Washers and dryers:
 - a) can be used immediately following a flood whether or not they got wet.
 - b) should never be elevated because they may vibrate off of blocks during use.
 - c) can be relocated to a floor with at least a 12-inch safety margin above the base flood elevation to protect them from flooding.
 - d) are designed to withstand floodwaters and are therefore not affected during a flood.

4. The *surest* way to protect a building from flood damage is to:
 - a) Close all windows and doors as soon as you receive the flood warning.
 - b) Construct a floodwall or levee around the building.
 - c) Move the building out of the flood-prone area.
 - d) Elevate the home above the base flood elevation level.

5. Circle the statement below that is true:
 - a) Dry floodproofing can be done only if you have a basement or crawl space.
 - b) In wet floodproofing, floodwaters are allowed into the building to counteract the pressure of the water on the outside of the walls.
 - c) Building permits are usually not necessary if you have written plans for altering your home or property.
 - d) If your house is flooded by ground water entering through the floor, adding a waterproof veneer will help.