SELECTING PRESERVATION-SENSITIVE MITIGATION OPTIONS

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INTRODUCTION

KEY QUESTION:

What are the main types of flood mitigation options?

Flood mitigation benefits from a holistic approach. When rebuilding following a flood, individual property owners may seek to make improvements to lessen potential damage from future floods. Community-wide mitigation strategies are often expensive and may take longer to complete than individual property mitigation, but they can alleviate the need for drastic changes at the individual property level. *(Refer to Planning & Preparedness, page 2.3, and Mitigation, page 2.51.)* ***Most communities will benefit from a combination of community-wide mitigation strategies that provide protection to multiple properties, as well as property-specific measures implemented by property owners to address specific needs.*** Communities that, prior to a flood event, establish parameters for change through zoning code requirements or design guidelines for flood mitigation will be in a better position to react to property owner requests. *(Refer to Modify Zoning Ordinance, page 2.54, Develop Design Guidelines for Flood Mitigation, page 2.55, and Zoning Options, page 3.12.)* In some cases, flood mitigation efforts help protect one property or area while increasing flood vulnerability of unprotected adjacent properties and areas. ***As a result, it is often prudent to evaluate protection options on a neighborhood or community-wide basis, and/or engage adjacent properties or communities with similar flood challenges to evaluate and implement protection options together.***

The practice of flood mitigation, although intended to protect life and property, is often at odds with historic preservation. Flood mitigation strategies tend to require change, often radical change, that can damage or destroy the integrity or character of historic properties. As with all proposed physical alterations to historic buildings, *The Secretary of the Interior's Standards for the Treatment of Historic Properties* (2017) provides the best guidance in the evaluation of flood mitigation options, but many situations will require trade-offs. To help balance the needs of flood mitigation and historic preservation, local preservation planners and advocates should be involved in the hazard mitigation planning process. *(Refer to Planning & Preparedness, page 2.3.)*

Historic integrity is the authenticity of a property's historic identity, evidenced by the survival of physical characteristics that existed during the property's prehistoric or historic period. Historic integrity is the composite of seven qualities: location, design, setting, materials, workmanship, feeling, and association.

Character refers to all those visual aspects and physical features that comprise the appearance of every historic building.

This chapter of the Guide will help planners, preservation advocates, and others who are engaged in hazard mitigation planning for individual properties or communities and wish to evaluate potential strategies with both flood mitigation and historic preservation goals in mind. Property-specific mitigation options are determined by individual property owners within the requirements of the National Flood Insurance Program (NFIP), if applicable, as well as local zoning, floodplain ordinances, and the local historic preservation commission. *(Refer to National Flood Insurance Program, page 1.17, and Understanding Repairing / Rebuilding Requirements, page 2.45.)* Community-wide strategies are typically determined through the hazard mitigation planning process and ideally benefit from extensive public engagement and vetting. *(Refer to Engage the Public, page 2.17.)* Readers who are beginning the hazard mitigation planning process or who are interested in the process of evaluating and selecting options should refer to *Chapter 2: Historic Preservation & Emergency Management* of this *Guide.* *(Refer to Planning & Preparedness, page 2.3, and Mitigation, page 2.51.)*

Flood mitigation options typically have the following goals:

- **Mitigate direct impacts** such as erosion, high wave action, high-velocity water flow, and debris impact;
- **Mitigate secondary impacts** such as rain and wind impacts that can damage buildings; and
- **Mitigate property damage** to buildings and infrastructure, including damage to community-wide infrastructure, individual building systems, and long-term damage associated with water infiltration, such as mold.

To evaluate and select flood mitigation alternatives that meet these goals and protect historic properties, planners and preservation advocates should have an in-depth knowledge of:

- The location, significance, and integrity of local historic and cultural properties;
- How citizens value these properties, including which properties are deemed particularly important to the local sense of place;
- How those properties are vulnerable to flooding;
- How those properties are regulated, including whether they are locally designated and subject to review by an historic preservation commission; and
- How proposed mitigation measures might adhere to or conflict with *The Secretary of the Interior's Standards for the Treatment of Historic Properties.* (2017) (For more detail on the relationship of preservation planning considerations within the hazard mitigation planning process. *(Refer to Planning & Preparedness, page 2.3.)*

The following chapter is divided into two main sections: *Community-Wide Mitigation Strategies* and *Property-Specific Mitigation Strategies*. Each section provides a discussion of alternatives, including potential benefits and conflicts with preservation. ***The hazard mitigation planning team and/or property owner should consider these alternatives as they relate to locally established goals for flood mitigation and the local context for historic preservation, as outlined above.***

KEY QUESTION:

How does flood mitigation relate to historic preservation, and how are flood mitigation decisions made?

KEY QUESTION:

How should readers use this section of the Guide?

Figure 3.1 - Streetscape in the Whitehaven National Register Historic District with elevated property (yellow house). Whitehaven, Wicomico County.

A. COMMUNITY-WIDE MITIGATION STRATEGIES

KEY QUESTION:

What are the goals and benefits of community-wide mitigation strategies?

Community-wide mitigation strategies can provide protection from floods, lessen the severity of flood-related damage, or assist in or promote response and recovery efforts. The potential impact of large-scale physical mitigation options on historic integrity is generally reduced if the mitigation is physically remote from the historic resource. As a rule, community-wide strategies will:

- Reduce or mitigate the extent of flood threat within the risk management timeframe;
- Benefit large numbers of properties, whether they are historic or not;
- Create an environment which facilitates the continued population and lifestyle associated with the intangible sense of place; and
- Encourage community-wide buy-in, since the approach protects all properties rather than being geared towards only historic properties.

KEY QUESTION:

How do these strategies relate to historic preservation concerns?

The appropriate strategies to consider for each community will depend on the risk management timeframe as well as the level of threat or vulnerability. *(Refer to Establish a Timeframe for Planning Goals, page 2.20.)* In addition, it is valuable to consider implementation of a variety of options simultaneously, to increase the likelihood of effectiveness. Some large-scale options adjacent to historic properties may have a negative impact on the historic context of a resource. For example, significantly increasing the height of a sea wall adjacent to a historic district can obstruct the visual and physical connection to the water, altering the historic context and sense of place.

Strategies that are best geared towards community-wide implementation include:

- Shoreline or bank protection;
- Stormwater management systems upgrades;
- Utility and infrastructure improvements; and
- Roadway and bridge improvements.

Before evaluating community-wide mitigation strategies, the local planning team should take the following considerations into account.

- They require planning and analysis to identify potential long-term benefit.
- Many strategies can be costly to implement, and implementation must be balanced against other community needs.
- To be effective, several strategies – particularly the natural strategies – require control of large areas of land, some of which may be in private ownership.
- The implementation of the strategy could increase the severity of the threat on adjoining unprotected areas.
- There must be both political will and community buy-in to complete the project.
- Significant time might be required for implementation, and local support for the project might not be sustained.
- A community must make a commitment to maintain the improvements so that they remain effective as long as possible.
- There could be secondary consequences associated with a strategy – such as a decrease in the local tax base associated with undeveloped or underdeveloped real estate.

For shoreline protection and stormwater management projects, options range from emulating the natural landscape at one extreme, to building "structured" or "hard" adaptations at the other. ***Long-term, "natural" strategies are likely to be more effective than structural improvements because they tend to be more adaptable as the level of risk increases and present lower overall maintenance requirements.*** In addition, from a preservation point of view, natural strategies may provide a more historically appropriate setting. Many of the natural approaches are also scalable, in that they can be adapted to a single property or across a city, where they can provide equal protection to entire areas irrespective of property values or the means of individual owners.

When evaluating these options, it important to consider the potential preservation implications, direct and long-term costs associated with maintenance, and the potential impact of reduced property tax revenue. *(Refer to pages 3.5 to 3.15 for descriptions and sidebars for each mitigation option.)* The *Community-Wide Mitigation Options Matrix* provides a framework for making choices by identifying potential strategies and related flood mitigation benefits and issues. *(Refer to Community-Wide Mitigation Options Matrix pages 3.16 to 3.18.)*

Figure 3.3 - Shoreline armoring and natural protection (rock in front of marsh) preventing erosion along the St. Mary's River to protect the bluffs where Historic St. Mary's City is located. St. Mary's City, St. Mary's County.

Figure 3.2 - Rip-rap shoreline protection (rocks in center of photograph) preventing further erosion of the shoreline along the West River, protecting the fisherman's village of Shadyside, Anne Arundel County.

A.1 SHORELINE PROTECTION

Shorelines occur along all bodies of water, including oceans, bays, rivers, and streams. During flood events, water levels will typically rise and sometimes be compounded by wave action, storm surge, or high-velocity water flow threatening adjacent communities. A range of shoreline protection measures can provide protection for communities and individual properties. These generally fall within two broad categories, those that are constructed, "hard," or "armored" adaptations and "soft," "natural," or "landscape" adaptations that emulate more natural mechanisms.

a. Structural Shoreline Protection

Hard adaptations are structural elements constructed to protect shorelines from wave impact-induced erosion, as well as high-velocity flow of floodwater. These elements can be located immediately at or along the shoreline or, in the case of lessening the effects of wave action, can be located offshore. Seawalls, bulkheads, and revetments are all examples of shoreline (or coastal) armoring. Shoreline armoring protects development by reinforcing the shoreline to prevent it from retreating or eroding.

i. On-Shore

There are a number of structural protective measures that can be constructed parallel to a shoreline to fortify it against potential flood-related damage.

- **Seawalls** are vertical walls constructed along a shoreline to provide protection from waves on one side and retain earth on the other, possibly extending above existing grade. They are constructed to reflect incoming wave energy back out towards the water. It should be noted that they do not protect the land at the base of the wall from erosion and can accelerate damage to unprotected adjacent shorelines.

- **Bulkheads** are like seawalls in that they are vertical walls that extend along a shoreline and retain soil. However, unlike sea walls, bulkheads provide minimal protection from waves. They prevent shoreline erosion, but can also create erosion in adjacent unprotected areas (lacking bulkheads).
- **Revetments and rip-rap** are fortified slopes or banks made of boulders or chunks of concrete that disperse wave energy upon impact. They prevent erosion and improve the structural stability of soil slopes (basically the same protections as sea walls).
- **Flood barriers, levees, dikes, and embankments** are designed to contain water and provide protection against high floods. They can be constructed of natural or artificial materials. When located along a river, they confine the flow of water, increasing its velocity and limiting the potential absorption of floodwater across a wider area.
- **Floodgates** provide access through a flood barrier, and must be operational to control the retention and equalization of water levels.

Figure 3.4 - Embankment with structural protections (concrete wall and embankment) to prevent erosion and stabilize the bank of the Potomac River. Westernport, Allegany County.

STRUCTURAL SHORELINE PROTECTION

One of the distinct advantages of structural shoreline protection is that it can provide equal protection to many properties in a vulnerable area. However, these measures present challenges such as:

- High construction costs
- Necessity for regular maintenance
- Increased erosion and flooding at nearby unprotected shorelines
- Alteration of the natural characteristics of the shoreline

Potential Preservation Benefits:

- Reduction of the potential flood damage risk at large numbers of properties and historic districts without requiring alteration of individual buildings and structures
- Potential protection of historic landscapes, landscape features, and archeological resources

Potential Preservation Challenges:

- Alteration of the physical and visual relationship of historic resources to the shoreline, particularly if the implementation blocks view and access to water
- Possible requirement for destruction or alteration of cultural resources located along the shore, particularly archeological resources, both on land and in the water and historic landscapes

ii. **Off-Shore**

Off-shore options, including those described below, can limit the effects of storm surge and wave action.

- **Breakwaters** are typically constructed of large boulders ranged in a linear or curvilinear form, with one end connected to the shoreline. *(Refer to Oyster Reef Breakwaters, page 3.8.)* As incoming waves hit a breakwater, the wave intensity and force is greatly reduced as it approaches the shoreline. Thus, a breakwater provides protection of the shore. It may also provide a protected harbor for boats.
- **Jetties** are like breakwaters in that they are constructed of large boulders in the water. However, they are constructed in pairs at the mouth of a navigable channel such as where rivers discharge into a bay. They provide a buffer from storm surge and serve to confine the tidal flow of water to within the channel. In addition, they help maintain a navigable depth within the channel.

Figure 3.5 - Natural shoreline protection of marsh infill behind small rocks to protect historic buildings. St. Michaels, Talbot County.

b. Natural Shoreline Protection

Natural shoreline protections, also known as nonstructural or “soft” measures, are based on emulating the natural ecosystem of a specific area. These can be the basis for flood-resilient design. In considering the treatment options, it is important to have a clear understanding of the local natural environmental conditions and how water is managed in the community.

Natural shoreline protections utilize natural materials to absorb rainfall and intense storm surge. They can be more effective and less costly than structural measures, but they too will typically require maintenance.

i. **On-Shore**

There are several natural protective measures that can be constructed parallel to a shoreline to fortify it against potential flood-related damage.

- **Wetland reclamation** seeks to reestablish wetlands that have been removed or reduced over time. Wetlands are areas that are saturated with water that provide a distinct ecosystem for vegetation and fauna. This vegetation has the ability to filter water and promote ground absorption. In a flood event, it can store floodwater as well as reduce the effects of storm surge.
- **Floodplain restoration** involves increasing the area for water disbursement and storage adjacent to a water body or channel such as a river, stream, or dry creek bed that is subject to inundation during a rain or flood event. Floodplain restoration, which often requires a reduction in impervious surface coverage, facilitates water absorption and potentially reduces the velocity of water flow, downstream flooding, and flash floods. *(Refer to Landscape Options, page 3.10.)*
- **Dune re-establishment** seeks to replace dunes that have been removed or reduced over time. Dunes are sand hills typically located on the shore of a large body of water such as an ocean, bay, or lake. They can provide protection from flooding and storm surge. Dunes are naturally formed by blowing sand, but can be manmade (also known as engineered). Because they are formed of particulate matter, they can be highly susceptible to damage in a storm event. Established vegetation, with a dense root network and few intermediate pathways between dunes, reduces its vulnerability.
- **Beach nourishment** is the addition of sand to an eroded beach to replace lost sand or to widen an existing beach to provide protection from inland flooding and storm surge. Beach nourishment is often completed in conjunction with dune enhancement. Because beaches are relatively unprotected, they are highly vulnerable to scour and erosion in the event of a storm or flood.

ii. **Off-Shore**

Similar to their structural counterparts, natural off-shore options, including oyster shell breakwaters, can limit the effects of storm surge and wave action.

- **Oyster reef breakwaters** (a natural, living breakwater) are similar to traditional breakwaters (usually constructed out of concrete, stone, or other building materials) in that they are formed in a linear or curvilinear form, with one end connected to the shoreline, utilizing oyster shells in lieu of boulders or rocks. *(Refer to Breakwaters, page 3.7.)* As incoming waves hit a breakwater, the wave intensity and force is greatly reduced as it approaches the shoreline. Thus, a breakwater provides protection of the shore. It may also provide a protected harbor for boats.

Natural shoreline protection has the advantage of being constructed of native, regionally appropriate materials,

NATURAL SHORELINE PROTECTION

Similar to structural protection, natural shoreline protection presents issues including:

- High construction costs
- Necessity for regular maintenance
- Requirement for large areas of undeveloped land

Potential Preservation Benefits:

- Reduction of the potential flood damage risk at large numbers of properties and historic districts without requiring alteration of individual buildings and structures
- Potential to protect historic landscapes, landscape features and archeological resources
- Potential to reestablish historic context, settings and landscapes

Potential Preservation Challenges:

- Alteration of the physical and visual relationship of the historic resources to the shoreline, particularly if implementation blocks water
- Possible requirement for destruction or alteration of resources located along the shore, particularly archeological resources both on land and in the water and historic landscapes; These effects may be greater for natural shoreline protection measures such as wetlands and floodplains, which require large land areas to be effective

reducing the visual impact of the interventions and promoting biodiversity. Wetlands and floodplains have the added advantage of providing water storage, promoting infiltration and reducing potential downstream flooding. However, both require large land areas to be effective, limiting potential developable land. Dunes and beach nourishment can be effective protective measures for beaches and shorelines; however, they are highly susceptible to damage from erosion or a storm event, particularly if not vegetated.

Figure 3.6 - Drainage ditch to convey stormwater runoff away from historic houses along the main road in the historic village of Royal Oak, Talbot County.

A.2 STORMWATER MANAGEMENT IMPROVEMENTS

In addition to flooding along the shorelines of a water body, flooding can also occur because of precipitation, or stormwater, in the form of rain, ice, and snow melt. ***In a developed landscape, the ability of the land to absorb stormwater is reduced due to the presence of impervious surface coverage, unplanted areas, and areas planted with shallow-rooted and non-native species.*** Developed landscapes can be urban or rural and include homes, businesses, roadways, and paved surfaces, as well as man-made landscapes such as farms and golf courses. By reducing soil absorption capacity and altering drainage patterns, alteration of the landscape can have a detrimental effect on the way a site processes water, leading to uncontrolled water flow, erosion, and localized flooding. Possible improvements to address inland flooding include both engineered and natural options.

a. Engineered Options

- **Drainage ditches** are a surface drainage system to remove excess water from a land surface. These are typically employed in less developed and rural areas and consist of depressed channels, often located adjacent to roadways, that can discharge into large drains or a body of water. Drainage ditches can be hard construction, made of natural materials, or a combination of the two. The use of natural materials increases the propensity for soil absorption of stormwater. Culverts, often part of a drainage ditch system, are engineered channels or pipes that allow stormwater to flow under an intersecting road, driveway, railroad, etc.

- **Stormwater management systems** channel the flow of stormwater and remove it, often through subsurface piping or culverts, and are typically utilized in cities, towns, and more developed communities. The level of complexity of a stormwater management system will likely be greatest in urban areas due to the dense level of development and the preponderance of impervious surface coverage. In most cities, it is not uncommon to have intakes that collect stormwater draining from road and sidewalk surfaces, and possibly also roof surfaces, into a piping system which conveys stormwater to a water treatment facility. The water treatment facility will then remove pollutants and contaminants including grease, automobile oil, pesticides, and animal waste bacteria before discharging stormwater back into an adjacent body of water. The conveyance, such as piping, limits or prohibits the potential for stormwater absorption, and the rapid discharge from the water treatment facility during a storm event can overwhelm a body of water. In addition, many older cities have combined stormwater and sewage systems, which are often undersized relative to increased development and significant storm events. When the water treatment facility is overwhelmed, untreated stormwater, and in some municipalities also sewage, is discharged directly into the waterway or backs up into the stormwater system.
- **Pumping stations** supplement a stormwater management system by pumping floodwater out of a vulnerable area. They require an uninterrupted power or fuel supply to remain operational during a flood event.
- **Water storage areas and retention ponds** are man-made areas used to contain stormwater and slowly drain it to minimize the dependence on stormwater management systems and pumping stations. A disadvantage of this approach is that a man-made pond can create a new ecosystem that is incongruous with the natural landscape as well as reduce developable land.

Like structural shoreline protection, inland structural or engineered improvements can provide equal protection to a large number of properties in an affected area. However, they share some common issues including that capacities may need to be increased over time as conditions worsen and development increases the amount of impervious surface in the watershed.

b. Landscape Options

Landscape measures can be utilized on a large-scale in an urban or suburban setting or at an individual property. Contrary to many of the structural or engineered measures, they can be relatively low impact, inexpensive to implement, and integrated into a

ENGINEERED OPTIONS

As with other options that provide large-scale protection, engineered options face similar issues, as well as those specific to these systems:

- High cost to upgrade systems
- Necessity for regular maintenance
- Most systems require to handle changing weather and extreme precipitation

Potential Preservation Benefits:

- Existing systems that can be upgraded/maintained in place serve multiple properties and historic districts without additional adverse impacts
- Increased effectiveness when used in combination with green infrastructure, which can result in lower project costs

Potential Preservation Challenges:

- Increasing capacity of systems could damage or destroy archeological resources if additional excavation is needed to implement upgrades
- Undersized/outdated systems will cause or exacerbate flooding during storms

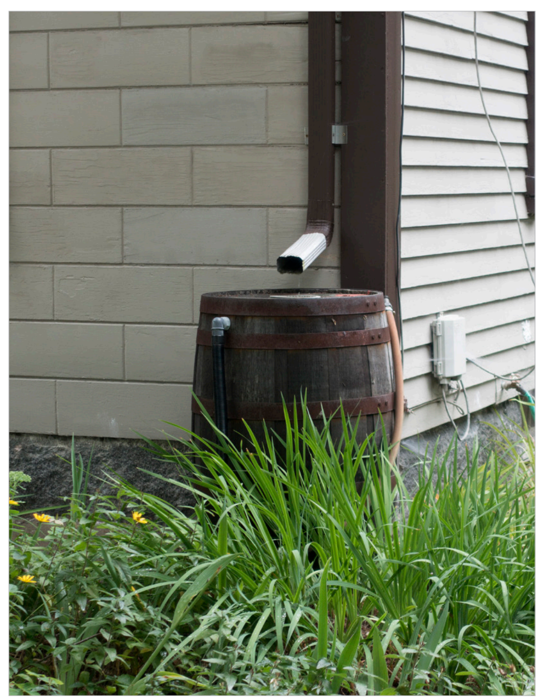

Figure 3.7 - Rain barrel unobtrusively located at rear of a historic building.

designed landscape, particularly at new areas of development. Many of these landscape measures either preserve or mimic natural landscape systems, featuring native plant species, diverse wildlife and rich soils from the decomposition of plants and trees, thereby facilitating both shallow and deep absorption of stormwater.

- **Levees and berms** are landscaped hills that can be used to protect areas from flooding or, if continuous, to contain floodwater and encourage infiltration. They can be effectively utilized across multiple sites, at an individual parcel or to protect a single building. *(Refer to Perimeter Barriers, page 3.34.)*

Figure 3.8 - Engineered drainage system to convey stormwater to a rentention area away from historic cottages. Shady Side, Anne Arundel County.

- **Swales** are either natural or man-made depressed landscaped channels used to manage stormwater runoff and promote infiltration. Similar to levees and berms, they can be effective across multiple sites, or on a single parcel, where they are often constructed to direct stormwater away from building foundations. They can also direct stormwater towards a wetland area, drywell, or rain garden to promote infiltration.
- **Reduction of impervious surfaces** and **introduction of permeable surfaces** provide a means of increasing infiltration and decreasing stormwater runoff. Impervious surfaces include roofed buildings and structures, roadways, parking areas, and paved surfaces. Any rainfall or other form of water that hits these impervious surfaces becomes runoff, increasing the propensity for flooding downstream. Because of their limited absorption, impervious surfaces have the added effect of reducing infiltration into the ground, thus reducing the replenishment of aquifers. As another strategy to reduce the impact of runoff, roadways, and paved surfaces can be sloped towards drainage ditches in lieu of curbed asphalt that discharges into a stormwater system. *(Refer to Zoning Options, page 3.12.)*
- **Rain gardens** are gardens located in depressed areas of land, often near paved surfaces, that collect stormwater runoff and promote infiltration; they often incorporate native plants.

LANDSCAPE OPTIONS

Potential Preservation Benefits:

- Direction of stormwater away from historic resources by levees, berms, and swales
- Visually unobtrusive collection of stormwater by such measures as levees, berms, swales, and rain gardens of appropriate scale with carefully chosen plantings
- A potentially more appropriate context for historic resources with reduction in impervious surfaces

Potential Preservation Challenges:

- Alteration of historic landscapes, settings, and potential archeological resources during construction, particularly at dramatic grade changes
- Alteration of the physical and visual relationship of the historic resources to the landscape

- **Rain barrels** are located at the base of buildings to collect stormwater discharged from roof surfaces through downspouts. These are a property-specific mitigation measure.
- **Native plants** absorb water to a greater degree than non-native plants, do not require significant maintenance, and can tolerate the range of extremes from very wet to very dry soil.

Figure 3.9 - Zoning requirements can include limiting stormwater run-off through the use of pervious paving. Shadyside, Anne Arundel County.

c. Zoning Options

Governments use zoning codes to control land development and land use. Municipalities can regulate development and improvements in a manner that promotes infiltration and minimizes runoff and the overburdening of existing waterways and stormwater systems. Because local regulatory review is typically initiated by a request for a building permit, the use of zoning regulations to limit or reduce runoff is often only initiated in cases of new development, a substantial improvement to a property such as a new building or structure, or the expansion of the footprint of an existing building or structure. ***Even if no physical changes are required to be implemented on historic properties, any changes made on other properties in the community to reduce runoff can provide relief to existing and historic properties.*** If changes are required of historic properties, communities should consider providing design parameters to ensure that changes protect the historic character and integrity of the buildings. *(Refer to Develop Design Guidelines for Flood Mitigation, page 2.55.)*

Potential means for reducing runoff utilizing zoning include:

- Utilizing berms and swales to retain stormwater on site;
- Minimizing impervious surface coverage including driveways, parking areas, walkways, and patios and draining these to the site and not the public roadway;
- Installing permeable paving only where required;
- Disconnecting roof and subsurface drainage from the municipal stormwater system and encouraging on-site infiltration;
- Encouraging the use of rain barrels and stormwater to irrigate gardens;

ZONING OPTIONS

Potential Preservation Benefits:

- Reduction of additional runoff associated with construction and new development
- Regulating height of building
- Maintaining streetscape rhythm and patterns

Potential Preservation Challenges:

- Potentially inappropriate landscape improvements including berms, swales, and on-site drywell requirements at historic properties seeking to construct an addition or secondary building, as well as at new development in a historic district

Figure 3.10 - Zoning requirements can include limiting stormwater run-off through the use of drainage ditches and rain gardens. Shadyside, Anne Arundel County.

- Removing street curbs and installing drainage ditches and/or rain gardens along roadways;
- Requiring an on-site dry well to promote slow stormwater infiltration where the capacity of the land area is incapable of natural absorption at a sufficient rate; and
- Increasing the use of native plantings with deeper root systems to encourage infiltration. (These provide the added advantage of minimizing the need for supplemental irrigation and fertilization.)

Zoning modifications can also be used to improve stormwater management and manage alterations at historic buildings such as building elevation heights and streetscape rhythm. *(Refer to Modify Zoning Ordinance, page 2.54.)*

d. Building Code Options

Building codes set the standards for safe construction. Although most communities utilize the International Building Code as the basis for their construction reviews, codes can be modified locally to address specific concerns such as flooding. *(Refer to Modify Building Code Requirements, page 2.58.)*

e. Floodplain Management Ordinance Options

A community's floodplain management ordinance can also address community-wide mitigation strategies for reducing flooding through incorporating higher standards than required by the National Flood Insurance Program (NFIP). *(Refer to National Flood Insurance Program, page 1.17.)* Examples include a compensatory storage clause that requires property owners who decrease the area available for floodwater storage in the floodplain by filling and constructing in the floodplain (even if in accordance to the regulations) to mitigate this effect by providing an equal volume of flood storage at or adjacent to the development site. A non-preservation benefit of including

BUILDING CODE OPTIONS

Potential Preservation Benefits:

- Reduces the potential for flood-related damage

Potential Preservation Challenges:

- Potentially difficult to implement at historic buildings
- May have significant impact on an individual building, or a new building constructed within a historic context, based upon the relative elevation of buildings to the floodplain

FLOODPLAIN MANAGEMENT ORDINANCE OPTIONS

Potential Preservation Benefits:

- Reduces the potential for flood-related damage

Potential Preservation Challenges:

- Depending on how the volume for capturing the compensatory storage is constructed, it could be an adverse effect to a historic district or adjacent historic properties higher standards in the floodplain ordinance is the potential to capture additional credits for communities that participate in the Community Rating System. *(Refer to Community Rating System, page 1.25, and Participate in the Community Rating System, page 2.59.)*

A.3 UTILITY INFRASTRUCTURE IMPROVEMENTS

Utility Infrastructure provides access to necessities such as fresh water, sewage disposal, and electricity. If disrupted, quality of life can become severely compromised, limiting the ability of an area to remain habitable. In most communities, water, sewer, and electrical service are public utilities relying on processing, generating, and treatment plants. These facilities must be located and constructed to minimize service interruption in the event of a flood event. In addition, they require regular maintenance upgrades to ensure that a potential system failure, such as a burst water main, does not result in a flood. In communities that rely on well water and/or septic systems, sea level rise and subsidence can cause the water supply and soil to become compromised by brackish water and contaminated with bacteria from untreated sewage. In these cases, alternative water supply and sewage treatment may be required to allow continued occupancy.

Figure 3.11 - Utility infrastructure improvements can be challenging to fund for small municipalities. Westernport, Allegany County.

Figure 3.12 - An old outfall (left) and a potentially unpermitted discharge from a nearby property (center) that discharge into a ditch which could be retrofitted to allow for a stormwater filtration best management practice such as bioretention a swale, or a manufactured filtration device to improve water quality downstream. Williamsport, Washington County.

UTILITY INFRASTRUCTURE IMPROVEMENTS

Potential issues related to the improvement of utility infrastructure include:

- May require elevation; hardening to make it less susceptible to damage from flooding or associated debris, modification, replacement; or relocation to reduce flood vulnerability
- Alternative systems may need to be provided during an upgrade
- May require additional adaptation if conditions worsen
- Costly to construct
- Require regular maintenance

Potential Preservation Benefits:

- Mostly "invisible" and considered necessities rather than visually obtrusive
- Potential to protect historic buildings, structures, settings, and archeological resources

Potential Preservation Challenges:

- Potential abandonment of historic buildings and structures due to failure of infrastructure to provide needed services including access to fresh water, sewage disposal, and electricity
- Potential to impact historic landscapes and archeological resources due to installation of new inland structural improvements, i.e. trenching for new stormwater piping
- Possible destruction or alteration of resources, particularly archeological resources and historic landscapes, if below grade
- In the case of construction of water storage areas or retention ponds, alteration of the physical and visual relationship of historic properties to the landscape by the introduction of a potentially large-scale body of water where none previously existed

TRANSPORTATION INFRASTRUCTURE IMPROVEMENTS

Potential issues related to the improvement of transportation infrastructure include:

- Roadways, bridges, and causeways may require further elevation or structural enhancement as flood conditions worsen
- Costly to construct
- Require regular maintenance

Potential Preservation Benefits:

- Mostly "invisible" and considered necessities rather than visually obtrusive
- Potential to protect historic buildings, structures, settings, and archeological resources

Potential Preservation Challenges:

- Potential abandonment of historic buildings and structures due to failure of infrastructure to provide needed services including access by road
- Potential to impact historic landscapes and archeological resources due to installation of new or elevated transportation infrastructure
- Possible destruction or alteration of cultural resources, particularly archeological resources and historic landscapes, through construction activities
- Alteration of the physical and visual relationship of the historic properties to the landscape through construction

Figure 3.13 - Maintaining the main route to Taylors and Hoopers Islands could be challenging as the height of the Bay continues to increase and renders portions of the road impassable. Dorchester County.

A.4 TRANSPORTATION INFRASTRUCTURE IMPROVEMENTS

Transportation infrastructure, including roadways, bridges, and causeways, provides a transportation network for communities as well as a potential means of evacuation in a flood event. Establishing raised roadways or raising the elevation of existing roadways can prevent nuisance flooding and allow safe passage in more severe conditions. In addition to ensuring the roadway surface remains passable, bridge and causeway structural support systems may also require adaptation. This can include providing sufficient height and openings between structural members to allow the free flow of water without trapping debris and a support system adequate to withstand the force of running water.

A.5 COMMUNITY-WIDE MITIGATION OPTIONS MATRIX

The following matrix is intended to provide a brief overview of the potential flood benefits and issues associated with the options presented in this section. Refer to the text boxes in the narrative for potential preservation benefits and challenges.

Strategy	Type	Potential Flood Benefits	Potential Issues
Seawalls, Blukheads, Reventments, Rip-Rap	Shoreline / Structural	• Provide protection from wave action • Stabilize shoreline	• Encouragement of continued development closer to the shoreline – possibly providing a false sense of security • Possible increased shoreline damage at nearby unprotected areas • Adaptability necessary to allow modification with increased threat
Flood Barriers – Levees, Dikes, Embankments	Shoreline / Structural	• Provide protection from high floodwaters	• Water velocity increase in creeks, streams, and rivers • Continued development encouraged – possibly providing a false sense of security • Possibly increased shoreline damage at nearby unprotected areas • Adaptability necessary to allow modification with increased threat
Breakwaters, Jetties	Shoreline / Structural	• Decrease shoreline wave impact • Provide added benefit of creating a potential harbor	• Adaptability necessary to allow modification with increased threat
Establishment of Wetlands	Shoreline / Natural	• Promotes water absorption • Dissipates storm surge	• Fewer issues with installations that do not require property acquisition or abandonment • Acquisition and/or abandonment of property possibly necessary if significant land area required to be effective
Floodplain Restoration	Shoreline / Natural	• Promotes water absorption • Reduces the velocity of running water • Reduces the potential for downstream flooding	• Possibly costly acquisition and/or abandonment of property • Reduction of tax base growth with prevention of future development
Dunes	Shoreline / Natural	• Reduce inland flooding • Reduce the effects of storm surge	• High susceptibility to damage in a storm event

Strategy	Type	Potential Flood Benefits	Potential Issues
Beach Nourishment	Shoreline / Natural	• Reduces inland flooding • Reduces the effects of storm surge	• High susceptibility to damage in a storm event
Oyster Reef Breakwaters	Shoreline / Natural	• Decrease shoreline wave impact • Provide added benefit of creating a potential harbor	• Adaptability necessary to allow modification with increased threat
Drainage Ditches	Inland Structural Improvements	• Remove excess water from land surface • Reduce reliance on stormwater management system • Potentially increase infiltration	• Possible direction of untreated stormwater directly into waterway
Stormwater Management Systems/ Pumping Stations	Inland Structural Improvements	• "Invisibly" collects stormwater and removes it from developed areas, diverting it to treatment facilities	• Difficulty of upgrading older systems - often near or at capacity due to increased development and combined stormwater/ sewage • Susceptibility of older systems to failure due to aging infrastructure • Possible untreated sewage discharge into waterway or back-up during flood events • Adaptability necessary to allow modification with increased threat and floodproofing necessary to the BFE plus freeboard if within the 1% floodplain
Water Storage Areas	Inland Structural Improvements	• Increase infiltration • Decrease runoff	• Low impact if within public realm • Possible necessity to acquire and/or abandon of property if significant land area is required to be effective
Levees, Berms	Inland Structural Improvements / Landscape	• Divert stormwater • Protect from flooding • Contain stormwater to encourage infiltration if continuous	• Diversion of problem water to other areas
Swales	Landscape	• Divert stormwater • Contain stormwater to encourage infiltration	• Diversion of problem water to other areas

Strategy	Type	Potential Flood Benefits	Potential Issues
Reduce Impervious Surface Coverage	Landscape / Zoning	• Increases infiltration • Decreases runoff	• Low impact within public realm • Reduction of tax base growth with prevention of future development • Possible high cost of acquisition and abandonment and/or limited development potential of property
Rain Gardens	Landscape	• Increase infiltration • Decrease runoff	• Low impact within public realm
Rain Barrels	Landscape	• Collect storm water from roof drains for future use • Decrease runoff or stormwater system discharge	• Low impact
Native Plants	Landscape	• Increase water absorption • Minimize supplemental watering and care	• Low impact
Zoning Regulation Improvements	Zoning	• Increase infiltration / decrease runoff • Establish height for building elevation • Maintain streetscape rhythms	• Reduction of tax base growth with prevention of future development • Possibly costly acquisition and/or abandonment of property
Building Code Modifications	Compliance with some / all NFIP regulations or local requirements if more stringent	• Reduce the potential for flood-related damage	• Possibly difficult implementation at existing buildings
Utility Infrastructure Improvements – Water, Sewage, Electric	Inland Structural Improvement	• Possibly make systems more resistant, allowing continued functionality of water sewer and electrical systems via replacement, modification, or hardening	• Low impact if within public realm • Adaptability necessary to allow modification with increased threat
Transportation Infrastructure Improvements	Structural Improvement	• Maintain access to historic communities and resources • Provide increased clearance for floodwater by removal of or raising bridge or causeway	• Low impact if within public realm

Figure 3.14 - The Captain Salem Avery House was relocated further from the water's edge. Shadyside, Anne Arundel County.

B. PROPERTY-SPECIFIC MITIGATION STRATEGIES

KEY QUESTION:

What are the goals and benefits of property-specific mitigation strategies?

KEY QUESTION:

How do these strategies relate to historic preservation concerns?

While local governments can implement flood protection measures to protect entire communities, residential, business, and institutional property owners can take various measures to reduce the effects of flooding on their properties. There are three general categories of property-specific mitigation options available:

- Landscape improvements;
- Basic improvements; and
- Building mitigation.

As implied, landscape mitigation options occur within a site and are generally geared towards managing stormwater and providing shoreline protection. Basic improvements are generally simple, low-impact strategies that are relatively easy and inexpensive to complete. ***Building mitigation strategies are often more complex, likely require the assistance of a design professional, and typically have the greatest impact on the integrity of historic properties***. Proposed mitigation measures at designated historic properties may be subject to historic preservation commission or Maryland Historical Trust (MHT) review. *(Refer to Historic Property Project Review sidebar, page 2.36, and Mitigation, page 2.51.)*

Figure 3.15 - Rain garden with native plants. Shady Side, Anne Arundel County.

B.1 LANDSCAPE IMPROVEMENTS

Except for dense, urban environments, individual properties often include a combination of land and one or more buildings or structures. As presented in the community-wide strategies, many of the landscape measures are scalable, meaning they can be applied across a community or district, or at an individual property. *(Refer to Community-Wide Mitigation Strategies, page 3.3.)* These include:

- Bulkheads;
- Rip-rap;
- Retention ponds;
- Berms;
- Swales;
- Disconnection from stormwater drainage;
- Impervious surface reduction / pervious surface introduction;
- Rain gardens;
- Drywells;
- Native planting; and/or
- Rain barrels.

B.2 BASIC IMPROVEMENTS

A first step for many property owners will include basic improvements that are relatively easy to complete and low cost, typically with nominal impact on historic integrity. In addition to interior building improvements, which are often not subject to preservation review, basic exterior improvements can include:

- Maintenance of historic resources and properties *(refer to Encourage Property Maintenance, page 2.52)*;
- Relocation of critical systems and equipment above flood-prone elevations;
- Installation of solar collectors to allow electrical independence after a storm; and
- Use of flood damage-resistant materials in flood-prone locations.

Figure 3.16 - Elevating mechanical and electrical equipment above the BFE is a basic improvement that may prevent the need for replacement in the event of a flood. Shady Side, Anne Arundel County.

B.3 BUILDING MITIGATION

In addition to landscape mitigation measures, building alterations can be implemented to increase flood resistance and/or reduce flood insurance premiums. Under the National Flood Insurance Program (NFIP), buildings located within Special Flood Hazard Areas (SFHAs) that participate in the program may be required to meet specific design criteria to minimize potential damage from future flood events. Compliance with local floodplain regulations is required for new construction, repair of "substantially damaged" buildings and buildings that are "substantially improved." *(Refer to Understanding Repairing/Rebuilding Requirements, page 2.45.)* **Unfortunately,**

alterations may also compromise the historic integrity of a property to such an extent that it may no longer be considered historic (either according to the criteria of the National Register of Historic Places or via local designation criteria). *(Refer to Mitigation, page 2.51.)*

Through *The Secretary of the Interior's Standards for the Treatment of Historic Properties* (U.S. Department of the Interior, 2017), the National Park Service provides guidance on the effects of alterations, demolition and relocation within a historic context, generally making recommendations for minimal impact on both historic fabric and context. With minimal guidance available on the appropriateness of extreme building elevations, significant additions to existing buildings, or elevated new construction within the historic context, these mitigation options are often the most challenging for local planners, historic preservation commissions, and citizens trying to protect their historic communities.

Examples of building mitigation options include elevation, wet floodproofing, dry floodproofing, perimeter barriers, relocation, and/or acquisition and demolition. *(Refer to Adaptation, page 2.67; each of these treatments is described in detail in the following subsections.)* ***If local planners are considering these options, this Guide recommends establishing limits under existing local ordinances including zoning and historic preservation.*** *(Refer to Modify Zoning Ordinance, page 2.54, and Develop Design Guidelines for Flood Mitigation, page 2.55.)* Policy statements and/or design guidelines should limit mitigation options, such as restricting building elevation to specific heights relative to the Base Flood Elevation (BFE) or Design Flood Elevation (DFE), to lessen impacts. *(Refer to Location Definitions sidebar, page 1.22.)* As each option is evaluated, communities should also evaluate the existing local preservation regulatory review process and criteria to identify inconsistencies that will need to be addressed as part of the implementation process.

a. Elevation

Building elevation is raising a building to or above the BFE to achieve the desired level of protection. Elevation typically involves abandoning basements and crawlspaces, raising the first floor level, and constructing a new foundation. Elevation of slab-on-grade buildings can include the original slab or abandoning it in place, with the construction of a new support system. Methods of lifting and supporting the building will vary from location to location, relying on the expertise of trained design professionals, although there are some common issues, outlined below, that must be addressed.

- **Feasibility**. Some buildings might be extremely difficult to elevate due to size, configuration, or construction type, such as row houses with common party walls, or whether or not they are sufficiently sound and stable to lift.
- **Appearance**. The greater the height of the elevation, the greater the exposed foundation, altering the appearance of the building and its relationship to its neighbors along the streetscape.

ELEVATION

Potential Preservation Benefits:

- Historic buildings can remain on original parcel

Potential Preservation Challenges:

- The relationship between the historic building and the ground plane is altered, as is the relationship to site features and possibly landscape elements such as trees, gardens, and fencing
- The visual relationship between historic building and neighboring buildings on the site or along the streetscape is altered
- Given the expense and interruption associated with elevation, property owners might elect to elevate higher than mandated, increasing the impact on integrity
- Elevation can significantly alter the basic proportions of a building from horizontal to vertical, which could be stylistically inappropriate, particularly for slab on grade construction, such as ranch houses
- The elevation of exterior building systems and equipment has the potential to increase their visibility making screening more challenging
- Elevation of wood-framed buildings requires a taller foundation or piers, increasing their visual prominence – Structural materials required to resist loads and forces may not be historically appropriate requiring sensitively-designed screening
- Elevation of masonry buildings, or elements such as chimneys, typically require the addition of masonry infill, which may be difficult to match to original materials
- Lower level features, such as basement windows and doors, will likely be removed as part of building elevation
- Stairs, porches, or landings may require modification – Depending on the change in height and location of the building relative to the lot lines, the modification might necessitate relocation of the historic entrance

Figure 3.17 - Sensitive elevation of historic building. Whitehaven, Wicomico County.

¤ **Foundation Modification**. Although it might be possible to extend existing foundation walls or piers, they may not have sufficient strength or stability to be reused.

¤ **Access**. Elevation requires modification of building access including stairs and could include the installation of an elevator. Consequently, it may be difficult to maintain entrance stair orientation for buildings located close to a front property line and to provide access for physically challenged individuals.

¤ **Building Equipment and Systems**. All equipment and systems previously located in the now abandoned basement or crawl space will need to be relocated within the building interior, resulting in loss of habitable space. Exterior equipment should be located above the BFE/DFE and all connections will require extension and potentially weatherproofing.

Depending on the type of construction, elevation can be achieved by first lifting the building and then either extending the existing support system or constructing a new support system. The system will need to provide for both the vertical support of the building and for resistance to the lateral forces related to the increase in height, potential wind load, and storm surge. As a result, lateral reinforcing or stronger, non-traditional building materials may be required, such as foundations of filled concrete block or cast-in-place concrete. Based on the original foundation or pier materials and architectural style, it may be possible to mimic the appearance of the original material with a brick or stone veneer as appropriate, which could visually reduce the impact of the higher foundation.

As part of elevating the building, the abandoned lower level must be addressed. This can include the:

¤ Removal of abandoned equipment and hazardous materials before infilling a basement or crawlspace;

¤ Modification of the area below the first floor to be wet floodproofed, providing flood openings to allow the free passage of water; and/or

¤ Re-grading the area below the foundation to promote drainage away from the building foundation.

In addition to elevating the building, it may be desirable to also raise the grade around the building to maintain the relative height of the building above grade. On larger parcels, it may be possible to construct a berm that gradually extends up to the required height, while smaller parcels may require the installation of retaining walls to address the grade change. The significant runoff impact to adjacent parcels of raising all or a part of the grade should be considered.

Given the cost associated with elevating a building, many property owners seek to raise a building a full story, often well above the required BFE/DFE, to achieve "bonus" space for parking or storage. As individual properties are raised, this can have a significant impact on historic streetscapes, particularly in districts with consistent scale, form, massing, and fenestration patterns. Similarly, conformance with floodplain regulations typically requires that new buildings, and significant additions to existing buildings, be constructed in a manner that at a minimum meets current elevation requirements. As a result, they can have similarly detrimental impacts on a historic streetscape.

b. Wet Floodproofing

Wet floodproofing allows floodwaters to enter an enclosed area of a building and rise at the same rate, and to the same levels, as floodwaters outside of the building. As a result, the lateral and buoyancy forces are equalized across the interior and exterior, significantly lessening strain on the building's structure.

To be compliant with the NFIP, wet floodproofing relies on automatic passage of floodwater in and out of a building so pressures remain equalized. In addition, spaces located below the DFE should be considered "wet," use of these spaces should be limited to non-living functions, and materials used should be moisture tolerant. These criteria apply to all wet floodproofed floor levels, including basements.

Wet floodproofing may be the best alternative for buildings that are required to comply with NFIP design criteria and are technically difficult to elevate or relocate. This can include very large or complex buildings, or buildings that share party walls,

ELEVATION

Potential Preservation Challenges (continued):

- Providing access for disabled persons is more challenging, impacting commercial and institutional buildings as well as some residences
- Overall level of alteration required for effective implementation might compromise historic integrity

Figure 3.18 - Flood openings are barely visible within the elevated concrete block foundation along the second course of blocks just above the ground level, minimizing their impact on the house's character. The darker, higher openings are crawlspace vents. Crisfield, Somerset County.

such as row houses. To meet wet floodproofing requirements, it may be necessary to abandon or limit the use of a portion of a building. This could pose an economic challenge to the building owner, who might seek to compensate for lost space by altering the building with an incompatible addition.

i. **Uses Below Base Flood Elevation**

To be considered wet floodproofed, the allowable uses of enclosed space below the BFE/DFE should be limited to minimize potential flood damage. Uses that should be permitted include building entrances, storage, and parking. To be considered floodproofed, all building systems must be located above the BFE/DFE. In the case of existing buildings, modification and/or abandonment of lower floor levels to comply with a community's floodplain regulations can include the following options:

Basements

- **Abandon the Use of the Basement**. The basement may need to be partially or fully infilled with a water permeable material like gravel to provide sufficient resistance against the lateral forces of floodwater.
- **Allow Floodwater to Freely Enter and Leave the Building**. This might include adding flood openings in the walls and providing openings for floodwater to infiltrate the soil through the floor slab. In addition, a sump pump with a secondary power supply above the BFE/DFE should be required for expelling residual water during and after an event.

- **Modify Basement Window and Door Openings**. Depending on their location, basement windows and doors can be modified to allow drainage or ventilation to facilitate drying of area after an event.

First Floors

- **Raise the Floor.** If sufficient first floor ceiling height is available, raise the floor above the BFE/DFE. This may require the modification of stairs, adjustment of interior doors, and alteration of windows.
- **Limit First Floor Use**. If the floor level is below the BFE/DFE and sufficient floor to ceiling height is not available to raise the floor, the use of the first floor may be limited to a building entrance, parking, and storage. This may require reconfiguration of upper building floors to accommodate formerly first floor public spaces, such as living rooms or kitchens.

ii. **Flood Damage-Resistant Materials**

Certain materials are less affected by being submerged in water than others. FEMA categorizes building materials in one of five levels to rank their potential resistance to flood, ranging from those that require a constant dry environment to those that can withstand high flood exposure. The materials evaluated include both structural and finish materials, with many traditionally historic materials considered "unacceptable" below the BFE, including plaster; solid wood doors, floors, trim, and cabinets; and wallpaper. In addition, several materials popularized during the mid-20th century that appear to be water resistant are also rated "unacceptable" including asphalt, ceramic and linoleum tile, and non-ferrous metals including aluminum, copper, and zinc tiles (FEMA, 2008).

Both FEMA and the International Building Code require that flood damage-resistant materials be used in the SFHA to a the minimum BFE/DFE height (FEMA, 2015). In the case of the International Building Code, such materials must be used to the BFE/DFE or the BFE/DFE plus one- to two-feet, whichever is higher, based upon building use and Flood Insurance Rate Map classification. *(Refer to Flood Insurance Rate Maps, page 1.15.)*

iii. **Flood Openings**

Flood openings allow the passage of floodwater in and out of a building without mechanical intervention such as sump pumps. They must be of sufficient size and number to be able to quickly equalize interior and exterior water levels. They will typically be located around the perimeter of a building or foundation, close to the adjacent grade height, and may also be needed between adjacent enclosed spaces, such as in interior foundation walls.

In cases in which all or portions of floors have been abandoned, flood openings must be located in a manner

FLOOD DAMAGE-RESISTANT MATERIALS: AN ALTERNATIVE APPROACH

In the publication *Flooding and Historic Buildings* (2015), Historic England's conclusions differ from FEMA's National Flood Insurance Program Technical Bulletin 2, *Flood Damage-Resistant Materials Requirements* (2008), regarding historic materials and flooding.

Flooding and Historic Buildings

Although relatively resistant to flood damage, historic-building materials can all suffer some degradation and may need appropriate treatment. These materials include stone, solid brick-and-mortar walls, timber frames, wattle-and-daub panels, timber boarding and paneling, earthen walls and floors, lime-plaster walls and ceilings and many decorative finishes.

Organic materials such as timbers swell and distort when wet and suffer fungal and insect infestations if left damp for too long. If dried too quickly and at temperatures that are too high, organic materials can shrink and split, or twist if they are restrained in panels. Inorganic porous materials do not generally suffer directly from biological attack.

Significant damage can occur when inherent salt and water (frost) crystals carried through the substrate are released through inappropriate drying or very cold conditions.

- Historic England, 2015

To best preserve historic building components, English Heritage recommends a slow, temperature-controlled, carefully monitored process of drying-out. Although they acknowledge that there will be some material degradation, particularly for high floods or if the floodwater contains salts or other contaminants, they argue that many historic materials can be saved with proper care. This approach may be an appropriate alternative to material replacement where not otherwise required for NFIP compliance.

WET FLOODPROOFING

Potential Preservation Benefits:

- Historic buildings can remain at original location and elevation
- It might be possible to minimize exterior alterations, retaining the exterior integrity, which under many programs and jurisdictions is the extent of preservation regulatory review
- Typically, abandonment of a basement level will not significantly impact historic integrity

Potential Preservation Challenges:

- Loss of historic materials on the interiors of buildings is detrimental regardless of whether changes to interior spaces is regulated – Such a loss of historic fabric would likely not be allowable under many financial incentive or easement programs
- Abandonment or reconfiguration of a first floor often involves modification to windows and doors and thus can significantly alter the integrity of the interior of a building, as well as potentially the exterior
- Loss of space associated with abandonment may necessitate construction of an addition or rooftop addition, impacting the exterior appearance of the building
- Flood openings must be sensitively-designed for compatibility as should openings and mechanisms to promote ventilation
- Wholesale removal of historic materials may be required below a specific elevation to meet NFIP requirements, including wood and plaster components
- Application of waterproofing membranes, sealers, etc. for proper wet floodproofing can potentially trap moisture in historic buildings and building materials during non-flood periods, leading to deterioration
- The elevation of exterior building systems and equipment often increases their visibility, making screening more challenging
- The level of alteration required for effective implementation might compromise historic integrity

Figure 3.19 - The brick headers that conceal flood vents reduce the opening size of the vent, and may impeed the flow of floodwaters out of the crawlspace. Whitehaven, Wicomico County.

that allows the relative level of the water, at the interior and exterior of the building, to be equalized. In the case of an abandoned basement, installation of drainage through the basement slab may be required.

Many manufactured flood openings are metal louvers or vents. Flood openings can be designed to be more in keeping with the architectural character of the building with the understanding that they must be designed to allow the free flow of water and to prevent animal and insect infestation.

In addition to flood openings, it is important to consider how spaces will be ventilated in the event of a flood. Secondary damage after a flood such as mold and rot can be reduced with adequate ventilation. Although operable windows can typically be used for inhabited spaces, ventilation of abandoned basements or areas below raised finish floors can be more challenging.

iv. **Building Systems and Equipment**

A potential costly effect of flooding can be damage to building systems and equipment. Traditionally, building systems and equipment are often located in a basement, first floor, or at exterior grade. This can include boilers, water heaters, electrical and internet service, air conditioning equipment, and appliances. Exposure to floodwater can irrevocably damage any of these systems, rendering them useless in the flood recovery process.

Two options to address building systems and equipment are protection in place or relocation to an area that will not be affected by floodwater. Some equipment can be protected in place by dry floodproofing the equipment, that is, constructing perimeter floodwalls with secondary drainage such as a sump pump to remove any water seepage. *(Refer to Dry Floodproofing, page 3.28.)*

Relocation will often require raising the systems and equipment to higher levels. This includes not only major equipment, but raising secondary elements such as electrical outlets and switches. Relocated equipment should be installed in a manner that meets both manufacturers' and local code requirements including clearances, access, and ventilation. At the interior of a building, the relocation of equipment to upper floors can result in the loss of habitable space. Relocation of exterior equipment may require mounting on roofs, walls, and platforms, as well as providing screening to minimize visibility.

c. Dry Floodproofing

To be effective, dry floodproofing must keep all, or almost all, water out of a building. Essentially, it provides a "wetsuit" at the exterior of the flood-prone areas of the building to prevent infiltration through:

- Wall surfaces;
- Floor slabs;
- Window and door openings; and
- Joints and gaps at pipe penetrations and between different materials.

In considering whether dry floodproofing is a viable option, it is important to understand the potential depth and duration of the flood and the characteristics of the building. In a flood event, standing water and saturated soil exert two types of forces: lateral and buoyancy. There may be additional forces imposed by wave action or debris impact from flowing water. The type and method of construction must be able to withstand the anticipated forces in order for dry floodproofing to be considered a feasible alternative. Dry floodproofing is allowed under the NFIP for historic residential structures only when other adaptations what would mitigate the building to the BFE would case the structure to lose its' historic designation. However, it would not reduce the residential property owner's flood insurance premium and there are many issues to consider when dry floodproofing a residential property.

Dry floodproofing, that is, keeping floodwater out of a building, is only viable as an option in situations that meet the criteria described below.

- The depth of floodwaters is relatively low, typically no higher than to 2-3 feet, so that lateral forces are limited.

- The exterior building and foundation walls can withstand the lateral forces, wave action and flood-borne debris impact forces. This limits viable wall materials to load-bearing masonry and concrete.
- The building or basement slab can resist buoyancy forces.
- Window and door openings can be effectively sealed to protect against the anticipated lateral force of the floodwater and to prevent infiltration for the flood's duration. This will generally require human action in anticipation of a potential flood event. *(Refer to Barriers and Shields - Windows and Doors, page 3.31.)*
- Minor openings such as pipe penetrations and crevices can be effectively sealed to minimize seepage.
- The duration of flooding is limited. Seepage can accelerate as materials are exposed to water for longer periods of time.
- Water seepage can be removed until floodwaters recede. This typically requires a sump-pump or other mechanical system that will remain operational even with a power failure.

Because the feasibility of dry floodproofing is so site-specific, it is important to have a structural engineer evaluate the structural soundness of the building and determine whether it can withstand flood-related forces.

i. **Construction Types**

As a general rule, only masonry bearing wall and concrete buildings are potential candidates for dry floodproofing. *(Refer to Document & Assess the Vulnerability of Historic Properties, page 2.23.)*

- **Masonry buildings** include stone, brick, and block construction, and have walls composed of masonry units bonded with mortar, grout, or sealant. The wall

Figure 3.20 - Dry floodproofing is hidden behind the building's façade at the Recreation Pier. Fells Point, Baltimore City.

composition tends to be continuous from the roof to the foundation, often providing sufficient structural capacity to withstand the lateral force of water or capable of being reinforced to have sufficient capacity. Conversely, their irregular surface can be difficult to waterproof and they often have openings or voids through which water might pass – either designed, such as weep holes, or openings develop over time through deterioration or lack of maintenance.

- **Concrete buildings** and slabs might appear to be waterproof, but concrete is a very porous material and typically allows water seepage. In addition, concrete may be vulnerable to seepage at transitions between structural members or between installation "pours." Because of concrete's relatively smooth surface, the application of a waterproof membrane can often be readily accomplished. The structural capacity of concrete to resist lateral and buoyancy forces is influenced by thickness of the concrete, the size and configuration of reinforcing, and the manner in which it was constructed.
- **Wood-framed buildings**, typically constructed of wood studs with exterior clapboard, shingles, or siding, are generally porous, with many small holes and crevices that allow water seepage. In addition, wood-framed structures are vulnerable to water penetration at the connection between the foundation and the wall framing. ***As a result, effective dry floodproofing of wood-framed buildings is typically limited to a continuous masonry or concrete foundation or basement.***

iii. **Wall and Slab Surface Sealers**

To prevent infiltration through masonry and concrete walls and slabs, the surfaces must be sealed. Wall and slab sealants generally fall into two categories, either asphalt-based coatings, that can be brush or spray applied, or a heavy-duty rubber membranes. It is generally most effective to seal a building at the exterior wall, foundation wall, or slab surface to prevent prolonged saturation of building materials during a flood event.

Because the building's "wetsuit" needs to be continuous, or as continuous as possible, this can present challenges at existing buildings in which foundations need to be exposed to apply the protection. Slabs may need to be replaced to allow installation of an underlying sealant barrier. There are different challenges above-ground where building materials or aesthetic considerations, such as historic preservation regulations, may limit options for the application of wall sealant systems. In these cases, it may be necessary to rely on joint sealers to minimize infiltration.

iii. **Joint Sealers**

Many buildings have joints or gaps at penetrations, where dissimilar materials meet, or where different elements are joined. To improve the effectiveness of dry floodproofing, all crevices and gaps must be sealed to provide a continuous barrier at the wall and slab.

Joint sealers generally come in two categories, sealants and gaskets. Sealant is typically a flexible, putty-like material that adheres to surfaces and to form a watertight seal. Gaskets are generally rubber and are compression fit to form a water-resistant seal between two materials. While sealants adhere to adjacent materials, gaskets can be utilized as a sealer between two joining parts, such as around an operable door or window.

One of the difficulties associated with sealants and gaskets is that they tend to degrade and fail relatively quickly. As they begin to fail, they lose their water tightness, becoming ineffective as a water barrier.

Figure 3.21 - Metal flood barriers for covering exterior doors are stored inside the Mount Vernon Mill #1, Baltimore City.

iv. **Barriers and Shields – Windows and Doors**

Barriers and shields can provide temporary protection against floodwater entering doors and windows and are installed immediately preceding an anticipated flood event. The range of barriers and shields includes sandbags, drop-in or roll-up barriers, shields at door openings, floating barriers and engineered barriers secured to building walls and the ground. With the exception of the engineered barriers, the other forms of protection are typically limited structurally to a maximum of two- to three-feet of floodwater.

Shields and barriers are generally constructed of metal, with heavier gauges for engineered applications. To minimize potential seepage, the shields and barrier systems typically include gaskets at the junction of components and where they meet the building wall or ground surface.

Property owners and planners should consider the following factors when contemplating utilizing barriers and shields at windows and doors:

- Most, such as drop-down or roll-up barriers, window and door shields, and engineered barriers, are dependent on individuals to install them preceding an event (with the exception of floating flood barriers). Sufficient trained manpower must be available and in place for the implementation. Therefore, this approach is most effective when there are a limited number of openings requiring protection and sufficient advance notice. Consequently, this approach is less effective in locations prone to flash floods.
- Since exit doors typically swing out, barriers and shields that prevent doors from operating should only be installed after a building has been evacuated.
- Sandbags require substantial available materials, onsite trained personnel to properly stack bags, and appropriate disposal methods if contaminated by floodwater.
- The Association of State Floodplain Managers in collaboration with the USACE National Nonstructural/ Floodproofing Committee have implemented a national program to test and certify flood barriers. The barriers tested under the program, the National Flood Barrier Testing and Certification Program, are evaluated for materials properties, consistency of manufacturing, and resistance to water forces. It is recommended that if using flood barriers, that the program website be consulted and certified barriers chosen in lieu of untested, non-certified barriers.

v. Fenestration Modification

An alternative to installing a barrier or shield at existing window and door openings would be to modify low-lying openings to prevent floodwater infiltration. In the case of very low openings, such as basement windows, this could mean infilling the opening. For windows and unused doors with sill heights vulnerable to flooding, it might mean infilling the lower portion of the opening and raising the sill.

In either case, the infill material must provide a watertight seal and have sufficient structural capacity to withstand the lateral force of floodwater. This generally suggests infilling with masonry or concrete. ***However, permanent modification of windows and doors can dramatically change the exterior appearance of a building.***

Figure 3.22 - Accumulated flood water is evacuated through floor grates and a sump pump at Mount Vernon Mill #1, Baltimore City.

vi. Secondary Drainage System

No matter how effective a dry floodproofing system is, it is highly likely that some water will seep into the building through the walls, joints, and underlying slab. Therefore, it is prudent to have a drainage and under drainage system with a sump pump to evacuate any accumulated water. In addition, building systems should be installed so that they will not be damaged by seepage. *(Refer to Wet Floodproofing, page 3.24.)*

vii. Maintenance

One of the key requirements of a dry floodproofing option is a well-maintained building. *(Refer to Encourage Property Maintenance, page 2.52.)* During a flood event, the force of the water can easily undermine a compromised structural system. In addition, any small gap or opening can provide a path for water seepage. Therefore, for dry floodproofing to be effective it is critical to ensure that:

- Structural framing is sufficient to resist forces;
- Masonry and concrete walls have sufficient lateral load capacity;
- Masonry walls are fully pointed; and
- All joints are properly sealed, including around window and door frames, pipe penetrations, etc.

viii. Cautions

Although dry floodproofing can provide protection from water infiltration during a flood event, the application of permanent or semi-permanent sealers and waterproof membranes can lead to deterioration of building materials by trapping moisture or promoting condensation, both of which can lead to material degradation of masonry, concrete, and wood. In the case of wood, increased

DRY FLOODPROOFING

Potential Preservation Benefits:

- Historic buildings can remain at original location and elevation

Potential Preservation Challenges:

- Installation of waterproofing materials may necessitate modification of historic appearance
- Proper floodproofing application of waterproofing membranes, sealers, etc. has the potential to trap moisture in historic buildings and building materials during non-flood periods, potentially leading to deterioration
- Attachment or installation locations for barriers and shields can be obtrusive
- Interior structural elements may require reinforcing
- Lower elevation window and door openings may be infilled or modified to achieve waterproofing and provide required lateral resistance to floodwater
- The elevation of exterior building systems and equipment often increases their visibility, making screening more challenging

moisture can promote rot, mold and insect infestation, such as termites and carpenter ants, in both exterior wall elements and in other parts of the building such as floor framing and interior finishes.

Figure 3.23 - Flood wall (black granite, foreground) forms a perimeter barrier surrounding the National Museum of African American History and Culture and protects the museum from flooding by the Potomac River. Washington, DC.

d. Perimeter Barriers

An alternative to wet or dry floodproofing is providing a continuous barrier to keep the floodwater away from the perimeter of a building, or group of buildings, either permanently or immediately preceding a flood event. Permanent barriers can be a constructed masonry or concrete floodwall or levee. (In some cases, existing masonry site walls can be modified to have sufficient strength to act as a floodwall.) Because levees are constructed of sloped earth, they require significantly more space than floodwalls. To be effective, both options should be engineered to assure that they:

¤ Are located in soils that are impermeable and can withstand the forces associated with floodwater;

¤ Are of sufficient height to provide protection during a flood event;

¤ Have sufficient structural capacity to withstand the lateral force of floodwater;

¤ Include temporary barriers to seal off openings at walkways and driveways;

¤ Are watertight above and below grade to minimize seepage; and

¤ Include a secondary drainage system within the perimeter to remove groundwater, rain, or seepage.

An important consideration for a permanent barrier system is that many of the same mechanisms used to prevent water from approaching a building during a flood event will tend to trap or collect water adjacent to a building. Prolonged periods of soil saturation can have long-term ramifications for building materials.

PERIMETER BARRIERS

Potential Preservation Benefits:

- The location and elevation of the historic building is unchanged
- Temporary barriers can reduce or prevent flood damage minimizing lasting effects at historic buildings

Potential Preservation Challenges:

- Permanent barriers, such as a surrounding levee or landscape wall, alter the historic context of a building
- Permanent barriers can prevent adequate drainage away from the protected building, essentially trapping moisture near the foundation, potentially leading to the degradation of historic materials

Temporary barrier systems can include water-filled rubber tubes or structural wall systems installed immediately preceding a flood event. The empty tubes are laid on the ground and filled with water; these might provide up to two feet of protection depending on the contour of the land and whether joints between sections are properly sealed. Temporary structural wall systems typically require installation into pre-mounted anchors on the ground and can provide protection to higher elevations. Both of these options rely on human intervention to establish a continuous perimeter barrier and do not necessarily include a secondary drainage system to evacuate water collected within the barrier.

Figure 3.23 - Historic house on cribbing with a cradle of steel I-beams to stabilize the structure in preparation for relocation. Lewes, Delaware.

e. Relocation

Relocation involves moving a building out of a flood area onto a portion of the existing parcel that is at a higher elevation, if available, or onto a different parcel. ***It provides an alternative to demolition for situations where it is not feasible for the building to remain in place.***

Property owners and planners should consider the factors below when evaluating how difficult it will be to move a building.

- **Foundations**. Buildings resting on piers or with basements facilitate the installation of lifting beams. Slab-on-grade buildings can be more challenging.
- **Size**. Smaller buildings are easier to move than larger, multi-story buildings.
- **Footprint Geometry**. Simple rectangular buildings are easier to move than buildings with multiple wings and complex footprints.

- **Material**. Wood framed buildings are lighter than masonry buildings and therefore easier to move.
- **Condition**. Buildings in good condition are better candidates for relocation than buildings in poor or fair condition.

The actual process of moving the building is similar to building elevation in that it generally involves the building being lifted off its foundation. From there it is placed onto a flatbed truck, driven to its new location and set upon a new foundation. Because the building is being moved horizontally (not simply lifted vertically and set down again), relocation is a complex process that involves:

- Finding an available, appropriate parcel;
- Ensuring that there is an accessible route to the new location with minimal obstructions, such as underpasses, utility lines, traffic signals, and narrow or low load capacity roadways and bridges;
- Securing the required permits;
- Constructing a foundation and providing utility hook-ups at the new site;
- Disconnecting utilities at the existing site;
- Reinforcing the existing building to ensure it can take the stress of moving;
- Bracing chimneys, porches, and other projecting elements, or carefully dismantling them to allow reassembly at the new site;
- Inserting a structural support system under the building, detaching the building from and lifting it off its existing foundation;
- Placing the building and its structural support system onto a trailer;
- Transporting the building to the new location;
- Lowering the building onto the new foundation;
- Connecting the utilities;
- Finishing the new site, including regrading and installing paving and plantings;
- Removing and/or addressing contaminated materials including septic systems and fuel storage tanks; and
- Restoring the former site to address local requirements, potentially including removal of utilities, backfilling the basement, removing paving, regrading, and replanting the site to a more "natural" landscape.

f. Demolition

Demolition involves the intentional tearing down of all or part of a building or structure. In flood-prone areas, demolition may be proposed if a building has been extensively damaged by a flood event. Considerations for the future resultant site include the following possibilities:

RELOCATION

Potential Preservation Benefits:

- Historic buildings and structures can be saved

Potential Preservation Challenges:

- Historic context is lost
- Recreating historic relationships between site elements and surroundings can be difficult; for example, a building's or structure's relationship to a shoreline might be difficult to duplicate
- Relationship to adjoining buildings and sites is lost
- Building may be moved out of the historic district boundaries
- Building may be de-listed

DEMOLITION

Potential Preservation Benefits:

- Restoration of natural conditions
- Reduction of risk of flooding at adjacent historic properties

Potential Preservation Challenges:

- Loss of historic resource
- Alteration of historic context, particularly along the streetscape within a historic district
- Possible damage to archeological resources

Figure 3.24 - Demolition rubble from a historic cottage.

- Potential replacement of a non-flood-compliant building with a flood-compliant building, with all that entails, including floor elevations and flood resistant materials, which may be incompatible with the historic context;
- Allowing an area regularly affected by flood to return to a more natural state as part of a buy-out or similar program;
- Disconnecting utilities at the existing site;
- Removal of or addressing contaminated materials at the property including septic systems and fuel storage tanks; and
- Restoring the site to address local requirements, potentially including removal of utilities, backfilling of the basement, removal of paving, regrading, and replanting the site to a more natural landscape.

Demolition of some buildings may also be used to reduce the risk of flooding at others. This can occur when developed sites are retuned to a more natural setting such as wetlands or floodplains. In considering this adaptation option, the relative significance of the saved and sacrificed properties should be evaluated as should their flood vulnerability. Another consideration is whether the property has been abandoned through migration, and whether the property is slated for demolition to improve the functionality of the floodplain as part of a buy-back program. *(Refer to Adaptation, page 2.67.)*

Documentation should precede the demolition of any historic property and should be a requirement in a historic preservation ordinance, a floodplain management ordinance, or as part of the permitting process for any building over a certain age. The extent of required documentation can be as basic as exterior photographs or detailed enough to meet the standards of the Historic American Buildings Survey (HABS). Whenever possible and appropriate, documentation should be shared with the MHT for inclusion in the Maryland Inventory of Historic Properties (MIHP) to provide a lasting contribution to the understanding of the state's architecture, engineering, archeology, or culture. *(Refer to Historic & Cultural Resource Documentation, page 2.73.)*

B.4 PROPERTY-SPECIFIC MITIGATION OPTIONS MATRIX

The following matrix is intended to provide a brief overview of the potential issues and impacts associated with the options presented in this section. Refer to the text boxes in the narrative for potential preservation benefits and challenges.

Strategy	Potential Design Option	Potential Issues	Additional Considerations
Elevation	Elevate building or structure	• Size, configuration, or materials may make elevation cost prohibitive • Vertical extension of building foundation and building elements such as chimneys • Extension of building systems, equipment, and associated connections – Removal of abandoned equipment and hazardous materials • Abandonment of former basements – Potential need for infill and grading or wet floodproofing and removal of windows and doors • Extension of access stairs and potentially ramps and elevators	• Level of alteration required for effective/desired implementation might compromise historic integrity • Relationship between building and ground plane as well as adjacent buildings will be altered • Significant elevation change can alter stylistic proportions • More foundation will be exposed • Basement-level openings will be lost • Modification of stairs, ramps, and potentially porches necessitated • Property owners might desire higher elevation than required to provide off-street parking • Excavation around foundation to accommodate cribbing and elevation equipment may damage or destroy archeological resources
	Elevate ground plane with building or structure	• Sufficient area required around building to berm-up to raised foundation or construct retaining walls to provide a "plinth" • Grading to prevent runoff onto adjacent parcels • Vertical extension of building foundation and building elements such as chimneys • Extension of building systems, equipment, and associated connections – Removal of abandoned equipment and hazardous materials • Abandonment of former basements – Potential need for infill and grading or wet floodproofing and removal of windows and doors • Removal and reinstallation of paving at new elevated grade	• Relationship between building and adjacent buildings will be altered • Site regrading may impact historic landscapes or archeological resources • Berming or retaining walls may be inconsistent with historic context • Minimal impact to archeological resources if fill is brought in from off-site

Strategy	Potential Design Option	Potential Issues	Additional Considerations
Wet Floodproofing	Abandon basement level if below DFE	• Modification of basement to allow floodwater to enter and drain from building • Installation of flood openings and potentially ventilation • Modification of basement window and door openings to accommodate floodproofing • Relocation of building systems and equipment above DFE	• Basement windows and doors must be modified • Flood and ventilation openings must be provided • Elevation of exterior and interior systems and equipment may require alteration of interior spaces or new construction to house the equipment
	Raise 1st floor level above DFE while maintaining exterior walls at existing elevation	• Modification of basement and 1st floor structures to address lateral and buoyancy forces • Installation of raised 1st floor level – modification of stairs • Modification of windows and doors at basement and potentially 1st floor • Installation of flood openings and potentially ventilation • Replacement of existing materials with flood damage-resistant materials • Relocation of building systems and equipment	• Basement windows and doors must be modified • Flood and ventilation openings must be provided • Existing materials must be removed and replaced with flood-damage-resistant materials • Exterior systems and equipment must be elevated
	Abandon basement and 1st floor	• Modification of basement and 1st floor structures and 1st floor walls to address lateral and buoyancy forces • Removal of all functions with the exception of storage, garage, and entry at residential • Modification of windows and doors at basement and 1st floor • Installation of flood openings and potentially ventilation • Replacement of historic materials with flood damage-resistant materials • Relocation of building systems and equipment	• Basement and 1st floor windows and doors must be modified • Garage doors may be added • Flood and ventilation openings must be installed • Historic materials may be removed and replaced with flood-damage-resistant materials that do not retain the appearance, workmanship, etc. of the original material • Exterior systems and equipment may be elevated

Strategy	Potential Design Option	Potential Issues	Additional Considerations
Dry Floodproofing	Sealing walls and slabs	• Possible requirement for trenching of building perimeter to apply sealer material below-grade • Possible requirement for new basement slab with secondary drainage system below • Structural modifications to address lateral and buoyancy forces • Application and maintenance of joint sealers at all openings and penetrations • Relocation of building systems and equipment	• Trenching may damage or destroy archeological resources • Wall sealers may trap moisture in wall system or promote condensation • Windows and doors may require modification to withstand lateral loads and prevent seepage • Exterior systems and equipment may be elevated
	Window and door barriers and shields	• Pre-installation of anchors or channels adjacent to each affected opening • Installation of barriers and shields in an accessible location • Installation training and practice in preparation for flooding, and regular inspection and maintenance of anchors, channels, and panels • Emergency operations plan to address installation in advance of flood event and protocol for building evacuation • Access to sufficient materials, assembly and proper installation of temporary sandbags in advance of flood event – Can become hazardous waste requiring proper handling and disposal if floodwater is contaminated	• Channels and anchors can be visible at building exterior
	Fenestration modification	• Installation of waterproof infill in openings or portions of openings able to withstand force of lateral loads	• Alteration of window and door openings can impact the historic integrity of the building and may cause more damage to the building if they fail

Strategy	Potential Design Option	Potential Issues	Additional Considerations
Perimeter Barrier	Site walls and levees	• Sufficient available land around building(s) and structure(s) • Sufficient soil capacity to withstand water forces • Limited opening for walkways or driveways – Requires installation of barriers or shields in advance of flood event • Secondary drainage system with emergency power to remove seepage during flood event	• Historic landscapes and archeological resources may be affected • Site wall or levee might not be appropriate in historic context • Stormwater may be trapped at perimeter of building foundation, degrading materials
	Temporary barriers	• Effectiveness up to 2 feet • Installation in advance of flood event	• None
Relocation	Relocate on same or different parcel	• Preparation of new building location, foundation, and utility hook-ups • Clearance of a path to move building – Move building • Abandonment of former location with removal of utilities, hazardous materials, foundations, and paving • New paving and landscaping at new location	• Building will be severed from historic context, which may be difficult to recreate at new site • Loss of building at former site may create a "hole" in the streetscape • Historic landscapes and archeological resources may be affected • Secondary buildings and structures might not be relocated, altering historic relationship
Demolition	Site Abandonment	• Abandonment of location, removal of utilities, hazardous materials, foundations, and paving – Provide appropriate landscaping	• Historic resource will be lost • Historic context, particularly along a streetscape, will be lost
	Replacement with compliant building	• New construction meeting all regulatory requirements	• Compliant building might be incompatible with historic context
Do Nothing (Not Mitigation)	Limited to properties not required to have flood insurance	• Financial burden for flooding on property owner	• Existing conditions are maintained until potential flood impact or change of ownership • Likelihood is increased for more significant damage if and when flooding occurs

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Note: All references are available online. References that are only available as online resources are noted as "online resource."

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