Build on Partially Elevated Areas

Photo Credit: Kossina Creative Photography

Sea level varies based on the rate of sea level rise relative to land elevation in a particular location. It amplifies near-term vulnerability to storm surge and increases long-term flood and inundation risks. Building on partially elevated areas can mitigate and reduce these risks.

Solution Timeline	**Long Term**
Scale	**Micro**
Adaptation Infrastructure	**Hybrid**
Degree of Protection	**Medium**
Relative Cost ($, $$, $$$)	**$$**

Check Valve / Non-Return Valves

Photo Credit: Taylor Engineering, Inc.

A check valve or non-return valve can be installed in pipes that are vulnerable to backflow during various flood conditions. The valve will work by blocking the flow of water if it is entering in the wrong direction. This will help with flooding control, standing water control, and water quality issues. Different size and shape valves can be used, as needed.

Solution Timeline	**Intermediate**
Scale	**Macro**
Adaptation Infrastructure	**Gray**
Degree of Protection	**Medium**
Relative Cost ($, $$, $$$)	**$$$**

Projects:

23FRP44 City of West Palm Beach Tidal Valve Adaptation Project

Elevated Flood Wall / Flood Gate

Photo Credit: Taylor Engineering, Inc.

A flood wall can be constructed to protect individual buildings or facilities against flooding. Flood walls can either be permanent or dismountable depending on short or long-term goals. Sometimes flood gates are built in a flood wall to create space for roads. These gates are only closed during a flood event.

Solution Timeline	**Long Term**
Scale	**Macro**
Adaptation Infrastructure	**Gray**
Degree of Protection	**High**
Relative Cost ($, $$, $$$)	**$$$**

Projects:

25SRP09 PortMiami Berth 10 Bulkhead Improvements

Flood Barriers (Passive or Active)

Photo Credit: Taylor Engineering, Inc.

Flood barriers are used around a building or its utility components to protect from flooding. Flood barriers can be categorized as either passive or active devices. Passive flood barriers operate automatically during a flood or storm event and do not require any human intervention or power source. An example of a passive flood barrier is a floodwall or levee. Active flood barriers require warnings in advance to deploy during a flood or storm event. This strategy is of limited value when flash floods are frequent. FEMA recommends passive flood barrier devices when planning and building.

Solution Timeline	**Intermediate**
Scale	**Micro**
Adaptation Infrastructure	**Gray**

Degree of Protection	**Medium**
Relative Cost ($, $$, $$$)	**$$**

Projects:

22FRP59 Miami-Dade County Deployable Flood Barriers

Flood Damage-Resistant Materials

Photo Credit: Taylor Engineering, Inc.

Flood damage-resistant materials such as non-paper-faced gypsum board and terrazzo tile flooring for building materials and furnishings located below the base flood elevation help

to reduce structural and nonstructural damage and post-flood event cleanup. The useful life of flood damage-resistant materials ranges between 10 and 20 years with annual maintenance costs depending on the type of material.

Solution Timeline	**Intermediate**
Scale	**Micro**
Adaptation Infrastructure	**Gray**
Degree of Protection	**Medium**
Relative Cost ($, $$, $$$)	**$$**

Living Shoreline

Photo Credit: Florida Department of Environmental Protection

Living shorelines are a shoreline management practice that provides erosion control

benefits; protects, restores, or enhances natural shoreline habitat; and maintains coastal processes through the strategic placement of plants, stone, sand fill, and other structural organic materials (e.g. biologs, oyster reefs, etc.). Living shorelines can reduce wave damage to the coast and inland structures by creating a solution that incorporates segmented breakwaters and plantings along the shoreline.

Solution Timeline	**Long Term**
Scale	**Macro**
Adaptation Infrastructure	**Hybrid**
Degree of Protection	**Medium**
Relative Cost ($, $$, $$$)	**$$**

Projects:

22FRP08 Treasure Island Bay Living Shoreline and Resiliency Project

Raising Land

Photo Credit: Florida Department of Environmental Protection

Raising land is often used to increase the difference between water levels and construction levels. Usually, sand is used to raise the new roads above the existing ground level. This measure reduces the flood risk for that area and structure. Raising land also provides added time during a flood event for ground and surface waters to rise, slowing down the time it would take for exponential damage to take place.

Solution Timeline	**Long Term**
Scale	**Macro**
Adaptation Infrastructure	**Hybrid**
Degree of Protection	**Medium**
Relative Cost ($, $$, $$$)	**$$$**

Project:

22FRP84 Pensacola 9th Avenue Flooding Retrofit

Reduced Paved Surfaces

Photo Credit: Escambia County

Paved surfaces like roofs, roads, and parking lots reduce the infiltration capacity of the soil and increase the surface water runoff. Consequently, flood risk and the need for additional water retention capacity are increased. By decreasing the total area of paved surfaces, more water can infiltrate the soil and extra green space is created.

Solution Timeline	**Long Term**
Scale	**Macro**
Adaptation Infrastructure	**Green**
Degree of Protection	**Medium**
Relative Cost ($, $$, $$$)	**$$**

Utility Elevation

Photo Credit: Taylor Engineering, Inc.

Installing or locating utility systems and components at or above the flood protection level can lessen the impacts/damage to units during flood events. The flood protection level is set by local flood plain management regulations or building codes. Floodproofing building

utilities will work best when all utility meters are elevated as well.

Resources:
FEMA - Protecting Building Utilities from Flood Damage

Solution Timeline	**Long Term**
Scale	**Micro**
Adaptation Infrastructure	**Gray**
Degree of Protection	**High**
Relative Cost ($, $$, $$$)	**$**

Project:

22FRP92 Wakulla County Coastal Lift Stations Flood Mitigation

Foundation Flood Vents

Photo Credit: Taylor Engineering, Inc.

Flood vents can reduce the overall structural damage caused by flooding. These permanent openings allow for water to pass into or out of a building's exterior foundation walls, lessening erosion impacts to the foundation elements.

Resources:
FEMA – Reducing Flood Risk to Residential Buildings that Cannot be Elevated

Solution Timeline	**Intermediate**
Scale	**Micro**
Adaptation Infrastructure	**Gray**
Degree of Protection	**Low**
Relative Cost ($, $$, $$$)	**$$**

Elevate Finished First Floor

Photo Credit: Florida Department of Environmental Protection

A common method in mitigating flood damage to structures is elevating the first floor to the required Flood Protection Elevation (FPE). An FPE is generally above the base flood elevation plus freeboard level required by the local municipality where the structure is located. Another method is to abandon the lowest floor, given that the building is at least two stories tall. Here the lowest floor walls must be retrofitted with flood openings that allow automatic entry and exit of floodwaters and any utility systems and associated equipment on the lowest floor must be elevated to protect utilities from damage or loss of function from flooding.

Resources:
FEMA - Elevating Your House
FEMA – Reducing Flood Risk to Residential Buildings that Cannot be Elevated

Solution Timeline	**Long Term**
Scale	**Macro**
Adaptation Infrastructure	**Gray**
Degree of Protection	**High**
Relative Cost ($, $$, $$$)	**$$$**

Relocate Structure

Photo Credit: Flint and Doyle Structural Movers

Relocating structures from high risk areas can provide complete flood protection as long as

there is an appropriate site available that is above the 500-year flood level. The technology used to move buildings is well established and readily available. Relocation may be the best option for buildings that experience frequent and large flood events.

Solution Timeline	**Long Term**
Scale	**Macro**
Adaptation Infrastructure	**Hybrid**
Degree of Protection	**High**
Relative Cost ($, $$, $$$)	**$$$**

Dune Restoration / Beach Nourishment

Photo Credit: Florida Department of Environmental Protection

Increasing the volume of a beach or dune through nourishment provides a physical buffer between the sea and inland areas. This buffer can naturally shift during storms, unlike hard

structures, such as seawalls and bulkheads. As waves hit a beach or dune and sediments move and shift, the wave energy is absorbed, protecting landward areas from the full brunt of the storm. To maintain dunes as an effective physical buffer, sediment may need to be added regularly to maintain the dune's height, width, and volume at appropriate levels.

Solution Timeline	**Intermediate**
Scale	**Macro**
Adaptation Infrastructure	**Green**
Degree of Protection	**Medium**
Relative Cost ($, $$, $$$)	**$$$**

Wetland Restoration / Retention Pond

Photo Credit: Florida Native Plant Society, Inc.

Natural wetlands function as water retention basins, sediment traps, and stormwater treatment areas. Wetlands can be implemented with or without additions which can improve the treatment capacity. With the correct management practices, wetlands can maintain and enhance hydrologic processes and water quantity; reduce soil erosion; design and manage enhanced and created wetlands to accommodate changes in

hydrologic variability.

Solution Timeline	**Long Term**
Scale	**Macro**
Adaptation Infrastructure	**Green**
Degree of Protection	**Medium**
Relative Cost ($, $$, $$$)	**$$**

Floodable Park / Water Square

Photo Credit: VisitTallahassee

This type of park or square can combine water storage with the added benefits of an urban public space. A floodable park or water square is considered a twofold strategy: (1) It makes money invested in water storage facilities visible and enjoyable, and (2) it generates opportunities to create quality environmentally friendly spaces central in neighborhoods. Most of the time the park or square can be used as a recreational space. When heavy rains occur, rainwater that is collected from the surrounding area will flow into the floodable park or water square for a short duration. After it has been used as a buffering space for floodwaters, this water is filtered by the vegetation and soils, and the filtered water is returned to the water system.

Solution Timeline	**Intermediate**
Scale	**Macro**
Adaptation Infrastructure	**Hybrid**
Degree of Protection	**Medium**
Relative Cost ($, $$, $$$)	**$$**

Increase Plantings

Photo Credit: Taylor Engineering, Inc.

Using groundcover and shrubbery has many benefits compared to unplanted and paved surfaces. The velocity of floodwaters is reduced, which in turn can reduce damage from floating debris. Infiltration and uptake of floodwaters are improved and accelerated by

plants, which resolves the flood event sooner and more effectively than bare ground. And, erosion occurring as flooding recedes is reduced when the soil is held in place by plant roots.

Solution Timeline	**Long Term**
Scale	**Macro**
Adaptation Infrastructure	**Green**
Degree of Protection	**Low**
Relative Cost ($, $$, $$$)	**$**