RESILIENCE + PRESERVATION

ADAPTING TO SEA LEVEL RISE

CASE STUDY SITE : EAST LITTLE HAVANA

TYPE: SINGLE FAMILY HOUSE

Prepared and presented by the University of Miami's Center for Urban & Community Design at the School of Architecture in collaboration with the Department of Civil, Architectural, & Environmental Engineering, and the City of Miami's Historic Resources Division.

Professor:

Sonia Chao (UM/SoA/CUCD)
Landolf Rhodes-Barbarigos (UM/CoE/ CUCD)

Collaborators:

Bernute Augustin
Yasmine Benchekroun
Ana Luiza Leite
Danielle Todd

Fall 2020

RESILIENCE + PRESERVATION
WHAT CLIMATE CHANGE MEANS FOR SOUTHEAST FLORIDA

SOUTHEAST FLORIDA VULNERABILITIES - PAST & PRESENT

Hurricane Andrew struck Dade County on August 24th 1992 as a Category 5 hurricane. The devastating storm triggered roughly $25 billion in damage. Among the estimated 49,000 destroyed and 108,000 damaged homes (National Weather Service, 2012) were many treasured historic buildings, which had survived previous hurricanes. The extensive structural damage from Hurricane Andrew gave rise to improved building codes and practices in South Florida. Some of the important changes included wind provisions from a national standard, impact resistant glazing requirements, and positive ties at all connections to resist uplift forces. Today, the Florida Building Code is considered amongst the more incisive in the nation.

Given Southeast Florida's geographical location, the region remains at risk to hurricanes and flooding events. Recently, in light of warmer and expanding oceans, the region is increasingly vulnerable, as identified by the United Nation's Intergovernmental Panel on Climate Change (IPCC), the US Army Corp of Engineers (USACE), as well as by the four county Southeast Florida Regional Climate Change Compact (SEFRCCC) (SEFRCCC, 2018).

More intense and frequent weather events are expected over time, as are the rise of sea levels, sunny-day flooding (daylight flooding), storm surge, and the increase of subsurface hydrostatic pressure (IPCC, 2007) (SEFRCCC, 2018). Snap-shots of the future are readily available in low-lying barrier islands and inland areas, where swamps were previously located. Seawalls, along both coastal and riverfront neighborhoods across the region, are threatened by rising seas, especially when combined with lunar tides or during hurricanes as storm surge wave action increase.

Weather patterns are shifting, and with them the risks faced by neighborhoods far and wide, especially in Southeast Florida, given its coastal and riverfront settings, which host over 60% of the regions population. Coincidentally, many are home to historic buildings, that in turn anchor our collective and rich cultural legacy and identity, which in turn fuel our tourism and economy.

Developing resilience guidelines can help historic property owners and infill developments adjust to changing paradigms, ensuring both responsible adaptation and sensible future growth. Each intervention by a property owner represents an opportunity to reduce disaster-related risks, increase community resilience, enhance livability, and protect natural and historic resources while protecting property values. This pamphlet employs as a case study site the historic neighborhood of East Little Havana and its once prevalent bungalow style single family building type. This pamphlet is the first in a series aimed at historic property owners but its content can be useful to all property owners. Readers are encouraged to proactively engage in additional and further research and to participate in local resiliency efforts and conversations.

DEFINITIONS:

Resiliency and ***sustainability*** are two closely associated terms but they are not synonymous. Resilience indicates a community's capacity to "tolerate—and overcome—damage, diminished productivity, and reduced quality of life from an extreme event [or from incremental stressors] without significant outside assistance." (Mileti, 1999)

Sustainable Development is "the preservation of livable, inspiring, enduring and equitable places, where the quality of life and the long term quality of human existence will be enhanced rather than depleted" (United Nations, Brundtland Commisson, 1987)

Adaptation refers to "adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderately harm or exploits beneficial opportunities." (Institute for Sustainable Communities, 2012)

Sources: *Mileti, 1999,Institute for sustainable communities, 2012, (IPCC), (USACE), (SEFRCCC), -US Army Corp of Engineers (USACE) ,- Southeast Florida Regional Climate Change Compact (SEFRCCC).*

KEY CHARACTERISTICS
EAST LITTLE HAVANA ZONING + AVERAGE FLOOD RISK

ZONING

East Little Havana features multiple zones ranging from T3 to T6-12 residential as well as D1 work place, D3 marine, CI civic institutional, and CS space.
The majority of single and multi-family houses are within T3, T4 , T5 and T6 zoning.
Average Lot Size: 50 x 150 ft
This pamphlet focuses on this riverfront historic neighborhood due to it's vulnerability. The adaptation and mitigation strategies provided herein can be applied to similar single-family structures, such as those listed below and to new construction across the region.

HISTORIC BUILDING STYLES

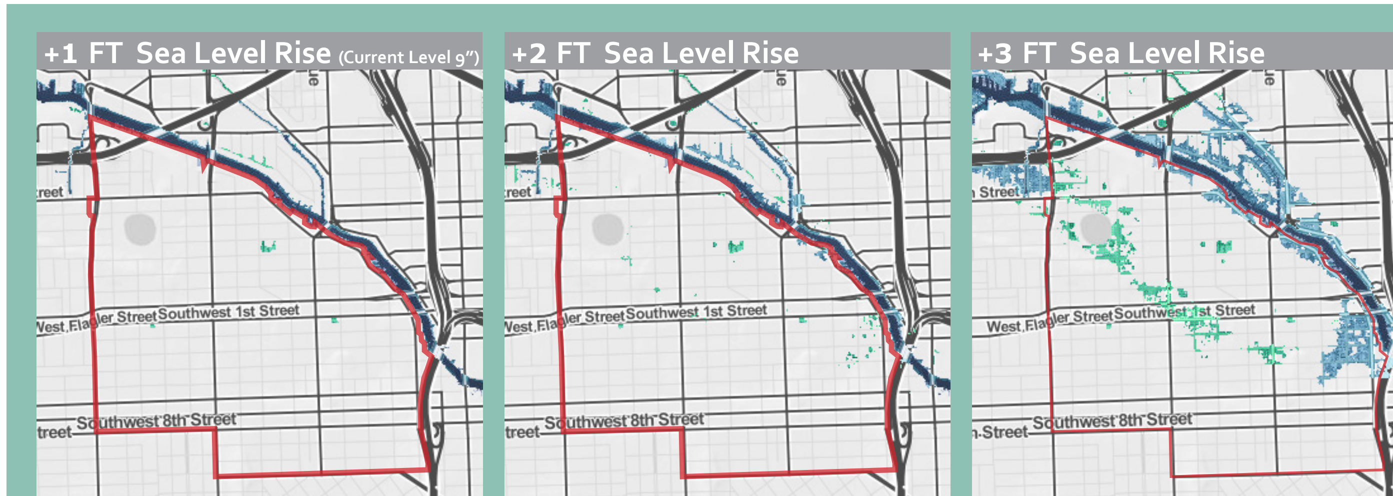
Bungalow
Wood Frame Vernacular (Cracker Style)
Masonry Vernacular
Mission Style
Moorish Style
Mediterranean Revival
Art Deco
Miami Modern

FLOOD RISK

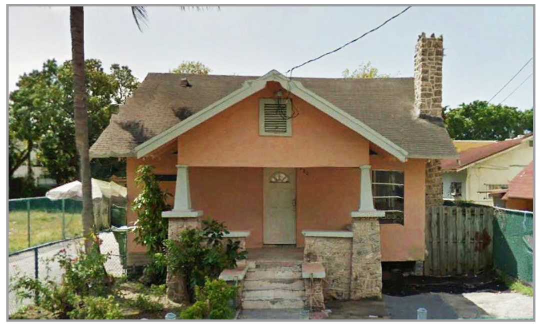
FEMA Flood Zone: AE
Avg. Elevation at Grade: +9 ft (USGS, NAVD 88)vvv
Avg. Base Flood Elevation: +9 ft (FEMA, NGVD 29)
Avg. Design Flood Elevation: +12 ft (FEMA, NGVD 29)
Avg. Depth to Water Table: -5 ft (FGS FAVA II, MSL)
Flood Source: Atlantic Ocean/Intracoastal Waterway
Transect Number: 16
Flood Rate Insurance Map Panel: 314L

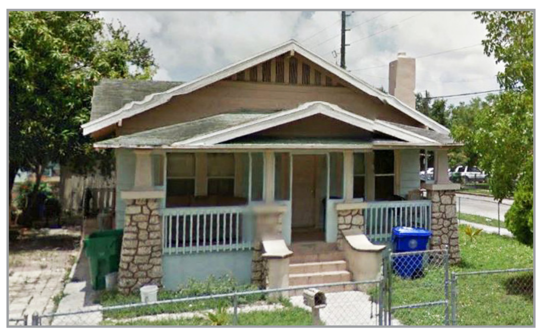
"East Little Havana Figure Ground," Center for Urban Community Design, *1996.*

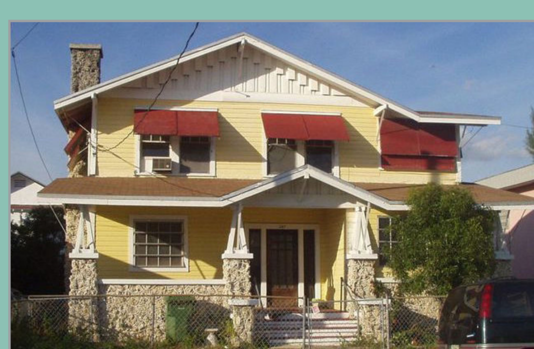
Sources:
FEMA Flood Insurance Study Miami-Dade County. No. 12086CV000A, September 11, 2009.
"Miami Dade County Elevation Map." USGS Topographic Survey Map. http://www.peakbagger.com/peak.aspx?pid=7934.
"Hurricane Andrew Storm Surge Map." FIU. XXXXXXXXBolter, Keren. "Depth to Water Table Map." FAU. http://www.rsmas.miami.edu/blog/2014/10/03/sea-level-rise-in-miami/.
https://www.fema.gov/zone-ae-and-a1-30
https://mdc.maps.arcgis.com/apps/webappviewer/index.html



Source: *Climate Central's Surging Seas* - http://sealevel.climatecentral.org/







Source: Google Earth

SOUTH FLORIDA BUNGALOW

The bungalow represents a building style found in middle income suburbs that grew, around Miami, multiplying vastly between 1915 and 1925. Built primarily from mail order house plan catalogs published in Southern California, bungalows in South Florida are commonly of wood frame construction.

Taking advantage of the area's natural resources, the South Florida bungalow was traditionally made of Dade County pine, with horizontal weatherboards and wood shingles covering the exterior facade. Oolitic limestone, extracted on site, was utilized to finish the foundation walls, chimneys and porch supports. Stucco surfaces were widely used along with large windows, deep-set porches, and wide eaves.

The battered stone piers added considerable stability against high winds and the utilization of elephantine columns strengthened the porch by breaking the vertical supports of the porch roof into a broad tapered masonry pier at the bottom and a short wooden post above. Traditional bungalows feature raised foundations, consisting of a masonry stemwall and footings, which support the exterior walls of the house, with the middle portion supported on posts and piers. This shallow foundation allows for a small crawlspace, typically 18" above grade, which provides cross-ventilation to further cool the structure,as well as protect it from floods and insects.

Referenced: Metropolitan Dade County . Historic Preservation Division. *From Wilderness to Metropolis : The History and Architecture of Dade County (1825-1940).* Second ed. 1992

MAIN DESIGN FEATURES

1. Horizontal Weatherboard Siding
2. Battered Stone Piers
3. Elephantine Posts
4. Front Porch
5. Stone Chimney
6. Exposed Rafter Ends
7. Gable Roof
8. Dormer
9. Raised Foundation with Crawlspace

BUILDING STRATEGIES

This strategy enables parking below for the residents', while it removes livable spaces from flood waters, it does not deal with standing nor the presence of water within the parcel. Elevating the existing building with, extended foundation is a better option from a purely aesthetic perspective, yet there are more advantageous options such as filling and elevating the entire site. Elevating, filling, and raising a site requires lifting the existing structure to a new grade and filling in the area beneath with soil, crushed stone, or gravel. This option increases ground elevations or changes soil properties. This is potentially the most expensive but also most resilient option and best able to preserve a property's value in the long run.

REINFORCING CONNECTIONS:

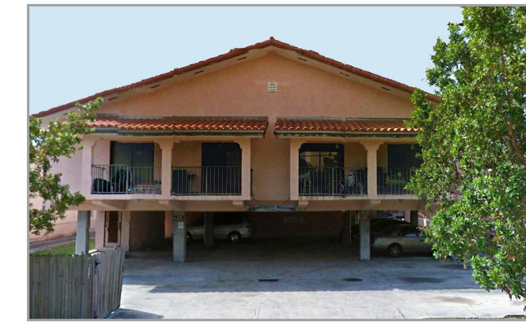
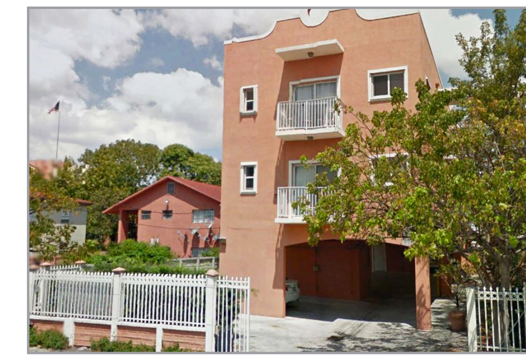
The weakest part of any building is found typically at connection points between roof members and walls, and between walls and foundations. Structurally reinforcing these connections, as indicated in local codes, will improve a historic property's overall integrity.

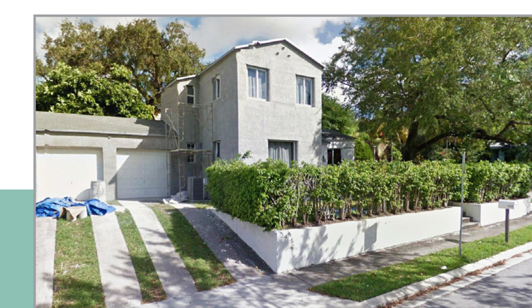
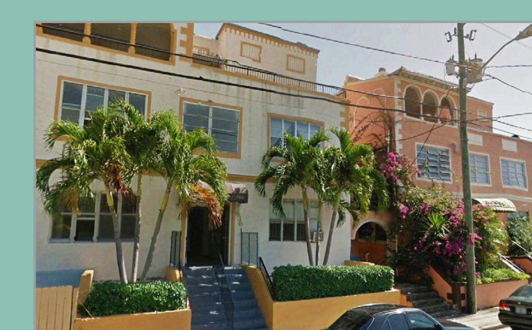
Referanced: Metropolitan Dade County . Historic Preservation Division. *From Wilderness to Metropolis : The History and Architecture of Dade County (1825-1940).* Second ed. 1992

ELEVATED BUILDING STRATEGIES

1. Elevated Single-Story Building on Piers With Parking Below
2. Elevated Multi-Story Building on Piers
3. Elevated Building with Extended Foundation
4. Filled & Elevated Site of Single Family Home With Retaining Walls along Property Line
5. Filled & Elevated Site of Multi-Family Housing

Historically less sympathetic

More sympathetic

Source: Google Earth

IMPORTANT CONCEPTS & TERMS
GLOSSARY

Base Flood Elevation (BFE)
The computed elevation in feet to which floodwater is anticipated to rise during the 1% annual chance storm shown on the FIRMs issued by FEMA. A building's flood insurance premium is determined by the relationship between the BFE and the level of the lowest habitable floor of a structure.

Design Flood Elevation (DFE)
Defined by the Florida Building Code as the elevation to which the lowest habitable floor must meet or exceed which is the higher of:

1) The BFE at the depth of peak elevation of flooding including wave crest height in the 100-year Floodplain.

2) The elevation of the design flood associated with the area designated on a flood hazard map or adopted by the community, or otherwise legally designated.

Flood Insurance Rate Maps (FIRMs)
The official flood map, on which FEMA has delineated the 1% Annual Chance Floodplain or Special Flood Hazard Area (SFHA), 0.2% annual floodplain, Base Flood Elevations (BFEs) and flood-ways.

100-Year Floodplain
The area that has a 1% chance of flooding in any given year. It is indicated on FEMA's FIRMs and is also referred to as the "Special Flood Hazard Areas".

Lowest Habitable Floor
According to the Florida Building Code, the floor of the lowest enclosed area, including basement, but excluding any unfinished flood-resistant enclosure that is usable solely for vehicle parking, building access, or limited storage.

Lowest Adjacent Grade
Elevation of the lowest natural or re-graded ground surface, or structural fill, abutting the walls of a building.

Sources:
- "FEMA Flood Insurance Study Miami-Dade County" *No. 12086CV000A, September 11, 2009.*
- "Section R322: Flood-Resistant Construction." *Florida Building Code: Residential (2014).*
-"Coastal Climate Resiliency: Retrofitting Buildings for Flood Risk". *New York City Department of Planning (October, 2014).*
- "The National Flood Insurance Program." *The National Flood Insurance Program | FEMA.gov, www.fema.gov/national-flood-insurance-program.*

National Flood Insurance Program (NFIP)
Federal program that makes flood insurance available to municipalities that enact and enforce floodplain management regulations meeting or exceeding the criteria established by FEMA.
Visit (https://www.floodsmart.gov/)

NATIONAL FLOOD
INSURANCE PROGRAM

RESILIENCY STRATEGIES
TOOLKIT OF SOLUTIONS

DRY FLOODPROOFING
Involves making a building, or an area within a building, substantially impermeable to the passage of water up to the DFE. Structural components having the capacity to resist specified loads and walls able to resist the penetration of flood water are used below the DFE. Under the NFIP standard, <u>only non-residential buildings</u> can use dry floodproofing.

WET FLOODPROOFING
Allows floodwaters to enter and exit parts of the building below the DFE in order to equalize hydrostatic pressure. This technique relies on the use of flood damage-resistant materials. Parts of the building below the DFE are only to be used for parking, storage, building access or crawl space.

ELEVATE CRITICAL SYSTEMS
Involves elevating electrical & mechanical systems to the BFE or higher.

REINFORCE STRUCTURE
May involve repair, rehabilitation, renovation, or reconstruction of the superstructure, and the foundation.

BACKFLOW VALVES & SUMP PUMPS
Backflow valves inhibit flooding from backed-up sewers & sump pumps inhibit flooding from groundwater.

FLOOD VENTS & BREAKWALLS
Both wetproofing methods allow flood water to enter & exit crawlspace or structural enclosures below the BFE.

ELEVATE: FILL & RAISE SITE
Requires raising the existing structure to a new grade & filling in the area beneath with soil, gravel, or crushed stone. This will increase ground elevations and change soil properties.

ELEVATE: RAISE BUILDING
Elevating the lowest habitable floor of a building above the DFE and floodproofing any structure below the DFE.

ELEVATE: ABANDON LOWEST FLOOR & WET FLOODPROOF
Involves wetproofing and abandoning any habitable floors below the DFE. In some jurisdictions across the country, Floor Area Ratios (FAR) on a site are being adjusted in light of this adaptation option. In others, where the threat of flooding may be more eminent or severe, Transfer of Development Rights (TDR) mechanisms are being introduce to lighten the burden on property owners.

NGVD 29
The National Geodetic Vertical Datum of 1929 is the datum, or established starting point, for surveyors and engineers to measure ground and flood elevations for most of the 20th century. It was presumed to reflect the average national sea level, though it later became evident that no such average exists.

NAVD 88
The North American Vertical Datum of 1988 is the datum, or established starting point, for surveyors and engineers to measure ground and flood elevations that corrects many of the problems of the NGVD 29 by accounting for gravitational forces in different areas. It is the standard vertical orthometric datum used in most recent surveys and flood maps.

FLOODING EVENTS

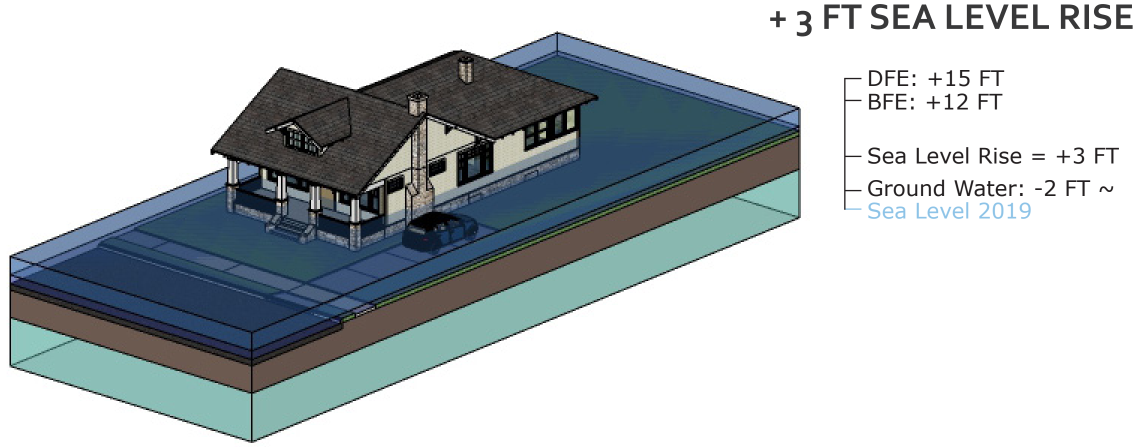
STORM SURGE + SEA LEVEL RISE SCENERIOS

The following diagrams illustrate possible storm surge impacts to a building during a Category 5 hurricane if it is located in a low-lying "Special Flood Hazard Area" and how over time those risks increase as sea levels rise.

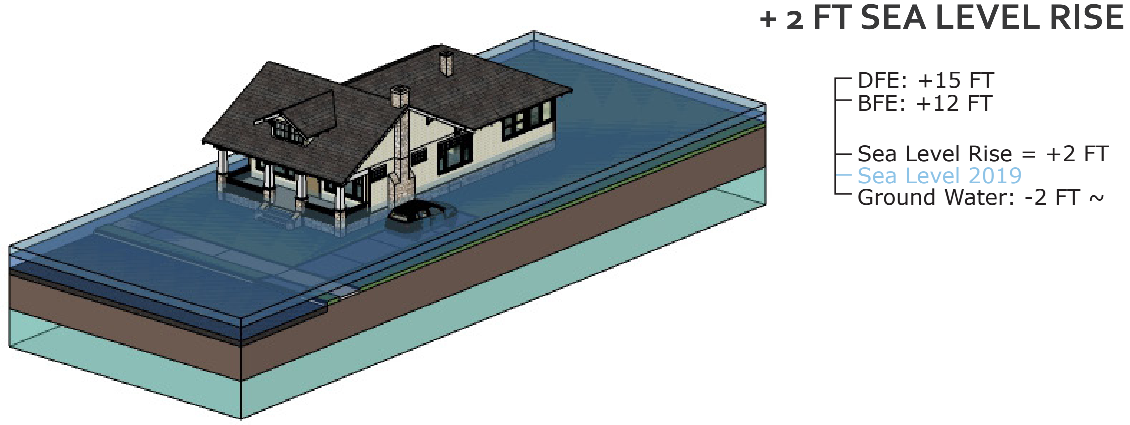
Future

Present

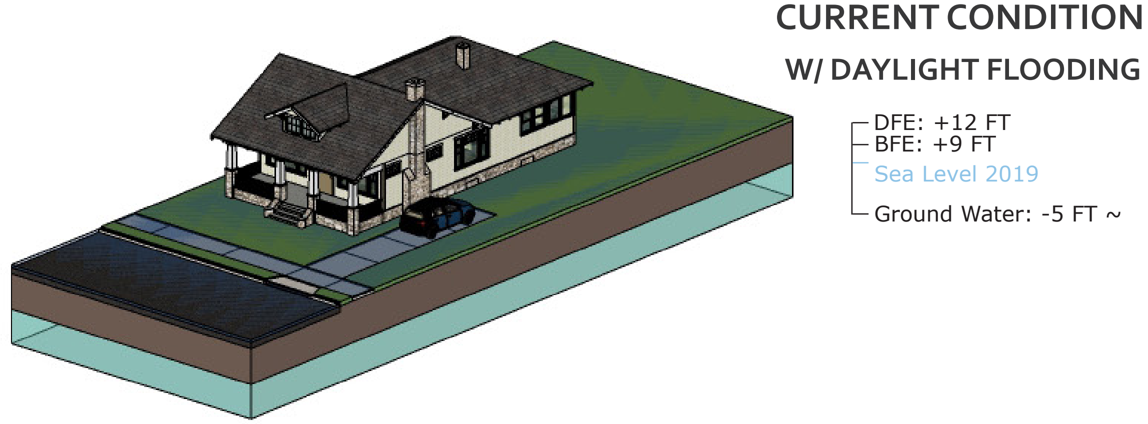
+ 3 FT SEA LEVEL RISE



+ 2 FT SEA LEVEL RISE



CURRENT CONDITION W/ DAYLIGHT FLOODING

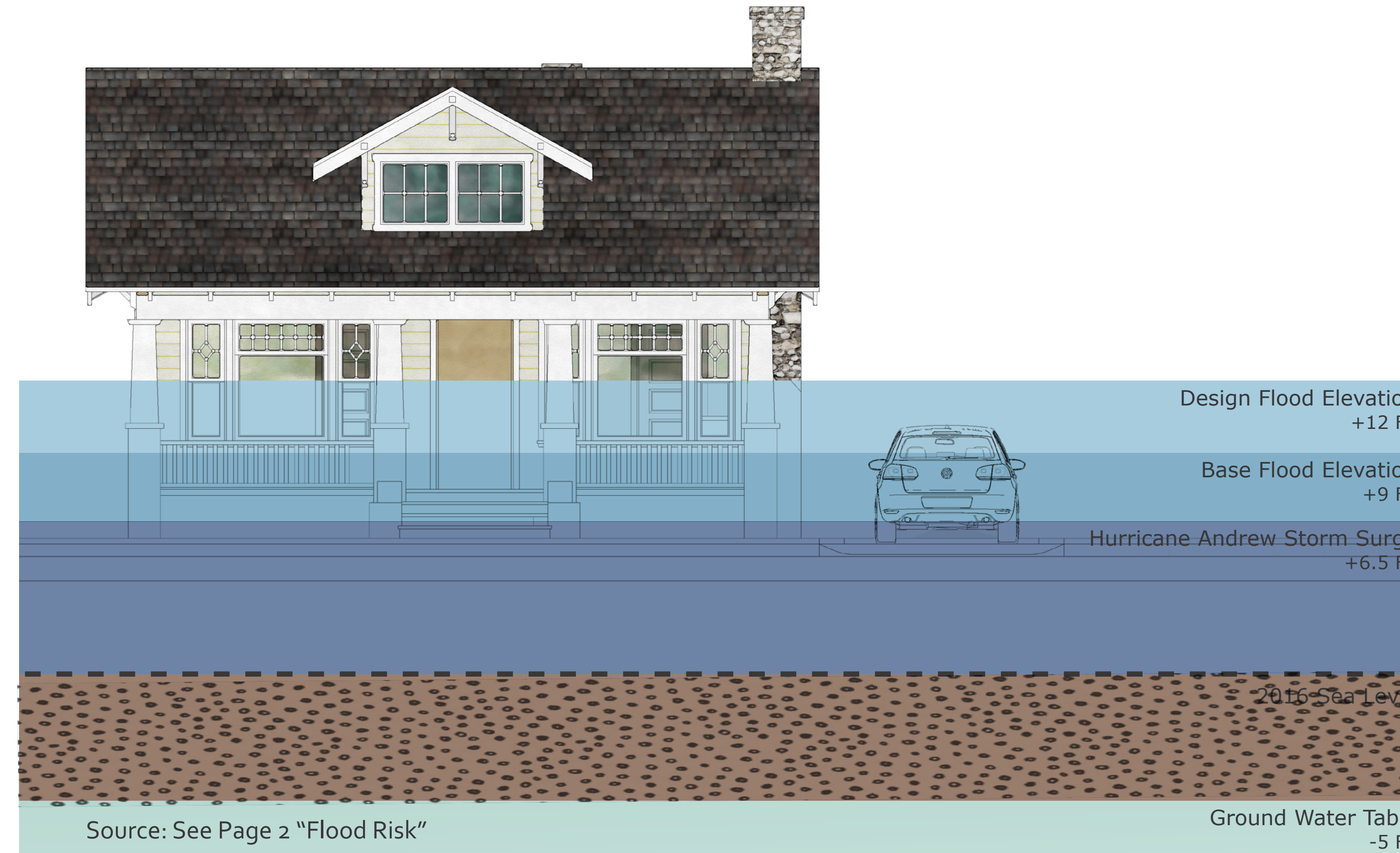


STORM SURGE WILL VARY

Sources: https://www.fema.gov

PLAN OF ACTION

5 OPTIONS FOR PROPERTY OWNERS



Source: See Page 2 "Flood Risk"

PLAN OF ACTION:

5 OPTIONS FOR HOME OWNERS + PROPERTY OWNERS

1. PREPARE: Identify Flood Risks, Regulations, & Assess My Property
2. DEFEND: Protect My Home Today from Possible Flooding
3. ADAPT: Elevate My House or Entire Lot Above the DFE
4. MITIGATE: Make My House Sustainable & Improve Its Performance
5. RELOCATE/REBUILD: Find a New House or Start from Scratch

IDENTIFY MY FLOOD RISK

According to FEMA's Flood Insurance Rate Map (FIRM) Panel 314L most of East Little Havana is within an AE Flood Zone. This zone is an area that corresponds to the 100-year floodplains determined in the Flood Insurance Study. Base Flood Elevations (BFE) are determined from detailed hydraulic analyses and mandatory flood insurance is required for property owners.

IDENTIFY MY FLOOD ELEVATION

Before determining what flood-proofing measures must be taken, you must first understand where your building is in relation to FEMA's flood elevation requirements and the existing grade. This means locating the lowest habitable floor and the Design Flood Elevation (DFE) for your building. The DFE is the elevation to which the lowest habitable floor must meet or exceed.

According to FEMA's FIRM, most of East Little Havana has a BFE of +9 FT. The DFE is typically combination of the BFE + Additional Wave Crest Heights. Based on FEMA's Flood Insurance Study, the Wave Crest Height for transect 16 is up to 13.2 FT for a Still-water Elevation of 9.7 FT, which equals a wave height of about 3 FT. **This would bring the average DFE for East Little Havana to +12 FT.**

Because there is some topography in the neighborhood the best way to guarantee an accurate flood level for your building is to obtain an Elevation Certificate from a professional engineer, architect, or land surveyor.

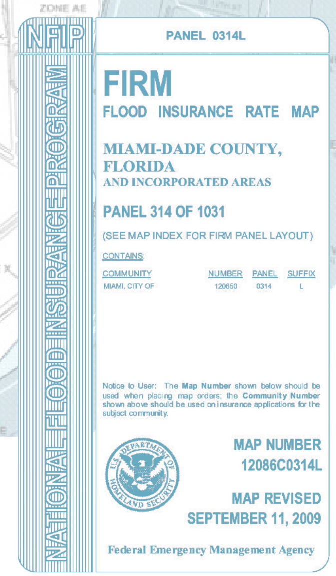
REVIEW RELEVANT REGULATIONS

Knowing the regulations at the federal, state, and local level will inform your approach to retrofitting. Flood retrofitting design and construction is regulated by FEMA's FIRMs, the Florida Building Code, local zoning codes, and other local laws. FEMA also administers the NFIP, or National Flood Insurance Program. In order for property owners in the city to receive insurance as part of the NFIP, the City must adopt these federal standards into its building code. For more information about NFIP visit www.floodsmart.gov.

ASSESS MY BUILDING & SPEAK WITH PROFESSIONALS

Understanding how your building is currently functioning is critical in designing an appropriate adaptation strategy for your home. This includes identifying what kind of foundation and structural system you have, where your critical systems (such as mechanical and electrical equipment) are located, and how well these elements are working.

Most Florida Bungalows have raised foundations, which in general makes it less expensive to elevate them further if necessary, however, because of their age and the quality and consistency of previous maintenance, these homes may require a degree of structural reinforcment as well as electrical, plumbing, and mechanical upgrades to meet today's building codes, as well as become more

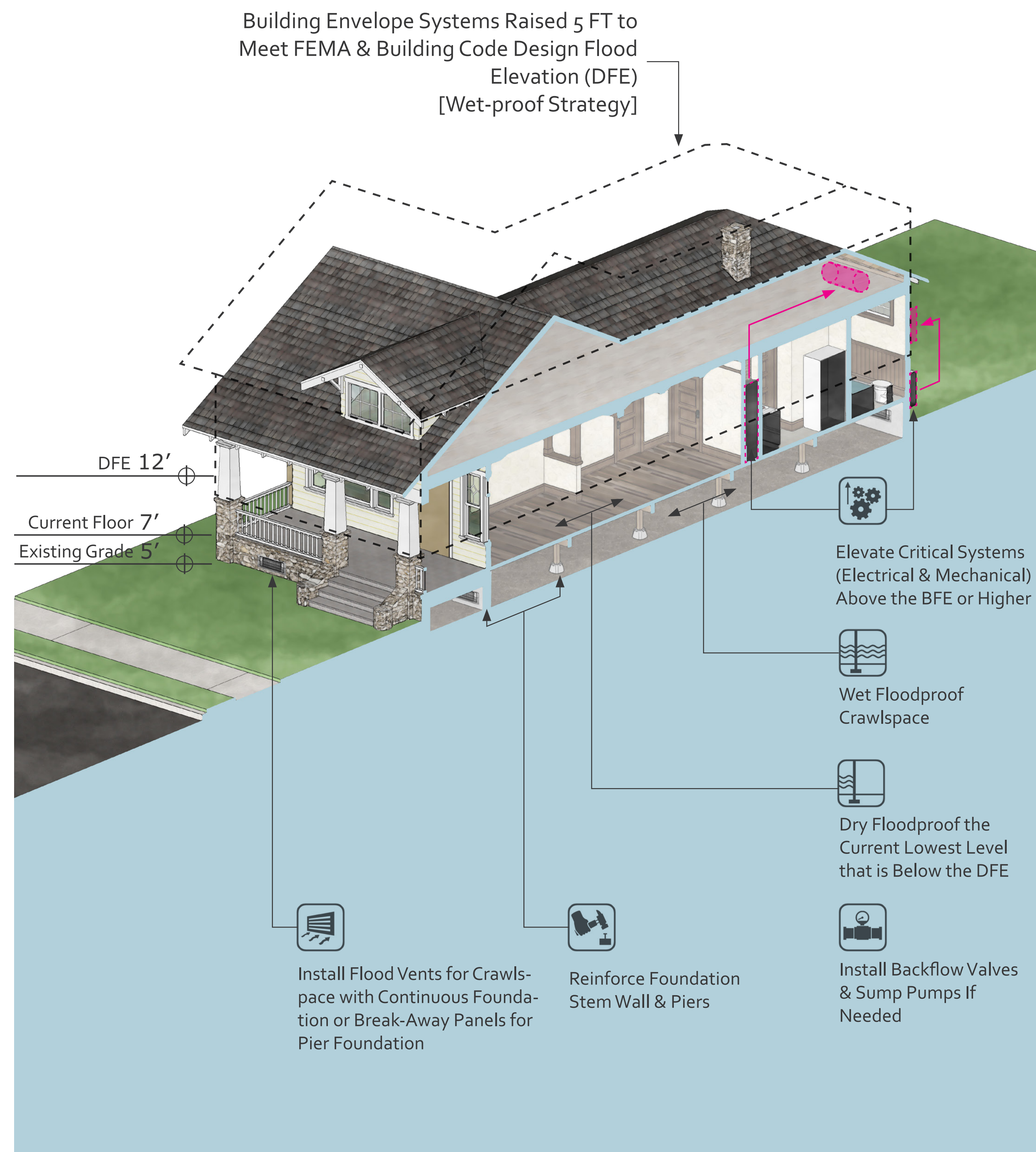

NFIP
NATIONAL FLOOD INSURANCE PROGRAM
PANEL 0314L
FIRM
FLOOD INSURANCE RATE MAP
MIAMI-DADE COUNTY, FLORIDA
AND INCORPORATED AREAS
PANEL 314 OF 1031
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)
CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
MIAMI, CITY OF	120650	0314	L

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

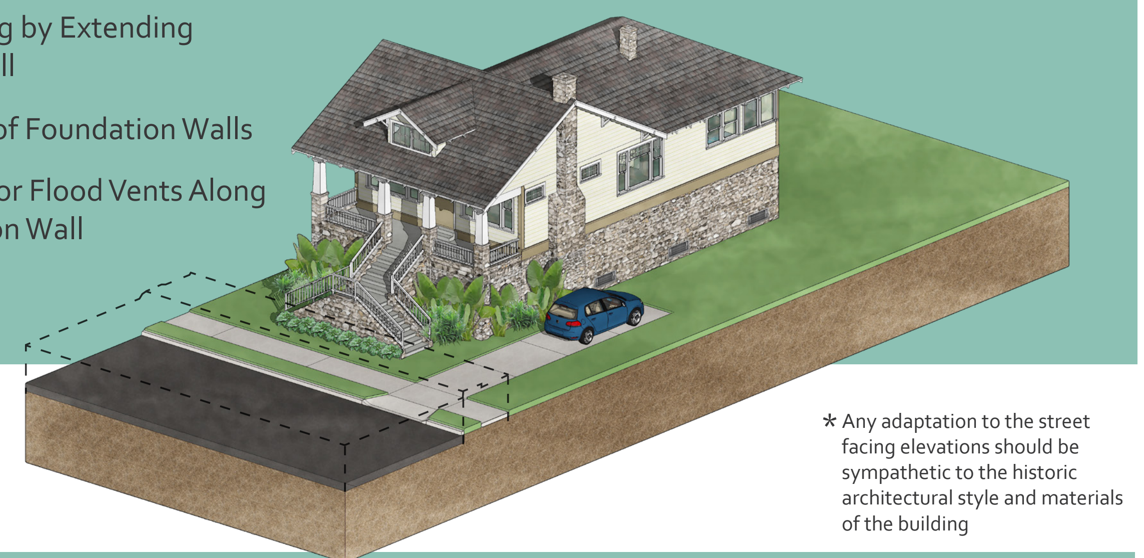
MAP NUMBER
12086C0314L
MAP REVISED
SEPTEMBER 11, 2009
Federal Emergency Management Agency

To access FEMA firm data: *http://map1.msc.fema.gov/idms/IntraView.cgi?KEY=16389533&IFIT=1*



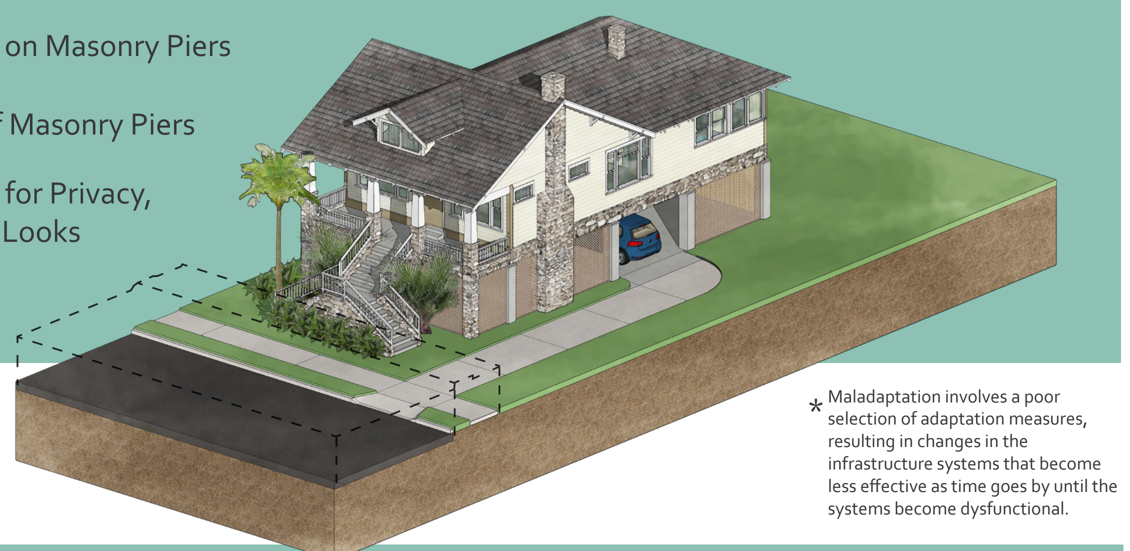
3. ADAPT
WHAT CAN I BE DOING FOR THE LONG TERM? (WET-PROOFING)

- Elevate Building by Extending Foundation Wall
- Wet Flood-proof Foundation Walls
- Add Openings or Flood Vents Along New Foundation Wall
- Structural Reinforcement



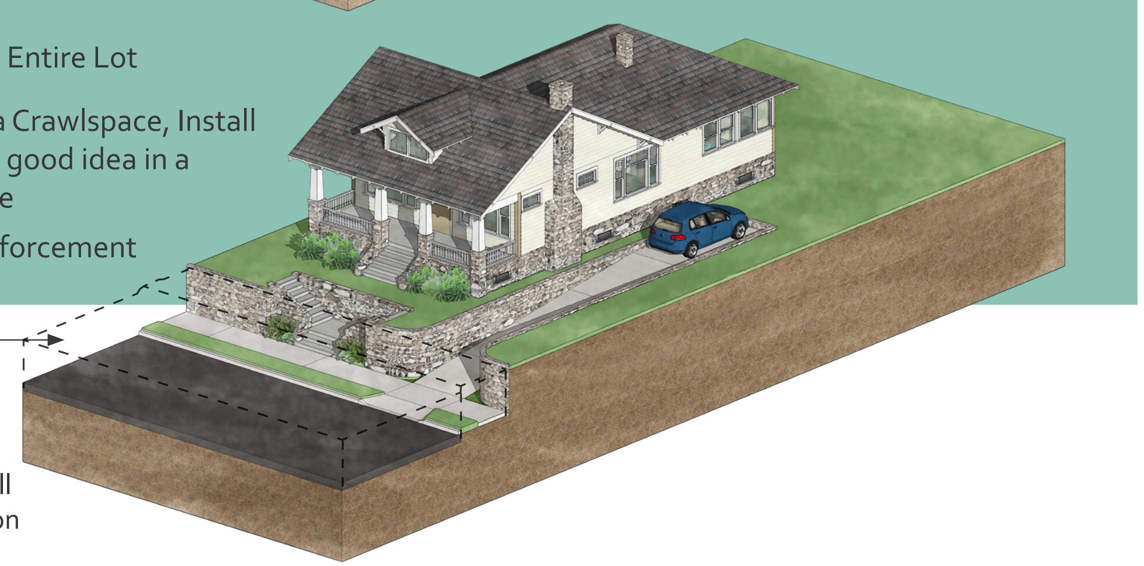
* Any adaptation to the street facing elevations should be sympathetic to the historic architectural style and materials of the building

- Elevate Building on Masonry Piers
- Wet Flood-proof Masonry Piers
- Add Break-walls for Privacy, Landscaping, or Looks
- Structural Reinforcement



* Maladaptation involves a poor selection of adaptation measures, resulting in changes in the infrastructure systems that become less effective as time goes by until the systems become dysfunctional.

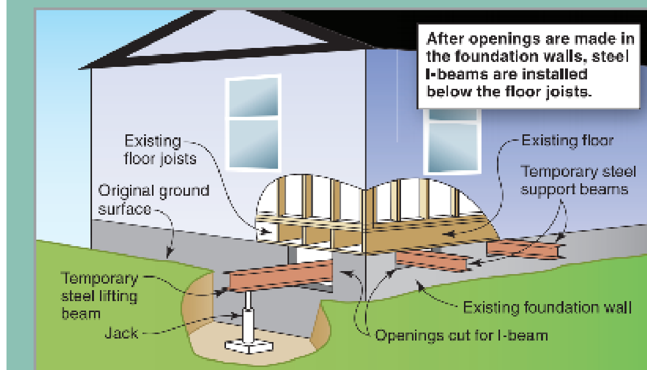
- Fill and Elevate Entire Lot
- If Maintaining a Crawlspace, Install Flood Vents. (A good idea in a Tropical Climate
- Structural Reinforcement

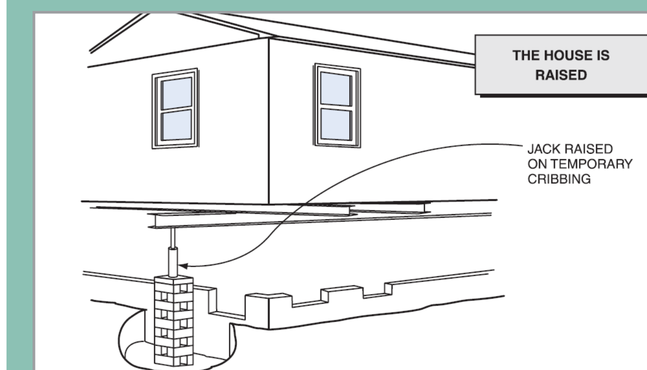


Stay informed about government projects to elevate streets, as this will likely affect the adaptation of your home & property.

3. ADAPT
ADDITIONAL INFORMATION FOR ELEVATING MY HOUSE FROM FEMA

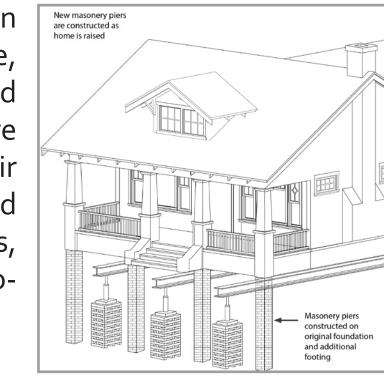
Steps to Elevate Any Crawlspace Foundation:



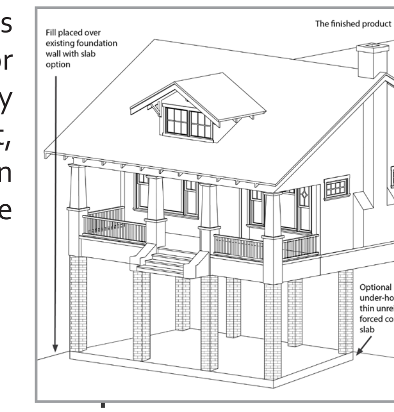


B. Elevating on Open Foundation with Piers:

During the elevation process, most frame, masonry veneer, and masonry homes are separated from their foundations, raised on hydraulic jacks, and held by temporary supports.

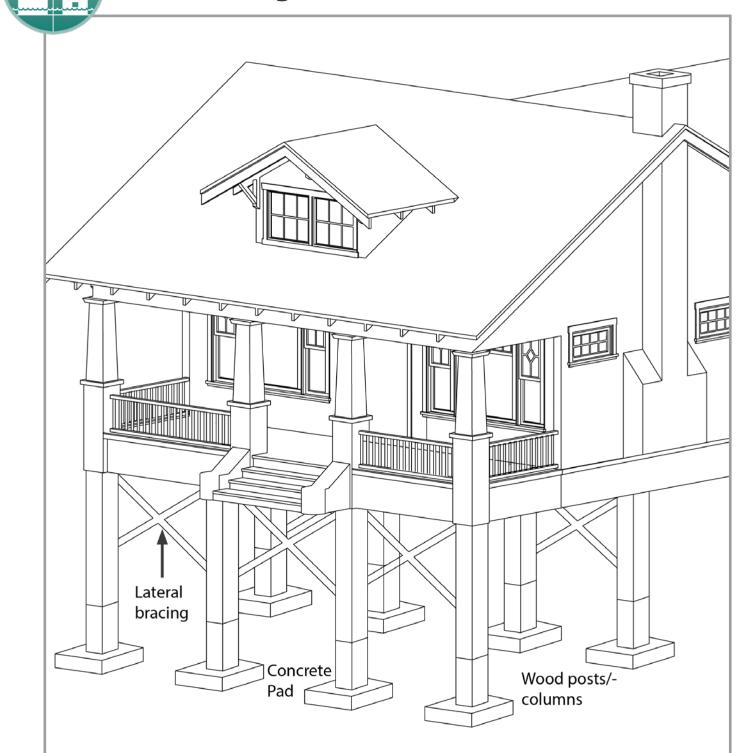


This technique works especially well for homes originally built on basement, crawlspace, and open foundations, like the Bungalow.

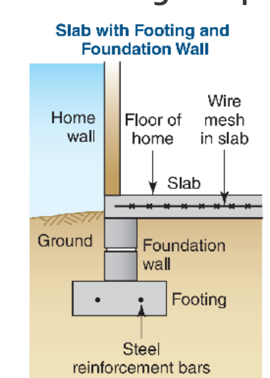


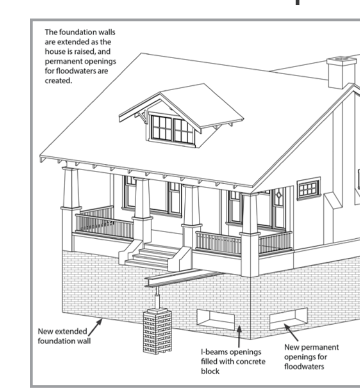
Diagrams Inspired from: https://www.fema.gov/media-library-data

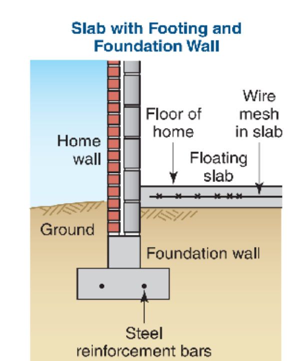
A. Elevating on Extended Foundation Wall:

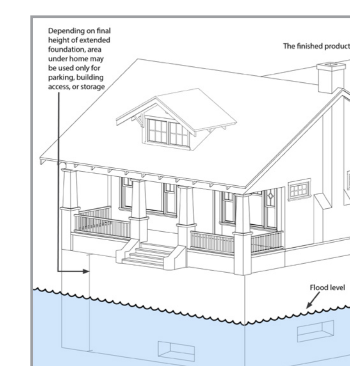


C. Elevating on Open Foundation: Other Options



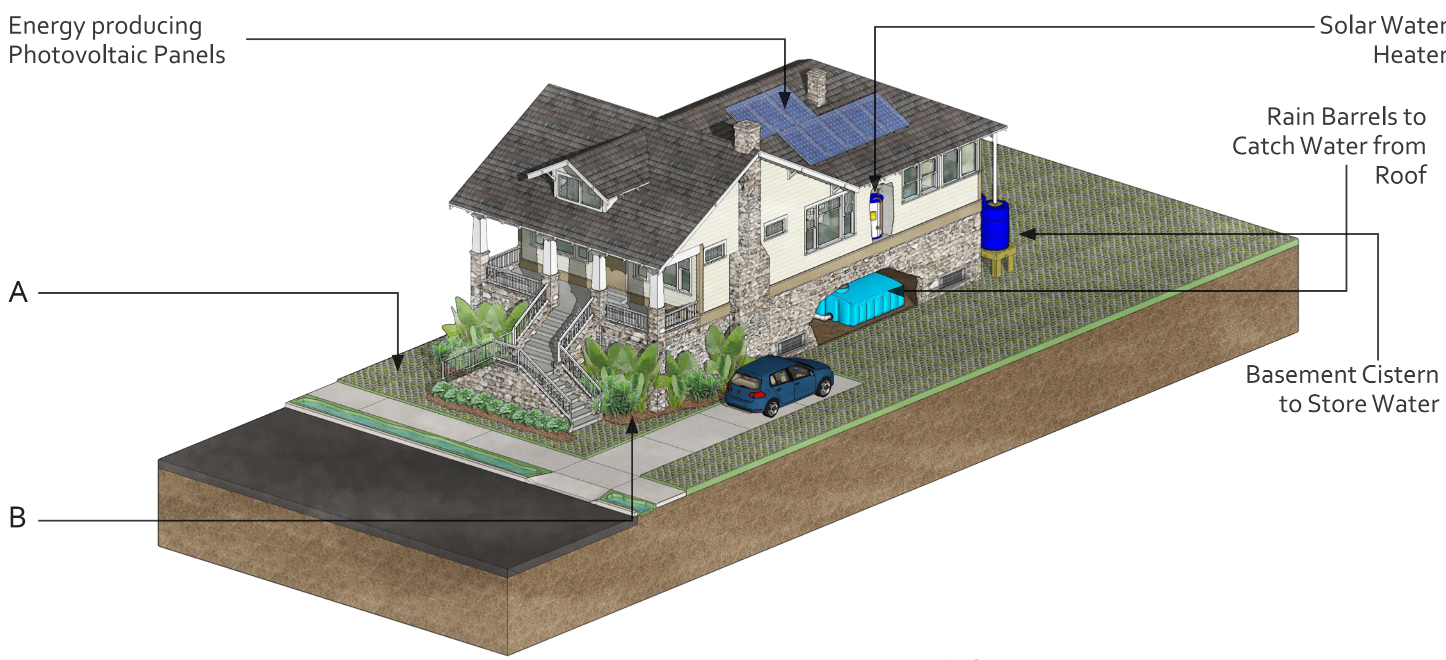


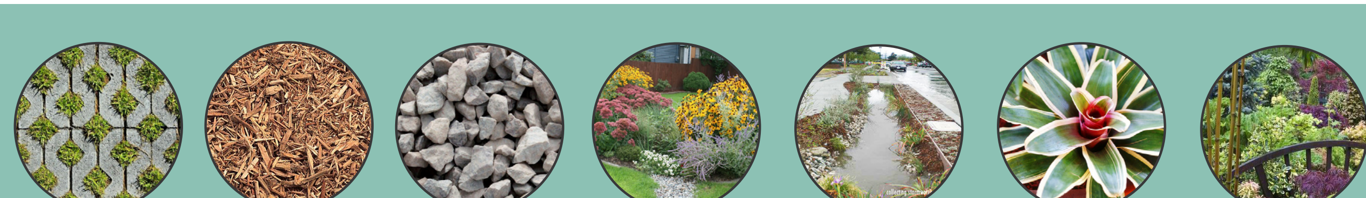




4. MITIGATE

HOW CAN I MAKE MY RESILIENT HOME MORE SUSTAINABLE?





A	B	C	D	E	E	F
Replace Asphalt in front of lawns with Permeable Pavers	Use Mulch to retain moisture in plant boxes	Replace lawn with gravel , crushed shells or rocks	Pitch Yard to Drain Water into Rain Gardens	Consider Bioswales or Drainage Canals to Help Absorb Flood Water	Grow Drought-Resistant Bromeliads or Succulents to Reduce Water for Irrigation and/or Grow Bog and Moisture-Loving Plants to Reduce Garden Floods	

4. MITIGATE

There are different ways to reduce a household's energy use, water consumption, while contributing towards a more sustainable environment. Efforts can range from simple no cost behavioral adjustments to more assertive home improvements.

Here are 8 examples!

Unplug idle appliances and electronics

It's as simple as that! Unplugging a toaster or even a phone charger next to a dresser, will save on expensive light bills while reducing, their carbon footprint!

https://www.energy.gov

Solar Photovoltaic Panels

Solar power is the key to a clean energy future. Every day, the sun gives off far more energy than needed to power everything on earth. . If you can't afford the number needed to power your house, start with a smaller number of panels... and don't forget to use solar chargers for your cellphone.

https://www.usgbc.org/articles/top-four-benefits-installing-solar-panels-your-home

Take Public Transportation

Transit reduces greenhouse gas emissions by reducing the number of vehicles on the road, which in turn conserves land and decreases the distances people need to travel to reach destinations.

https://www.transit.dot.gov/regulations-and-guidance/environmental-programs/transit-environmental-sustainability/

Turn off the Taps and Fix Leaky Taps

Save 6 litres of water a minute by turning off your tap when not in use. Additionally fixing leaky taps can stop about 60 litres of water from just going down the drain.

https://www.theguardian.com/environment/2010/jan/07/how-to-fix-leaky-tap

Upgrade HVAC system

Air conditioning, in this climate, is responsible for more that 67% of a home's energy consumption. Upgrading can save up to 20% on an electric bill.

https://www.energystar.gov/

Planting Drought Resistant and Native Plants

Native Drought-tolerant plants will require minimal supplemental irrigation, if any.

https://www.sfwmd.gov/community-residents/florida-friendly-landscaping

Carpool

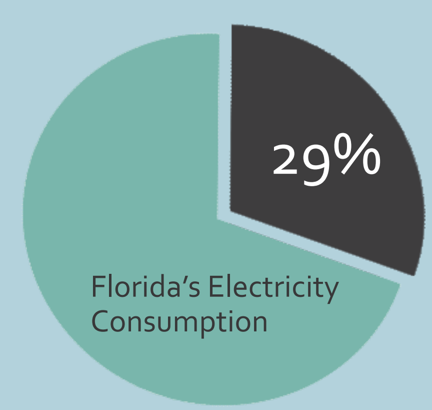
Sharing rides will help reduce the number of vechiles on the road, thereby reducing the need for constructing new roads, road maintenance and resulting in less air pollution related health costs. Having fewer cars on the road means reduced Greenhouse Gas (GHG) emissions and improved air quality.

https://www.greenamerica.org/green-living/carpool-climate-and-community

Replace Light Bulbs

Traditional incandescent light bulbs added electricity and must be replaced more often. Energy efficient lights use from 25-80% less electricity and last three to 25 times longer than traditional bulbs. Thereby saving home's money both in the long-term and short-term.

https://www.energysage.com/energy-efficiency/101/ways-to-save-energy/



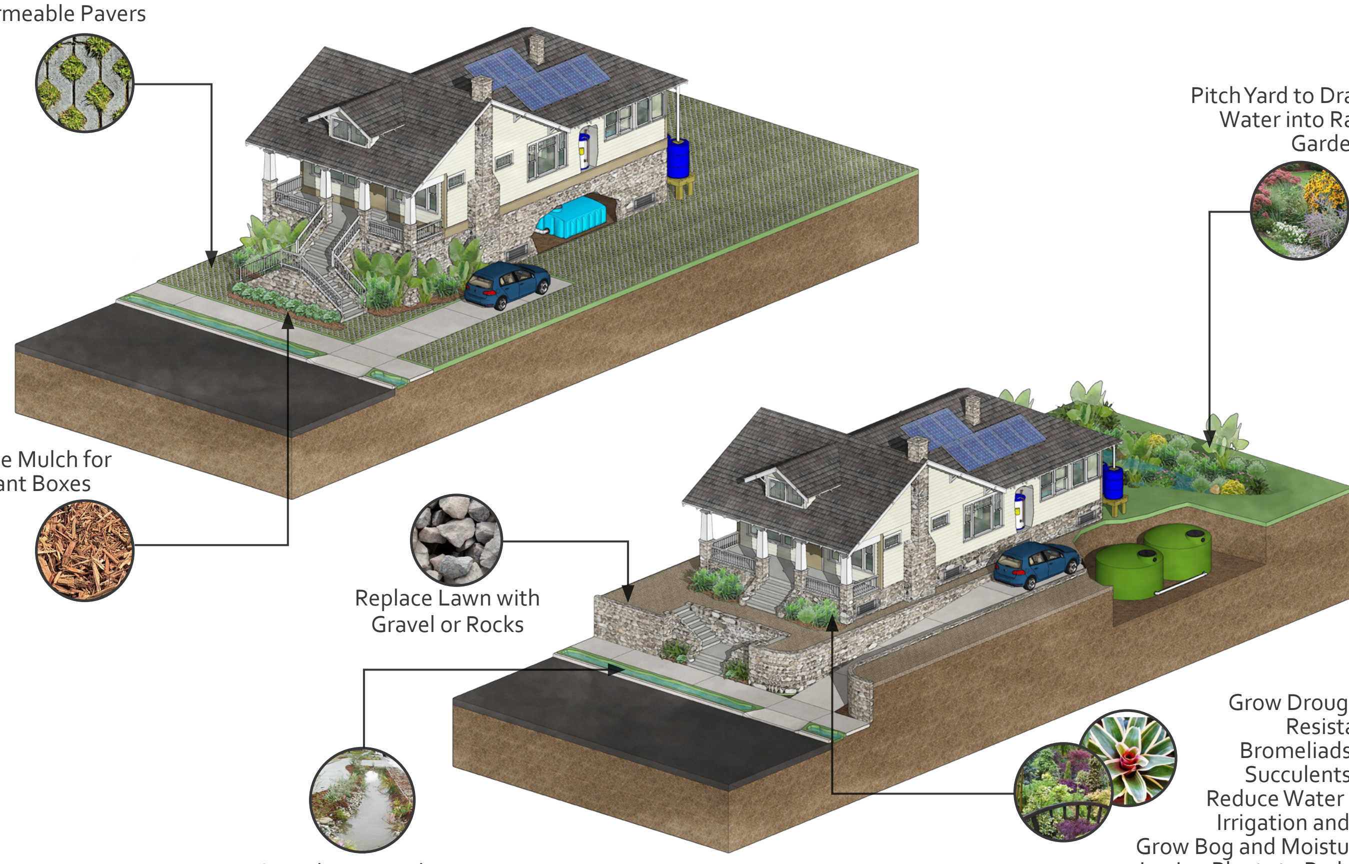
On average a Florida Home Consumes or Produces:

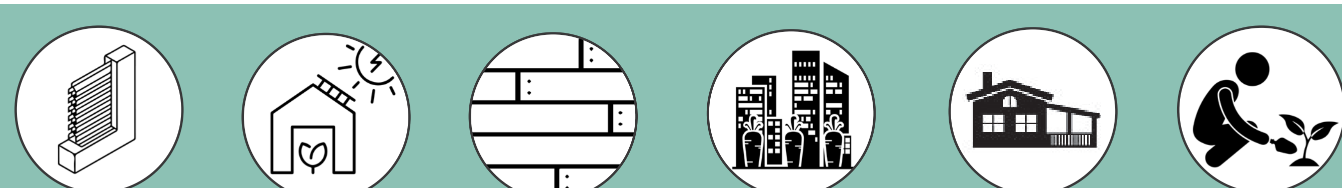
- 15,000 kWh Electricity/Year
- 400 Gallons Water/Day
- 11 Tons CO2 Emissions/Year

Source: EIA.gov

5. MITIGATE

HOW CAN I MAKE MY RESILIENT HOME MORE SUSTAINABLE?





Temper sunlight reduce heat can and facilitate cross-ventilation through louvres/persianas.

Produce energy or heat with solar panels, photovoltaic panels, glass, or photovoltaic

Reduce heat gain with white/ reflective timber roof or with metal cladding or similar.

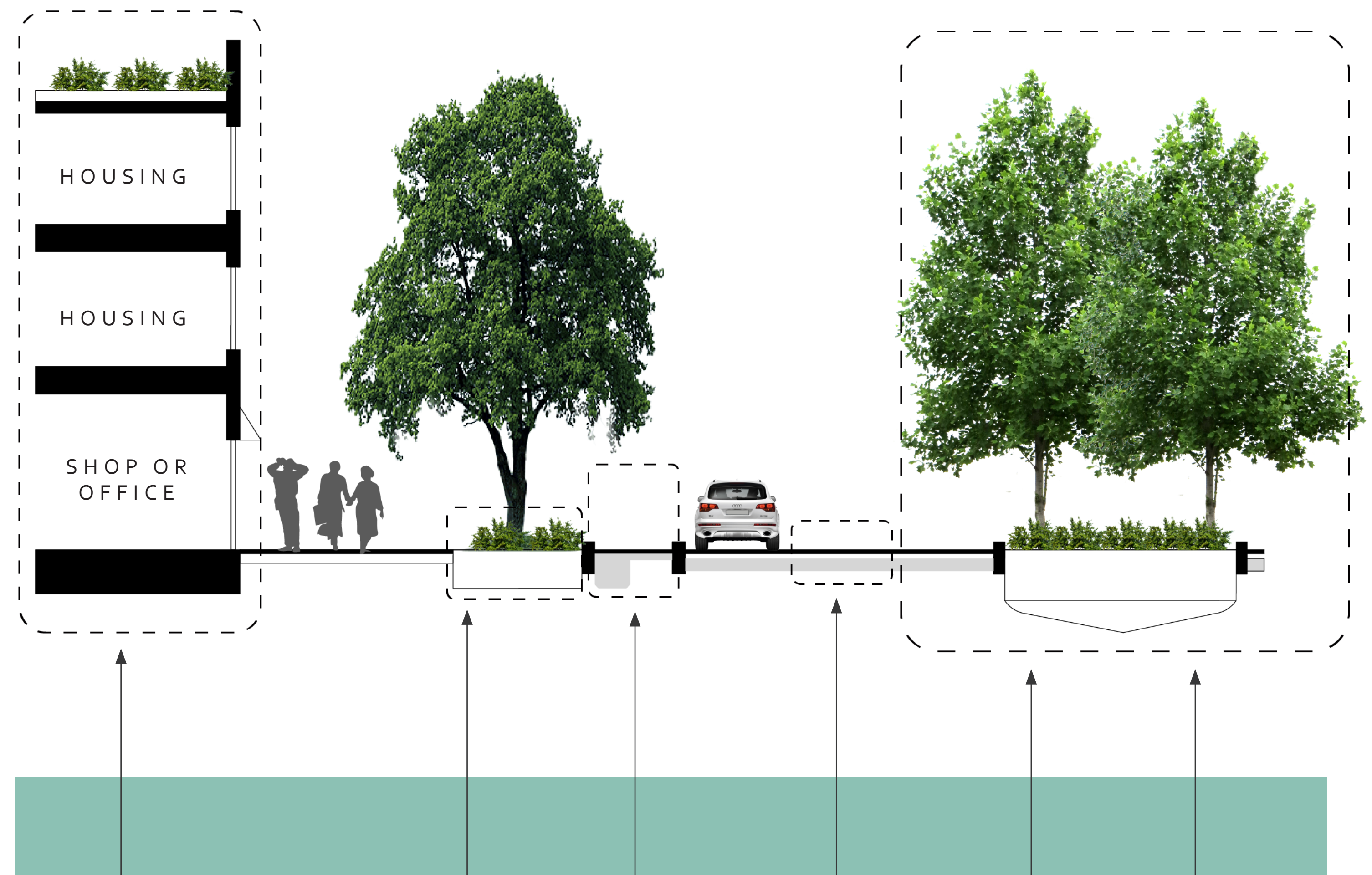
Increase urban farming and reduce heat gain with green roofs and walls

Reduce heat gain with porches and trellises on southern or western facades

Reduce urban heat island effect by planting decidous trees

5. MITIGATE

IDEAL URBAN SUSTAINABILITY SCENERIOS



Building section. Create a range of housing and a mix of uses.

Create absorbent landscapes while using structural soils where appropriate. Use of healthy plants in trenches or continous soil zones.

Improve streetscape for bicycles. Provide transportation choices.

Minimize impervious paved areas, while maximizing pavement albedo. Use of recycled/ reclaimed materials.

Increase and improve public green spaces. Increaing the quantity, denisity and diversity of trees to maximize shading of pedestrian and bicycle paths

Incorporate water efficient landscape deisgn and optimize right-of-way drainage.

6. RELOCATE OR REBUILD

WHAT IF ADAPTATION IS NOT COST EFFECTIVE FOR ME?

Cost will always be an integral factor when thinking about adapting and retrofitting your home. In addition to construction costs and design fees, owners may face an additional loss of usable square footage when abandoning the first floor or moving mechanical equipment. In some cases, the cost of defending and adapting a building may exceed the value of the property, even with the insurance credits or local governement incentives such retrofits could provide. In these cases homeowners may choose to either:

1) Relocate:
Sell the property as is and find a new home at a higher elevation or one that has already been retrofitted.

2) Rebuild:
Demolish the building and rebuild a new flood-compliant home or redevelop the property entirely.

Relative Cost of Retrofitting House w/ Crawlspace Foundation

Tool	Retrofit	Relative Cost
	Elevate and Fill Entire Lot	Highest
	Elevate on Continuous Foundation Walls or Open Foundation	
	Wet Flood-proof Crawlspace Areas or Structure Below the BFE	
	Dry Flood-proof Habitable Areas to Above the BFE and/or Areas 3 FT Above Adjacent Grade Minimum.	
	Elevate Critical Systems Above the BFE	
	Install Flood Vents in Basement or Crawlspace to Allow Water In and Reduce Pressure	
	Install Back-flow Valves to Avoid Sewage Overflow and/or Sump Pumps for Groundwater Flooding	Lowest
	Reinforce Building Superstructure and Foundation to Withstand Forces of Storm Events & Floording	Varies

6.URBAN DESIGN CONSIDERATIONS

HOW WILL CLIMATE CHANGE AFFECT MY NEIGHBORHOOD?

Adapting buildings to climate change should not come at the expense of a vibrant and inviting streetscape. Homeowners, city planners, and community groups should work together to develop standards for ramps, staircases, landscape, parking, and sidewalk-facing retaining walls to ensure that streets remain active, interesting, and comfortable for both pedestrians and cars. Community developed design guidelines can ensure a retrofitting initiative that preserves the integrity and character of the neighborhood.

ACCESS
When moving access points and entrances up, it is important to design stairs and ramps that are inviting and that enhance connectivity.

HISTORIC PRESERVATION
When adapting historical buildings, the goal is to, a at minimum, keep the front elevation true to the original character and materials of the building.

STREETSCAPE
Elevating houses can disrupt connectivity. Screening, landscaping, & other design solutions can help visually ground buildings into their surroundings in a harmonious manner.

MALADAPTATION
Involves a poor selection of adaptation measures, resulting in changes in the infrastructure systems that become less effective as time goes by until the systems become dysfunctional. This term can also be used to refer to interventions, which negatively impact or add a burden to adjacent

PARKING
Parking, garage entries, and curb cuts should be located strategically so as not to interrupt the pedestrian experience the functionality, or aesthetic of the street.

SOURCES FOR ADDITIONAL

- *Federal Emergency Management Agency (FEMA)* - http://fema.gov
- *Resilient 305 Strategic Plan*- http://www.mbrisingabove.com/wp-content/uploads/Resilient305_final.pdf
- *National Flood Insurance Program (NFIP)* - http://floodsmart.gov
- *American Society of Civil Engineers (ASCE)* - http://asce.org/climate-change
- *Florida Building Code* - http://floridabuilding.org
- *Surging Seas* - http://climatecentral.org
- *National Oceanic & Atmospheric Administration (NOAA) Digital Coast* - http://coast.noaa.gov/digitalcoast
- *U.S. Climate Resilience Toolkit* - http://toolkit.climate.gov
- *100 Resilient Cities* - http:// 100resilientcities.org
- *Southeast Florida Regional Climate Change Compact* - http://southeastfloridaclimatecompact.org
- *Miami-Dade Green* - http://miamidade.gov/green

University Of Miami
Center for Urban & Community Design:
Sonia Chao, Research Associate Professor
Director, Center of Urban & Community Design (CUCD)
Landolf Rhodes-Barbarigos Assistant Professor at College of Engineering
Reasearch Affiliate at the CUCD
Website: https://cucd.arc.miami.edu/contact-us/who-we-are/index.html

City of Miami Chief Resilience Office:
Jane Gillbert, Chief Resilience Officer
Website: http://www.miamidade.gov/planning/resilience.asp

Dade Heritage Trust:
Christine Rupp, Director
Website: http://www.dadeheritagetrust.org/

This pamphlet was made possible by the pro-bono contributions of University of Miami faculty and the support of Dade Heritage Trust.