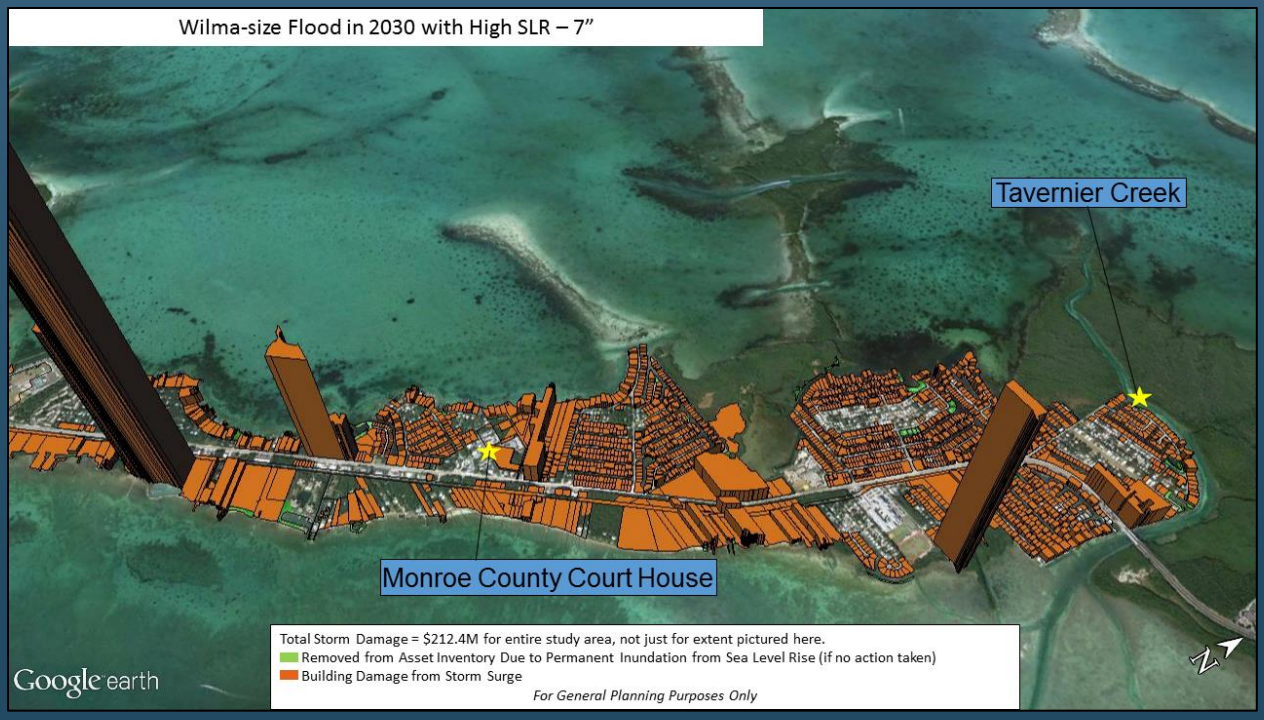

Islamorada Matters

ANALYSIS OF DAMAGES FROM STORM SURGE AND SEA LEVEL RISE IN ISLAMORADA USING THE COASTAL ADAPTATION TO SEA LEVEL RISE TOOL (COAST)

Jonathan T. Lockman, AICP
Samuel B. Merrill, PhD
Alexander Gray, MS

CATALYSIS ADAPTATION PARTNERS, LLC | 242 Sawyer Street, South Portland, ME 04106
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Islamorada Matters
A Plan to Enhance, Preserve and Protect Our Quality of Life

ERIN L. DEADY, P.A.

Catalysis
Adaptation Partners LLC

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1 EXECUTIVE SUMMARY

Catalysis Adaptation Partners, LLC (Catalysis) specializes in analyzing impacts from storm surges and long-term sea level rise using its COastal Adaptation to Sea level rise Tool (COAST). COAST modeling software mimics floods from storms and sea level rise on community assets such as homes and businesses, then tallies the cumulative damages over time so communities can better understand the cost to them of not adapting (vulnerability assessment), as well as the costs and benefits (damage reduction) of implementing various adaptation actions.

Catalysis was contracted by Erin L. Deady, P.A. to use COAST to perform a vulnerability assessment of homes and commercial building structures and to model adaptation action scenarios in the Village of Islamorada (Islamorada) as part of the Islamorada Matters Project. Working with Erin L. Deady, P.A., Catalysis conducted three (3) community workshops in October, November and December 2014, during which participants voted on modeling parameters and assumptions for "no-action" and three (3) adaptation action scenarios: 1) elevating and floodproofing buildings; 2) building barriers close to shore; and 3) purchasing properties vulnerable to sea level rise through a voluntary buyout program. Voting occurred during Workshops #2 and #3 (results can be found in the appendix Section 6 of this report) and focused on certain model parameters as well as whether or not actions should be further evaluated.

The "asset" selected for analysis was the value of residential and commercial buildings, obtained from Monroe County tax records. Sea level rise assumptions were based upon the Unified Sea Level Rise Projection for Southeast Florida[1]. Those projections included a low and high estimate of sea level rise in 2030 of 3" and 7" respectively, as well as a low and high estimate of sea level rise in 2060 of 9" and 24" respectively. Surge values from various sized storms were obtained from the most recent Federal Emergency Management Administration (FEMA) Flood Insurance Study. Key findings from the "worst case" vulnerability assessment included one-time damage estimates of $2.3 Million from a nuisance flood in 2060 under a high sea level rise scenario of 24" and $288.0 Million from a Hurricane Wilma-sized flood in 2060 under the same sea level rise scenario. Cumulative damages over time from storms of various sizes resulted in significantly higher damage estimates by 2060, with $1.734 Billion in damages under a "low" sea level rise scenario and $2.741 Billion in damages under a "high" sea level rise scenario. The value of properties (buildings and land) permanently inundated by sea level rise alone by 2060 (from daily flooding at high tide) ranged from $151.1 Million (low scenario) to $295.5 Million (high scenario). Once the modeling indicated such properties would be flooded by the daily high tide, the software no longer subjected it to continuing cumulative damages from that point in time forward.

The three (3) adaptation actions to model identified by the Islamorada Matters consultant and staff team included:

- Elevating and floodproofing buildings
- Building barriers close to the coast to protect from storm surge but not sea level rise

[1] Southeast Florida Regional Climate Change Compact Counties, Sea Level Rise Ad Hoc Technical Working Group (April 2011).

- Purchase of properties vulnerable to sea level rise through a voluntary buyout program over a phased timeframe.

For each action, costs were determined by the consultant and staff team, and in some cases, modified by workshop participants by polling. Modeling parameters (e.g., building elevation heights, the distance between the constructed barrier and the coast as well as the height of the barrier, the number of residents accepting a buyout for their properties, etc.) also were established by workshop participants through a keypad polling process. Catalysis then used COAST again with the adaptation actions in place to quantify the predicted reduction in damages over the same time period as the vulnerability assessment.

These results were converted into benefit-cost ratios. Ratios greater than 1 represented actions that reduced more in damages in the future than it cost to implement them. Ratios less than 1 represented actions that would cost more than the amount of reduced damages in the future (i.e., not cost effective). The action that had the best benefit-cost ratio was **elevating and floodproofing buildings** (accounting for those not already elevated or floodproofed in Islamorada), which had a benefit-cost ratio between 5.24 and 15.28 (meaning for every $1.00 spent on elevating and floodproofing, the avoided damages would range from $5.24 to $15.28), depending on the sea level rise scenario (high or low) and construction cost estimates (high or low). **Building barriers** had the second highest benefit-cost ratios (1.59 to 2.20). The voluntary buyout program had the lowest benefit-cost ratios (0.02 to 0.18). Aside from the model outputs, there were other factors which contributed to these results as discussed in this document.

These benefit-cost ratios were presented to Islamorada residents, and keypad polling technology was used to evaluate their opinions. After looking at the COAST model results and participating in the group discussions, residents voted that elevating and floodproofing buildings was their most preferred action. In addition, residents supported Islamorada pursuing sources of funding to help private property owners implement this strategy.

The modeling results and community engagement process enabled the consultant and staff team to provide the residents of Islamorada with a context for beginning more difficult conversations and decision-making processes regarding their vulnerabilities. Discussions of factors outside of the model should lead to diverse co-benefits (e.g., choosing to restore mangrove forests to not only improve coastal ecosystems but also protect buildings from wave attenuation) and planning outcomes. Importantly, benefit-cost ratios resulting from this work tend to open difficult conversations about exactly what is most important to a community in planning how to adapt to sea level rise and future storm surges.

However, these results do not mean that Islamorada should begin implementing a program to elevate and floodproof residential and commercial buildings. Catalysis recommends that Islamorada use this information to:

- Further discuss sea level rise vulnerability with residents and the importance of having a method to weigh different adaptation actions against one another (benefit-cost analysis)
- Develop a framework for using new knowledge to engage with residents so that consensus on an eventual adaptation action is data- and stakeholder-driven

- Share this information with neighboring communities so that more regional communication can take place and strengthen any local momentum towards adaptation
- Document any progress or failures towards adaptation so that other communities around the country have lessons from which they can learn.

2 METHODOLOGY AND ASSUMPTIONS USED FOR COAST MODEL ANALYSIS

Initial development of the COAST software tool was funded by the US Environmental Protection Agency. The tool is used to predict damages from varying amounts of sea level rise and storm surge under a range of candidate adaptation action scenarios that users construct. The software was run for Islamorada by Catalysis, who use it to help communities around the country. COAST is used to calculate the potential damage from one particular storm in the future, as well to calculate the cumulative potential damage from all storms that may occur over a period of years, from today until a point in the future. These storm events can also be modeled to become worse over time based on scenarios that include assumptions for sea level rise, which was the case for Islamorada.

2.1 PREPARING MODEL INPUTS FOR ISLAMORADA

2.1.1 Add Accurate Elevation Data

A Light Detection and Ranging (LiDAR) image of the area was used, which is a highly accurate map of land elevations made by taking laser measurements from an airplane. With this data layer the COAST model could identify the ground elevation of any point in the study area. The 2008 LiDAR data for Islamorada was provided by the National Oceanic and Atmospheric Administration (NOAA) and distributed by the Florida Geographic Data Library (FGDL). It was then converted to the proper vertical units for use in the COAST software by Dr. Jason Evans and his team at the University of Georgia and Stetson University, and consisted of a 5 meter by 5 meter grid, with a single elevation value in feet for each square.

2.1.2 Add Tax Map Parcels and Assessed Building Values from Islamorada

Property values for land and buildings were provided by the Monroe County Tax Collector's Office, and prepared by Dr. Jason Evans and his team, ensuring that the LiDAR images and tax map layers had the same coordinate system and units (feet) for both vertical and horizontal positions. Each property was classified according to general land-use (i.e., residential, commercial and government as categorized by the Tax Collector's Office) and the year it was built. Parcels with buildings that had already been elevated according to FEMA requirements were also identified so that those buildings could be treated differently during the modeling process. Given that most properties after 1974 have already been elevated an average of eight (8) feet, this was an important process to assure the accuracy of the model and the benefits from the proposed strategies. Tax assessment values were raised by 15% across the board to adjust the assessed values of buildings to market prices, per the direction of the attendees at the first workshop.

2.1.3 Determine Water Levels and Probabilities

The starting value of the high tide level for Islamorada was taken from the nearest tide station in Vaca Key, where the Mean Higher High Water (MHHW) value was -0.36 feet (in NAVD 88 units). This is considered the highest daily average tide; on top of which storm surge and sea level rise assumptions were added. The four (4) sea level rise (SLR) scenario estimates were obtained from the Unified Sea Level Rise Projection for Southeast Florida, Southeast Florida Regional Climate Change Compact Counties, Sea Level Rise Ad Hoc Technical Working Group (April 2011), and were as follows:

- By the year 2030
  - An additional 3 inches (Low)
  - An additional 7 inches (High)
- By the year 2060
  - An additional 9 inches (Low)
  - An additional 24 inches (High)

An "exceedance curve" was also established for particular neighborhoods throughout Islamorada, and added into the COAST model. These curves set the height of water expected from storms of different sizes and probabilities for these different areas. The model then has information on how deep the floodwaters may be in each part of the study area, when future storms arrive. For instance, one neighborhood may have a 100-year storm (1% chance of occurring in any given year, or once every hundred years) flood height of ten (10) feet, but an adjacent neighborhood may have a 100-year flood height of only six (6) feet, if it contains higher ground or is more protected from storm surges.

Islamorada was divided into nine (9) areas based on these predicted flood heights, which came from a digital flood insurance map file (dfirm_fldhaz_jun13.shp) produced by FGDL. The probabilities and water levels for the 1-, 10-, 50-, and 100-year storm events came from the latest available Flood Insurance Study for Monroe County (February 18, 2005). The table below represents the flood heights and probabilities for various neighborhoods in Islamorada, used in creating the exceedance curves in the COAST model:

Storm Event	Recurrence Interval	Probability in Any Given Year	Surge Height Above MHHW of 3.52 ft. (NAVD 88 units)	
			Minimum Value	Maximum Value
100 Year Storm	Once every 100 years	0.01	6.0	15.0
50 Year Storm	Once every 50 years	0.02	5.9	6.4
10 Year Storm	Once every 10 years	0.10	3.9	4.5
1 Year Storm (known as Nuisance Flood or King Tide)	Once every year	1	1.08	1.08

Table 1. Storm events, recurrence intervals, probabilities and surge heights above Mean Higher High Water for Islamorada, FL, used to create Exceedance Curves for COAST modeling.

These water levels were established for the creation of simulated storms, with identified sea level rise assumptions added over time.

2.1.4 Provide a Depth-Damage Function: Predicting Damage from Various Flood Depths

Finally, COAST relies on a function to calculate damage predicted to occur on each property, depending on flooding depth at the center of the property during each predicted storm event. This is called a "depth-damage function." COAST used depth-damage function tables created by the US Army Corps of Engineers, based on the Army Corps' damage measurements from years of studying floods and associated insurance claims (see U.S. Army Corps of Engineers, Contract No. DACW29-00-D-0001, Depth-Damage Relationships…in Support of the Donaldsonville to the Gulf, Louisiana, Feasibility Study, March 7,

2006). Four (4) different depth-damage functions were assigned to each property, according to whether it was classified as either residential or non-residential, and whether it was elevated or not elevated. Dr. Evans' team assigned whether a property was elevated based on the year built (properties constructed in flood zones after 1974 were required to be elevated). It was also assumed that once the daily high tide (mean higher high water) with no storm surge reached the center of a parcel, the entire value of the building or buildings would be permanently lost due to sea level rise, if no action was taken. Therefore buildings on such parcels would no longer be subject to repeated damage, once their centers were permanently inundated.

2.1.5 Ensure Asset Data are Appropriately Structured

COAST creates flood scenarios over many years and measures flood depth at the center of each parcel. In the case of multiple buildings on one lot, and with the version of the software being used at the time, there unfortunately was no way to apportion building value between separate buildings. The County tax parcel database aggregated "building value" for all buildings on a lot. Therefore, for the purposes of this model, the aggregate building value was assigned to the group of buildings on each multi-building lot. Implications of this are that if the model showed the centroid of the parcel as flooded, it calculated damage to all buildings on the parcel using the depth-damage function, as if it were combined into one flooded building located at the center of the parcel. This may have overestimated damage on some parcels, but very few.

2.2 LIMITATIONS OF COAST MODEL RESULTS

- The effects of waves, wind, and erosion are not considered in the COAST model, as it calculates new high tide levels due to sea level rise (SLR) only, using still water flood elevations on the existing terrain.

- Values for individual buildings were not available, as County assessing records combined the values of all buildings on a particular lot into one number.

- Total loss of building value and land value for the lot was assumed to occur when daily tidal waters (without any surge) reached the imaginary point centered in the parcel polygon, known as the parcel "centroid."

- Only structural damage to buildings was included, based upon U.S. Army Corps of Engineers Depth Damage Functions for still water or static flooding. Damage to building contents or damage from wind or wave action was not included, meaning that damage figures are conservative in quantifying true loss.

- Structural Building Value was the only asset analyzed. COAST did not estimate damages to other assets such as roads, storm drainage systems, sewers, sewage treatment and pumping facilities, or other utilities.

3 VULNERABILITY ASSESSMENT

One-time flood damage estimates for Islamorada were generated for a "nuisance flood" or "king tide" arriving in the years 2030 or 2060 as if no adaptation action had been taken. A nuisance flood or king tide is defined as the highest tide of the year which occurs when the moon is full and is at perigee (the closest distance to the earth in its orbital path). One-time damage estimates were also generated for a Hurricane Wilma-sized storm surge (6 feet in 2005), made worse over time by sea level rise. COAST created visualizations of the pattern of these predicted damages (Figures 1-4). Parcels in coral represent those flooded from storm surge, with the height of each coral bar showing relative dollar damage. Parcels in green represent those permanently inundated from sea level rise (SLR). All images for three (3) major sections of Islamorada are located in the appendix of this report (Section 6.2).

Cumulative building damage over time was also calculated, through the years 2030 and 2060. Results are summarized in tables below.

Key Findings of Vulnerability Assessment – If No Action is Taken

- By 2030 a nuisance flood would cause $400,000 in damages to buildings even in a low (3") sea level rise scenario (Table 2).
- By 2060 a nuisance flood would cause $2.3 Million in damages to buildings under a high (24") sea level rise scenario (Table 2).
- By 2030 a Wilma-sized flood would cause $204.8 Million in damages to buildings under a low (3") sea level rise scenario (Table 3).
- By 2060 a Wilma-sized flood would cause $288.0 Million in damages to buildings under a high (24") sea level rise scenario (Table 3).
- By 2060, cumulative damages from all possible storms (Table 4) would result in damages ranging from $1.734 Billion (low sea level rise) to $2.741 Billion (high sea level rise).
- By 2060, the total value of all buildings and land that are no longer inhabitable as a result of sea level rise (Table 6) would be between $151.1 Million (low sea level rise scenario) and $295.5 Million (high sea level rise scenario).
- This represents a loss of $0.38 to $0.75 Million in annual tax revenue.

Table 2. One-time damage estimates from nuisance floods in Islamorada in 2030 and 2060 with high and low sea level rise.

Event: 1.08 ft. Surge Nuisance Flood	SLR Scenario	One-Time Damage to Building Values
Year 2030	Low - 3.00"	$ 0.4 Million
Year 2030	High - 7.00"	$ 0.2 Million
Year 2060	Low - 9.00"	$ 0.2 Million
Year 2060	High - 24.00"	$ 2.3 Million

Table 3. One-time damage estimates from Hurricane Wilma-sized floods in Islamorada in 2030 and 2060 with high and low sea level rise.

Event: 6.00 ft. Surge Wilma-Sized Flood	SLR Scenario	One-Time Damage to Building Values
Year 2030	Low - 3.00"	$ 204.8 Million
Year 2030	High - 7.00"	$ 212.4 Million
Year 2060	Low - 9.00"	$ 233.3 Million
Year 2060	High - 24.00"	$ 288.0 Million

Figure 1. Google Earth image of potential flooding damages from a nuisance flood (low sea level rise scenario) in 2060 for a section of Islamorada, FL. Coral parcels indicate those flooded from storm surge, with the height of the coral extrusions representing relative damage amounts (in dollars). Parcels in green indicate those permanently inundated from sea level rise.

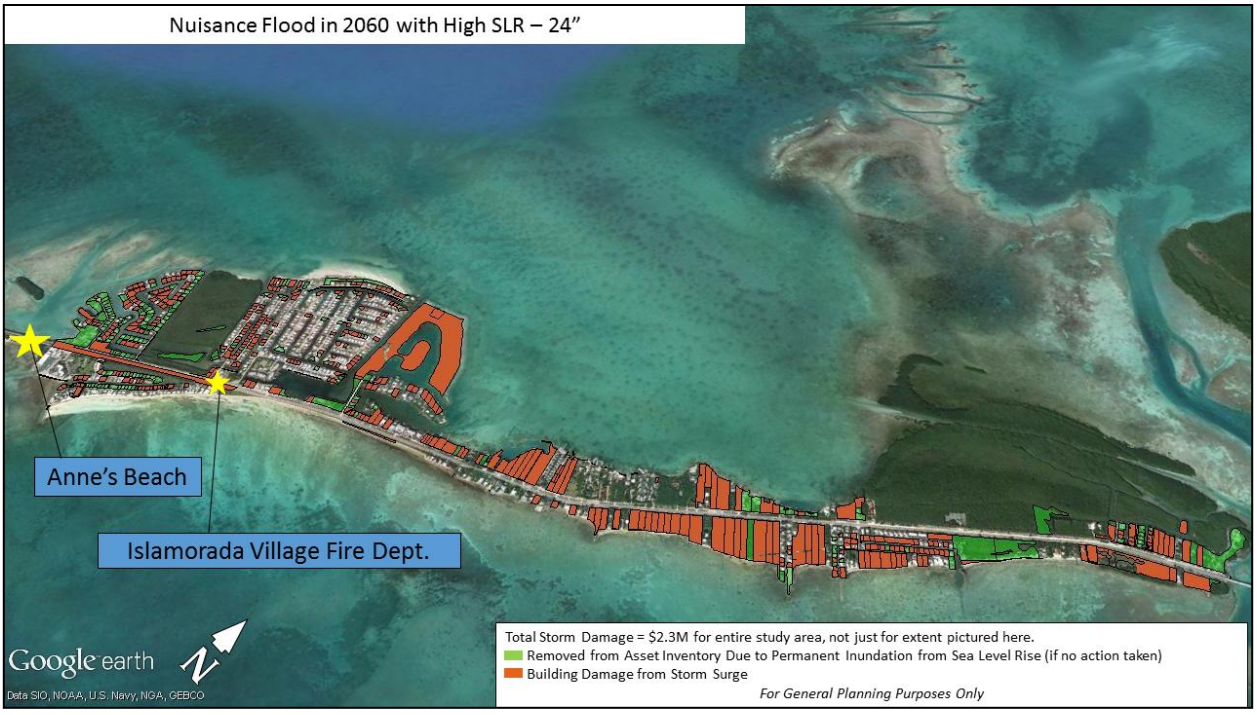


Figure 2. Google Earth image of potential flooding damages from a nuisance flood (high sea level rise scenario) in 2060 for a section of Islamorada, FL. Coral parcels indicate those flooded from storm surge, with the height of the coral extrusions representing relative damage amounts (in dollars). Parcels in green indicate those permanently inundated from sea level rise.

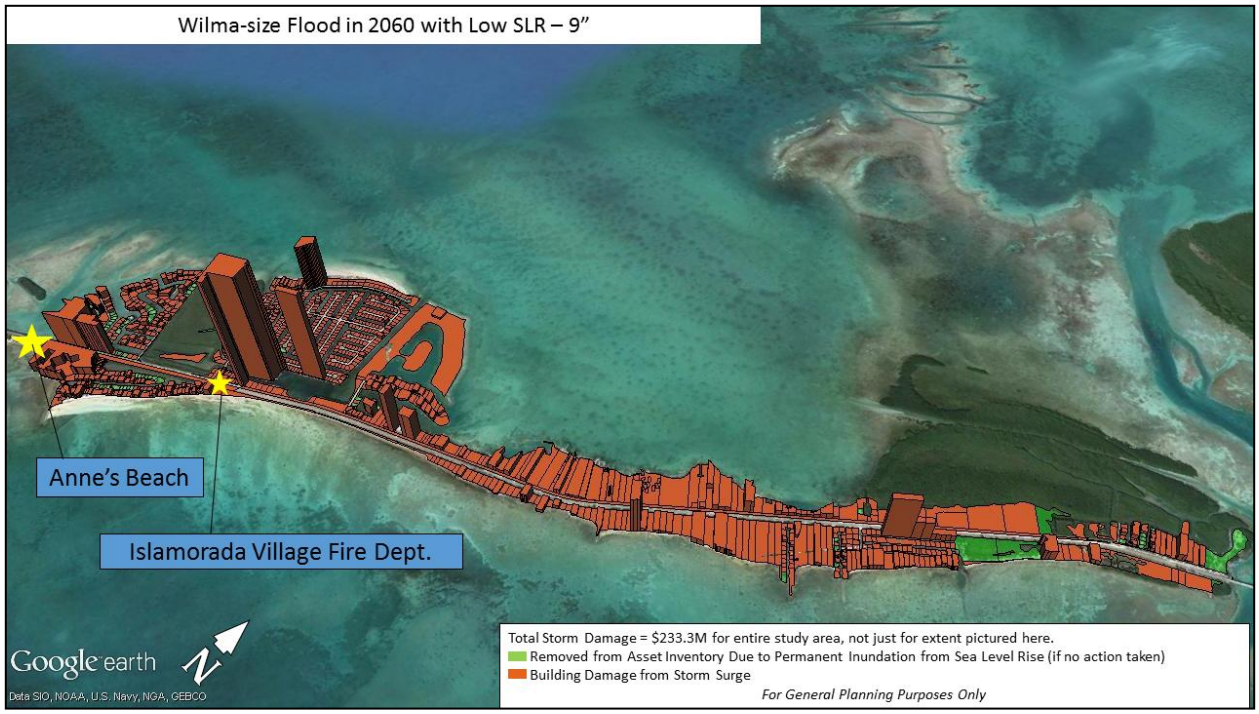


Figure 3. Google Earth image of potential flooding damages from a Hurricane Wilma-sized flood (low sea level rise scenario) in 2060 for a section of Islamorada, FL. Coral parcels indicate those flooded from storm surge, with the height of the coral extrusions representing relative damage amounts (in dollars). Parcels in green indicate those permanently inundated from sea level rise.

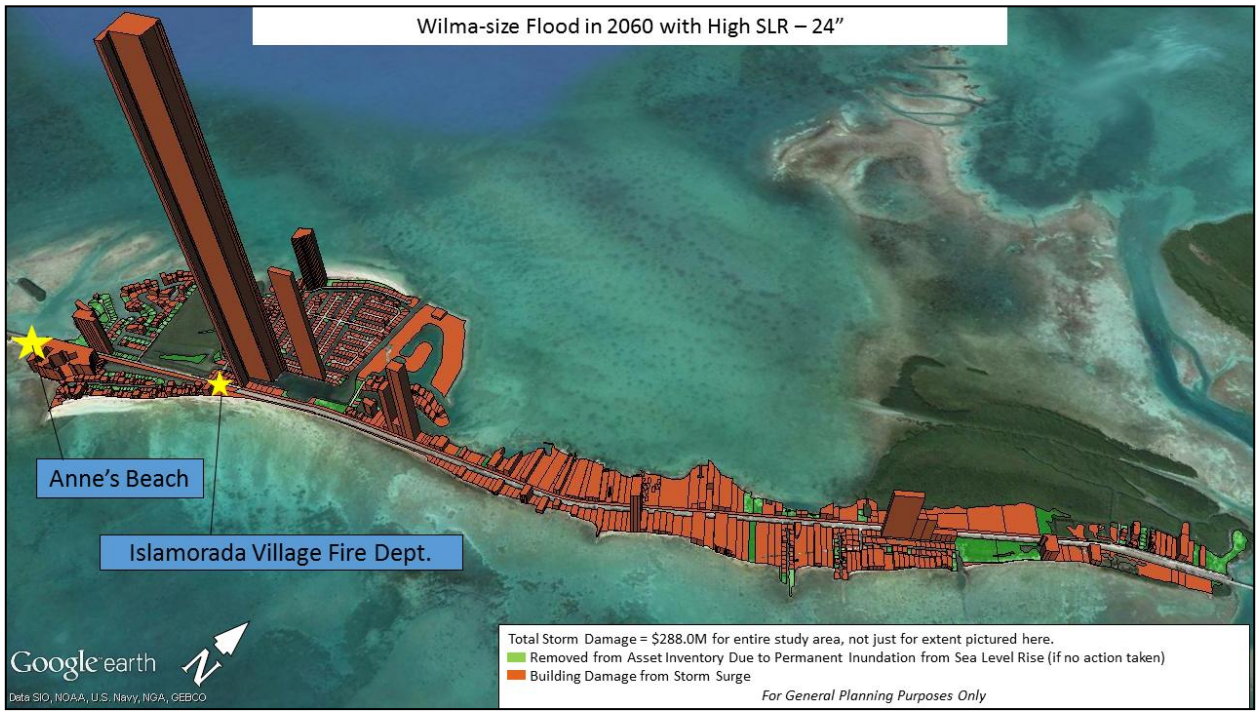


Figure 4. Google Earth image of potential flooding damages from a Hurricane Wilma-sized flood (high sea level rise scenario) in 2060 for a section of Islamorada, FL. Coral parcels indicate those flooded from storm surge, with the height of the coral extrusions representing relative damage amounts (in dollars). Parcels in green indicate those permanently inundated from sea level rise.

Timescale	SLR Scenario	Cumulative Damage to Buildings by Scenario Date
2014-2030	Low - 3.00"	$ 544.7 Million
2014-2030	High - 7.00"	$ 610.2 Million
2031-2060	Low - 9.00"	$ 1.189 Billion
2031-2060	High - 24.00"	$ 2.130 Billion
2014-2060	Low - 9.00"	$ 1.734 Billion
2014-2060	High - 24.00"	$ 2.741 Billion

Table 4. Cumulative damage estimates from all possible storms during a given time period with high and low sea level rise.

Timescale	SLR Scenario	Value of Buildings Lost to SLR	Value of Land Lost to SLR	No. of Parcels Lost to SLR	Total Value of Builds and Land Lost to SLR
2014-2030	Low - 3.00"	$ 44.7 Million	$ 28.7 Million	145	$ 73.4 Million
2014-2030	High - 7.00"	$ 69.4 Million	$ 73.8 Million	371	$ 143.2 Million
2031-2060	Low - 9.00"	$ 29.0 Million	$ 48.7 Million	249	$ 77.7 Million
2031-2060	High - 24.00"	$ 50.4 Million	$ 101.9 Million	410	$ 152.3 Million

Table 5. Buildings and land permanently inundated from sea level rise during scenario years 2014-2030 and 2031-2060 with high and low sea level rise.

SLR Scenario	Value of Buildings Lost to SLR	Value of Land Lost to SLR	No. of Parcels Lost to SLR	Total Value of Builds and Land Lost to SLR	Annual Tax Revenue Lost to SLR
Low - 9.00"	$ 73.7 Million	$ 7.4 Million	394	$ 151.1 Million	$ 0.38 Million
High - 24.00"	$ 119.8 Million	$ 175.7 Million	781	$ 295.5 Million	$ 0.75 Million

Table 6. Buildings and land permanently inundated from sea level rise during scenario years 2014-2060 with high and low sea level rise.

4 ADAPTATION ACTIONS

4.1 POSSIBLE STRATEGIES: DO NOTHING, FORTIFY, ACCOMMODATE OR STRATEGICALLY RELOCATE

Options for responding to sea level rise and storm surge can be divided into four (4) categories:

- *Doing nothing* simply involves waiting for a storm incident to happen and responding afterwards to save those structures and resources that are not completely lost due to the incident. *Doing nothing* is not proposed for Islamorada.
- Adaptation approaches that *fortify* use hard or soft structures to prevent flood waters from reaching community assets. Such fortification can be "hard," such as seawalls or bulkheads, or "soft" structures such as geotextiles tubes, giant fabric sandbags designed to be replaced after storms (Fig. 7a and 7b). Unfortunately, wetlands and beaches in front of such structures can disappear as they are pinched out between the rising water levels and the fortifying structures behind them.

Figures 7a and 7b. USACE hurricane barrier in Stanford, CT (left) and geotextile tubes in front of apartment complex in Sea Isle City, NJ (Right)

- Adaptation approaches that *accommodate* modify community assets to reduce the impact of flood waters, but they do not protect against sea level rise (only storm surge). Accommodation acknowledges that structures will become wet, but actions are taken to make them resilient, such as elevating structures or their critical systems.

Figures 8a and 8b. Elevated house (left) and floodproofed house (right). Source: http://www.theepochtimes.com/n3/4747-hurricane-sandy-katrina-offer-similar-lessons-for-builders/

- *Strategic relocation* involves relocating existing structures, people and land-uses away from areas at high risk of flooding to a new location to eliminate the risks of flooding and damage/loss, and allowing wetlands, beaches and natural coastal habitats to migrate to higher elevations naturally.

4.2 Use of COAST to Perform a Benefit-Cost Analysis for Three (3) Proposed Strategies

Once an adaptation strategy, or set of strategies, has been identified for a community or portion of a shoreline, COAST can be used to evaluate whether the strategy would be a good investment. Following the above vulnerability assessment stage, the COAST model can be run with adjustments to the depth damage functions. This serves as a proxy estimation of how much cumulative damage might be avoided if the adaptation strategies were put in place. Avoided cumulative damage can then be compared to the cost of the potential strategies, creating a benefit-cost ratio. If this ratio is high (i.e., costs are low and benefits are high) the option may be a good investment and worthy of further study, such as more detailed feasibility plans, construction designs or estimates. It should be noted that the cost estimates obtained for this study simply use high and low estimates, and further detailed work would need to be undertaken to arrive at a more specific adaptation strategies design, with more accurate permitting and construction costs.

4.3 Description of the Three (3) Proposed Adaptation Strategy Scenarios

Participant polling at the Islamorada community workshop in November 2014 (Workshop #2) refined three (3) adaptation strategy scenarios that were initially developed by the Project Team and Islamorada Staff. Agreed upon candidate adaptation strategy scenarios were as follows:

- Action 1: Elevate and Floodproof (Fig. 9a and 9b)
  - 50% of properties in FEMA V-Zones elevated to current code plus two (2) feet.
  - 100% of properties in FEMA A-Zones floodproofed to eight (8) feet.
- Action 2: Constructed Barriers (Fig. 10a and 10b)
  - Two (2) 0.5 mile long emergent breakwater structures built near shore (200 feet off of coast), constructed of limestone block topped with mangrove plantings.
- Action 3: Relocate – Voluntary Buyout (Fig. 11a and 11b)
  - 10% of properties permanently flooded from sea level rise by 2030 accept the voluntary buyout in 2015.
  - 50% of properties permanently flooded from sea level rise by 2045 accept the voluntary buyout in 2030.

Figure 9a and 9b. Action 1 Scenario: Images of two (2) locations in Islamorada. Parcels in red indicate those located in a FEMA V-Zone and had their buildings elevated (98 total parcels) as a result of the candidate action. Parcels in green indicate those located in a FEMA A-Zone and had their buildings floodproofed (1391 total parcels) as a result of the candidate action.

Figure 10a and 10b. Action 2 Scenario: Images of two (2) locations of constructed barriers in Islamorada. Only parcels located in the V-Zones behind the barriers would have reduced damage.

Figure 11a and 11b. Action 3 Scenario: Images of two (2) locations in Islamorada. Parcels in red indicate those permanently inundated from sea level rise by 2030 (94 total) subject to voluntary buyouts as a result of the candidate action. Parcels in green indicate those permanently inundated from sea level rise by 2045 (95 total) subject to voluntary buyouts as a result of the candidate action.

4.4 Results for Modeling the Three (3) Proposed Adaptation Strategy Scenarios

Table 7 below shows results for Adaptation Action 1, Elevate and Floodproof. Avoided damages by the year 2060 ranged from $850.6 Million (low sea level rise) to $1.210 Billion (high sea level rise). Costs to elevate a building ranged from $60,000 to $160,000[2], and costs to floodproof a building ranged from $52,682 to $105,364[3]. These costs represent low and high estimates for construction only, and are irrespective of building for specific sea level rise scenarios (i.e., based only on today's storm surge heights). Complete pricing information is available in the appendix of this report (Section 6.3). Avoided damage estimates by the year 2060 for high and low sea level rise (9 or 24 inches) and using the high and low cost estimates for elevating and floodproofing buildings resulted in four (4) benefit-cost ratios. These ranged from $5.24 (low sea level rise with high cost estimates) to $15.28 (high sea level rise with low cost estimates). The ratios represent long-term savings in the form of damage reduction for every dollar spent today. For example, under the scenario with the most favorable benefit-cost ratio, for every $1 spent today to elevate and floodproof buildings, $15.28 would be saved by 2060.

Table 7 - Elevate and Floodproof Buildings	
Avoided Damages Low SLR - (9.00")	**Avoided Damages High SLR - (24.00")**
($ Millions)	($ Millions)
850.6	1,209.8
Low Cost Estimate	**High Cost Estimate**
$79.2 Million - Total	$162.2 Million - Total
Avg. Price Per Unit - Elevation	Avg. Price Per Unit - Elevation
$60,000	$160,000
Avg. Price Per Unit - Floodproofing	Avg. Price Per Unit - Floodproofing
$52,682	$105,364
Benefit-Cost Ratios - Using Low Cost Estimate	
Low SLR	High SLR
$10.75	$15.28
Benefit-Cost Ratios - Using High Cost Estimate	
Low SLR	High SLR
$5.24	$7.46

Table 7. Results from COAST model of Adaptation Action 1 – Elevate and Floodproof buildings. 50% of buildings in FEMA V-Zones were elevated and 100% of buildings in FEMA A-Zones were floodproofed.

[2] Estimated elevation cost ranges were provided by a review of contractor websites and consultation with FEMA officials and Parsons Brinckerhoff.

[3] Estimated floodproofing cost ranges were calculated by taking 10% (low) and 20% (high) of the building values and dividing by the number of buildings to be floodproofed. These percentages were provided by Parsons Brinckerhoff.

Table 8 shows results for Adaptation Action 2- Constructed Barriers. Avoided damages by the year 2060 only ranged between $12.8 Million (with low sea level rise of 9") and $13.2 Million (with high sea level rise of 24") because a barrier does not protect against sea level rise – it only diminishes wave from storm events for properties in the FEMA V-Zones located behind the barriers. Costs to build a barrier ranged from $6.0 Million to $8.0 Million (see Section 6.3 for cost breakdown), four (4) benefit-cost ratios were calculated. These ranged from $1.59 (with low sea level rise of 9" and a high cost estimate) to $2.20 (with high sea level rise of 24" and a low cost estimate). The ratios represent long-term savings in the form of damage reduction for every dollar spent today. For example, under the best benefit-cost ratio, for every $1 spent today to build barriers to protect buildings, $2.20 would be saved by 2060.

Table 8 – V-Zone Properties Behind Barriers = Reduced Damage from Wave Heights Reduced by 80% All Other Properties = Unchanged	
Avoided Damages Low SLR - (9.00")	**Avoided Damages High SLR - (24.00")**
($ Millions)	($ Millions)
12.8	13.2
Low Cost Estimate	**High Cost Estimate**
$6.0 Million - Total	$8.0 Million - Total
Avg. Price Per Linear Foot	Avg. Price Per Linear Foot
$1,141.62[4]	$1,518.36[4]
Benefit-Cost Ratios - Using Low Cost Estimate	
Low SLR	High SLR
$2.12	$2.20
Benefit-Cost Ratios - Using High Cost Estimate	
Low SLR	High SLR
$1.59	$1.65

Table 8. Results from COAST model of Adaptation Action 2 – Constructed Barriers.

[4] Cost estimates derived from contractor estimates provided by Palm Beach County Environmental Resources Management Department.

Table 9 shows results for Adaptation Action 3- Voluntary Buyouts. Avoided damages by the year 2060 ranged from $1.1 Million (with high sea level rise of 24") to $6.7 Million (with low sea level rise of 9"). The total cost to purchase homes before they are permanently inundated from sea level rise ranged from $37.3 Million to $56.0 Million[5] (see Section 6.3 for cost breakdown). Avoided damage estimates by 2060 for high and low sea level rise (24" or 9") with either high or low cost estimates for purchasing vulnerable buildings resulted in four (4) benefit-cost ratios. These ranged from $0.02 (with high sea level rise of 24" and high cost estimates) to $0.18 (with low sea level rise of 9"and low cost estimates). The ratios represent long-term savings in the form of damage reduction for every dollar spent today. However due to these ratios being less than 1, under the most favorable benefit-cost ratio every $1 spent today to buy people's homes in the future would only save $0.18 by 2060. In other words, it may make more sense economically to do nothing than to follow through with this particular action. However, this result is based on assumptions chosen by the participants, and there could be some more positive benefits in implementing this action, under a different set of parameters.

Table 9 – Voluntary Buyouts	
Avoided Damages Low SLR - (9.00")	**Avoided Damages High SLR - (24.00")**
($ Millions)	($ Millions)
6.7	1.1
Low Cost Estimate	**High Cost Estimate**
$37.3 Million - Total	$56.0 Million - Total
Avg. Price Per Buyout	Avg. Price Per Buyout
$643,103	$965,517
Benefit-Cost Ratios - Using Low Cost Estimate	
Low SLR	High SLR
$0.18	$0.03
Benefit-Cost Ratios - Using High Cost Estimate	
Low SLR	High SLR
$0.12	$0.02

Table 9. Results from COAST model of Adaptation Action 3 – Voluntary Buyouts. The scenario was run as if 10% of buildings permanently inundated from sea level rise by 2030 were purchased from owners and 50% of buildings permanently inundated from sea level rise by 2045 were purchased from owners.

[5] The building and land values for parcels permanently inundated from high sea level rise by 2030 and 2045 were calculated using discount rates for the dates they were to be purchased and multiplied by the appropriate percentages (i.e., participation rates in both phases, and estimated legal costs for the high cost estimate scenario).

5 DISCUSSION AND CONCLUSIONS

5.1 COMPARISONS OF MODELING RESULTS FOR THE THREE (3) ADAPTATION ACTIONS

The appendix of this report includes keypad polling results from the Islamorada Community Workshops #2 and #3, in which audience members voted on specific COAST modeling assumptions and responded to the COAST modeling results (See Sections 6.1 and 6.4).

In Community Workshop #3, audience members preferred results of Adaptation Action 1, Elevation and Floodproofing, more than the other two (2) actions. Depending on cost estimates and sea level rise assumptions, benefit-cost ratios for Action 1 ranged from 15.3 to 5.2. Benefit-cost ratios with a value above 1.0 are considered positive results (benefits greater than costs). Probably as a result of such favorable ratios, one hundred percent (100%) of participants believed it would be worth Islamorada's time to conduct additional study of an initiative to elevate and floodproof buildings. Similarly, a majority of participants (65%) believed Islamorada should pursue sources of funding to help private property owners elevate their buildings in the FEMA Velocity flood zone.

While Adaptation Action 2, Constructing an Offshore Limestone Barrier with Mangrove Plantings, did have favorable benefit-cost ratios ranging from 1.6 to 2.2, the action would only have protected buildings located in the FEMA V-Zone and directly behind the barrier. While a positive result, these ratios are not as highly positive as those for Adaptation Action 1. In addition, to make the ratios more favorable the barriers had been "placed" in areas where they protected the highest values of buildings, not necessarily the highest number of buildings. This may make sense financially, however it would be a challenge to build consensus around the barrier locations. Moreover, the barrier would not prevent damages from sea level rise but would only reduce wave action during storms which was a concern for community members.

Adaptation Action 3, Voluntary Buyouts, had the least favorable benefit-cost ratios compared to the other actions. Unfortunately each result for this modeled action suggested it would cost more than the cumulative damage reduction over time, with benefit-cost ratios ranging from 0.02 to 0.2 (always less than 1.0). However, modeling assumptions for this action significantly influenced the results. For example, if a person were to be able to stay in their home until 2030 despite having accepted a voluntary buyout for that home today, in this scenario money would be invested toward purchase of that house *and* toward repair of damages that occur between today and 2030. The benefit-cost ratio for this action would thus improve if less time were to be allowed between purchasing a house and the date when title for that house transfers. Because of these issues, keypad polling in Workshop #3 determined that a majority of participants (53%) did not think Islamorada should pursue funding to support a voluntary buyout program.

5.2 HOW THE COAST MODELING RESULTS RELATE TO THE LARGER ISLAMORADA MATTERS PROJECT

COAST modeling results showed that Adaptation Action 1 (elevating and floodproofing buildings) had the most favorable benefit-cost ratio compared to the other two (2) adaptation actions. However in discussions at the public meetings, it became clear that elevation and floodproofing alone could not be considered as a solution to future threats from sea level rise and storm surges. Impacts on roads and other infrastructure in Islamorada will need adaptation actions to prevent damage at the same time as

private properties are made safer by elevating and floodproofing. If road access and sewer and water services to these properties will be lost, making private properties safer by minimizing damage from storm surge will not be a sustainable solution. Therefore it is important to review the COAST modeling results in the larger context of the Islamorada Matters and the Monroe County GreenKeys! projects. In future modeling efforts in Islamorada or elsewhere, it may be beneficial to model benefits and costs of joint action for adapting roads and buildings. Nevertheless, the modeled actions for adapting real estate alone do provide useful results that should help provide momentum toward additional important steps in Islamorada's sea level rise adaptation planning process.

It is also important to review results from this project with the larger adaptation context in mind. That is, adapting to the threats of a changing climate is as much of a governance problem as it is an uncertainty problem. Choosing one adaptation action over another will not be (and should not be) a simple or linear process determined by one report or study. Rather it should be a process that involves multiple stakeholder groups (e.g., private property owners, utilities, local governments and state governments) in a process where concerns and interests, data gathering, and reciprocal learning can be shared between groups so that all parties involved have an opportunity to shape the adaptation action(s) over time.

One of the main challenges with this process is moving beyond simple vulnerability assessments to a robust benefit-cost analysis that can begin to address real-world solutions and start (or compliment) the overall adaptation process. The analysis presented here is intended to substantively fill this void. But importantly, it is just a first step in this direction; filling the void completely can be expected to take more time. In many cases choosing an adaptation action and determining how it should be implemented will take as long as the actual implementation itself. However this should not deter people from taking their time to evaluate multiple climate change threats and adaptation actions, as long as the lessons learned continue to create momentum towards an overall strategy that can be supported by those it is intended to help.

It is important to remain aware that threats to a community such as sea level rise and storm surge transcend jurisdictional boundaries, political cycles and fiscal calendars. As a result communities need to consistently work together and communicate to ensure individual efforts are not working against one another, but rather in tandem. When communities coordinate their adaptation efforts in this manner benefits can be scaled up and have more of a regional impact – which in turn helps strengthen the individual actions.

5.3 Comparison of COAST Results in Islamorada to Nearby Locations

During fall 2014, Catalysis also used the COAST model to analyze vulnerabilities and test similar adaptation actions in the next community to the north, the geographic area of Key Largo. The Islamorada study area had 5,601 properties with a total market value of $3.67 billion. The Key Largo geographic area had 12,289 properties with a total market value of $4.24 billion. Even though Islamorada is smaller with 54% fewer properties and 13% lower market value than Key Largo, predicted cumulative dollar damages to buildings from storm surges and sea level rise was actually 28.7% higher with a high sea level rise scenario.

Timescale	SLR Scenario	Cumulative Damage to Buildings Islamorada Study Area	Cumulative Damage to Buildings Key Largo Study Area	Percent Increase (decrease) in Cumulative Damage, Islamorada vs. Key Largo
2014-2060	Low – 9”	$1.734 billion	$1.778 billion	(-2.5%)
2014-2060	High – 24”	$2.741 billion	$2.130 billion	+28.7%

Table 10. Comparison of COAST Model Results for Cumulative Damage to Buildings by 2060, Islamorada versus Key Largo Geographic Area.

Analysis of this situation indicates two (2) factors that would lead to this unexpected result:

1. In general, as one travels south down Route 1 from the beginning of the Keys in Key Largo, the land area becomes lower and flatter and subject to more surge damage compared between the two.
2. A larger percentage of the higher value real estate may be located in lower, more vulnerable areas in Islamorada, than in Key Largo geographic area. In particular, Key Largo has more high value development along Route 1 (on higher ground) compared to its southern neighbor.

It should also be noted as a positive factor, that by 2060, the benefit-cost ratios for Action 1 (Elevation and Floodproofing) with a high SLR scenario, were higher for Islamorada than for Key Largo. Because results suggest there may be more danger from surges in Islamorada than in Key Largo, this strategy is shown to be somewhat more effective in this location.

Timescale	SLR Scenario	Benefit-Cost Ratio: Elevation and Floodproofing, Islamorada (with High Cost Estimate)	Benefit-Cost Ratio: Elevation and Floodproofing, Key Largo (with High Cost Estimate)
2014-2060	Low – 9”	5.24	5.72
2014-2060	High – 24”	7.46	6.51

Table 11. Comparison of COAST Model Results of Benefit-Cost Ratios for Elevation and Floodproofing by 2060, Islamorada versus Key Largo Geographic Area.

5.4 How COAST Results Have Led to Adaptation Actions in Other Communities, and How Islamorada Can Use Them

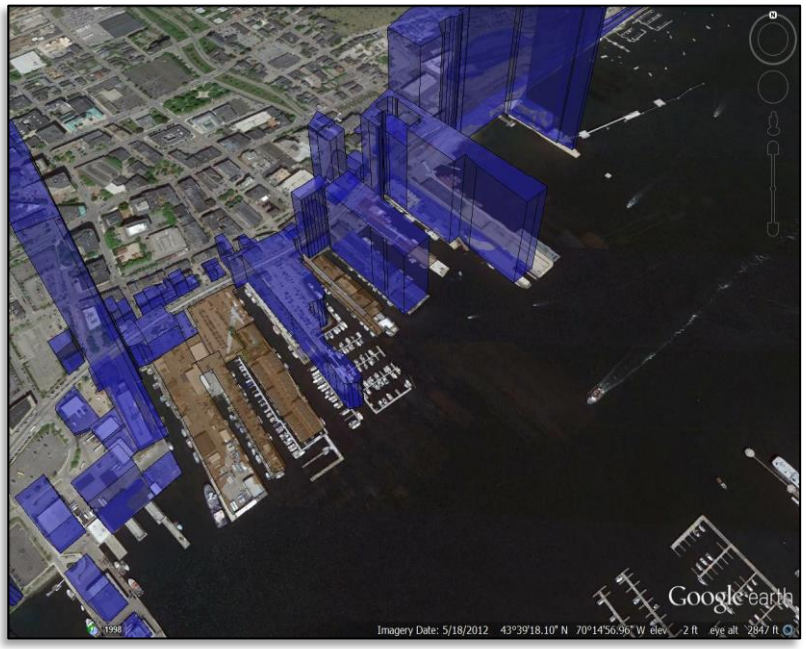
Now that problems of sea level rise and storm surge have been discussed with probabilities and estimated damage figures attached, vulnerabilities will have begun to seem more real than before the effort began.

These model results provide powerful insights and information to seek funding and develop political leadership around adaptation strategies that will protect the community – whether the solution will be fortification, accommodation, strategic relocation, or a combination of these. However the COAST process is not just about these results. This project has built models of the future *in collaboration with* a broad collection of stakeholders and concerned citizens. Now that problems of sea level rise and storm surge have been discussed with probabilities and damage figures attached, vulnerabilities will have begun to seem more real than before the effort began. Candidate adaptation actions have also been evaluated in detail, creating the opportunity for political momentum should community leaders wish to take additional steps in these directions.

Many communities have completed the COAST modeling process during the past three (3) years. Examples of some positive steps taken by other communities that have used COAST include:

- Kingston, New York – Results of the COAST model have led to continuing discussions about further floodproofing and even relocating the main sewage treatment plant, which was identified as an extremely vulnerable asset predicted to be subject to a high level of cumulative damage over the coming decades. Sea level rise issues are being considered for inclusion with ongoing updates to the Master Plan and Waterfront Redevelopment Plan for Kingston.

- Portland, Maine – Results of COAST modeling in the Back Cove area led to inclusion of specifications in requests for proposals for storm drainage work, specifically that designers and engineers must address potential sea level rise conditions in prospective projects. Another product of this effort was a second round of COAST modeling to study the vulnerability of the Commercial Street waterfront (arranged by the local nonprofit Portland Society for Architecture). Results have highlighted opportunities for the City of Portland to revise ordinances and make other changes in the direction of a more resilient working waterfront.



Interestingly, the most cost-effective option is not always the one favored; communities sometimes determine other values are more important, such as maintaining ocean views or protecting natural resources.

Given the short period the COAST approach has been in use and how long it takes to actually implement most adaptation strategies, construction stages of actions modeled by the Catalysis team have not yet occurred in communities that have used the approach. However, COAST modeling results have started many important public conversations. For example when considering adaptations to sea level and storm surge, numerous communities have indicated preferences for which directions they might like to head next. Interestingly, the most cost-effective option is not always the one favored; communities sometimes determine other values are more important, such as maintaining ocean views or protecting natural resources. That is, benefit-cost ratios from this work tend to open difficult conversations about what is most important to a community. Additionally, this type of modeling exercise usually results in broad discussion of vulnerabilities outside the model and helps identify diverse co-benefits of taking action. It is hoped results from this project will galvanize similar conversations and move the Islamorada towards its desired courses of action.

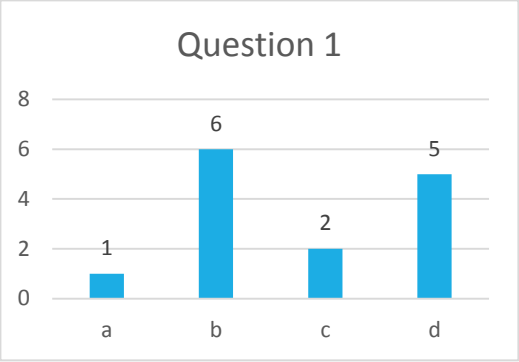
6 APPENDIX: PUBLIC INPUT AND COST CONSIDERATIONS OF PROPOSED STRATEGIES

6.1 KEYPAD POLLING RESULTS FROM COMMUNITY WORKSHOP #2

Keypad Polling Results from the COAST community modeling exercise conducted November 10, 2014 at the Community Center in Islamorada, FL.
Answers with the Highest Number of Votes are Highlighted in Gray.

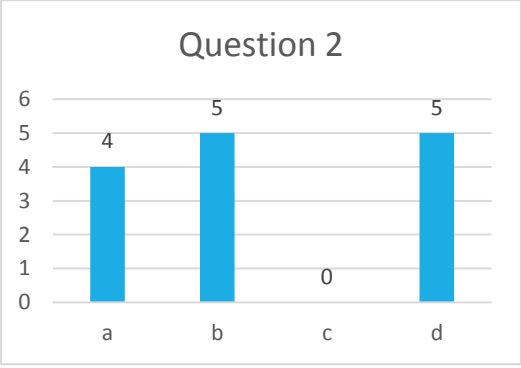
Question #1: Currently in Islamorada, 46% of properties are already elevated. What percentage of additional Islamorada V-zone buildings do you want to see elevated in this model?

1	a	25%
	b	**50%**
	c	75%
	d	The draft input of 100%



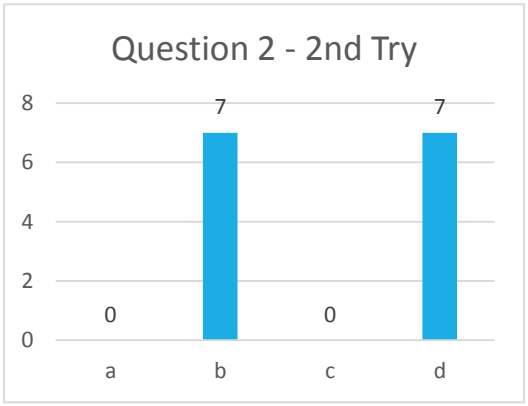
Question #2: What percentage of Islamorada A-zone buildings do you want to see floodproofed in this model?

2	a	25%
	b	50%
	c	75%
	d	The draft input of 100%



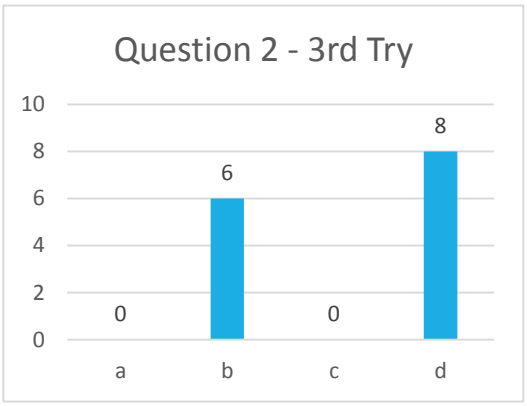
2nd Try: Asking Respondents to Choose Between B and D

2	a	25%
	b	50%
	c	75%
	d	The draft input of 100%



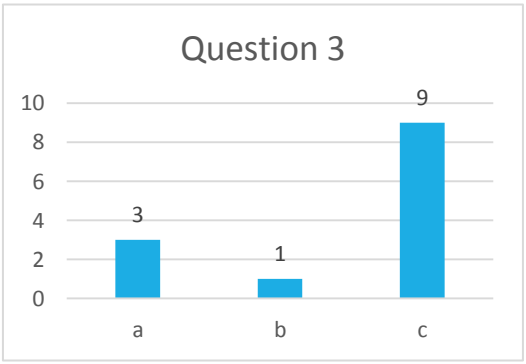
3rd Try: Asking Respondents to Choose Between B and D

2	a	25%
	b	50%
	c	75%
	d	**The draft input of 100%**



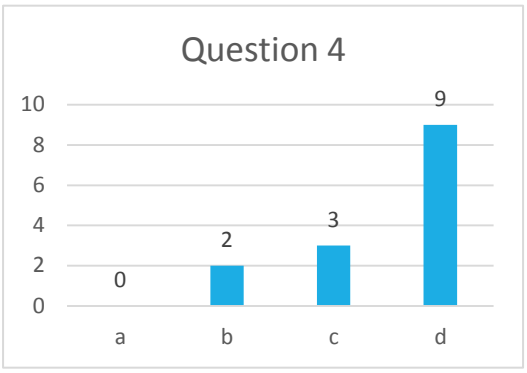
Question #3: Currently in Islamorada, new buildings are required to be elevated to the 100-year flood elevation, which ranges from 6 to 15 feet across the Key. For parcels that will be elevated in the model, do you want them to be elevated up to this code or to something higher?

3	a	Up to current code
	b	Up to current code plus 1 ft
	c	**Up to current code plus 2 ft**



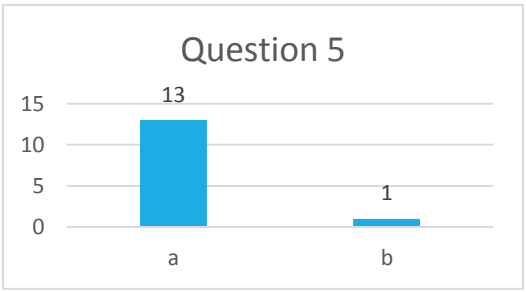
Question #4: The model estimates floodproofing to a certain height. How high would you like to see parcels floodproofed?

4	a	1 ft
	b	3 ft
	c	6 ft
	d	**The draft input of 8 ft**



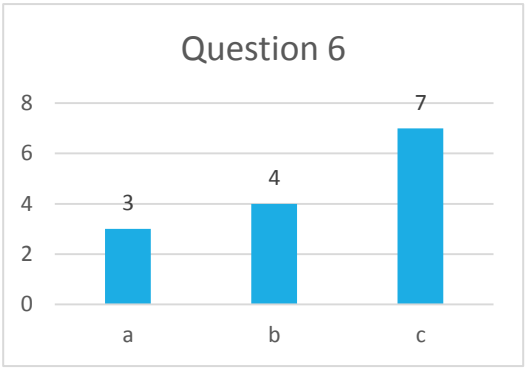
Question #5: Should the planning group model this action?

5	**a**	**Yes**
	b	No



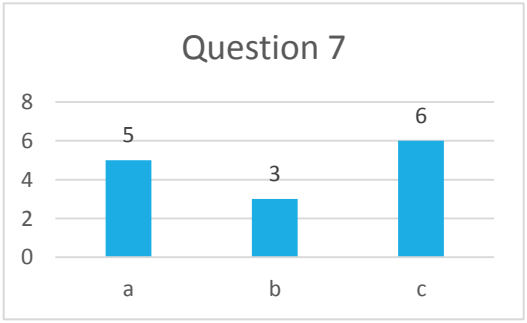
Question #6: Which of the following types of structures would you like to see us model:

6	a	Submergent
	b	At water level
	c	**Emergent**



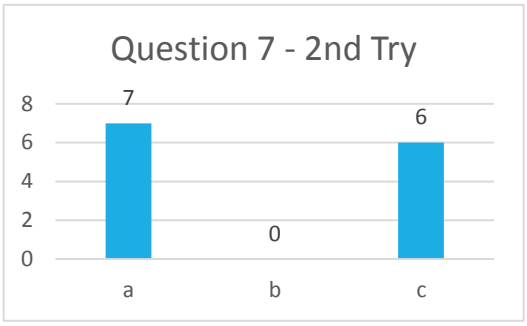
Question #7: How far out from the shore do you think the structures should be?

7	a	On the shore
	b	Nearshore
	c	Offshore



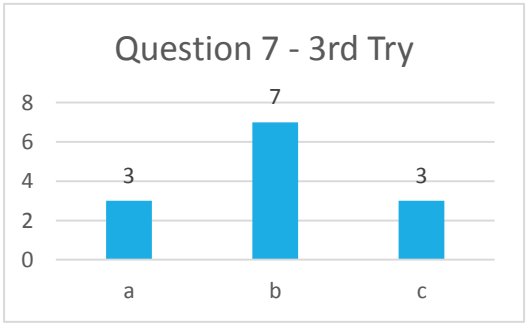
2nd Try: Asking Respondents to Choose Between A and C

7	a	On the shore
	b	Nearshore
	c	Offshore



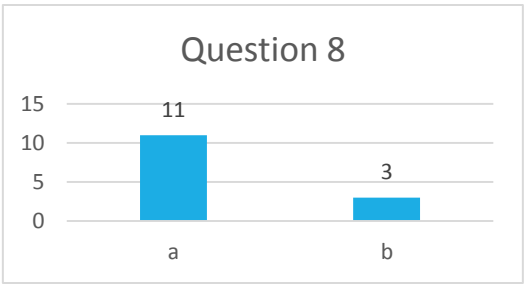
3rd Try: Asking Respondents to Choose Among All Choices, After Discussion of Water Access Problems Raised by Opponents of Choice A

7	a	On the shore
	b	**Nearshore**
	c	Offshore



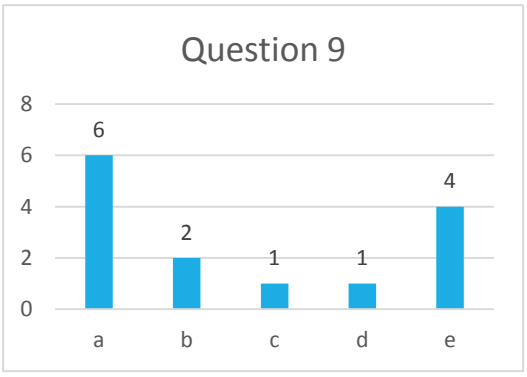
Question #8: Should the planning group model this action?

8	**a**	**Yes**
	b	No



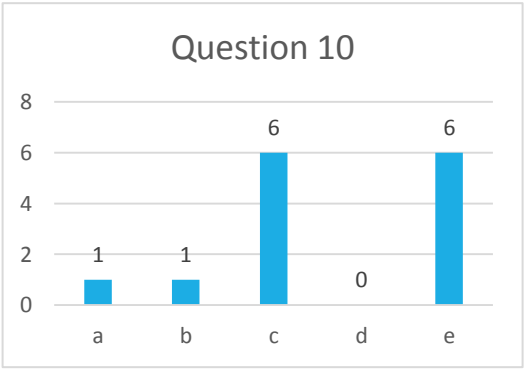
Question #9: What percent of property owners illustrated in red for Islamorada should we model would accept this voluntary buyout in the next few years (Phase 1)?

9	**a**	**10%**
	b	25%
	c	50%
	d	75%
	e	The draft input of 100%



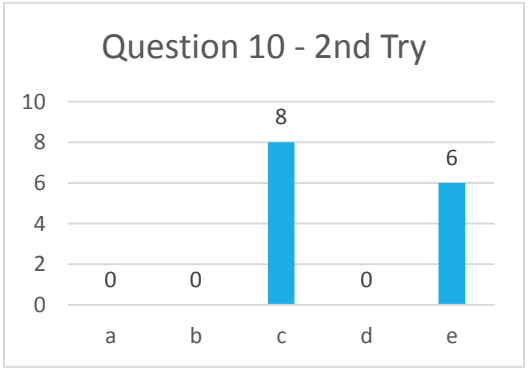
Question #10: What percent of property owners illustrated in green for Islamorada should we model that would accept this voluntary buyout in the year 2030 (Phase 2)?

10	a	10%
	b	25%
	c	50%
	d	75%
	e	The draft input of 100%



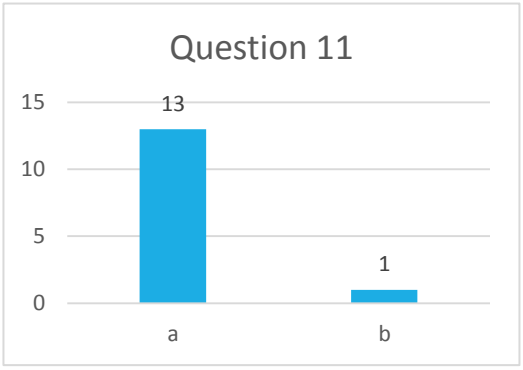
2nd Try: Asking Respondents to Choose Between C and E

10	a	10%
	b	25%
	c	**50%**
	d	75%
	e	The draft input of 100%



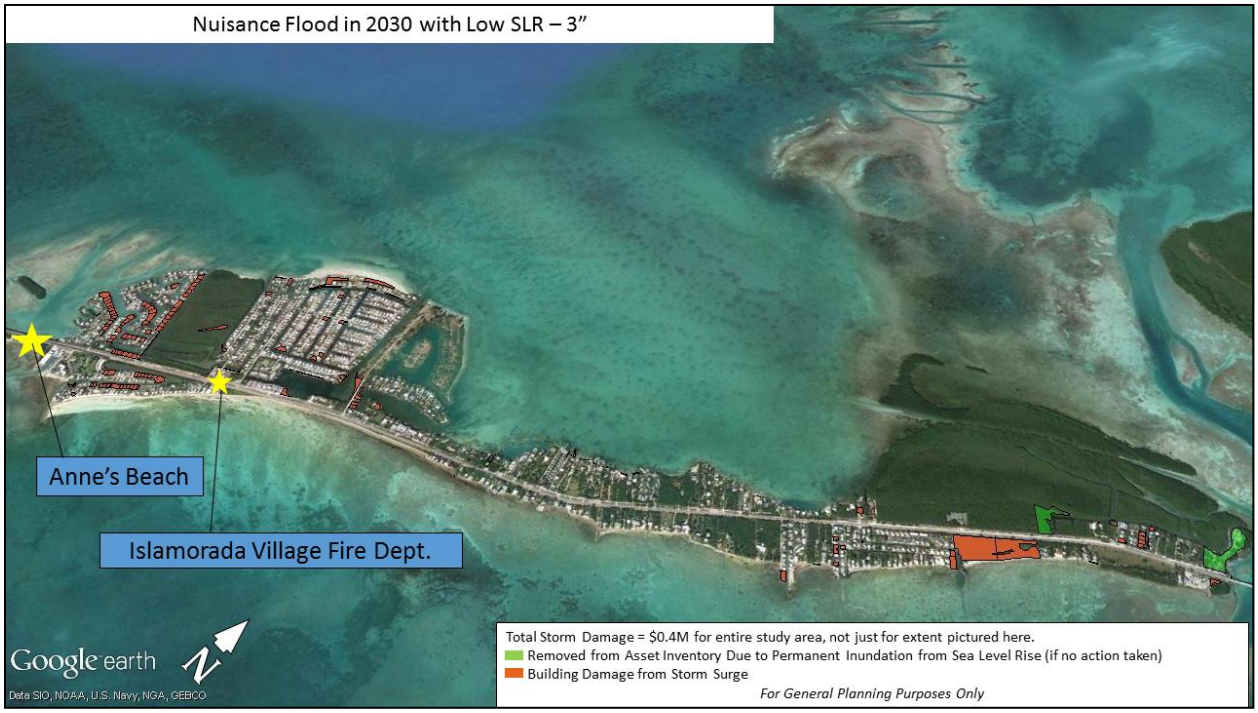
Question #11: Should the planning group model this action?

11	**a**	**Yes**
	b	No

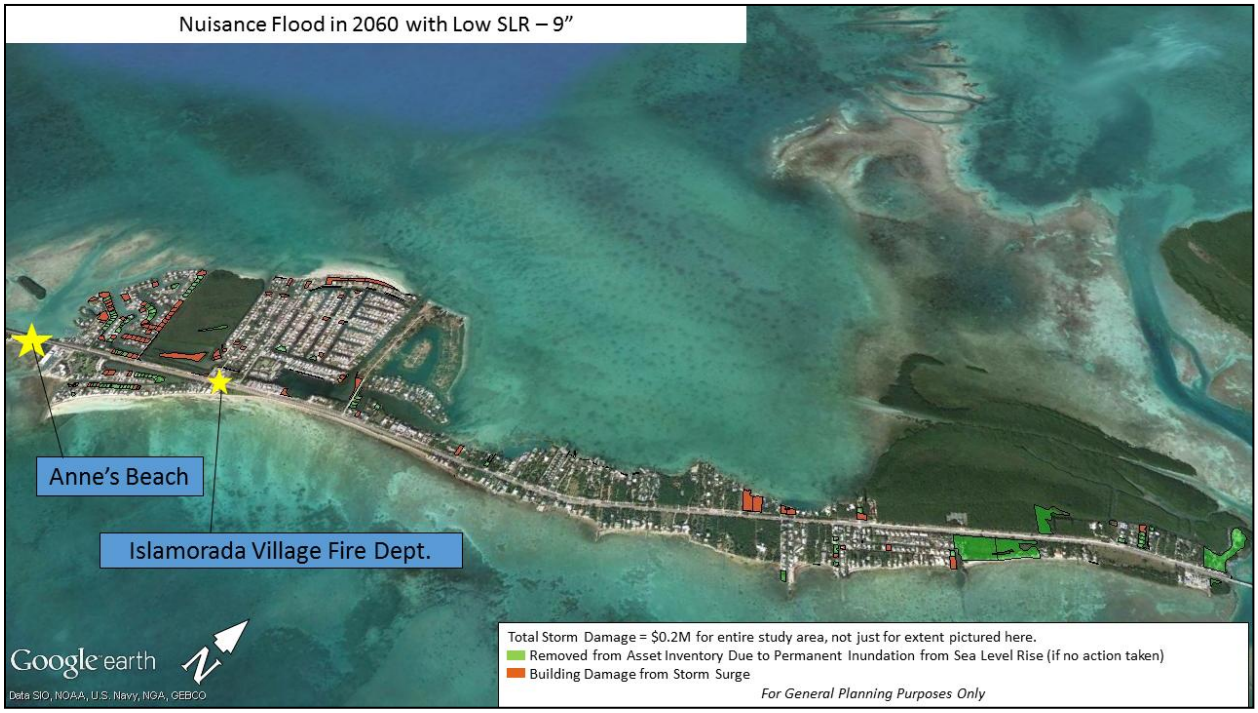


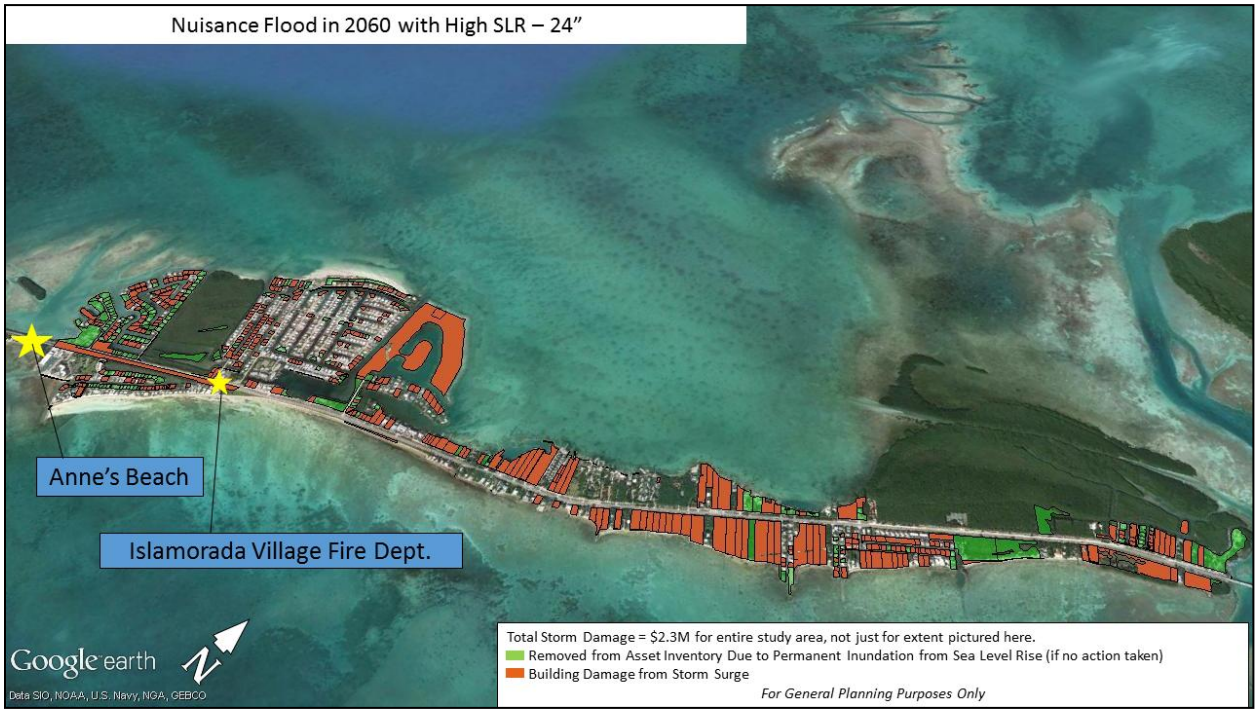
6.2 Maps of Potential One-Time Flooding Damage in Islamorada, FL

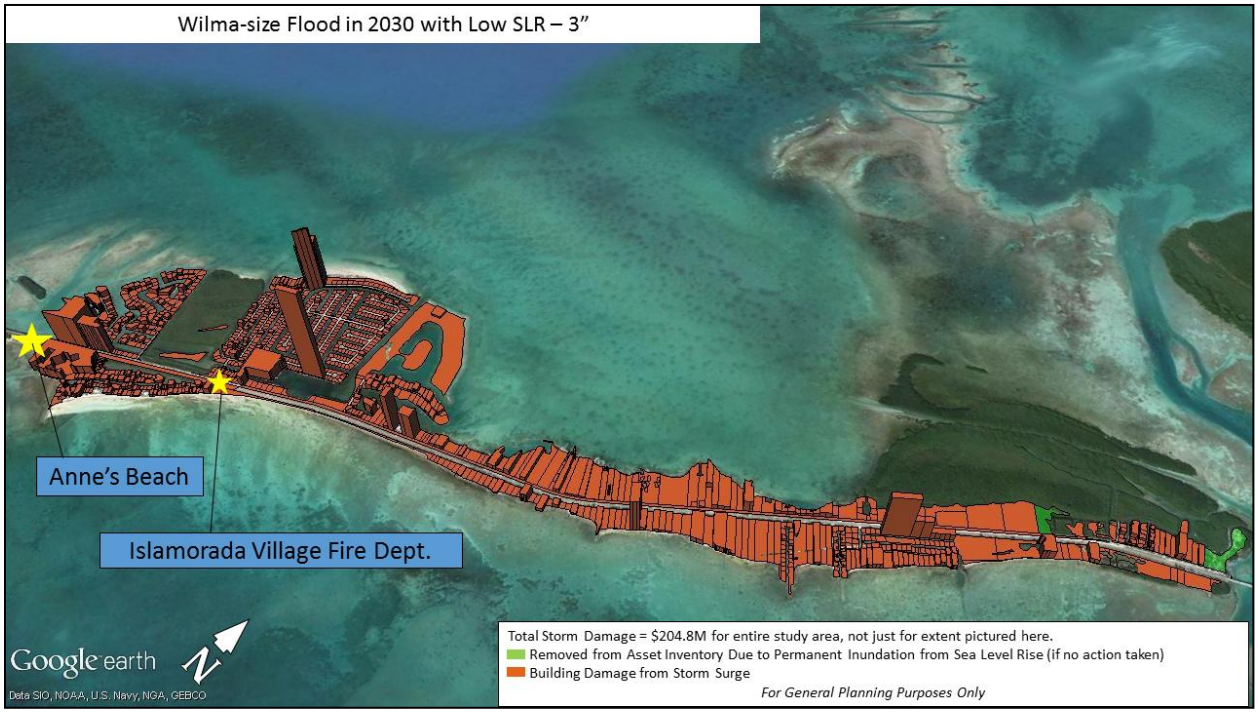
Sea Level Rise assumptions were based upon the report: Unified Sea Level Rise Projection for Southeast Florida, Southeast Florida Regional Climate Change Compact Counties, Sea Level Rise Ad Hoc Technical Working Group (April 2011).

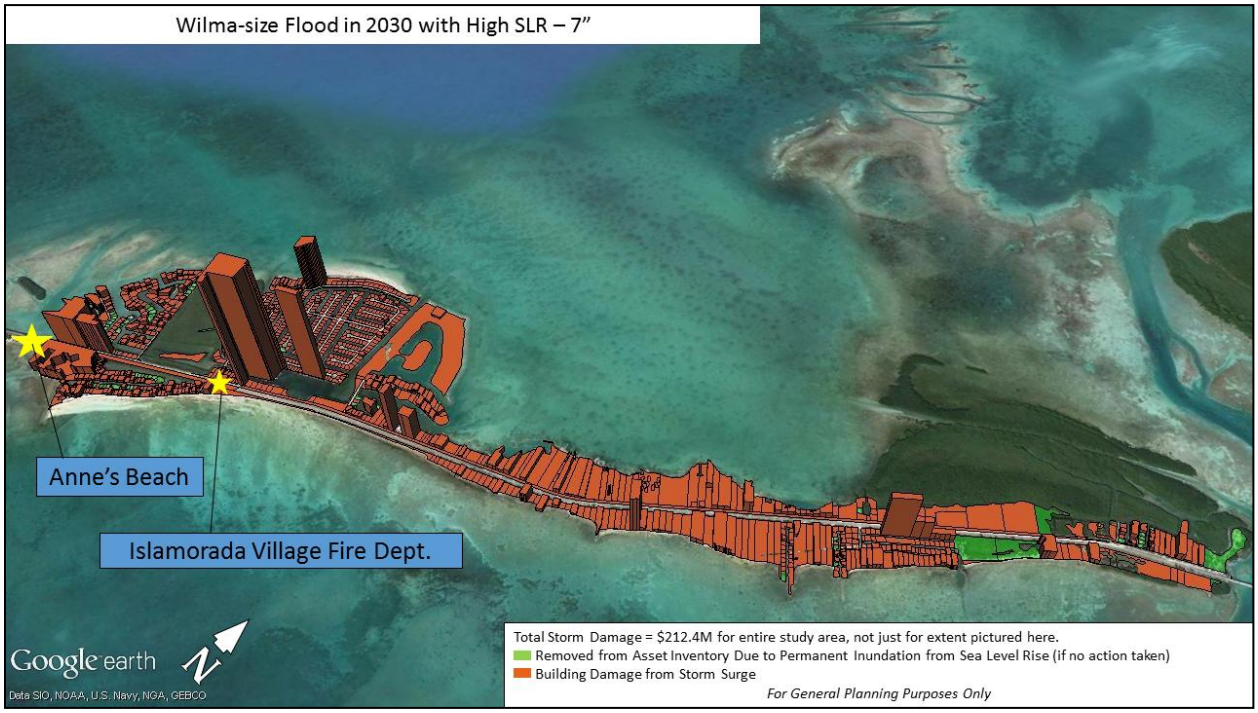

Nuisance Flood in 2030 with Low SLR – 3”
Anne’s Beach
Islamorada Village Fire Dept.
Google earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Total Storm Damage = $0.4M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only

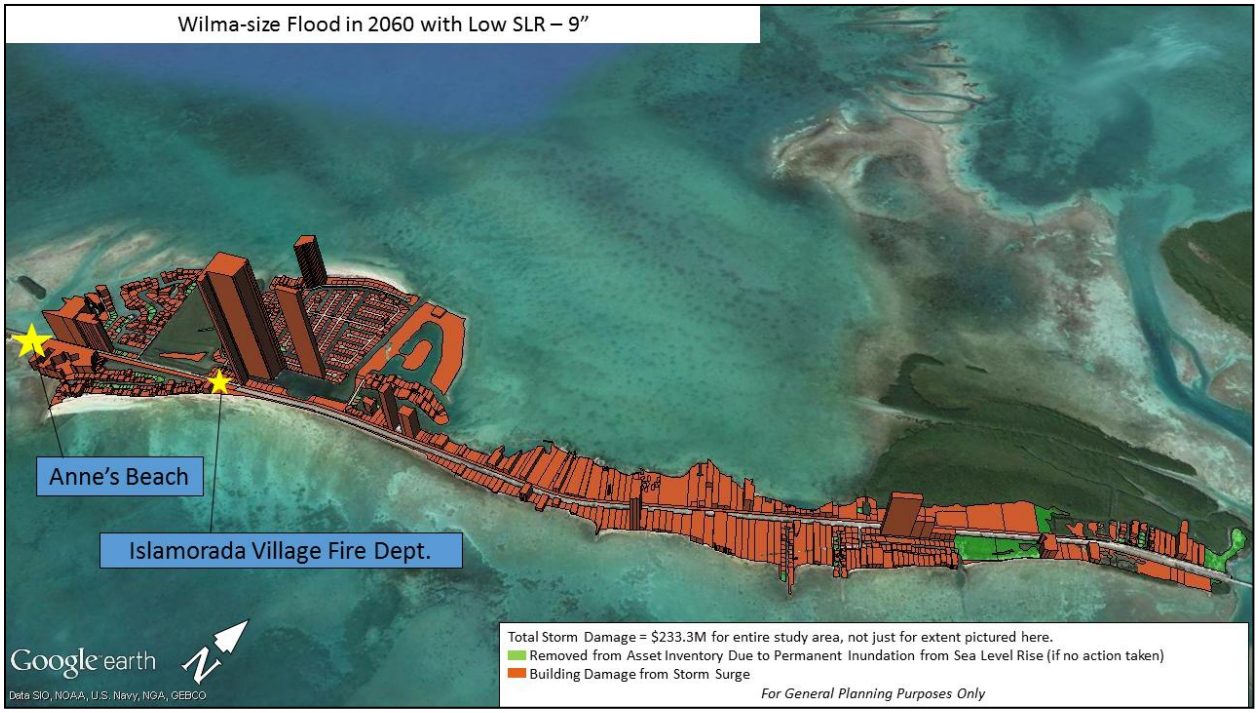

Nuisance Flood in 2030 with High SLR – 7”
Anne’s Beach
Islamorada Village Fire Dept.
Google earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Total Storm Damage = $0.2M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only

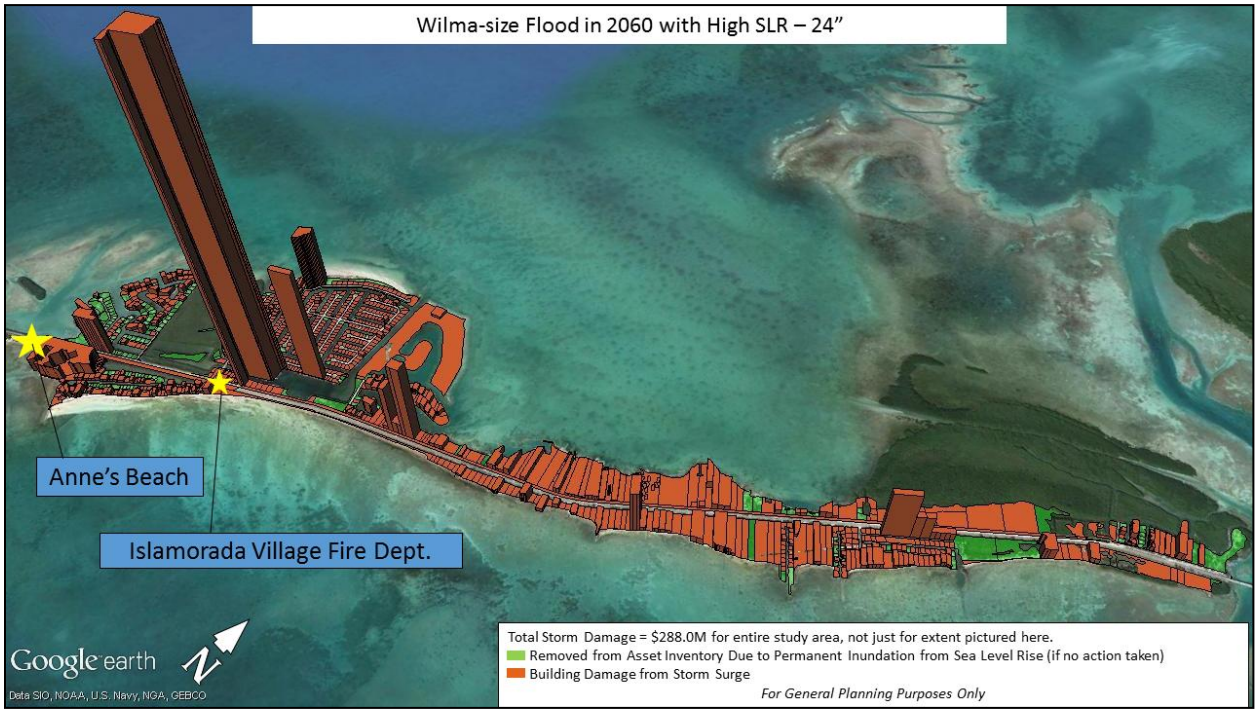

Nuisance Flood in 2060 with Low SLR – 9”
Anne’s Beach
Islamorada Village Fire Dept.
Google earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Total Storm Damage = $0.2M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only

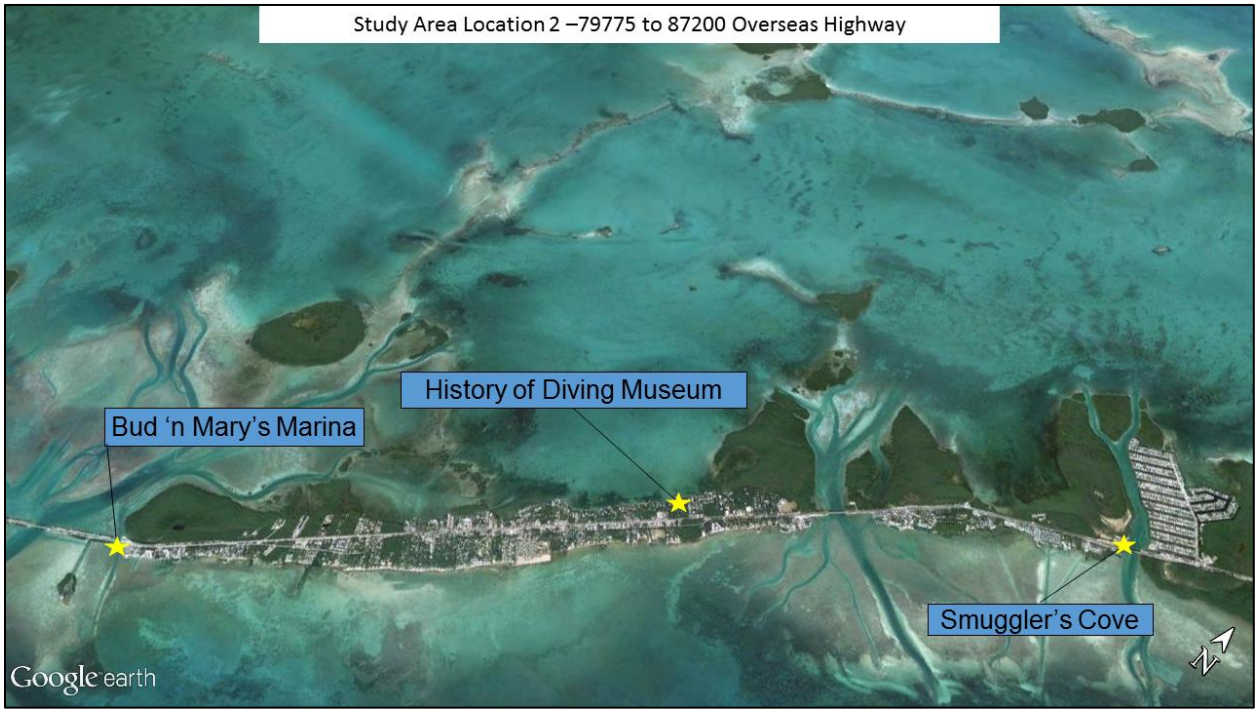

Nuisance Flood in 2060 with High SLR – 24”
Anne’s Beach
Islamorada Village Fire Dept.
Google earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Total Storm Damage = $2.3M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only

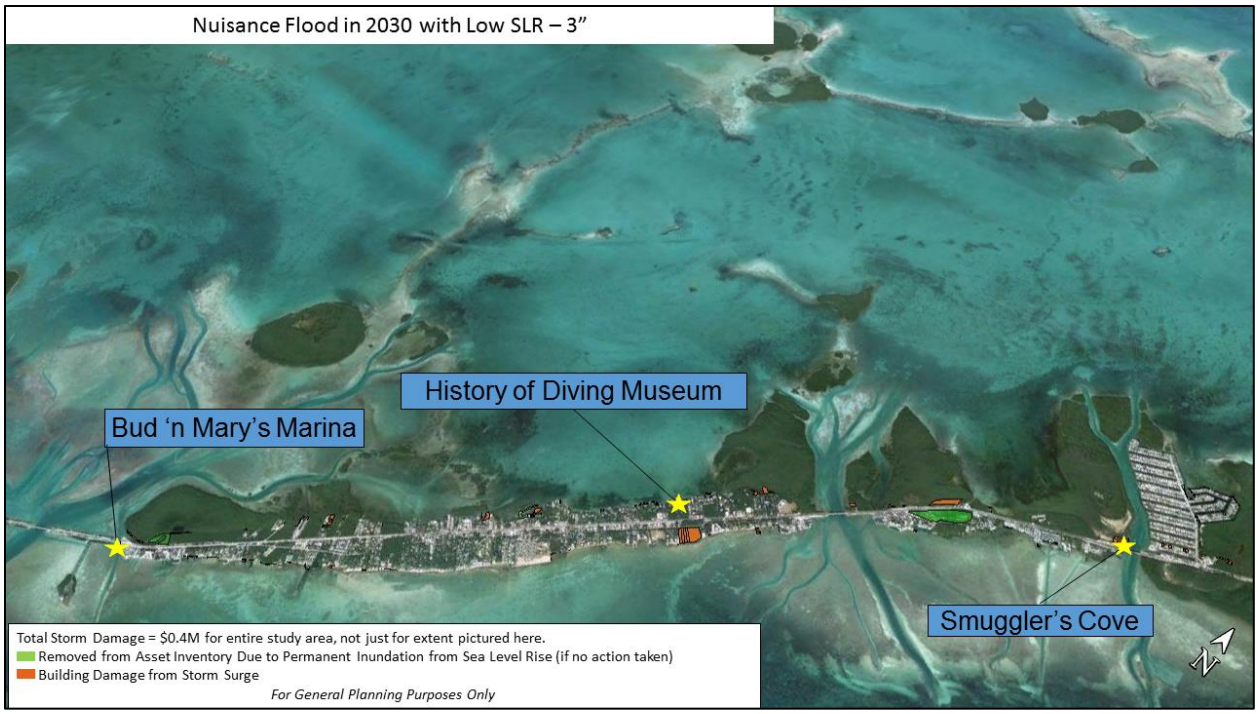

Wilma-size Flood in 2030 with Low SLR – 3”
Anne’s Beach
Islamorada Village Fire Dept.
Google earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Total Storm Damage = $204.8M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only

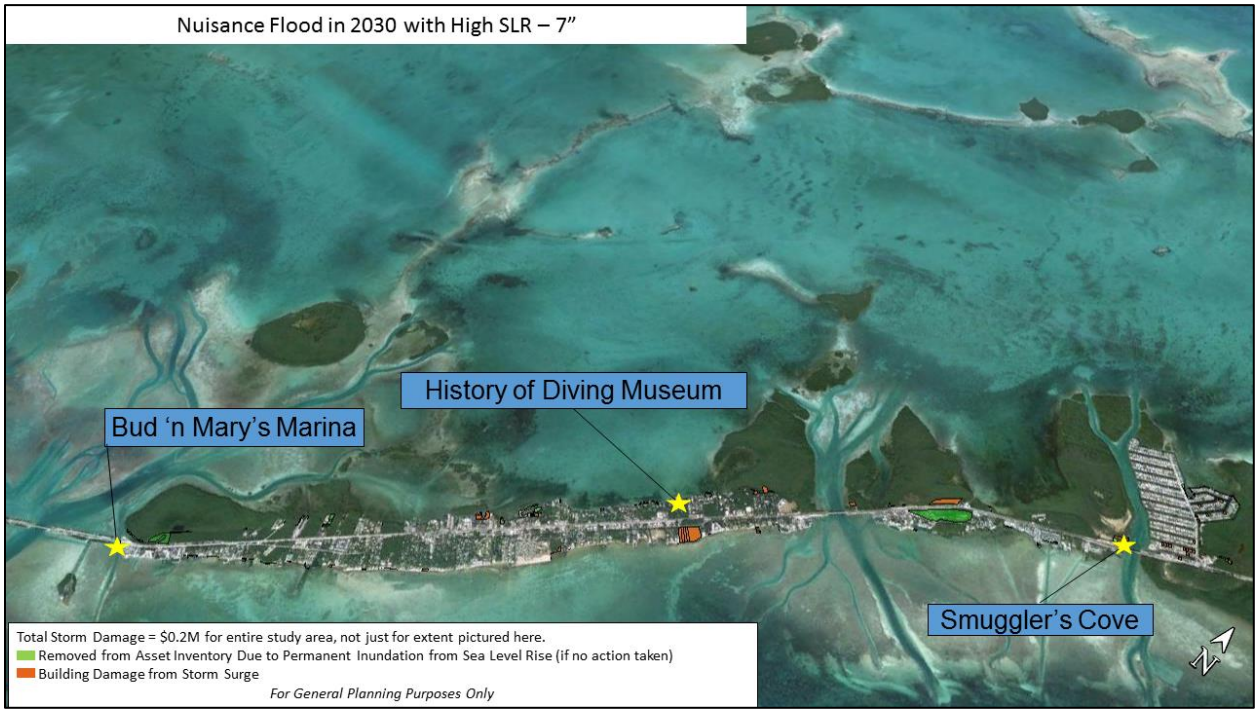

Wilma-size Flood in 2030 with High SLR – 7”
Anne’s Beach
Islamorada Village Fire Dept.
Google earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Total Storm Damage = $212.4M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only

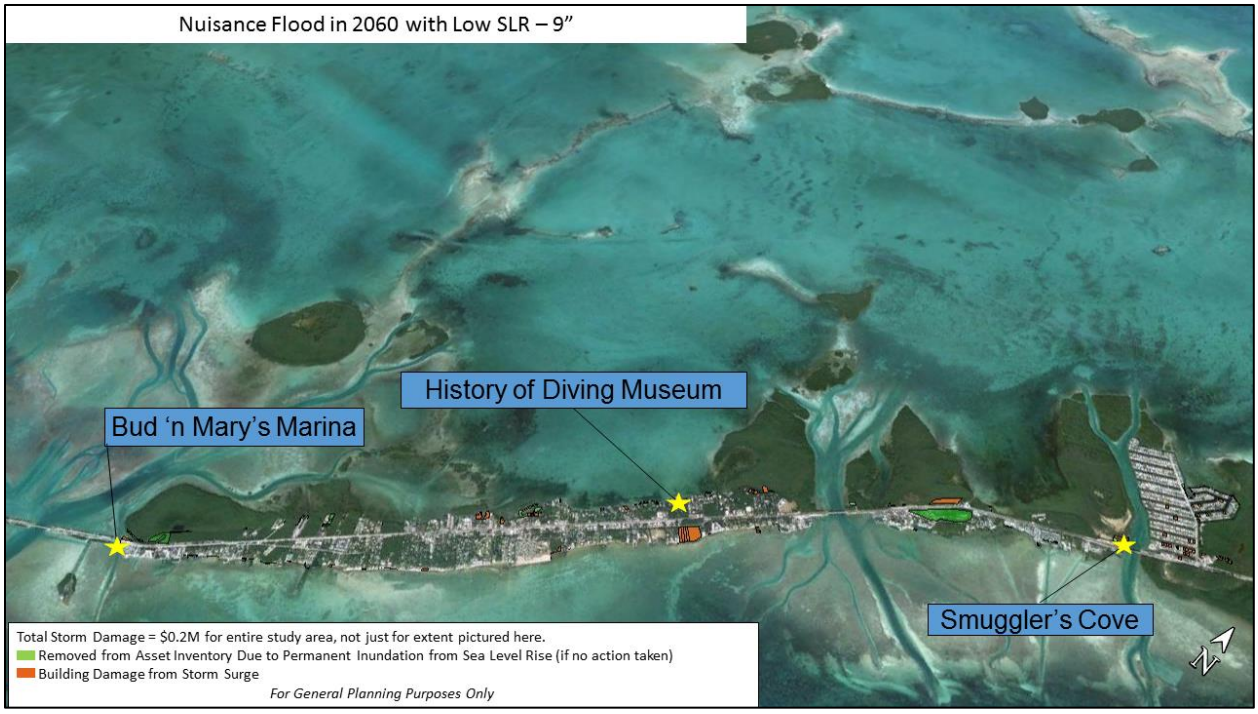

Wilma-size Flood in 2060 with Low SLR – 9”
Anne’s Beach
Islamorada Village Fire Dept.
Google earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Total Storm Damage = $233.3M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only

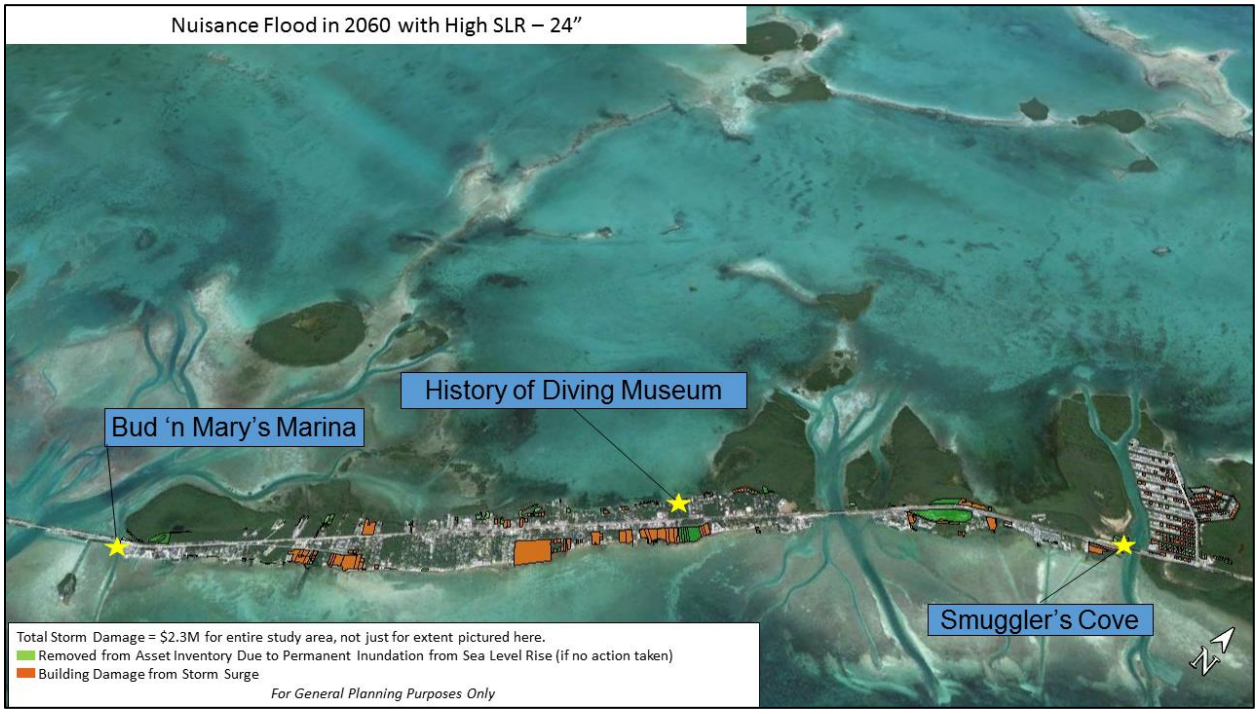

Wilma-size Flood in 2060 with High SLR – 24”
Anne’s Beach
Islamorada Village Fire Dept.
Google earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Total Storm Damage = $288.0M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only


Study Area Location 2 –79775 to 87200 Overseas Highway
History of Diving Museum
Bud 'n Mary's Marina
Smuggler's Cove
Google earth
N

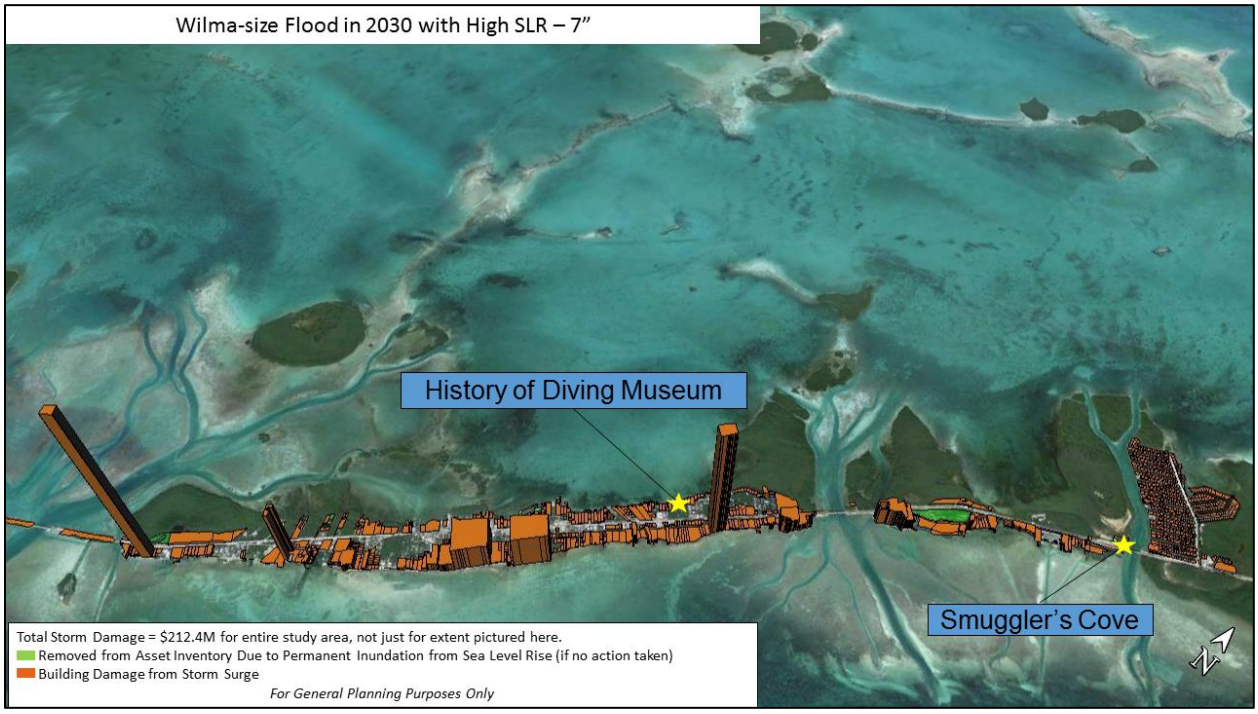

Nuisance Flood in 2030 with Low SLR – 3”
History of Diving Museum
Bud ‘n Mary’s Marina
Smuggler’s Cove
Total Storm Damage = $0.4M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only


Nuisance Flood in 2030 with High SLR – 7”
History of Diving Museum
Bud ‘n Mary’s Marina
Smuggler’s Cove
Total Storm Damage = $0.2M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only


Nuisance Flood in 2060 with Low SLR – 9”
History of Diving Museum
Bud ‘n Mary’s Marina
Smuggler’s Cove
Total Storm Damage = $0.2M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only

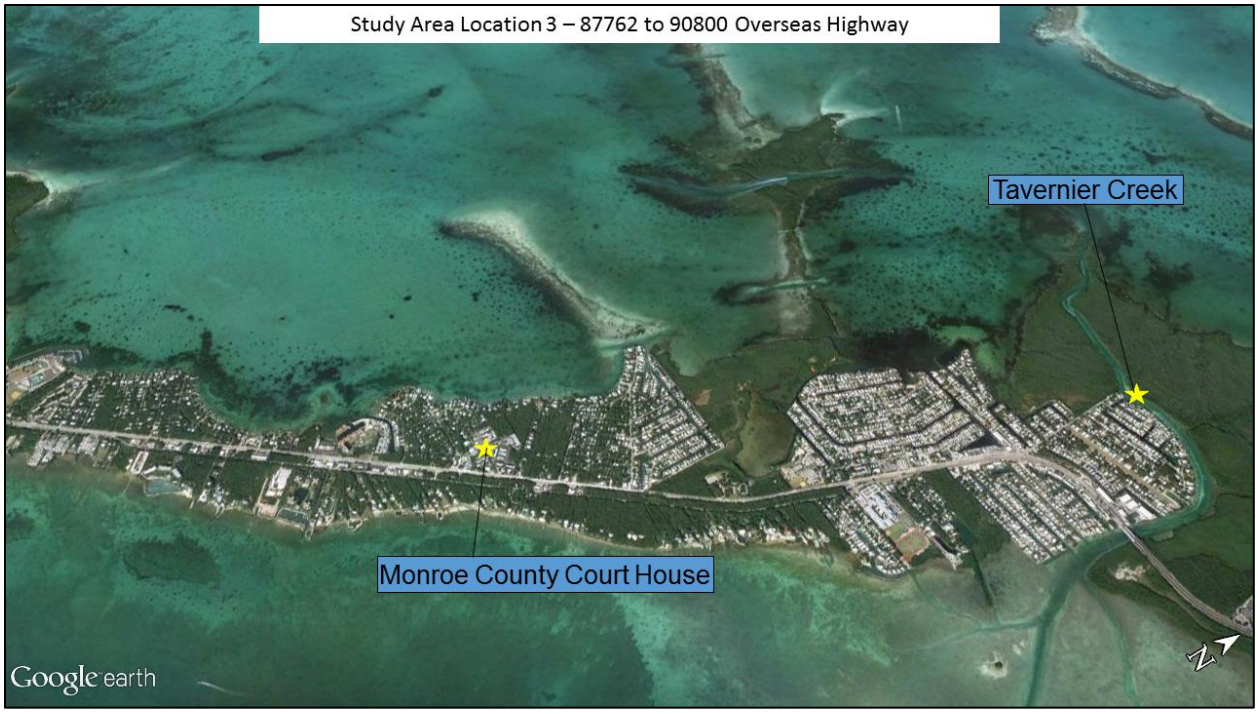

Nuisance Flood in 2060 with High SLR – 24”
History of Diving Museum
Bud ‘n Mary’s Marina
Smuggler’s Cove
Total Storm Damage = $2.3M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only

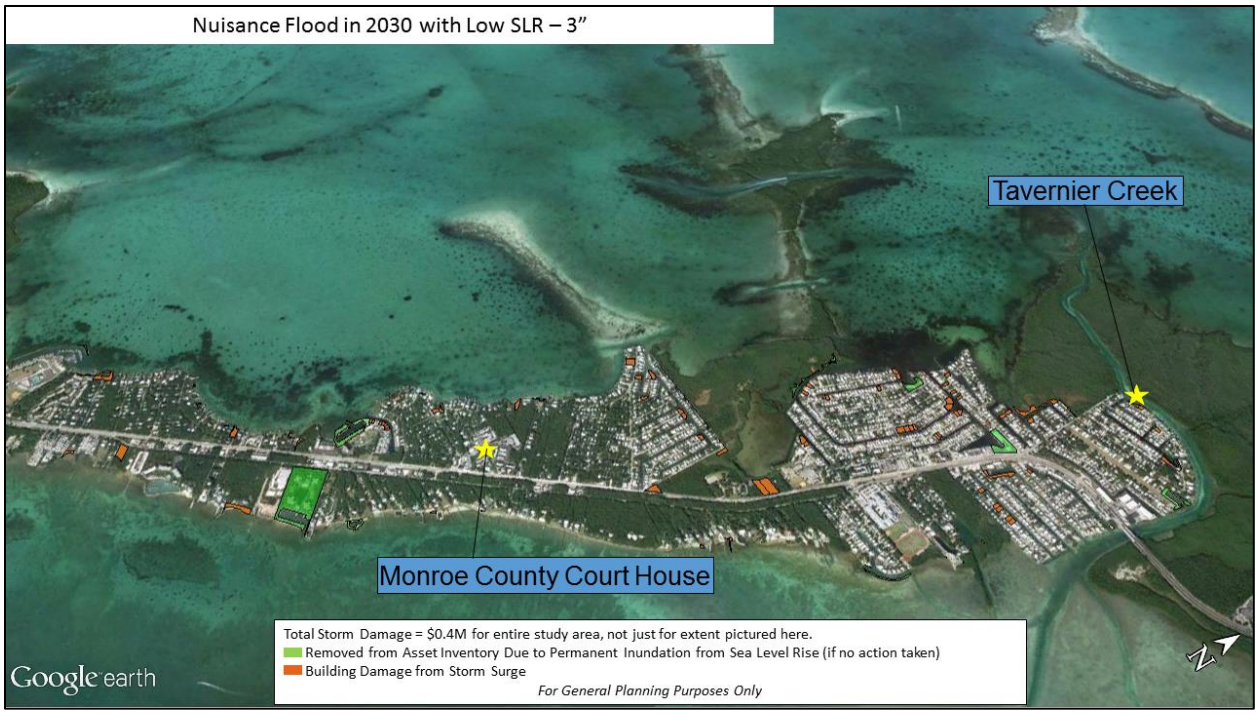

Wilma-size Flood in 2030 with Low SLR – 3”
History of Diving Museum
Smuggler’s Cove
Total Storm Damage = $204.8M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only

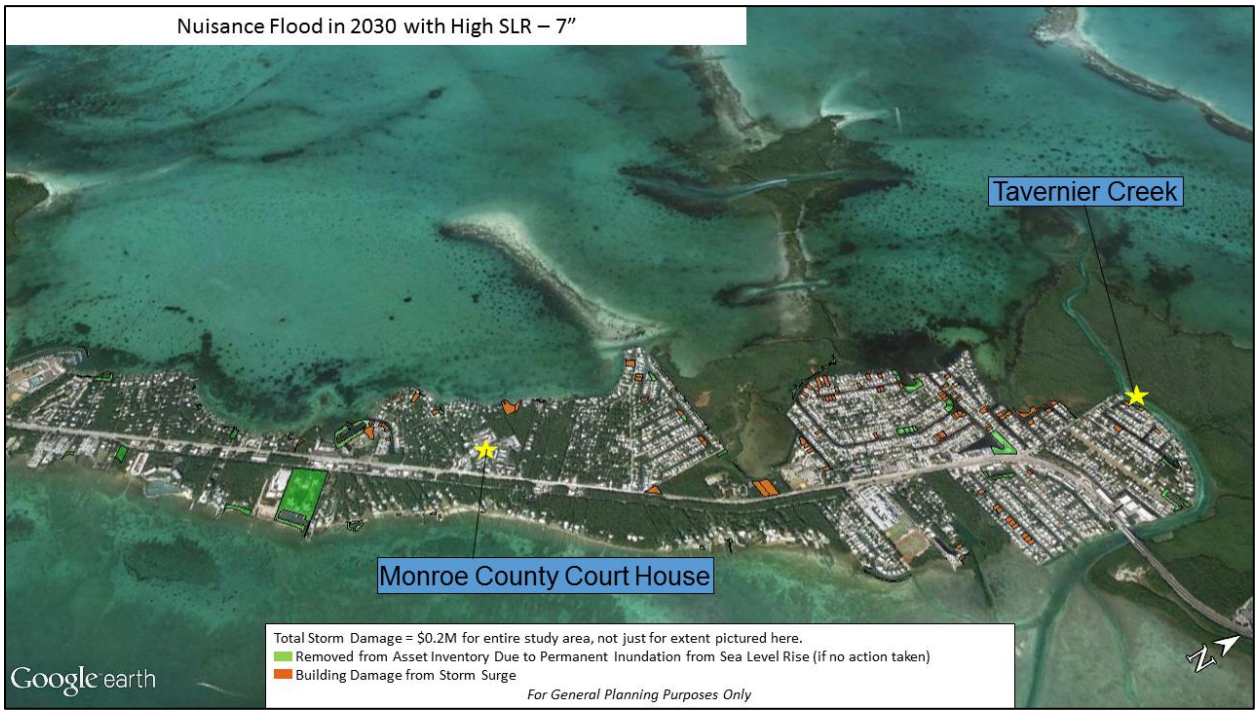

Wilma-size Flood in 2030 with High SLR – 7”
History of Diving Museum
Smuggler’s Cove
Total Storm Damage = $212.4M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only

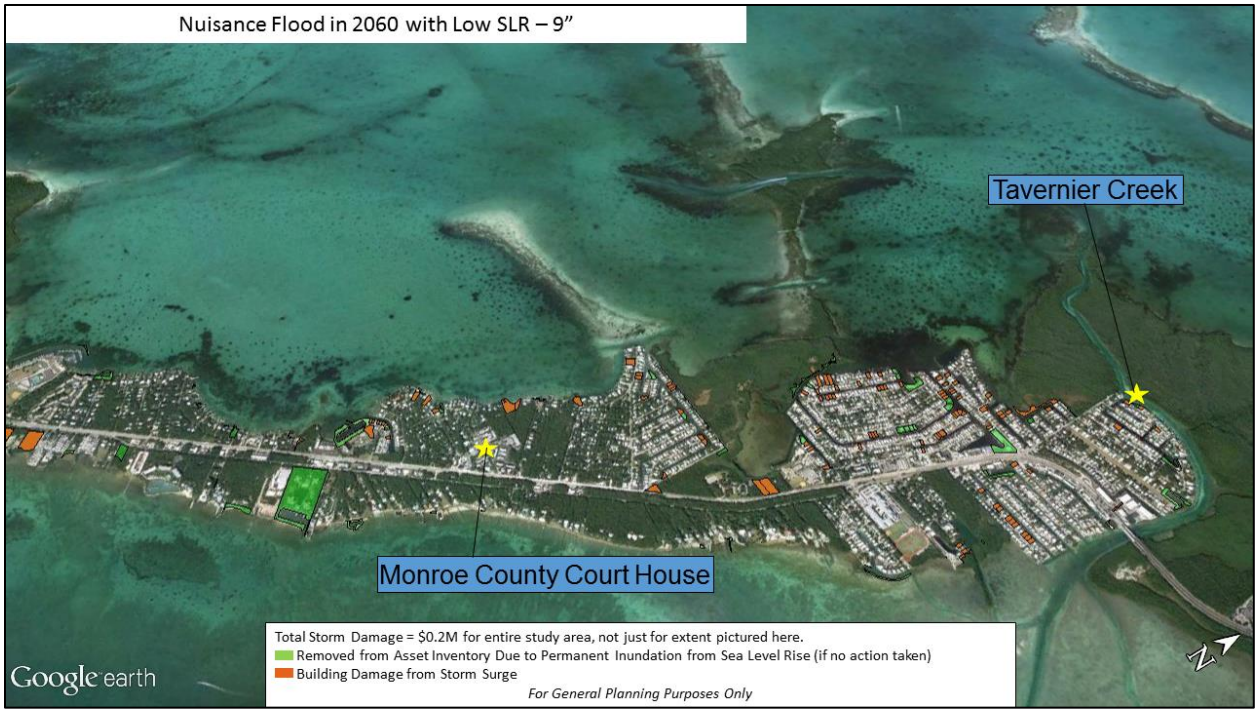

Wilma-size Flood in 2060 with Low SLR – 9”
History of Diving Museum
Smuggler’s Cove
Total Storm Damage = $233.3M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only

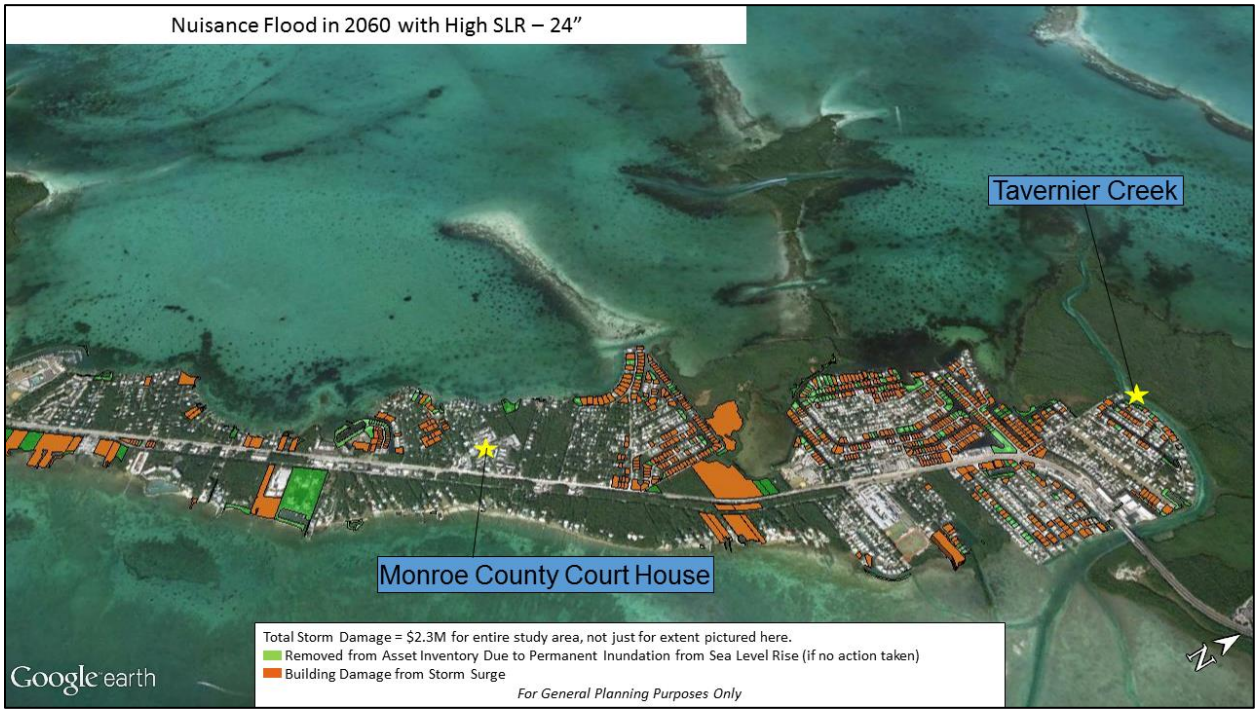

Wilma-size Flood in 2060 with High SLR – 24”
History of Diving Museum
Smuggler’s Cove
Total Storm Damage = $288.0M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only

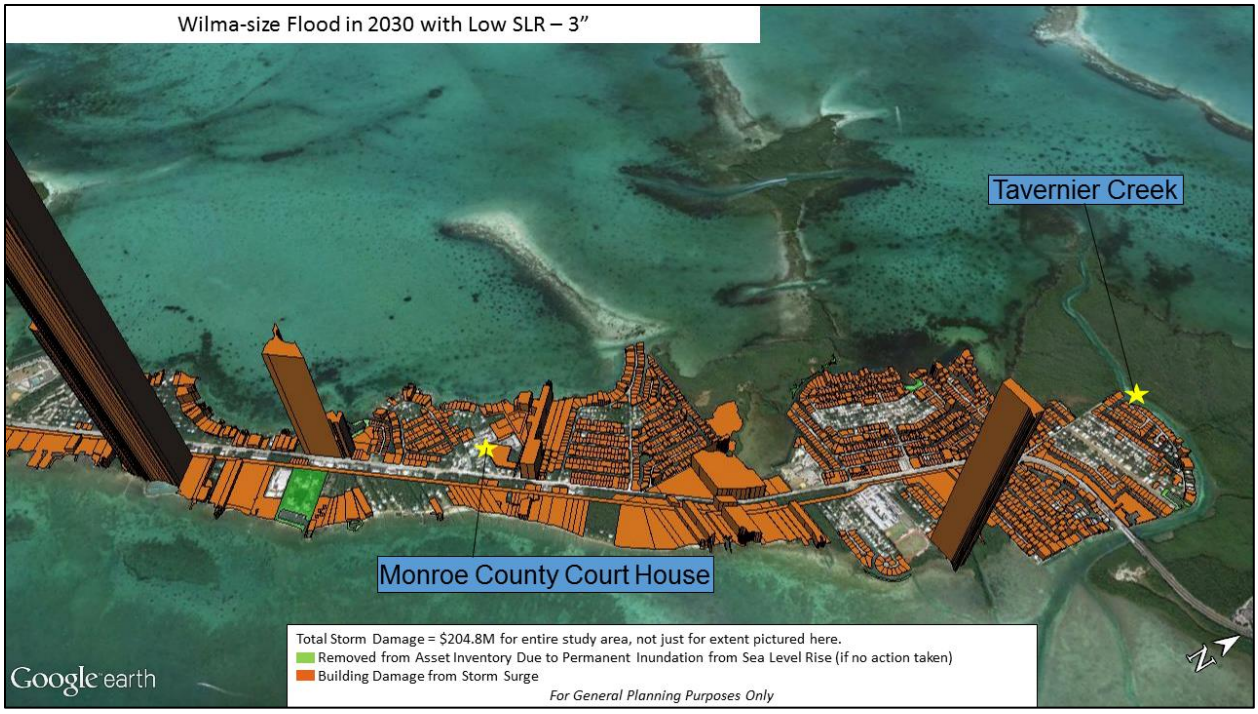

Study Area Location 3 – 87762 to 90800 Overseas Highway
Tavernier Creek
Monroe County Court House
Google earth

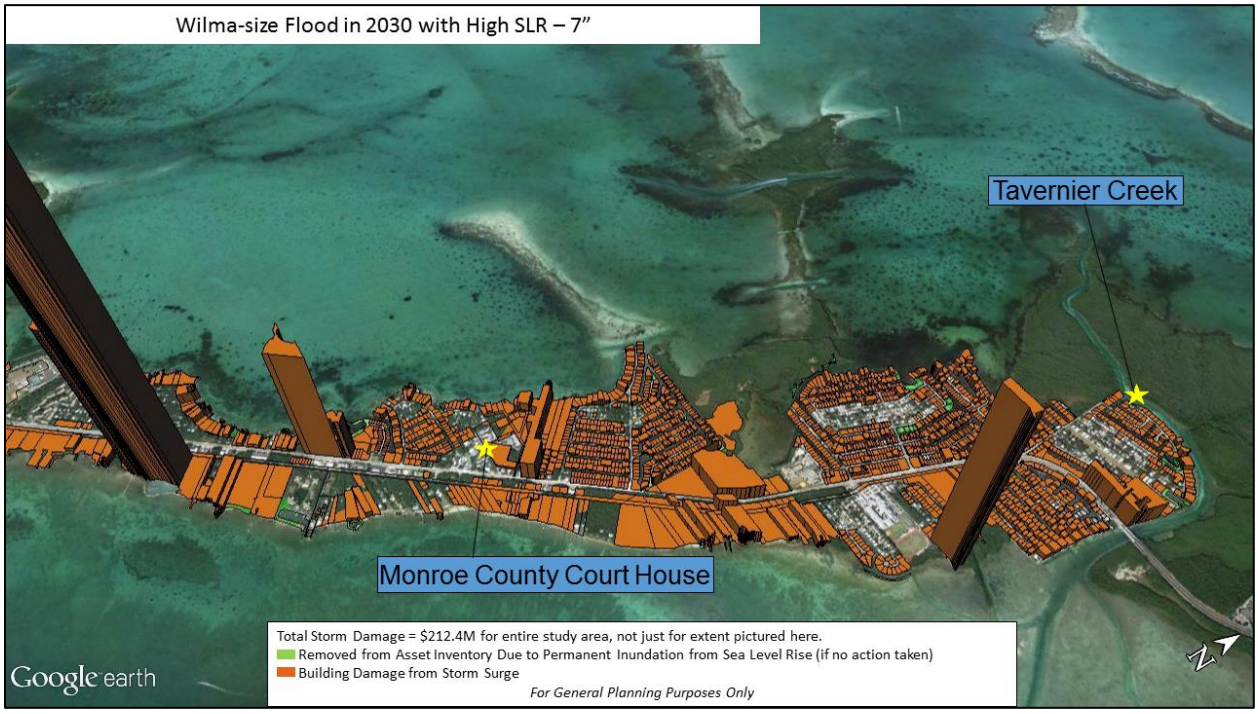

Nuisance Flood in 2030 with Low SLR – 3”
Tavernier Creek
Monroe County Court House
Total Storm Damage = $0.4M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only
Google earth

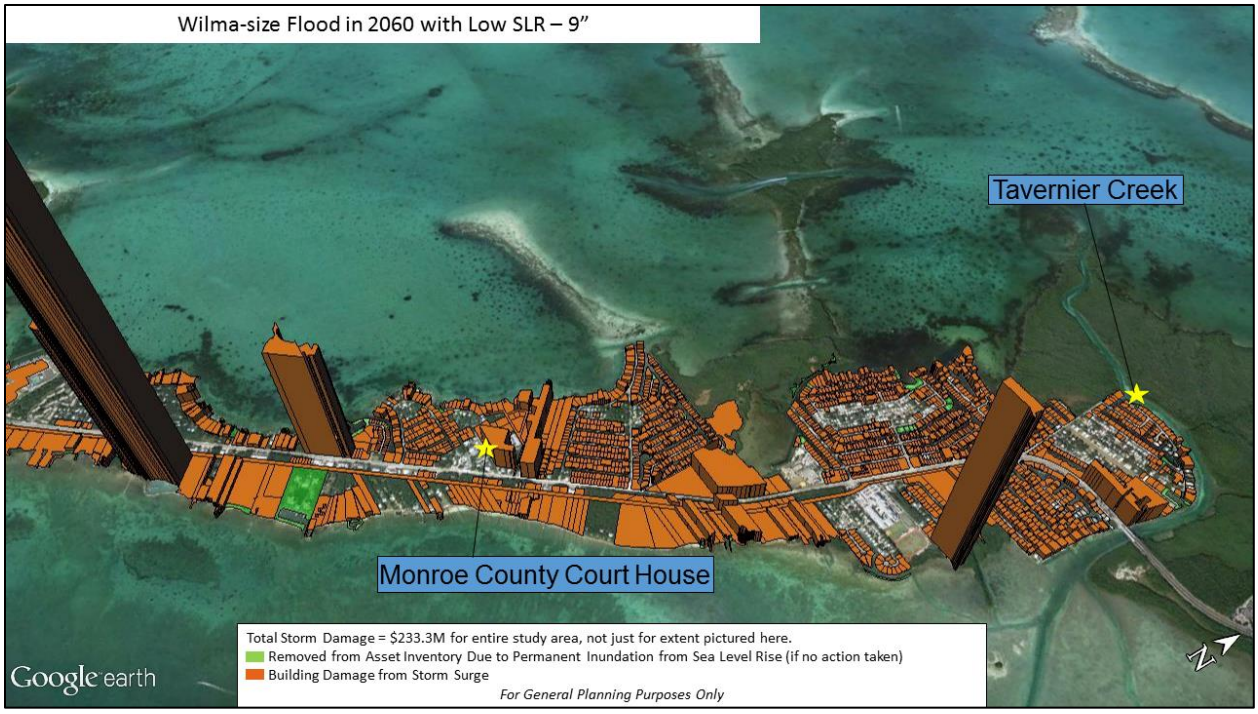

Nuisance Flood in 2030 with High SLR – 7”
Tavernier Creek
Monroe County Court House
Total Storm Damage = $0.2M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only
Google earth


Nuisance Flood in 2060 with Low SLR – 9”
Tavernier Creek
Monroe County Court House
Total Storm Damage = $0.2M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only
Google earth


Nuisance Flood in 2060 with High SLR – 24”
Tavernier Creek
Monroe County Court House
Total Storm Damage = $2.3M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only
Google earth


Wilma-size Flood in 2030 with Low SLR – 3”
Tavernier Creek
Monroe County Court House
Total Storm Damage = $204.8M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only
Google earth


Wilma-size Flood in 2030 with High SLR – 7”
Tavernier Creek
Monroe County Court House
Total Storm Damage = $212.4M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only
Google earth


Wilma-size Flood in 2060 with Low SLR – 9”
Tavernier Creek
Monroe County Court House
Total Storm Damage = $233.3M for entire study area, not just for extent pictured here.
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Building Damage from Storm Surge
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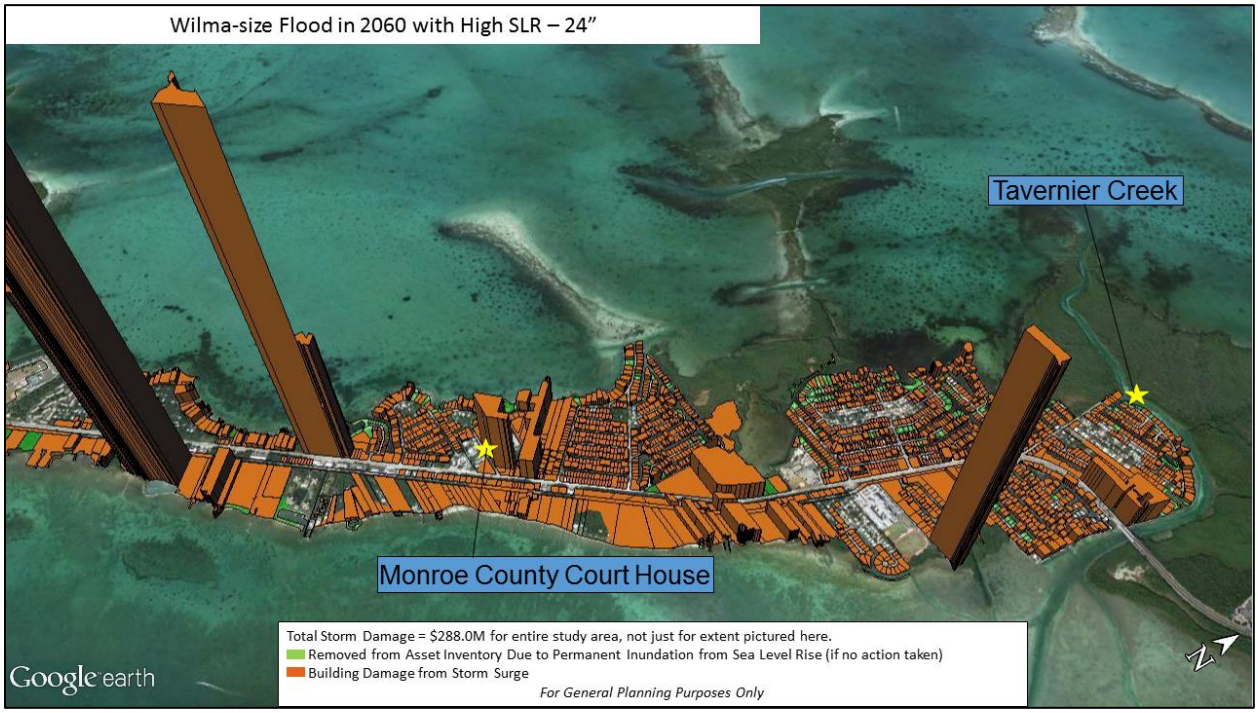
Google earth


Wilma-size Flood in 2060 with High SLR – 24”
Tavernier Creek
Monroe County Court House
Total Storm Damage = $288.0M for entire study area, not just for extent pictured here.
Removed from Asset Inventory Due to Permanent Inundation from Sea Level Rise (if no action taken)
Building Damage from Storm Surge
For General Planning Purposes Only
Google earth

6.3 COST BREAKDOWN FOR ADAPTATION ACTIONS

6.3.1 Adaptation Action 1 – Elevate and Floodproof Buildings

	Cost Estimates for Action 1 - No Discounting, Costs paid Now				
	Number of Units Elevated in the V Zone	**Elevation Price Per Site - Low**	**Elevation Price per Site-High**	**Cost - Low**	**Cost - High**
For Elevation Component	98	$ 60,000[6]	$ 160,000[2]	$ 5,880,000	$ 15,680,000
	Total Bldg Market Value of Flood-proofed Units in A Zone (1391 properties)	**Cost as percent of Building Structure Value - Low**	**Cost as percent of Building Structure Value - High**	**Cost - Low**	**Cost - High**
For Flood-proofing Component	$ 732,805,839	10%[7]	20%[3]	$ 73,280,584	$ 146,561,168
Total				**$ 79,160,584**	**$162,241,168**

[6] Cost estimates derived from internet search of pricing from Florida-based elevation contractors. This range of values also is consistent with FEMA post-Sandy grants to homeowners for elevations, during 2013-2014.
[7] Provided by Parsons Brinckerhoff cost estimators as a good "rule of thumb," based on post-Sandy floodproofing work in the New York metropolitan area in 2013.

6.3.2 Adaptation Action 2 – Constructed Barriers

	Estimated Costs Using Bid Numbers from South Cove Restoration Plan (2011) - Limestone Breakwater with Mangroves in Similar Depth - Palm Beach County ERM/Lake Worth Area					
	Qty	Unit	Unit Cost - Avg 3 Lowest Bids in 2011	Total Cost	Scale-Up Multiplier for Islamorada (1500 feet to 1 miles)	**Islamorada Cost Estimate**
Mobilization - Demobilization	1	lump sum	$ 146,533.00	$ 146,533	1.5	**$ 219,800**
Design Drawings	1	lump sum	$ 28,900.00	$ 28,900	2	**$ 57,800**
Fill	35000	CY	$ 20.37	$ 712,950	3.52	**$ 2,509,584**
Armor Stone	9600	Tons	$ 73.10	$ 701,760	3.52	**$ 2,470,195**
Bedding Stone	1600	Tons	$ 77.92	$ 124,672	3.52	**$ 438,845**
Total				$ 1,714,815		**$ 5,696,224**
Adjust by CPI since 2011						**$ 6,027,758**
					Low Cost Estimate	**$ 6,027,758**
				For High Cost Estimate, Add 33%		**$ 8,016,918**

6.3.3 Adaptation Action 3 – Voluntary Buyouts

	Cost Estimates for Action 3 - 100% participation				
	Rolling Easement Acquisition Costs				
	Current Building Market Value	**Current Land Value - Assessed Value**	**Current Land Market Value**	**Current Total Market Value, Land + Bldg**	**Discounted to Today's Price from 2030 for reds; from 2045 for greens**
Red Parcels (94 total)	$27,756,169	$30,982,565	$35,629,950	$63,386,119	$ 37,704,138
Green Parcels (95 total)	$22,875,081	$34,806,967	$40,028,012	$62,903,093	$ 22,991,221
Total (Low Estimate)					**$ 60,695,359**
Total (High Estimate - 50% increase for High Legal Costs)					**$ 91,043,038**

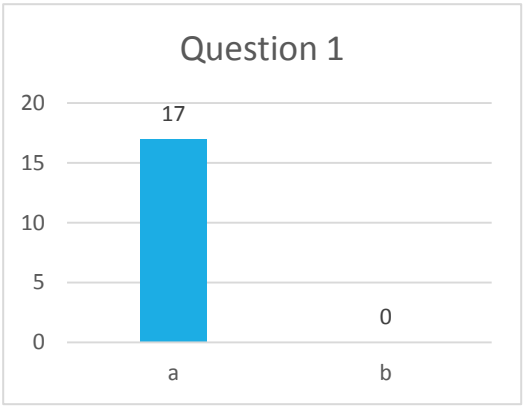
	Cost Estimates for Action 3 - 10% participation now and 50% in 2030					
	Rolling Easement Acquisition Costs					
	Current Building Market Value (100%)	**Current Land Value - Assessed Value (100%)**	**Current Land Market Value (100%)**	**Current Total Market Value, Land + Bldg (100%)**	**Discounted to Today's Price from 2030 for reds; from 2045 for greens, reduced to 10% participation now, 50% in 2030**	**Average Cost per Easement**
Red Parcels (10 total)	$53,781,942	$80,484,581	$92,557,268	$146,339,210	$ 8,704,735	$ 870,474
Green Parcels (48 total)	$59,385,014	$84,529,363	$97,208,767	$156,593,781	$ 28,617,688	$ 596,202
Total (Low Estimate) 58 properties					**$ 37,322,423**	**$ 643,103**
Total (High Estimate - High Legal Costs) 58 properties					**$ 55,983,635**	**$ 965,517**

6.4 KEYPAD POLLING RESULTS FROM COMMUNITY WORKSHOP #3

Islamorada Matters - Keypad Polling Results from the COAST community modeling exercise conducted December 11, 2014 at the Founders Park Community Center in Islamorada, FL

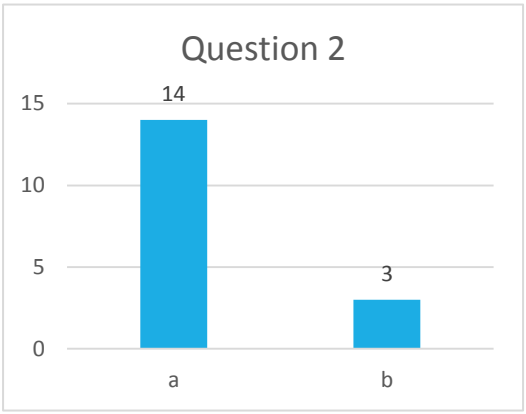
Floodproof & Elevate: 1. Given the results of the COAST model do you think this action deserves further study by Islamorada?

1	a	**Yes**
	b	No



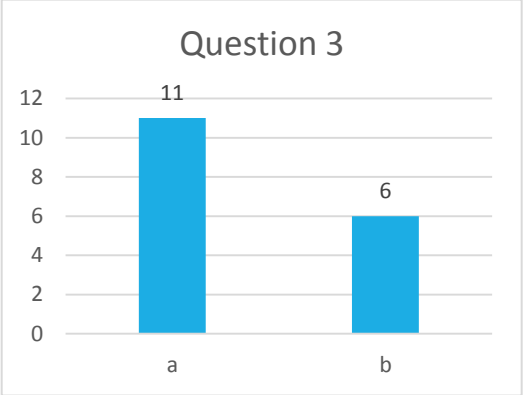
Floodproof & Elevate: 2. Do you think Islamorada should require elevations of structures in Islamorada after they are damaged by more than 50% by a storm surge event, to a higher level than the current code requires? (Such as the 100 year flood height plus 2 or 3 feet, versus just the 100 year flood height, as required today?)

2	a	**Yes**
	b	No



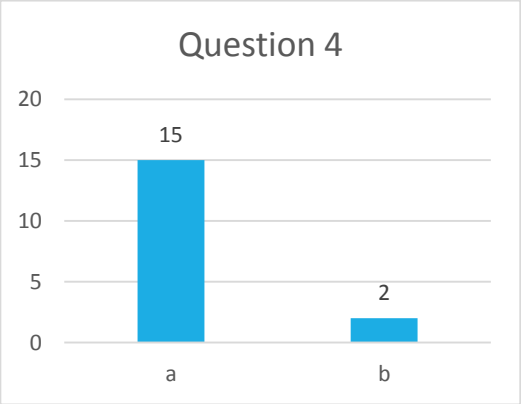
Floodproof & Elevate: 3. Do you think Islamorada should pursue sources of funding to help private property owners elevate properties located in the FEMA V-zone, as a way to prevent storm surge damage?

3	a	**Yes**
	b	No



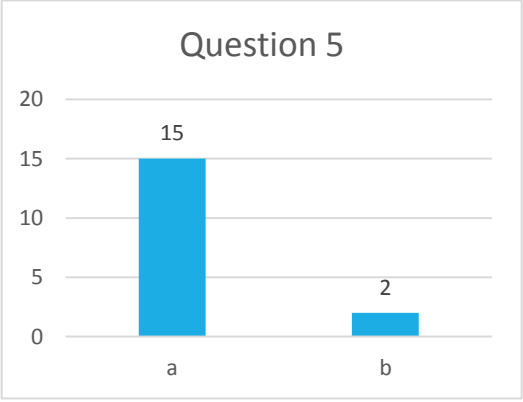
Floodproof & Elevate: 4. Do you think Islamorada should pursue sources of funding to help private property owners flood-proof their properties located in the FEMA A zone, as a way to prevent storm surge damage?

4	a	**Yes**
	b	No



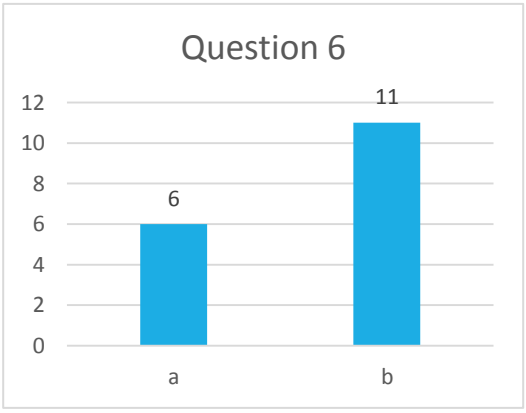
Floodproof & Elevate: 5. After looking at the model results, and participating in the group discussions of the three (3) actions modeled, do you like this one the best?

5	a	**Yes**
	b	No



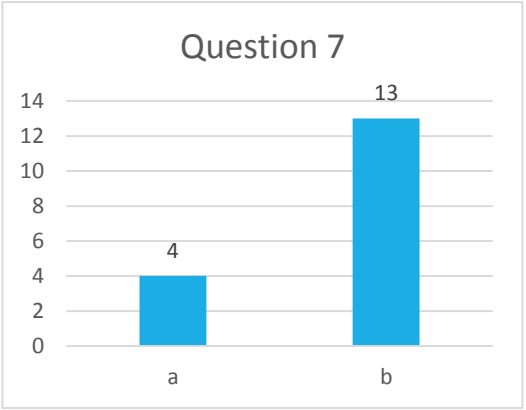
Construct Breakwater: 6. Given the results of the COAST model, do you think this action deserves further study by Islamorada?

6	a	Yes
	b	**No**



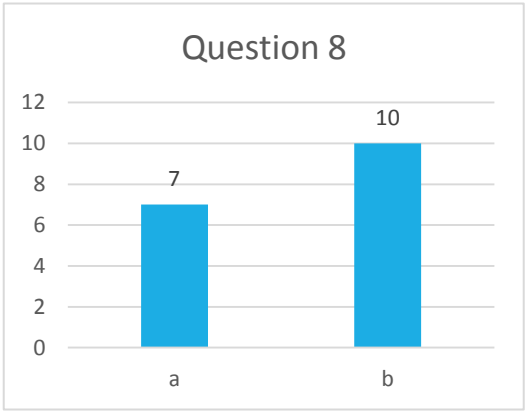
Construct Breakwater: 7. Given that there may be local, state and/or federal regulations constraining such breakwaters from being constructed in the areas shown, do you think Islamorada should spend any effort to change laws or rules to facilitate such projects?

7	a	Yes
	b	**No**



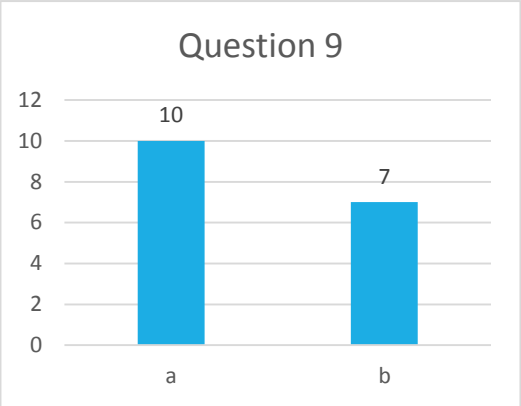
Construct Breakwater: 8. Do you think Islamorada should pursue sources of funding to construct limestone/mangrove breakwaters to protect homes from storms?

8	a	Yes
	b	**No**



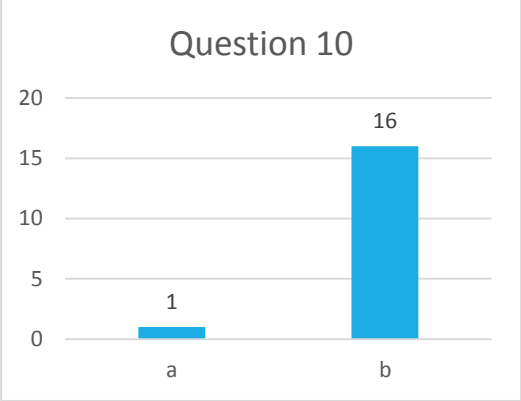
Construct Breakwater: 9. Do you think Islamorada should pursue identification of resources at risk from storm damage for which breakwaters might have a favorable benefit-cost ratio?

9	a	**Yes**
	b	No



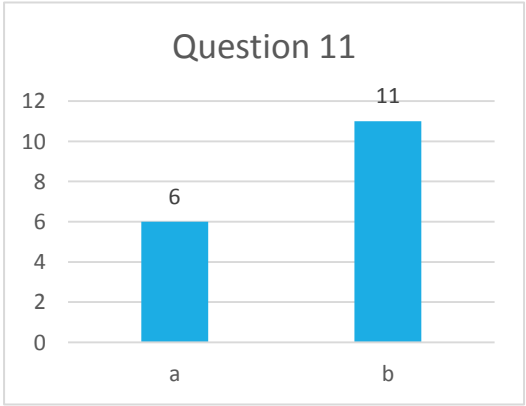
Construct Breakwater: 10. After looking at the model results, and participating in the group discussions of the three (3) actions modeled, do you like this one the best?

10	a	Yes
	b	**No**



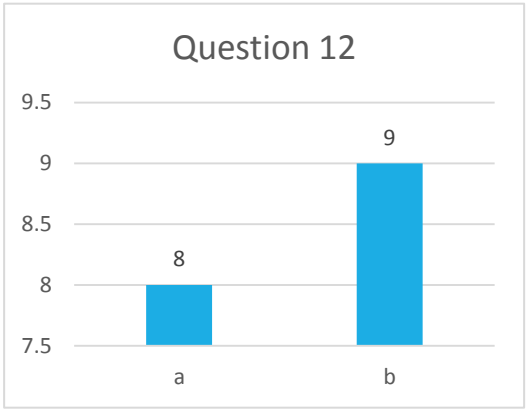
Relocate Over Time: 11. Given the results of the COAST model, do you think this action deserves further study by Islamorada?

11	a	Yes
	b	**No**



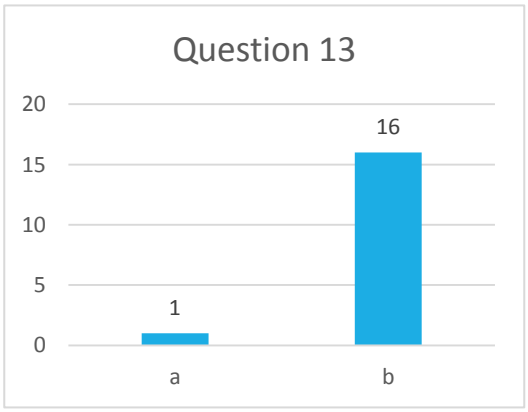
Relocate Over Time: 12. Do you think Islamorada should pursue sources of funding to support a voluntary rolling easement purchase program, similar to what was modeled in this study?

12	a	Yes
	b	**No**



Relocate Over Time: 13. After looking at the model results, and participating in the group discussions of the three (3) actions modeled, do you like this one the best?

13	a	Yes
	b	**No**



6.5 COMMUNITY PRESENTATION AND WORKSHOP MINUTES

6.5.1 Islamorada Matters Community Workshop #1 – October 7, 2014

In attendance: Mayor Ted Blackburn, Vice Mayor Deb Gillis, Councilman Ken Philipson, Councilman Dave Purdo, Village Manager Maria Aguilar, Village Attorney Roget Bryan, Assistance Village Manager Shane Lakkso, Consultant Erin Deady, Consultant J.T. Lockman, Consultant acting as Recording Secretary Mitty Barnard, Panel Member Joe Roth, Panel Member David Makepeace, Panel Member Ana Zalesky, additional Village Staff Members and members of the community

A. Shane Laakso Introduction – 5:37pm

- Pledge of allegiance
- Brief history of how IslamoradaMatters project came about
- Introduced partners involved in project
- Turned it over to Erin Deady

B. Erin Deady Brief Overview – 5:40pm

- Turned over to JT Lockman 5:45pm

C. JT Lockman Presentation – started at 5:45pm

- Piermont example:
  - JT's vulnerability assessment slide –
    - Audience Question – Are the estimates based on real time dollars or future dollars?
  - Presentation ended 6:17pm
  - Question & Answer session opened 6:17pm
    - How do you deal with future growth? You can increase building values over time if you know that things are going to be built, software has capability to do this
    - Has he worked scenario attempting to build levy? JT says he has not worked on anything like that, only time levy will work is when federal government pays for it (cities and counties won't have funds to do that)

D. Panel Discussion started 6:20pm

- Question 1 – from your perspective, what do you think the biggest concern is with regard to sea level rise within the Village of Islamorada?
  - Panelist Joe Roth – damage to commercial structures, loss of life
  - Panelist David Makepeace – as homeowner his concern is erosion, landscaping issues for normal sea level rise because vegetation cannot handle salt; property value
    - As biologist – whole new succession of vegetation will occur, loss of hammock, reef impacts that won't rise with the sea level, storms won't break on the reef like they do now, mangroves won't be same kind of buffer they are now
  - Panelist Ana Zalesky – agrees with Joe Roth on safety issue; concern is property values and what is to become of them – can they be fortified, will we be able to save all of them?
    - Erin Deady says might need tools for financing

  - Panelist Mayor Ted Blackburn – very optimistic because of Southeast Florida Regional Climate Change Compact (SEFRCCC); last week's conference in Miami Beach provided example of storm surge, having dramatic effect of sea and fresh water coming together; but in Keys there are tides that protect us – but concerned about initiative and whether community can look at them and figure out something to do about the seas rising – are we going to take steps to mitigate? Near term council will have to look at these issues, but there are things that we can do now to buy time – need to start now – his major concern that we are talking about it but might not be willing to take the necessary steps
- Question 2 – similarities with Piermont?
  - Panelist David Makepeace – need to set own baseline data to add into the scenario going forward (so that 2 feet from where has reference); need to use assessed value since only thing that will remain consistent regarding property values; need to figure out a factor (assessed value vs. sale value) to use; Cost-Benefit Analysis (CBA) individual and infrastructure/government CBA is helpful – good to have both since public doesn't have typical access to government info – side comment is that perception is the reality (we need to prepare without scaring tourists and future homebuyers) – need to keep emphasizing this to the community so not scaring people
  - Panelist Joe Roth – similar most in the peninsular aspect, everything is coastal here too; from commercial property owner/homeowner side we need multi-prong approach (flood proofing structures) – walling is not going to be useful; different because we have a lot of runoff happening; he also likes blended property value (factor/multiplier included)
  - Panelist Ana Zalesky – says different because Piermont is a river community with dredged land; walling is not an option for us here, we are built on a rock (not dredged)
  - Panelist Mayor Ted Blackburn – differences? Started by touching on insurance – FEMA analysis to determine what to charge residents – but we need to show that we are being proactive to take hardening steps (could result in financial benefit for all of us); talked about Sea Oats Park that breaches during all storm events; 200 yards on left from that the mangroves are almost underwater and the road is right there – we have to have the right data to make the correct decisions going forward; resaid he is optimistic that we can come up with good solutions
- Question 3 – unique characteristics of Islamorada?
  - Panelist David Makepeace – some of the most valuable property in the Keys are in harm's way to rising water and nuisance tides (waterside rests, resorts) – moving forward those places need our help in terms of CBA to determine what to do moving forward; different – don't have large land masses that we are backed up against with high elevations – water can run around the Keys so not subject to storm surge – but porosity is an issue after storms; permitting issues - need to revise stormwater master plan to address what will happen
  - Panelist Ana Zalesky – local economy relies on the water so important to look at what is going to happen so we can help ourselves as much as possible – since so dependent on water; how the locals live. Influx of second homes but locals see it different than those in Piermont – here most people live here and work here, makes it more important to our economy
  - Panelist Joe Roth – need to take into account, Piermont has a lot more elevation but here we don't have option to relocate – need to keep resorts on water not on US1 (or people won't come here); residential concern/tax base concerns that several areas that were built on fill dirt that didn't previously exist – substantial economic value in those

areas that are very vulnerable to ground washing out from underneath them – make canals shallower, shore up docks, walls – also stormwater issue because of nature of fill areas

- Panelist Mayor Ted Blackburn – loved what Joe Roth said, have to look at totality of where we are, gave example of Lower Matecumbe Key – Sea Oats beach is low and breaches but because it does, the areas of Port Antigua survive since there is less of a storm surge (other places where not same flow have much worse flooding); Upper Matecumbe Key is rock – can you put tunnels between ocean and bay? – would that preserve recreate flow? (he doesn't know); we are unique but there are ways to find solutions to keep us around for longer than we think; mentioned Hemingway article after 1935 wipeout – 400 veterans came here to rebuild but residents are here by choice – same with today's residents, they choose to live here despite the perils though we must make efforts to stall and buy time

- Erin Deady's recap – she heard the following concerns: limited land envelop, limited ability for growth, fill issue, canal systems issues/solutions
- Session ended 7:01pm for 5 minute break

E. Public Comment Period – Erin Deady started back up at 7:16pm

- Erin Deady turned presentation over to JT Lockman
- Using same numbers Jason Evans presented last month for infrastructure 3-7" by 2030 or 9-24" by 2060 – JT Lockman to use same numbers –
    - no objection from public
- Using Monroe County parcel data; surges from all years 10,25, 50 (2005 study is best we have) –
    - 12 runs of the model will be done total – proposing to show damage from 8 single storms
    - Erin Deady explained difference between nuisance flooding (1.08') and Wilma storm event (6')
    - Once results are obtained, then extrapolate places in between or times in between
    - Doing whole area rather than select areas – though more consistent based on infrastructure work being done by Jason Evans
    - Comments on dates, storms being modeled
        - Public (Sue Miller) – as water rises, effect is different because of reef height and mangroves - observation is drastic difference in effect of hurricanes if come from Bay or Ocean side – is that being considered? No, when you make models, you have to simplify things – results that are overestimated will balanced with those that are underestimated, model doesn't factor wind, just using FEMA numbers of how high water will rise – can do more complicated water modeling that takes into account wind, shape of bottom, wave shape but would cost million for the Keys
            - Panelist David Makepeace comment – if Wilma-type flood worst on Ocean side is 6 feet and worst on Bay side is 6 feet – surges not seen greater than that – if 10 feet surges, no hardening options will work
        - Councilman Ken Philipson – interested in seeing total Islamorada modeled, not just a specific portion in Islamorada
    - Elevation of mean high tide – using Vaca Key gauge, explained mean higher high water (MHHW) data since they have that at Vaca Key, using that as the starting point –
        - No Comments from public

- Subsidence – JT Lockman said not really an issue, mostly in other areas, so we are not proposing to use and subsidence data in model –
  - No Comments from public
- Location of 100 year flood zone – proposing to use 2005 flood maps, divide the Village into subareas to look at all parcels with particular flood height, will then do separate runs of the model based on different characteristics; will likely divide Village into 8 different areas so 12 runs of 8 = 96 total runs of the model
  - No Comments from public
- Surge height , flood insurance data – using 2005 flood insurance study –
  - No Comments from public
- Topography – obtained LiDAR data (measured every 3 feet to within 2-3 inch accuracy); proposing to use 5 meter data (measured every 15' to same accuracy)

- JT Lockman asked the audience if anything bothering them so far, if they would do anything different?
  - Deb Gillis said 300 ft property with 10' height variance on her property – questioned if same elevation every 15' is accurate enough – JT Lockman explained that it was
  - Panelist Joe Roth – asked how are we going to value? Transcends so many issues
    - JT Lockman says use digital tax map for buildings and lots; first thing is Jason Evans has worked with tax assessors to make sure everything is properly classified by use, also put in year built for each building, can then assign different depth damage function to each property
    - JT Lockman says one decision to make here is about property values – use assessed value or apply sales ratio with a multiplier?
      - Up to the audience as to what they want? What does the audience want?
        - Public responses:
          - Panelist Ana Zalesky says definitely apply 15-20% to assessed value (because assessed values are is running lower on average)
          - Panelist David Makepeace says we don't need to set number – but wants to see some multiplier because if the assessed values are off, that will make a big difference in CBA in determining what to do going forward – especially in commercial and public properties - says assessed values are not accurate and lag behind market value (Erin Deady says 115% is best data so far – Panelist Ana Zalesky asked if this pertained to residential or commercial or both – Erin Deady said she needs to follow up but the 115% is aggregate number
          - Seems to be consensus that there needs to be a multiplier but not much public comment on by how much
          - Panelist Mayor Ted Blackburn says they use total assessed appraised value to determine value of village – they discovered in last 4 years is that there is a 2 yr lag on that – after end of recession it took 2 years to reflect end of recession – he says 10-15% sounds ok but

doesn't know how to quantify the 2 year lag in data if you use the assessed values – says we need to use multiplier but doesn't know what it should be

- JT Lockman says this could be a project for staff – if you have last 5 years of sales and 5 years of assessed values – could determine the ratio with actual data
    - Someone (Ken Philipson) in audience public said don't do that calculation because then you get into lag issue – just need to pick
    - Deb Gillis asked how many people Erin Deady had consulted – Erin responded three (3) total
        - She then asked if consistent across entire Keys or just Islamorada – Ana Zalesky says across keys that it is 15-20%
        - Panelist David Makepeace said we want higher number, some ground proofing is good – he is comfortable with 15% since somewhat close to real values when doing CBA
    - Erin Deady suggested more ground truthing within a certain range – if we fall within range then people will feel ok about the percentage
    - Panelist David Makepeace asked what the average home sales in Islamorada is - 50 or 100? – so small sample size to extrapolate from
    - Panelist Mayor Ted Blackburn said a lot of factors go into it – if you do aggregate then we would at least have a base to work off of
        - Panelist Ana Zalesky talked about homestead exemption making assessed values low
- Consensus of audience agreed to 115% multiplier

- Depth damage function – 1996 and 1992 reports to be used
    - Panelist David Makepeace asked about stilt homes – is it water at the stilts or water in home? – JT Lockman said its water at the stilts
    - Erin Deady said we spent time with property appraiser to spot check year of construction and elevations to deal with elevation issue
- JT Lockman discussed next public meetings in November and December and what will each will entail
- JT Lockman opened for public comment and questions at 8:04pm
    - Questions/comments:
        - Cost analysis is based strictly on structure in village? Yes this will be model of possible damage to buildings
        - No other comment or questions from public
- Workshop ended at 8:09pm

6.5.2 Islamorada Matters Community Workshop #2 – November 10, 2014

In attendance: Mayor Ted Blackburn, Vice Mayor Deb Gillis, Councilman Ken Philipson, Councilman Dave Purdo, Village Manager Maria Aguilar, Assistance Village Manager Mary Swaney, Senior Planner Shane Laakso, Planning Director Cheryl Cioffari, Consultant Erin Deady, Consultant J.T. Lockman, Consultant Chris Burgh, Consultant Jason Evans and members of the community.

Workshop started at 5:39 PM

1. **Erin Deady Introduction** – started at 5:39 PM
   - Discussed purpose of meeting
   - Turned over to J.T. Lockman at 5:42 PM

2. **J.T. Lockman Presentation** – started at 5:42 PM
   - Review of sea level rise tool model
     - Parcel valuations
     - Sea level rise scenarios (4-County Compact)
     - FEMA flood levels
     - Land elevations (LiDAR)
   - Review of "no-action" results
   - J.T. takes questions at 5:58 PM
     - Audience member asked if damage results include roads.
     - J.T. answered that the model only used building values; not roads, or sewage pipes.
     - Erin Deady responded by saying that the village is looking at other infrastructure impacts and those results were presented to the village in September.
     - Audience member asked if the number are broken down to tax loss to the village.
     - J.T. answered that the answer could be determined from market value of the building (market value divided by 1.15, then multiplied by the mill rate).
     - Audience member asked if cumulative damage is based on today's assessed value.
     - J.T. answered with yes.
     - Audience member commented by saying that even with discounting future dollars things probably wouldn't look any better.
   - J.T. continues presentation at 6:05 PM
   - Presents images of modeled flooding from storms and sea level rise.
   - Reviews next steps for modeling adaptation strategies.
   - J.T. takes questions about visuals at 6:12 PM.
     - Audience member commented that some parcels that are not on the tax roll will be inundated as well.
     - J.T. agreed.
     - Audience member asked how they can get access to the visuals to show other people in town the potential risks; so more community members are involved in this planning process.
     - J.T. responded by saying that Erin Deady is coordinating the effort to share the information.

- Erin Deady said that they will be emailing and posting results on the website.
- The same audience member clarified their question by asking if the information will be available on a parcel-by-parcel basis to the general public. Will there be a number can people can call to find out their personal risks?
- Erin responded by saying that the model aggregates all the parcels into one number so people will not be defensive about what is being conveyed economically, but did say they can work on following up with people but right now that information is not available.
- Audience member commented that he works for the Nature Conservancy and that his organization has put together maps with different sea level rise scenarios so people can see their individual properties.
- J.T. commented that the Nature Conservancy's maps will illustrate different flooding scenarios, but it's not going to calculate damage or cumulative damage from those events.
- Audience member commented that maybe simplicity (the Nature Conservancy's tool) is better at these early planning stage.
- Erin commented that they would make available the Nature Conservancy's tool on the website (link to it) and then hands it over to at 6:19 PM.

3. **Jason Evans Presentation** – started at 6:20 PM
   - Review of actions others around the world are taking to combat sea level rise.
     - Do nothing
     - Fortify
     - Accommodate
     - Relocate
     - Pros and cons of various actions
   - Turns it over to Chris Burgh at 6:34 PM

4. **Chris Burgh Presentation** – started at 6:34 PM
   - Presents information about natural barriers.
     - Benefits to infrastructure and natural environment
     - Reviews voting choices during break-out session:
       - Onshore, near-shore or off-shore
       - Submergent, at the waterline, or emergent
     - Reviews actions being taken in other parts of Florida
     - Reviews voting options for elevating and flood-proofing properties:
       - Height of elevation
       - Percent of properties adapted
     - Reviews voting options for relocation (rolling easement):
       - Percent of parcels that would accept buyouts
   - Erin hands out summaries of strategies and choices.
   - Erin goes over the agenda for the breakout sessions and ends the presentation at 6:54 PM

5. **Roundtable Discussions** – started at 7:00 PM
   - Group was divided into three (3) groups according to numbers assigned at check-in
   - Each group discussed the proposed action at each station: Elevation & Floodproofing; Construct Breakwater; and Voluntary Relocation over time
   - In each discussion, the group discussed possible refinements or modifications on how the action could be modeled

6. **J.T. Lockman** Runs Keypad Polling on Adjustments to Modeled Adaptation Actions – started at 8:08 PM
   - Instructions for using the keypad polling devices
   - Starts polling for adaptation actions
   - Results for future modeling from keypad polling:
     - **ELEVATE AND FLOODPROOF**
     - 50% of properties in V-Zone elevated
     - 100% of properties in A-Zone floodproofed
     - Elevate properties to current code plus 2 feet
     - Floodproof properties to 8 feet
     - Yes – model this action
     - **NATURAL BARRIERS**
     - Emergent structure
     - Audience member commented that an on-the-shore structure (which won the polling) would impact tourism since people wouldn't be able to see the ocean. The polling was re-run and the audience chose to place the structure near-shore.
     - Yes – model this action
     - **RELOCATE (BUYOUT OPTION)**
     - 10% of properties flooded by 2030 accept the voluntary buyout in 2015
     - 50% of properties flooded by 2045 accept the voluntary buyout in 2030
     - Yes – model this action
   - J.T. ends keypad polling at 8:37 PM

7. **Workshop ends** at 8:37 PM

6.5.3 Islamorada Matters Community Workshop #3 – December 11, 2014

In attendance: Vice Mayor Deb Gillis, Village Manager Maria Aguilar, Senior Planner Shane Laakso, Assistant Village Manager Mary Swaney, Building Official Gerry Albertson, Senior Building Inspector Phil Moretta, Consultants Erin Deady and J.T. Lockman. Also in attendance were former Council members: Ted Blackburn, Dave Purdo and Ken Philipson.

Workshop started at 5:36 P.M.

1. **Shane Laasko**– started at 5:36 P.M.
   - Welcome and introduction
   - Meeting agenda
   - Review of workshops and overall sustainability plan project
   - Turns it over to JT Lockman at 5:41 P.M.

2. **JT Lockman Presentation** – started at 5:41 P.M.
   - Review of COAST software
   - Review of inputs for modeling
     - 3 in. (low) and 7 in. (high) by 2040
     - 9 in. (low) and 24 in. (high) by 2060
     - FEMA Flood Insurance Study (10yr, 50yr, 100yr storm surge estimates)
       - Wilma-sized flood for 100yr and king tide for nuisance flooding
     - Review of "No-Action" scenario results for cumulative damages over time
       - $2.7 billion in damages by 2060 under high sea level rise scenario
       - $1.7 billion in damages by 2060 under low sea level rise scenario
     - Review of adaptation actions modeled after community voting in Meeting #2
       - Elevate and floodproof buildings
       - Construct a breakwater
       - Voluntary property buyouts/relocation
     - Audience member asked who is "we" in reference to JT saying "we would pay folks to vacate their homes"
     - JT responded by saying that the models assume someone would pay for these actions but the level(s) of government that would administer the actions is not known. If it turns out the action is a good fiscal idea, then the community can begin to look for money to do that action.
     - Audience member asked at 6:00 P.M. where the people were who voted. He didn't think they were located in the keys. He also said that he had to leave early so he didn't know there was polling during the meeting.
   - Erin Deady open the floor for more questions at 6:02 P.M. for people who may have missed the previous meeting
     - Audience member asked if these were the strategies that the county voted on
     - Erin responded that the county was looking at different parameters
     - Audience member commented that the polling results were just the collective feelings of the group about what Catalysis should model. There was no large survey across the village. Just collective thoughts from the people in the room.

  - Audience member asked for clarification about what the properties in red and those in green signified
  - JT responded by saying that in Action 1 the parcels in red were those that were located in the V-Zone and had buildings that were not elevated. The parcels that were green were those that were located in the A-Zone and had buildings that were not floodproofed.
  - Audience member asked how people voted.
  - Audience member responded by saying that it was done electronically and anonymously
  - Audience member asked if the model scenario used money to buy people out of their homes, or raise their homes
  - JT responded by saying that Action 1 was to raise homes, Action 2 was to build a breakwater and Action 3 was to buy people out of their homes
- JT continued is presentation at 6:07 P.M.
  - Went over the avoided damages by elevating and floodproofing houses
    - $890 M avoided under low sea level rise and $1.2 B avoided under high sea level rise
  - Went over the avoided damages by constructing a breakwater
    - $12.8 M avoided under low sea level rise and 13.2 M avoided under high sea level rise
  - Went over the avoided damages by relocating people away from vulnerable properties
    - $26.8 M avoided under low sea level rise and $4.5 M avoided under high sea level rise
  - Audience member asked about the roads
  - JT responded by saying that what was modeled on his end were the building damages and that the roads were another part of the project that Erin would speak about
  - Erin then responded by saying that the county looked at infrastructure (sewer, water, roads) and presented those findings to the village council in September and those reports are available online
  - Audience member commented that the new sewer line is already obsolete and has salt water intrusion problems and that people need to be more forward thinking
  - Council member commented that the pump stations were raised for sealevel rise, and the sewer system is sealed. Also the cost to resurface the roads is 1/10th the cost to raise and rebuild the road
- JT continued his presentation at 6:16 P.M.
  - Went over costs for adaptation strategies modeled
    - High and low estimates
  - Went over benefit-cost ratios for adaptation strategies modeled
    - Elevating and floodproofing had the best benefit-cost ratio
    - Constructing the breakwater had a positive benefit-cost ratio but was not as high as elevating and floodproofing houses

        - Voluntary buyouts had a benefit-cost ratio less than 1 (poor)
- JT opened the floor for questions at 6:25 P.M.
    - Audience member asked about the $1.2 M in savings for elevating and floodproofing but asked how that relates to the $1.2 B in damages if no action is taken
    - JT responded by saying that the benefits and costs were analyzed with discounted future dollars for economic purposes.
- Erin Deady asked the audience how they think the village could use this information at 6:32 P.M.
    - Audience member asked at what point the village is no longer viable because sea levels are too high and at what point property values will start to decline
    - JT responded by saying that if by 2100 there are four (4) or five (5) feet of sea level rise there is very little that can be done.
    - Erin responded that the US 1 corridor fairs pretty well under extreme scenarios but asked if any realtors in the room could speak to when property values would fall because she doesn't know.
    - JT commented Islamorada gets more damage than Key Largo, even though Key Largo has more people, simply because Islamorada is at a lower elevation
    - Audience member asked about impacts to critical habitat and coordination between multiple levels of government
    - Erin Deady responded that this information could be used to bring multiple levels and agencies of government together to begin having discussions about solutions. But without this information those conversations can't really begin
    - Audience member commented that we don't know what the technology will be like in 2060, and that maybe we won't need certain infrastructure that is vulnerable today. He mentioned underwater homes, using waterproof rail and energy sources that don't need pipes or wires
    - Audience member commented that this analysis will help the village make decisions about new codes for building and reconstructing homes
- Erin asked at 6:44 P.M. for ways to get information about this project out to the public (emails, workshops, discussion forums?)
    - Audience member said email or newspapers
    - Audience member commented that seeing charts on the village center wall might help
    - Audience member asked how to get people who don't believe climate change is happening to see this information
    - Audience member said that it isn't so much an issue of get people who don't believe to change their minds as much as it is getting everyone the information and letting people decide what they want. It's a distribution issue, not a persuasion issue.
    - Audience member said that it's important to present this information as a future problem, so that people don't stop buying homes out of fear

- Audience member said that things just need to be approached from a positive standpoint. There are things one (and the community) can do to make their home (and the community) last longer
- JT mentioned that the reason the benefit-cost ratios are used are so that people have a better understanding about what things are feasible. It should be a positive message (the steps that can be taken)
- Audience member followed by saying that he would have wanted to see a vision for the future of the keys (floating rail and futuristic buildings)

3. **JT Lockman Initiated Keypad Polling Questions** – started at 6:52 P.M.
   - Given the results of the COAST model, do you think the action deserves further study by Islamorada?
     - 17 yes, 0 no
   - Do you think Islamorada should require elevations of structures in Islamorada, after they were damaged by more than 50% after storm surge, to a higher level than the current code requires?
     - 14 yes, 3 no
   - Do you think Islamorada should pursue sources of funding to help property owners in the V-Zone elevate buildings?
     - 11 yes, 6 no
   - Do you think Islamorada should pursue sources of funding to help property owners in the A-Zone floodproof their buildings?
     - 15 yes, 2 no
   - After looking at the model results, do you like this action the best?
     - 15 yes, 2 no
   - Given the results of the COAST model should Islamorada further study the breakwater action?
     - 6 yes, 11 no
   - Given that there may be local, state and/or federal regulations constraining breakwaters from being built, should Islamorada spend any effort to change laws or rules to facilitate such projects?
     - 4 yes, 13 no
   - Do you think Islamorada should pursue sources of funding to construct limestone breakwaters to protect homes from storms?
     - 7 yes, 10 no
   - Do you think Islamorada should pursue identification of resources at risk from storm damage for which breakwaters might have a favorable benefit-cost ratio?
     - 10 yes, 7 no
   - After looking at the model results, do you like this action the best?
     - 1 yes, 16 no
   - Given the results of the COAST model, do you think Islamorada should further study rolling easements/voluntary buyouts?
     - 6 yes, 11 no

- Do you think Islamorada should pursue sources of funding to support a voluntary rolling easement purchase program similar to what was modeled in this study?
    - 8 yes, 9 no
- After looking at the model results, do you like this action the best?
    - 1 yes, 16 no
- JT then turns it over to Erin Deady at 7:04 P.M.

4. **Erin Deady Presentation of Islamorada Matters Project** – started at 7:04 P.M.
    - Reviewed next steps for the project
        - Summarize content and inputs
        - Develop tool to survey community for goals for sea level rise adaptations
    - New project website
    - Workshop on Draft Islamorada Matters Plan to Village Council
    - Erin opens the floor for questions
        - Audience member suggested incorporating home owners associations with this process to get more buy-in and attendance
    - Erin Deady ended the presentation at 7:13 P.M.
    - Audience member added that people can sign up for village news from the village website.

5. **Erin Deady Ended Workshop** – at 7:13 P.M.