TAYLOR ENGINEERING, INC.

Lessons Learned for Using FDEP's Sea Level Rise Impact Projection (SLIP) Tool

Angela Schedel, Ph.D., P.E.
November 2, 2022

Overview

- When is a SLIP Study Required?
- Defining the Terms
- What is a SLIP Study?
- SLIP Website Overview
- Review of a SLIP Report
- Recent Website Enhancements

When is a SLIP Study Required?

- Before a **state-financed constructor** builds a **major structure** or **nonhabitable major structure** within the **Coastal Building Zone**
- SLIP studies to be published on DEP website before construction starts and DEP must maintain copies for 10 years after receipt

Definition: State Financed Constructor

- 161.551(d) "**State-financed constructor**" means a **public entity** that commissions or manages a construction project using funds appropriated from the state.
- 161.551(b) "**Public entity**" means the state or any of its political subdivisions, or any municipality, county, agency, special district, authority, or other public body corporate of the state which is demonstrated to perform a public function or to serve a governmental purpose that could properly be performed or served by an appropriate governmental unit.

- **Examples that would fall under "state financed constructors":**
  - Line item appropriations
  - Legislative projects
  - FDOT new construction
  - State Park facilities
  - Ports facilities

- **Examples that would not fall under "state financed constructors":**
  - Federal funds administered by the state
  - State Revolving Funds (SRF)

Definition: Coastal Structure

- 161.551(a) **“Coastal structure” means a major structure or nonhabitable major structure within the coastal building zone.**

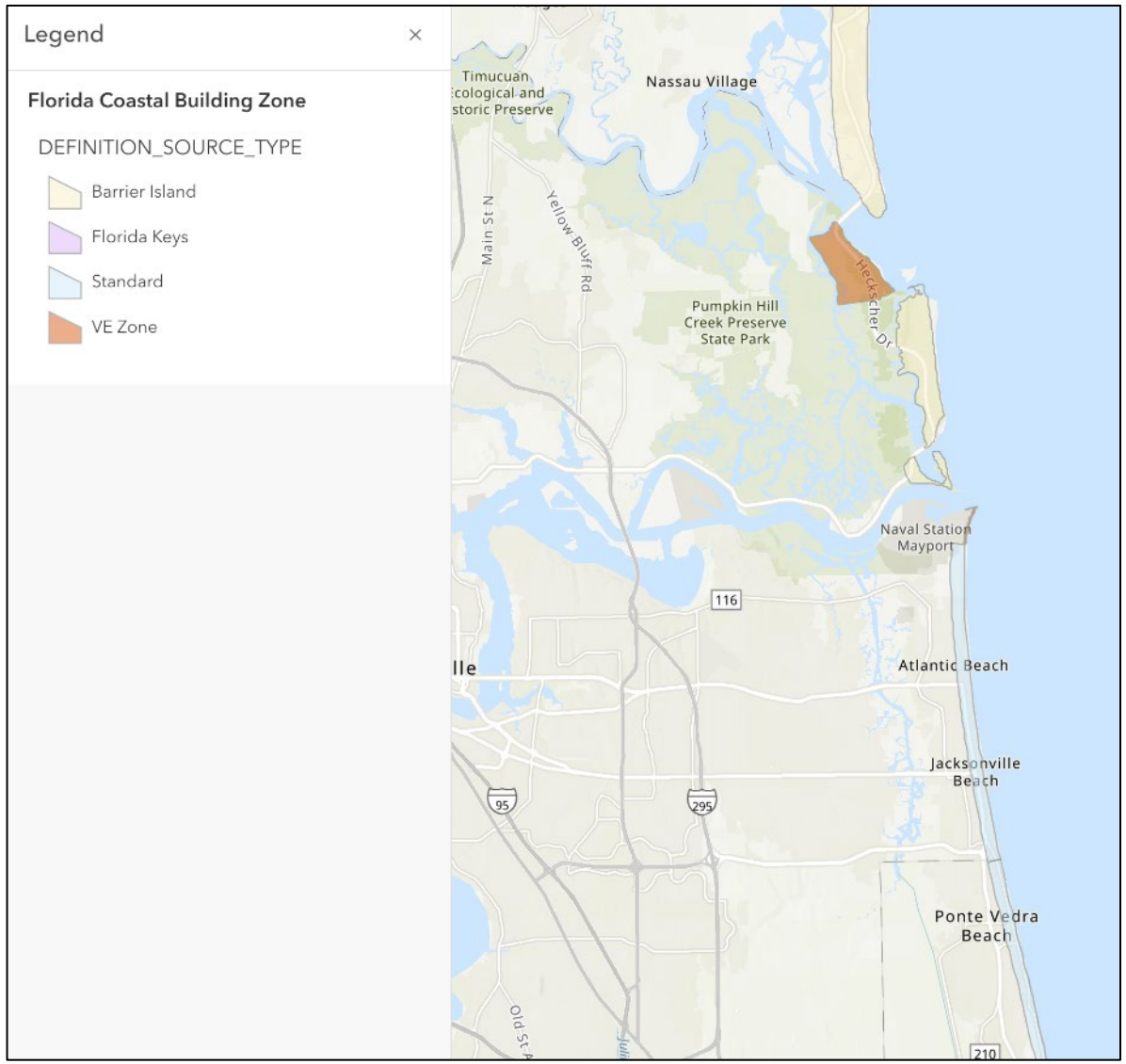
- 161.54(6)(a) “**Major structure**” means houses, mobile homes, apartment buildings, condominiums, motels, hotels, restaurants, towers, other types of residential, commercial, or public buildings, and other construction having the potential for substantial impact on coastal zones.
- (c) “**Nonhabitable major structure**” means swimming pools; parking garages; pipelines; piers; canals, lakes, ditches, drainage structures, and other water retention structures; water and sewage treatment plants; electrical power plants, and all related structures or facilities, transmission lines, distribution lines, transformer pads, vaults, and substations; roads, bridges, streets, and highways; and underground storage tanks.

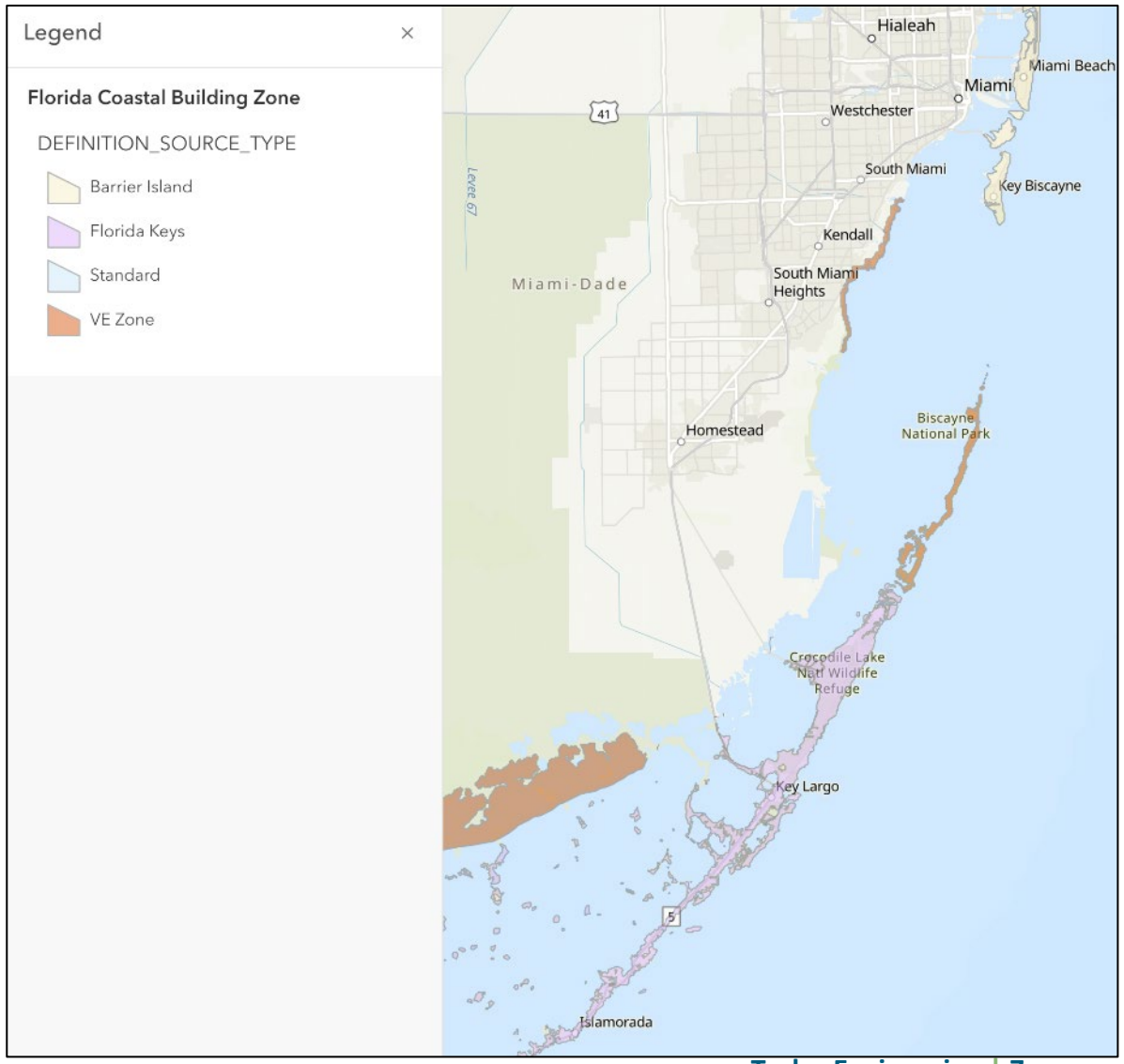
Definition: Not Defined as a Coastal Structure as per 161.551

- 161.54(6)(b) "**Minor structure**" means pile-supported, elevated dune and beach walkover structures; beach access ramps and walkways; stairways; pile-supported, elevated viewing platforms, gazebos, and boardwalks; lifeguard support stands; public and private bathhouses; sidewalks, driveways, parking areas, shuffleboard courts, tennis courts, handball courts, racquetball courts, and other uncovered paved areas; earth retaining walls; and sand fences, privacy fences, ornamental walls, ornamental garden structures, aviaries, and other ornamental construction. It shall be a characteristic of minor structures that they are considered to be expendable under design wind, wave, and storm forces.
- (d) "**Coastal or shore protection structure**" means shore-hardening structures, such as seawalls, bulkheads, revetments, rubble mound structures, groins, breakwaters, and aggregates of materials other than beach sand used for shoreline protection; beach and dune restoration; and other structures which are intended to prevent erosion or protect other structures from wave and hydrodynamic forces.

Definition: Coastal Building Zone

- Defined in previous statutes: 161.54(1) and 161.55(4)





Definition: Coastal Building Zone - Standard

- 161.54(1) "Coastal building zone" means the land area from the **seasonal high-water line landward to a line 1,500 feet landward from the coastal construction control line** as established pursuant to s. 161.053,

<u>Coastline without a CCCL:</u>

- …and, for those coastal areas fronting on the Gulf of Mexico, Atlantic Ocean, Florida Bay, or Straits of Florida and not included under s. 161.053, the land area **seaward of the most landward velocity zone (V-zone) line** as established by the Federal Emergency Management Agency and shown on flood insurance rate maps.

Definition: Coastal Building Zone- Barrier Island

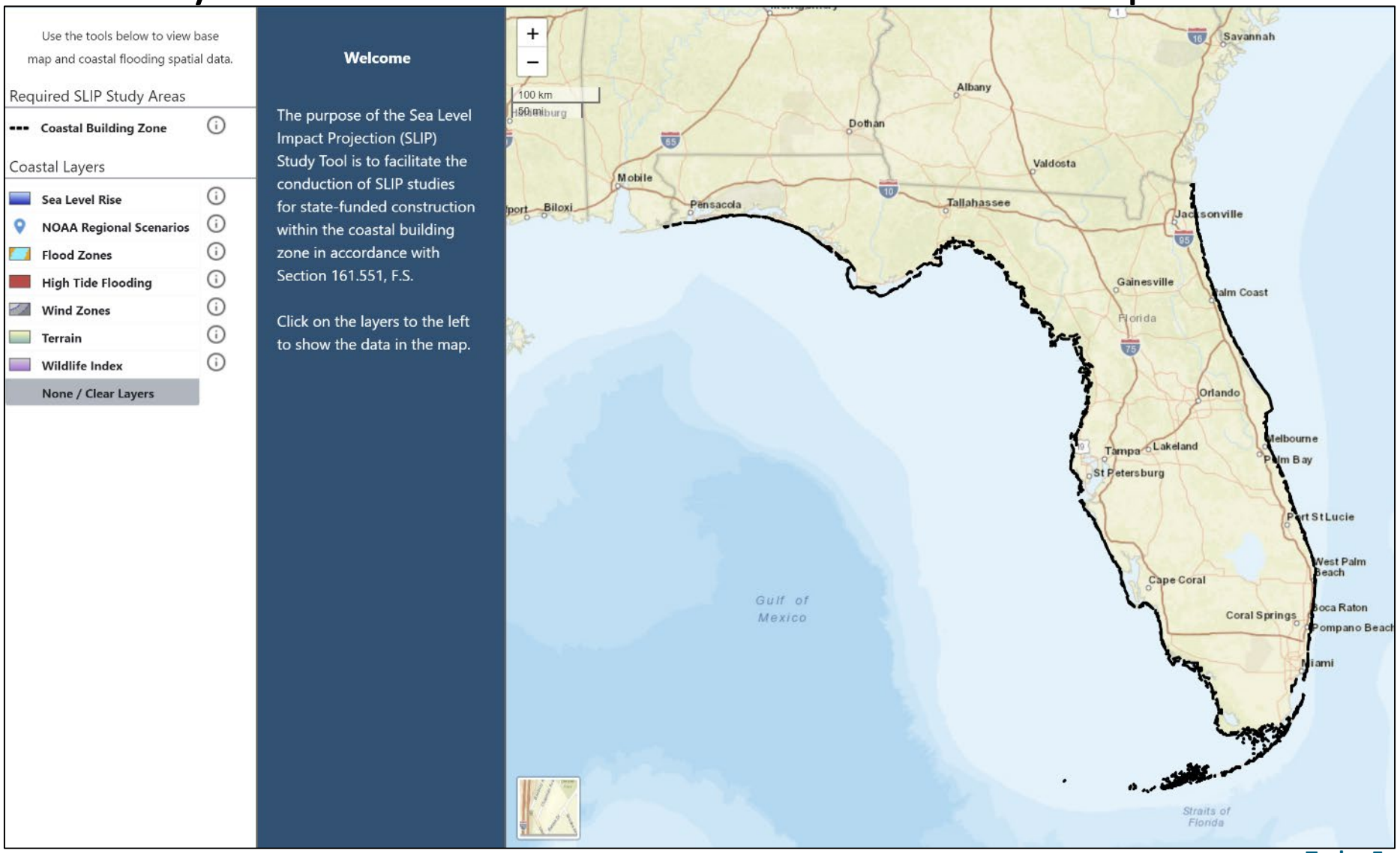
- 161.55(4) ... The coastal building zone on coastal barrier islands shall be the land area from the **seasonal high-water line to a line 5,000 feet landward from the coastal construction control line** established pursuant to s. 161.053, or the entire island, whichever is less….

Coastline without a CCCL:

- For coastal barrier islands on which a coastal construction control line has not been established pursuant to s. 161.053, the coastal building zone shall be the land area **seaward of the most landward velocity zone (V-zone) boundary line** fronting upon the Gulf of Mexico, Atlantic Ocean, Florida Bay, or Straits of Florida. …
- **All land area in the Florida Keys located within Monroe County** shall be included in the coastal building zone.

Definition: Coastal Building Zone

- FDEP GIS Layer of CBZ can be viewed on SLIP Tool Map

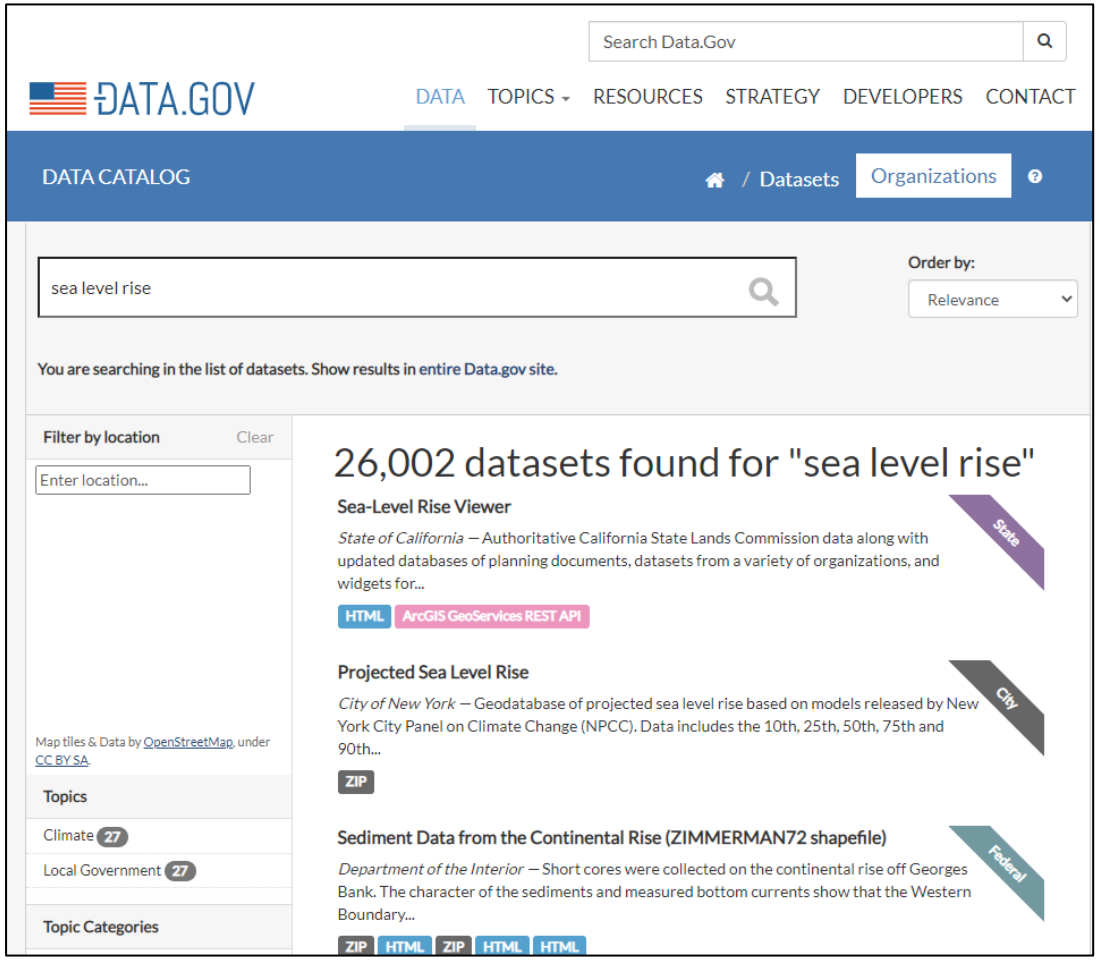


What is a SLIP Study?

- Use a **systematic, interdisciplinary, and scientifically accepted approach** in the natural sciences and construction design in conducting the SLIP study
- Assess the **flooding, inundation, and wave action damage risks** relating to the coastal structure over its expected life or 50 years, whichever is less
- Provide **alternatives for the coastal structure's design and siting**, and how such alternatives would impact certain public safety and environmental risks as well as the risk and cost associated with maintaining, repairing, and constructing the coastal structure

Data Sources in SLIP Tool

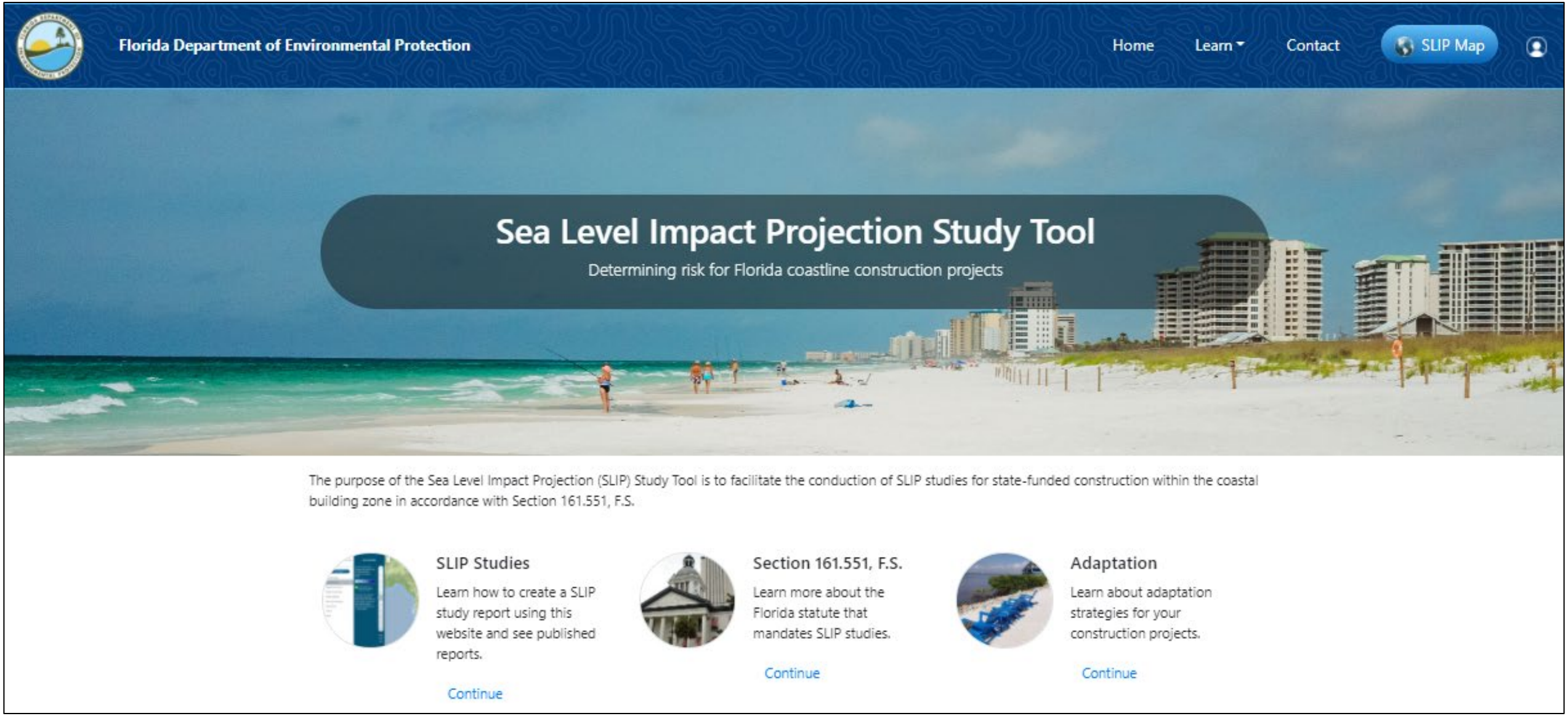
- NOAA Sea Level Rise viewer
- NOAA Regional SLR Scenarios
- NOAA High Tide Flooding Estimates
- FEMA Storm Surge Flood Depths (1% annual chance to 10% annual chance)
- FEMA Special Flood Hazard Zones
- NFWF Wildlife Index
- FL Building Codes - Maximum Winds
- USACE Depth Damage Functions
- NOAA/EPA Adaptation Measures



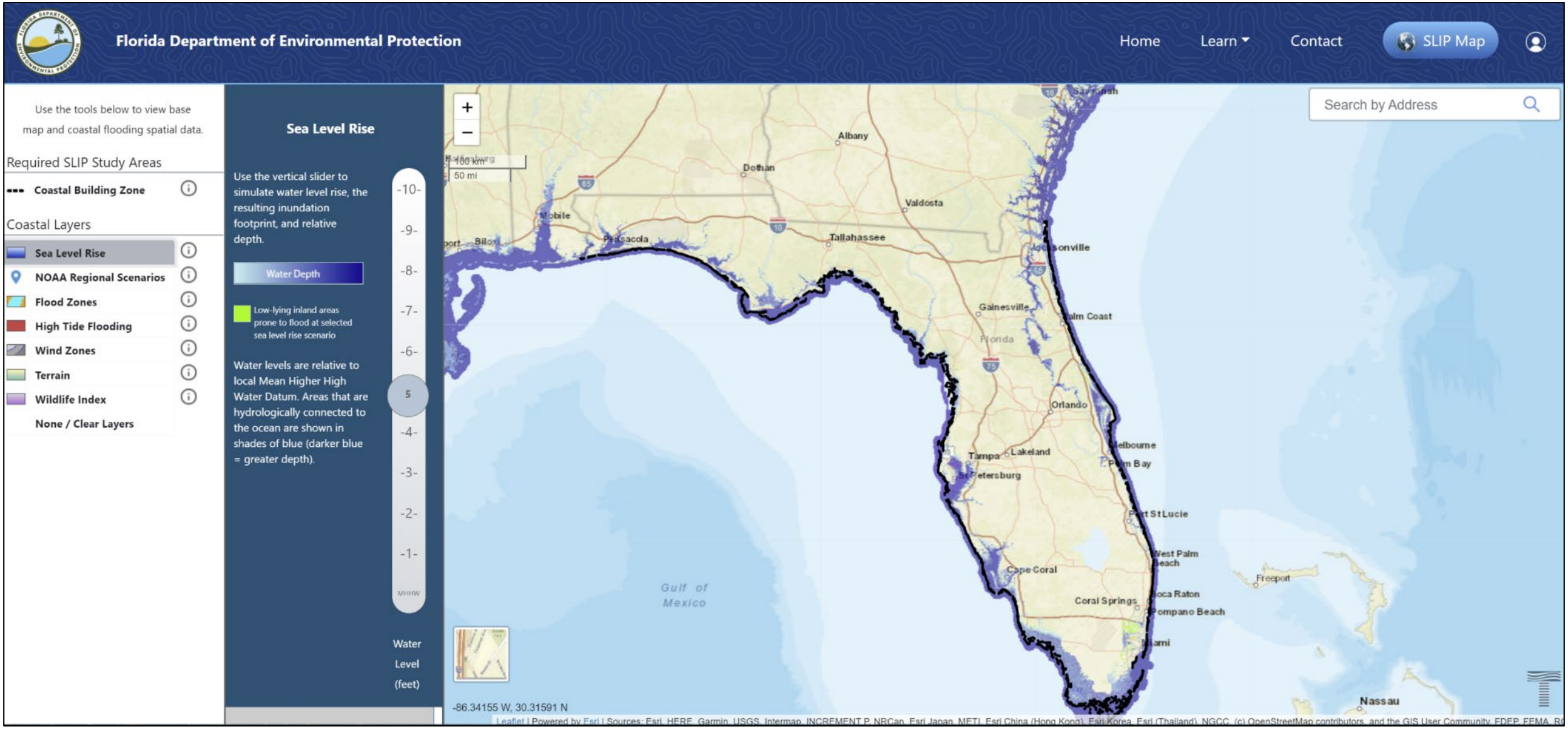
FDEP's Goals for SLIP

- #1 – User-friendly
- Mapping tool for viewing by general public
  - Illustrates risks using credible data
  - Informative in nature
- SLIP Report Creation
  - Secure sign-in for public entities
  - Minimal inputs needed by user
  - Quick generation of SLIP Report

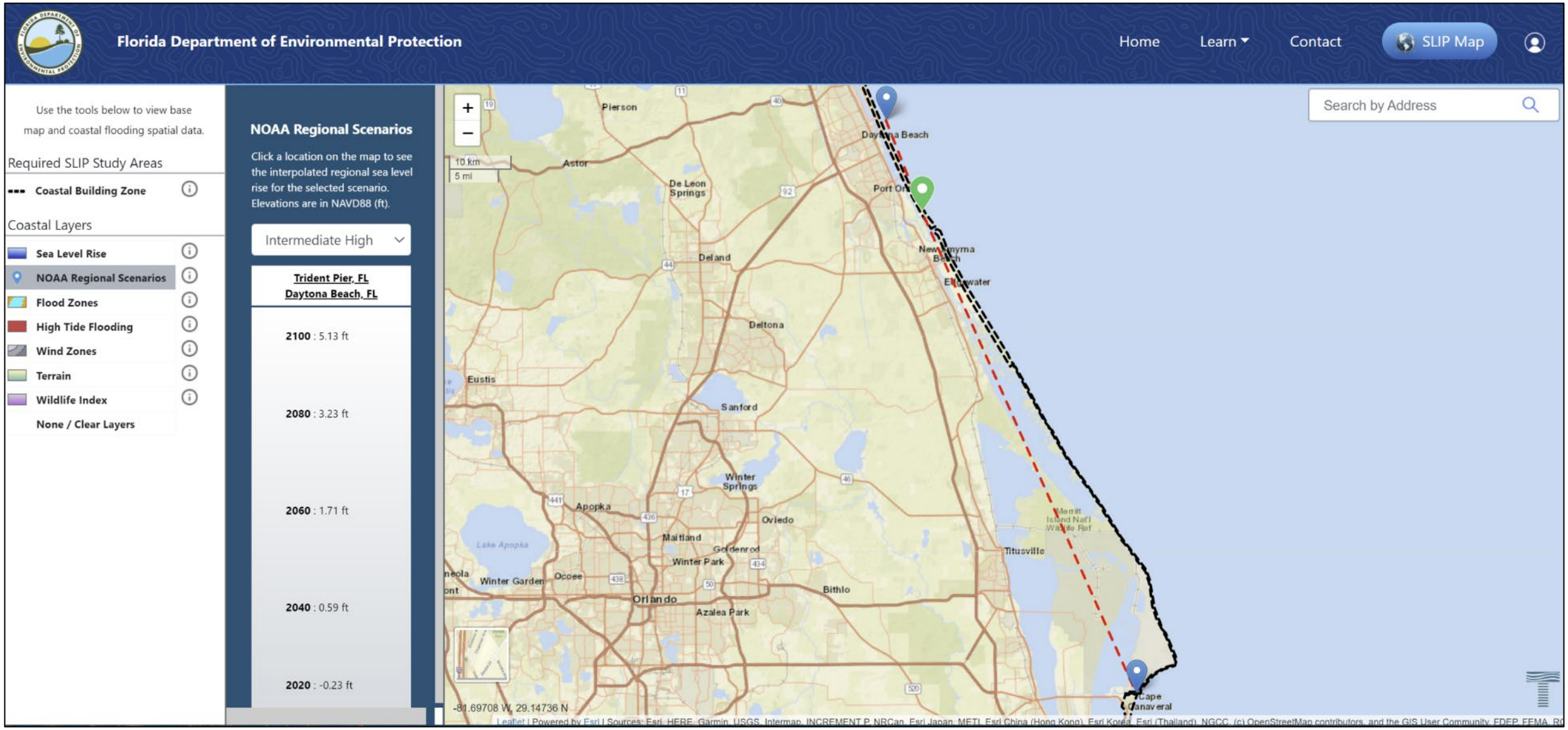
Homepage: www.floridadep-slip.org



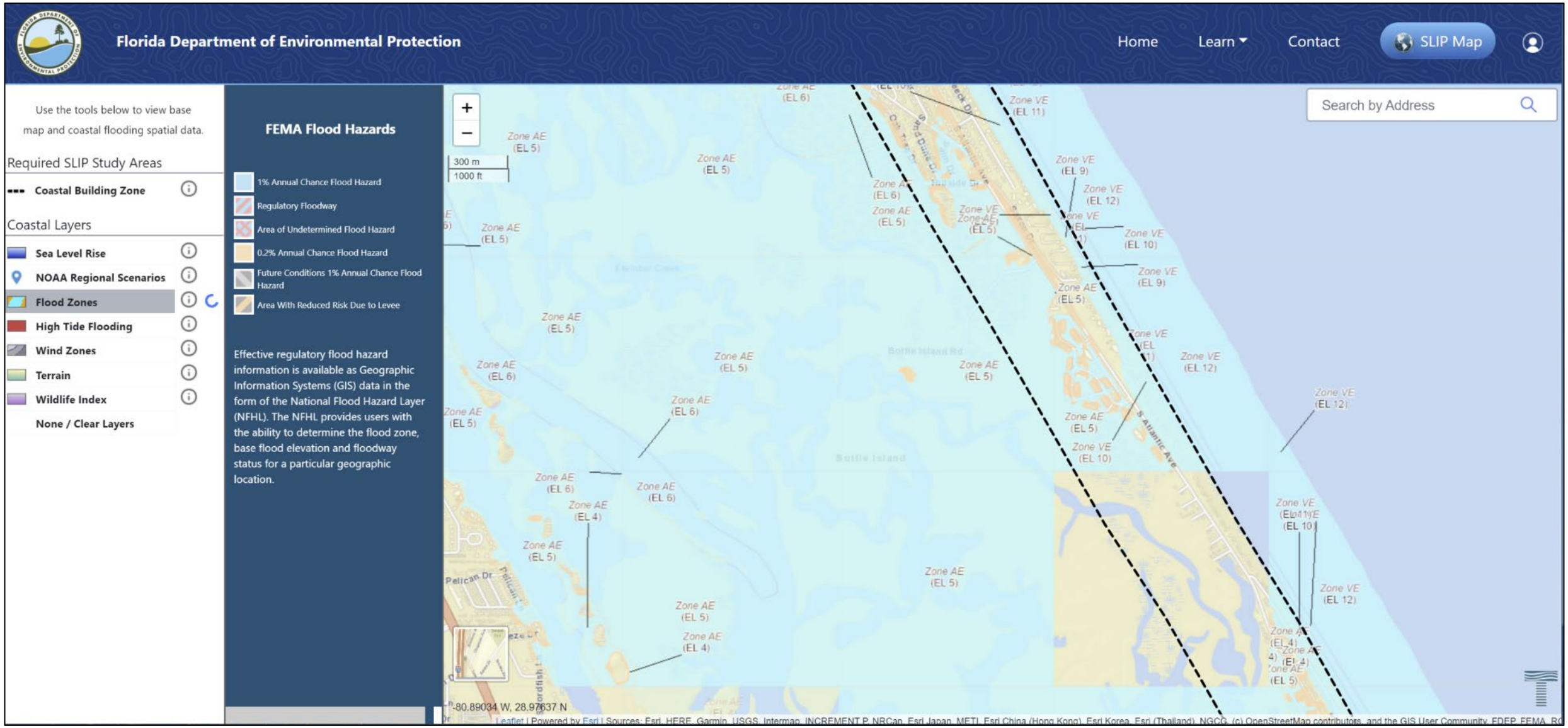
Public View: NOAA SLR Viewer



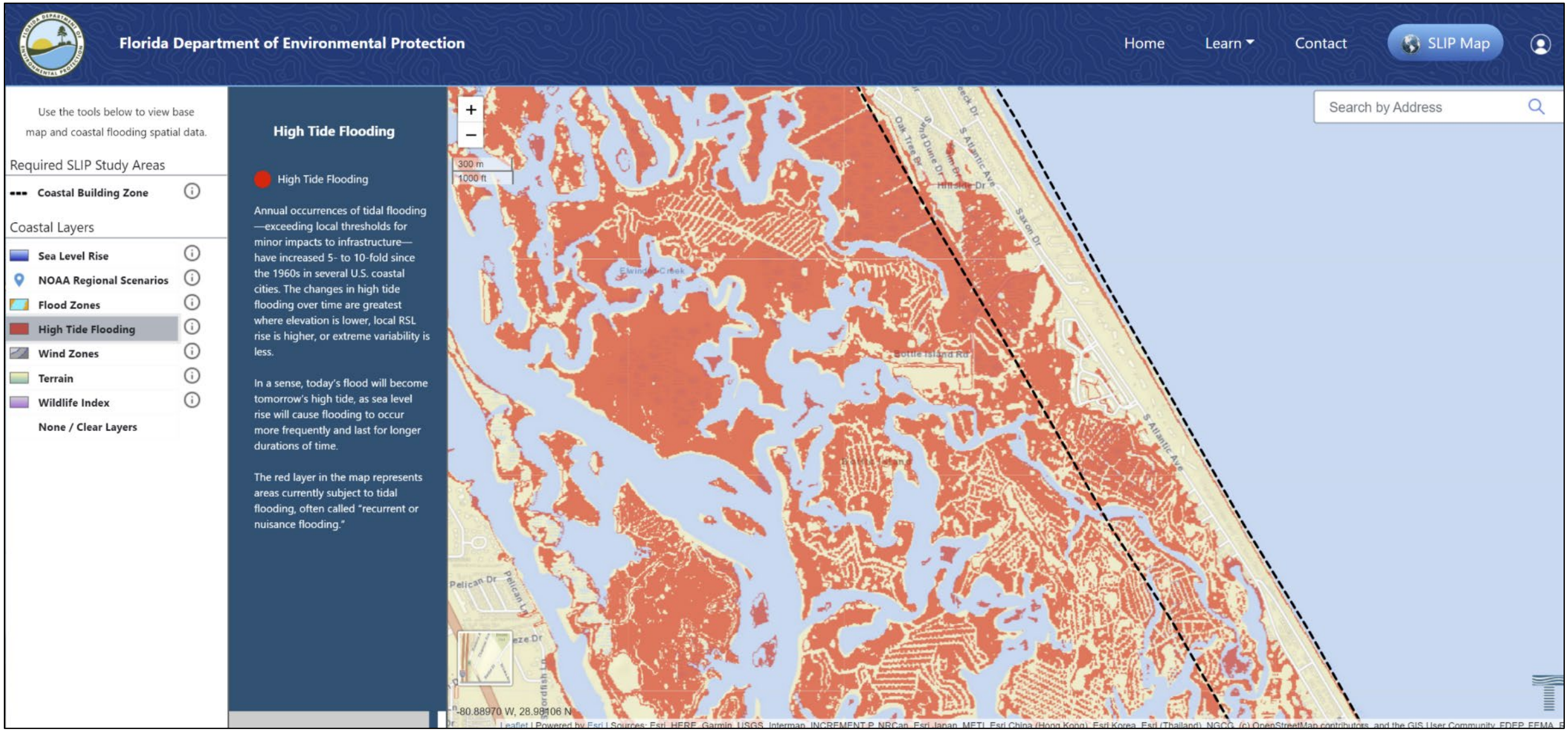
Public View: Regional SLR Scenarios (localized)



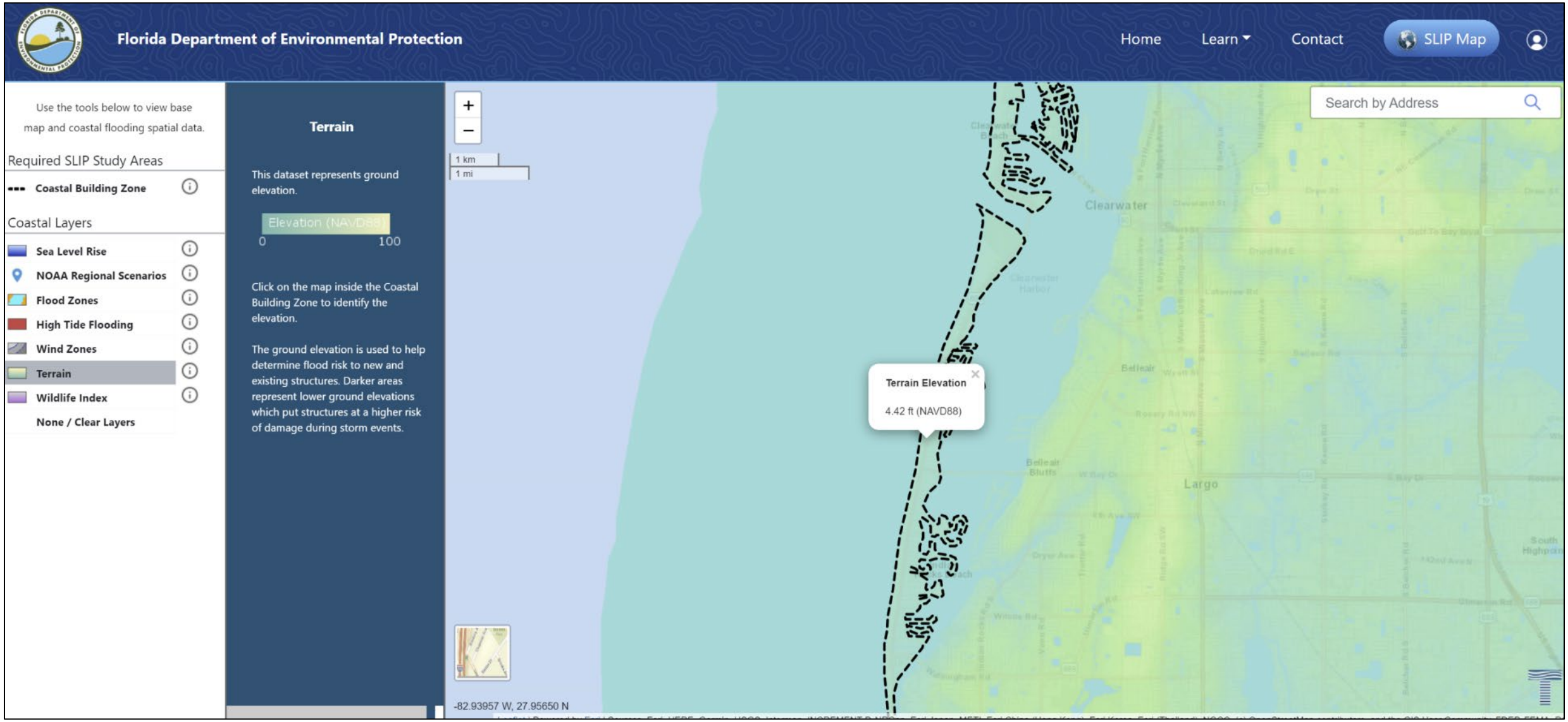
Public View: FEMA Flood Hazard Layer



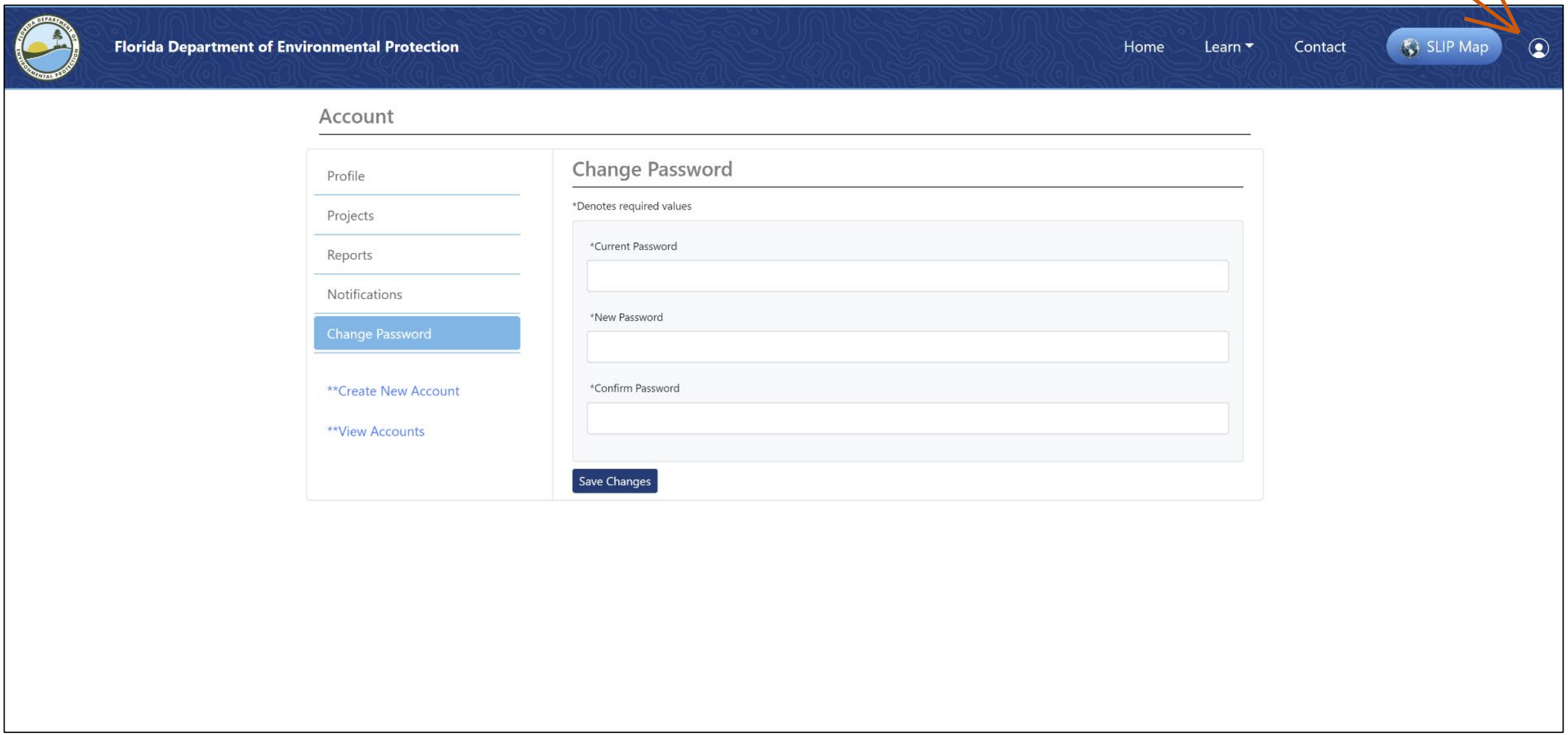
Public View: NOAA High Tide Flooding



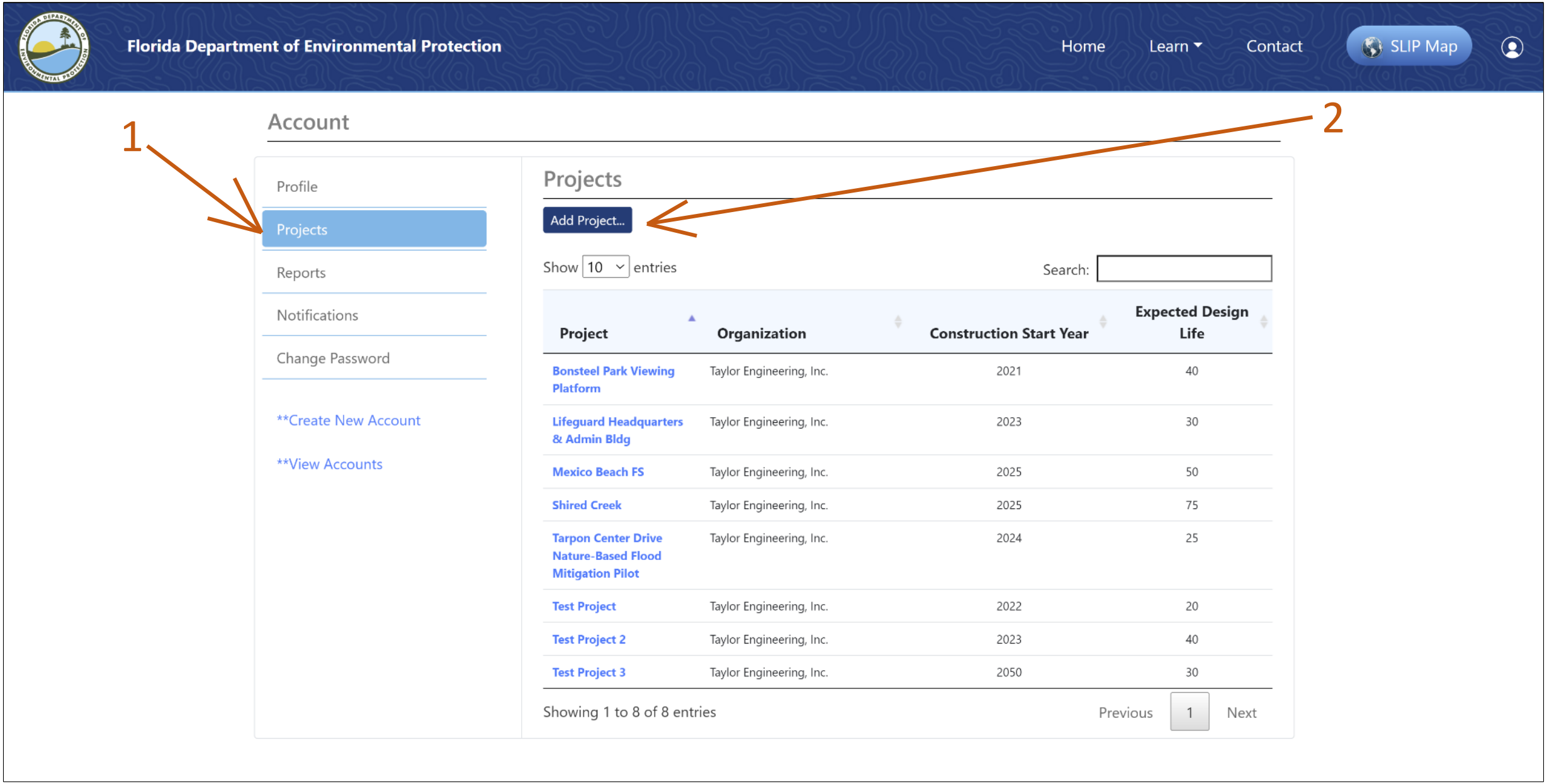
Public View: Terrain Elevation



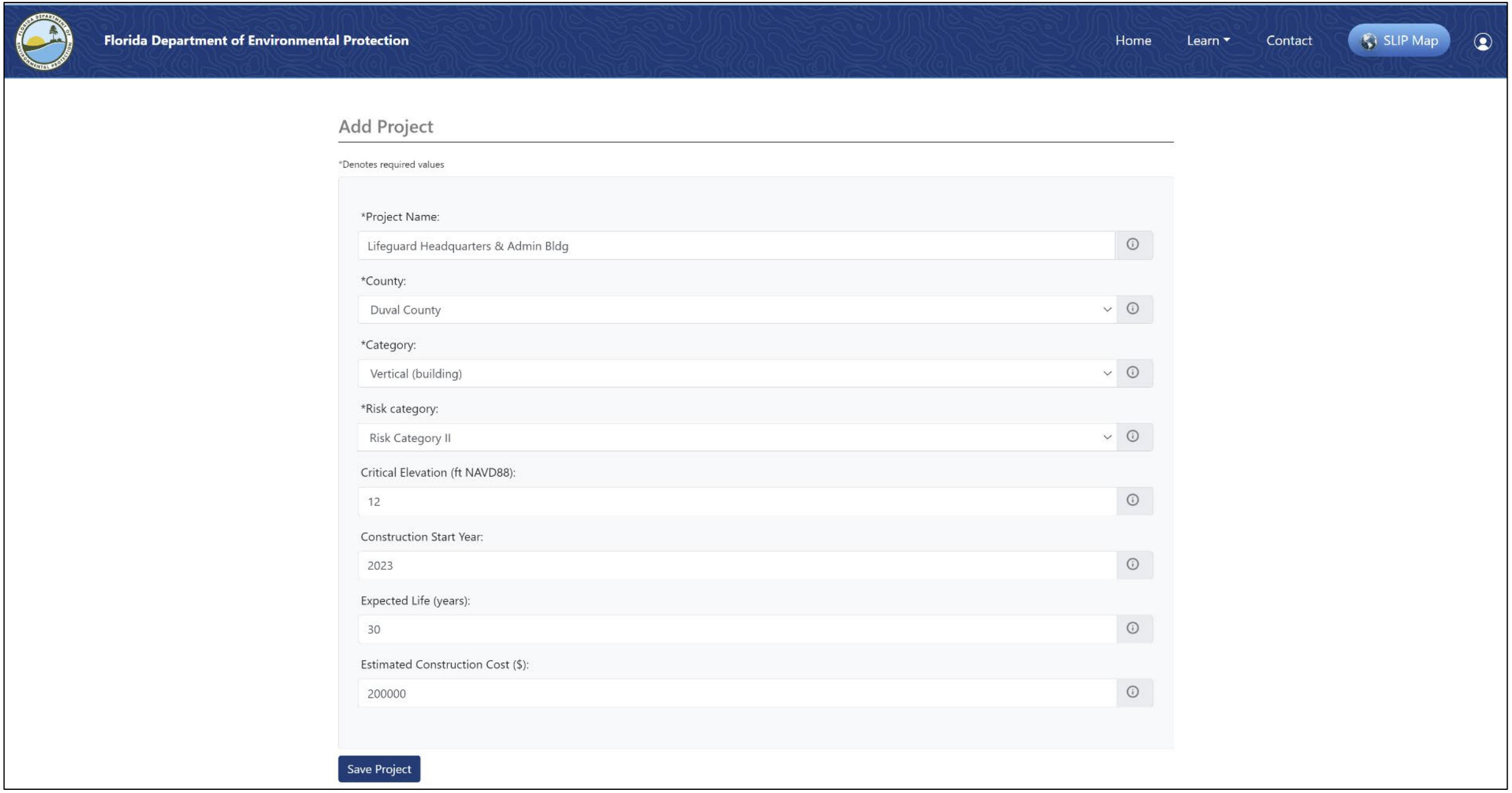
Signed-in User: Account Functions



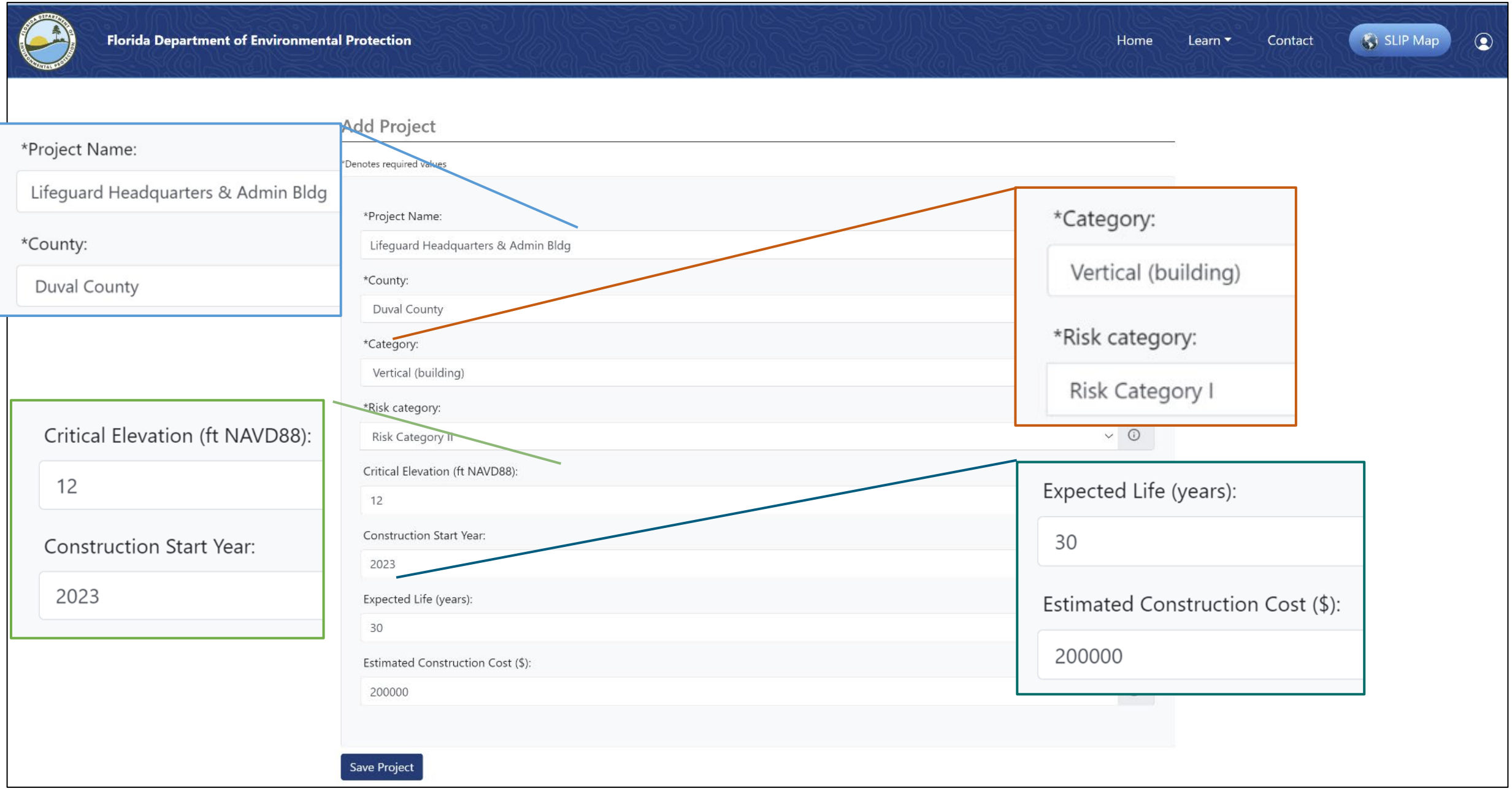
Signed-in User: Add Project



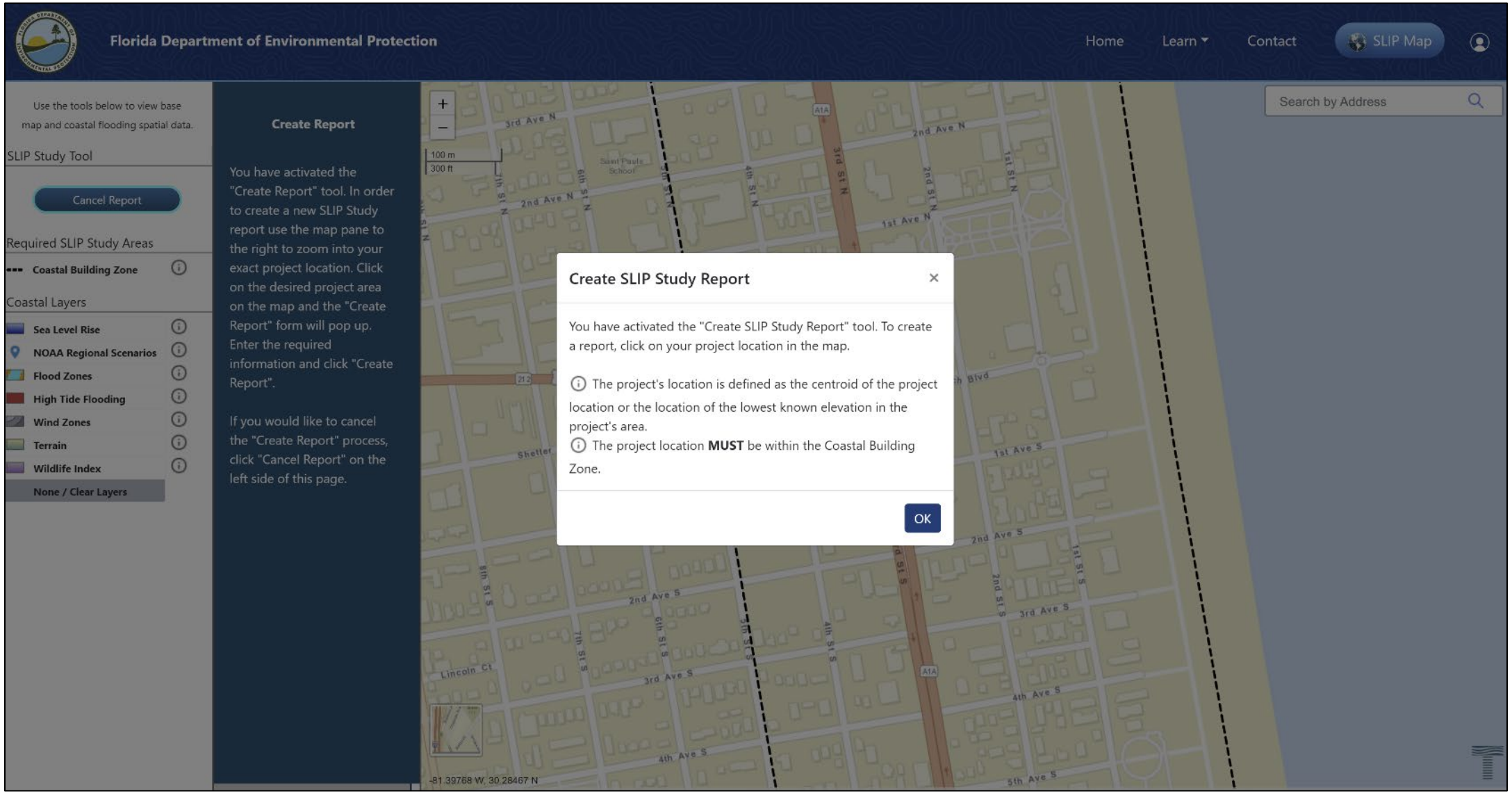
Signed-in User: Add Project



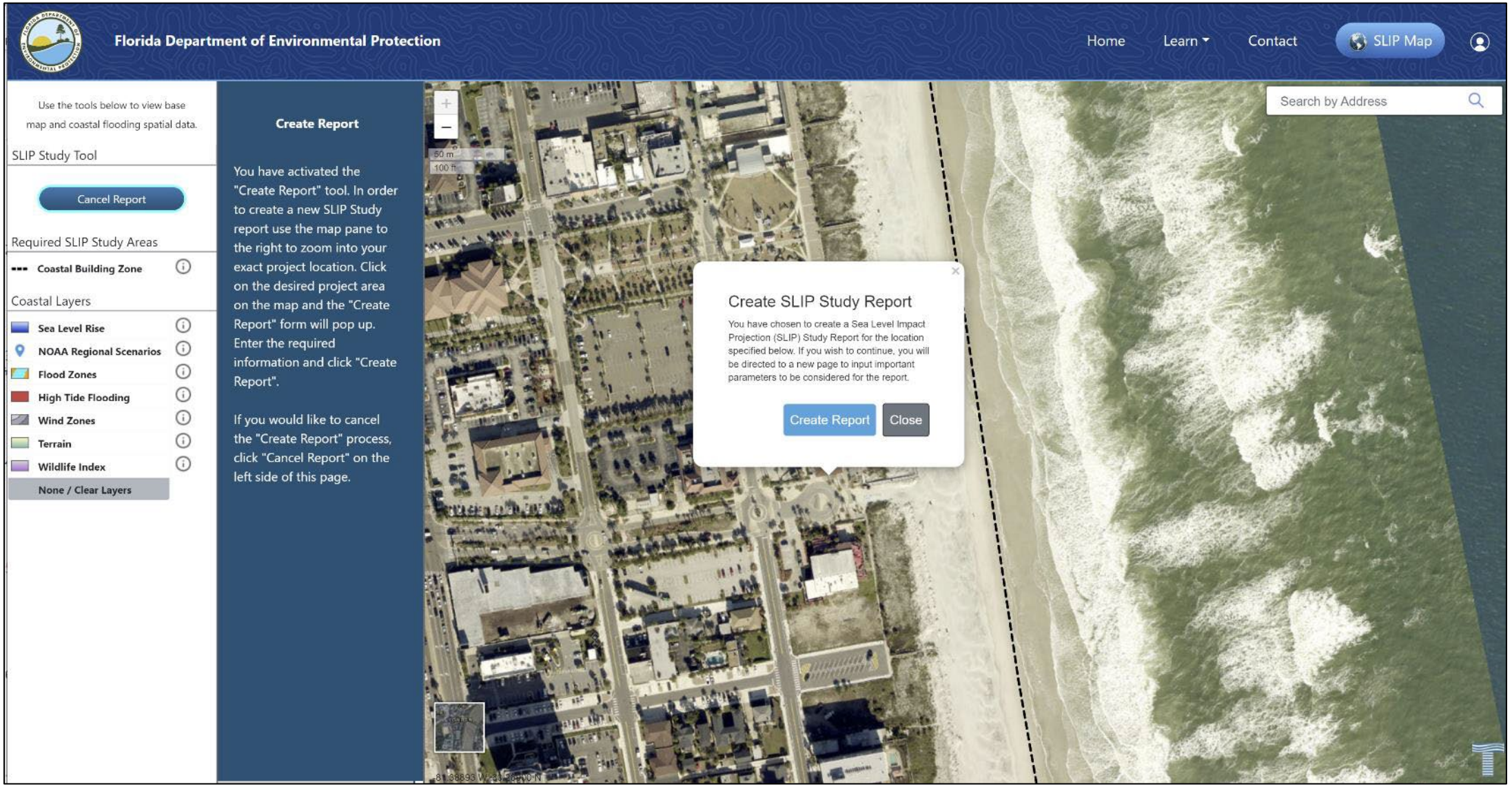
Signed-in User: Add Project



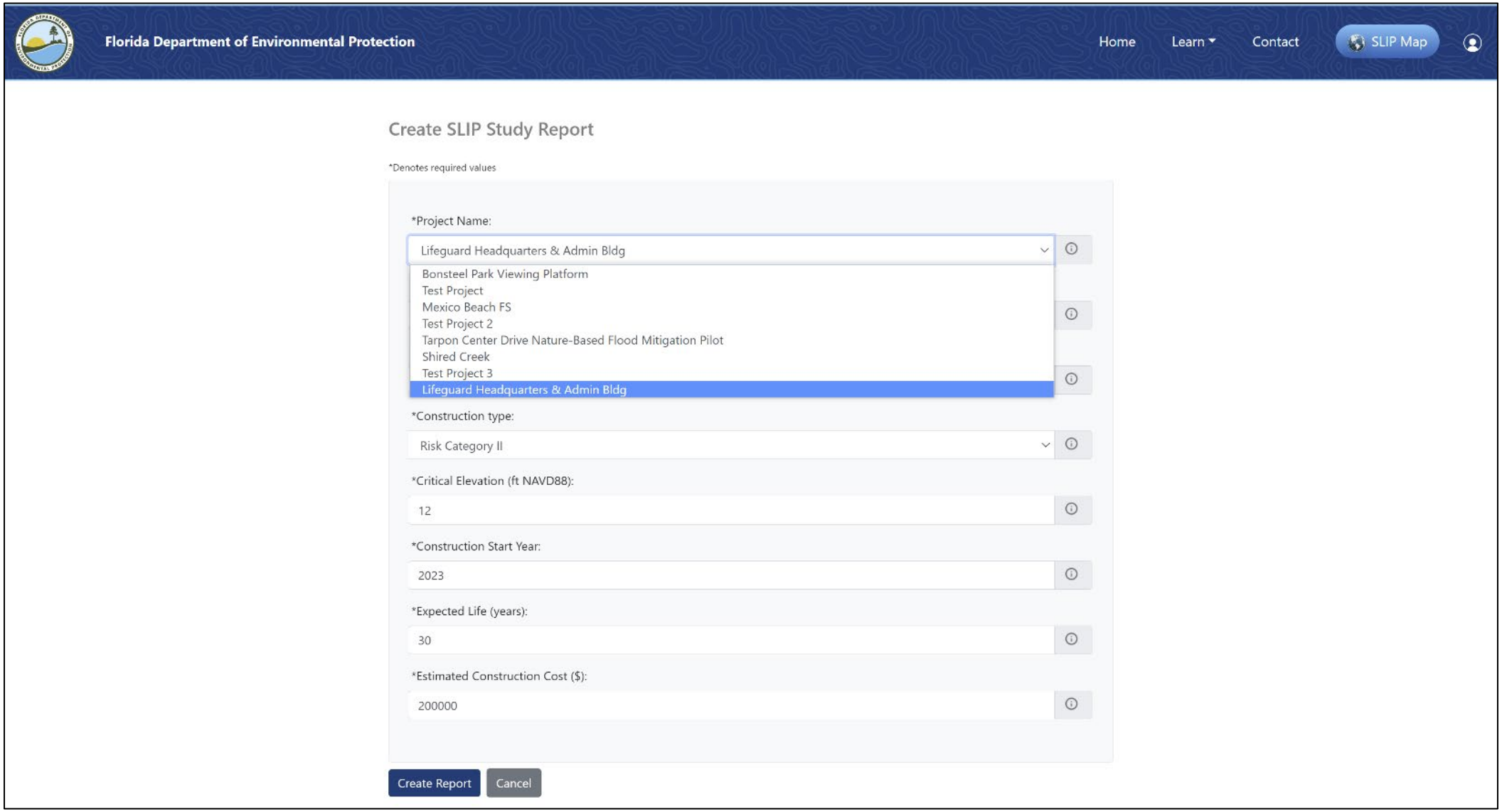
Signed-in User: Create SLIP Report



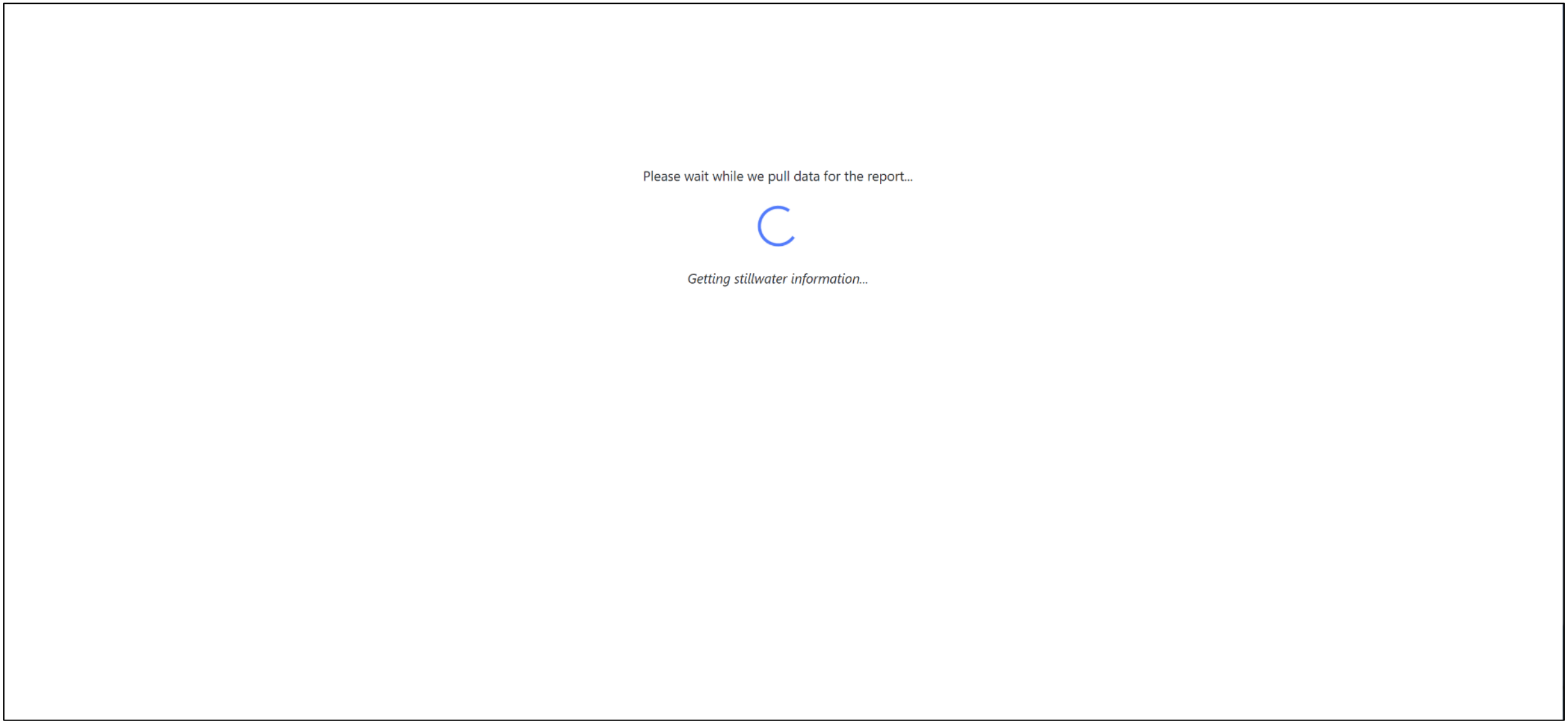
Signed-in User: Create SLIP Report



Signed-in User: Create SLIP Report



Signed-in User: Waiting for the SLIP Report

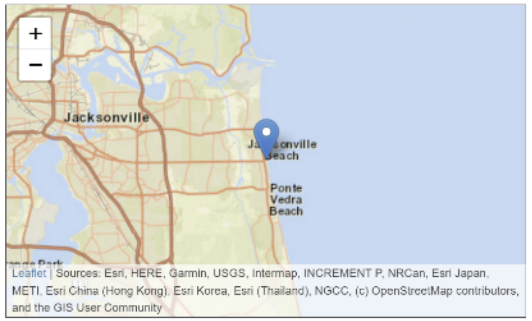


Signed-in User: SLIP Report

Back to Map | Save Report | Export/Print

Sea Level Impact Projection (SLIP) Study Report

Project name	Lifeguard Headquarters
County	Duval County
Coordinates	-81.38903 W, 30.28876 N
Project category	Vertical
Risk category	Risk Category II
Construction start year	2023
Expected life (years)	30
Estimated Construction Cost ($)	$200,000
Critical elevation (ft NAVD88)	12
Organization	Taylor Engineering, Inc.
Report Date	10/30/2022, 9:11:06 PM



Results

Average Annual Chance of Substantial Flood Damage: N/A*

Metric	Value
FEMA Flood Hazard Zone	X
Base Flood Elevation (ft)	Not Applicable
Terrain Elevation (ft NAVD88)	10.69
Int-High Sea Level Rise (year 2050) (ft NAVD88)	1.49
Wind Zone (mph)	120-130

Average Annual Chance of Substantial Flood Damage (AACSFD) is calculated using NOAA sea level projections, FEMA coastal storm surge events, and associated wave heights. This flood risk probability does not include high-tide flooding, precipitation (stormwater), or riverine flooding.

* Average Annual Chance of Substantial Flood Damage (AACSFD) value of N/A does not imply that the project is not at risk of flooding. N/A means that AACSFD is unable to be automatically calculated due to missing data required by the SLIP Tool and needs further analysis. The metrics presented in the SLIP Report can be used to assess the project's flood risk, such as comparing the project's critical elevation to the Terrain, Base Flood Elevation, and NOAA Intermediate-High SLR scenario. This information can be found in the top two sections of this report.

Potential Beneficial Adaptation Strategies

Based on the results of the SLIP Study, the following adaptation strategies may be beneficial to consider in the construction design. These are not recommendations, merely standard strategies used to mitigate risk.

Build on Partially Elevated Areas

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

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

Check Valve / Non-Return Valves

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

Projects:
R1928 - St. Augustine Stormwater Outfall Resiliency Retrofit

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

Elevated Flood Wall / Flood Gate

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

Resources:
FEMA - Floodwall with Passive Floodgates Signals Commitment

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

Flood Barriers (Passive or Active)

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

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

Signed-in User: SLIP Report

Potential Public Safety and Environmental Impacts

Based on the results of the SLIP Study, consider the following potential public safety and environmental impacts:

Flood Risk
When factoring in the flood zone, base flood elevation, terrain, and sea level rise trends for the project location, a moderate flood risk is present.

Wind Risk
The project location was found to be located in an area of moderate wind risk with a maximum wind speed of 120-130 mph. There is potential risk from flying debris.

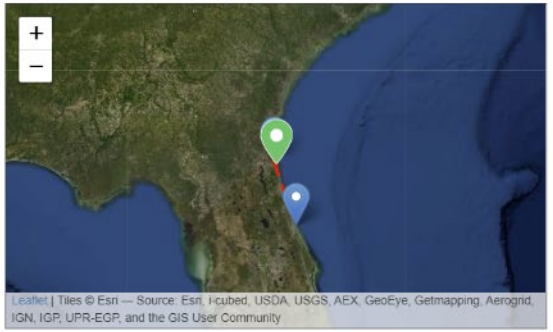
Explosion Risk
The high wind risk in this project location may contribute to a higher risk of explosion due to potential downed powerlines.

FEMA Flood Hazard Information

Flood Zone	X
Zone subtype	0.2 PCT ANNUAL CHANCE FLOOD HAZARD IN COASTAL ZONE
Static BFE (ft)	Not Applicable
Vertical Datum	

The base flood elevation (BFE) is provided in for VE, AE, and AH special flood hazard zones.

Regional Sea Level Rise Scenarios

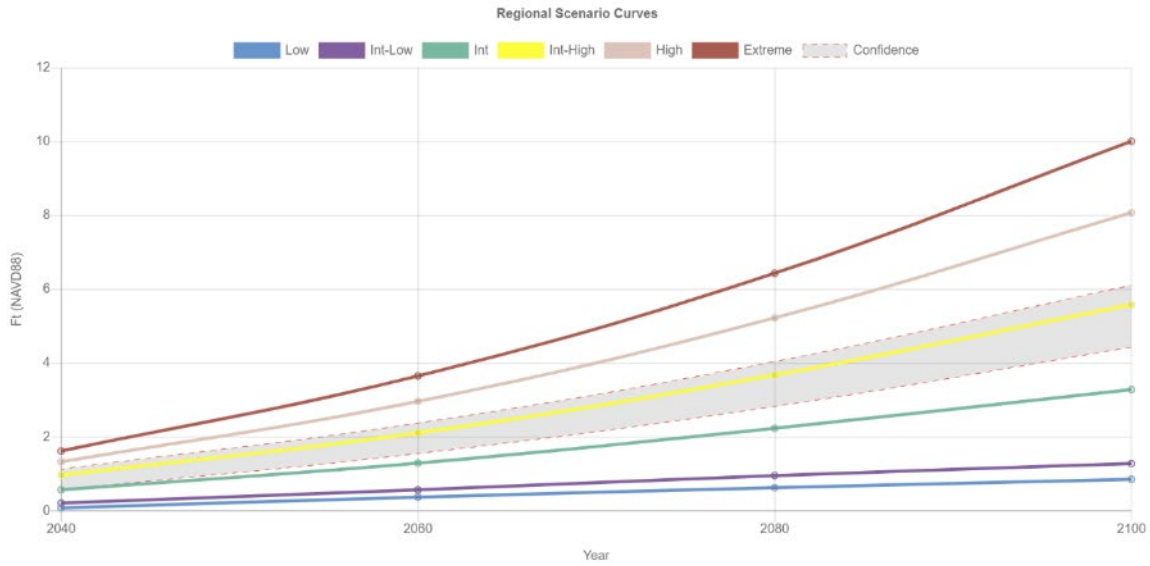


NOAA Regional Scenarios (ft NAVD88)

Scenario	2040	2060	2080	2100
Low	0.08	0.37	0.63	0.86
Intermediate Low	0.21	0.57	0.96	1.28
Intermediate	0.57	1.29	2.24	3.29
Intermediate High	**0.97**	**2.12**	**3.68**	**5.59**
High	1.33	2.97	5.23	8.08
Extreme	1.62	3.66	6.44	10.01

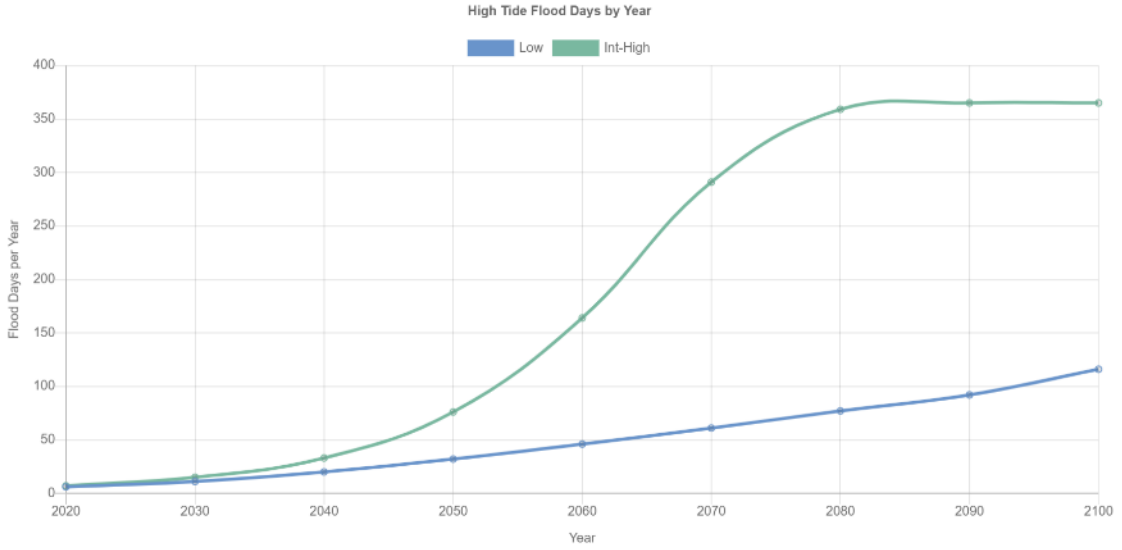
The five relative sea level rise (RSL) scenarios shown in this report are derived from NOAA Technical Report NOS CO-OPS 083 "Global and regional sea level rise scenarios for the United States" using the same methods as the USACE Sea Level Rise Calculator. These new scenarios were developed by the Sea Level Rise and Coastal Flood Hazard Scenarios and Tools Interagency Task Force, jointly convened by the U.S. Global Change Research Program (USGCRP) and the National Ocean Council as input to the USGCRP Sustained Assessment process and 4th National Climate Assessment. These RSL scenarios provide a revision to the (Parris et. al, 2012) global scenarios which were developed as input to the 3rd National Climate Assessment.

These RSL scenarios begin in year 2020 and take into account global mean sea level rise (GMSL), regional changes in ocean circulation, changes in Earth's gravity field due to ice melt redistribution, and local vertical land motion.



Signed-in User: SLIP Report

NOAA High Tide Flooding Information



High Tide Flood Days by Year

Year	Low	Int-High
2040	20	33
2070	61	291

Annual occurrences of tidal flooding—exceeding local thresholds for minor impacts to infrastructure—have increased 5- to 10-fold since the 1960s in several U.S. coastal cities. The changes in high tide flooding over time are greatest where elevation is lower, local RSL rise is higher, or extreme variability is less.

In a sense, today's flood will become tomorrow's high tide, as sea level rise will cause flooding to occur more frequently and last for longer durations of time.

Wind Zones

Metric	Value
Maximum Wind Speed	120-130mph

Terrain

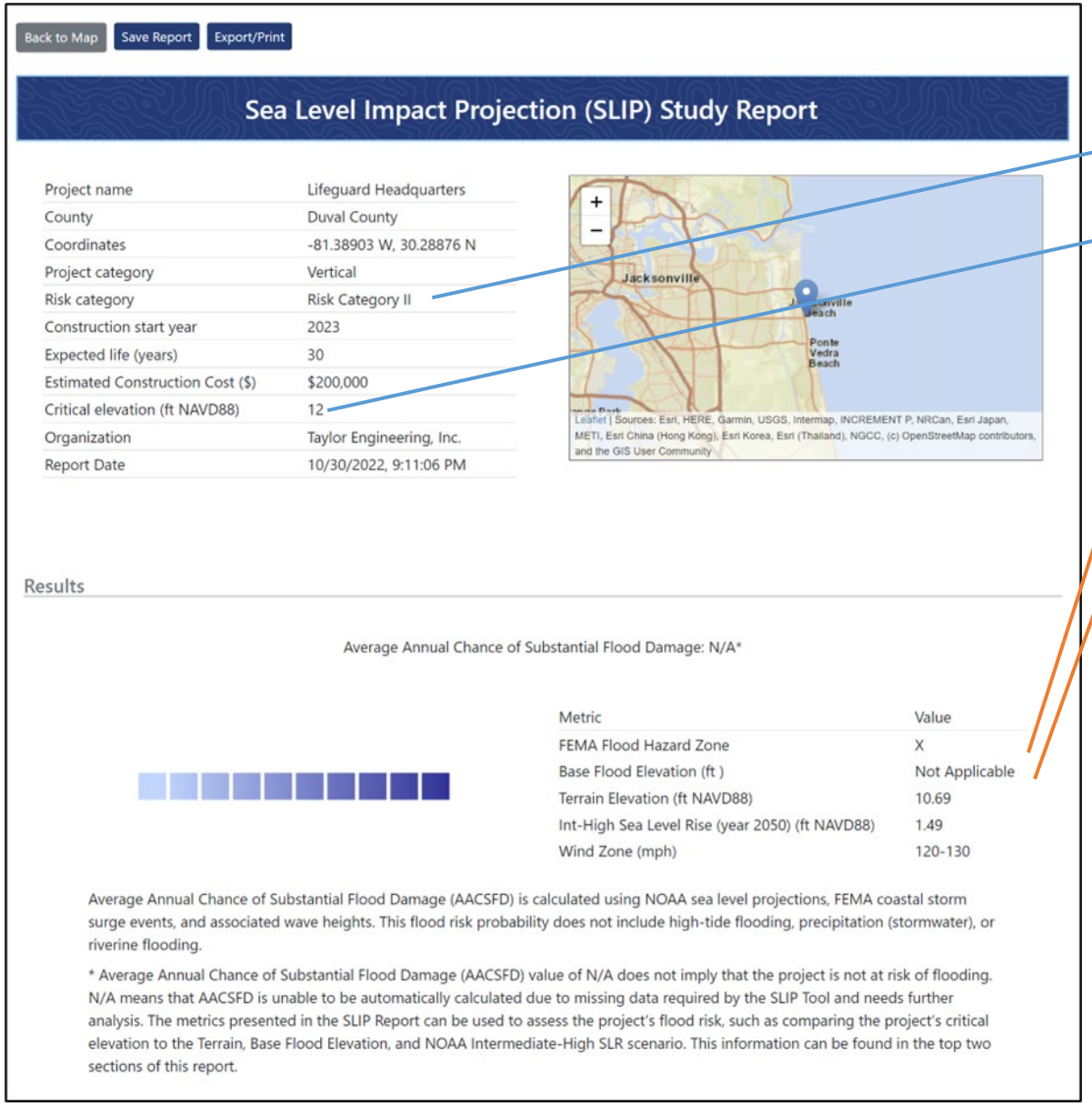
Metric	Value
Elevation (ft)	10.69
Vertical Datum	NAVD 88

This terrain elevation is derived from the latest compilation of terrain data from NOAA. This dataset contains the best publicly available terrain data in a 3m resolution.

Design Alternatives

The selection of a construction project location involves a considerable number of factors, including but not limited to regulatory issues, engineering, and logical decisions. The SLIP Study Tool may be run multiple times with different project locations and critical elevations, to achieve a desired result. Please use the SLIP Map along with the Coastal Hazard layers to assist you in selecting the optimal location. Review this report and assess the risks which may be mitigated by changing the design parameters, then run the SLIP Study Tool again.

Potential Pitfalls


Back to Map | Save Report | Export/Print

Sea Level Impact Projection (SLIP) Study Report

Project name	Lifeguard Headquarters
County	Duval County
Coordinates	-81.38903 W, 30.28876 N
Project category	Vertical
Risk category	Risk Category II
Construction start year	2023
Expected life (years)	30
Estimated Construction Cost ($)	$200,000
Critical elevation (ft NAVD88)	12
Organization	Taylor Engineering, Inc.
Report Date	10/30/2022, 9:11:06 PM

Results

Average Annual Chance of Substantial Flood Damage: N/A*

Metric	Value
FEMA Flood Hazard Zone	X
Base Flood Elevation (ft)	Not Applicable
Terrain Elevation (ft NAVD88)	10.69
Int-High Sea Level Rise (year 2050) (ft NAVD88)	1.49
Wind Zone (mph)	120-130

Average Annual Chance of Substantial Flood Damage (AACSFD) is calculated using NOAA sea level projections, FEMA coastal storm surge events, and associated wave heights. This flood risk probability does not include high-tide flooding, precipitation (stormwater), or riverine flooding.

* Average Annual Chance of Substantial Flood Damage (AACSFD) value of N/A does not imply that the project is not at risk of flooding. N/A means that AACSFD is unable to be automatically calculated due to missing data required by the SLIP Tool and needs further analysis. The metrics presented in the SLIP Report can be used to assess the project's flood risk, such as comparing the project's critical elevation to the Terrain, Base Flood Elevation, and NOAA Intermediate-High SLR scenario. This information can be found in the top two sections of this report.

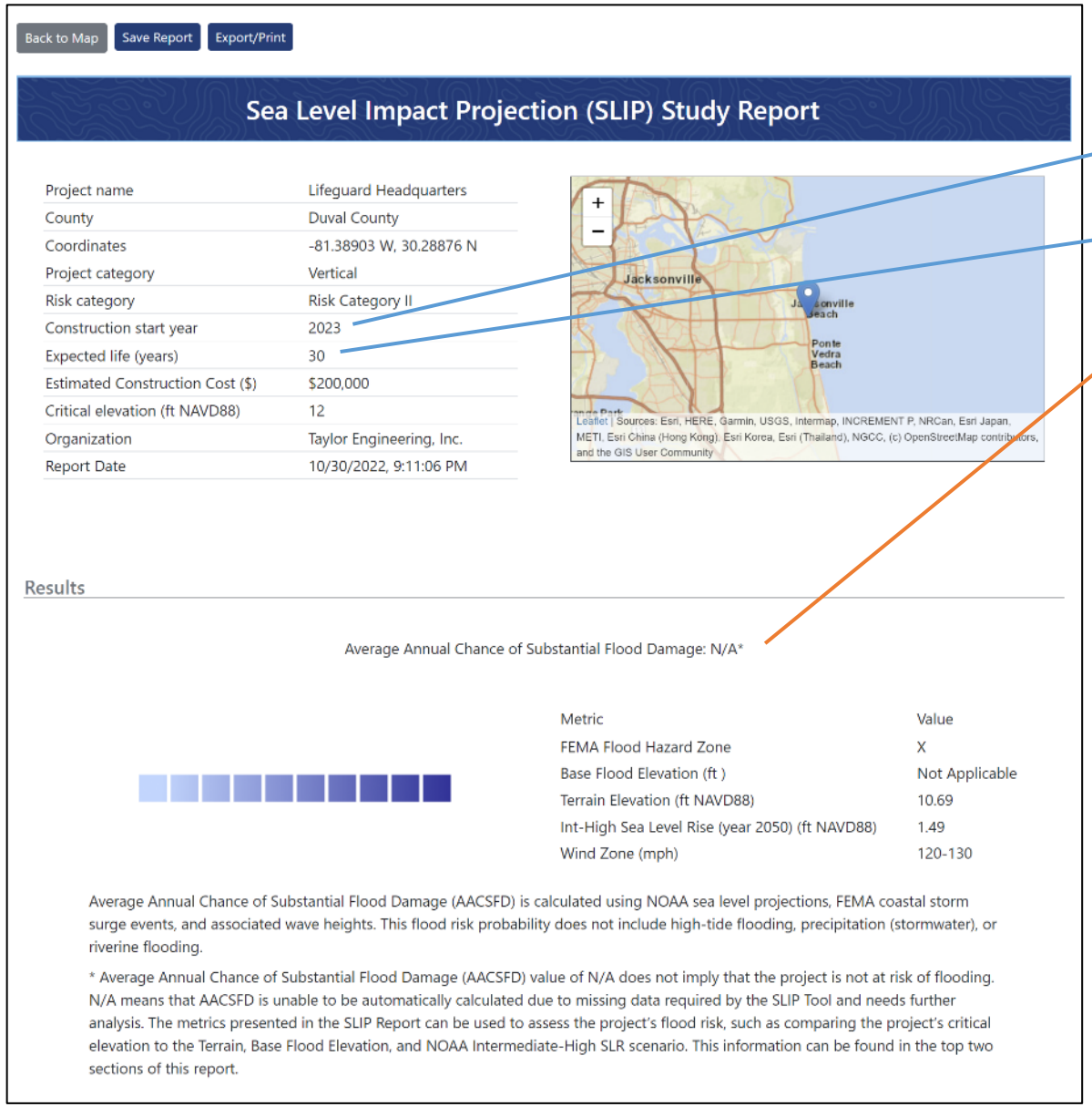
Items to pay special attention to:

- Risk Category
- Critical Elevation
- FEMA Special Flood Hazard Zone
- Base Flood Elevation (BFE)

Do these pass the "sniff test?"

- A critical facility (Risk Cat IV) should not have a critical elevation BELOW BFE, and should not be located in a VE zone!

Potential Pitfalls



Back to Map | Save Report | Export/Print

Sea Level Impact Projection (SLIP) Study Report

Project name	Lifeguard Headquarters
County	Duval County
Coordinates	-81.38903 W, 30.28876 N
Project category	Vertical
Risk category	Risk Category II
Construction start year	2023
Expected life (years)	30
Estimated Construction Cost ($)	$200,000
Critical elevation (ft NAVD88)	12
Organization	Taylor Engineering, Inc.
Report Date	10/30/2022, 9:11:06 PM

Results

Average Annual Chance of Substantial Flood Damage: N/A*

Metric	Value
FEMA Flood Hazard Zone	X
Base Flood Elevation (ft)	Not Applicable
Terrain Elevation (ft NAVD88)	10.69
Int-High Sea Level Rise (year 2050) (ft NAVD88)	1.49
Wind Zone (mph)	120-130

Average Annual Chance of Substantial Flood Damage (AACSFD) is calculated using NOAA sea level projections, FEMA coastal storm surge events, and associated wave heights. This flood risk probability does not include high-tide flooding, precipitation (stormwater), or riverine flooding.

* Average Annual Chance of Substantial Flood Damage (AACSFD) value of N/A does not imply that the project is not at risk of flooding. N/A means that AACSFD is unable to be automatically calculated due to missing data required by the SLIP Tool and needs further analysis. The metrics presented in the SLIP Report can be used to assess the project's flood risk, such as comparing the project's critical elevation to the Terrain, Base Flood Elevation, and NOAA Intermediate-High SLR scenario. This information can be found in the top two sections of this report.

Items to pay special attention to:

- Construction Start Year
- Expected Life
- Avg Annual Chance of Substantial Flood Damage (AACSFD)

Does this make sense?

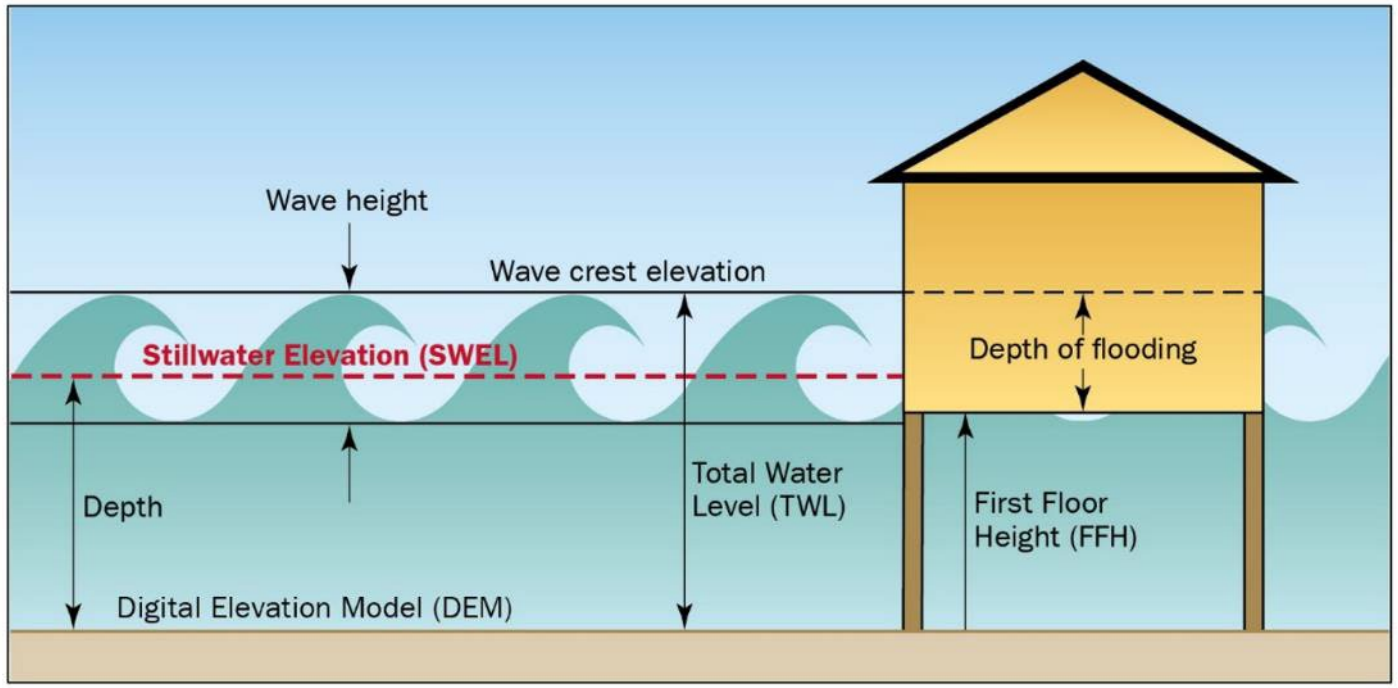
- Is the construction start year and the expected life reasonable?
- Does the AACSFD seem appropriate?

Average Annual Chance of Substantial Flood Damage

- Substantial Flood Damage = damages of ≥25% of market value of structure
- Only calculated for Vertical Construction (not for roads, parking lots, etc)
- Uses the following data in the calculation:
  - Critical elevation
  - Terrain elevation
  - FEMA data: Base Flood Elevation, storm surge flooding at 10% to 0.2% AEPs
  - Sea Level Rise (NOAA 2017 Intermediate-High) at Design Life

Average Annual Chance of Substantial Flood Damage

- Calculates Total Water Level = SLR + storm surge SWEL + wave height
- Compares TWL to critical elevation associated with substantial damage using Depth-Damage Function
- Interpolate AEP associated with depth of flood



FEMA depth of flooding diagram

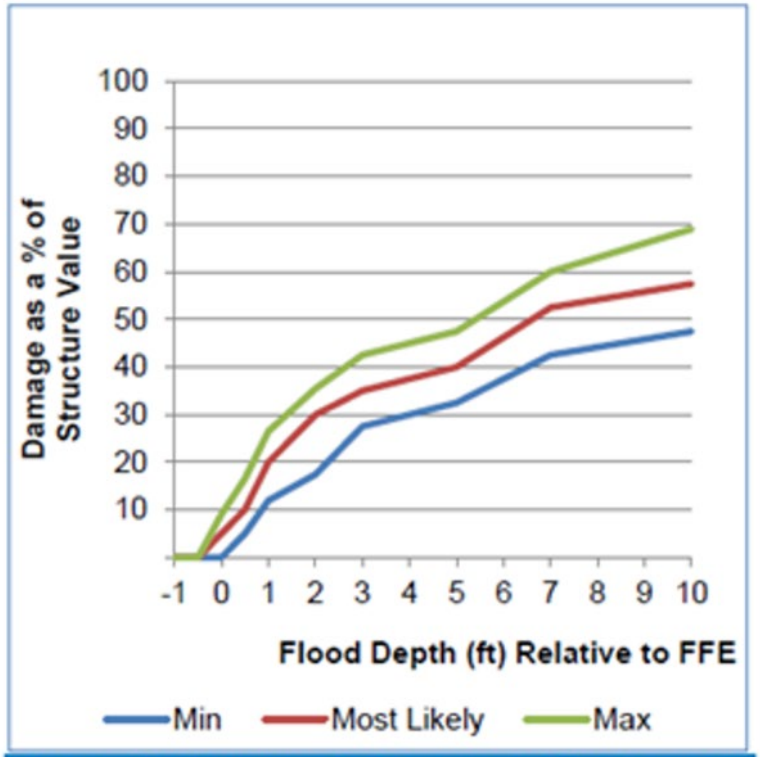
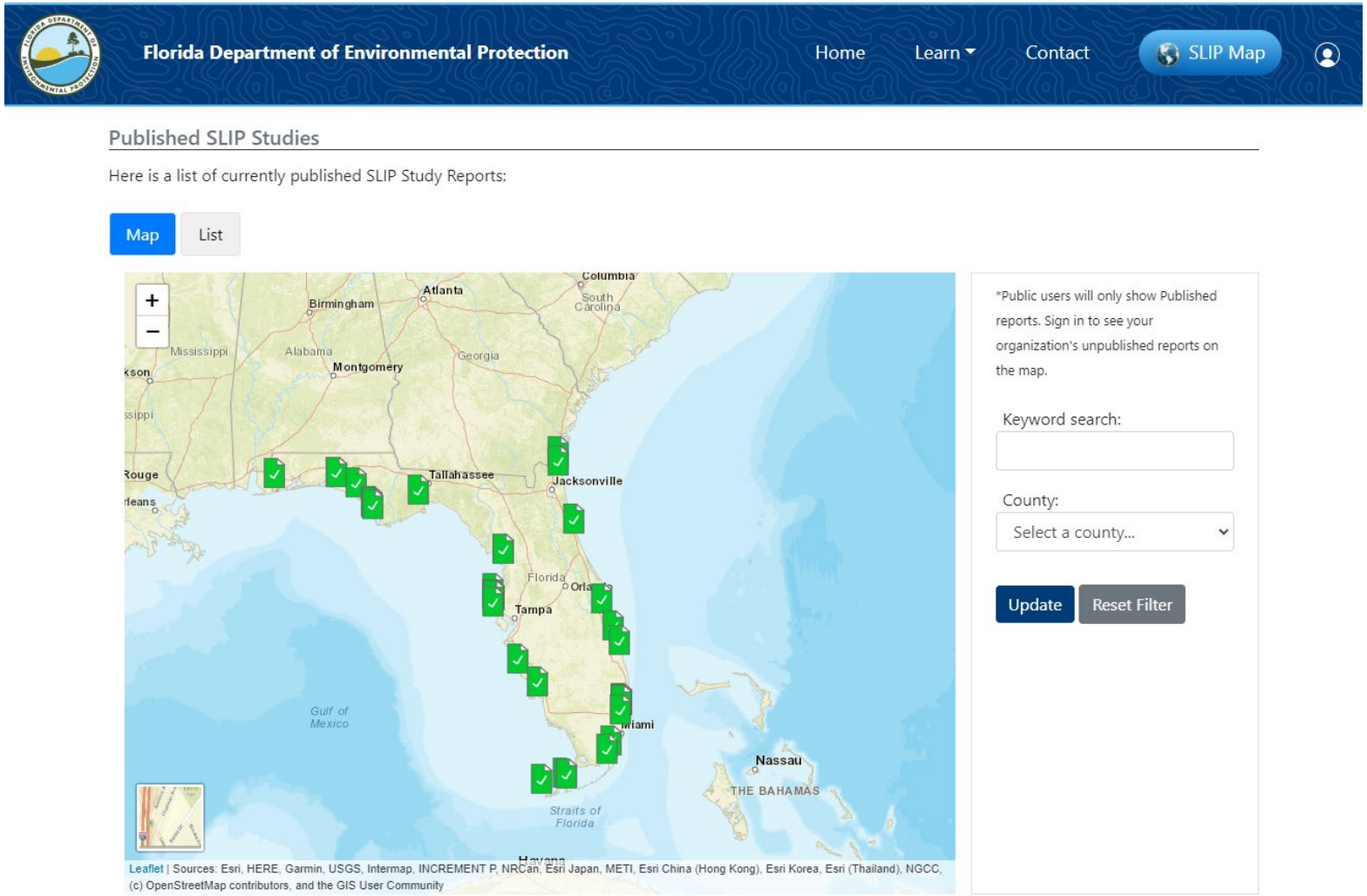


Figure 49. Prototype 2: Commercial Engineered, Inundation Damage – Structure

USACE depth-damage function (NACCS)

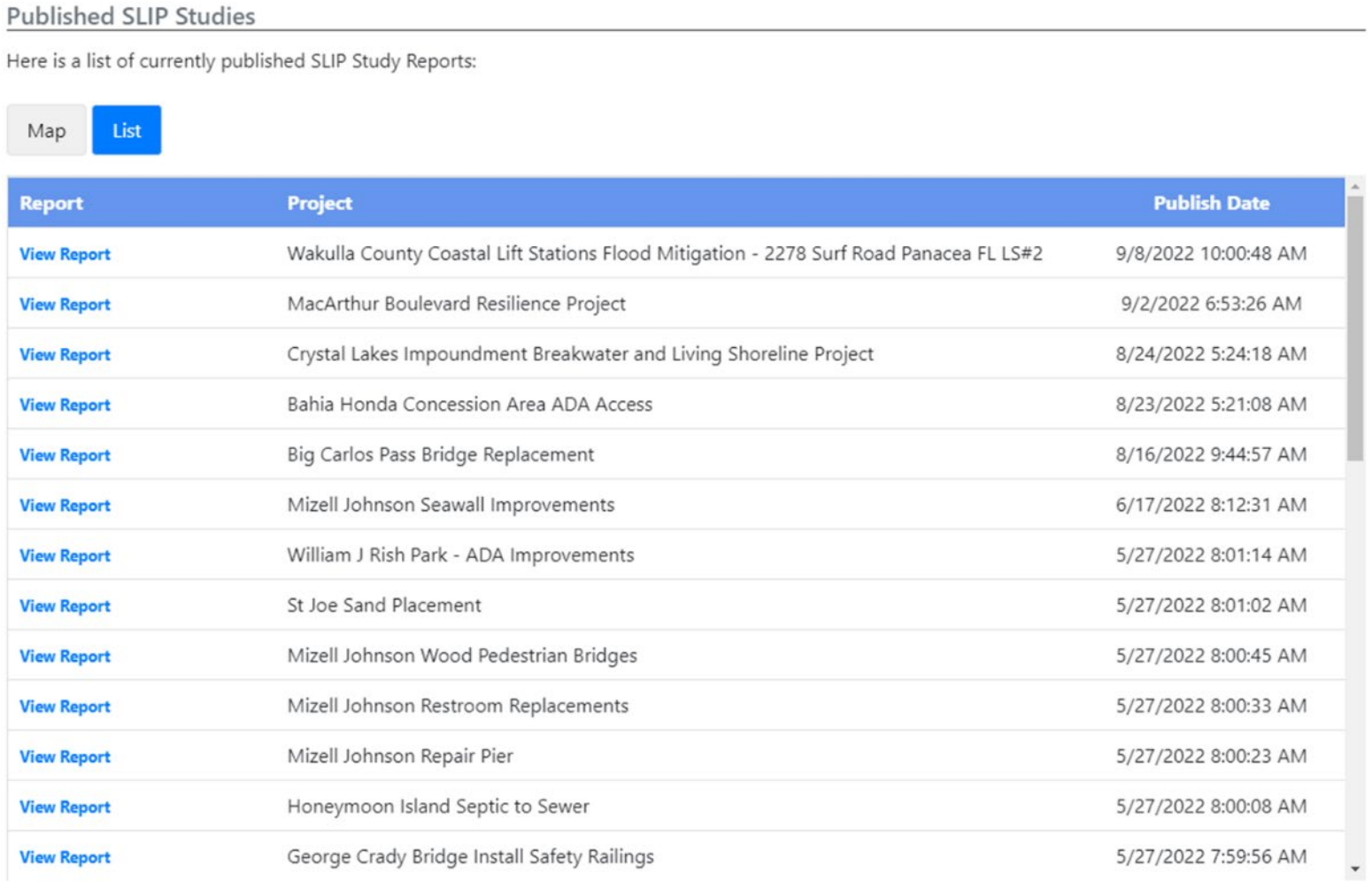
Recent Website Enhancements

- We heard you!
- Updates recently made to SLIP Tool
- Added a map to help users to view SLIP Study Reports



Recent Website Enhancements

- List of Published SLIP Studies is still available



Published SLIP Studies

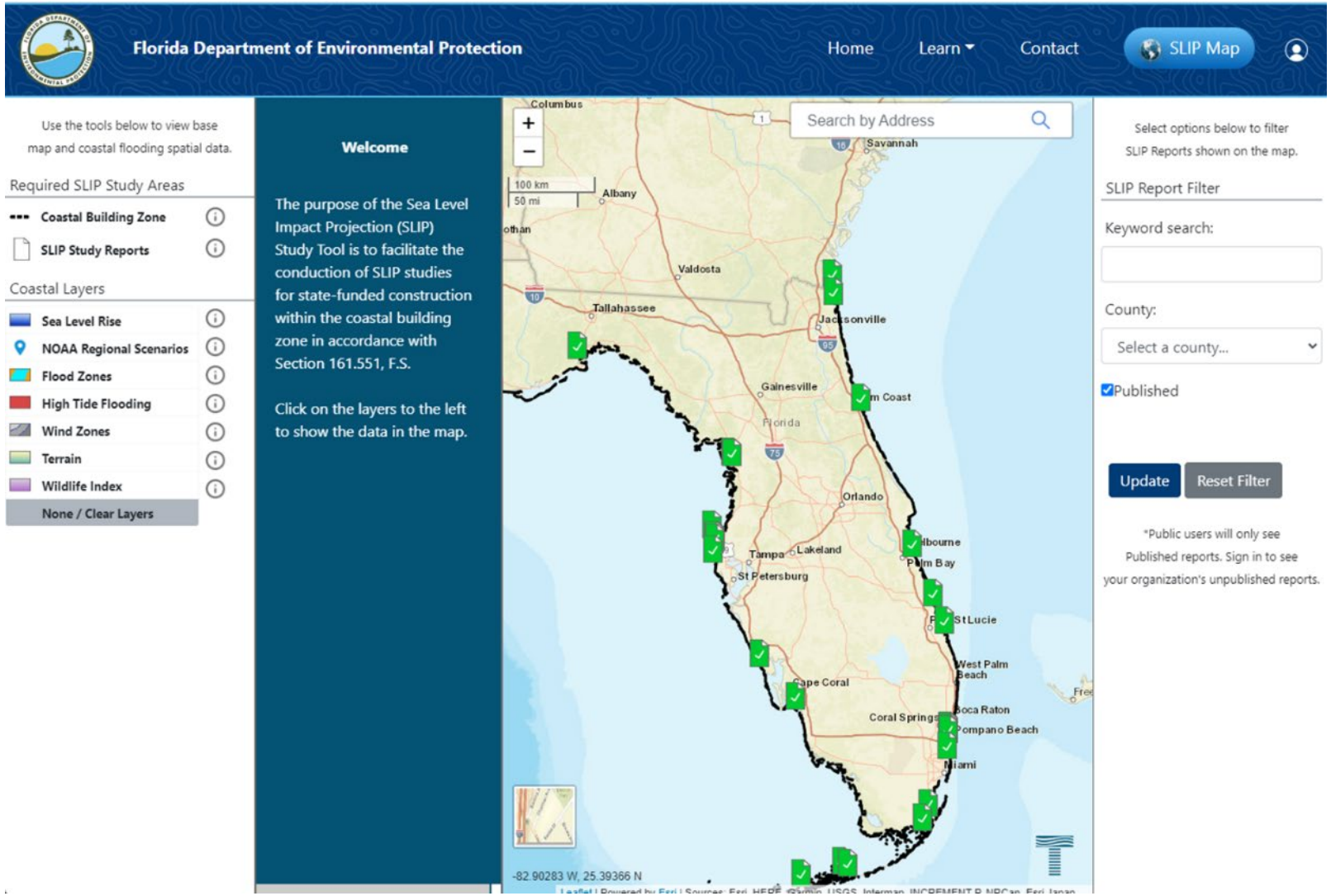
Here is a list of currently published SLIP Study Reports:

Map | List

Report	Project	Publish Date
View Report	Wakulla County Coastal Lift Stations Flood Mitigation - 2278 Surf Road Panacea FL LS#2	9/8/2022 10:00:48 AM
View Report	MacArthur Boulevard Resilience Project	9/2/2022 6:53:26 AM
View Report	Crystal Lakes Impoundment Breakwater and Living Shoreline Project	8/24/2022 5:24:18 AM
View Report	Bahia Honda Concession Area ADA Access	8/23/2022 5:21:08 AM
View Report	Big Carlos Pass Bridge Replacement	8/16/2022 9:44:57 AM
View Report	Mizell Johnson Seawall Improvements	6/17/2022 8:12:31 AM
View Report	William J Rish Park - ADA Improvements	5/27/2022 8:01:14 AM
View Report	St Joe Sand Placement	5/27/2022 8:01:02 AM
View Report	Mizell Johnson Wood Pedestrian Bridges	5/27/2022 8:00:45 AM
View Report	Mizell Johnson Restroom Replacements	5/27/2022 8:00:33 AM
View Report	Mizell Johnson Repair Pier	5/27/2022 8:00:23 AM
View Report	Honeymoon Island Septic to Sewer	5/27/2022 8:00:08 AM
View Report	George Crady Bridge Install Safety Railings	5/27/2022 7:59:56 AM

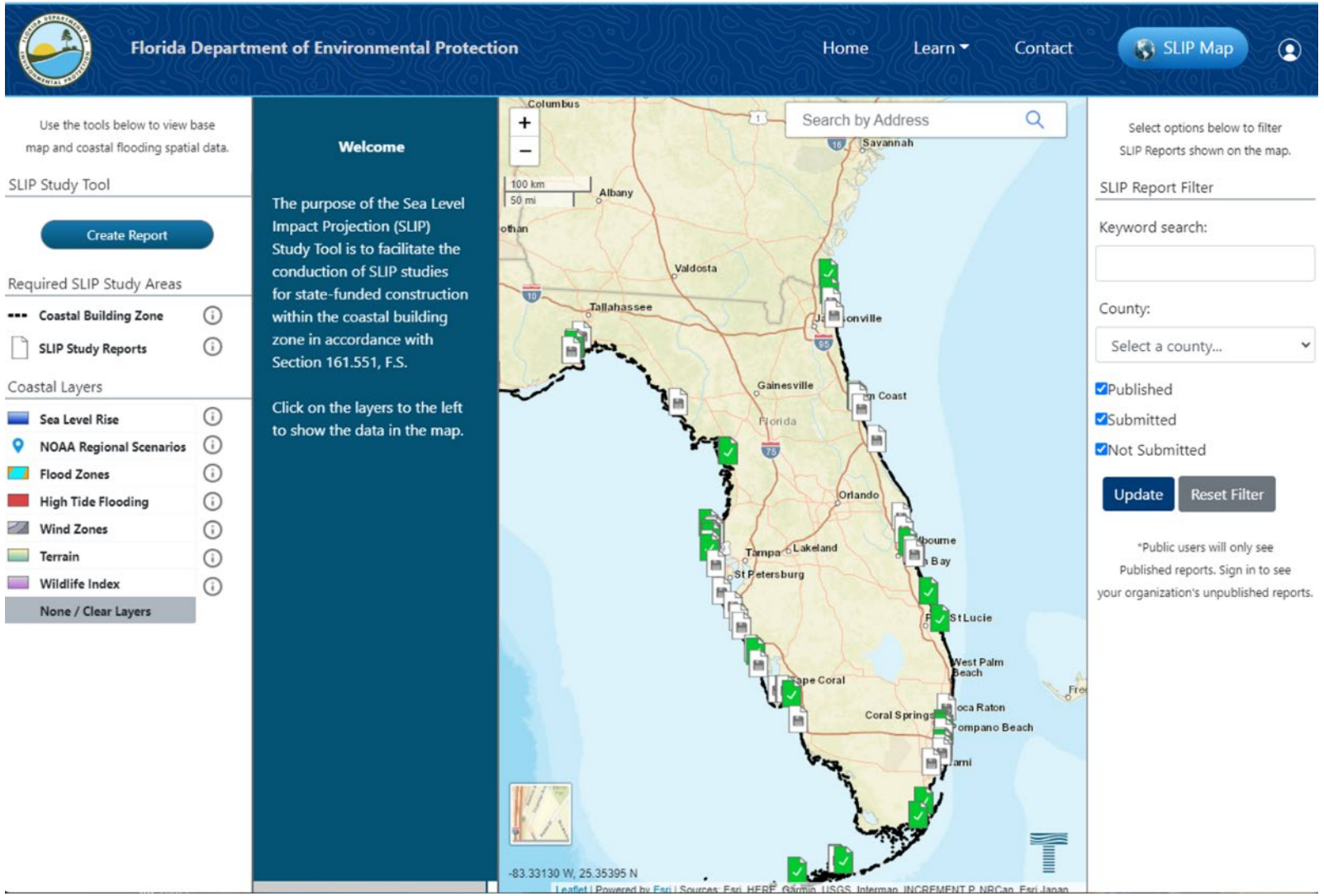
Recent Website Enhancements

- New map layer on the main page
- Can be filtered by County or keyword



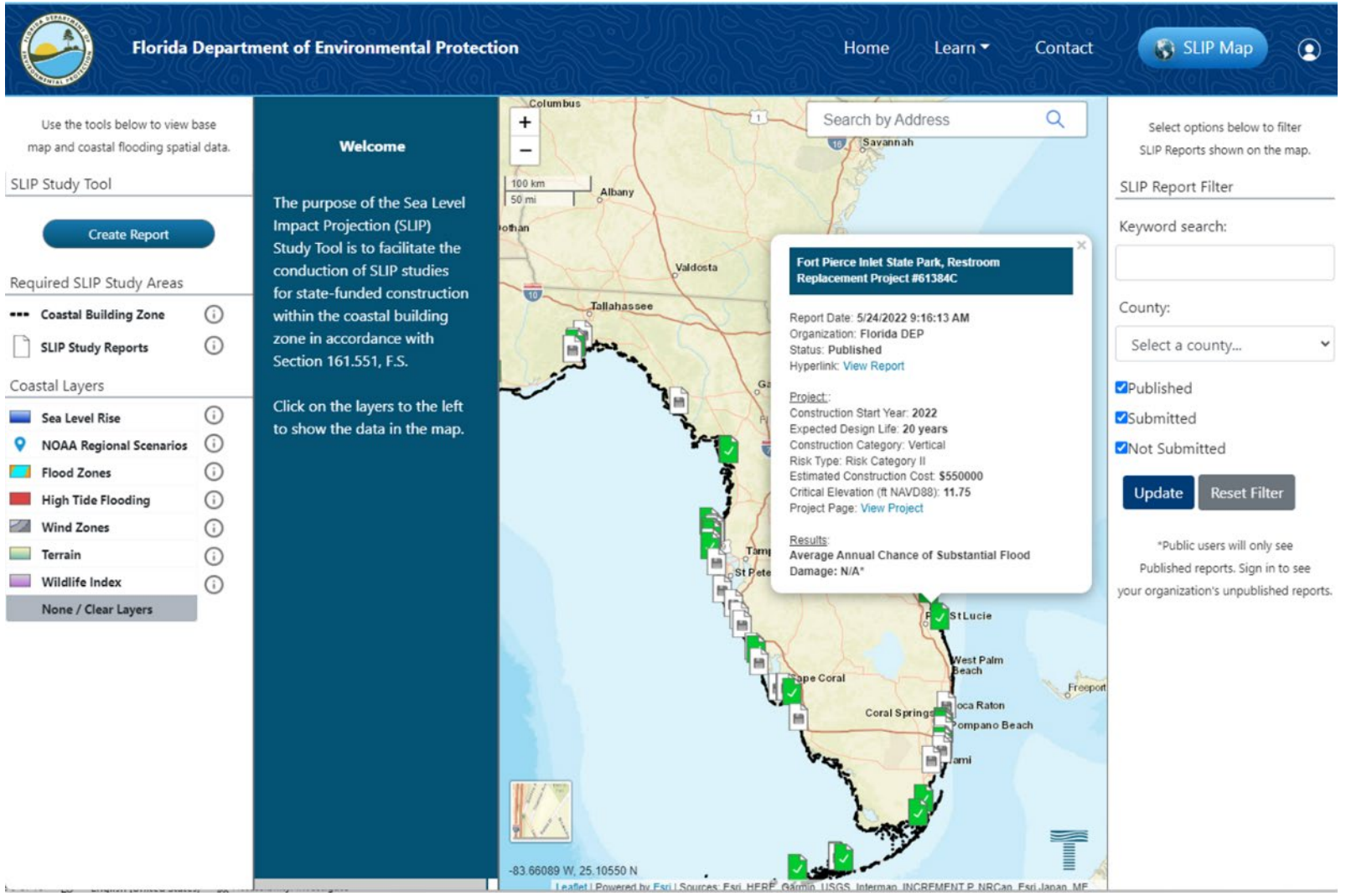
Recent Website Enhancements

- Signed-in users can view your org's unpublished SLIP reports
- Public can only view published reports



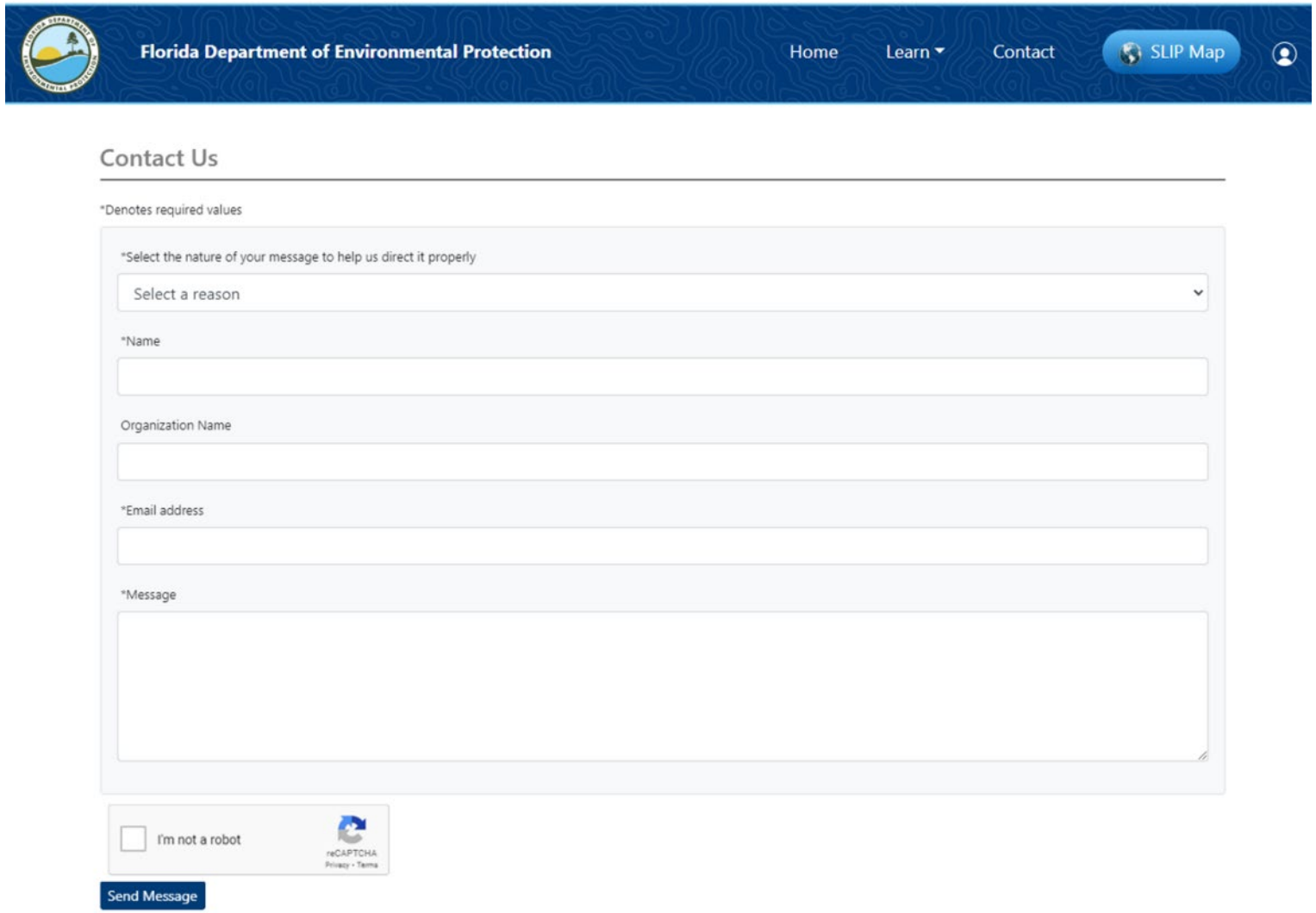
Recent Website Enhancements

- Select a report icon for a snapshot overview



Recent Website Enhancements

- Added a reCAPTCHA to reduce email spam received by FDEP



Summary

- FDEP's Sea Level Impact Projection Tool simplifies mandatory reports
  - Minimal inputs required
  - Quick and easy to perform SLIP study
  - Provides overview of risks and coastal flooding hazards
  - Shows adaptation options
  - Published SLIP reports available to the public
- SLIP Tool has room for growth
  - Legislation may change the SLIP requirements
  - More refined analysis may be requested
  - Integrate with Florida Statewide Vulnerability Assessment

Angela Schedel, aschedel@taylorengineering.com, 904-731-7040

Public View: Adaptation Matrix

CATEGORY	HORIZONTAL (Construction other than a Building)						VERTICAL (Building)				This columns overrides all others	To address the added wave hazard, more stringent building practices are required in Zone VE, such as elevating a home on pilings so that waves can pass beneath it, or a prohibition to building on fill, which can be easily washed away by waves. https://www.fema.gov/flood-maps/coastal/insurance-rate-maps
SUB-CATEGORY	Road (Evacuation Route)	Road (Non-Evacuation)	Parking Lot	Bridge	Utilities (Below Grade)	Utilities (Elevated)	I	II	III	IV		
DESCRIPTOR							Low Hazard to Human Life in the Event of Failure	Structures not in Categories I, III, or IV	Substantial Hazard to Human Life in the Event of Failure	Essential Facilities	Location: if on the open coast (within the VE zone)	
Build on Partially Elevated Areas	X	X	X	X	X			X	X	X	Not an option	
Check Valve / Non-Return Valves					X			X	X	X		
Elevated Flood Wall / Flood Gate	X							X	X	X		
Flood Barriers (Passive or Active)	X						X	X	X	X		
Flood Damage-Resistant Materials	X	X	X	X	X		X	X	X	X		
Living Shoreline											X	
Raising Land	X		X	X		X		X	X	X	Not an option	
Reduced Paved Surfaces			X					X	X	X		
Utility Elevation					X			X	X	X		
Foundation Flood Vents							X	X				
Elevate Finished First Floor								X	X	X		
Relocate Structure											X	
Dune Restoration / Beach Nourishment											X	
Wetland Restoration / Retention Pond	X								X	X		
Floodable Park / Water Square		X	X					X	X			
Increase Plantings	X		X				X	X	X	X	X	