

INTRODUCTION TO THE LIFE SAFETY RISK INDICATOR (LSRI)

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LSRI METHODOLOGY

- Efficient methodology to “answer” the question:

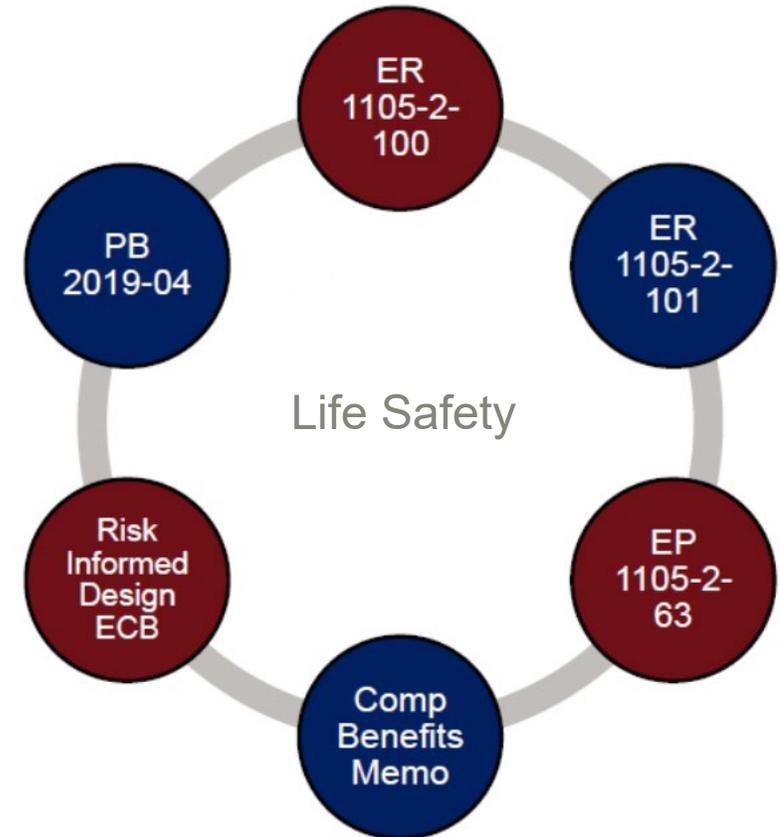
How much will a proposed flood risk management project reduce risk to life?



LIFE SAFETY, LSRI, AND YOU!



- The FY25 budget development process will use LSRI results to screen feasibility studies, PED and construction work packages to identify those for which *life safety benefits* might play a role in justifying funding.
- Not a new requirement
 - LSRI or LSHI (Life Safety Hazard Indicator) has been required for budgeting* for many years
 - Consistent, defensible results were difficult to obtain from previous methods
- LSRI 2.0 leverages consequence methodology and framework of LST 2.0.
- Support initial understanding of life safety in flood and coastal storm risk management studies





WHAT CHALLENGES HAVE YOU ENCOUNTERED WHEN IT COMES TO ESTIMATING LIFE SAFETY RISK?



Click on the Annotation option *N* in the top right-hand corner of your screen (to the left of the participant list if open) and then use the Pencil Tool or checkmark to mark your response.



RISK AND THE LSRI



HAZARDS

What are the hazards and how likely are they to occur?

PERFORMANCE

How will the infrastructure perform in the face of these hazards?

CONSEQUENCE

Who and what are in harm's way?
How susceptible to harm are they?
How much harm is caused?



$$\text{RISK} = f(\text{HAZARD, PERFORMANCE, CONSEQUENCE})$$

Problem Statement:

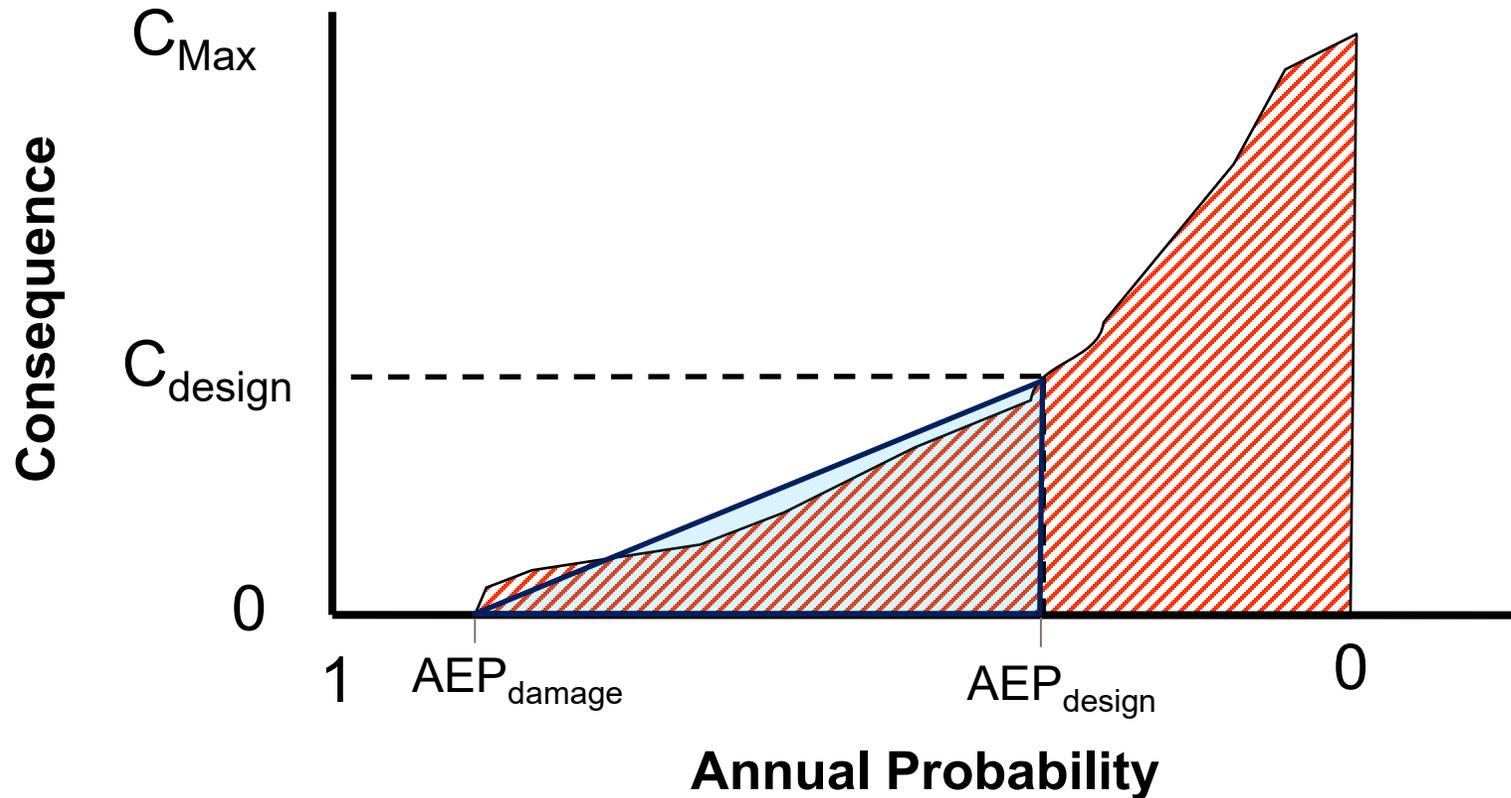
What is the lowest level-of-effort that can be applied to generate credible risk results?



METHODOLOGY



LSRI = Life Safety Risk Indicator \approx Expected Annual Life Loss Reduced



$$LSRI = \text{Life risk reduced} = \frac{1}{2} * C_{design} * (AEP_{damage} - AEP_{design})$$



LIFE LOSS ESTIMATION BASICS



Life loss calculation essential elements:

- Initial distribution of people
- Redistribution of people
 - Warning
 - Response
 - Evacuation potential
- Flood characteristics
 - Arrival time, depth, velocity
- Shelter provided by final location
- Fatality rates
- Indirect life loss





LIFE LOSS ESTIMATION BASICS



Life loss calculation essential elements:

- Initial distribution of people → NSI 2.0
- Redistribution of people → User inputs for:
 - 1. Evacuation Planning
 - 2. Community Awareness
 - 3. Flood Warning Effectiveness
 - 4. Hazard Advance Notice
 - Warning
 - Response
 - Evacuation potential
- Flood characteristics → Simplified HEC-RAS
 - Arrival time, depth, velocity
- Shelter provided by final location → Simplified LifeSim
- Fatality rates

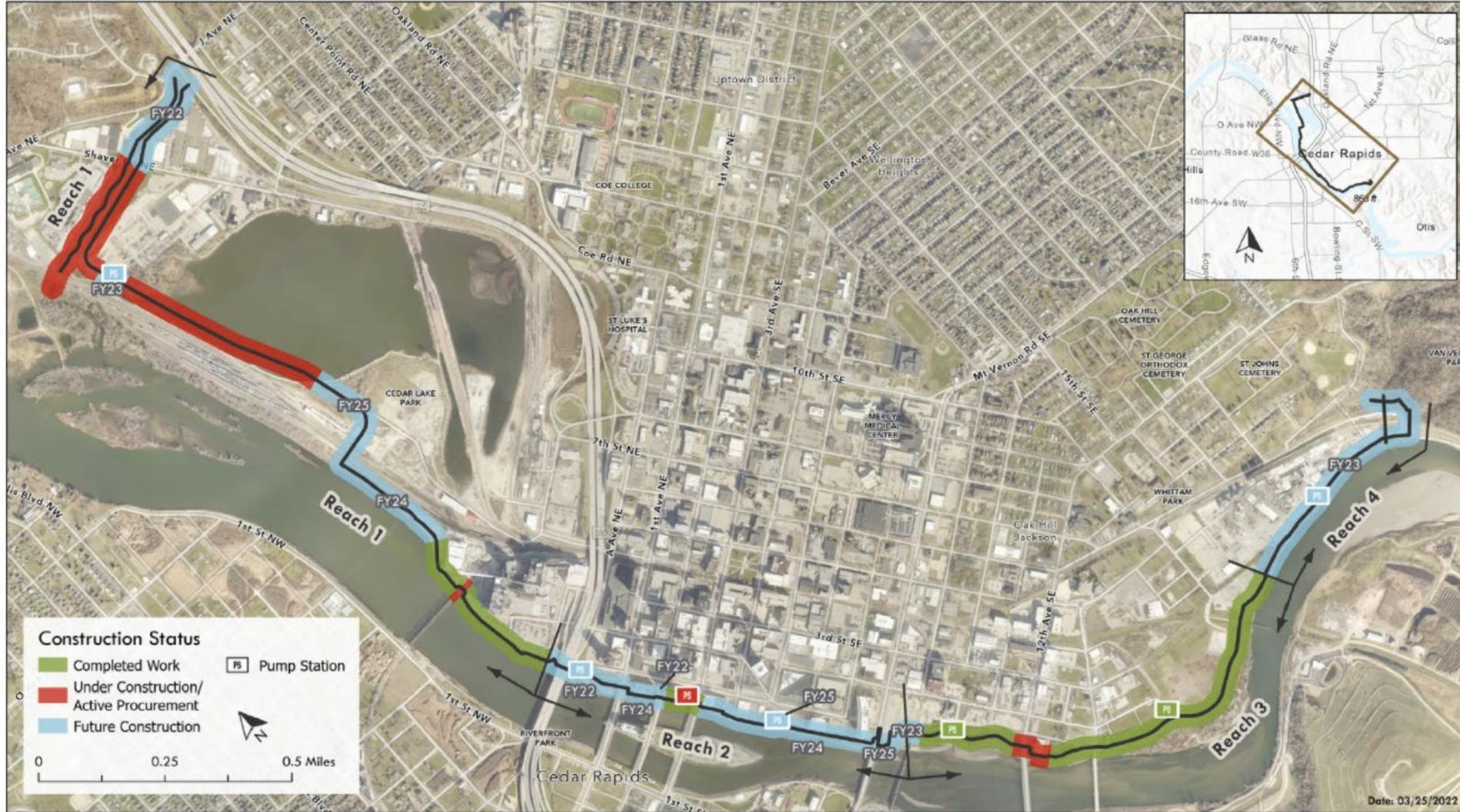


EXAMPLE APPLICATIONS



Rock Island District

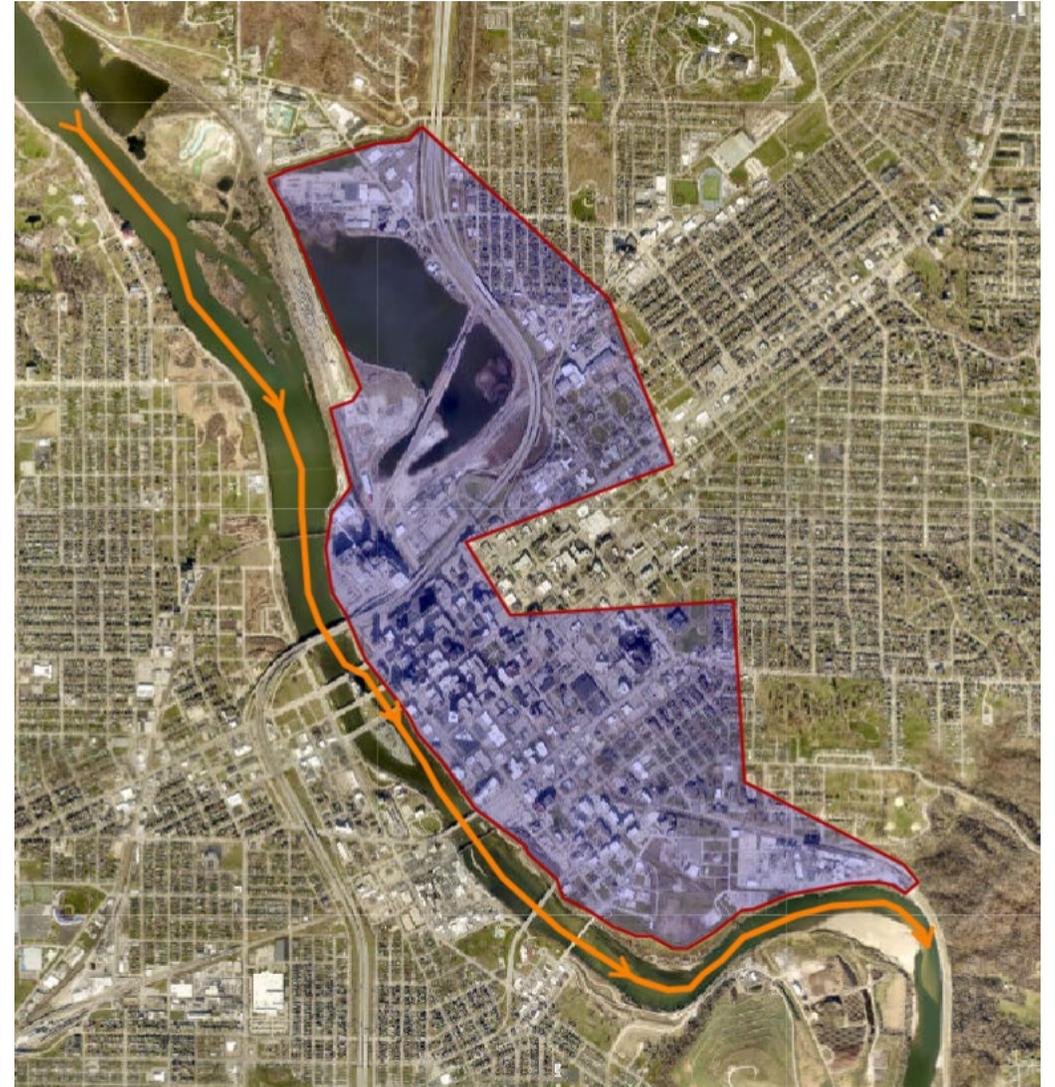
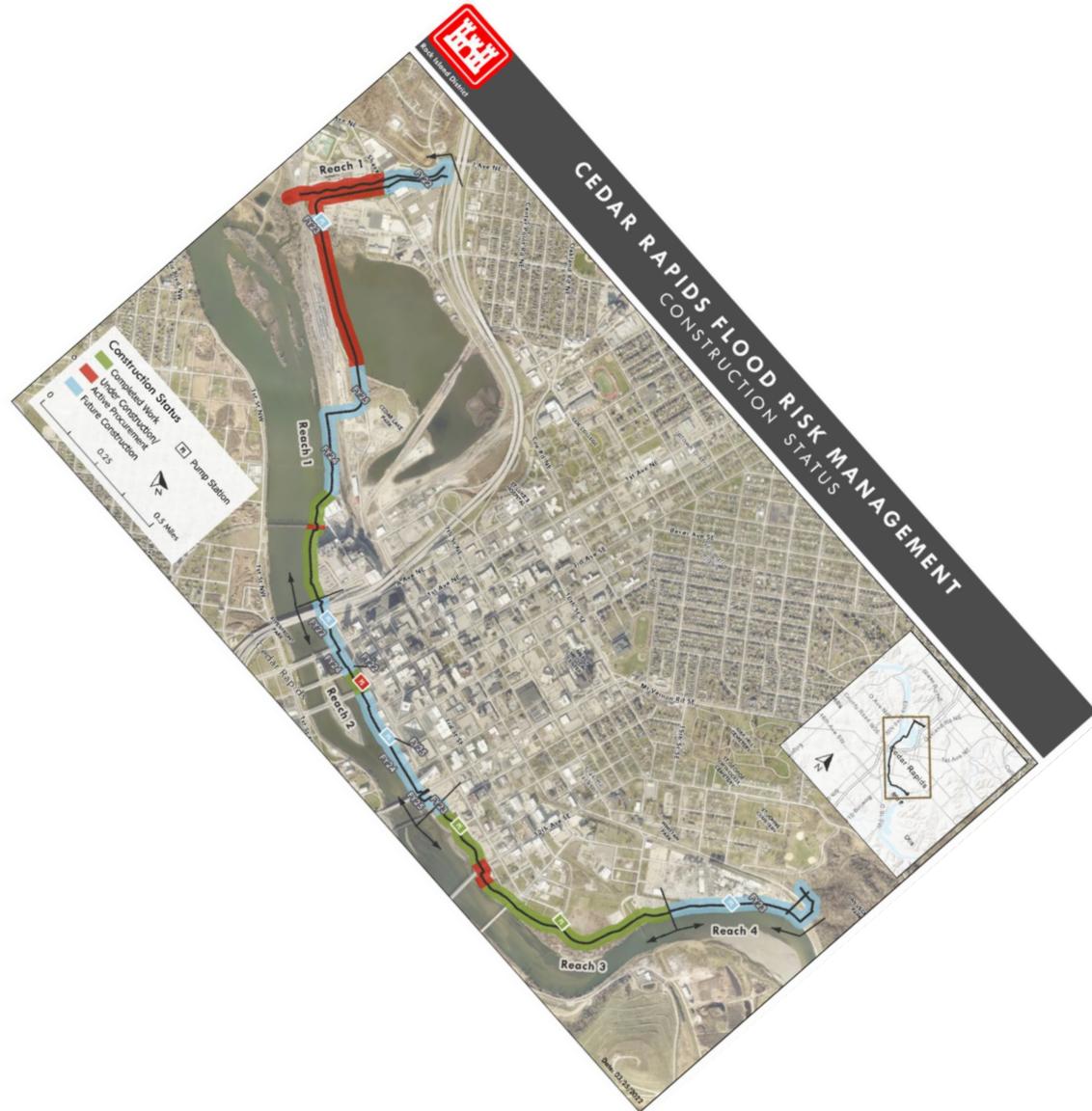
CEDAR RAPIDS FLOOD RISK MANAGEMENT CONSTRUCTION STATUS



- Recommended alternative provides protection along the east bank of the Cedar River. It includes earthen levees, floodwalls, and closure structures for a total length of 3.15 miles.



CEDAR RAPIDS PROJECT AREA





STRUCTURE INVENTORY/PAR



Project Area Information

Base Data	
Day population in Project Area	18,366
Night population in Project Area	3,772
Number of Structures in Project Area	1,455
Property Value in Project Area (\$1000s)	3,756,098

Index Factors	
Population Day Index Factor *	<input type="text" value="1.0"/>
Population Night Index Factor *	<input type="text" value="1.0"/>
Property Value Index Factor *	<input type="text" value="1.0"/>

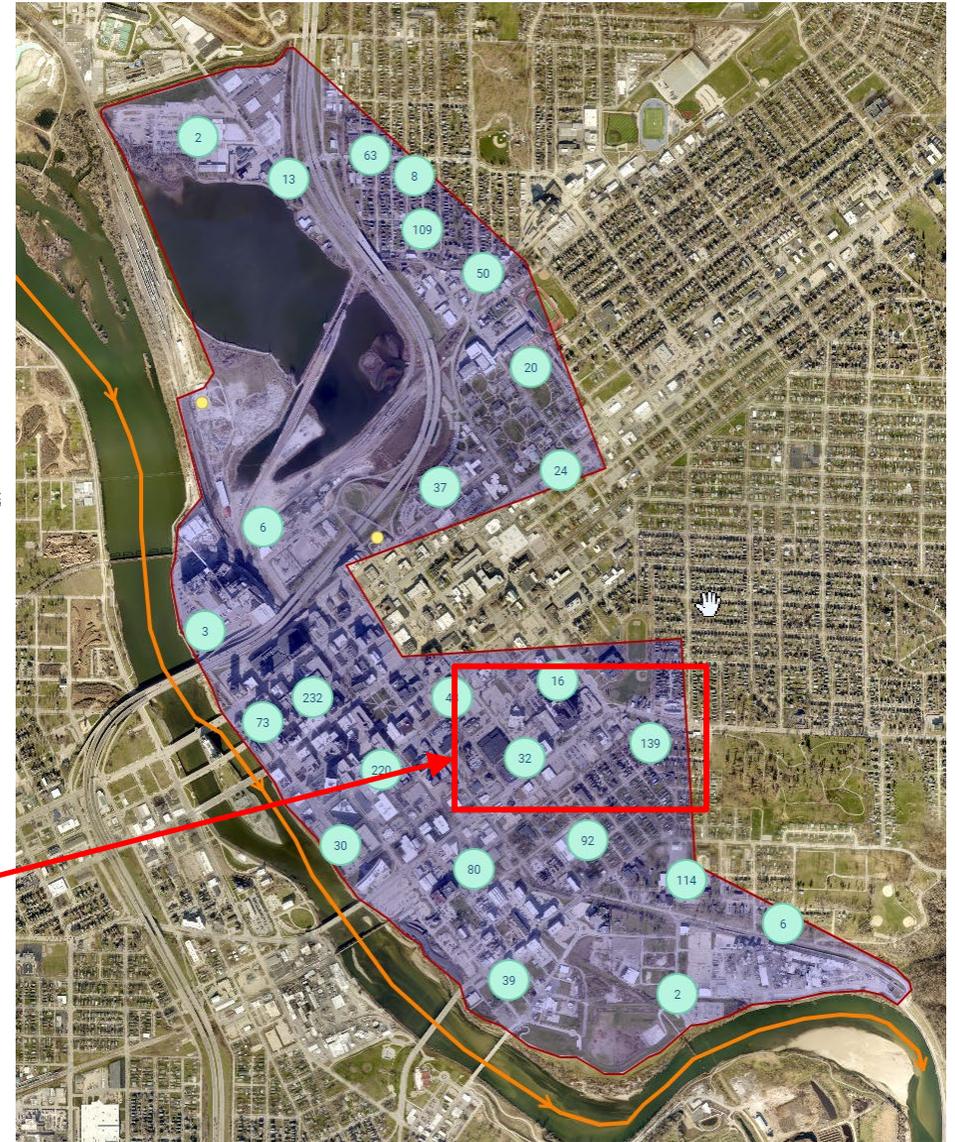
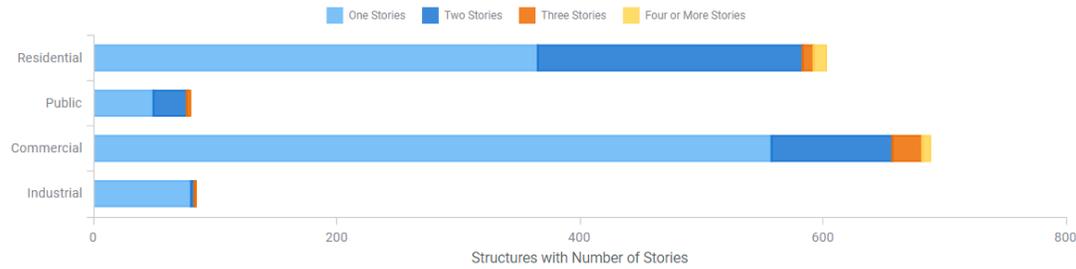
Indexed Data (Used In Compute)	
Daytime Population Estimate	18,366
Nighttime Population Estimate	3,772
Number of Structures in Project Area	1,455
Property Value in Project Area (\$1000s)	3,756,098

Comments

[Map](#) | [Structure Summary](#)

DAMAGE CATEGORY	POPULATION				STRUCTURE		
	UNDER 65 DAY	OVER 65 DAY	UNDER 65 NIGHT	OVER 65 NIGHT	# STRUCTURES	STRUCTURAL VALUE (\$1000S)	CONTENT VALUE (\$1000S)
Residential	1,644	557	2,402	580	603	283,315	179,526
Public	1,567	34	32	0	80	77,230	87,108
Commercial	13,076	660	686	29	688	1,242,788	1,474,106
Industrial	791	37	41	2	84	167,302	244,724
Total	17,078	1,288	3,161	611	1,455	1,770,635	1,985,463

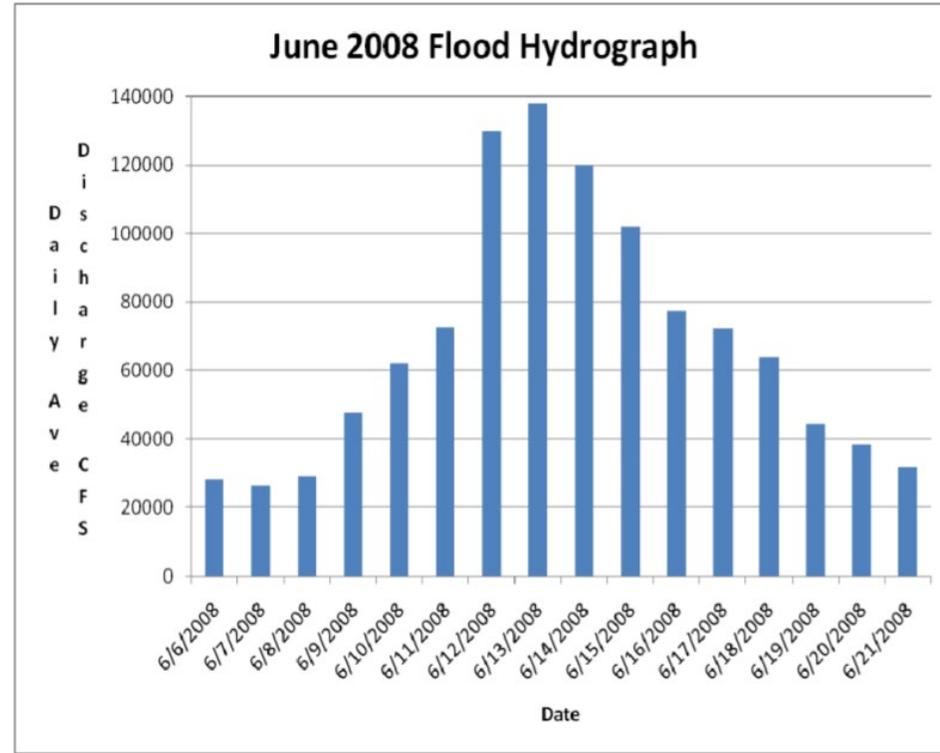
[Number of Stories](#) | [Construction Type](#) | [Foundation Height](#)





LSRI INPUTS

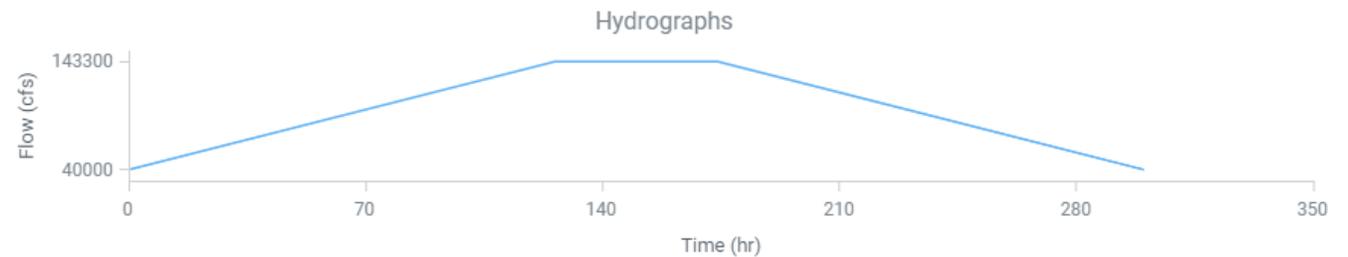
- AEP start of damages
 - 10-yr event (approximately)
 - Private levees
- AEP design event
 - 750-yr event (2008 flood)
- Design event hydrograph



Type:

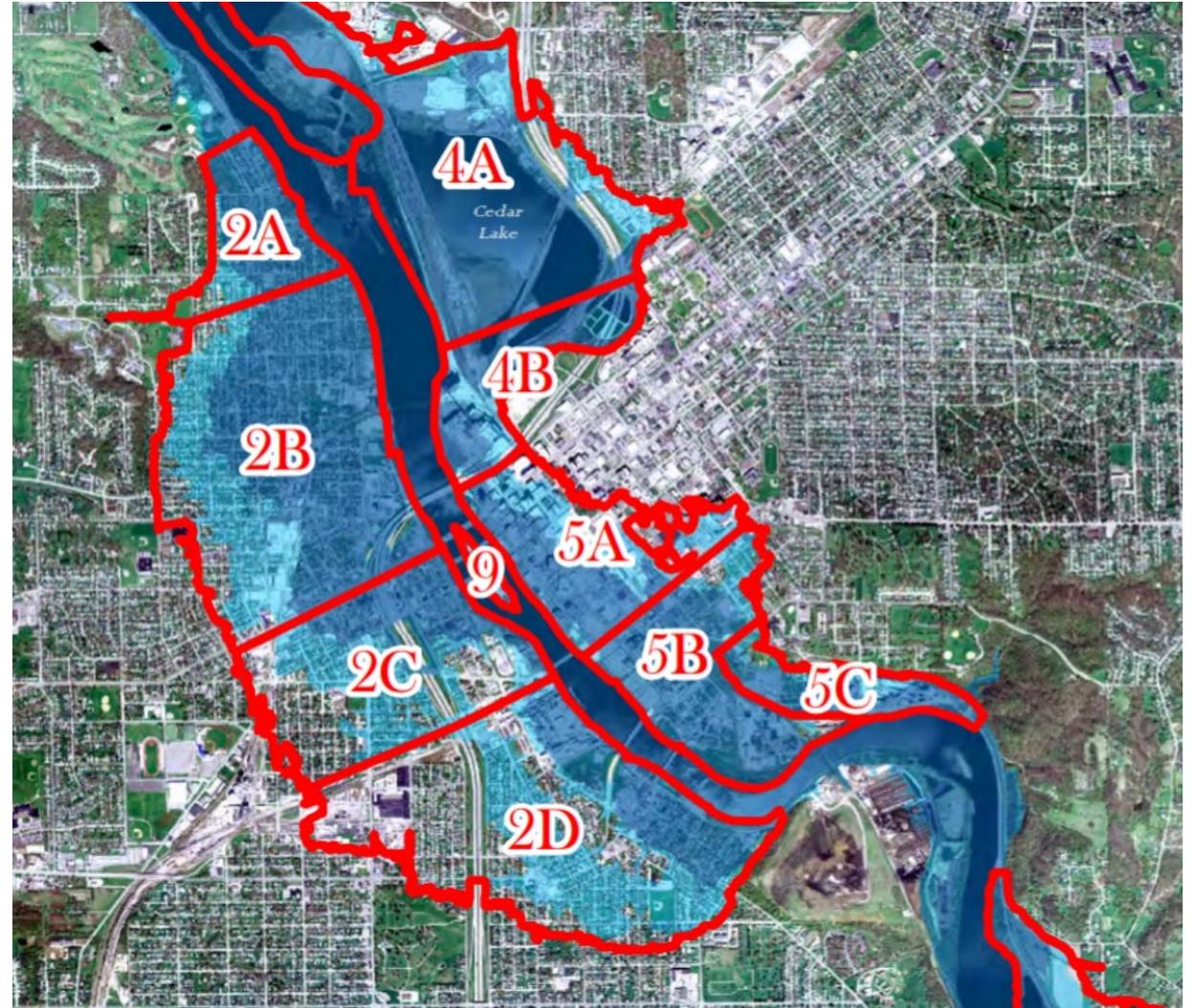
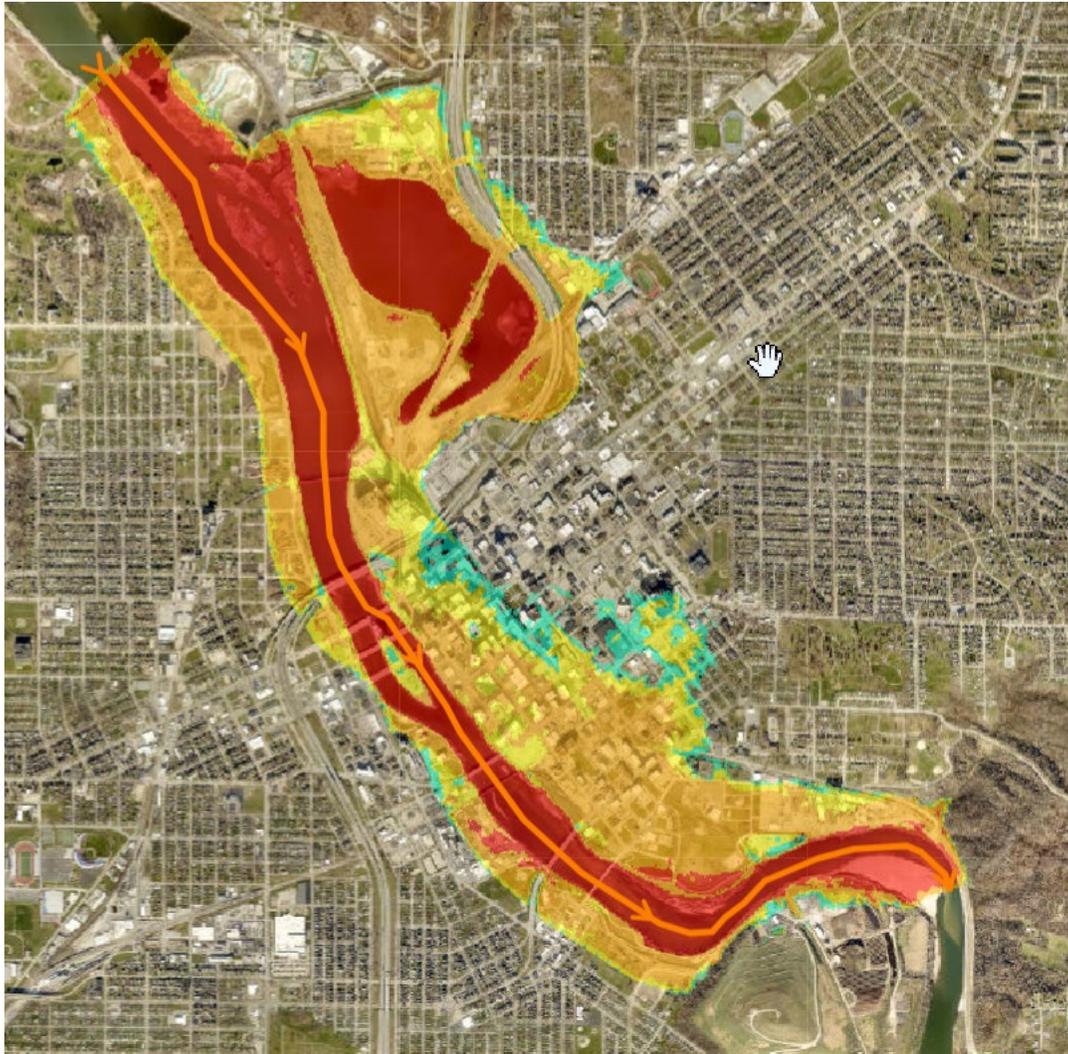
Base (cfs): Total Duration (hrs):

Peak (cfs): Peak Duration (hrs):





LSRI INUNDATION





CONSEQUENCE RESULTS



▶ EXPAND ALL

Evacuation Planning

Which category best describes the emergency evacuation planning for the community of the communities located in the leveed area?

Flood Specific ▼

▶ Comments (0 characters)

Community Awareness

Which category best describes the flood risk awareness of the community or communities located in the leveed area?

Very Aware ▼

▶ Comments (0 characters)

Flood Warning Effectiveness

Which category best describes the flood warning capabilities of the community or communities in the leveed area?

Fast ▼

▶ Comments (0 characters)

Hazard Advanced Notice

How would you describe the amount of warning time available prior to first structure getting wet?

Moderate ▼

▶ Comments (0 characters)



PARAMETER	DAY	NIGHT
PAR	8,358	5,693
Exposed PAR	155	110
Exposed %	1.85%	1.92%
Life Loss	1	1
Life Loss (Exposure Weighted)	1.00	
Fatality Rate	0.01%	0.02%
Life Loss as % of PAR	0.02%	
Weighted Fatality Rate (% of Exposed PAR)	0.79%	
Property Damages	\$760M	
# Structures Inundated	785	



LSRI RESULTS – CEDAR RIVER CEDAR RAPIDS



Table B-73c. Summary of Annual Charges for Alternative 4C
(Oct 2010 prices, 4-1/8% Discount Rate, 50-Year Evaluation Period)

Description	Amount
Estimated NED Cost	98,543,755
Interest During Construction	8,864,157
Total Economic Costs	107,407,912
Annual Interest & Amortization	5,107,353
Annual Operation & Maintenance ¹	17,679
Total Annual Charges	5,125,032

LSRI and CSSL Inputs

AEP for Damage ⓘ

AEP for Design ⓘ

Exposure Weighted Life Loss ⓘ

Annualized Project Cost ⓘ

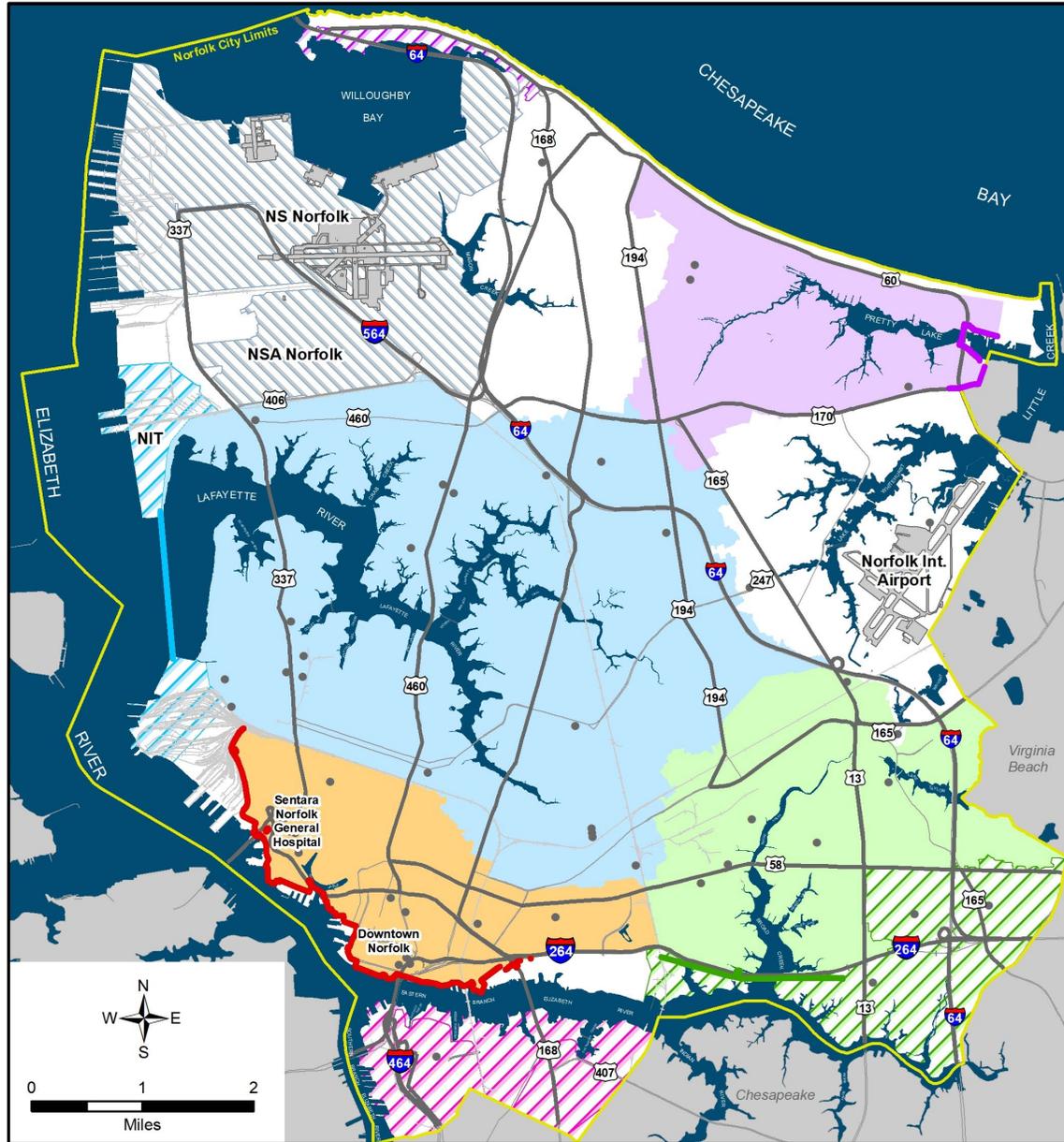
Results

LSRI ⓘ

CSSL ⓘ



NORFOLK CSRM PLAN



LEGEND

Structural Flood Risk Management Measures

- Ghent-Downtown-Harbor Park
- Pretty Lake Surge Barrier
- Lafayette Outer Surge Barrier
- Broad Creek Surge Barrier

Structural Measures Risk Management Area

Hatched Area Indicates Non-Structural Measures

- Ghent-Downtown-Harbor Park
- Pretty Lake Surge Barrier
- Lafayette Outer Surge Barrier
- Broad Creek Surge Barrier
- Campostella-Berkley Non-Structural Measures Area
- Critical Infrastructure
- Evacuation Route
- Navy Base
- Water
- Major Road
- Railroad



PRETTY LAKE SURGE BARRIER



Project Area Information

Base Data

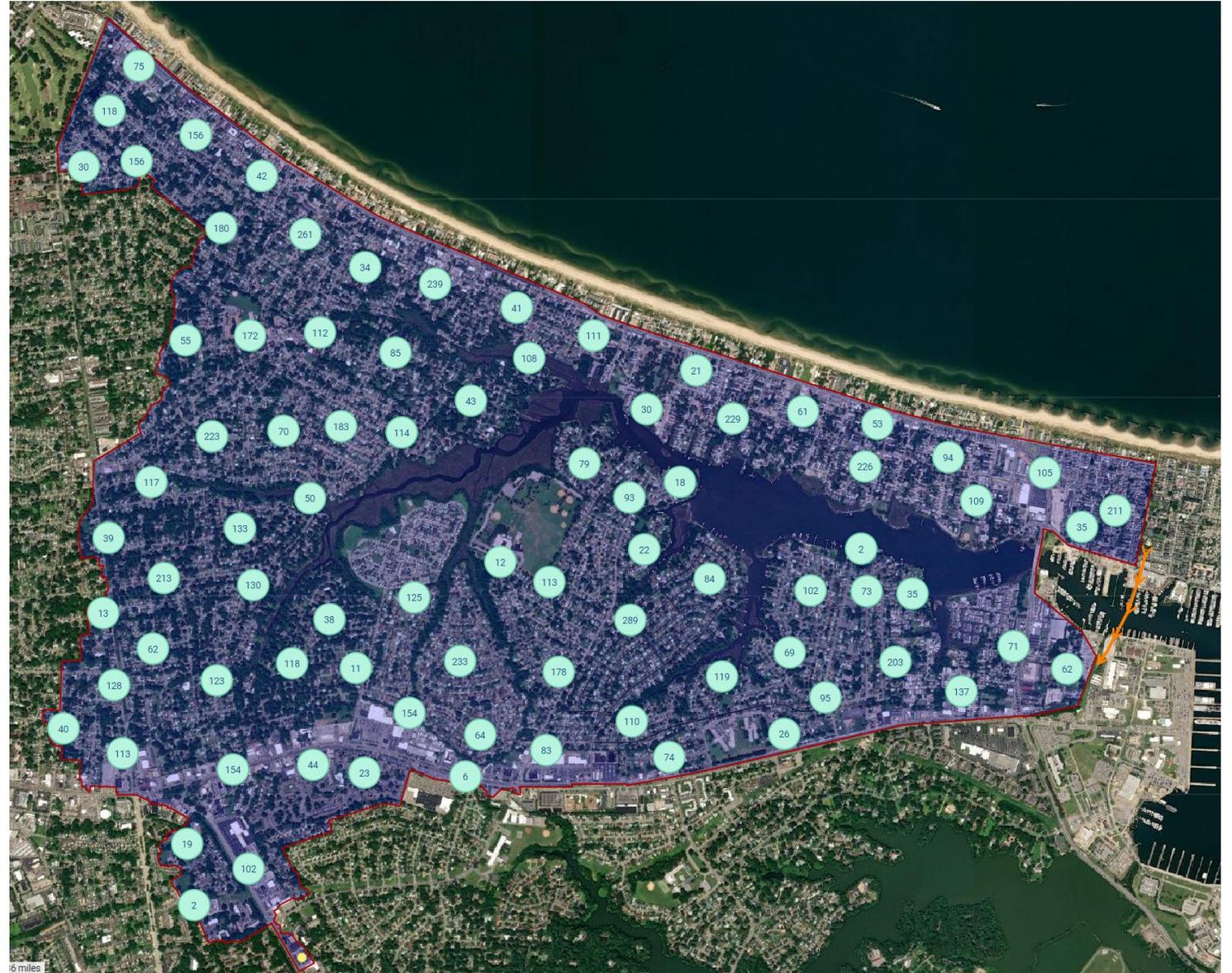
Day population in Project Area	17,624
Night population in Project Area	24,417
Number of Structures in Project Area	8,186
Property Value in Project Area (\$1000s)	3,323,478

Index Factors

Population Day Index Factor *	<input type="text" value="1.0"/>
Population Night Index Factor *	<input type="text" value="1.0"/>
Property Value Index Factor *	<input type="text" value="1.0"/>

Indexed Data (Used In Compute)

Daytime Population Estimate	17,624
Nighttime Population Estimate	24,417
Number of Structures in Project Area	8,186
Property Value in Project Area (\$1000s)	3,323,478





PRETTY LAKE SURGE BARRIER

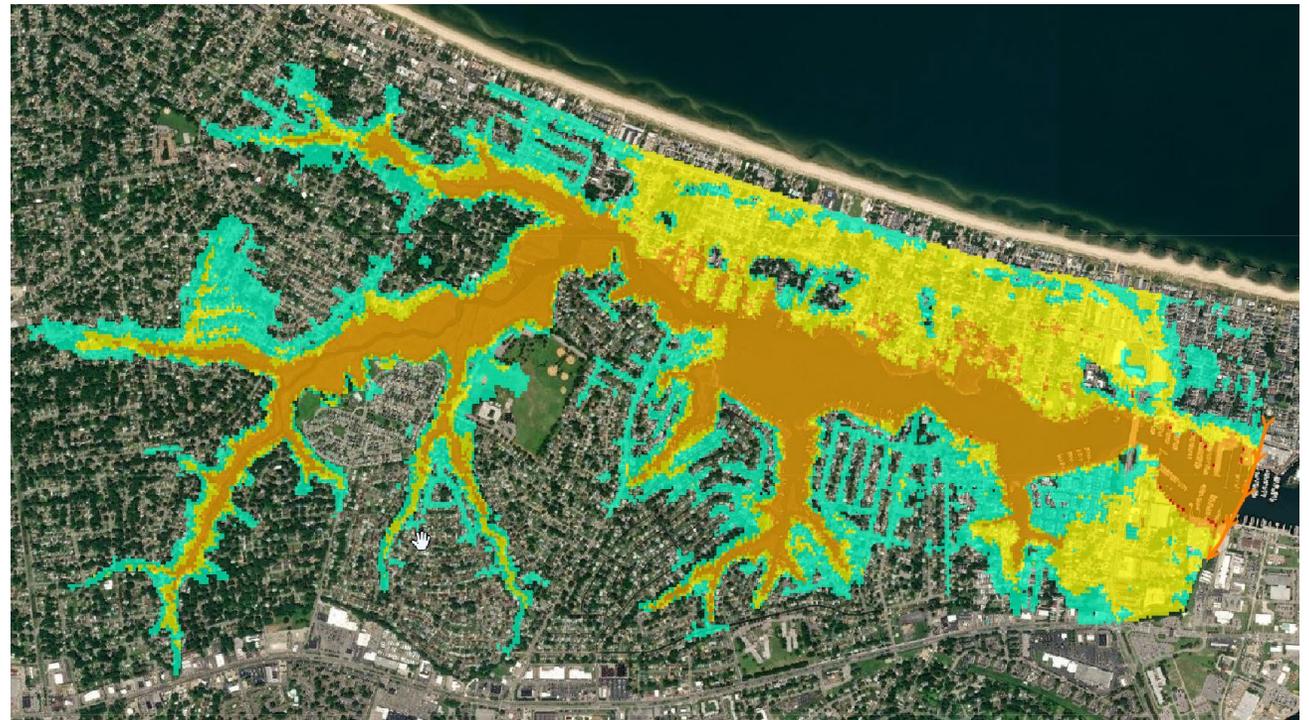
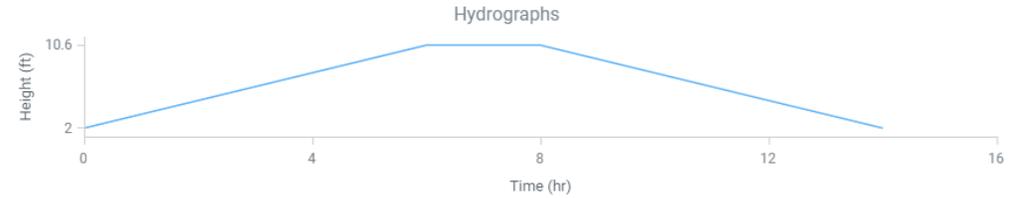


PARAMETER	DAY	NIGHT
PAR	5,257	5,257
Exposed Population	248	248
% of PAR Exposed	4.72%	4.72%
Life Loss	0	0
Fatality Rate	0.00%	0.00%
Life Loss (Exposure Weighted)	0.00	
Life Loss as % of PAR	0.00%	
Weighted Fatality Rate (% of Exposed PAR)	0.00%	
Property Damages	\$146M	
# Structures Inundated	1,692	

Type:

Base (feet): Total Duration (hrs):

Peak (feet): Peak Duration (hrs):





RESULTS – PRETTY LAKE



LSRI and CSSL Inputs

AEP for Damage ⓘ	<input type="text" value="1.000e-1"/>
AEP for Design ⓘ	<input type="text" value="1.400e-2"/>
Exposure Weighted Life Loss ⓘ	<input type="text" value="0"/>
Annualized Project Cost ⓘ	<input type="text" value="\$3,219,000.00"/>

Results

LSRI ⓘ	<input type="text" value="0.000"/>
CSSL ⓘ	<input type="text" value="N/A"/>



BROAD CREEK STRUCTURAL

Base Data

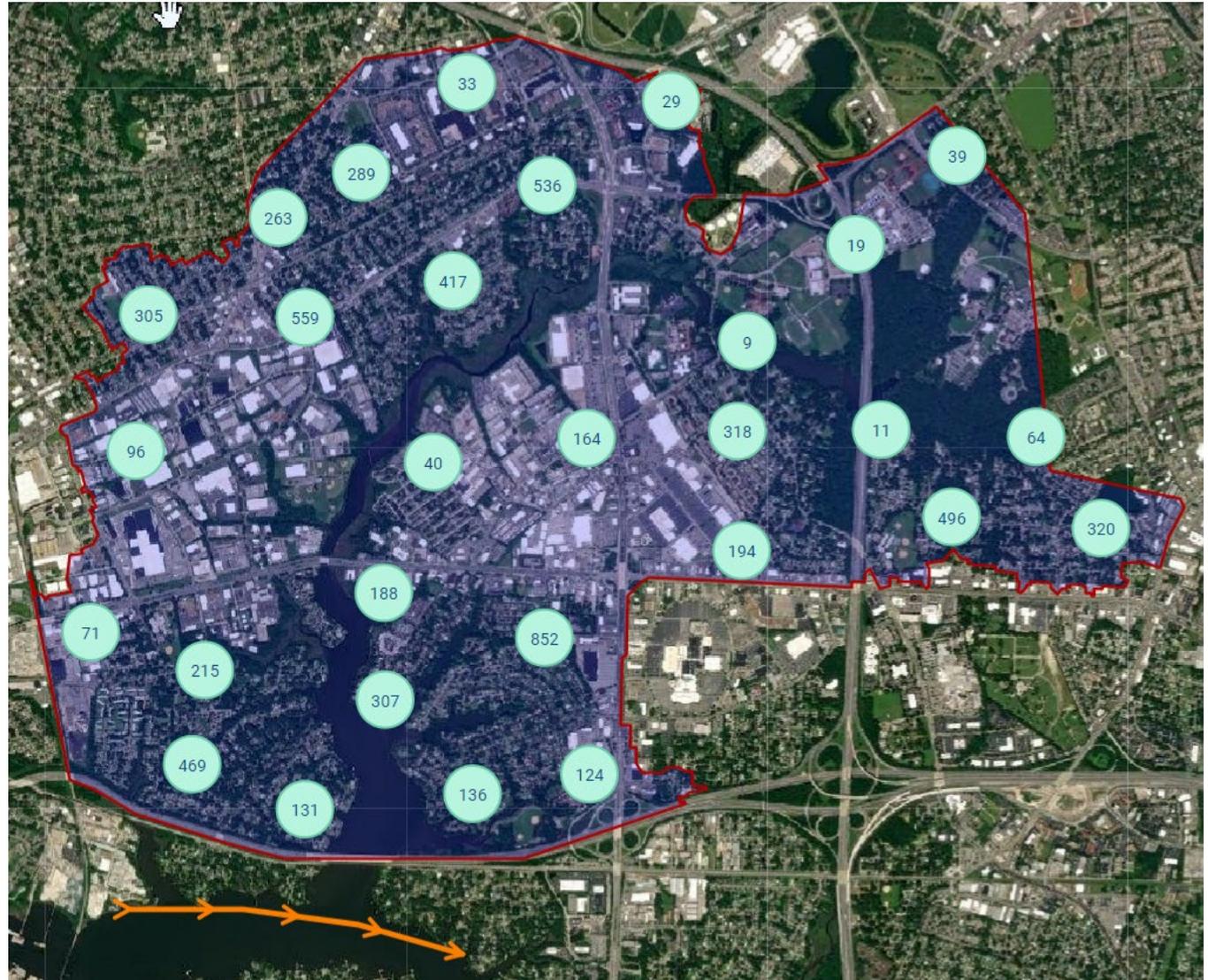
Day population in Project Area	33,904
Night population in Project Area	19,600
Number of Structures in Project Area	6,694
Property Value in Project Area (\$1000s)	7,381,287

Index Factors

Population Day Index Factor *	<input type="text" value="1.0"/>
Population Night Index Factor *	<input type="text" value="1.0"/>
Property Value Index Factor *	<input type="text" value="1.0"/>

Indexed Data (Used In Compute)

Daytime Population Estimate	33,904
Nighttime Population Estimate	19,600
Number of Structures in Project Area	6,694
Property Value in Project Area (\$1000s)	7,381,287

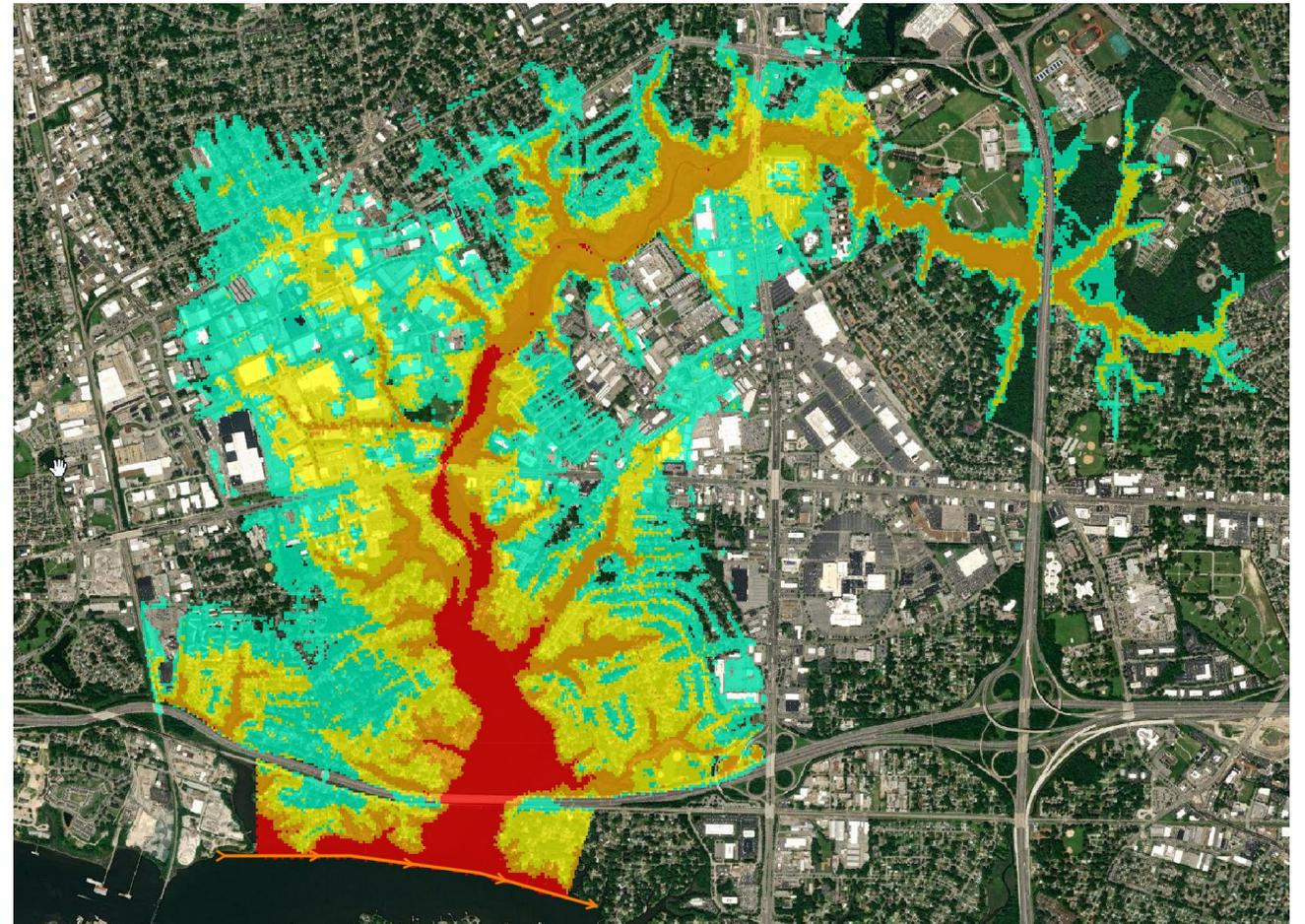




BROAD CREEK STRUCTURAL



PARAMETER	DAY	NIGHT
PAR	9,056	7,960
Exposed Population	1,642	1,508
% of PAR Exposed	18.13%	18.94%
Life Loss	4	2
Fatality Rate	0.04%	0.03%
Life Loss (Exposure Weighted)	2.90	
Life Loss as % of PAR	0.03%	
Weighted Fatality Rate (% of Exposed PAR)	0.18%	
Property Damages	\$404M	
# Structures Inundated	2,396	





RESULTS - BROAD CREEK STRUCTURAL



Project Information Consequences **Risk**

LSRI and CSSL Inputs

AEP for Damage ⓘ

AEP for Design ⓘ

Exposure Weighted Life Loss ⓘ

Annualized Project Cost ⓘ

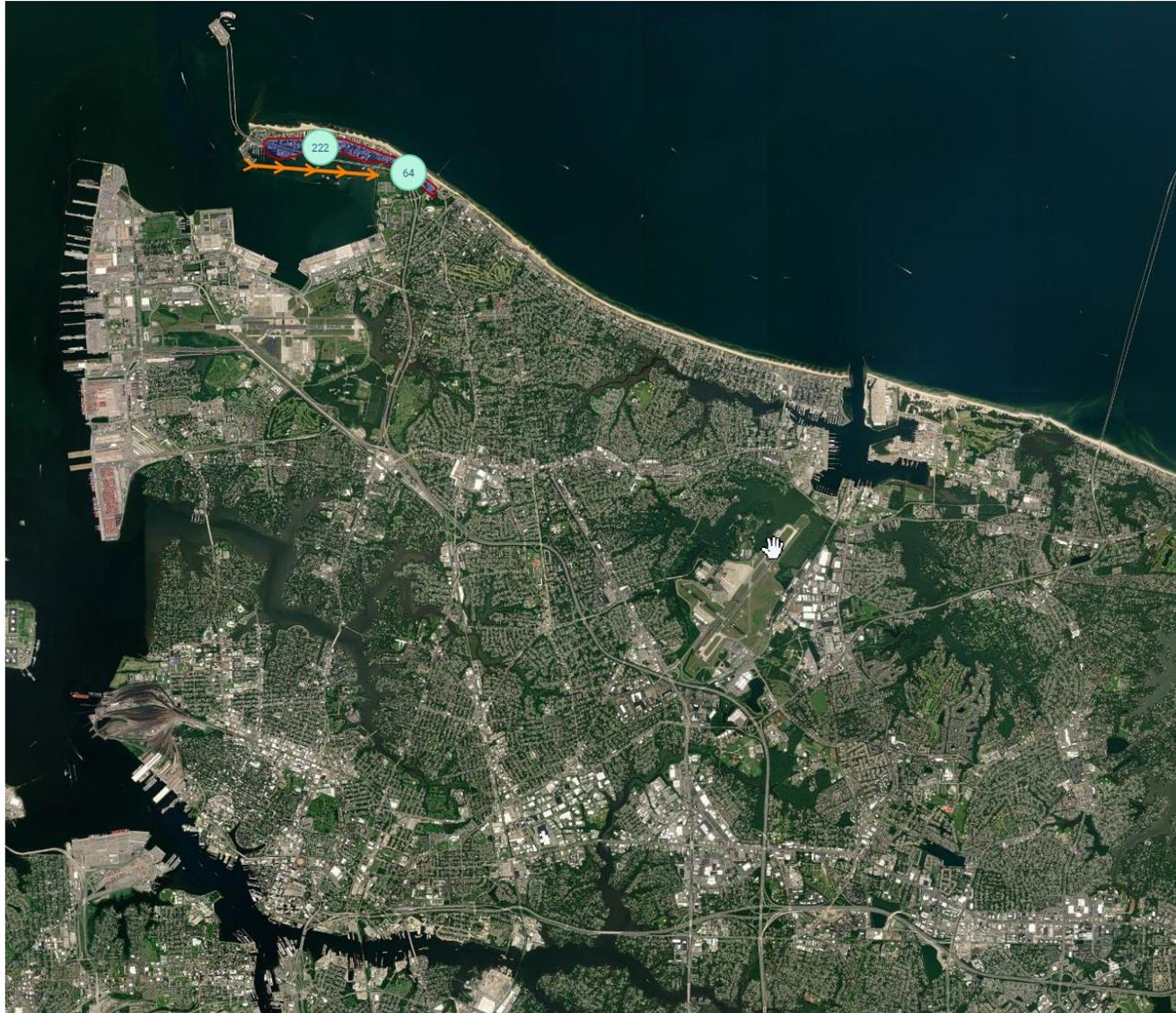
Results

LSRI ⓘ

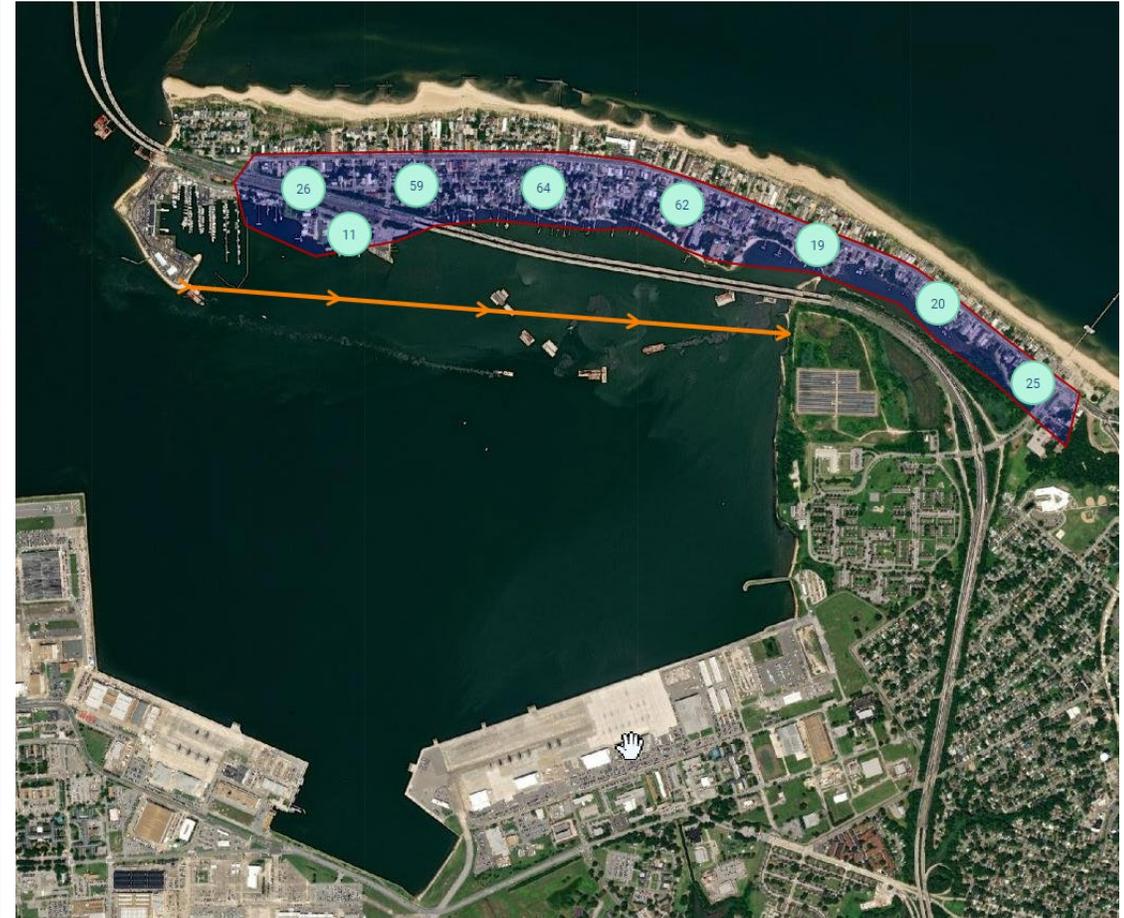
CSSL ⓘ



WILLOUGHBY SPIT - NONSTRUCTURAL

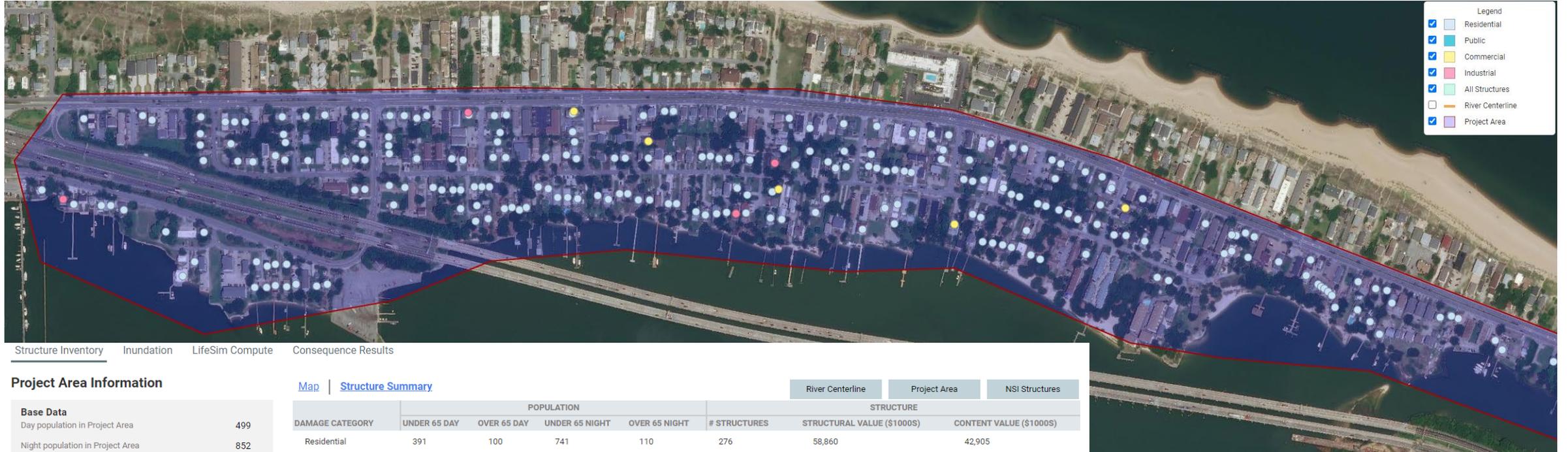


Only include those structures to which non-structural measures would be applied.





WILLOUGHBY SPIT - NONSTRUCTURAL



Structure Inventory | Inundation | LifeSim Compute | Consequence Results

Project Area Information

Base Data	
Day population in Project Area	499
Night population in Project Area	852
Number of Structures in Project Area	286
Property Value in Project Area (\$1000s)	106,336

Index Factors

Population Day Index Factor *

Population Night Index Factor *

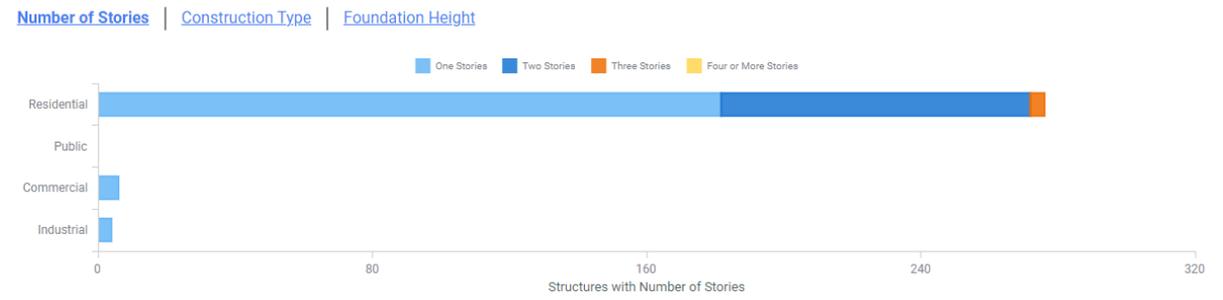
Property Value Index Factor *

Indexed Data (Used In Compute)

Daytime Population Estimate	499
Nighttime Population Estimate	852
Number of Structures in Project Area	286
Property Value in Project Area (\$1000s)	106,336

[Map](#) | [Structure Summary](#)

DAMAGE CATEGORY	POPULATION				# STRUCTURES	River Centerline	Project Area	NSI Structures
	UNDER 65 DAY	OVER 65 DAY	UNDER 65 NIGHT	OVER 65 NIGHT		STRUCTURAL VALUE (\$1000S)	CONTENT VALUE (\$1000S)	
Residential	391	100	741	110	276	58,860	42,905	
Public	0	0	0	0	0	0	0	
Commercial	3	0	0	0	6	2,093	2,093	
Industrial	4	1	1	0	4	192	192	
Total	398	101	742	110	286	61,145	45,191	





WILLOUGHBY SPIT - NONSTRUCTURAL



PARAMETER	DAY	NIGHT
PAR	776	776
Exposed PAR	234	233
Exposed %	30.15%	30.03%
Life Loss	6	5
Life Loss (Exposure Weighted)	5.45	
Fatality Rate	0.77%	0.64%
Life Loss as % of PAR	0.70%	
Weighted Fatality Rate (% of Exposed PAR)	2.33%	
Property Damages	\$39M	
# Structures Inundated	259	





WILLOUGHBY SPIT - NONSTRUCTURAL



Assumes all structures are floodproofed/raised to such an extent that would prevent damages and loss of life up to the design event.

LSRI and CSSL Inputs	
AEP for Damage ⓘ	<input type="text" value="0.1"/>
AEP for Design ⓘ	<input type="text" value="0.014"/>
Exposure Weighted Life Loss ⓘ	<input type="text" value="5.45"/>
Annualized Project Cost ⓘ	<input type="text" value="\$4,176,000.00"/>

Results	
LSRI ⓘ	<input type="text" value="0.23"/>
CSSL ⓘ	<input type="text" value="\$17,819,500.75"/>



QUESTIONS/DISCUSSION

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