



Village of Key Biscayne Stormwater Management Plan Task Order #1: Summary of Findings and Recommendations

Council Meeting || February 8, 2022

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Vice President – Water Resources SER

Elevating our island paradise

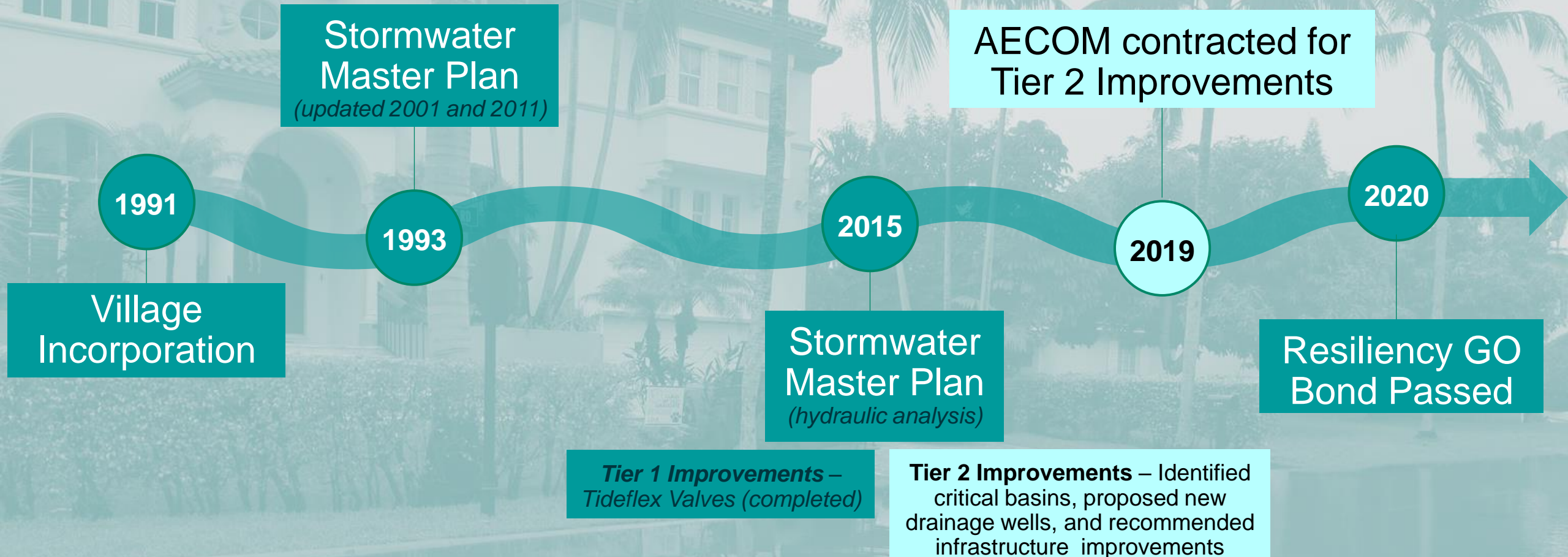
Purpose of the Presentation

Present Findings of Stormwater Assessment

- Gap Analysis Results
- Select a Sea Level Rise Projection
- Select Design Storm
- Establish a Level of Service

History: Stormwater Master Planning

Previous Stormwater Master Plans **did not consider sea level rise, level of service, or boundary conditions.**



History: Stormwater Master Planning





Why Stormwater System Upgrade Now?

- **Meet community's needs**
 - Mitigate street flooding
 - Streamline and maximize stormwater system capacity
 - Develop resilient strategies for Sea Level Rise
- **Improve water quality in Biscayne Bay**

Stormwater System: Discharge Opportunity Analysis

Current Stormwater Discharge

35

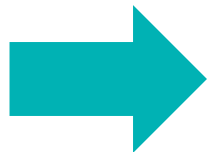
Gravity shallow drainage wells

2

Shallow Injection wells

17

Gravity outfalls



Collection system (inlets and pipes)



Discharge Gap Analysis

Total Service Area

794 acres

210
cfs Existing
Discharge
Capacity

Gap =
-1,774 cfs

Gap =
-2,171 cfs

1,984
cfs 5-year, 24-hour Storm
Discharge
Demand

2,381
cfs 10-year, 24-hour Storm
Discharge
Demand

Considerations to Mitigate the Gap



Interconnected systems with larger diameter pipes



Pump stations

(may require easements and property acquisition)



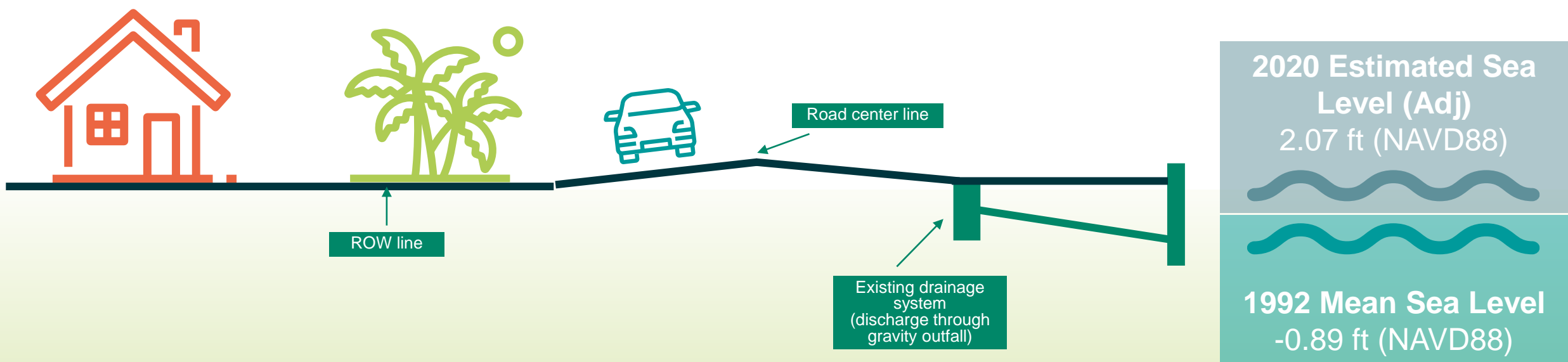
Storage structures to mitigate peak



Green infrastructure

(Right-of-Way encroachment removal)

2020 Estimated Sea Level



Existing system loses effectiveness due to Sea Level Rise

Boundary Condition Analysis - Sea Level Rise Projections

Projections were selected for planning time horizons of 2040, 2050, and 2070

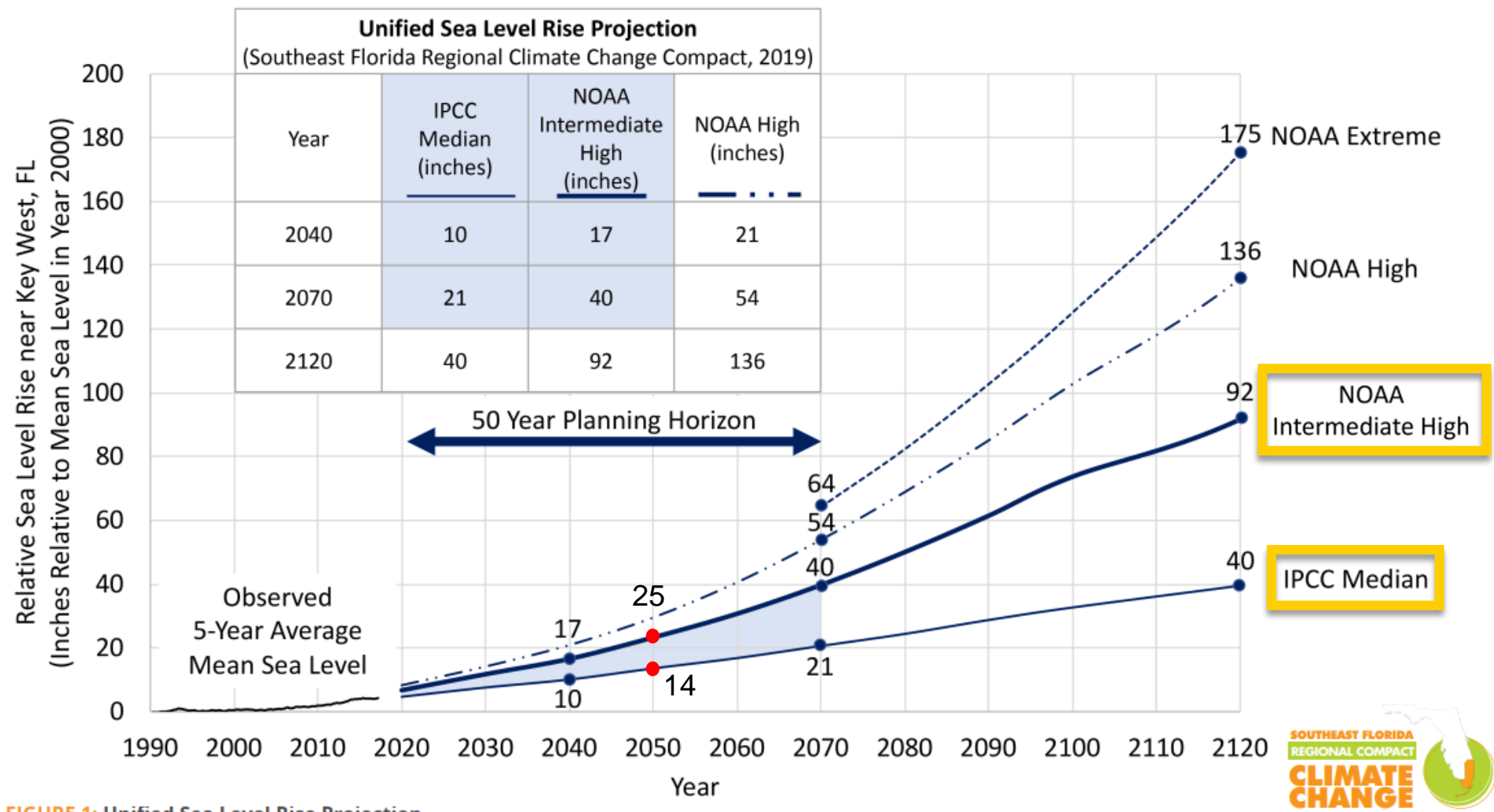


FIGURE 1: Unified Sea Level Rise Projection

2050 Sea Level Rise Projection

IPCC Median
Low Projection 14 in
(2.84 ft NAVD88)

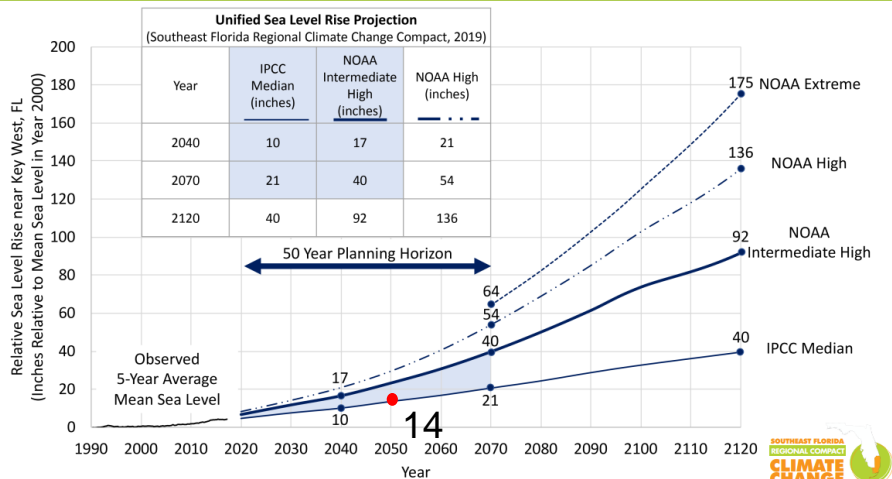


FIGURE 1: Unified Sea Level Rise Projection



2050 Sea Level Rise Projection

NOAA Intermediate High *Medium* Projection 25 in (3.11 ft NAVD88)

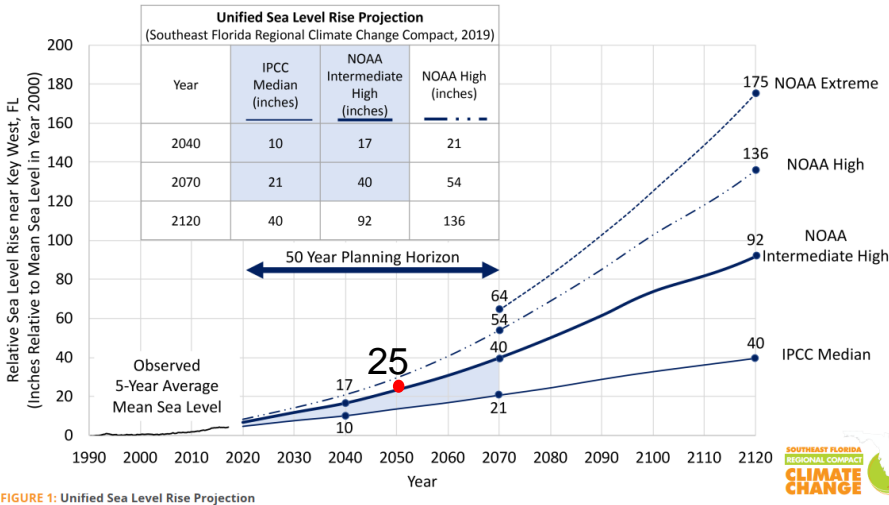


FIGURE 1: Unified Sea Level Rise Projection



Design Storms



5-year, 24-hour storm:
expected **7 inches**.



10-year, 24-hour storm:
expected **8 inches**.

What Do We Mean by “Level of Service?”



Level of Service means that a roadway is designed to meet certain performance expectations by the public

For example, the community could reasonably expect:

- Passable roadways
- Adequate stormwater storage
- Timely discharge
- Infrastructure design life ~30 yrs

Design Condition - Level of Service

ROW Ponding Tolerance

Ponding Depth (feet)

0 – 0.5 – 1.0

Ponding Duration (hours)

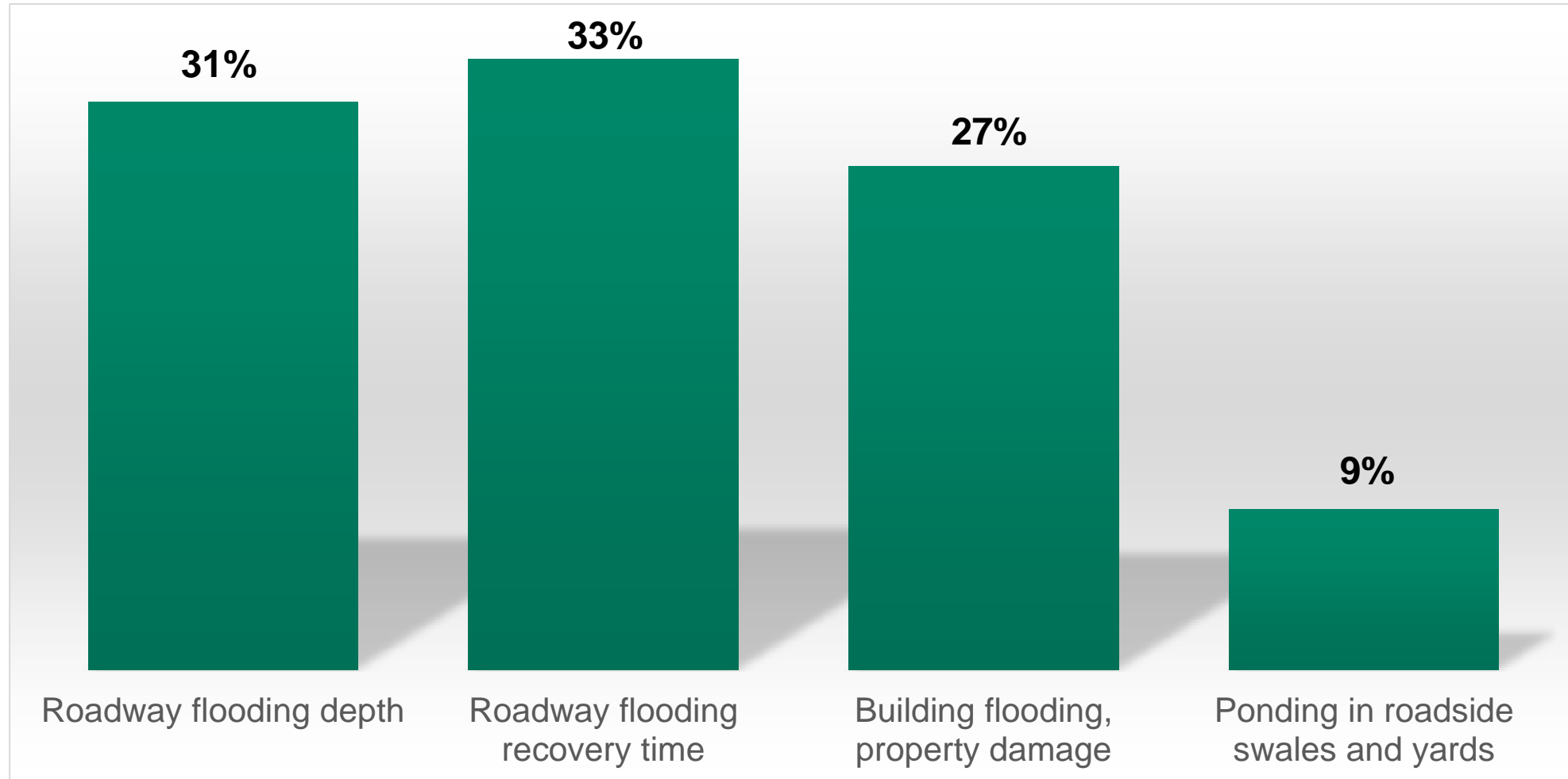
0 – 6-12 – 12-24

Ponding Location

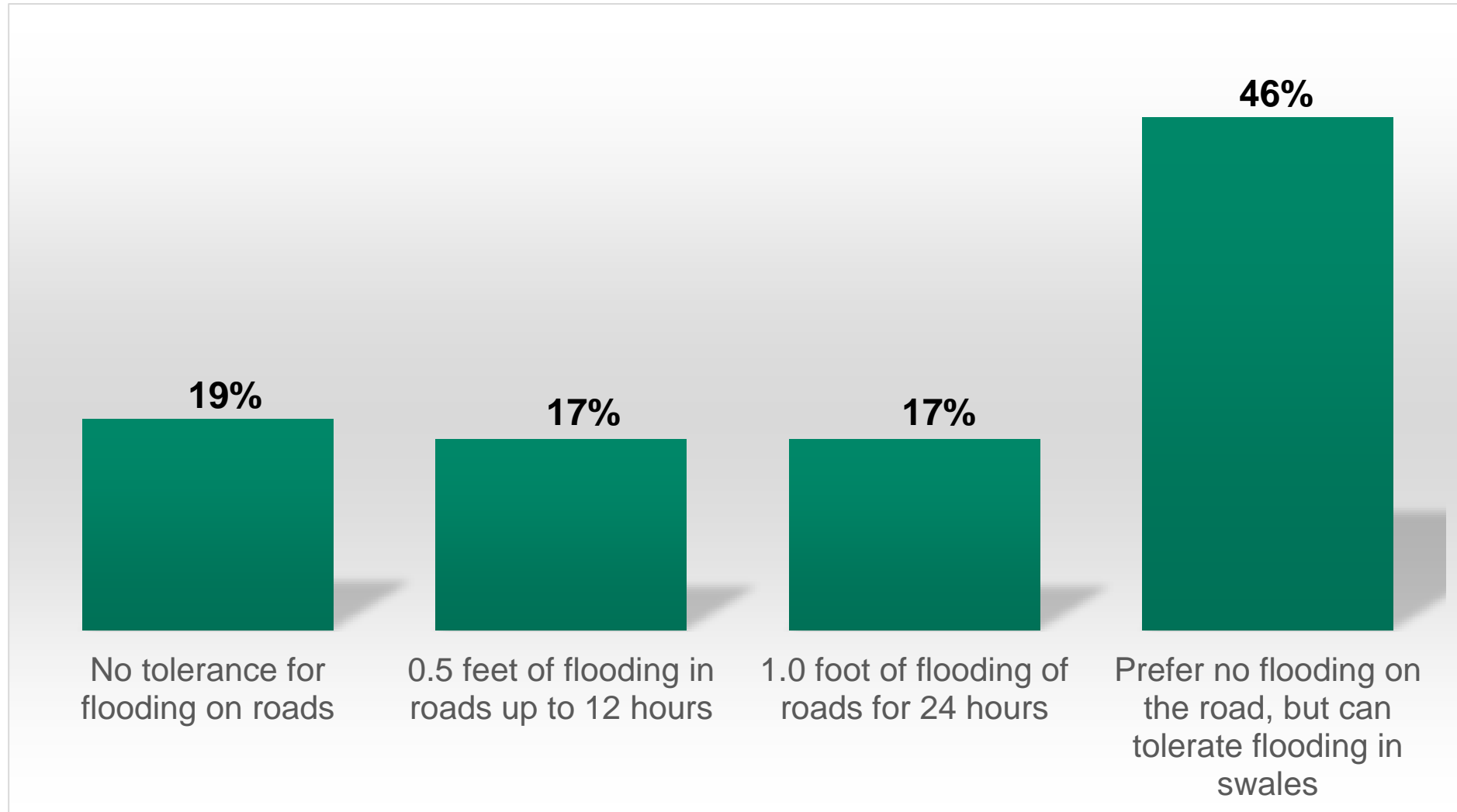
Roads – Swales



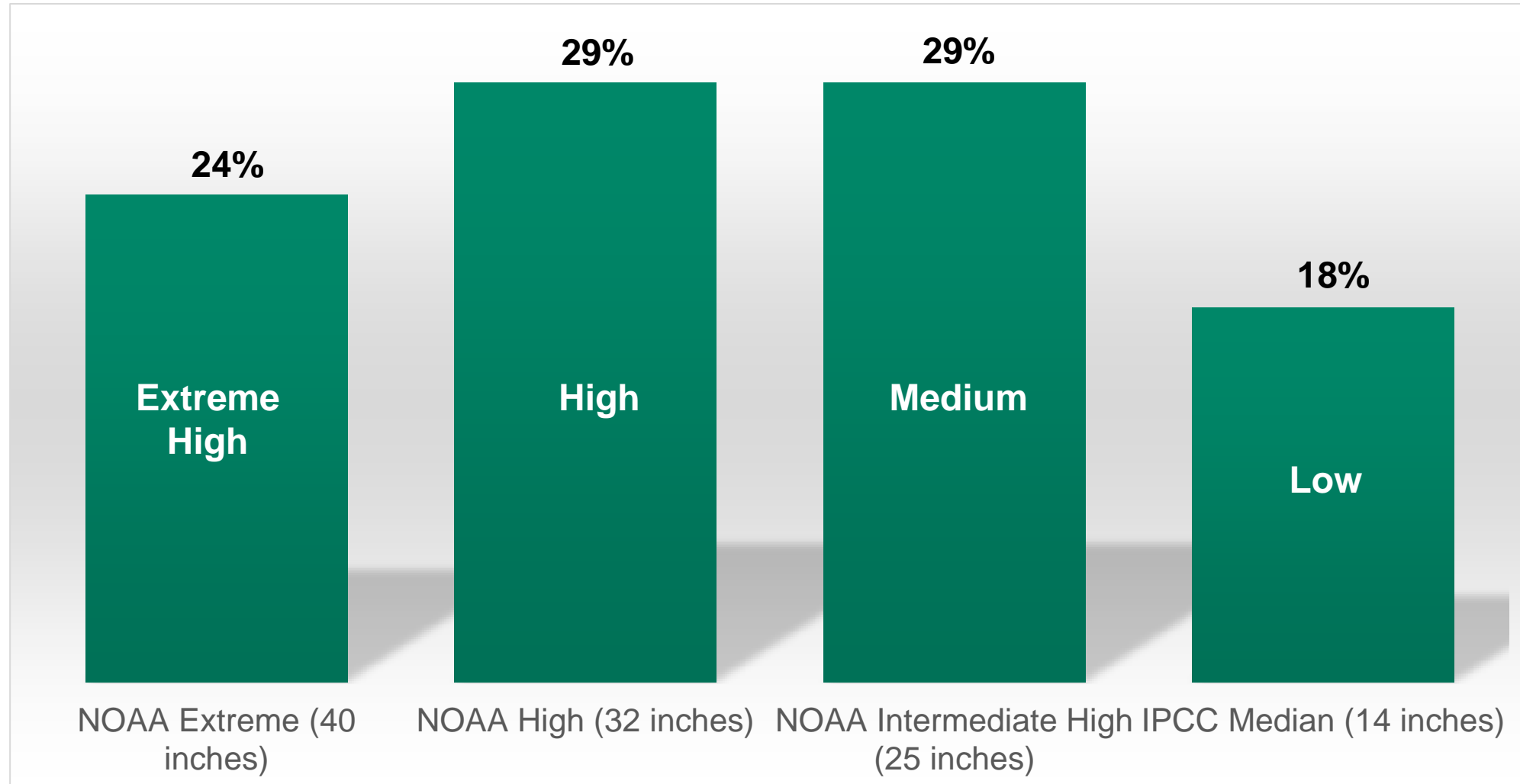
When it comes to water quantity, which items concern you most?



What is your tolerance for flooding?



Which 2050 projection curve do you feel Council should prepare stormwater infrastructure design?



Design Condition - Level of Service

ROW Ponding Tolerance

Ponding Depth (feet)

0 – **0.5** – 1.0

Ponding Duration (hours)

0 – **6-12** – 12-24

Ponding Location

Roads – **Swales**



Stormwater System: Discharge Opportunity Analysis

Challenges:

- Sea Level Rise and Groundwater Rise will diminish the discharge capacity of the gravity driven system.
- Outdated/disconnected system.

Recommendations:

- **Streamline, connect, and increase capacity** of collection system (inlets and pipes)
- **Shift from gravity to pressurized**
- **Enhanced outfalls**
- **Implement green/grey infrastructure** for improved water quality/quantity/conveyance



Stormwater System: Evaluation of green infrastructure options

VILLAGE OF KEY BISCAYNE GREEN INFRASTRUCTURE OPTIONS

BASED ON "CATALOG OF GREEN INFRASTRUCTURE TOOLS"
PREPARED BY GIT CONSULTING, INC. FOR THE VILLAGE IN 2015

AECOM Imagine it
Delivered

PAVING



CELLULAR CONCRETE PAVER

- MODULAR CONCRETE BLOCKS WITH GRAVEL-FILLED VOIDS
- STRUCTURALLY FLEXIBLE
- DRAINS AT RATE OF 80-90% OF NATURAL GRASSLAND
- UNDERDRAIN RECOMMENDED
- ON-STREET PARKING
- LIMITED STREET-SIDE VERGE
- ALLEYS, DRIVEWAYS, LOADING ZONES
- MODERATE INCREASED COST COMPARED TO STANDARD CONCRETE PAVING



PERVIOUS ASPHALT

- UNIFORMLY SIZED AGGREGATE WITH LESS BINDER THAN STANDARD
- INCREASED VOIDS ALLOW PERCOLATION TO BASE COURSE
- UNDERDRAIN RECOMMENDED
- ON-STREET PARKING
- ALLEYS, DRIVEWAYS, LOADING ZONES
- MODERATE INCREASED COST COMPARED TO STANDARD ASPHALT PAVING
- REQUIRES VACUUM MAINTENANCE

CHANNELING



VEGETATIVE SWALE

- 6+ FEET WIDE WITH SLOPES <3:1
- 1' - 2' DEPTH
- SHEET FLOW FROM ADJACENT SURFACES
- NATIVE PLANTINGS TOLERANT OF SALT AEROSOL AND GROUND INTRUSION
- STREET-SIDE VERGE ON RESIDENTIAL STREETS WITH LIMITED CROSSINGS
- LOW COST OPTION



VEGETATIVE / STONE SWALE

- 6+ FEET WIDE WITH SLOPES <3:1
- 1' - 2' DEPTH
- SHEET FLOW OR CHANNELIZED FROM ADJACENT SURFACES
- SMALLER POCKERS OF NATIVE PLANTINGS TOLERANT OF SALT AEROSOL AND GROUND INTRUSION
- STREET-SIDE VERGE ON VARIOUS STREET TYPES
- SLIGHTLY INCREASED COST COMPARED TO VEGETATED SWALE

STORAGE



LANDSCAPED TREE WELL

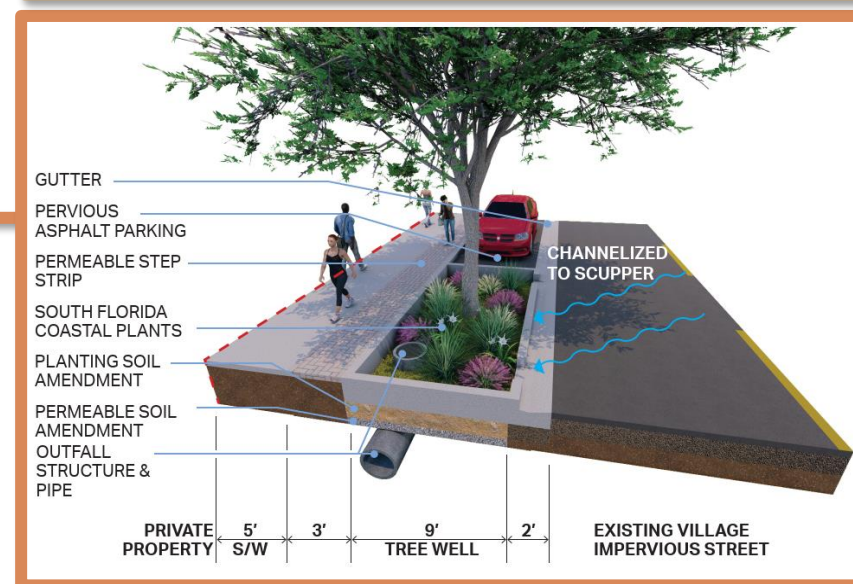
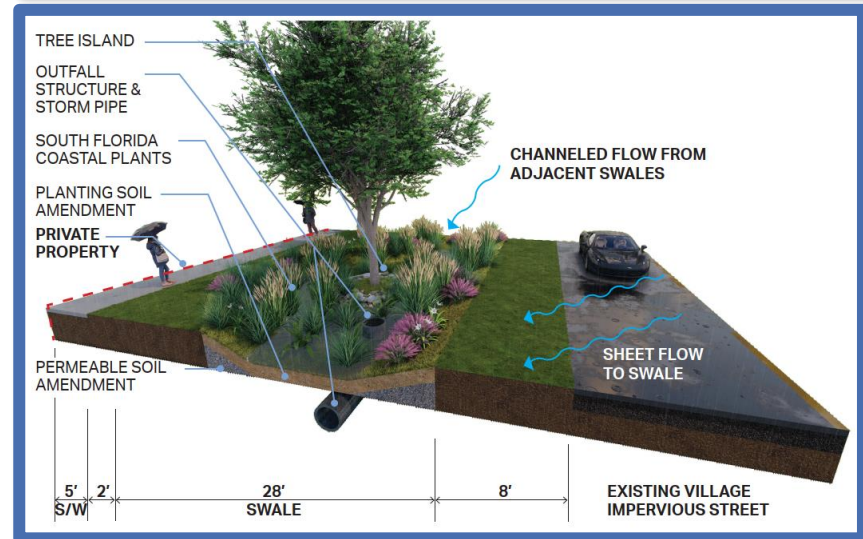
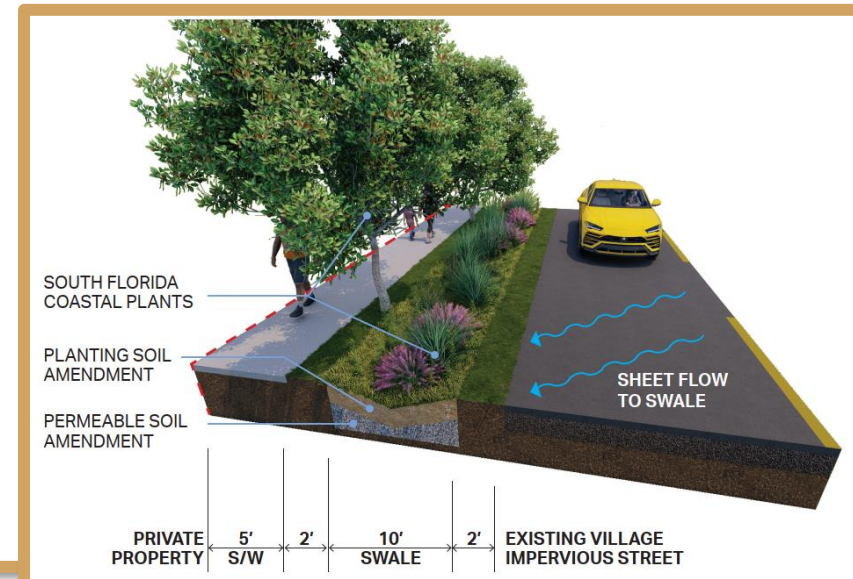
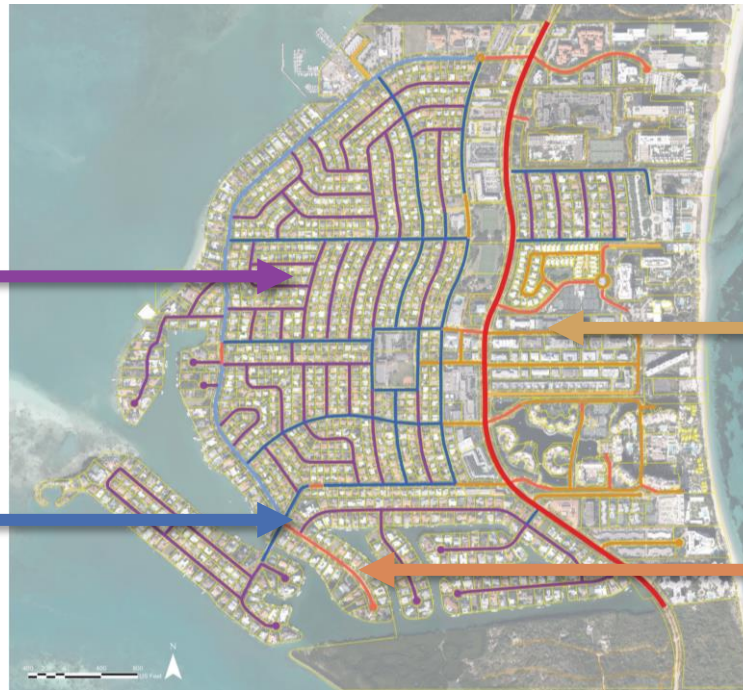
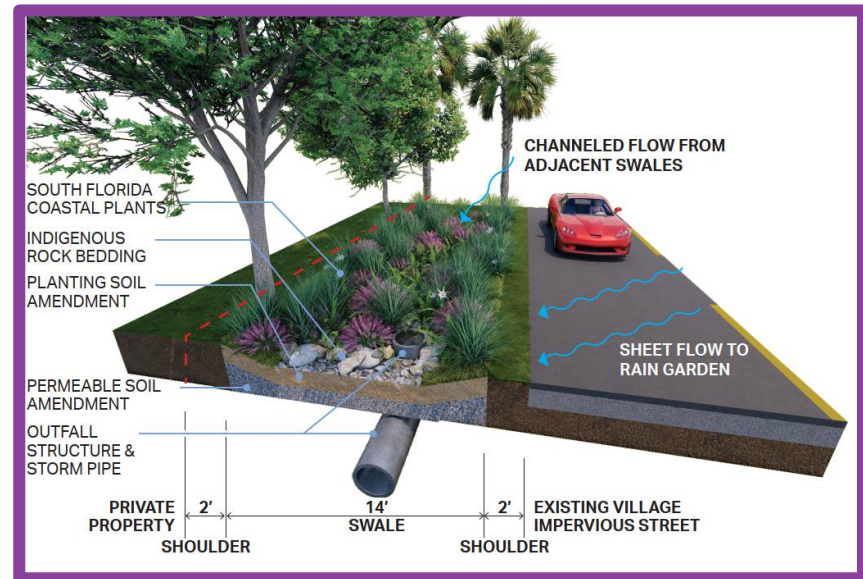
- <5 FEET WIDE WITH VERTICAL SIDES
- 1' - 2' DEPTH
- CURB & FLUME INLET FROM STREET
- NATIVE TREES TOLERANT OF SALT AEROSOL AND GROUND INTRUSION
- UNDERDRAIN RECOMMENDED
- CONSTRAINED STREET-SIDE AREAS WITH IMPERVIOUS CONDITIONS
- HIGH COST OPTION



RAIN GARDEN

- 10+ FEET WIDE WITH SLOPES <3:1
- 1' - 2' DEPTH
- TERMINATION OF DOWN SLOPE SWALES
- SPECIAL SOIL MEDIA
- NATIVE PLANTINGS TOLERANT OF SALT AEROSOL AND GROUND INTRUSION
- BROAD STREET-SIDE VERGE WITH LIMITED CROSSINGS
- LOW COST OPTION

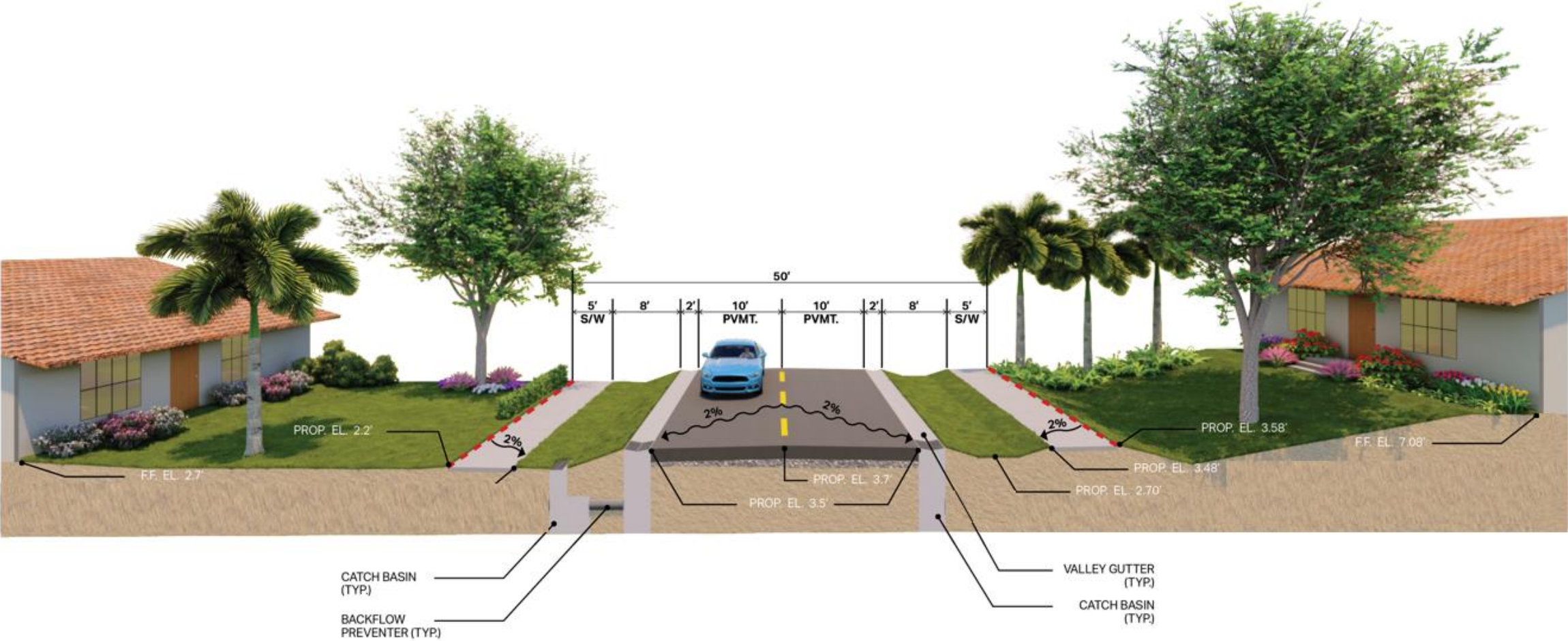
Village of Key Biscayne Green Infrastructure Options




Engineered Flood Protection: Specific Example

Elevated Streets

RAISING THE ROAD GRADE



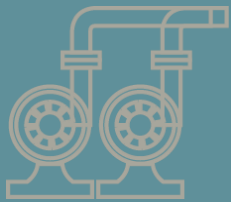
Number of Pumps by Design Storm and Discharge Capacity

	<div> Additional Needed Discharge Capacity (cfs)</div>				
	50	100	150	200	250
Number of Pumps for 5-year, 24-hour Storm Discharge (1,774 cfs gap)	36	18	12	9	8
Number of Pumps for 10-year, 24-hour Storm Discharge (2,171 cfs gap)	44	22	15	11	9

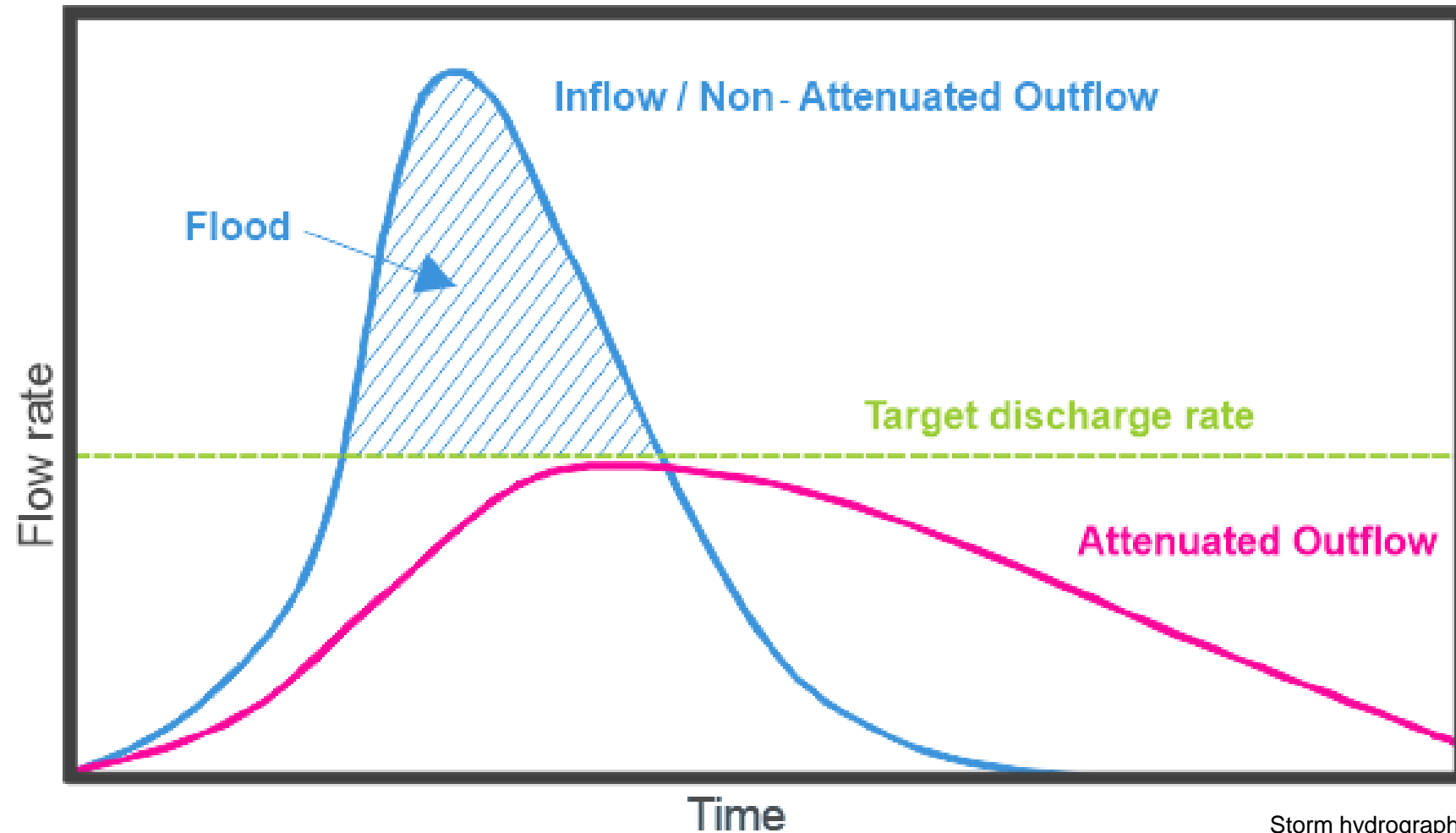
Note: This scenario only considers the addition of pipes and pump stations. A combination of green and gray solutions is preferred.

Ways to Mitigate Peak and Number of Pumps

Large pump stations
(additional easements required)



Added storage facilities in
combination with
larger diameter pipes



Storm hydrograph

Reference: 3P Technik UK Ltd

Solution Variables

\$

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Design Storm

2-year, 24-hour storm

5-year, 24-hour storm

10-year, 24-hour storm



Sea Level Rise Projection

IPCC Median

NOAA Intermediate High

NOAA High



Ponding Depth

2 ft

1 ft

0.5 ft



Ponding Duration

48 hrs

24 hrs

6-12 hrs



Ponding Location

Yards, Swales, and Roads

Swales and Roads

Swales



Green Solution Integration

Low

Medium

High

Level of Service

Recommendations

AECOM



Recommendations

LEVEL OF SERVICE

Keep roads
passable for traffic

- ✓ Ponding depth **0-0.5 ft**
- ✓ Ponding duration **6-12 hrs**
- ✓ Ponding located in **swales**

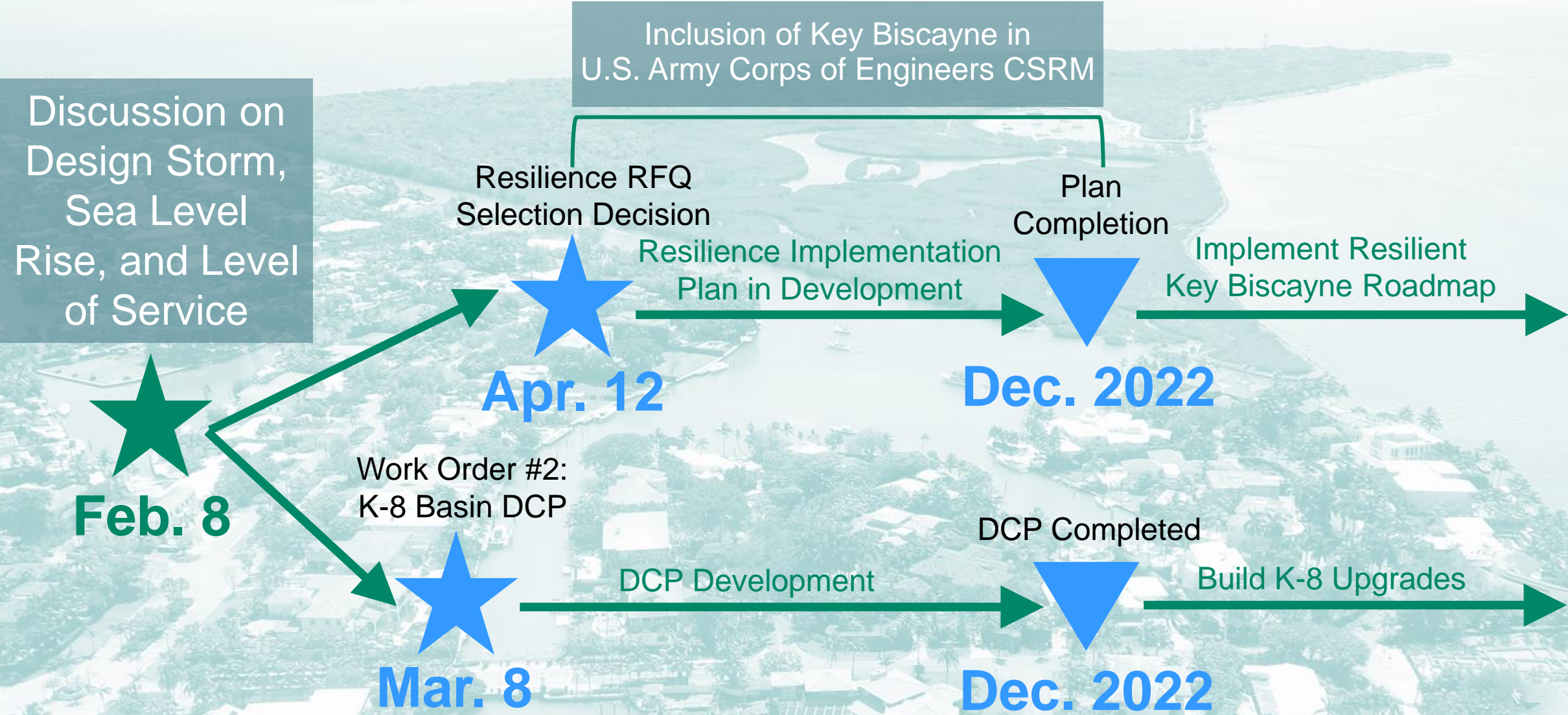
DESIGN STORM

10-year, 24-hour Storm

SEA LEVEL RISE PROJECTION

NOAA Intermediate High

Next Steps





Thank you

Elevating our island paradise