Resilience – Making it not just a buzzword

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Presented to:
Tuscaloosa Branch, ASCE
March 24, 2022

Jacobs

Challenging today.
Reinventing tomorrow.

The Textbook Definition…

Resilience is the capacity of individuals, communities, institutions, businesses, infrastructure and/or natural systems to survive, recover, adapt, and thrive, regardless of the chronic stresses and acute shocks they experience.

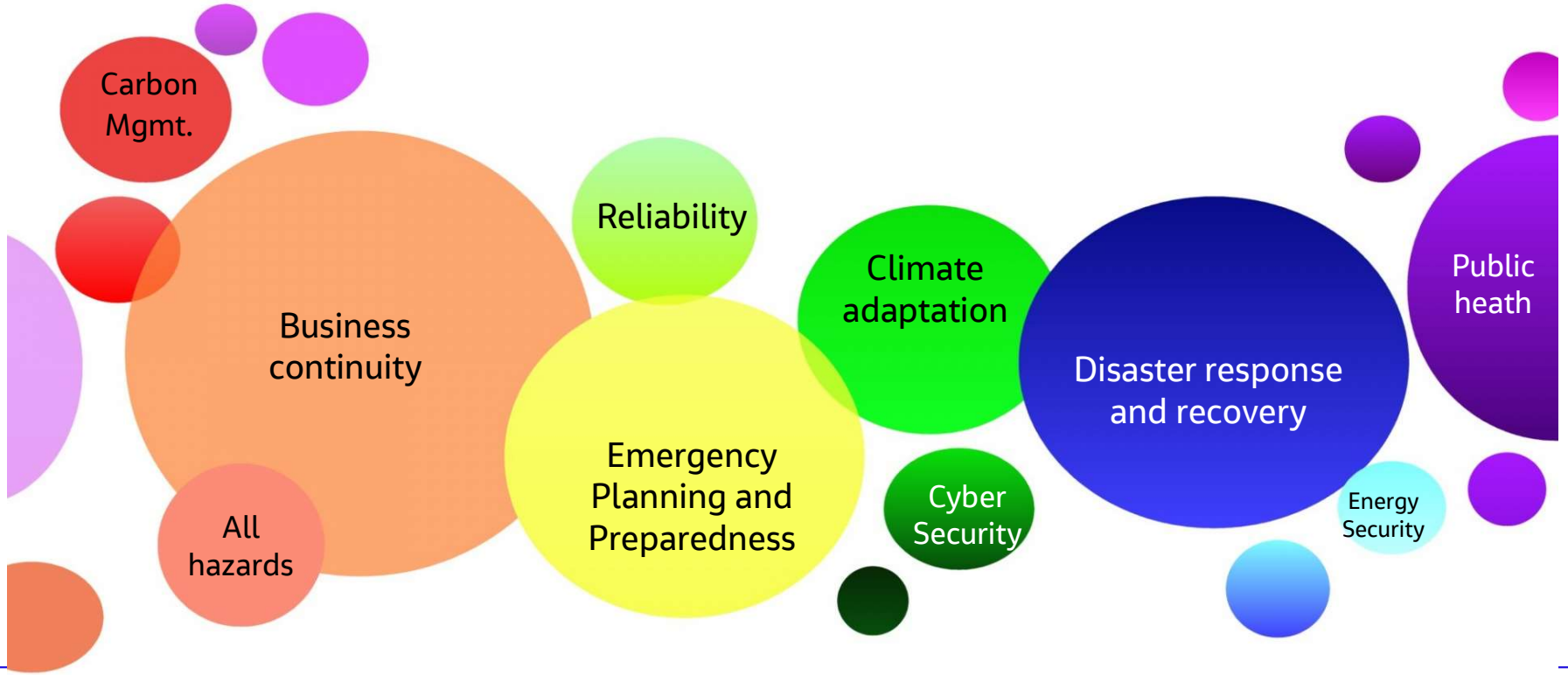
Acute SHOCKS are sudden, sharp events.

- tornados and hurricands
- floods
- extreme heat
- wildfire
- earthquakes
- disease outbreaks/ pandemics
- terrorist attacks
- cyberterrorism

Chronic STRESSES are slow moving disasters.

- **aging infrastructure**
- **climate change/sea level rise**
- **coastal erosion**
- **recurrent flooding**
- **high unemployment/ poverty**
- **demand growth/capacity limitations**
- **chronic food and water shortages**
- **regulation or market changes**

Resilience Lexicon:
The "Resilience" vernacular can be different for different groups and sectors: individuals, communities, institutions, businesses, infrastructure, or natural systems

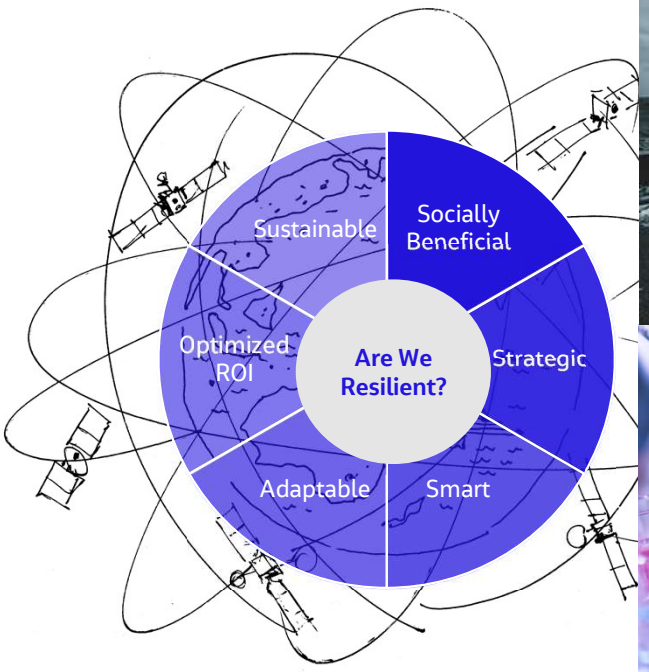


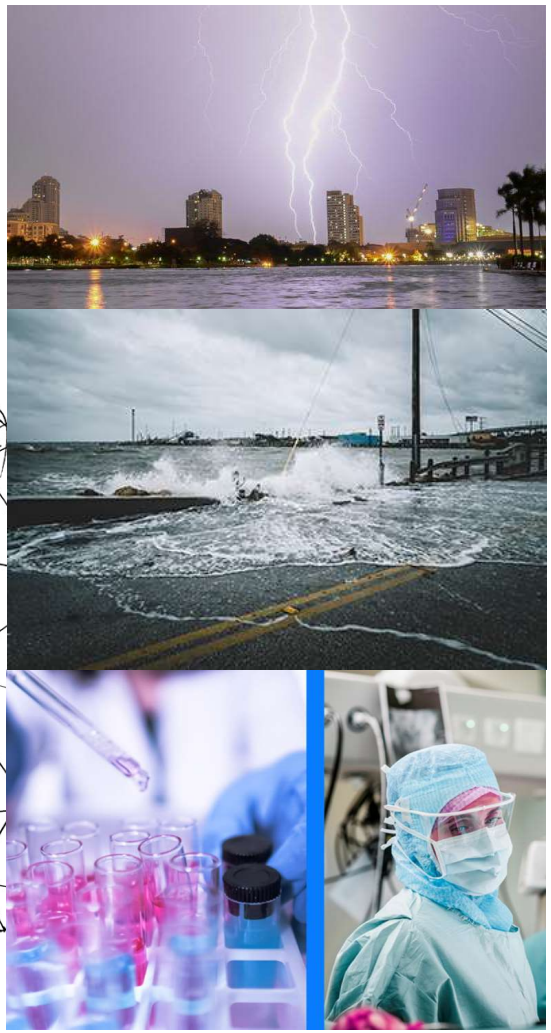
Resilience at Organizations…

Resilience should be at the center of every organization's purpose – it shapes our future and how we thrive.

- **Countries, States, Counties, Cities, Agencies, Institutions, Companies, Families**

- It enables our society to focus not only on today, but also to **anticipate and adapt to the future.**

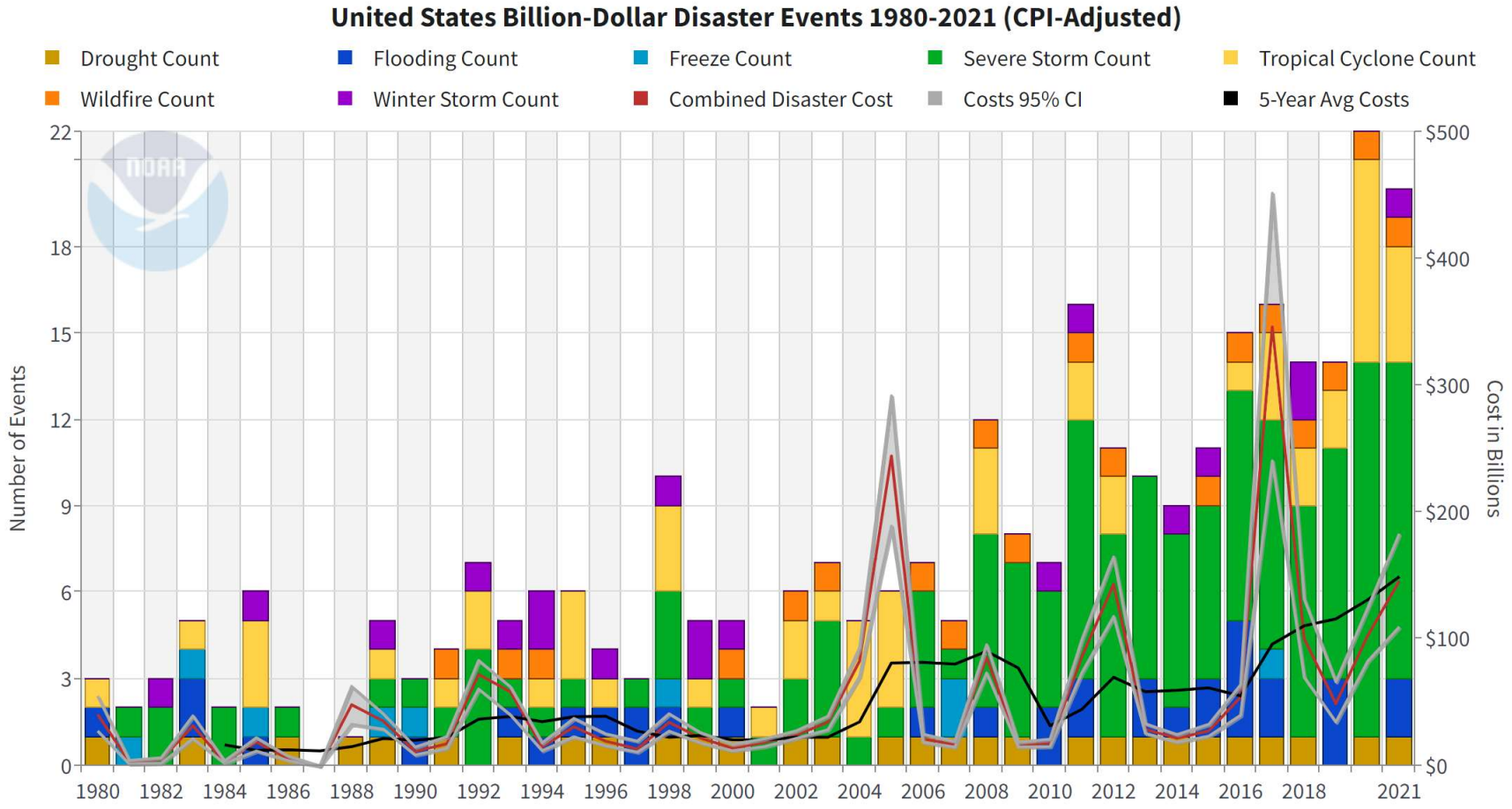




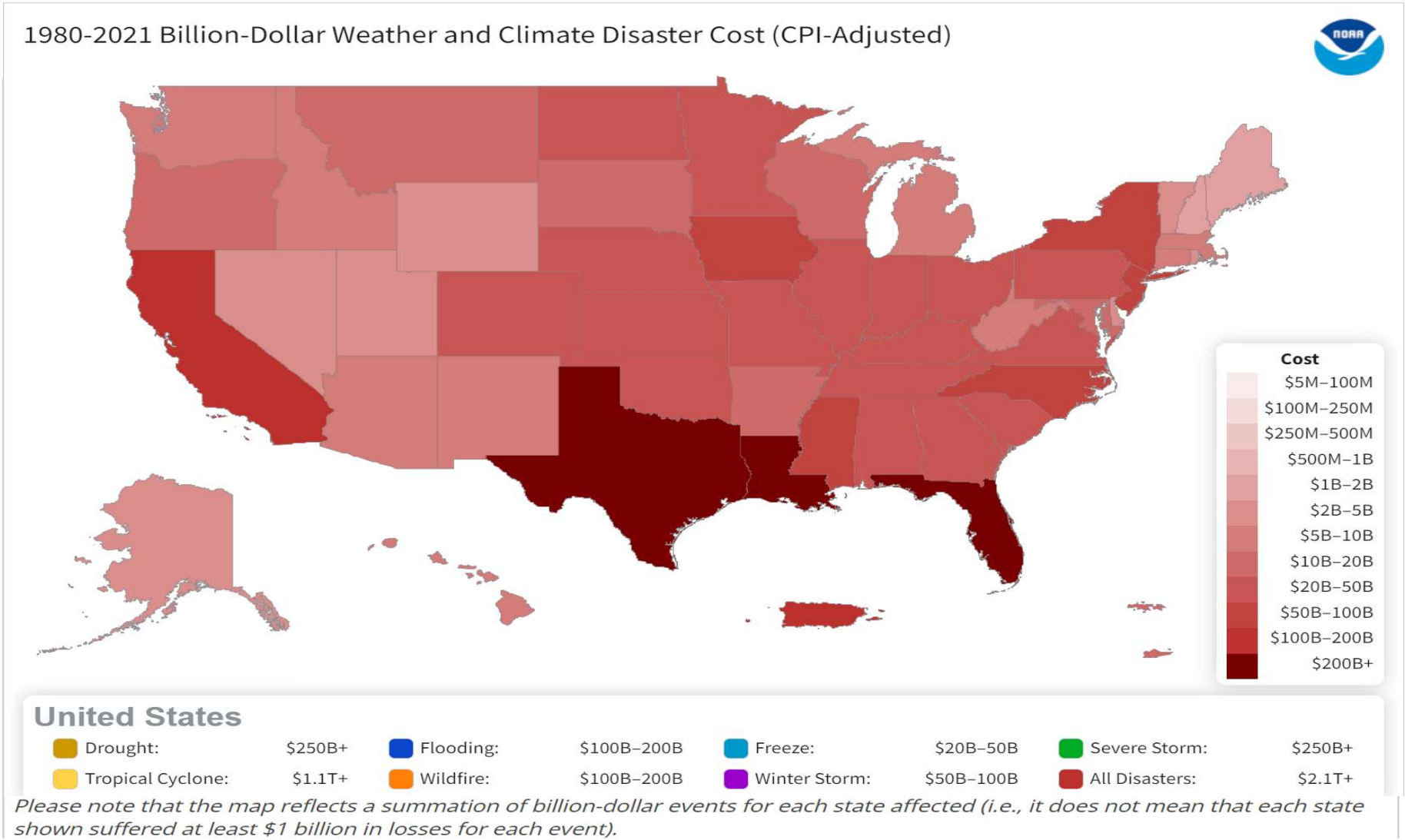
Resilience Challenges

Why is Resilience such a hot-topic right now?

Extreme Events Increasing in Frequency & Severity



Source: NOAA National Centers fo Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters. https://www.ncdc.noaa.gov/billion



Source: NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters.
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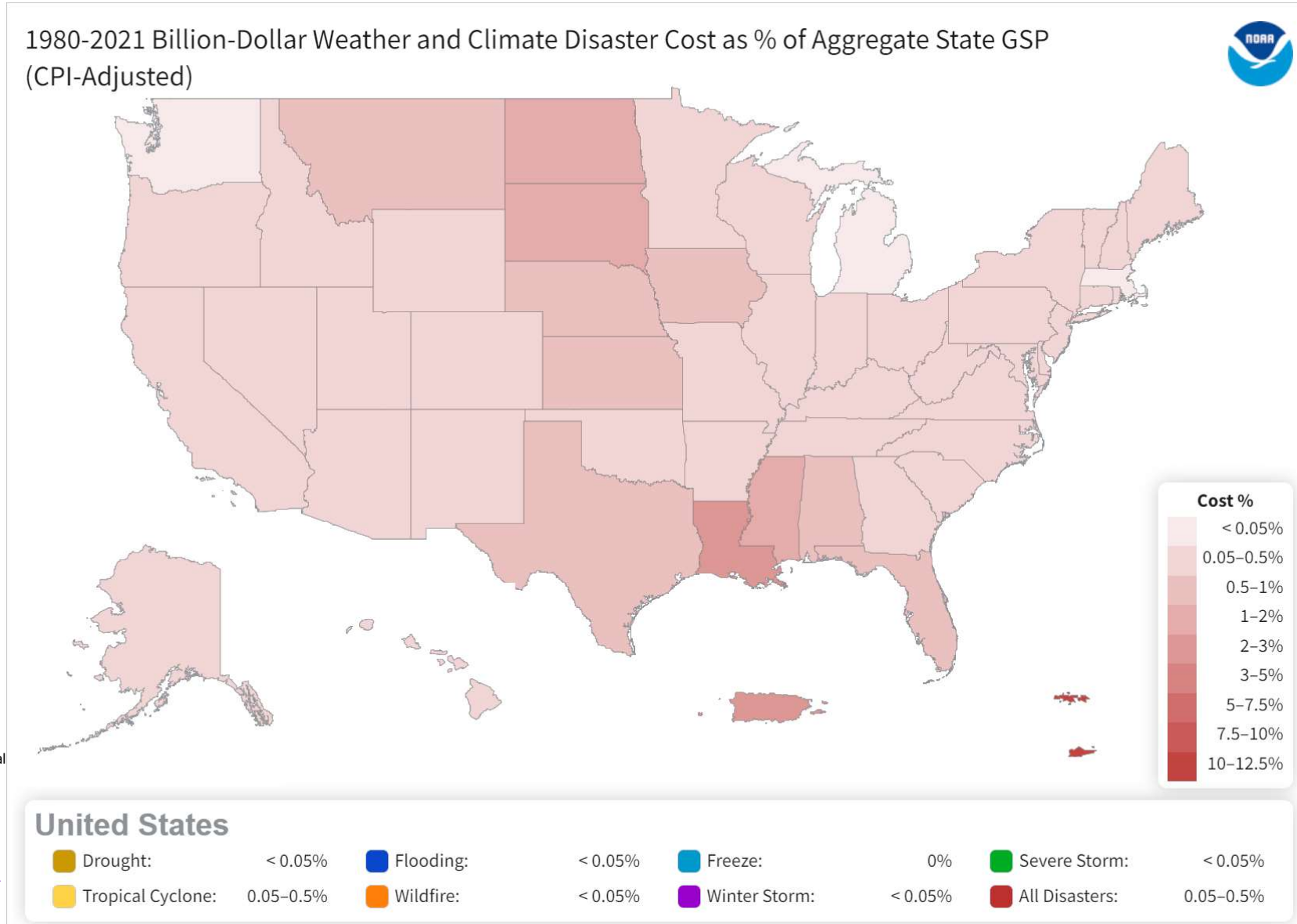


Source: NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters. https://www.ncdc.noaa.gov/billions/

Billion-dollar events to affect Alabama from 1980 to 2021 (CPI-Adjusted)

Disaster Type	Events	Events/Year	Percent Frequency	Total Costs	Percent of Total Costs
Drought	15	0.4	15.3%	$5.0B-$10.0B	13.5%
Flooding	2	0.0	2.0%	$100M-$250M	0.3%
Freeze	3	0.1	3.1%	$100M-$250M	0.3%
Severe Storm	44	1.0	44.9%	$10.0B-$20.0B	25.7%
Tropical Cyclone	24	0.6	24.5%	$20.0B-$50.0B	54.3%
Wildfire	2	0.0	2.0%	$500M-$1.0B	1.5%
Winter Storm	8	0.2	8.2%	$1.0B-$2.0B	4.4%
All Disasters	**98**	**2.3**	**100.0%**	**$20.0B-$50.0B**	**100.0%**

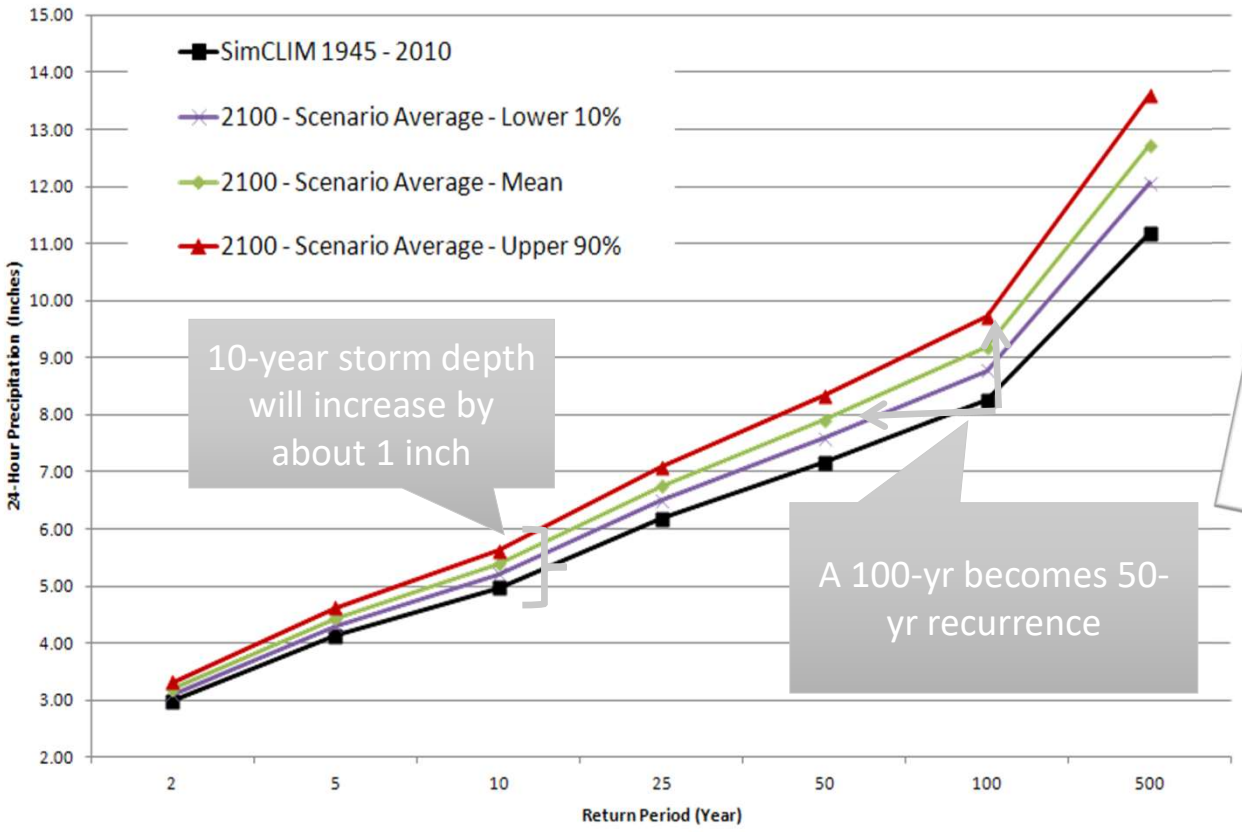
Select Time Period Comparisons of Alabama Billion-Dollar Disaster Statistics (CPI-Adjusted)

Time Period	Billion-Dollar Disasters	Events/Year	Cost	Percent of Total Cost
1980s (1980-1989)	13	1.3	$2.0B-$5.0B	10.4%
1990s (1990-1999)	15	1.5	$2.0B-$5.0B	10.5%
2000s (2000-2009)	25	2.5	$10.0B-$20.0B	40.4%
2010s (2010-2019)	30	3.0	$10.0B-$20.0B	25.4%
Last 5 Years (2017-2021)	29	5.8	$5.0B-$10.0B	19.8%
Last 3 Years (2019-2021)	18	6.0	$5.0B-$10.0B	13.4%
Last Year (2021)	6	6.0	$500M-$1.0B	1.3%
All Years (1980-2021)	**98**	**2.3**	**$20.0B-$50.0B**	**100.0%**

- ***Doesn't just impact infrastructure***
- ***Can impact overall resilience***
  - ***Supply chain***
  - ***Employee impacts***
  - ***Energy security***
  - ***Available funding pools***

Source: NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters. https://www.ncdc.noaa.gov/billions/

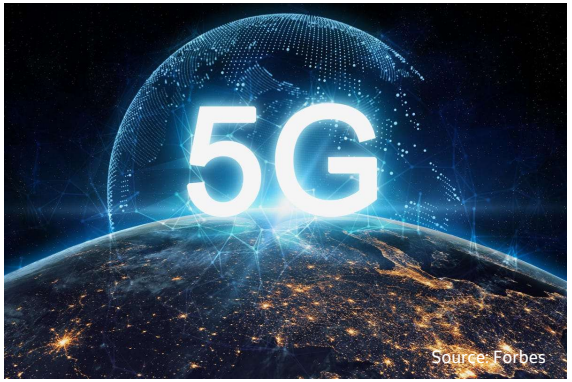
Increasing event intensity driving policy change that will impact infrastructure design and planning



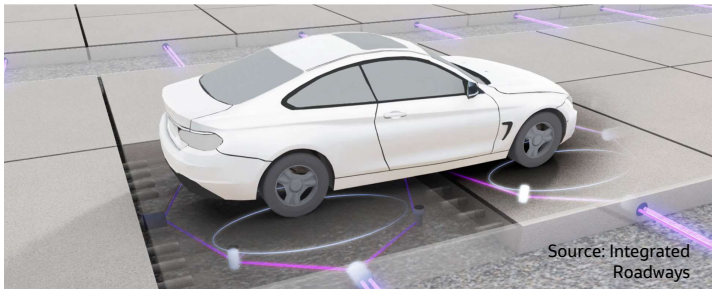
Reagan National AP, NWS ID 44-8906
Projected 2100 24-hour Precipitation IDF Values
from a 12 Daily GCM Ensemble

Resilience is increasingly important as our infrastructure becomes more connected and more digital


Source: QualComm

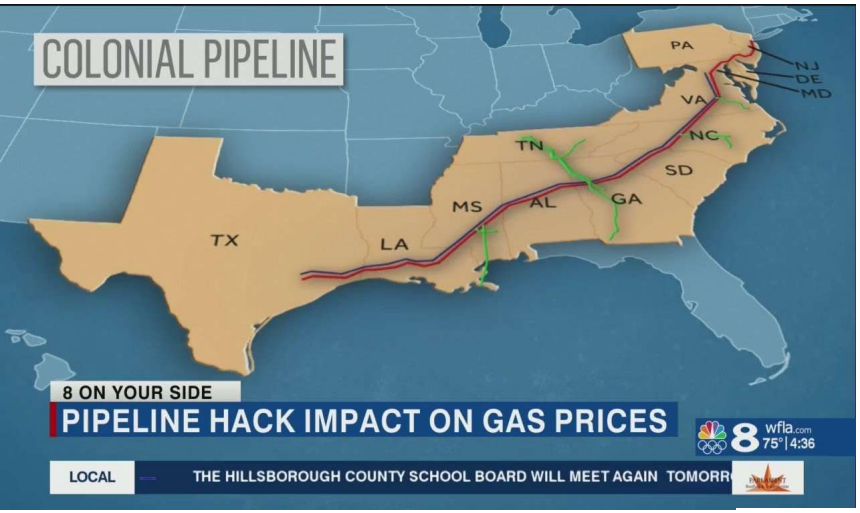


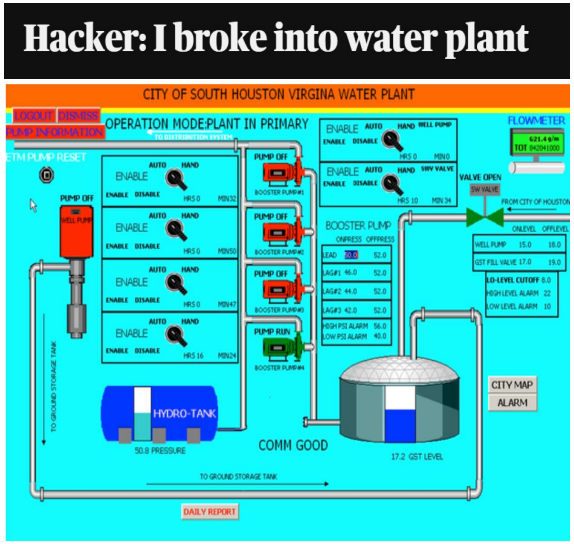
Source: Forbes


Source: Integrated Roadways

Source: Automotive IQ.com

Source: Kamstrupp.com

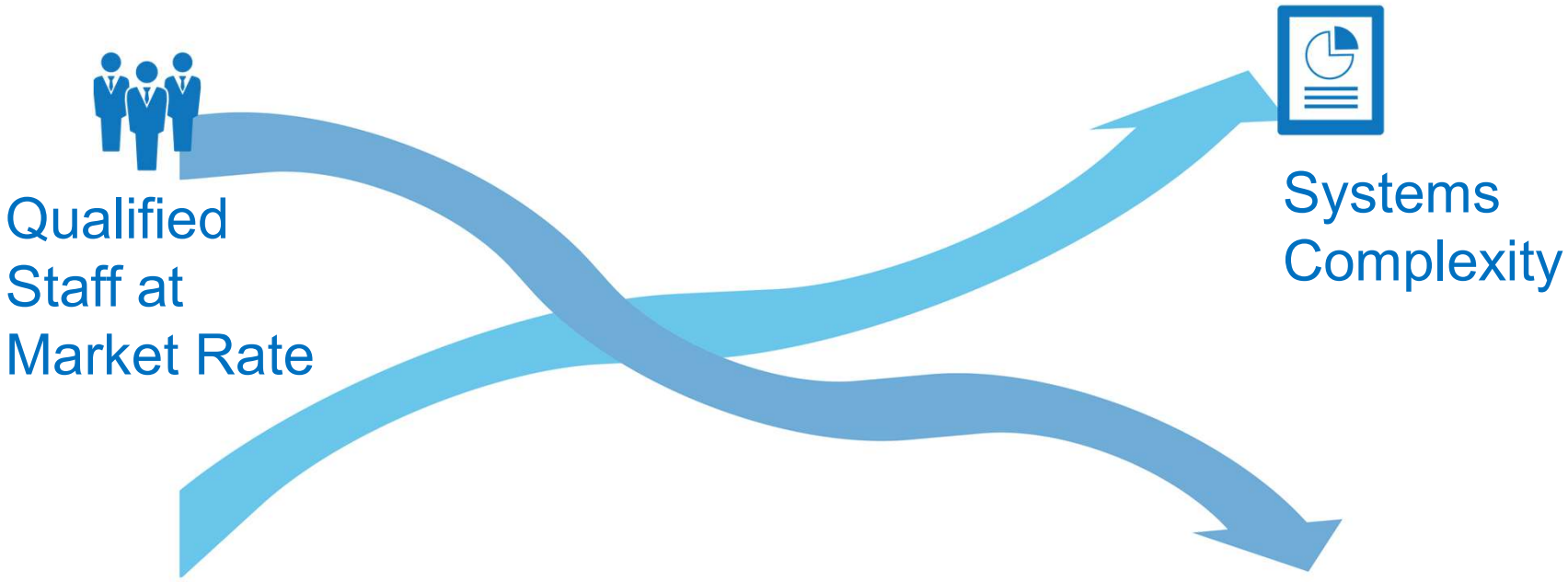




Hacker Tried Poisoning Water Supply After Breaking Into Florida's Treatment System

February 08, 2021 Ravie Lakshmanan

Industry trends demand change – while infrastructure complexity is increasing, the number/quality of qualified workers is decreasing



And of course, supply chain issues

Orlando officials urge residents to limit water usage to preserve oxygen supply for COVID-19 patients

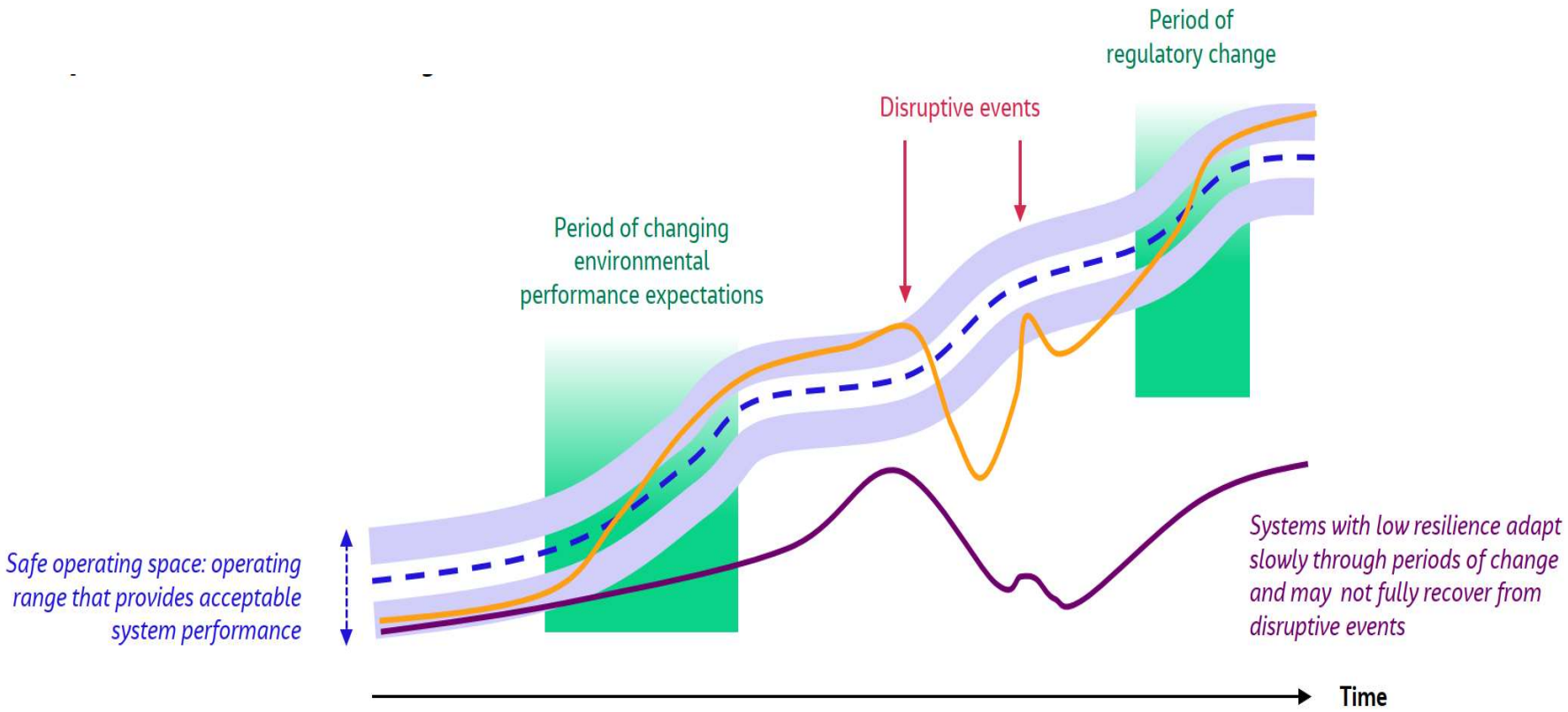
Price of chemicals needed to treat water in Midland rising due to COVID supply- chain issues

The chemicals usually cost the city a little under $2 milli
this year it has gone up about 15% percent.

Strained Rural Water Utilities Buckle Under Pandemic Pressure

Tampa Bay Water asks users to cut back as COVID-19 saps oxygen supplies

Resilience means different things for every entity, but with the same end goal

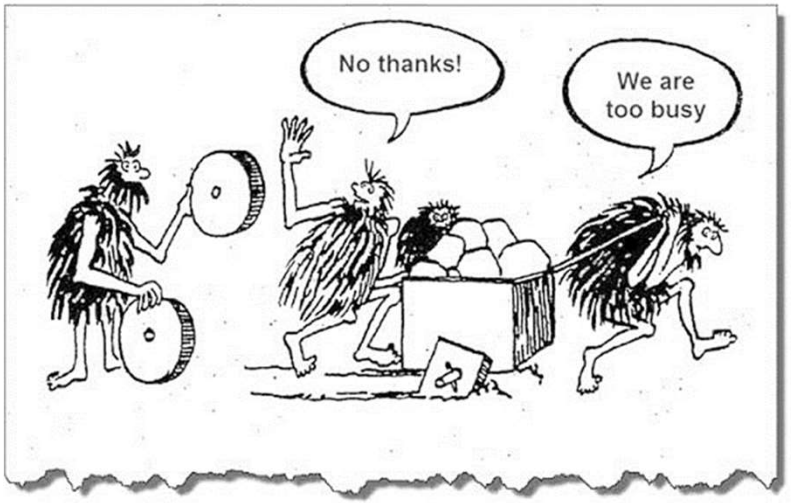


How can we promote resilience – making it not just another buzz-word

Setting our communities up for success

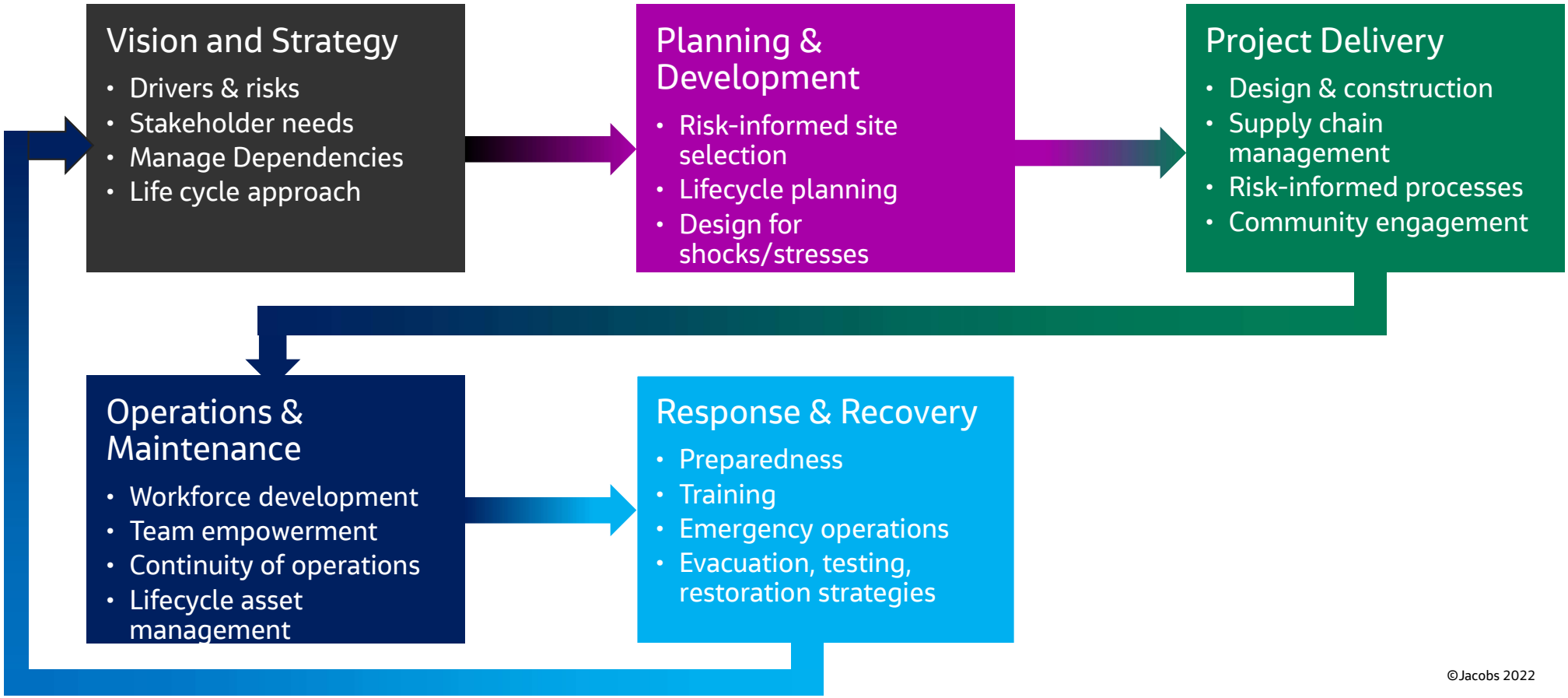
Incorporate "resilience thinking" throughout our community policy and leadership culture:

- **Risk Reduction** (from all known natural and man-made hazards)
- **Reliability** (against all known shocks and stressors)
- **Operational Continuity** (contingency and preparedness planning)
- **Resilience** (adaptive systems that respond well to impacts)

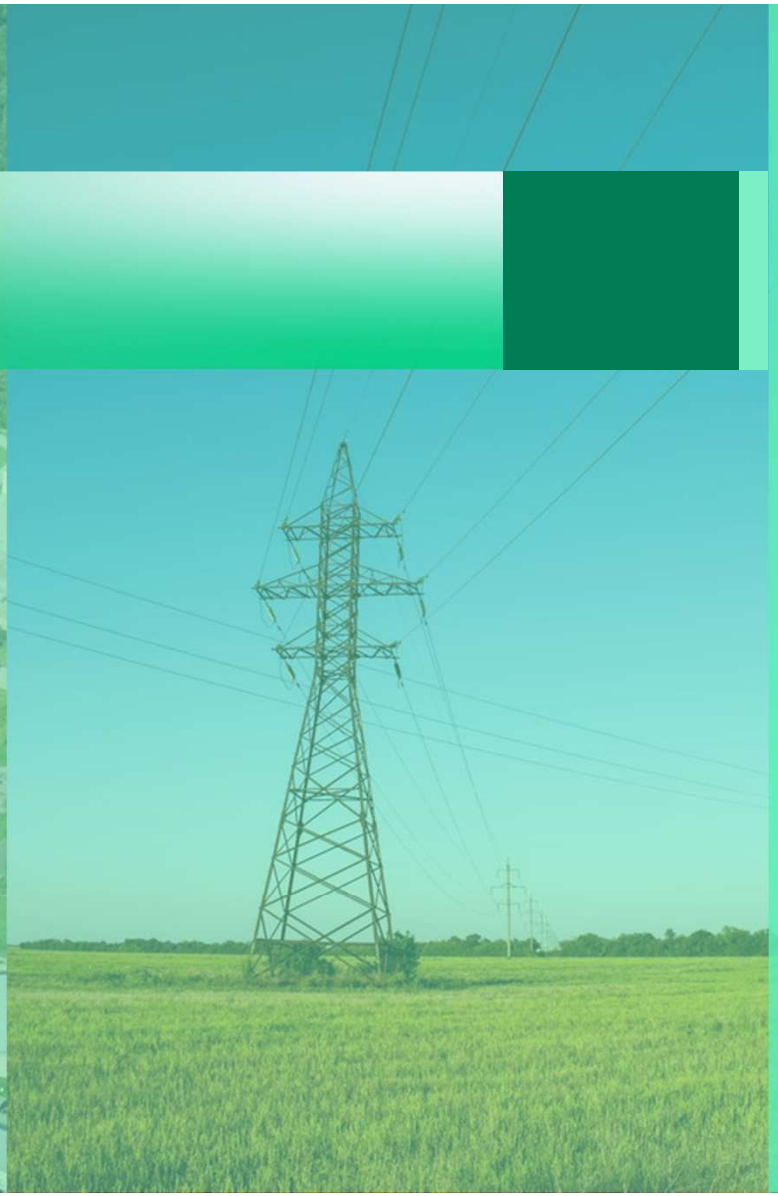


Proactively going beyond "the historical" to get ahead of the "new"

Integrating Resilience Thinking Throughout Organizations and Project Life Cycles: Comprehensive risk-based CIP decision making



Approaches to Infrastructure Resilience



Resilient infrastructure approaches avoid silos and promote collaboration

- Stormwater
- Utilities
- Transportation
- Urban planning
- Smart cities
- Buildings

- Define LOS
- Address all known hazards
- Forward looking view
- Smart decision making
- System interactions and dependencies
- Maximize co-benefits
- Integrate and collaborate

- Asset security
- Reduced risk
- Reliability
- Improved performance

Resilient Infrastructure = Improved Reliability = Less Risk and Liability

Co-location can create completely different risk profiles than asset condition alone

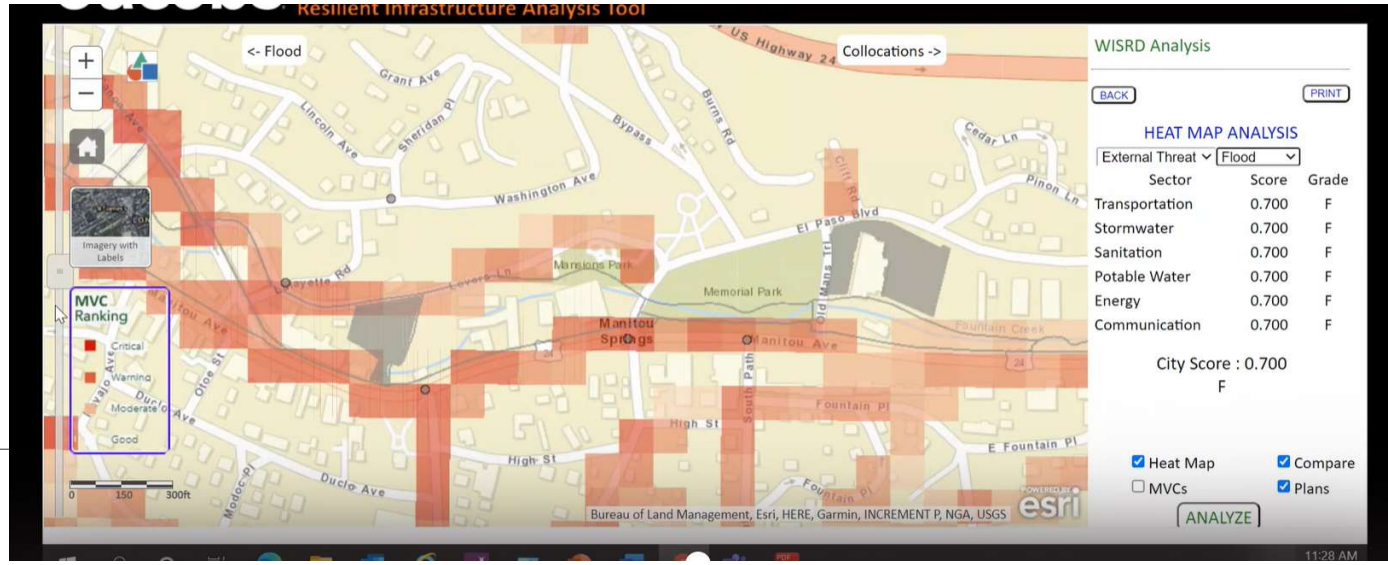
Next-generation asset condition assessment and prioritization exposes unforeseen vulnerabilities and areas to optimize investment

- Using GIS tools and “systems-based” thinking, identify interdependencies across multiple sections
  - Analyze 3 modes of infrastructure failure
  - Create rank-ordered list of vulnerable areas in city, installation, campus, or facility
  - Provide maps showing most vulnerable cells
  - Serves as baseline condition assessment for resilient development

Case Study: Co-location Prioritization Pilot, Manitou Spring, CO

- Analyzed multiple sectors for City
- Utilized multiple subsets of existing data
  - Hazard Mitigation Plans
  - Asset inventories/condition rating
- Provided updated priorities for consideration
- Challenges:
  - Requires multi-entity collaboration
  - Information sharing - potential NDAs, but to benefit of all

5 Sectors	55 Sub-sectors	Hazards
Sanitation	Mains	Earthquakes
Water	Laterals	Flooding
Communications	Raw	Fire
Energy	Valves/Fittings	Landslides
Transportation	Pump Stations…	Sea Level Rise…



Case Study: Co-location Prioritization Pilot, Manitou Spring, CO

Sufficiency Rating = 95% Nov. 2017

Failed Mar. 2018

Miami Beach Integrated Water Resource Plan

Miami Beach, FL

- $400M Capital Plan Prioritization, Publicly-vetted Project Evaluation Framework/Formulas, influencing $1B of future investment via policy/standards
  - Risk scenarios, scoring, grouping, prioritizing
  - Included:
    - Coastal flooding risk
    - Potable water distribution/fire suppression
    - Emergency/critical facilities & roads
    - Sanitary sewer delivery
    - Rain stormwater management
    - Environmental benefits
    - Economic development
    - Pedestrian and bicycle mobility
    - Road classification
    - Road conditions
    - Aesthetics
  - The inputs (capital projects) came from several city sources
    - transportation master plan, stormwater drainage reports, water master plan, sewer master plan,





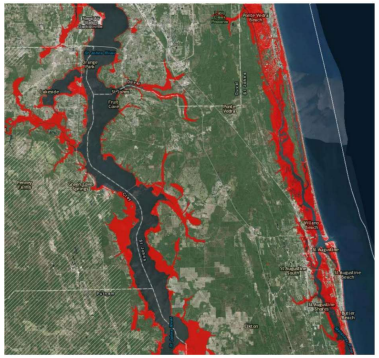
Miami Beach Integrated Water Resource Plan

Miami Beach, FL

- Evaluated individual capital projects against City's management priorities and goals
- Aggregated individual capital projects into logical geographical Project Group Areas that can be implemented as single consolidated projects
- Conferred with multiple departments to align city's priorities and conducted public meeting
- Recommended prioritization of capital Project Group Areas to be sequenced and funded over time' 560 projects were reviewed, and 401 projects were selected
- Objective, collaborative, and transparent process to enhance overall community resilience across multiple areas

Many cities recognizing benefits of multi-departmental, multi-pronged resilience strategies

- Resilience officials
- Resilience plans

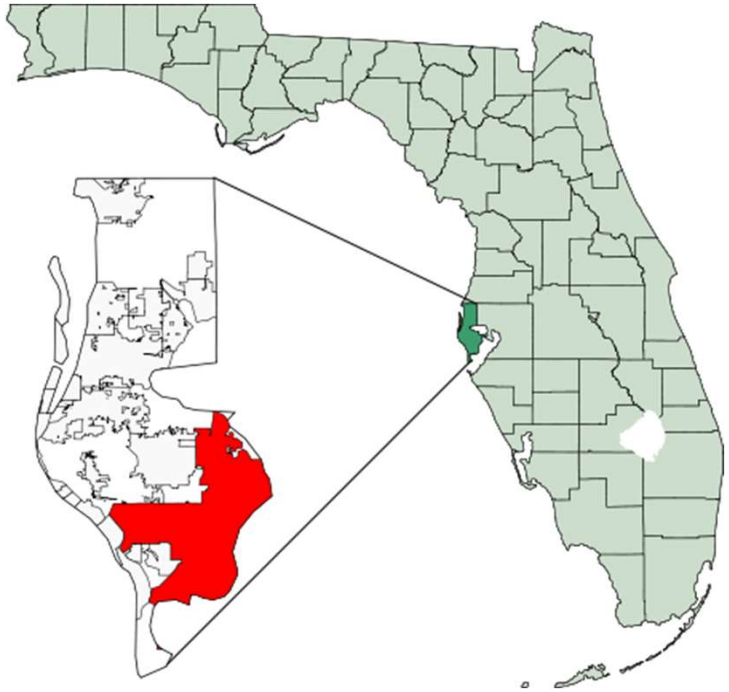


This scope of work is intended to review the flood related climate hazards, assess the potential for impacts to utility infrastructure from those hazards, establish climate based levels of protection to inform future design criteria and determine where additional vulnerability and risk analysis may be warranted. This initial effort will support the communication of climate based risk for built infrastructure and the need for high performance standards and continued investment, for County leadership and decision makers.

Jacobs Challenging today. Reinventing tomorrow.

City of St. Petersburg, Florida
A Resilience Journey

St. Petersburg, FL



"St. Petersburg will be a city of opportunity where the sun shines on all who come to live, work and play. We will be an innovative, creative and competitive community that honors our past while pursuing our future."

≈250,000 utility customers
110 neighborhood & business associations

Progressive one-water approach – 1st in nation with distributed reclaimed water system

Resilience for St. Pete

"Water is the most perfect traveler because when it travels it becomes the path itself!"

- Mehmet Murat ildan

Resilience Challenges Facing the City's Infrastructure

St. Petersburg Mayor Rick Kriseman addresses sewage problems

Millions of gallons of sewage dumped into bay

Top St. Pete headlines in 2015: No. 2 – Raw sewage

— by Janelle Irwin

Climate Strike Draws Hundreds In St. Petersburg

By JESSICA MESZAROS & THOMAS IACOBUCCI • SEP 20, 2019

Protesters in St. Petersburg took part in climate strikes happening across the world Friday, ahead of a United Nations Climate Change Summit next week.

Flooding in St. Pete and Tampa

Credit: 10News Photojournalist Deborah Whiteside

Vehicles drive through flooded roadways near 62nd Avenue N and Dr. Martin Luther King Jr. Street in St. Petersburg, Florida.

Other Resilience Challenges

City Staff Succession Planning

Walkable Communities

Recreational Water Quality

Level of Service Expectations

COVID19 Impacts

Vertical Growth and New Businesses

As the City develops solutions and plans for infrastructure improvements, they found it critical to consider non-asset related resilience challenges.

How did the City begin their “Resilience Journey”

Primary driver, eliminate SSOs, but in manner to support community needs.

Protect Human Health

Improve Water Quality

Support Quality of Life Attributes

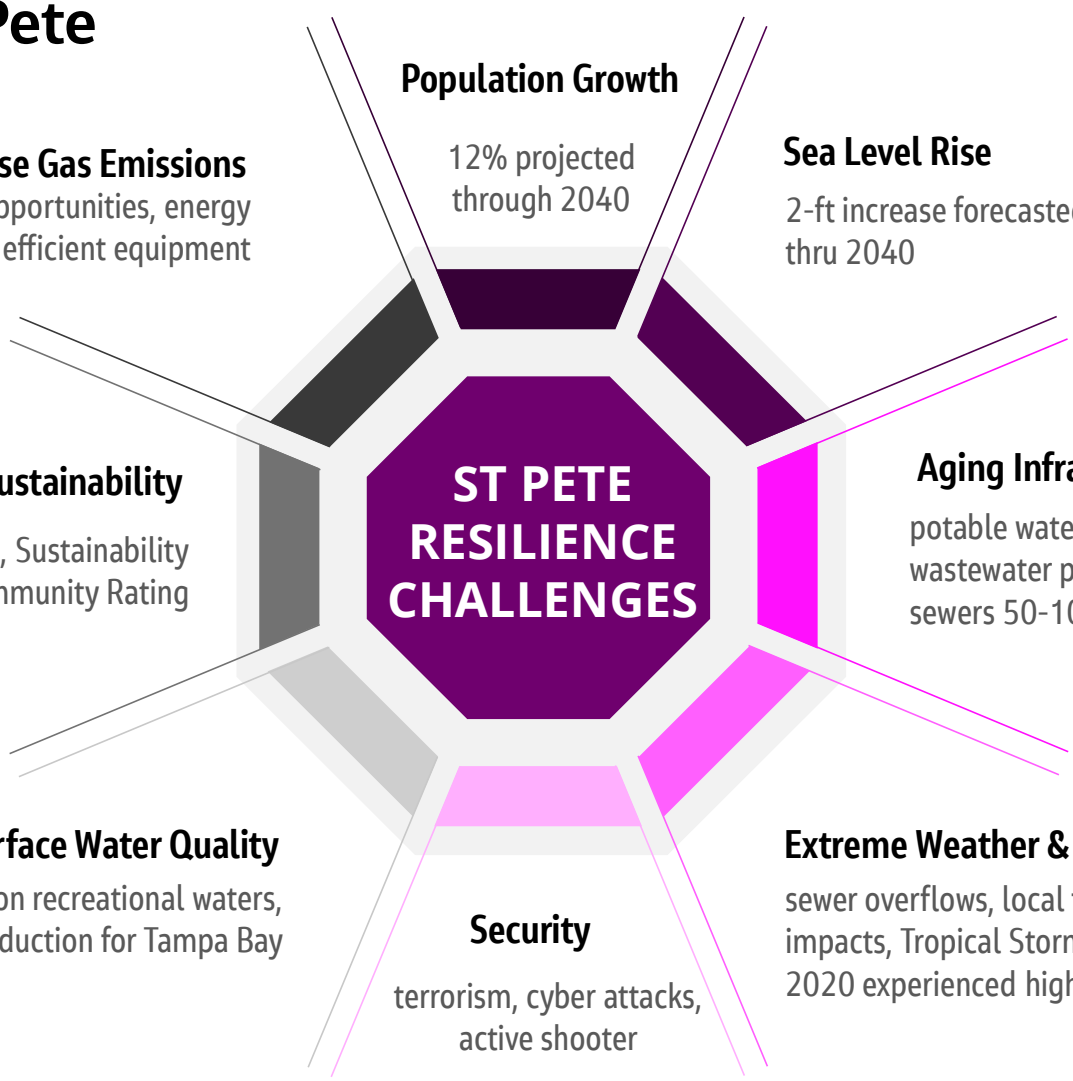
Recognizing the many benefits, St. Petersburg chose a **One Water** approach

Support Economic Benefits

Enhance Vitality of Community

Integrate Water Resources

Resilience for St. Pete



Population Growth

12% projected through 2040

Sea Level Rise

2-ft increase forecasted thru 2040

Aging Infrastructure

potable water plant >100 years old
wastewater plants >50 years old
sewers 50-100 years old

Extreme Weather & Flooding

sewer overflows, local flooding, King Tide impacts, Tropical Storm Eta on November 12, 2020 experienced high water of 4.16 ft

Security

terrorism, cyber attacks, active shooter

Surface Water Quality

sewer overflow impacts on recreational waters, nutrient reduction for Tampa Bay

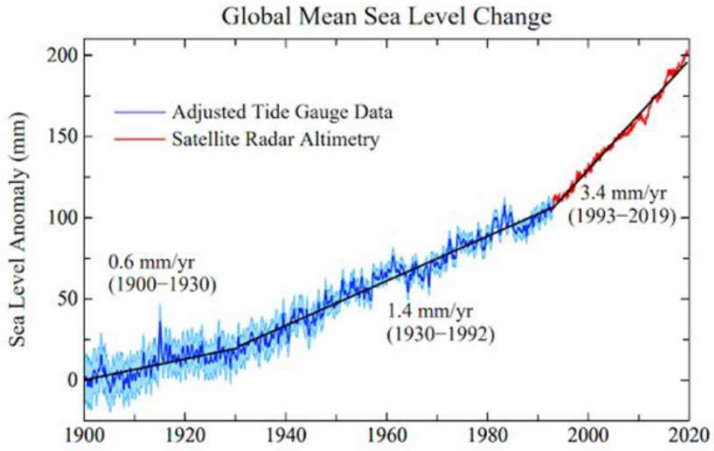
Sustainability

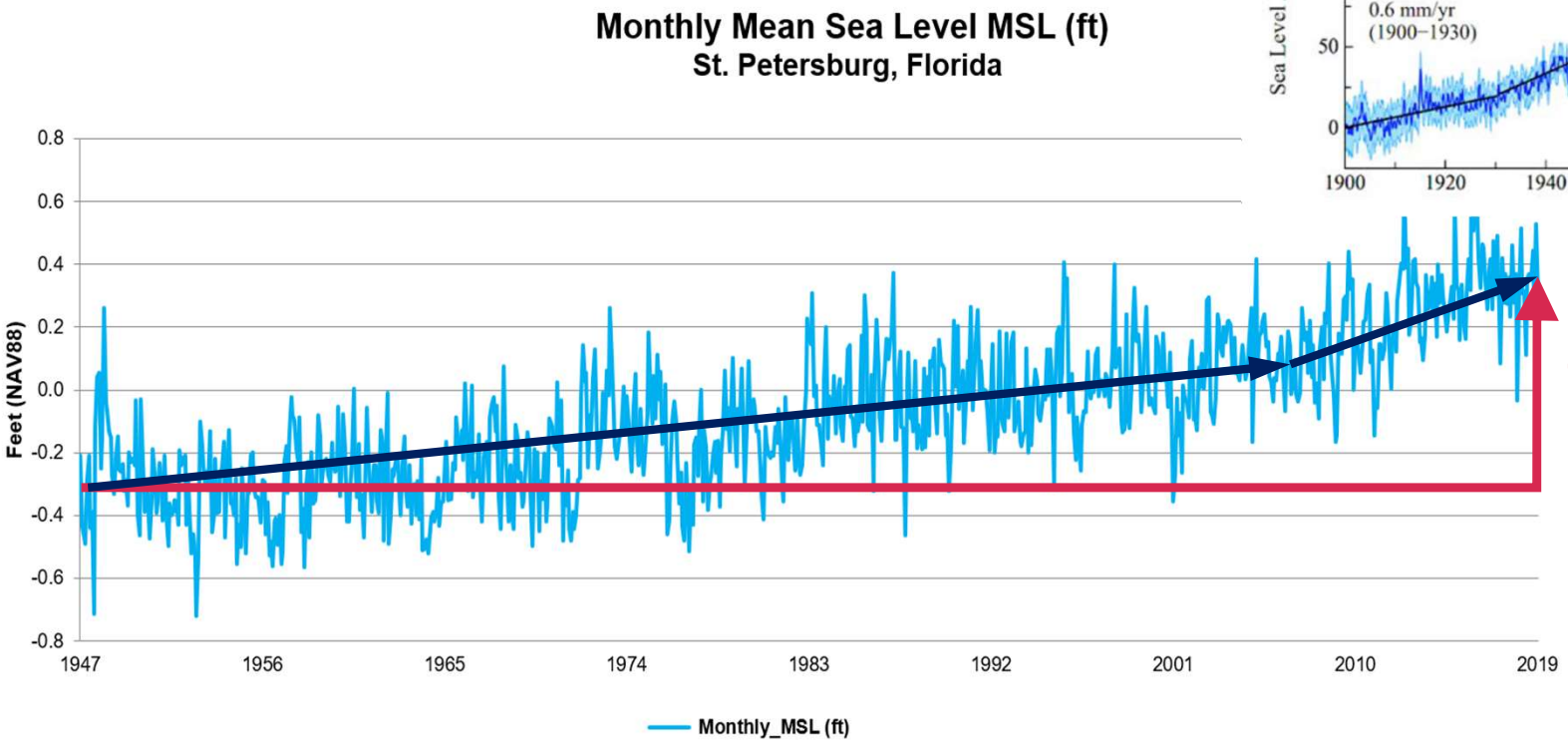
LEED & ENVISION certifications, Sustainability & Green Ordinances, STAR Community Rating

Greenhouse Gas Emissions

Clean energy opportunities, energy efficient equipment

Sea Level Rise over past 70+ years





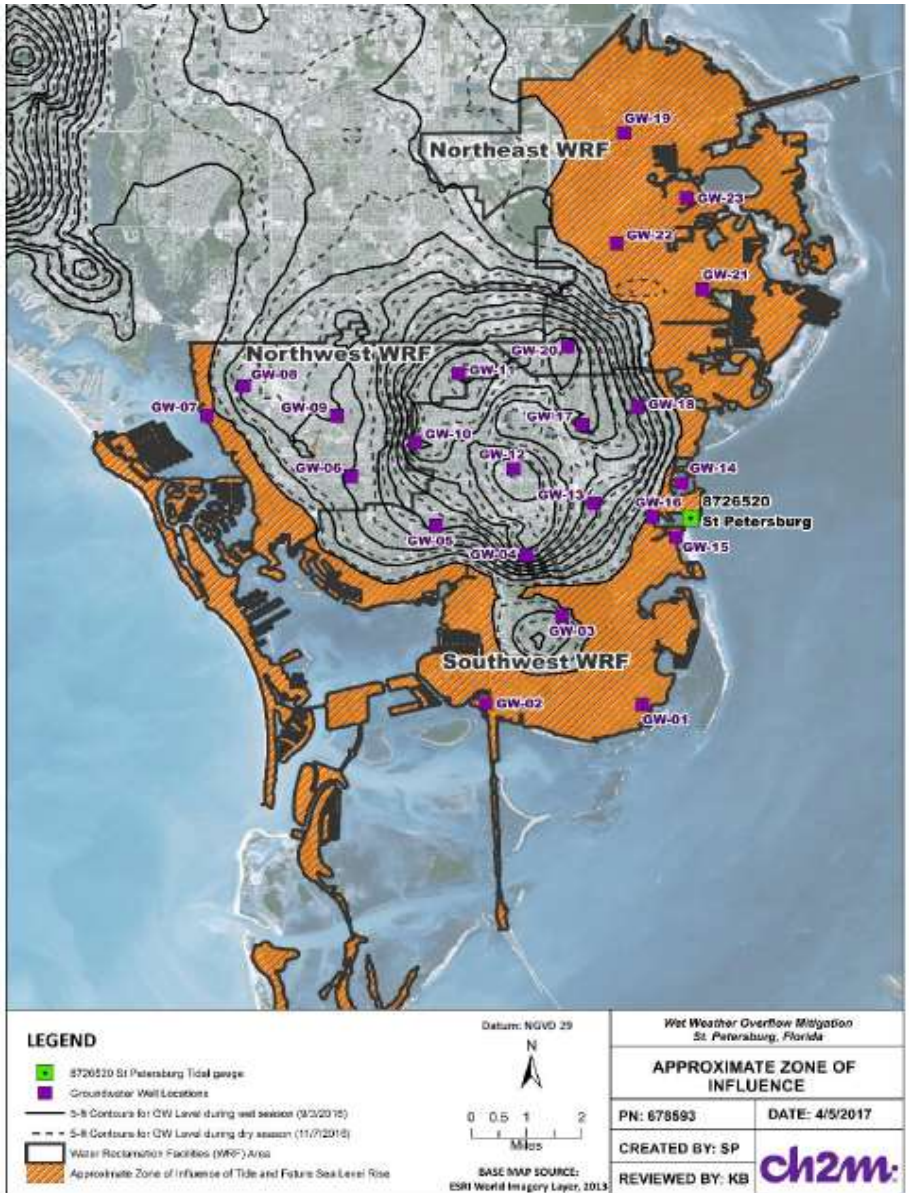
7.8 inches

Source: TBRPC CSAP 2019

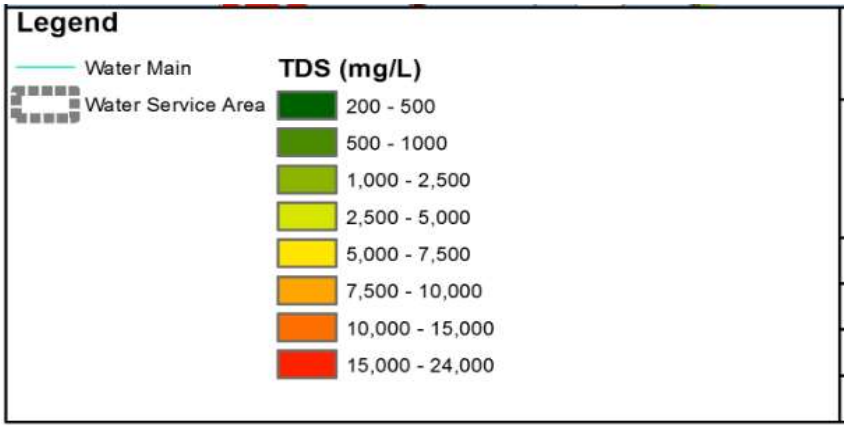
Effects on Groundwater Levels

- Direct correlation between SLR and groundwater for tidally influenced areas
  - Increase of 0.2-0.4 ft (1-2 ft SLR by 2040)
  - Increase of 0.4-1.0 ft (2-5 ft SLR by 2070)

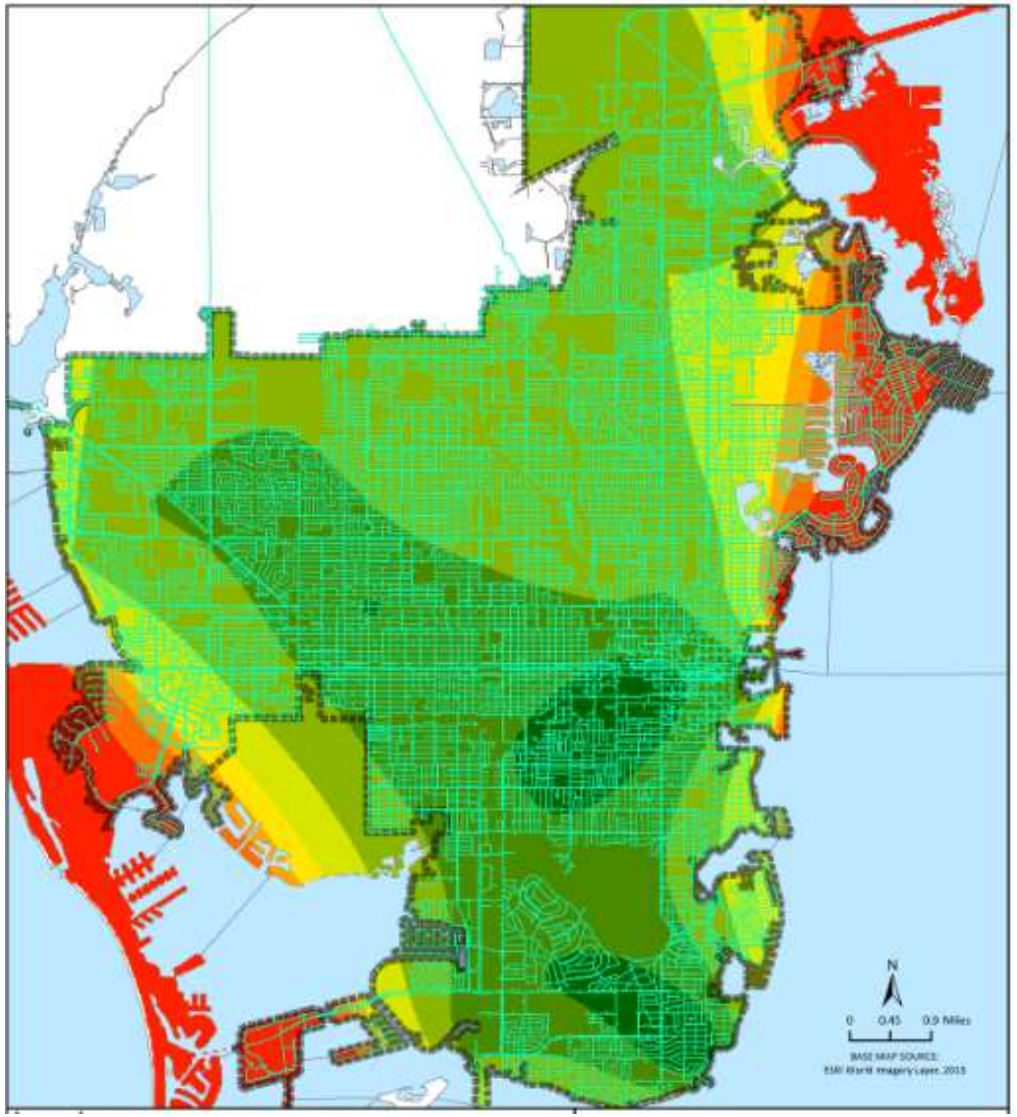
- Potential Stormwater Implications
  - Reduced capacity of infiltration and surface conveyance.
  - Backflow from tidally influenced outfalls.
  - Saltwater intrusion impacts on vegetation and corrosion of assets.



Potable Water Piping Corrosion Potential



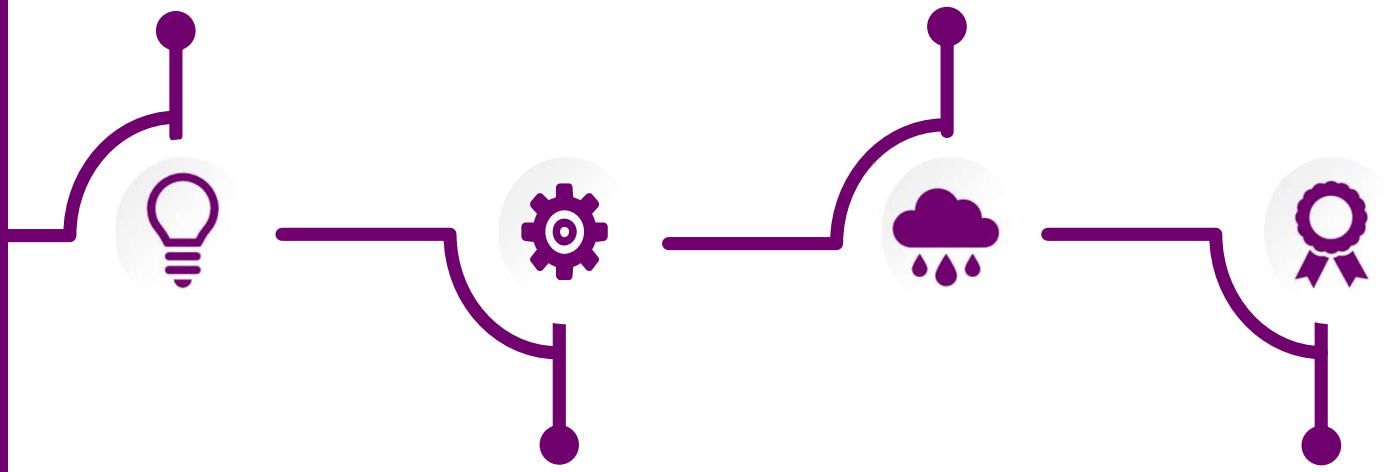
Operational challenges with cast iron pipe in highly saline areas (red on map)



St. Pete's Resilience Journey

The City embarked upon multiple concurrent plans and strategies to improve its ability to provide uninterrupted service to its customers.

The City's journey will continue as recommendations from these plans are implemented.



Integrated Sustainability Action Plan

Set of actions to protect against extreme weather, transition to clean energy, reduce greenhouse gas emissions and work toward a more sustainable, vibrant, equitable, and economically-robust community

Integrated Water Resources Master Plan

Holistic determination of ALL water resources capital needs including the general timing for investment, level of service, risk, compliance needs. Plan provides short, mid, and long-term strategies for potable water, wastewater, reclaimed water, and stormwater systems.

Stormwater Management Master Plan

Comprehensive plan working with the Southwest Florida Water Management District to develop a strategy that offers both local and regional stormwater management benefits and improves insurance rates.

American Public Works Association Accreditation

Staff developed standardized procedures for effectively managing utility assets and a Strategic Plan focused on the process improvements, infrastructure, data management, training, communication, and hiring practices.

Funding Resilience

The Value of Resilience? … It depends on the system and can be estimated to justify and prioritize investments. Typically $4-$6 benefit per $1 invested

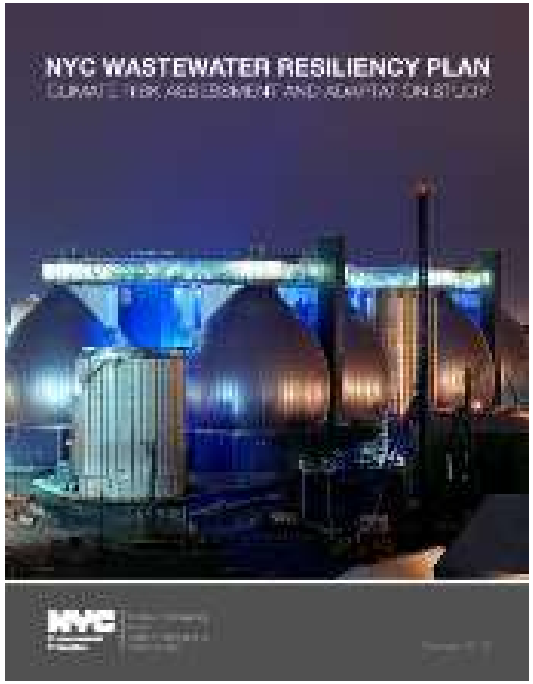
- Benefit of resilience can be measured in many ways:
  - damages avoided
  - business losses avoided
  - Social impacts
  - Environmental impacts
  - Financial impacts (bond ratings, insurance rates)

- $4 to $11 saved on average per $1 invested in Hazard Mitigation:
  - Adopting model building codes saves $11 per $1 spent
  - Mitigating infrastructure saves $4 per $1 spent

	ADOPT CODE	ABOVE CODE	BUILDING RETROFIT	LIFELINE RETROFIT	FEDERAL GRANTS
Overall Benefit-Cost Ratio	11:1	4:1	4:1	4:1	6:1
Cost ($ billion)	$1/year	$4/year	$520	$0.6	$27
Benefit ($ billion)	$13/year	$16/year	$2200	$2.5	$160
Riverine Flood	6:1	5:1	6:1	8:1	7:1
Hurricane Surge	not applicable	7:1	not applicable	not applicable	not applicable
Wind	10:1	5:1	6:1	7:1	5:1
Earthquake	12:1	4:1	13:1	3:1	3:1
Wildland-Urban Interface Fire	not applicable	4:1	2:1	not applicable	3:1

Source: "Natural Hazard Mitigation Saves: 2019 Report", National Institute of Building Sciences, 2019

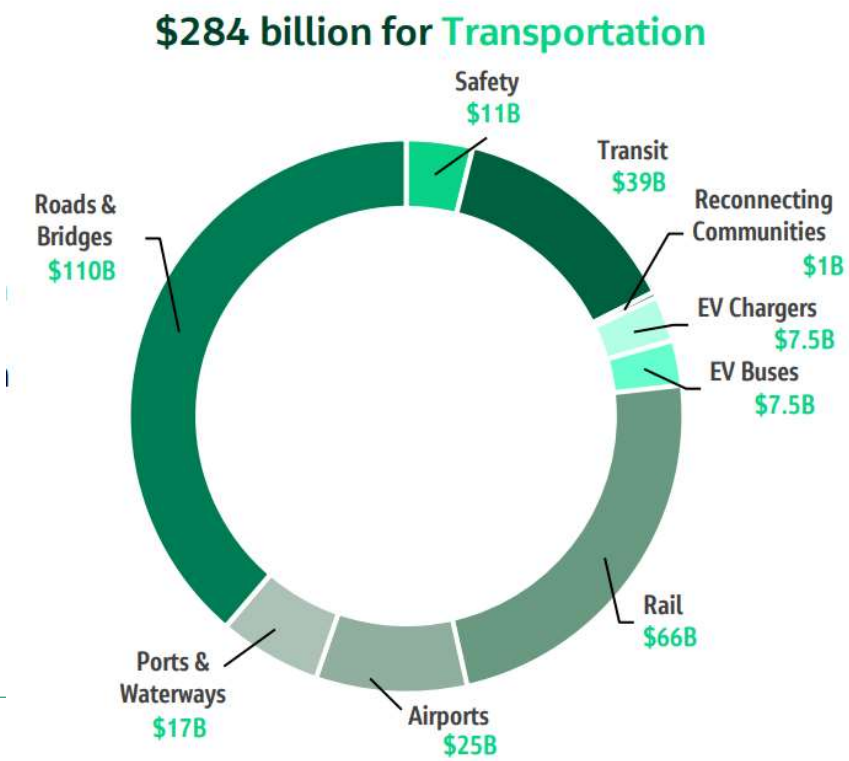
NYCDEP (NY) found $3.5 to $7 saved for every $1 invested in wastewater infrastructure flood resilience to guard against future Hurricanes like Sandy

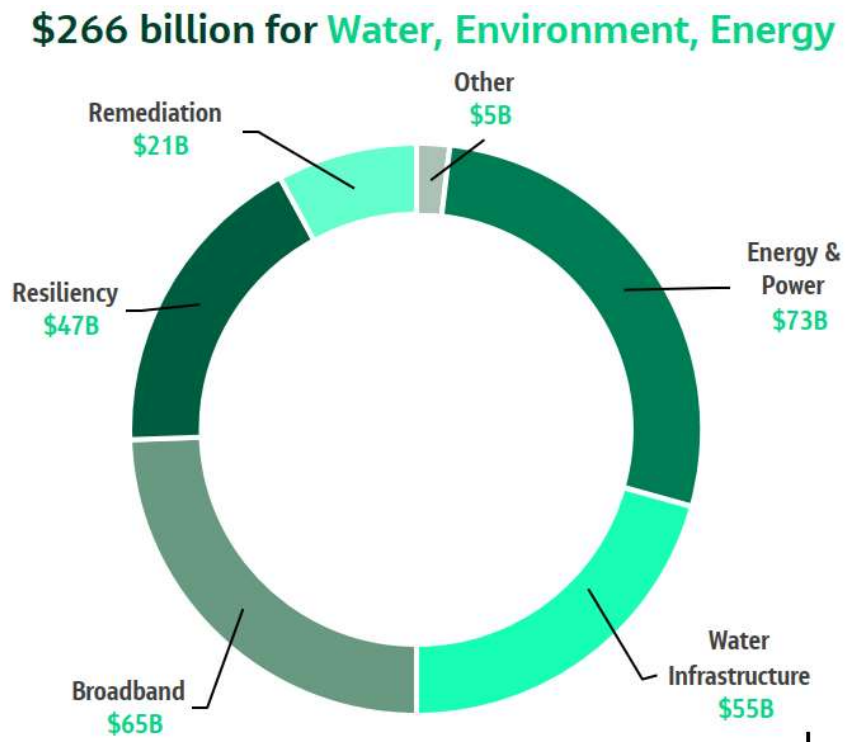


Investing **$315 Million** in strategic fortification can safeguard **$1.1 Billion** of vital infrastructure and save the city **$2.5 Billion** in emergency response costs over the next 50 years.

New Infrastructure Investment and Jobs Act is largest investment in the resilience of physical and natural systems in American history

- Signed into law November 15, 2021, creates $550B in *New* infrastructure funding
- 2 Funding Mechanisms: Formula funding and Competitive Grants





Resilience being incorporated into Federal programs

- By Executive Order 14008 "Tackling the Climate Crisis at Home and Abroad", each Federal Agency required to generate Climate Action Plans
- Not rule or law, but sets agency direction

USDOT

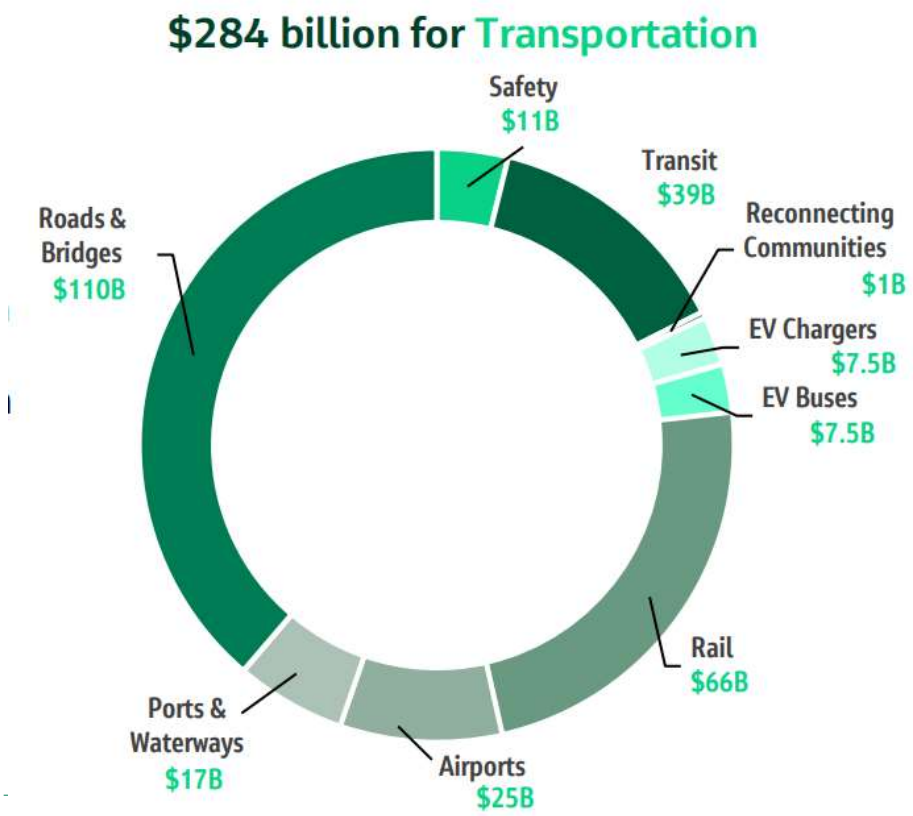
1. Incorporate Resilience Criteria in discretionary loan/grant programs
2. Incorporating resilience into project planning process
3. Ensuring resilience of DOT facilities and assets

EPA

1. Integrate resilience into discretionary/non-discretionary financial mechanisms as appropriate
2. Integrate climate-related considerations into rule making
3. Resilience assessments of EPA facilities

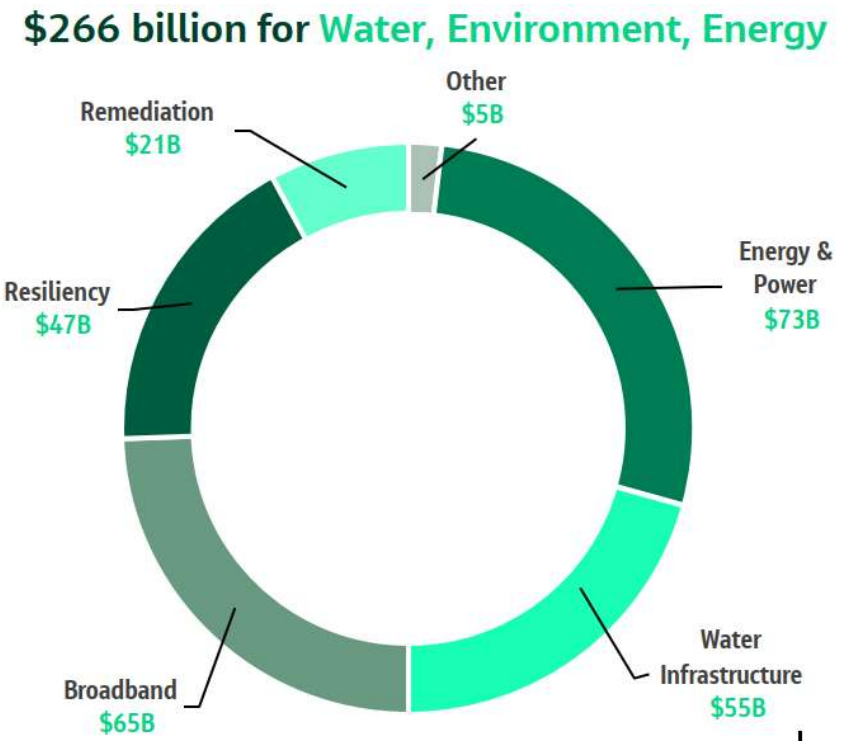
- Many IIJA programs focused around resiliency criteria – still being defined

Transportation-related programs



- 5-year surface transportation reauthorization (56% increase in FAST)
- 2 New Resilience-Focused DOT Programs - Carbon Reduction ($6.4B) and PROTECT Program ($7.3B)
- New Bridge Investment Program ($40B over 5 yrs)
- Additional $ for INFRA and RAISE
- Alabama
  - $5.2 billion for federal-aid highway programs and $255 million for bridge replacements
  - $400 million for public transportation
  - $79 million to support the expansion of electric vehicle charging throughout the state.
  - $140 million for infrastructure development at airports.

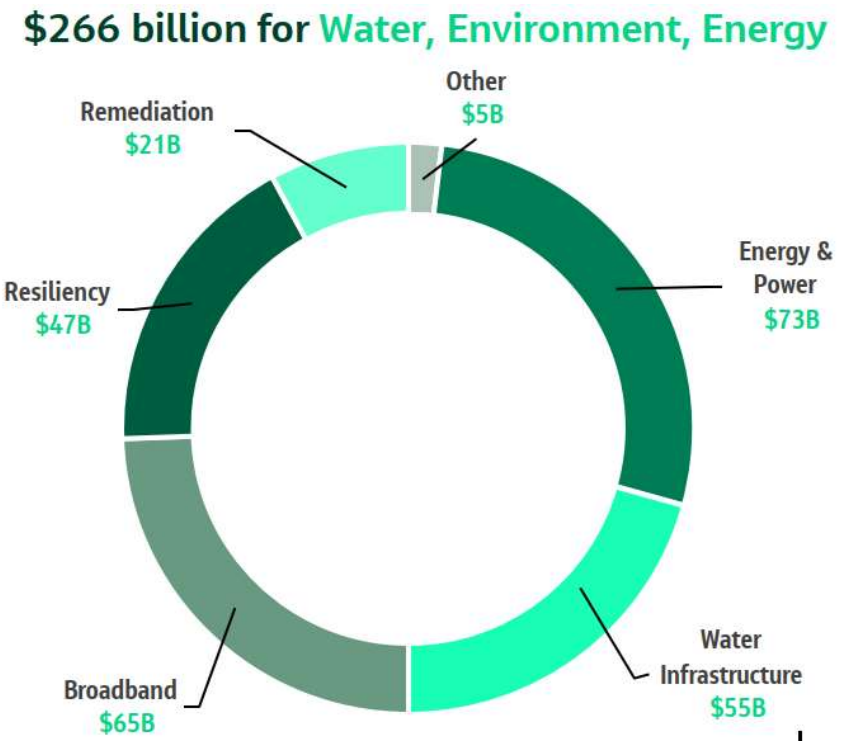
Water, Environment, Energy programs



EPA Water Programs	FY22	FY23	FY24	FY25	FY26	Total
Drinking Water SRF (CWSRF)	1.9B	2.2B	2.4B	2.6B	2.6B	**11.7B**
Clean Water SRF (CWSRF)	1.9B	2.2B	2.4B	2.6B	2.6B	**11.7B**
Emerging Contaminants ($ through DWSRF)	800M	800M	800M	800M	800M	**4B**
Emerging Contaminants ($ through Small & Disadvantaged Grant Program)	1B	1B	1B	1B	1B	**5B**
Emerging Contaminants ($ through CWSRF)	100M	225M	225M	225M	225M	**1B**
Lead Pipe ($ through DWSRF)	3B	3B	3B	3B	3B	**15B**

  - 10% match, 49% to principal forgiveness
- USACE - $17B
- Alabama
  - Water Infrastructure, $782M over 5 years
  - A minimum of $100 million to upgrade broadband coverage

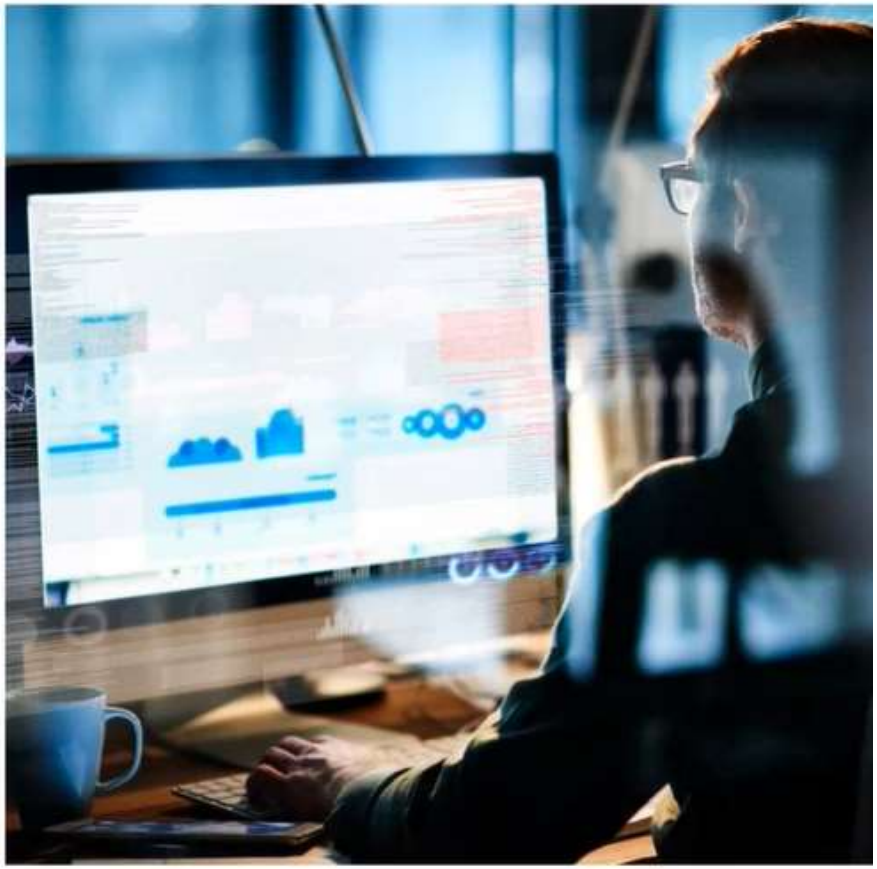
Water, Environment, Energy programs – Resilience-specific



- $47B in programs across multiple agencies to address wide range of threats to infrastructure
  - Cyber
  - Floods
  - Drought
  - Pollution
- Many are competitive grant programs
  - New and existing
    - FEMA BRIC and Hazard Mitigation $4.5B
    - STORM – FEMA Revolving Loan Program $500M
    - Multiple NOAA programs
    - Dept. of Int. Wildfire programs

Path to capitalizing on resilience funding

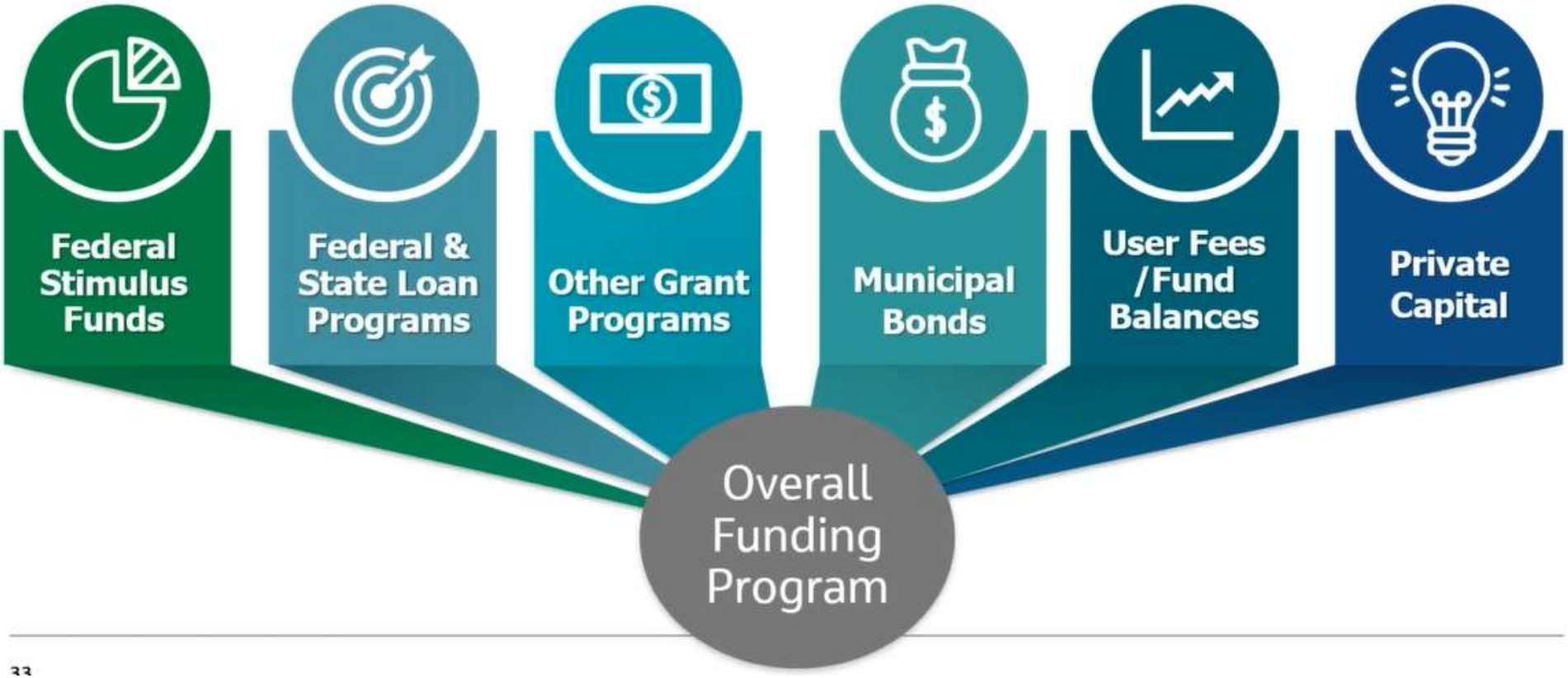
- Explore any remaining opportunities to secure funding from the American Rescue Plan Act
- Revisit your capital improvement plan (CIP) project prioritization processes
- In the water sector, develop SRF program applications for high-priority projects
- Conduct scenario analyses to identify key triggers for changes in policy and programs
- Update your financial forecasting and planning models
- Identify opportunities to advance environmental justice and social equity objectives as your resilience programs are implemented
- Make sure you have the capacity to deliver projects within funding program schedule requirements

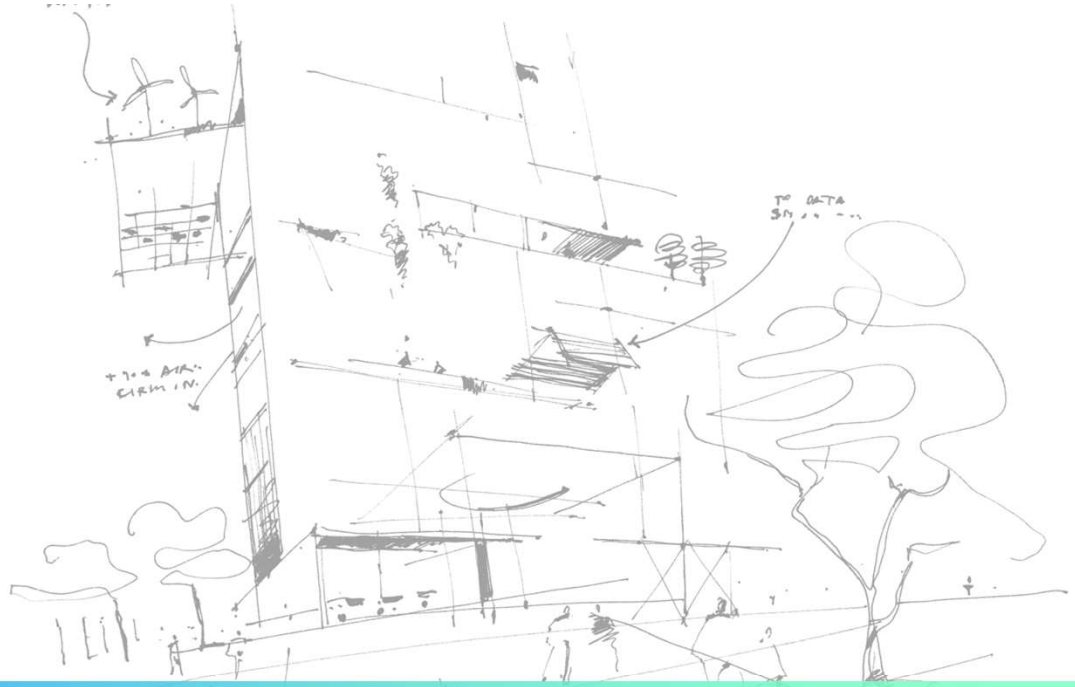


Path to capitalizing on resilience funding: strategies for securing federal grant funds

- Get an early start in developing a funding and grants strategy
- Re-submit past applications
- Scope projects that align with grant program evaluation criteria
- Showcase partnerships – especially non-traditional partnerships – as part of project applications
- Consider planning and pre-construction grant requests

Federal stimulus money can be integrated with many other funding sources to fully fund resilience programs





Questions?

Jacobs

Challenging today.
Reinventing tomorrow.