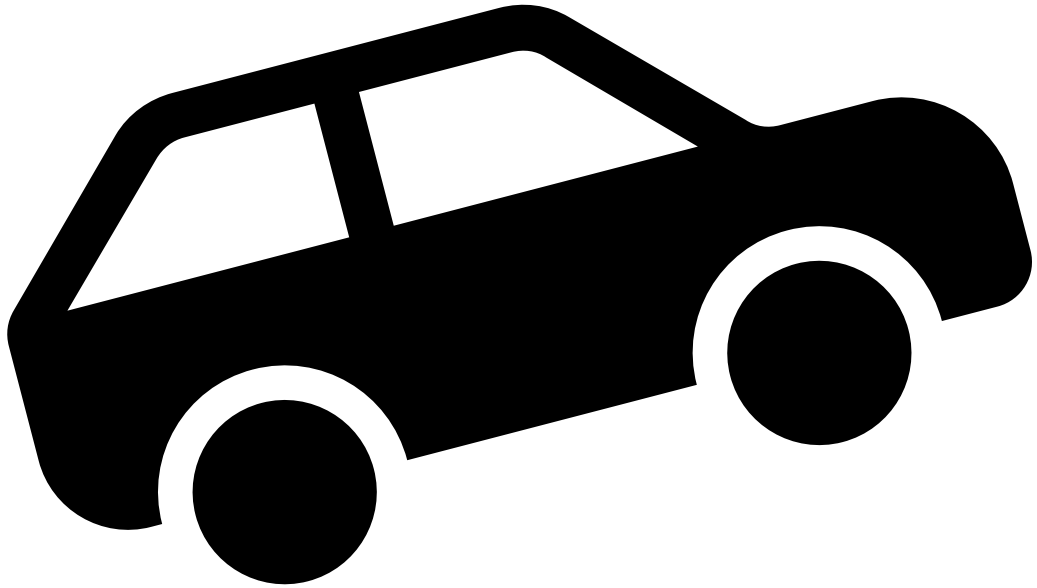
ARCADIS
Design & Consultancy for natural and built assets

RESILIENCE STRATEGIES FROM CONCEPT TO CONSTRUCTION

Lessons Learned for Protecting Critical Assets

Carly A. Foster

Health and Safety Moment – Vehicle Skidding



Updated guidance: Steer in the direction you want to go

AGENDA

The "key to success is to skate to where the puck is going to be…"

- Wayne Gretzky

- **Resilience primer**
- **Risk and resilience assessment**
- **Solution development**
- Benefit cost analysis
- Implementation

WHO IS IN THE ROOM?

How many engineers? Facility operators? Management consultants? Other?

How many have done a risk assessment before?

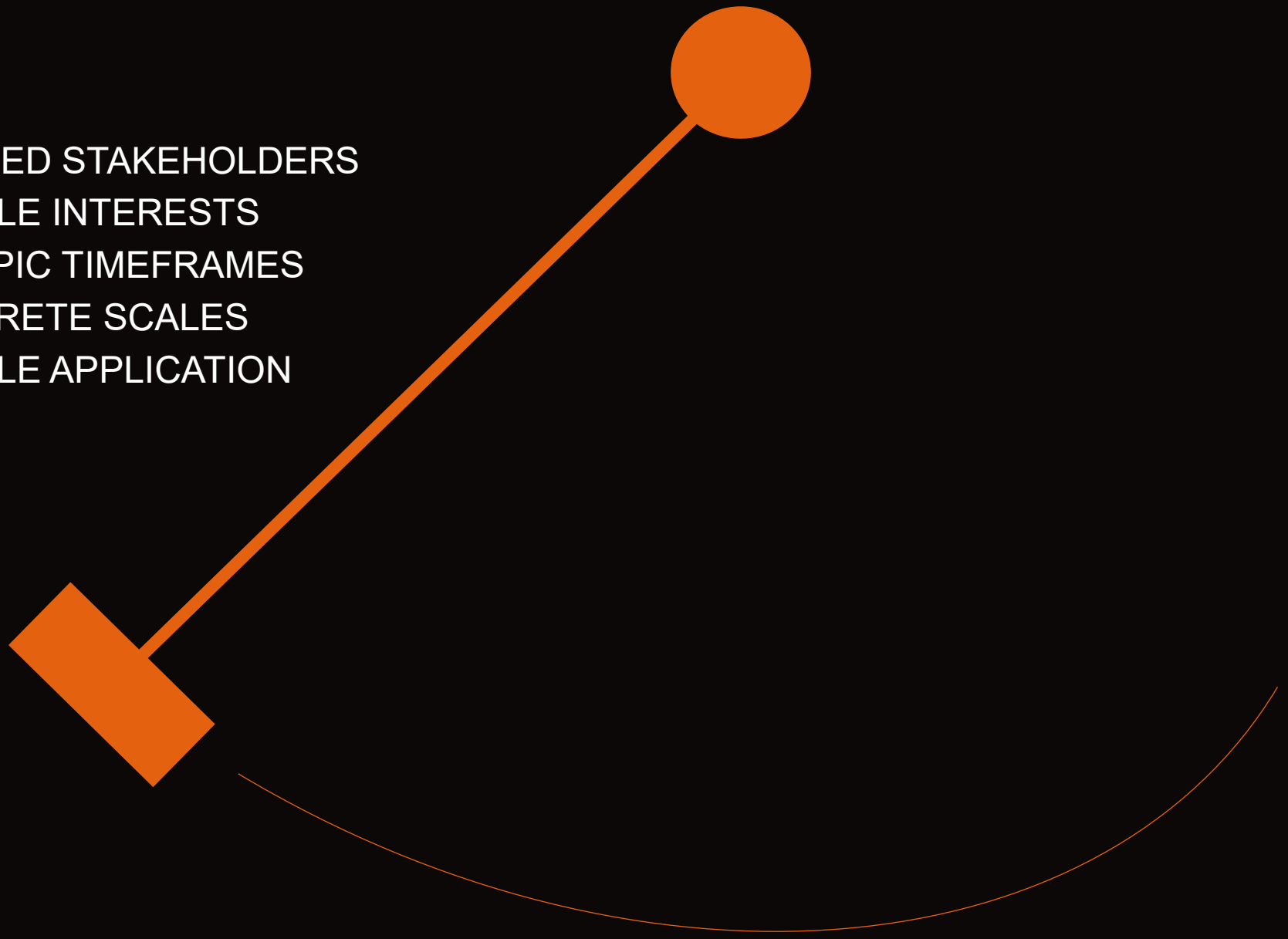
How many have assessed the overall resilience of a facility before?

Who thinks these are the same thing?

Who thinks they are different?

I'm going to pitch to you a holistic approach to reducing risk and maximizing resilience

LIMITED STAKEHOLDERS
SINGLE INTERESTS
MYOPIC TIMEFRAMES
DISCRETE SCALES
SINGLE APPLICATION



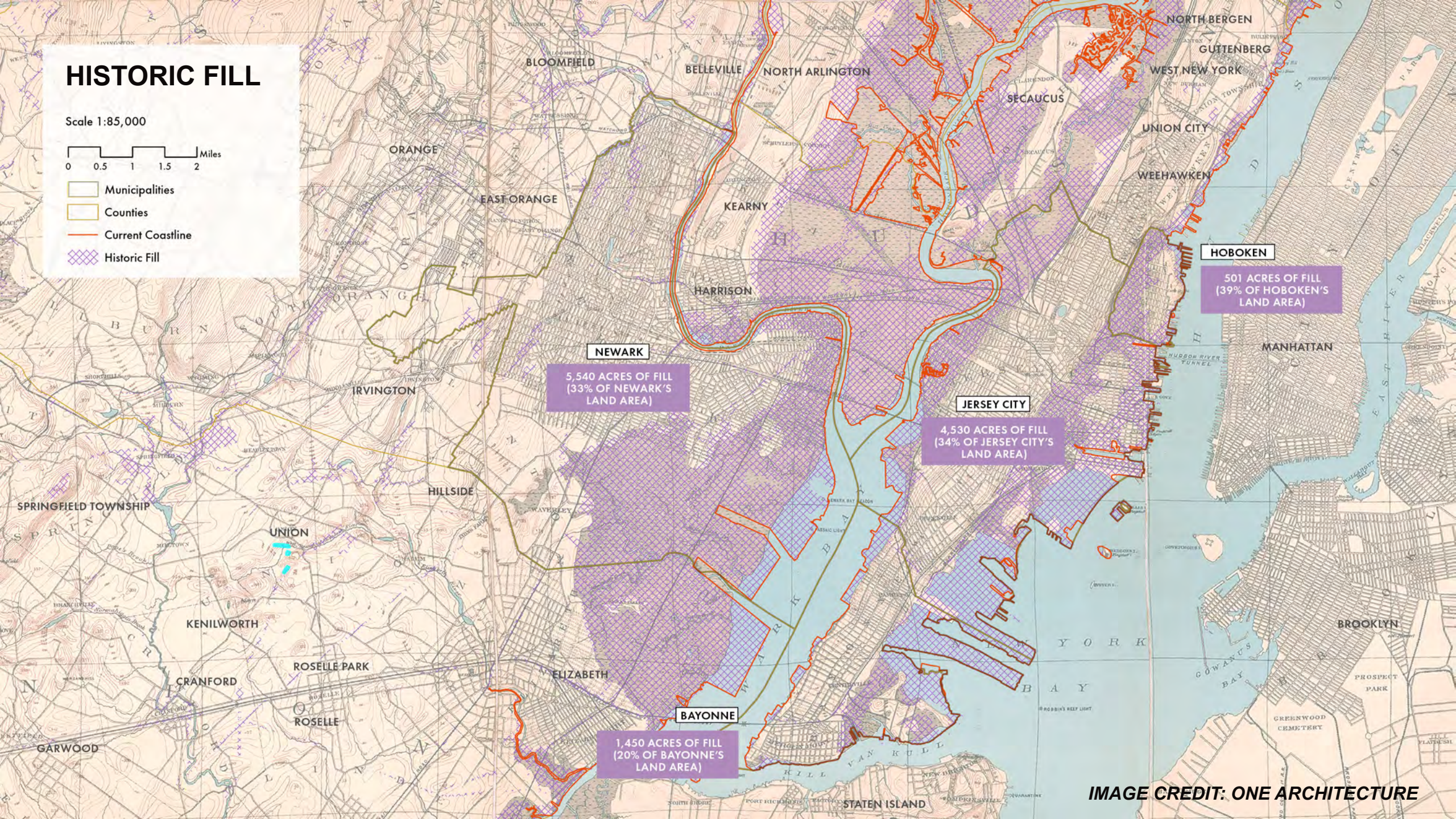


IMAGE CREDIT: ONE ARCHITECTURE

SANDY HIGH WATER MARKS 2012

+

2.4 FEET (2070 SLR)

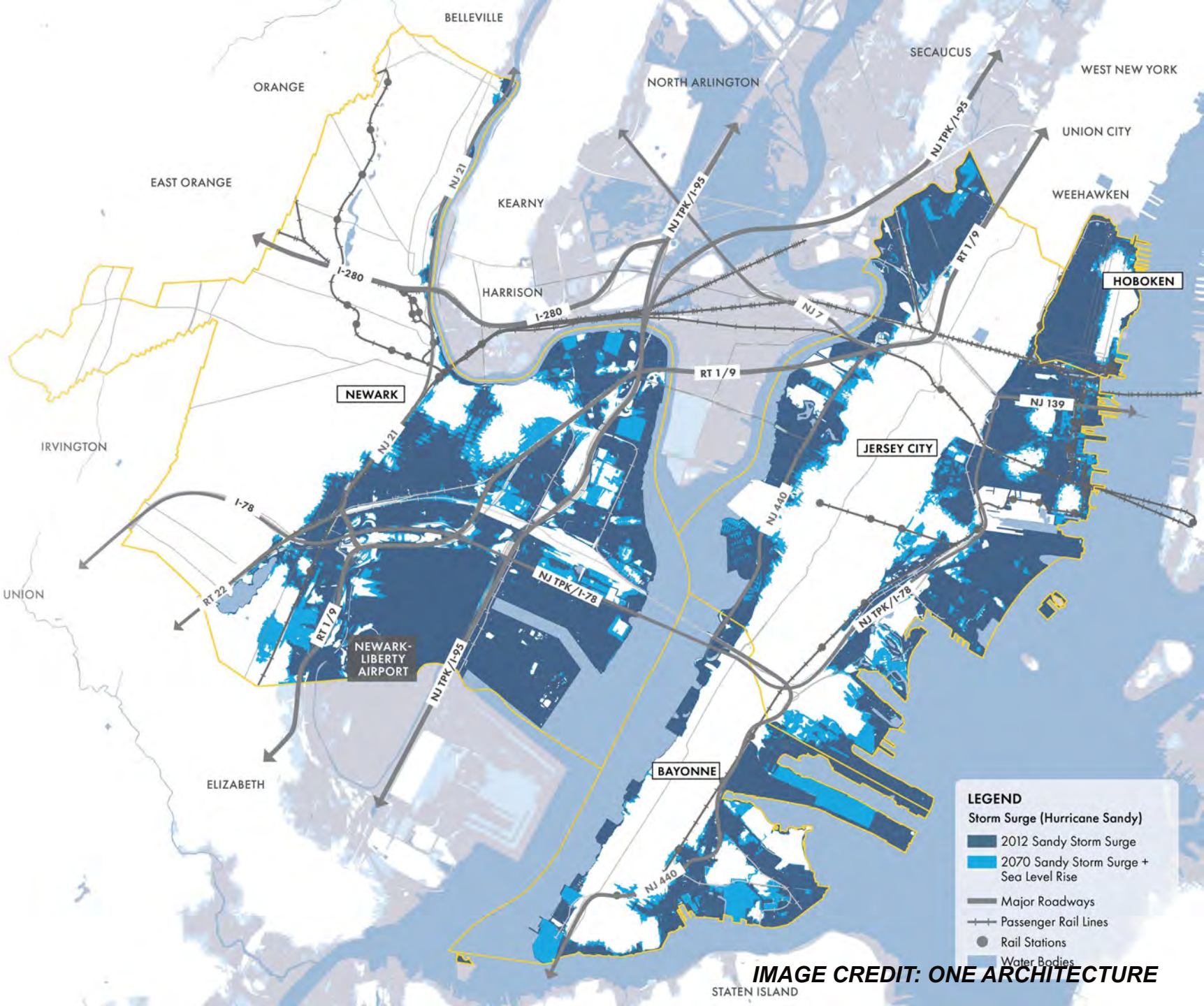


IMAGE CREDIT: ONE ARCHITECTURE

AREAL FLOODING

(24 HOUR 100YR RAINFALL)

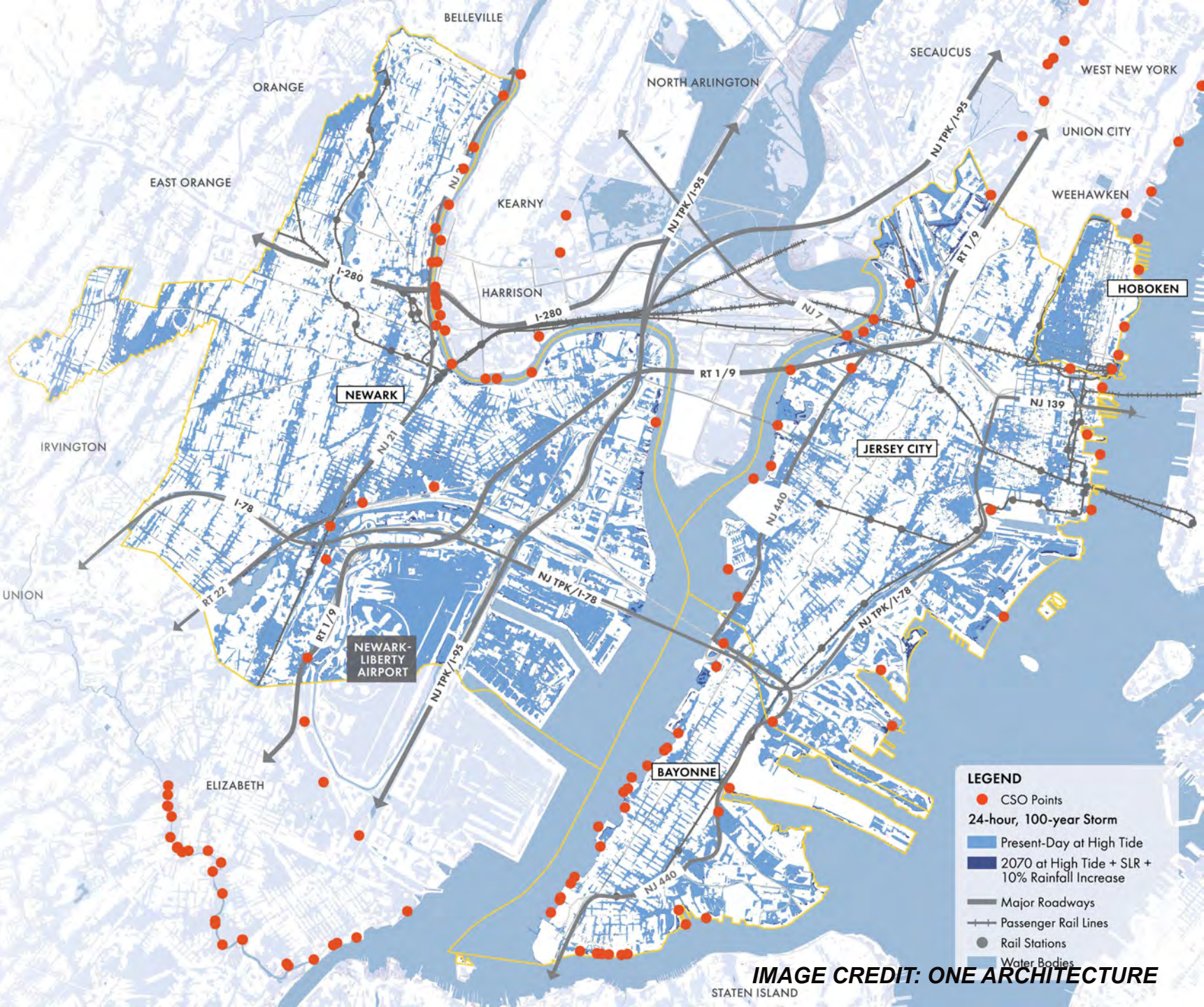
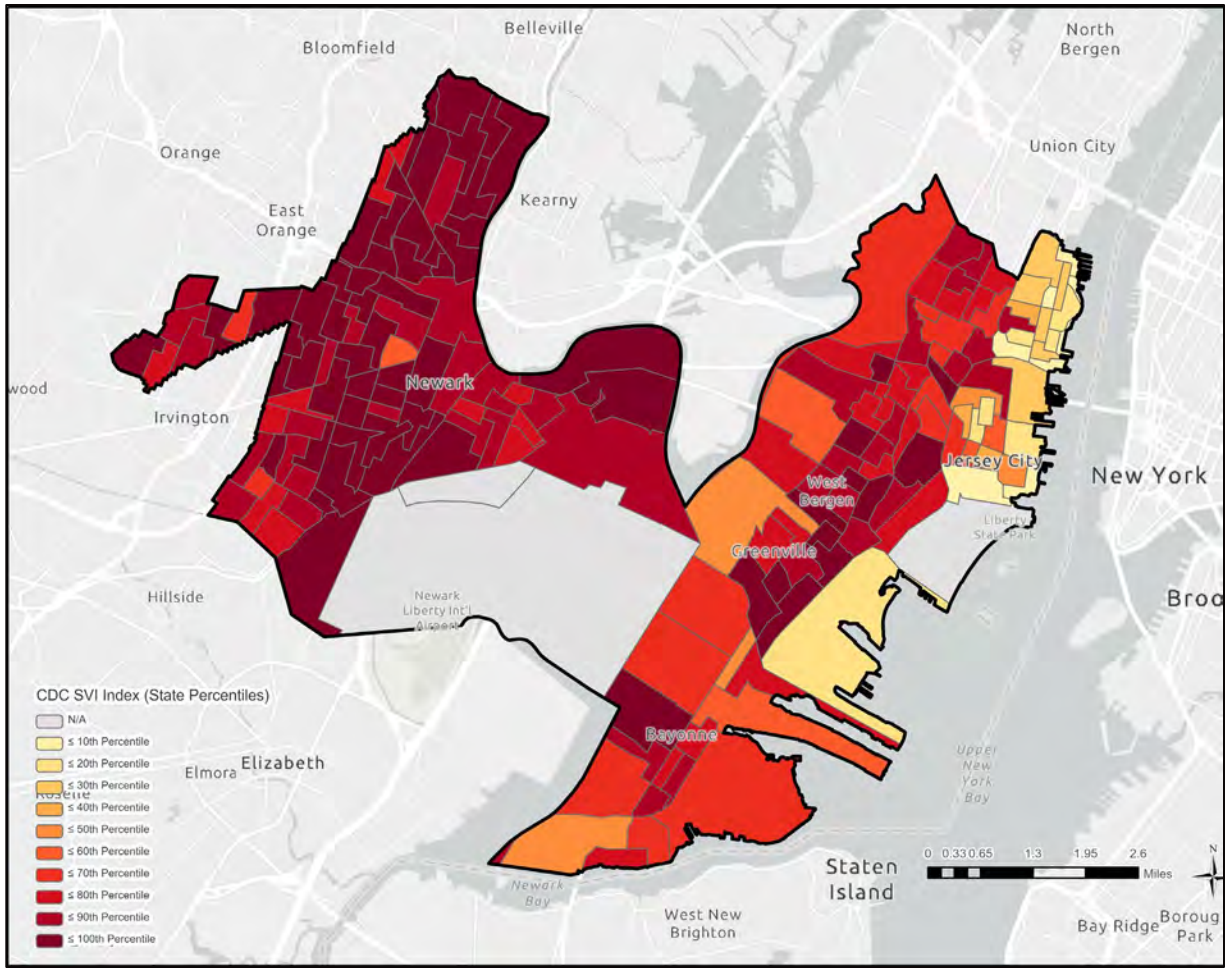
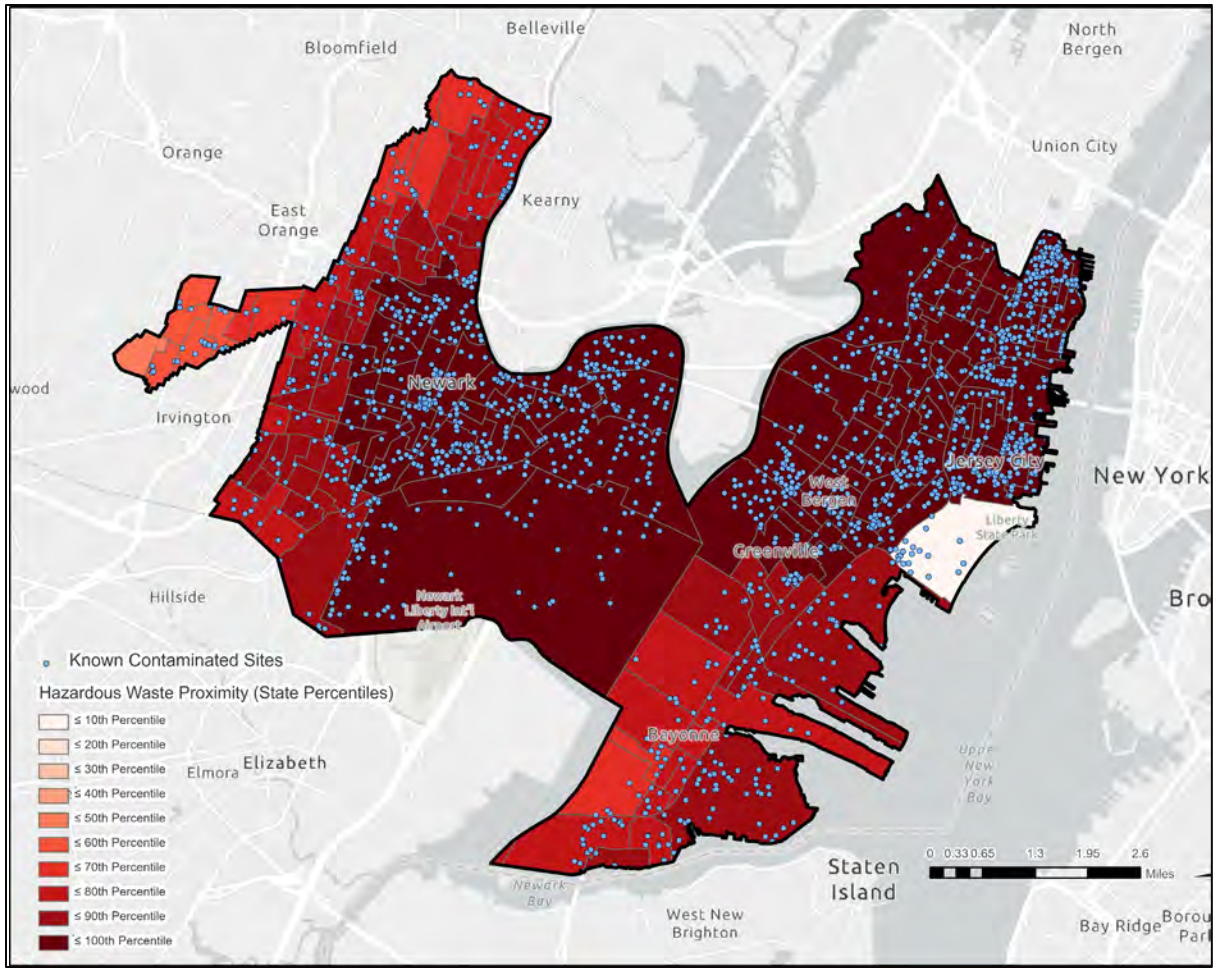


IMAGE CREDIT: ONE ARCHITECTURE

SOCIAL VULNERABILITY



EXPOSURE TO CONTAMINANTS



HOW DO WE PROGRESS TOWARD A CONSIDERATION OF…

Everybody

All who could be affected by the process and outcomes of our decisions

All who could affect the process or outcomes of our decisions

In all ways

All potential disruptions to the mission of an organization or entity

Sustainability alongside risk, and vice versa

For all time

The entire life-cycle of an asset

Potential residual impacts of decisions

At all scales

From individual assets to neighborhoods to cities to states to national and international portfolios

In all things

All mechanisms for implementation (e.g., operational, capital, etc.)

TO BUILD

Trust

Resilience

Sustainability

Scalability

Equity

THIS MOVEMENT *SOUNDS* HARDER THAN IT IS

Resilience

"Resilience is the capacity of individuals, communities and systems to **survive**, **adapt**, and grow in the face of stress and shocks, and even **transform** when conditions require it." (~The Rockefeller Foundation)

Resilience is the ability to achieve your mission *despite obstacles and setbacks*

Five Pillars of Resilience in any organization

e.g., Workforce succession strategy
Organizational Culture

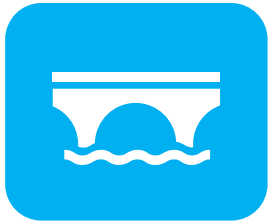
e.g., Operating costs
Revenue

e.g., Asset management
Physical Security

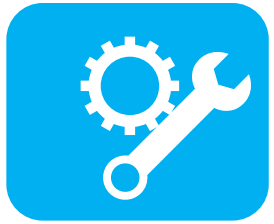
e.g., Facility polices
Regulations
Decision hierarchy

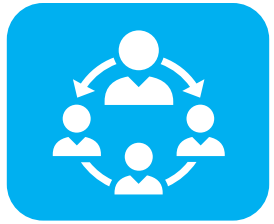
e.g., Permits
Active monitoring
Water quality

Supporting Functions

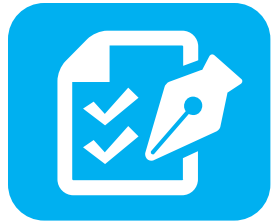

Built Asset Management


Digital/Cyber


Operations


Organization Culture


Regulatory Framework


Polices and Standards


Roles, Responsibilities and Authorities


Financial Resources


Human Resources


Emergency and Risk Management


Long-Term Strategy and Planning


Stakeholder and Community Engagement

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Analyzing the Current State

General knowledge of where we are

Bridging the Gap

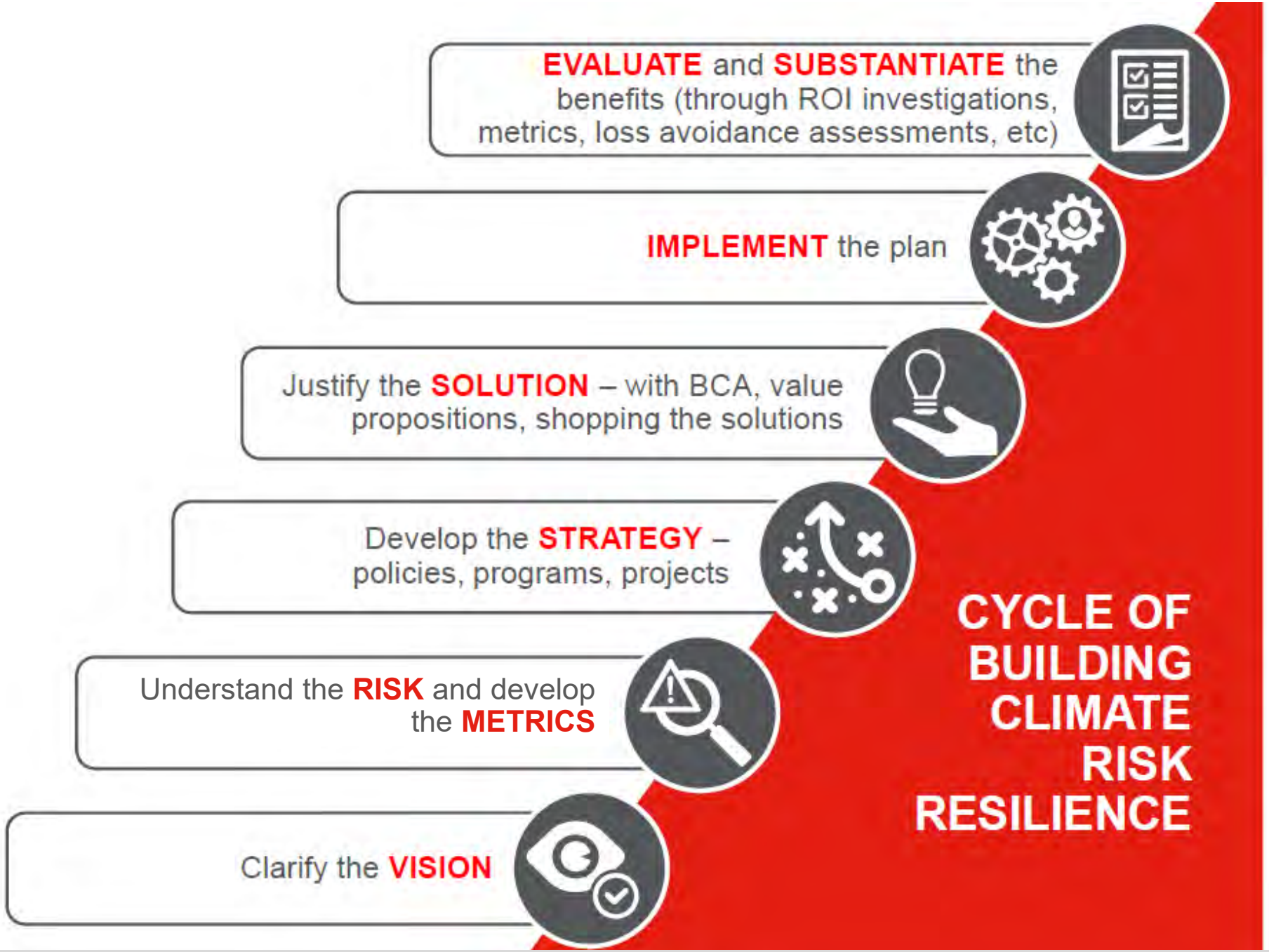
How where we are **COMPARES** to where we want to be

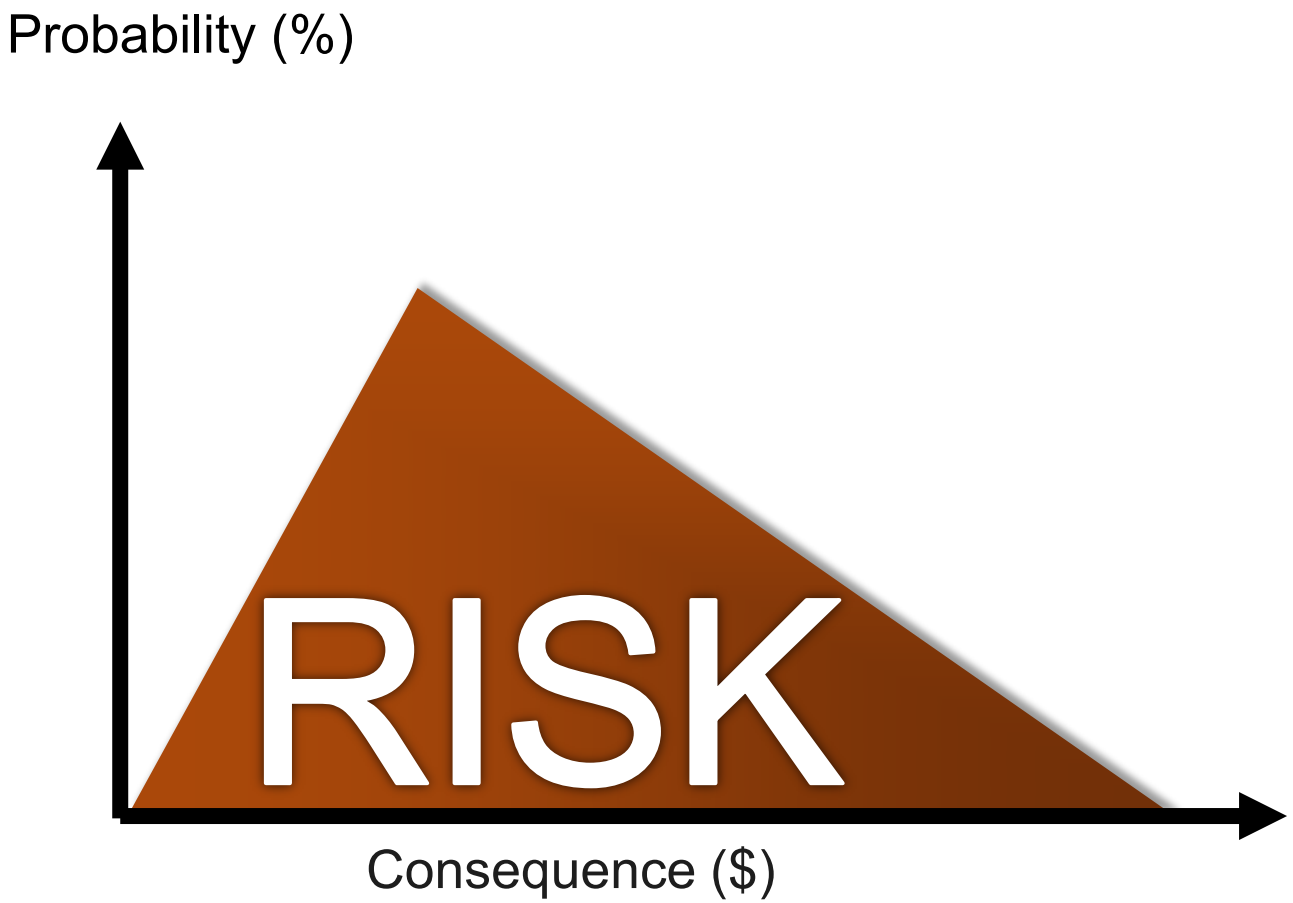
ROADMAP to get to where we want to be

What does it **MEAN** to be where we want to be

Defining the Ideal Future State

General knowledge of where we want to be





Consequence

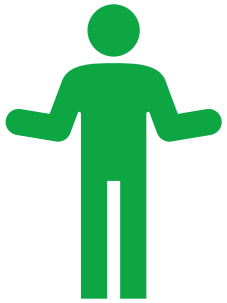
Hazard

Vulnerability

Impact

Criticality

Schools of Thought – Risk and Resilience Assessment



VS

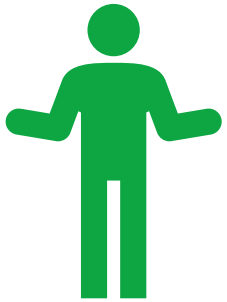
Traditional

What hazards are out there and how might they affect me?

Mission / Outcome focused

What is my mission, what is needed for me to accomplish my mission, and what could possibly get in the way of me accomplishing that mission?

Schools of Thought – Risk and Resilience Assessment



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Traditional

What hazards are out there and how might they affect me?

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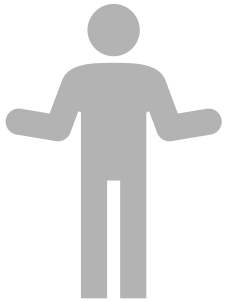
What is my mission, what is needed for me to accomplish my mission, and what could possibly get in the way of me accomplishing that mission?

Both perspectives are important to ensuring there are no blind spots and to appropriately prioritize investment

Schools of Thought – Risk and Resilience Assessment



Traditional

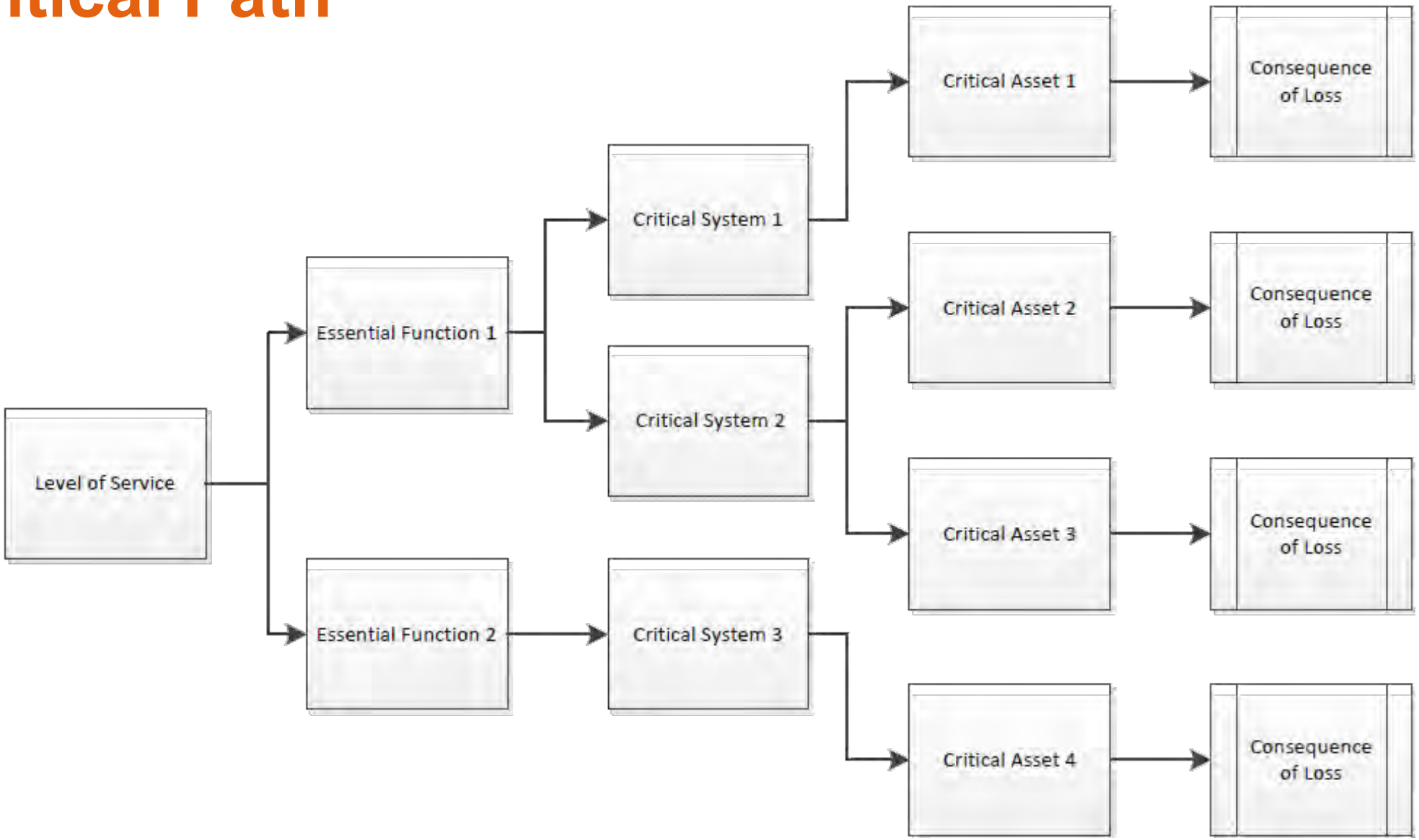
What hazards are out there and how might they affect me?

+

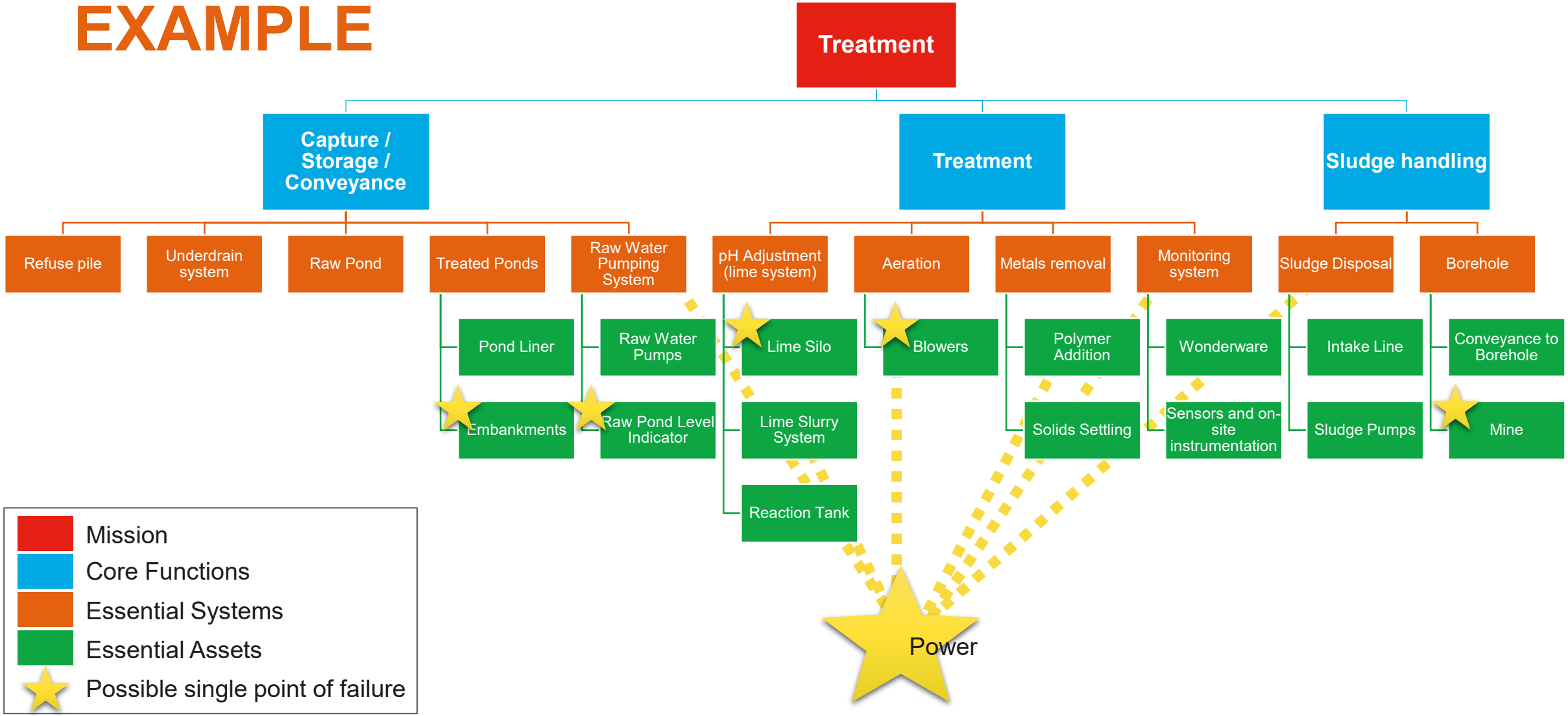
Mission / Outcome focused

What is my mission, what is needed for me to accomplish my mission, and what could possibly get in the way of me accomplishing that mission?

Critical Path

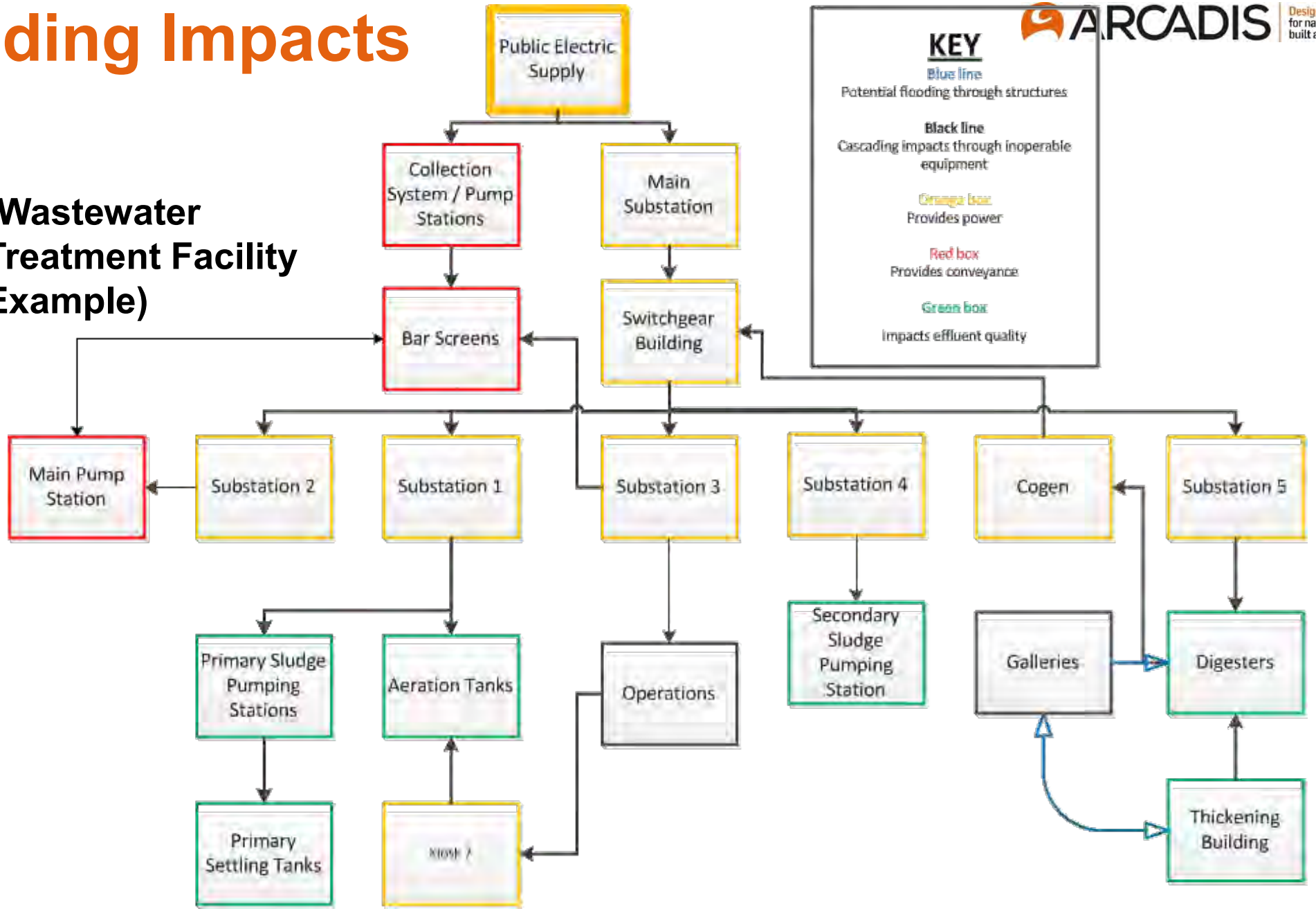


EXAMPLE



Cascading Impacts

(Wastewater Treatment Facility Example)



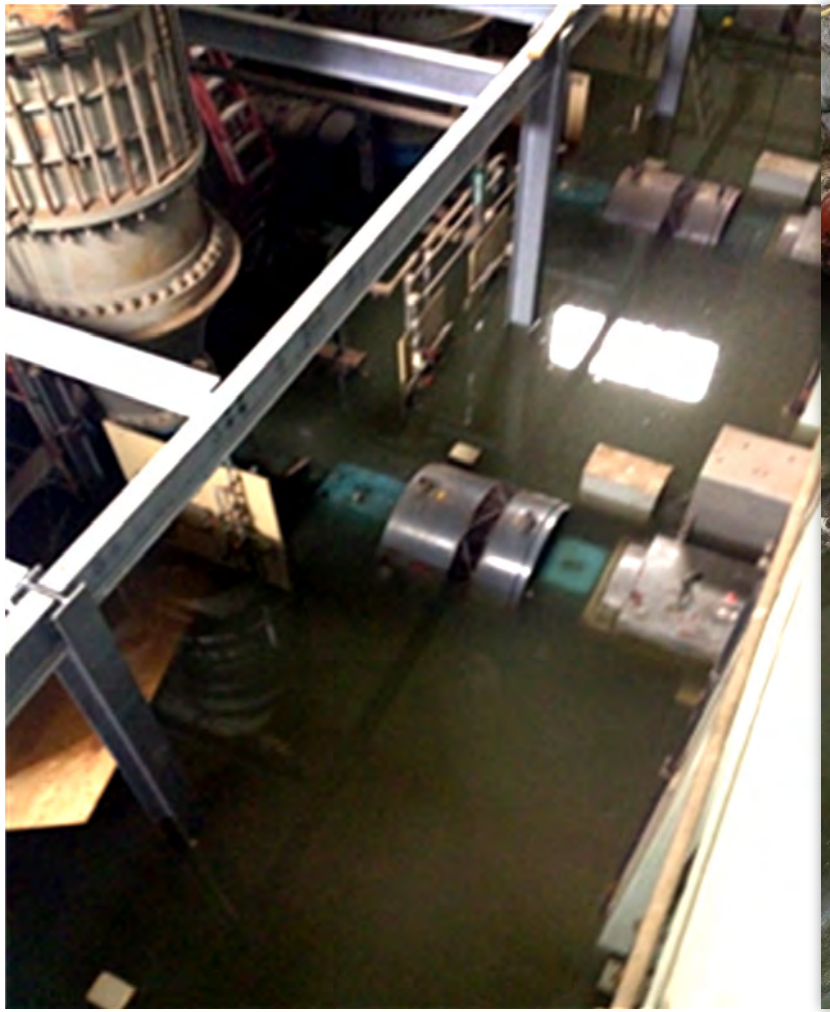
Example Flood Impacts

~ 3 Days Total Shutdown

~ 45 Days Partial Treatment

~ $400M in Damages

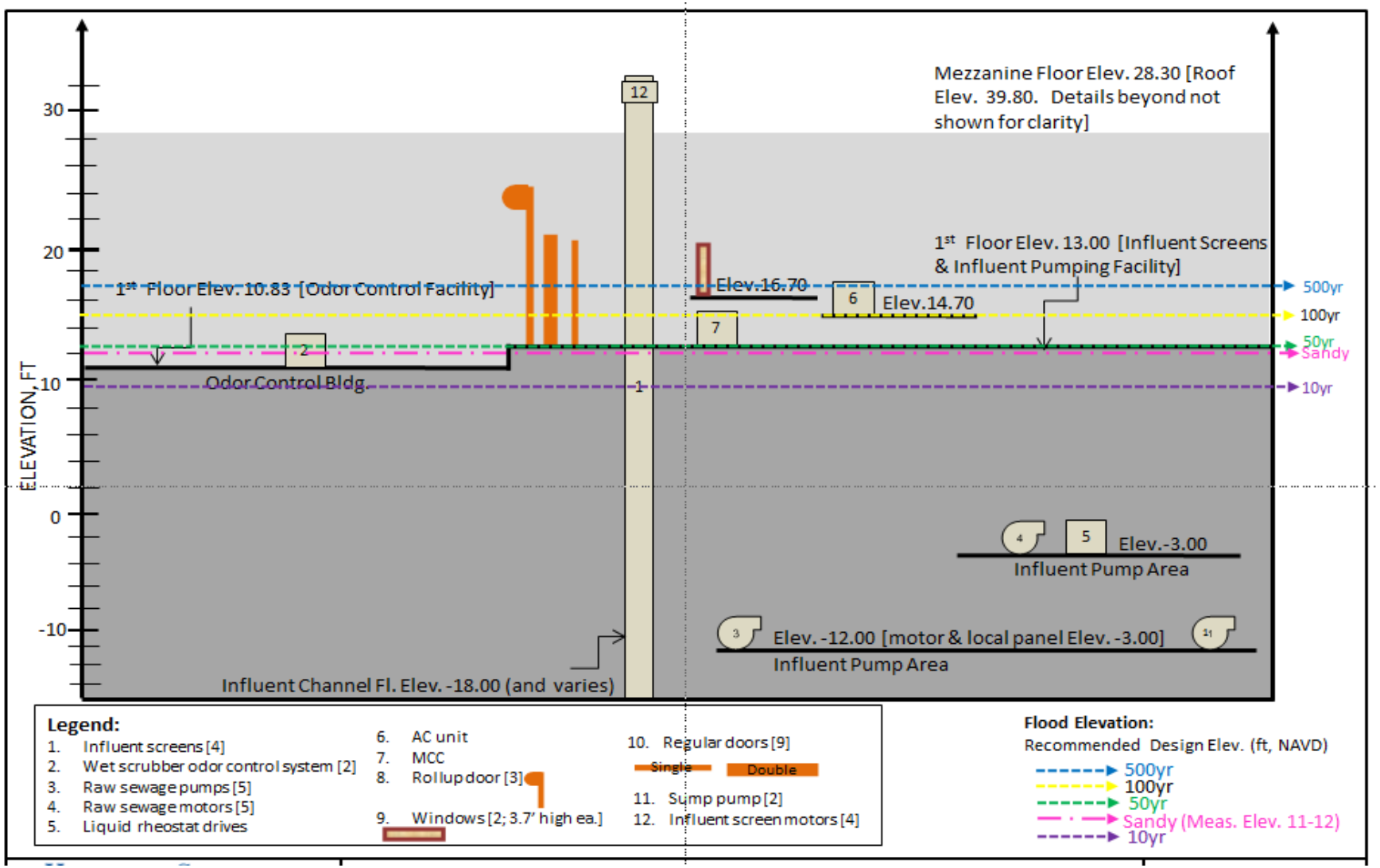
~ 2 Billion Gallons Raw / Partially Treated Waste into Channel



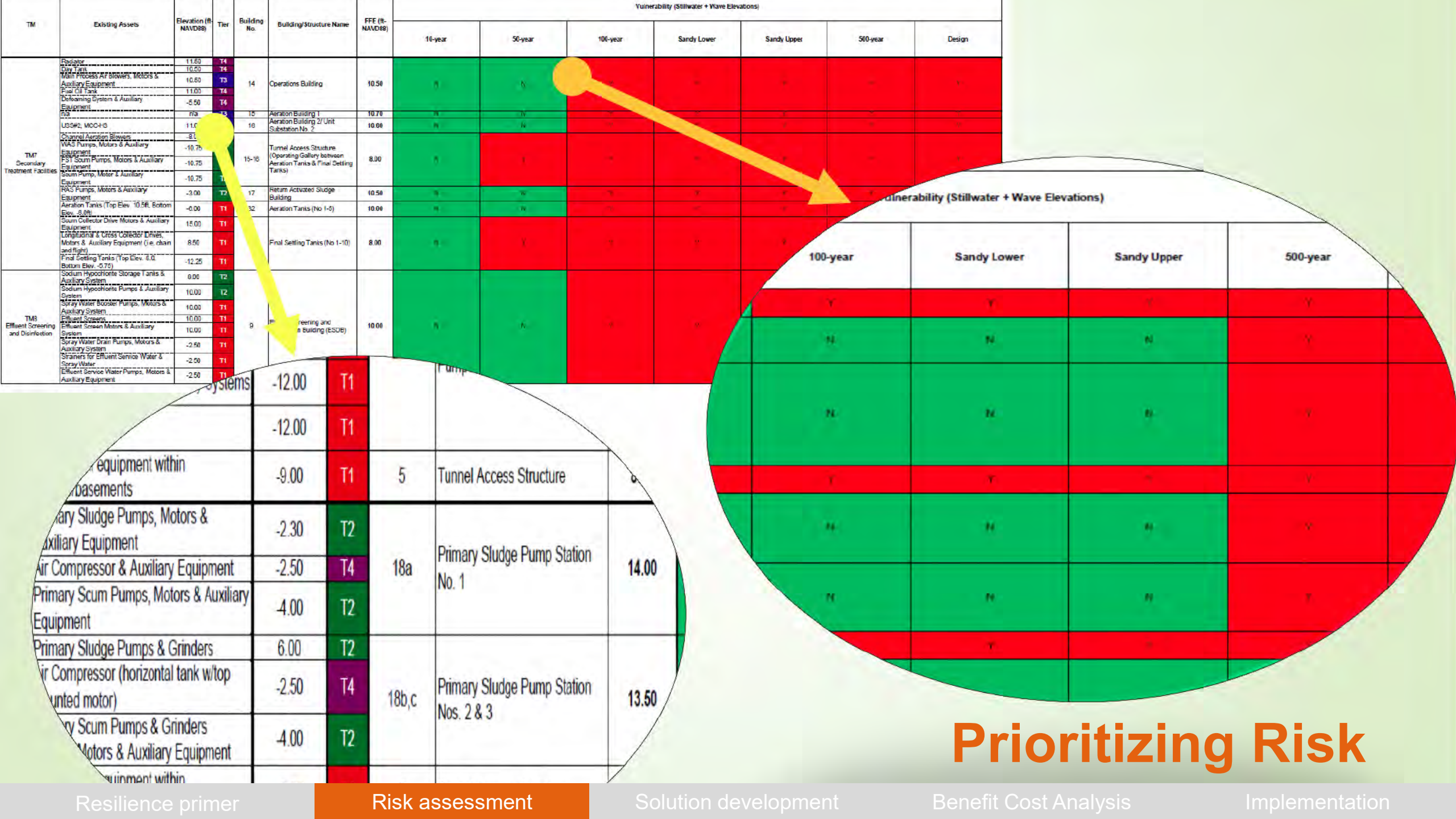
Asset Tiering

Tier	Essential Function
1	Conveyance
2	Solids Removal/ Handling
3A	Treatment- Minimal
3B	Treatment – Permit
4	Other Plant Services

Evaluating Vulnerabilities



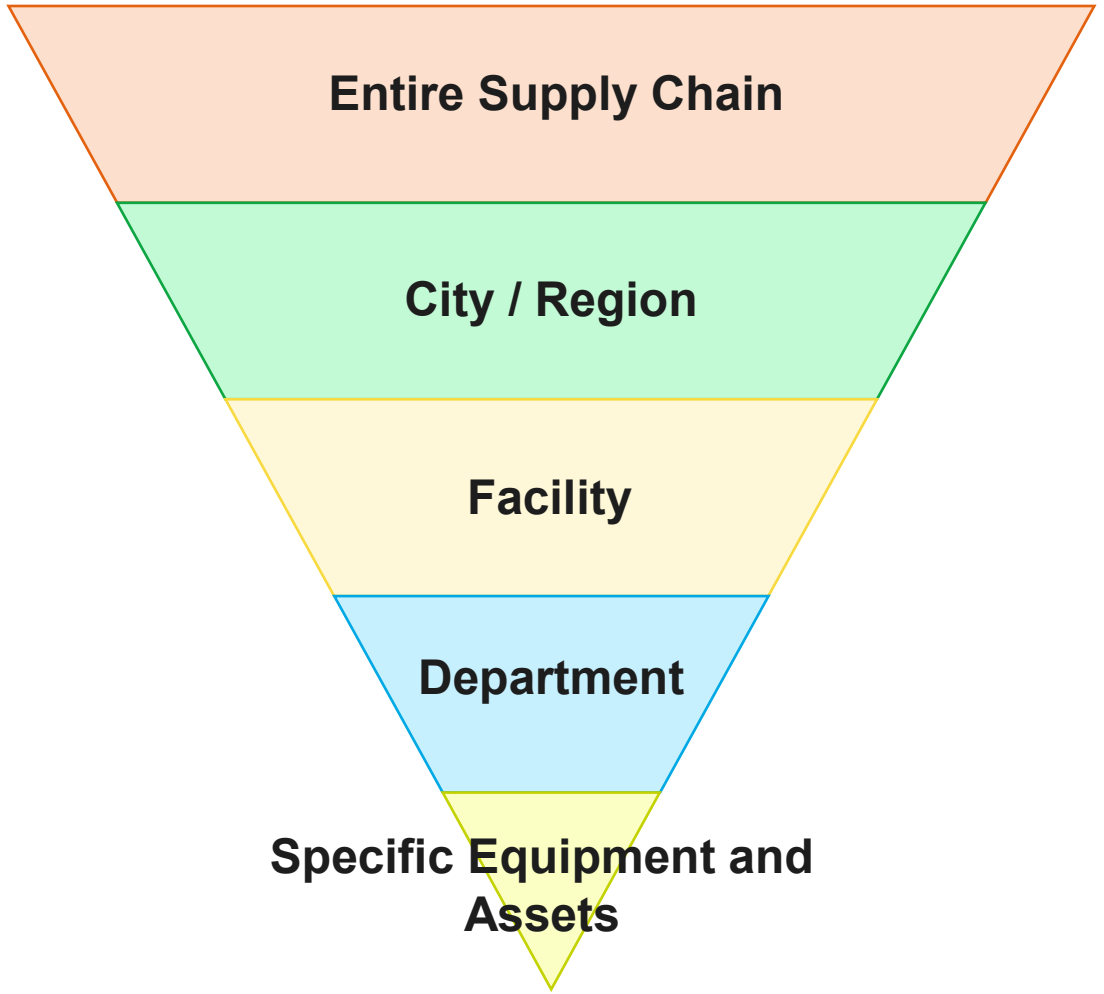
The most valuable flood elevation and associated probability to understand for a flood prone system is t**he elevation at which service is mostly likely to first be disrupted, and it's associated annual chance**.



Prioritizing Risk

Scales

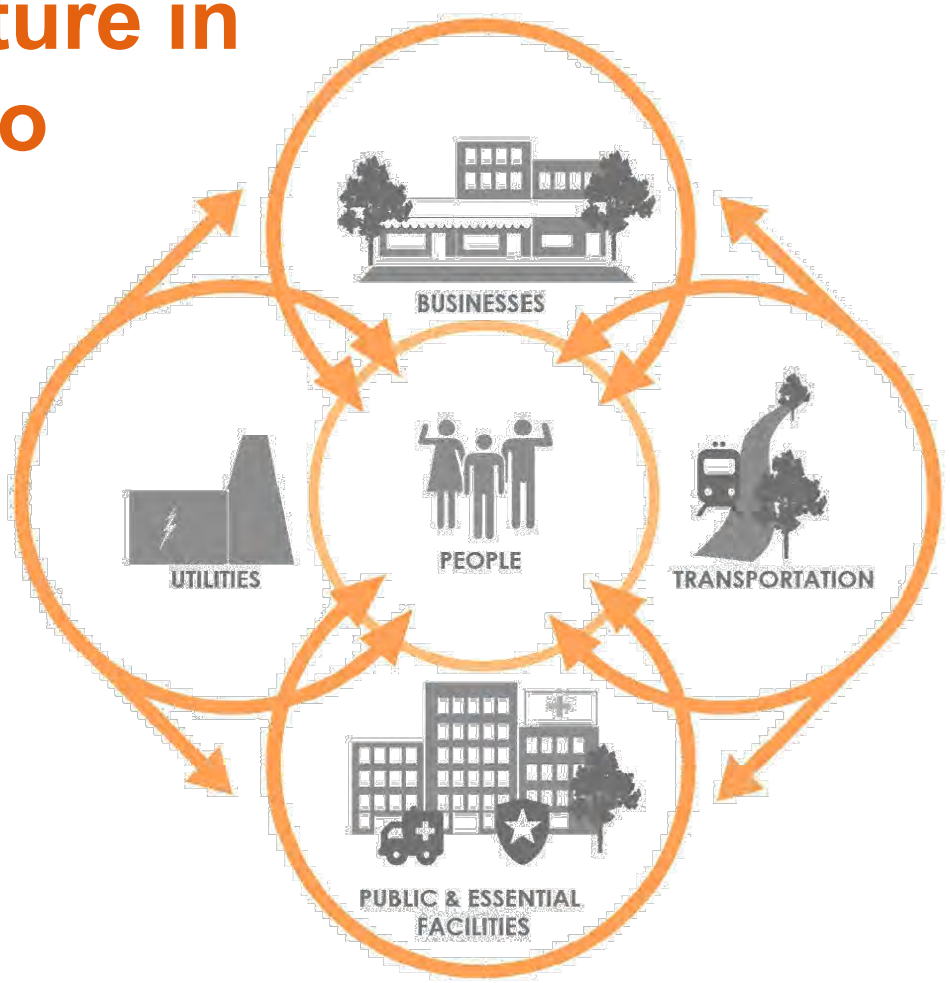
From the top down to the bottom up



Broader community resilience needs must be considered when developing risk mitigation solutions for any public service system

“U.S. efforts shall address the security and resilience of critical infrastructure in an integrated, holistic manner to reflect this infrastructure's interconnectedness and interdependency.”

Presidential Policy Directive 21 - Critical Infrastructure Security and Resilience



Why is it important to understand external interdependencies to the system to which you are responsible?

PARTNERSHIP

Interdependent entities could be partners in funding and implementation

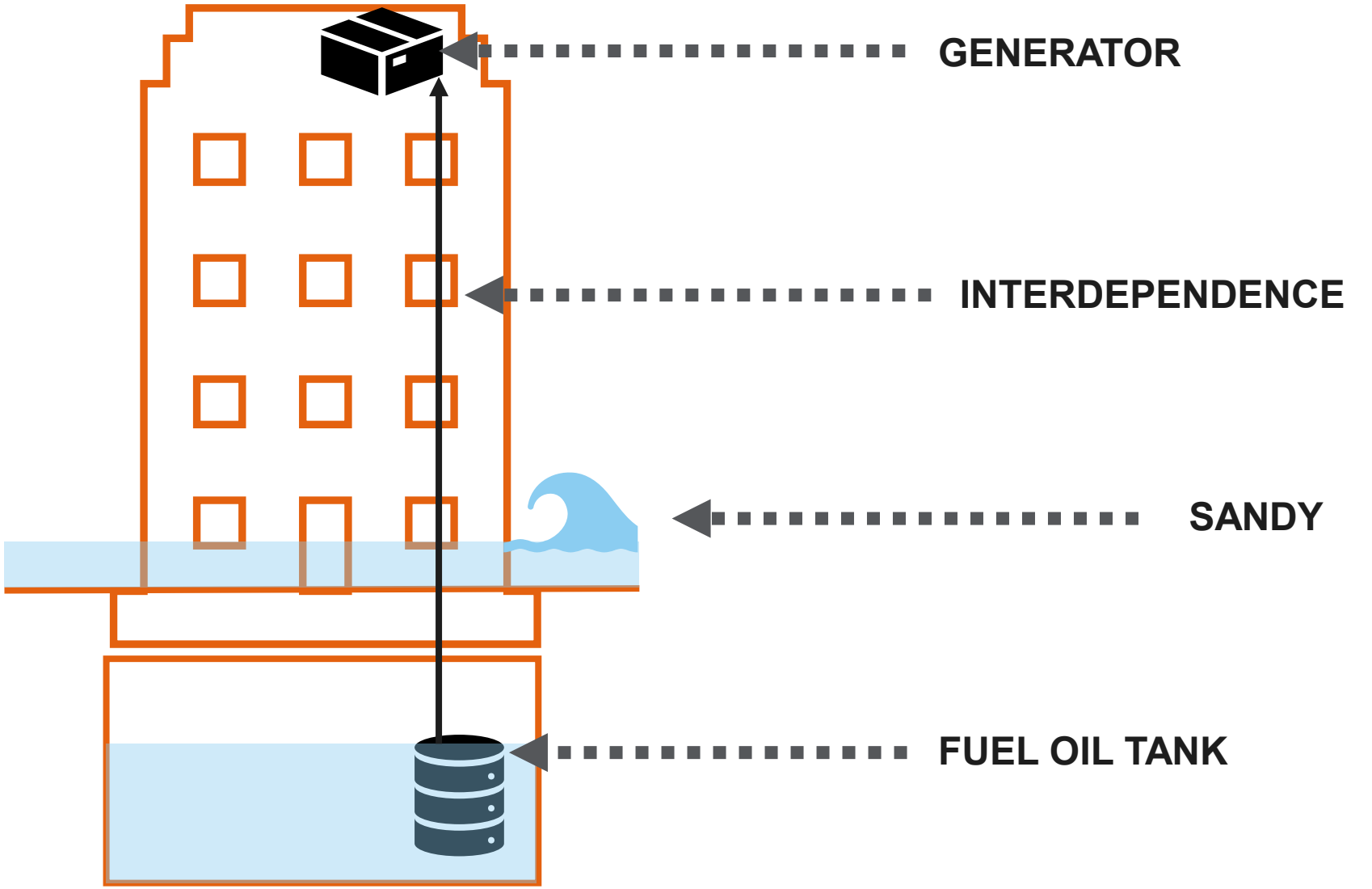
RISK MITIGATION

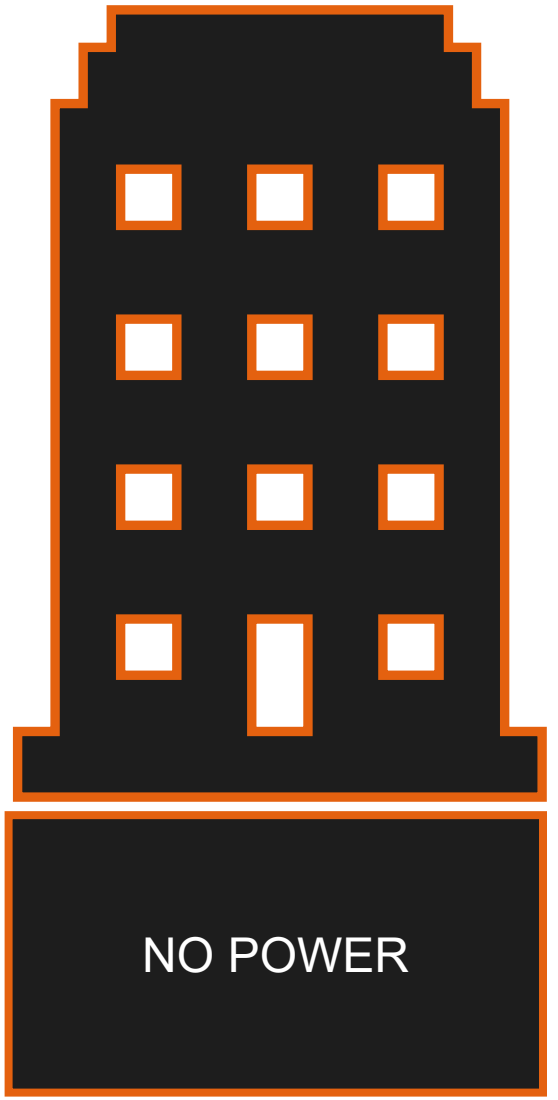
Failure to understand interdependencies could leave unnecessary, unmitigated risks and vulnerabilities

EFFECTIVE SOLUTIONS

Understanding interdependencies can support the development of effective solutions

…between assets in a facility





… between facilities in a system

…between systems within a community

…between systems AND the community

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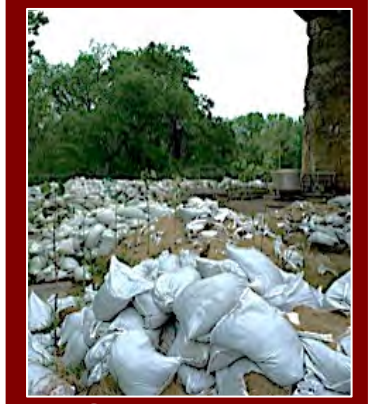
Offline

Limited Capacity

WTP 1

Day 1 30 60 90 120

WTP 2



Sandbags

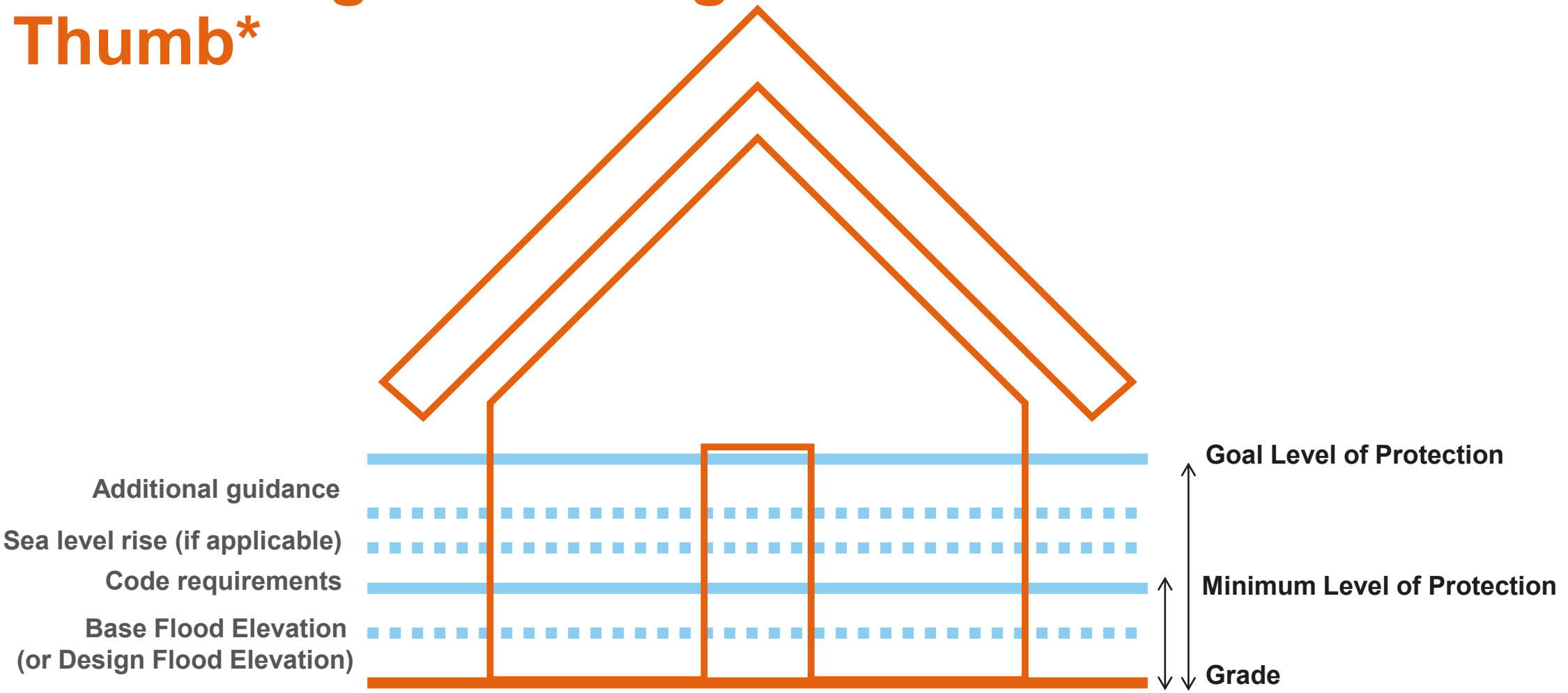
Intake Breach

Exec. Order to Halt Non-Essential Water Use

Artificial Water Shortage and Economic and Social Impacts

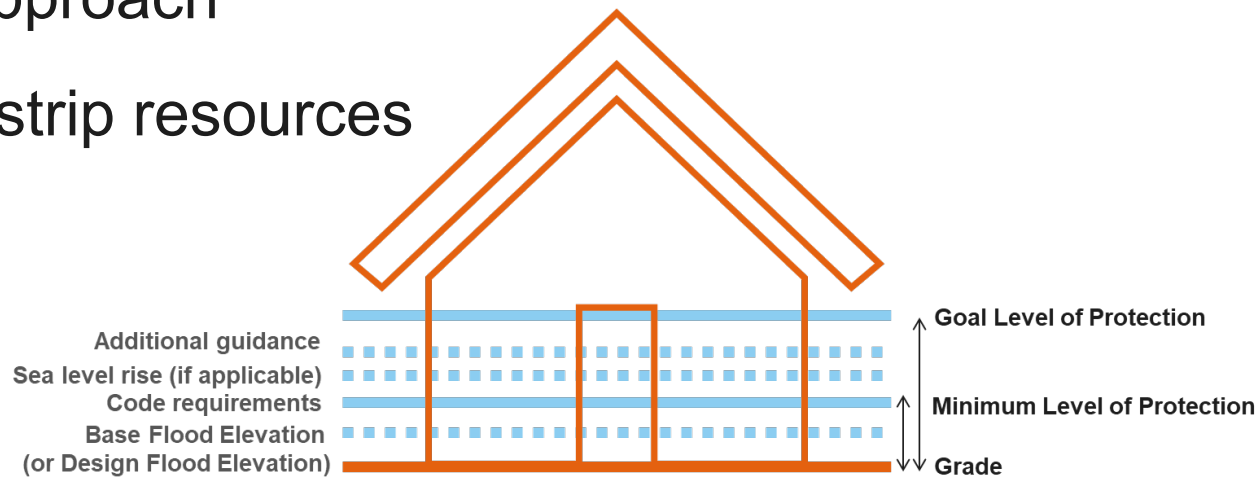
…between built and natural systems

Flood Mitigation Design Elevation Rule of Thumb*



When might the level of protection fall below minimum recommendations?

- When code requirements will not be triggered by the mitigating actions (this is a prerequisite)
- Urgent risk mitigation actions
- As part of a phased, cost effective approach
- When higher levels of protection outstrip resources



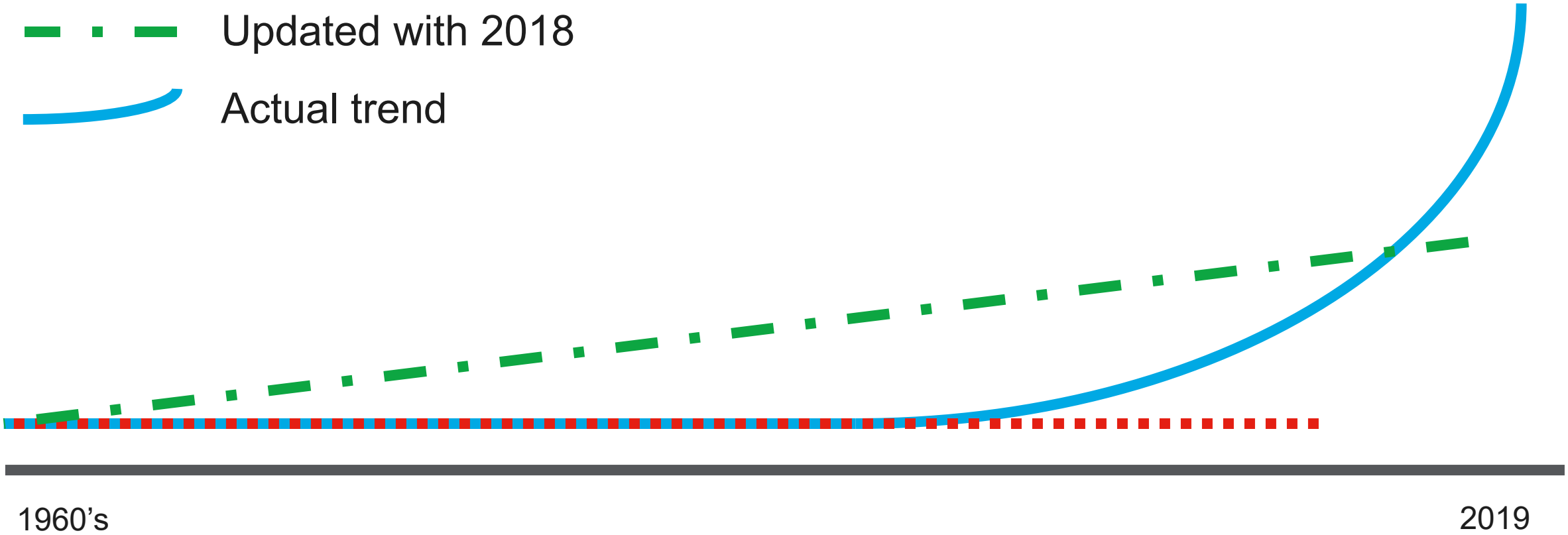
Know your data (case study)

**lines drawn only for illustration and not intended to accurately depict data differences*

2009 FEMA Flood Insurance Rate Map

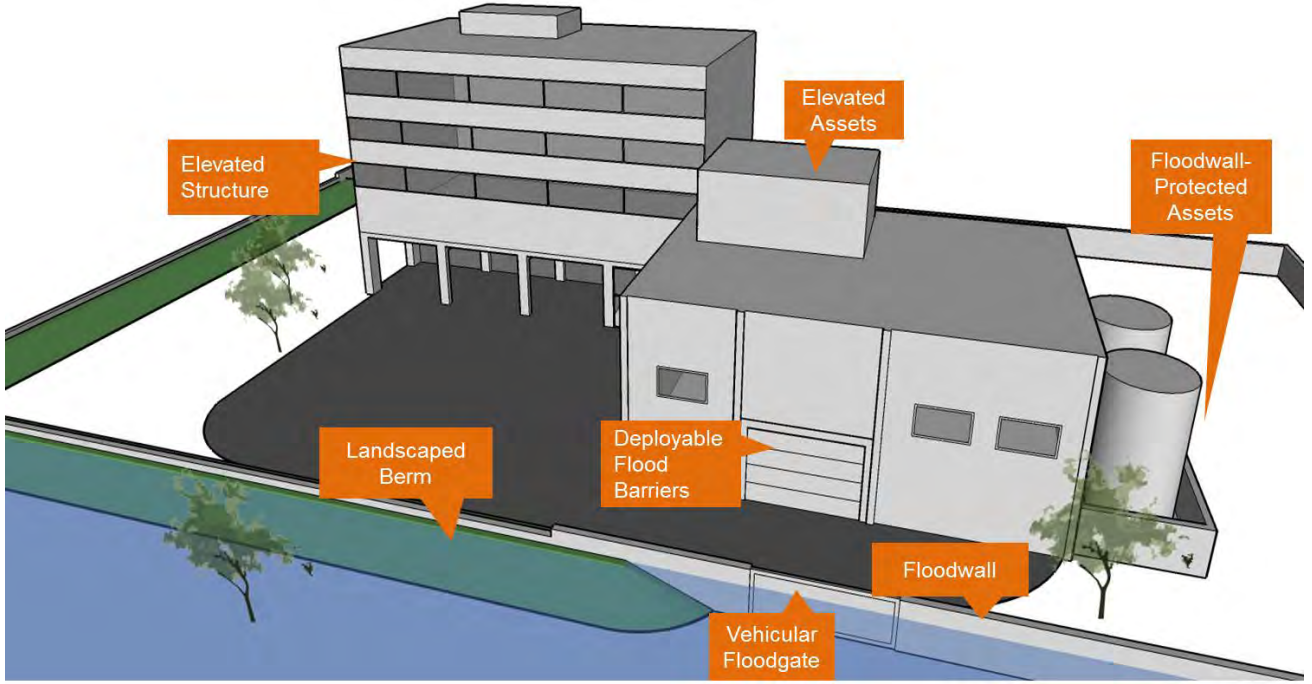
Updated with 2018

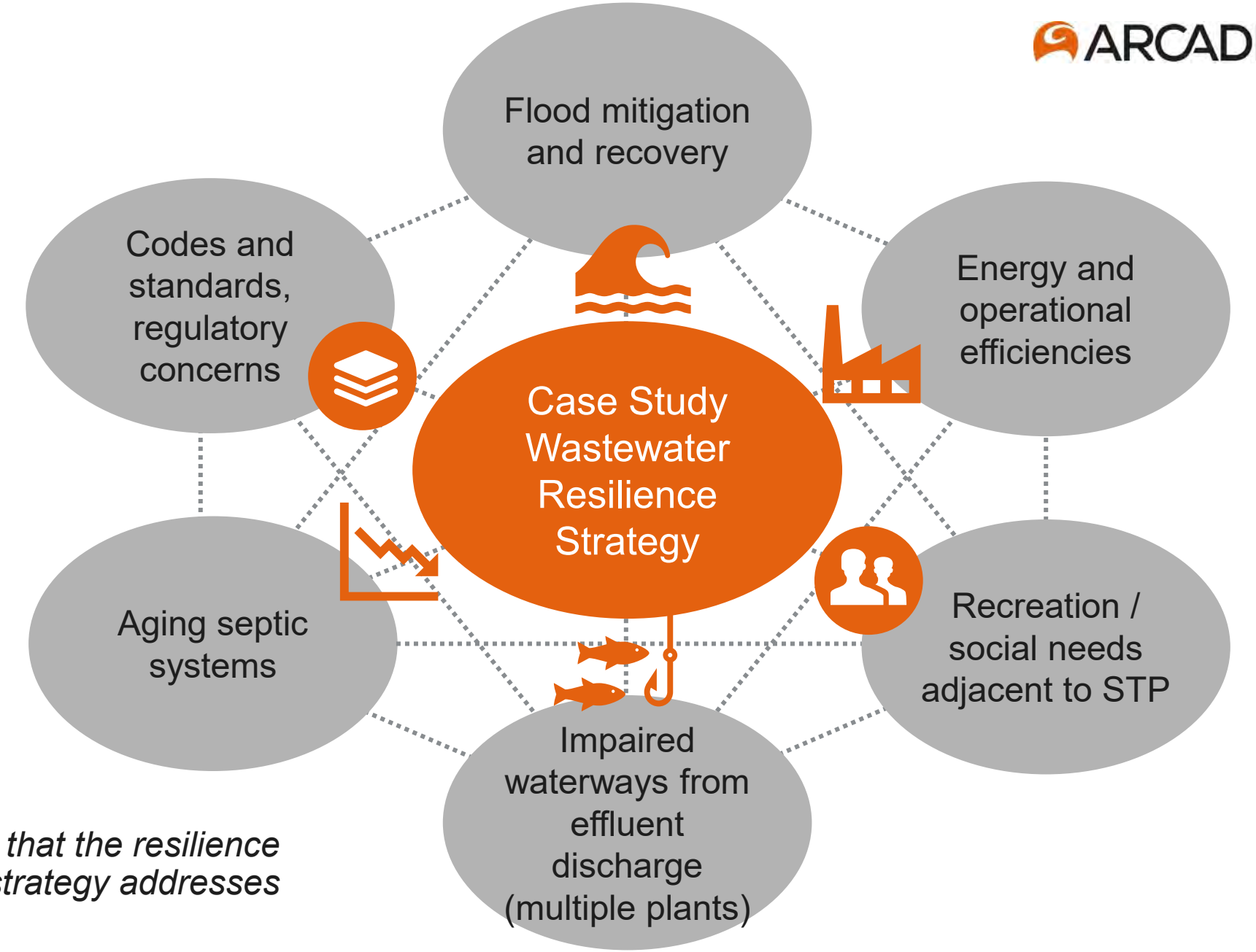
Actual trend



Example Key Considerations

- STAPLEE (Social, Technical, Administrative, Legal, Economic, Environmental factors)
- Multiple lines of defense
- Code triggers
- OSHA requirements
- Maintenance and operations
- Access and inclusion





Needs that the resilience strategy addresses

study continued

Wastewater Resilience Strategy

Flood protection hardening to STP and over 30 pump stations (*work now mostly complete*)

Convert three WPCP to hardened pump stations and pump to STP (*2/3 now complete*)

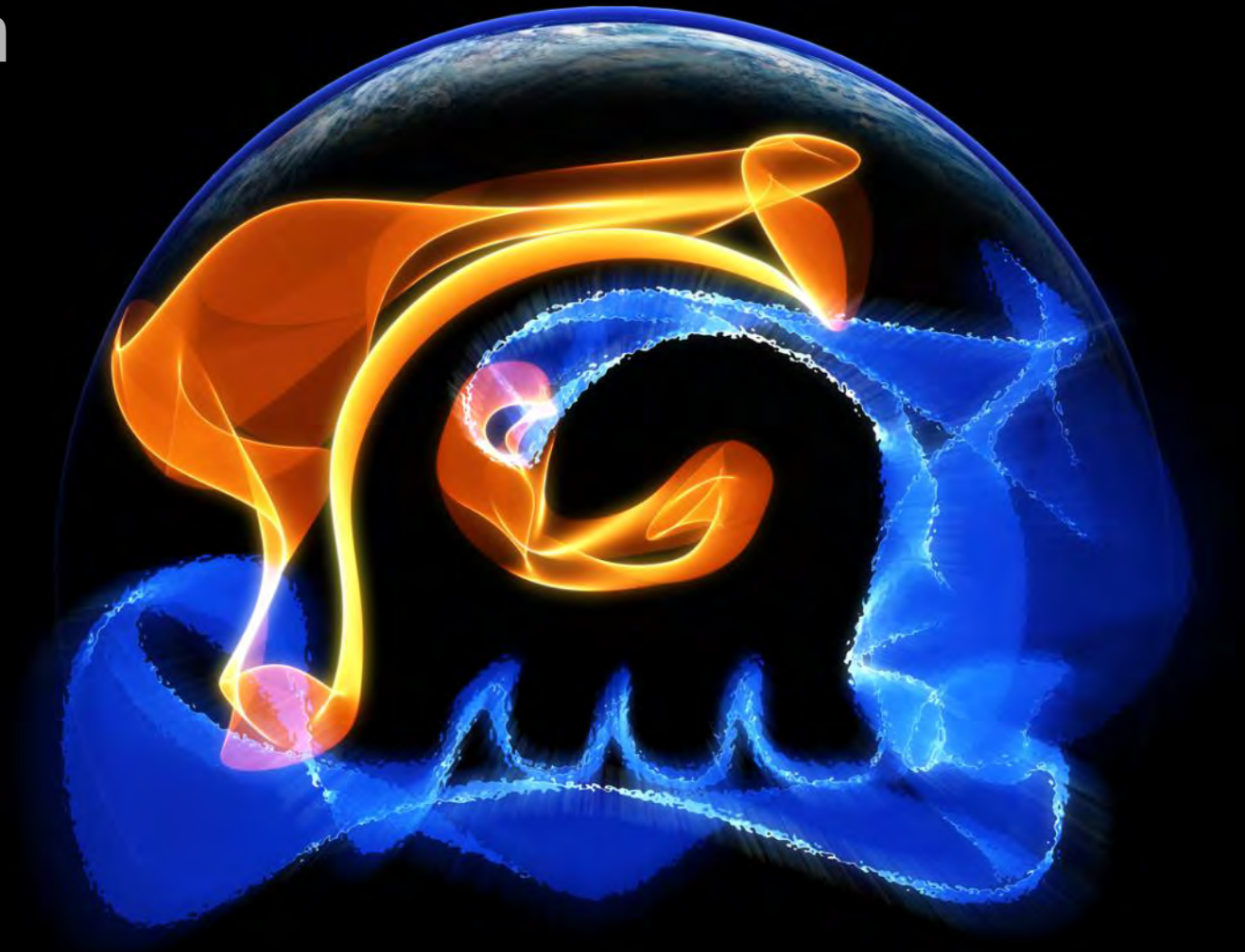
Convert community's septic systems to sewer (*feasibility study planned*)

Pump treated effluent from STP to a facility at lower risk of impact (*design in progress*)

Convey effluent through an ocean outfall to improve water quality by removing significant sources of nitrogen (*design in progress*)

Enhancement and integration of parks surrounding STP (*complete*)

We will cover BCA and funding in the next 30 min



Questions / Discussion

Arcadis

Improving the quality of life.

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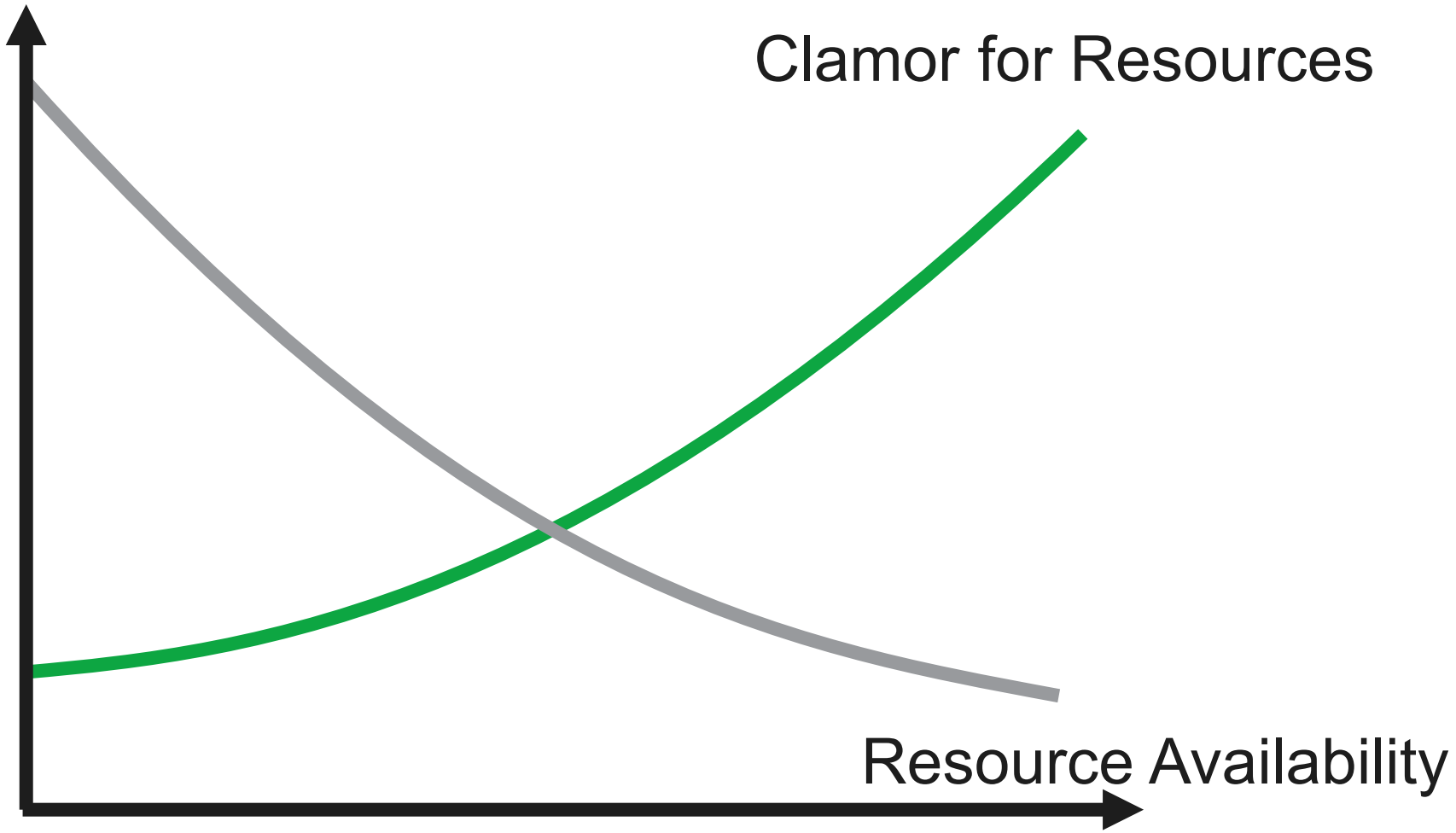
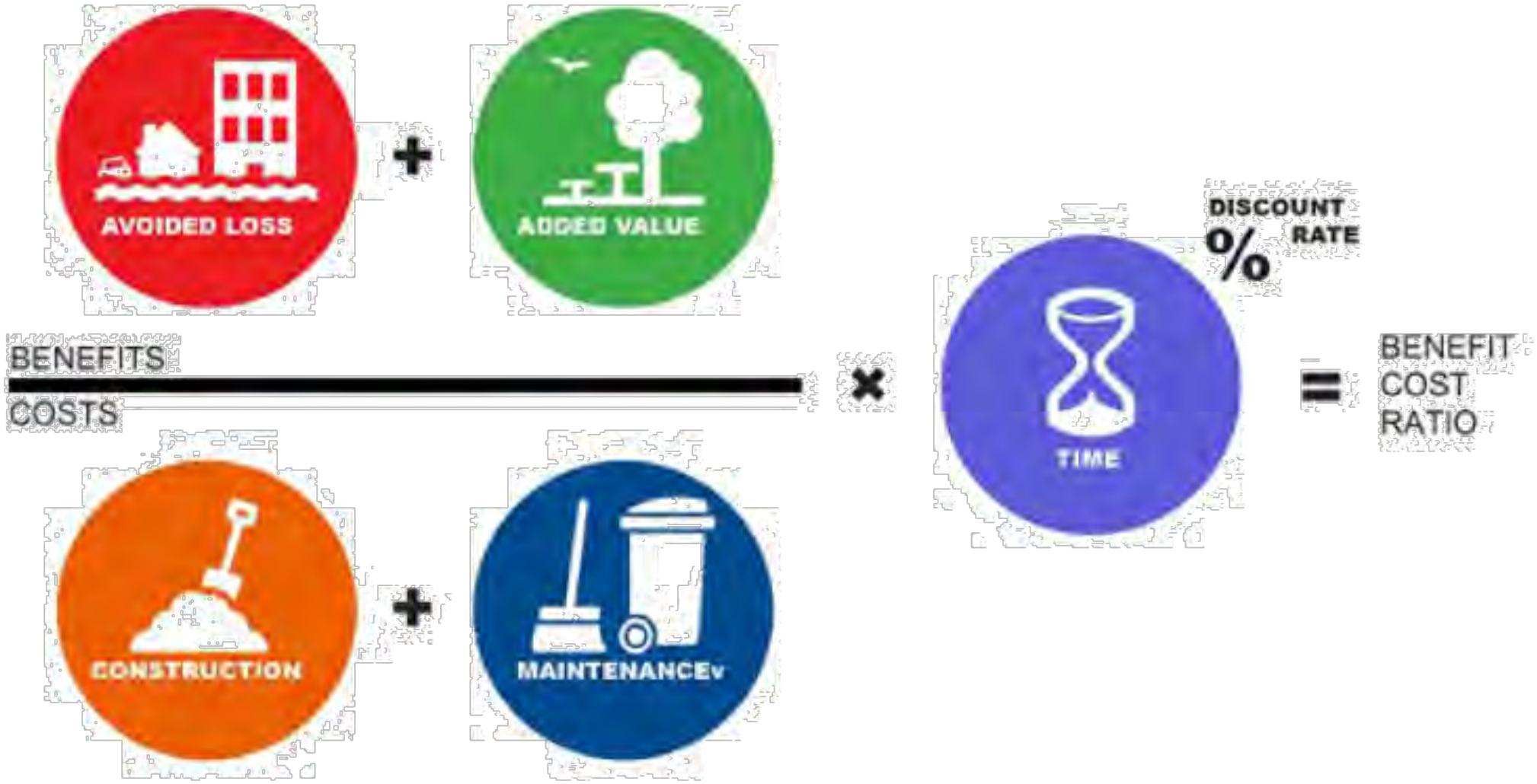
+850 228 6979

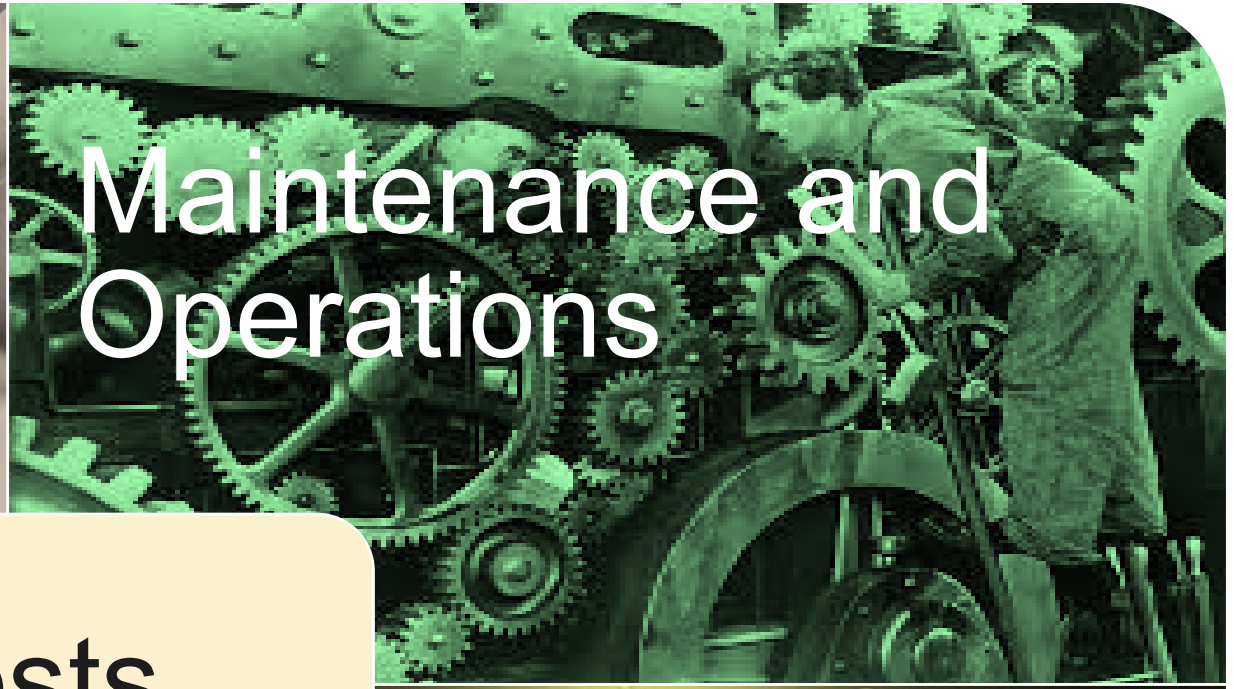
Thank You!

SIMPLE REALITIES



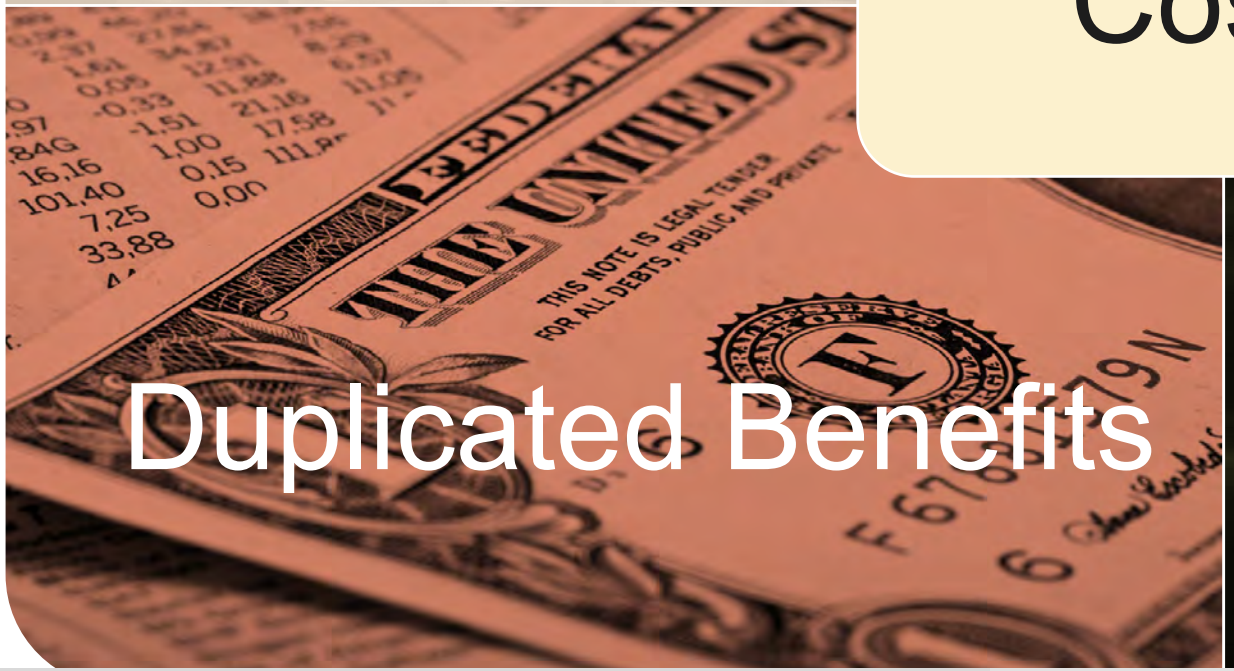


Capital Costs

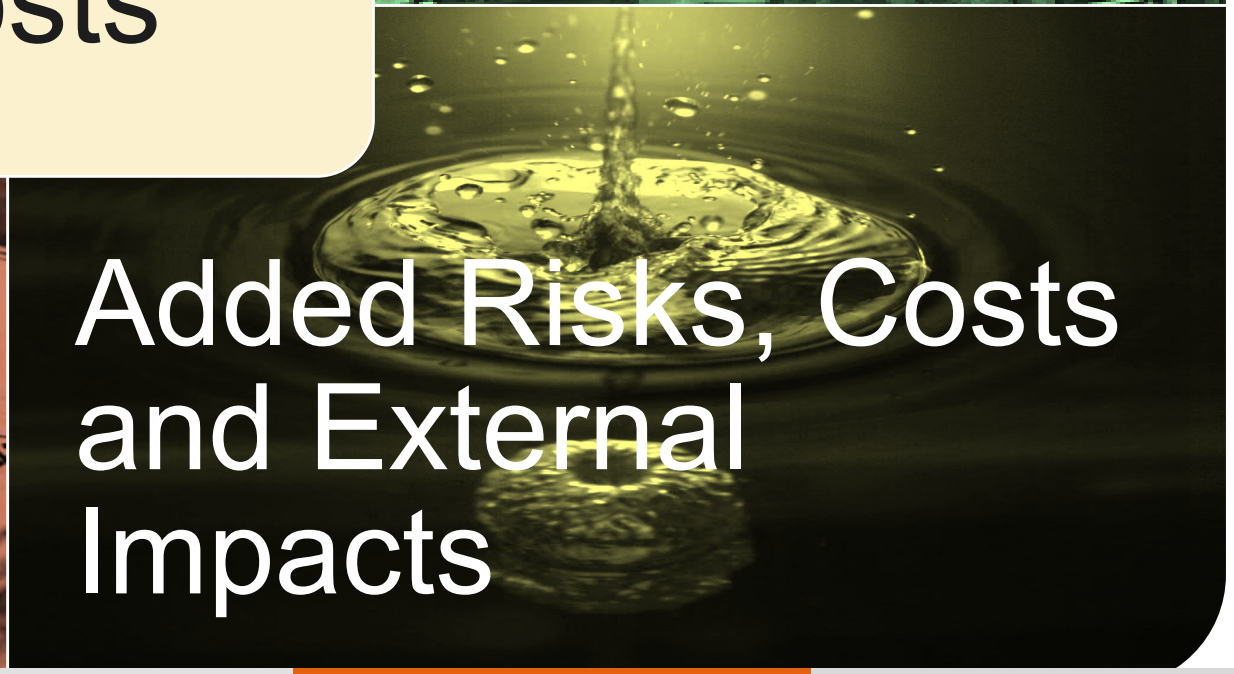


Maintenance and Operations

Costs



Duplicated Benefits

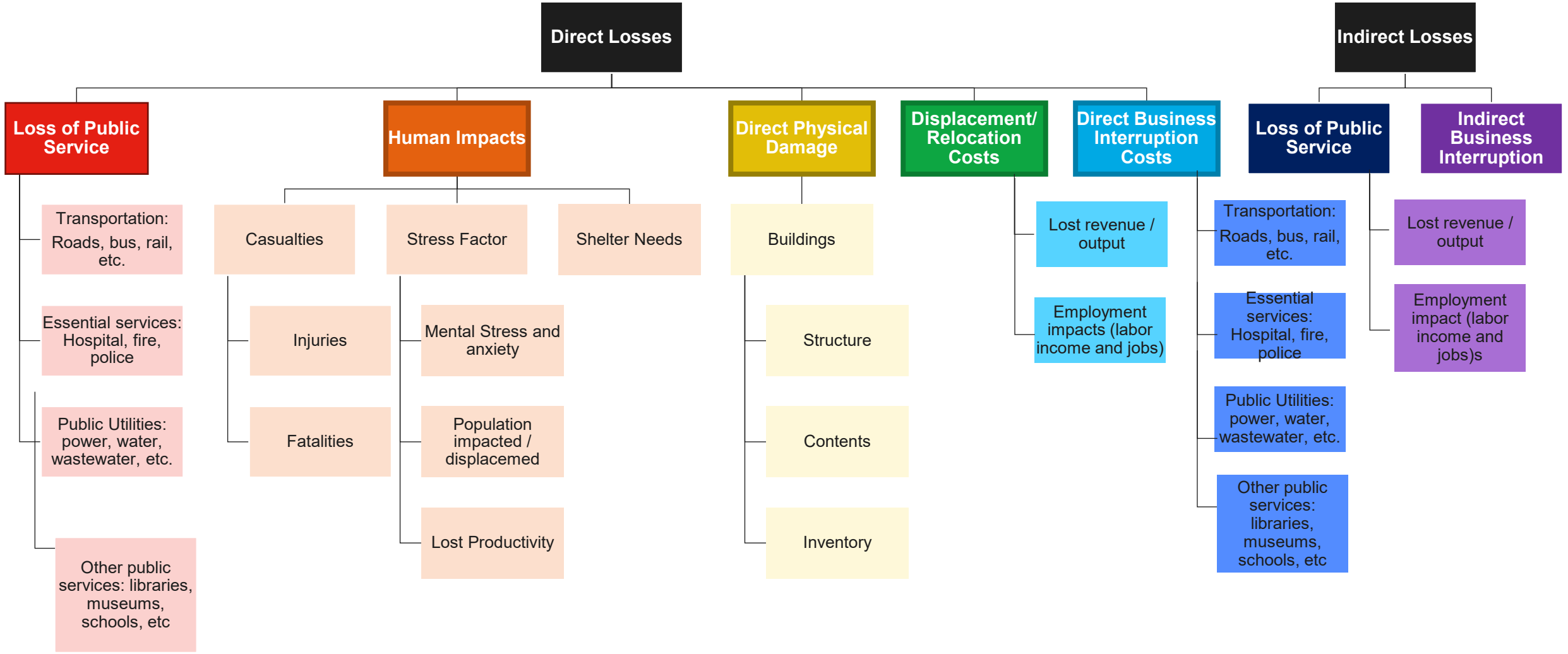


Added Risks, Costs and External Impacts

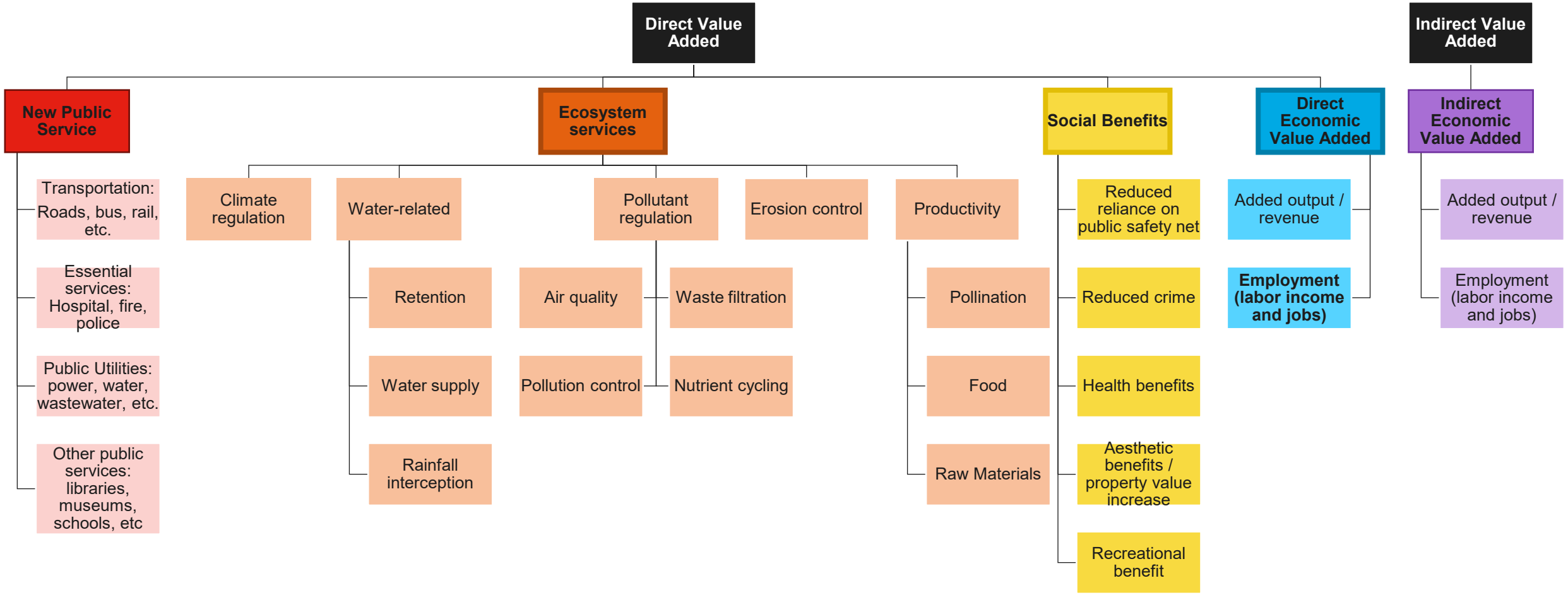
Historical Loss Documentation

- Provides an historical reference for understanding risk
- Reveals key vulnerabilities
- Provides insight into potential consequences of inaction
- Helps justify public expenditure for resiliency measures later on (e.g., Benefit Cost Analysis)

Example losses and losses avoided that can be calculated



Example value added that can be calculated



BENEFITS AND COSTS CAN BE EXPRESSED AS…

As one time benefits

At recurrence intervals based on probability

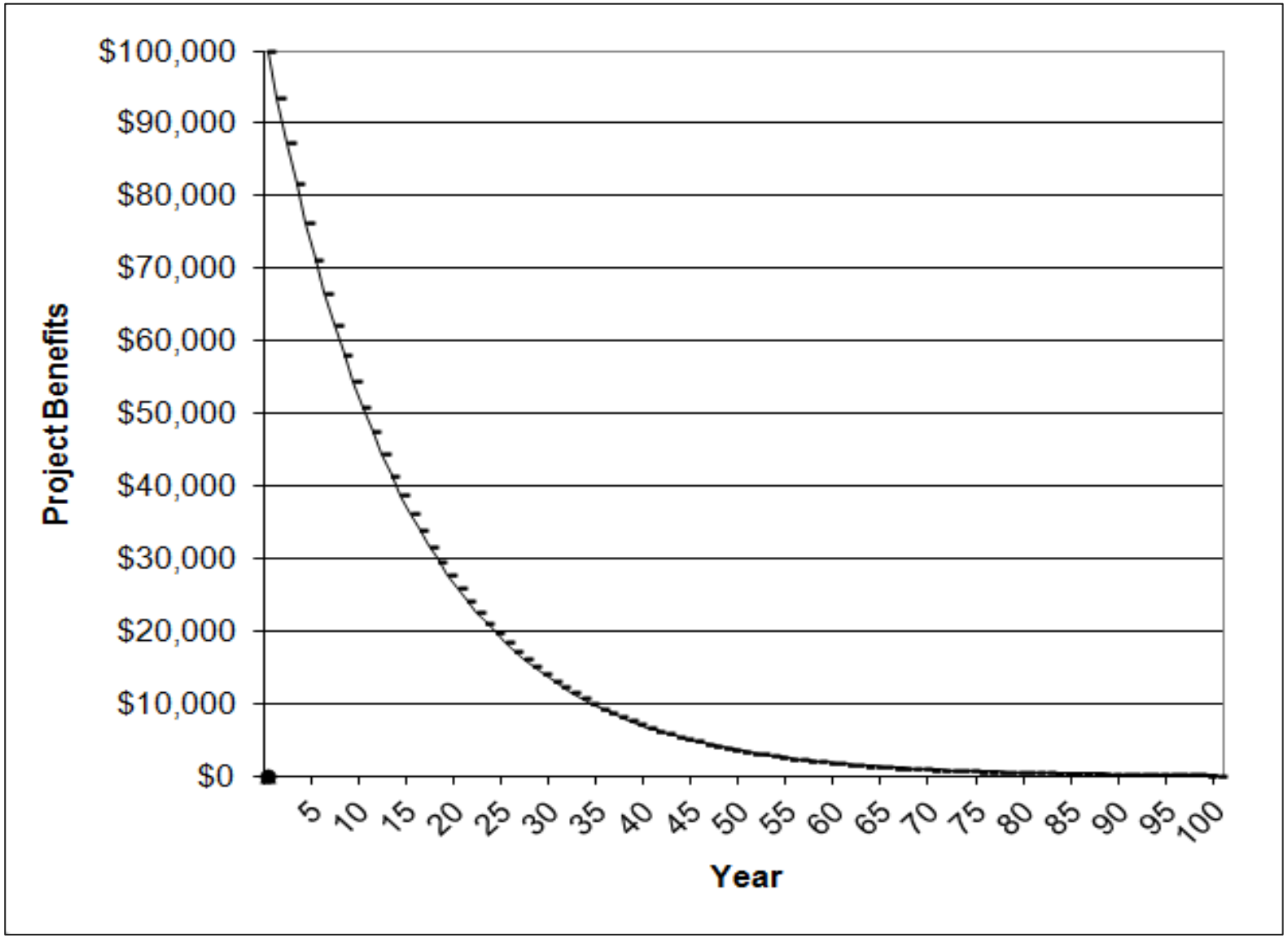
Annually

As net present value over the life of the project

The Benefit Cost Ratio is based on the NET PRESENT VALUE of life cycle benefits over life cycle costs

Time Value of Money

The amount of goods that can be purchased with a given amount of money decreases over time



Value of $100,000 over 100 years; Discount rate: 7%

The Value of

CRITICAL INFRASTRUCTURE

lies in the

SERVICE

it provides to

THE PUBLIC.

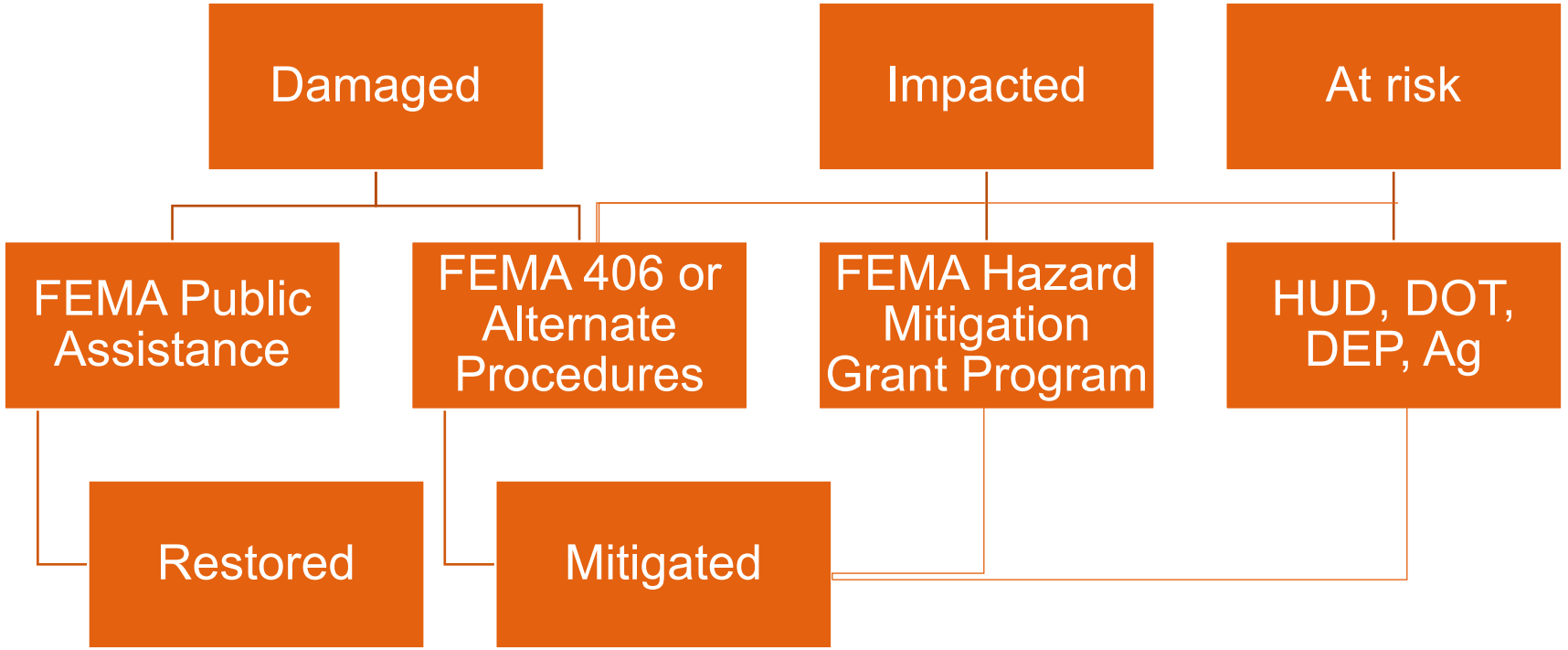
Example:

What is wastewater treatment worth?

FEMA values wastewater treatment at $58 per person, per day

That's service population X $58 X days

Federal Funding post-disaster



Federal funding in a post-disaster context

LEARN THE PROGRAMS

UNDERSTAND YOUR ELIGIBILITY

SELF-ADVOCATE

Funding in a Pre-Disaster Context

Fund Source and Policy Tracking

Stakeholder Engagement

Strategic submittals and application backbones to maximize ROI

Know the programs

Active Communication with Gatekeepers

The Local Hazard Mitigation Plan Working Group

Questions / Discussion

Arcadis

Improving the quality of life.

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Thank You!