CAIT-UTC-REG8

Prioritizing Infrastructure Resilience throughout the Capital Planning Process

FINAL REPORT
December 2023

Submitted by:

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In cooperation with

Rutgers, The State University of New Jersey
And
U.S. Department of Transportation
Federal Highway Administration

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16. Abstract

Improving the resilience of transportation infrastructure and operations to extreme weather events, natural disasters, and other disruptions is an important focus of transportation agencies. Over the past decade, many agencies have expanded resilience efforts to include preparing for and adapting to potential hazards. The threats and hazards facing transportation agencies in the United States vary by region, mode and physical location. Transportation system vulnerabilities are similarly varied. Many agencies have made notable progress incorporating resilience into transportation decision-making. The goal of this project was to document resilience and capital planning best practices from leading transportation agencies nationwide but with a focus on Region II. The research team developed a peer exchange that gathered regional agencies to share current practices and identify best practices.

17. Key Words	18. Distribution Statement
Capital Planning, Asset Management, Risk Management, Infrastructure Durability	

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DESCRIPTION OF THE PROBLEM

More than 50 million tons of freight were moved every day, equivalent to $18.7 trillion annually, across the United States in 2023 [1]. The U.S. relies on its vast transportation network to make this possible and to transport critical goods, connect people to employment and communities, and support a competitive national economy. Pavements, roads, and bridges make up the National Highway System, and transportation agencies are responsible for maintaining these critical assets. Unfortunately, the transportation system has deteriorated with age and in 2021 more than 40 percent of public roadways were found to be in poor or mediocre condition according to the American Society of Civil Engineers [2]. Similarly, 7.5 percent of all U.S. bridges were found to be structurally deficient in 2021 and 42 percent are more than 50 years old [3]. Ports, rail networks, and other transportation systems face similar challenges as they deal with infrastructure across the United States aging, the cost of deferred maintenance adding up, heavier and more fuel-efficient vehicles being built, construction costs increasing, and a myriad of other factors [4]. These factors have combined to place significant stress on transportation agencies to ensure their assets are resilient to current and future challenges and durable over time.

Recognizing this, many agencies have made notable progress incorporating resilience, durability and asset management into their organizational decision-making and long-term plans. Notably, in 2012 MAP-21 (Moving Ahead for Progress in the 21st Century) legislation required each state develop a risk-based Transportation Asset Management Plan (TAMP) for the National Highway System to improve or preserve asset condition and system performance [5]. This mandate led to the development of long-term plans from state agencies. Subsequently, FHWA published its "Case Study on Asset Management Practices and Benefits" that reviewed initial TAMPs submitted in 2019 by state DOTs for best practices including linking asset management to capital planning, supporting life-cycle planning, and mitigating risks [6]. The American Association of State Highway and Transportation Officials (AASHTO) has published and updated its Transportation Asset Management (TAM) Guide to support agencies in learning about and implementing the latest asset management techniques [7]. However, the needs of each agency vary by region, mode, and physical location among other factors. Capital plans need to be specific and tailored to an organization's unique structure and challenges in order to be implementable and support long-term success.

APPROACH

The Rutgers University research team identified a knowledge gap in how regional agencies were conducting their own long-term plans, from Capital Plans to Asset Management, and organized

a peer exchange in order to map and document processes used in the region to make capital planning and project selection/prioritization decisions. The research team designed the peer exchange to include presentations from a range of transportation agencies from across the nation but with a focus on Region II (New Jersey and New York), facilitate group discussions on how agencies are organized to address resilience and durability issues over the long term, and share lessons learned in regard to vulnerability and risk assessment, asset management methodologies, project identification and prioritization, and project design and construction.

The one-day peer exchange was held on August 17, 2020, and engaged speakers from the Port Authority of New York and New Jersey, Port of Long Beach, Southeastern Pennsylvania Transportation Authority, New York City Transit, and the Federal Highway Administration. The format and meeting content is described in the methodology section below.

METHODOLOGY

The peer exchange, titled Transportation Resilience Virtual Peer Exchange, was hosted on August 17, 2020 in a virtual format over one day to ensure many different parties could attend. Introductory remarks were provided by Rutgers and a representative from the Port Authority of New York and New Jersey (PANYNJ). Panel presentations were given by representatives from the Port of Long Beach, Southeastern Pennsylvania Transportation Authority, PANYNJ, NYC Transit, and FHWA where processes for capital planning and best practices at their respective organizations were shared. A moderated discussion session provided opportunity for questions and feedback.

The subsequent pages in this Methodology section demonstrate the presentations that were shared during the peer exchange. The Rutgers research team took this information, as well as notes from the discussion session, to generate findings and identify best practices for incorporating resilience, durability, asset management, and other considerations into long-term capital planning.

RUTGERS

TRANSPORTATION RESILIENCE VIRTUAL PEER EXCHANGE

Prioritizing Infrastructure Resilience throughout the Transportation Capital Planning Process

August 17, 2020

Today's Agenda

Welcome, meeting format, and logistics Introductory remarks

Background and research overview Panel presentations

Moderated discussion

Wrap-up

Introductory Remarks

Mary K Murphy

Director of Planning and Regional Development

PORT AUTHORITY NY NJ
AIR LAND RAIL SEA

RUTGERS
Edward J. Bloustein School of Planning and Public Policy

Resilience Peer Exchange

BACKGROUND & RESEARCH OVERVIEW

RUTGERS
Edward J. Bloustein School
of Planning and Public Policy

USDOT Region 2 UTC:

Prioritizing Infrastructure Resilience throughout the Transportation Capital Planning Process

Principal Investigator:
Jon Carnegie, AICP/PP
Alan M. Voorhees Transportation Center
Rutgers, The State University of New Jersey

Graphic courtesy of Barr Foundation

Region 2 UTC Project: Overview

Objective: Document methodologies and approaches being used by transportation agencies nationally to incorporate resilience considerations in the capital planning process

Work Products/Outputs:

- Literature review
- Leading practice case studies
- Peer learning workshop
- Agency identified action steps

Expected Outcome:
Capital planning decisions that result in transportation infrastructure more resilient to extreme weather events and changing climate conditions

Research Customers:

PORT AUTHORITY NY NJ
AIR LAND RAIL SEA

DEPARTMENT OF TRANSPORTATION
THE STATE OF NEW JERSEY

Emphasis Areas and Key Questions

Vulnerability Assessment

- At what level are vulnerability assessments most often conducted?
- What planning horizons are used?
- What hazards are considered?
- How often are assessments updated?

Asset Management Methodologies

- How are vulnerability/risk profiles incorporated in asset management systems?
- Do agencies track extreme weather-related infrastructure costs?
- Do agencies develop deterioration curves that account for climate change?

B-C and ROI Methodologies

- What B-C/ROI methodologies are agencies using?
- How do these methodologies incorporate resilience and durability considerations?

Project Identification & Prioritization

- Are there differences in how resilience is considered when selecting state of good repair projects vs. discretionary capital projects?
- How are resilience considerations incorporated into maintenance schedules and useful life determination?

Emphasis Areas and Key Questions

Project Design & Construction

- How are agencies incorporating weather/climate resilience into project design guidelines?
- Are there resilient infrastructure design guidelines from other regions of the country that may become relevant to protecting Region 2 assets over time?

Regional Coordination & Interdependencies

- How are agencies coordinating their resiliency planning efforts with intergovernmental partners?
- How are agencies considering interdependencies with infrastructure systems and networks that are outside their direct jurisdiction?

Personnel & Organization Structure

- Do agencies have dedicated personnel assigned to resilience planning?
- How centralized/decentralized are various resilience planning functions?

Region 2 UTC Project: Case Studies

- Maryland DOT
- Massachusetts Port Authority (Massport)
- Metropolitan Transportation Authority New York City Transit (MTA-NYCT)
- Port Authority of New York & New Jersey
- Port of Long Beach
- Southeastern Pennsylvania Transportation Authority (SEPTA)

MARYLAND DEPARTMENT OF TRANSPORTATION

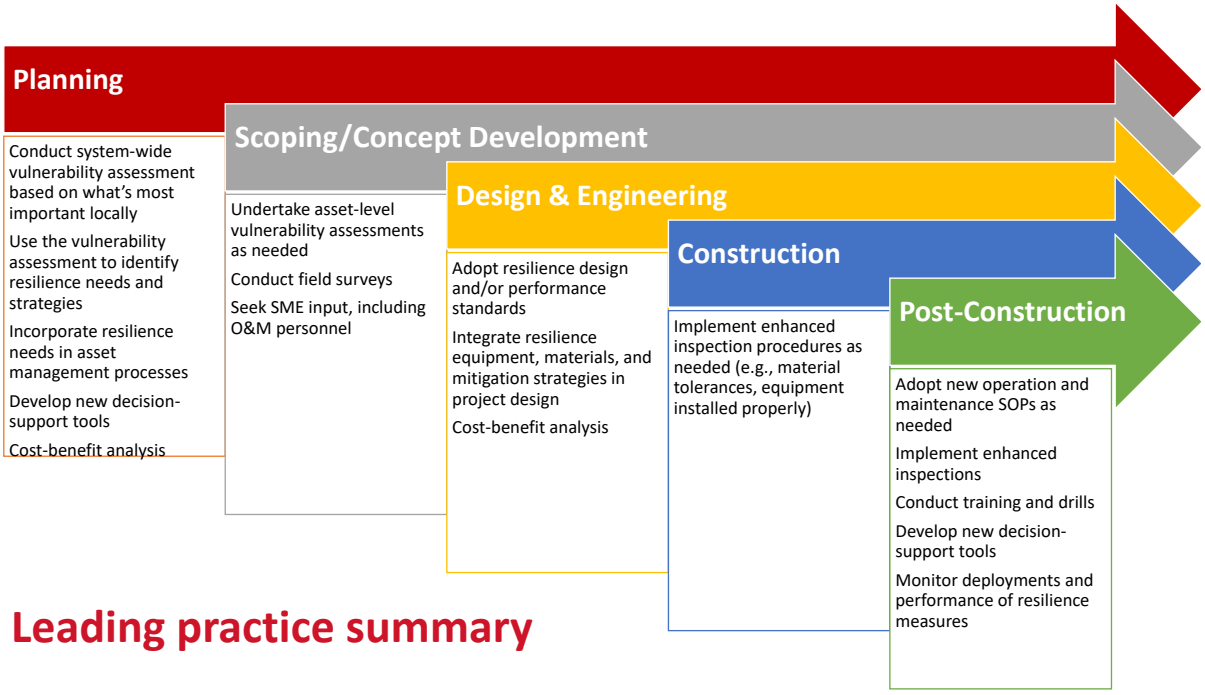
massport

MTA New York City Transit

PORT AUTHORITY NY NJ AIR LAND RAIL SEA

Port of LONG BEACH The Green Port

SEPTA



Leading practice summary

RUTGERS
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Resilience Peer Exchange

PANEL PRESENTATIONS

Panel Presentations

- **Matthew Arms**, Acting Director, Bureau of Environmental Planning and Environmental Affairs, Port of Long Beach
- **Philip Asabere**, PE, Director of Engineering, Southeastern Pennsylvania Transportation Authority (SEPTA)
- **Josh DeFlorio**, AICP, LEED AP, Chief, Resilience and Sustainability, Port Authority of New York and New Jersey
- **Elizabeth Habic**, Environmental Specialist, Sustainable Transportation and Resilience Team, Federal Highway Administration, USDOT
- **Steven Loehr**, Recovery and Resiliency Manager, NYC Transit, Department of Subways

Port of
LONG BEACH
THE PORT OF CHOICE

Climate Adaptation and Coastal Resiliency Plan

Matt Arms

Director of Environmental Planning

Importance of Resiliency

- Climate impacts already impacting the Port/SoCal
  - Sea level rise
  - Greater frequency & magnitude of storms
  - Greater number of hot weather days
- Decision making for port and port tenants & stakeholders
  - Prioritization of resource allocations
  - Investing in maritime infrastructure
- State Compliance
  - AB 691
  - SLR assessment on public trust lands
- Hurricane Marie—August 2014
  - Demonstrated relevance & importance of adaptation planning

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Hurricane Marie – A Case Study

- Damage at Navy Mole and Pier F shorelines & rock dikes
  - $7M in repairs
- Significant damage to breakwater
  - 3 large holes & many other breeches
  - $21M in repairs
- Access restricted to rail operations, critical facilities, fueling stations, etc.

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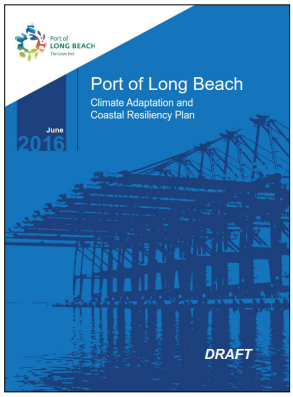
Climate Adaptation and Coastal Resiliency Plan

Project Goals

- Ensure resilience and business continuity
- Manage risks associated with climate change
- Identify most vulnerable assets
- Identify adaptation strategies to protect port infrastructure

Project Benefits

- A more resilient port able to maintain operations under changing conditions
- More future-looking risk assessment process
- Long-term sustainable development
- A port ready to adapt



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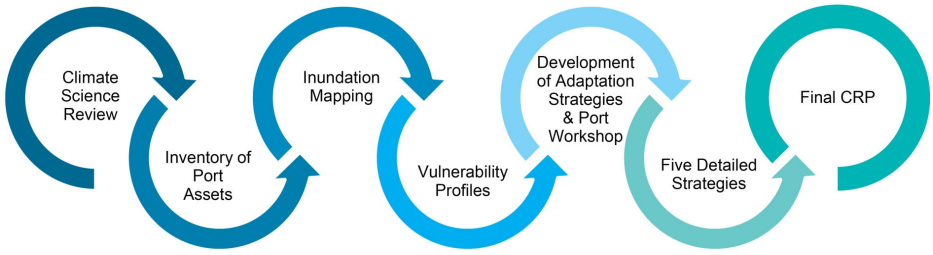
CRP – Project Approach



Phase 1: Data Gathering | ***Phase 2: Adaptation Strategies***

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Climate Science Review

Stressors

Climate Stressors	Mid-Century	End-of-Century
Temperature	▪ +0.6°F–6.4°F in Long Beach ▪ +two- to threefold extremely hot days	▪ +4.1°F–8.6°F in California
Precipitation	▪ −9% total rainfall on California Coast ▪ −13% days of rainfall on California coast	▪ Increased storm frequency/severity (20-year storm becomes 4–15-year storm) in California ▪ +10–25% total rainfall per storm in California
Sea Level Rise (SLR)	▪ 11–24 in. of SLR in Los Angeles	▪ 37–66 in. of SLR in Los Angeles
Extreme Wind	▪ Limited data available	▪ Limited data available
Ocean Acidity + Temperature	▪ −0.5 units pH in California waters ▪ Warming of coastal waters	▪ Warming of coastal waters

And Storm Surge!

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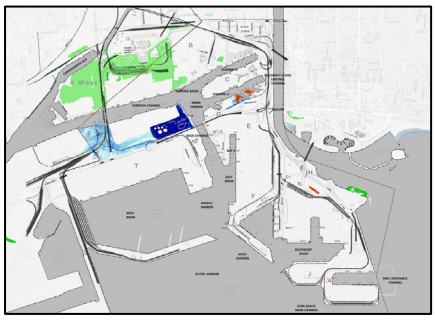
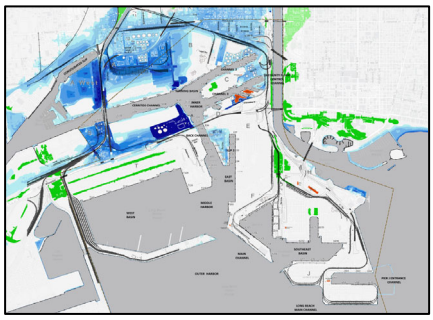
SLR Inundation Mapping



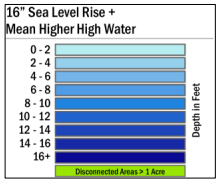
Least Extreme (16” SLR)



Most Extreme (55” SLR + 100yr Storm Surge)

Scenario		Year
16” SLR	16” SLR + Storm Surge	2050
36” SLR	36” SLR + Storm Surge	2070
55” SLR	55” SLR + Storm Surge	2100

These scenarios are most appropriate for the Port based on lifespan of assets.



Vulnerability Profiles

Profiles created for

- Pier Infrastructure
- Transportation Network
- Critical Facilities
- Utilities
- Breakwater

What's included in each Vulnerability Profile

Introduction: Review of asset location, photograph, summary, and site characteristics

Climate Stressors: Description of asset vulnerabilities due to potential SLR and storm surge, extreme temperatures, extreme winds, increased precipitation, and ocean acidity change

Thumbnail Inundation Maps: Thumbnail inundation maps illustrating the following scenarios:

- 16-inch, 36-inch, 55-inch SLR
- 16-inch, 36-inch, 55-inch SLR + 100-year Storm Surge

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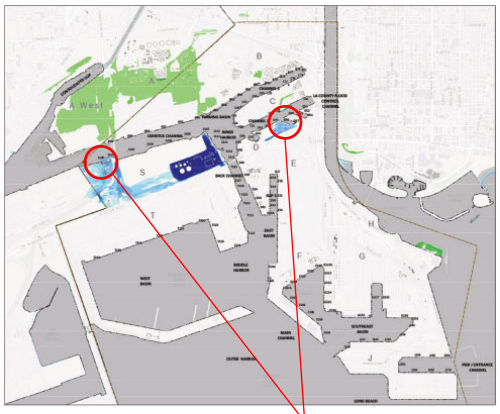
Pier Infrastructure

- Piers S and D are first to be inundated (16" SLR).
- Piers A and B include low lying areas that could flood if overtopping occurs.
- Piers F, G, J, and T not inundated, but may be isolated.



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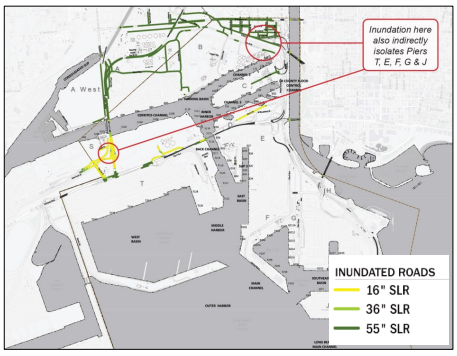
Transportation Network: Road

- Road traffic stops after few inches of inundation (pending vehicle type).
- Piers S and D roadway first impacted (16” SLR) and may prevent movement of cargo and access to facilities.
- Under most extreme conditions, roadways within Piers A, B, C, and tip of E would also be directly inundated as well as the SR-47 that connects to Terminal Island.



SLR Roads Overview

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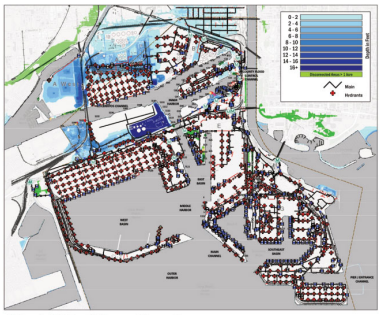
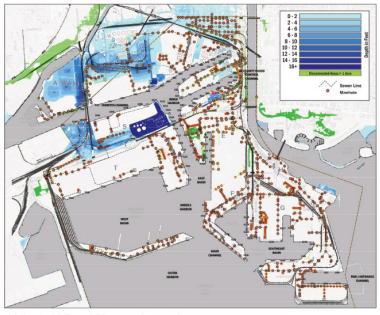
Utilities

Least vulnerable

- Freshwater: valve vaults could be impacted.
- Sewer System: lift/pump stations could be impacted.
- Communications: cables, joints, and splices could be impacted.



16-inch SLR + 100-year Storm Surge



16-inch SLR + 100-year Storm Surge

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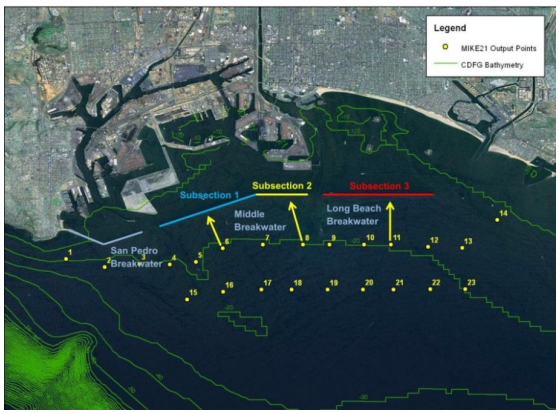
Breakwater

- USACE owned & maintained
- 9 miles long – 3 sections
- 200 feet wide at bottom, 23 feet wide at top
- Long Beach breakwater most vulnerable section
  - lower crest elevations
  - greater wave exposure
- Hurricane Marie included unusual wind and wave direction which caused damage to the Middle Breakwater, leading to infrastructure damage and an impact to Port operations.



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Prioritized Adaptation Strategies

Four Prioritized Strategies – concept design

Governance

1. Addressing climate change impacts through various Port policies, plans, and guidelines
2. Adding climate change analysis to the Harbor Development Permit process

Initiative

3. Piers A & B Study – combined impacts of riverine and coastal flooding around Dominguez Channel

Physical Infrastructure

4. Pier S Shoreline Enhancement (short & long term solutions)

*Additional future strategies to consider were also analyzed, but to a lesser degree.

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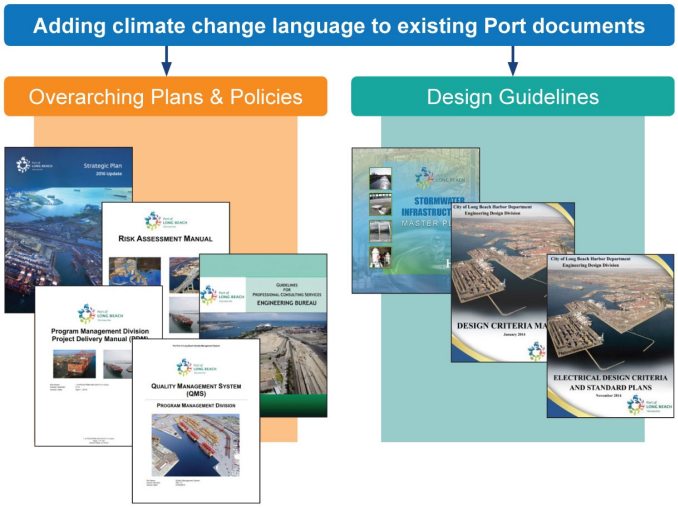
Strategy #1: Addressing Climate Change through Port Policies, Plans, & Guidelines



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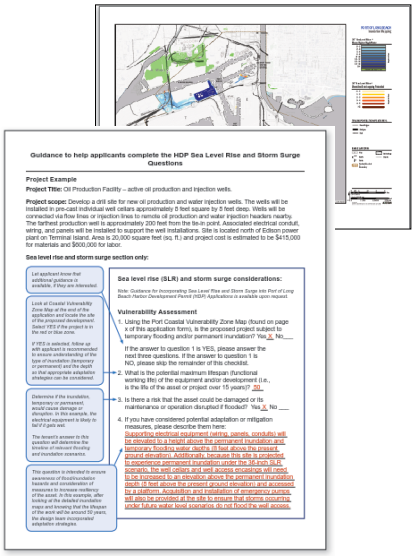
Strategy #2: Adding Sea Level Rise Analysis to Harbor Development Permit Process

Staff Guidance Document

- Introduction
- SLR/storm surge projections
- Definitions (vulnerability, risk, adaptation strategies)
- Forms, example project, and internal checklist for staff reviewing applicable projects



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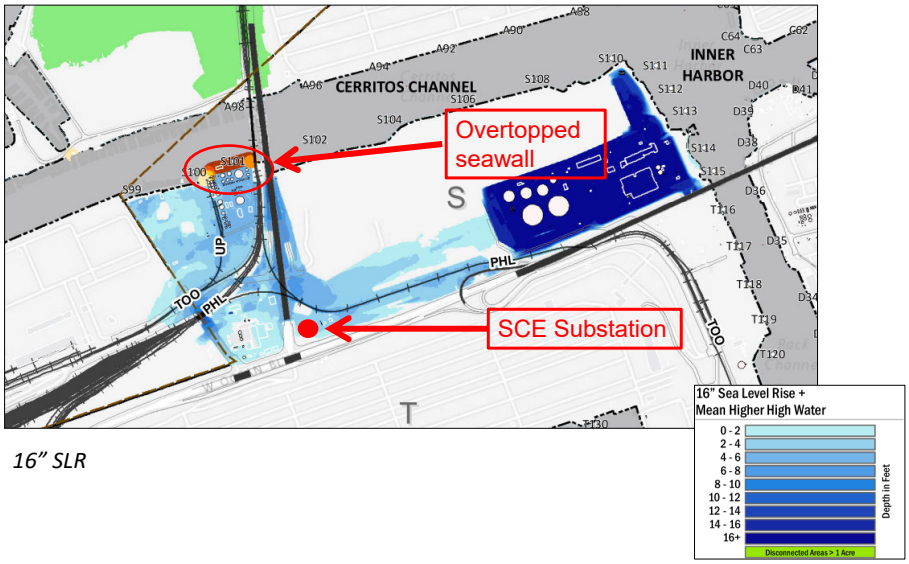
Strategy #4: Pier S Shoreline Enhancement & Substation Protection



16" SLR

Port of LONG BEACH
THE PORT OF CHOICE

THANK YOU

SEPTA RESILIENCY PROGRAM

PHILIP ASABERE

08-17-2020

Resilience Peer Exchange

Resiliency Program Overview

OBJECTIVES:

- Know and understand climate change projections
- Assess key vulnerabilities
- Develop forward-looking resiliency strategies

PARTNERS:

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

pennsylvania DEPARTMENT OF ENVIRONMENTAL PROTECTION

PHILADELPHIA WATER DEPARTMENT

STREETS PHILADELPHIA

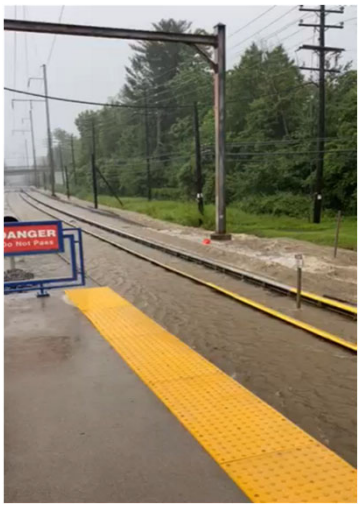
AMTRAK

PENNDOT

Resilience Peer Exchange

Resiliency Program Overview

FLOODING OF HAVERFORD STATION ON THE NHSL



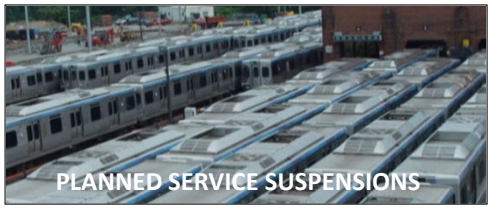
SINKHOLE NEAR HUGHES PARK STATION ON THE NHSL

Resilience Peer Exchange

Administrative Strategies

CORE FIRST, RESTORE OUTWARD

INTERAGENCY COOPERATION



PLANNED SERVICE SUSPENSIONS

CUSTOMER COMMUNICATIONS

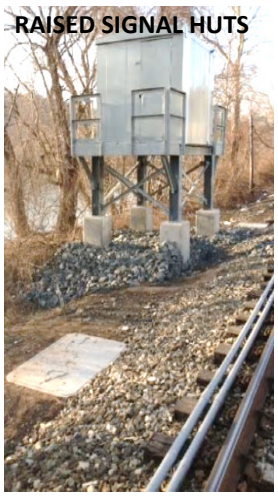

SEPTA
@SEPTA
Follow
SEPTA will suspend all services effective at the end of this Sunday service schedule due potential severe weather from Sandy.
3:58 PM - 28 Oct 2012
185 RETWEETS 4 FAVORITES

Resilience Peer Exchange

Operation and Maintenance

Resilience Peer Exchange

Engineering Strategies



Resilience Peer Exchange

Key Projects

MANAYUNK/NORRISTOWN LINE SHORELINE STABILIZATION ($4.5 M)

- $6 MILLION TOTAL PROJECT COST
- STABILIZE 2.45 MILES OF EMBANKMENTS ALONG SCHUYLKILL RIVER
- DECREASE LIKELIHOOD OF WASHOUTS
- INCREASE SPEED OF RECOVERY AFTER FLOOD EVENT

Resilience Peer Exchange

Key Projects

RAILROAD EMBANKMENT SLOPE STABILIZATION ($18.7 M)

- $25 MILLION TOTAL PROJECT COST
- STABILIZE KEY EMBANKMENTS ALONG REGIONAL RAIL
- GLENSIDE CUT ON SEPTA'S MAINLINE
- MEDIA CUT ON MEDIA/ELWYN LINE

Future Strategies

- COMPREHENSIVE TUNNEL DEWATERING AND WATERPROOFING
- COMPREHENSIVE SYSTEMWIDE STORMWATER MANAGEMENT

Thank you for your attention!

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TRANSPORTATION RESILIENCE PEER EXCHANGE

Port Authority of New York & New Jersey

August 2020

PORT AUTHORITY NY NJ
AIR LAND RAIL SEA

PANYNJ

OUR FACILITIES

Airports | JFK, EWR, LGA, TEB, SWF

Seaports | Newark, Elizabeth, Jersey, BMT, HH

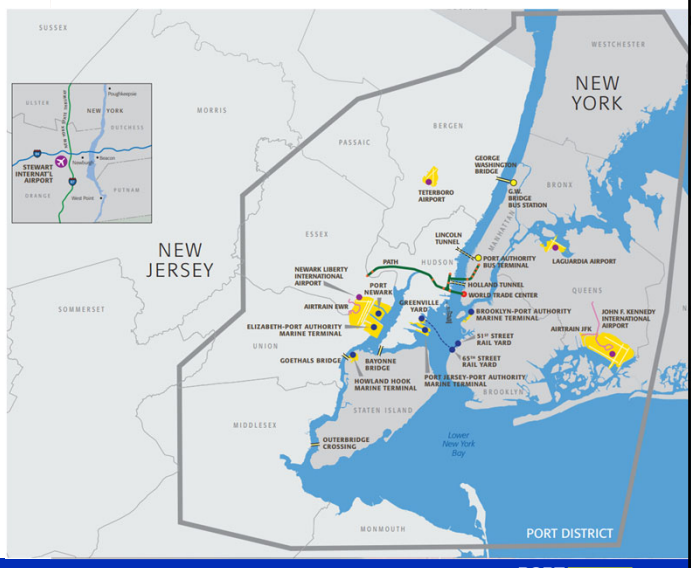
Bridges | GWB, Bayonne, Goethals, OBX

Tunnels | Lincoln, Holland

Terminals | PABT, GWB Bus Station

PATH Train | 13 stations

World Trade Center | Office buildings, Hub, Campus

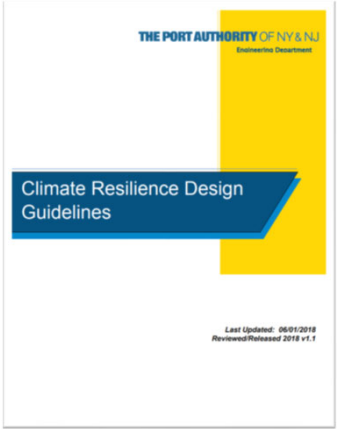


PORT AUTHORITY NY NJ
AIR LAND RAIL SEA

Climate Resilience Guidelines (CRG)

A KEY RISK MITIGATION TOOL

- 1993: PANYNJ adopts Environmental Sustainability policy
- 2008: Amends policy to include climate change, pledging to "*develop strategies that reduce the risk posed by climate change to its facilities and operations and, in collaboration with other regional stakeholders, develop strategies that mitigate the risk to the region posed by climate change in a manner that will promote a sustainable environment*."
- 2009: Engineering issues Design Memorandum
- 2015: Adopts Climate Resilience Guidelines (CRG)
- 2018: Updates CRG (v1.1) to broaden the application of the guidelines
- 2021: CRG v2 (Planned)



PORT AUTHORITY NY NJ
AIR LAND RAIL SEA

CRG

PRIMARY OBJECTIVES

- **Maximize the long-term safety, service, and resilience** of the Port Authority's assets, **now and in the future**, as climate conditions change
- **Science-based approach** to managing climate-related risks
- **Clear methodology** for factoring in sea level rise
- **Flexibility** to develop **cost-effective** design solutions
- Address the **most likely hazards** to impact the Port District

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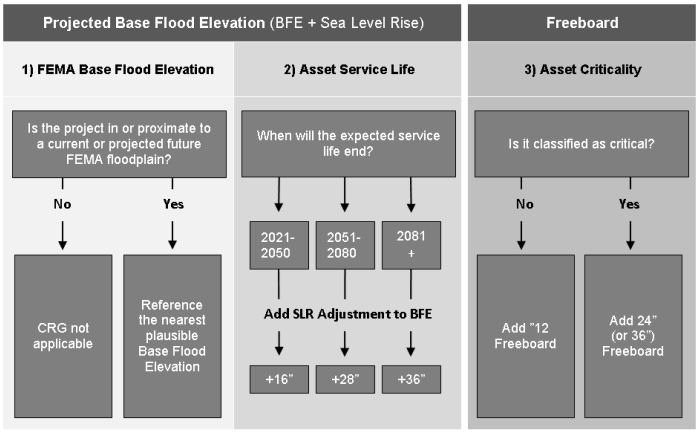
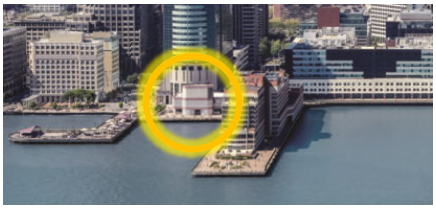
ESTABLISH PROJECT SLR DFE

PROJECT EXAMPLE: EXCHANGE PLACE HEADHOUSE





SLR Design Flood Elevation

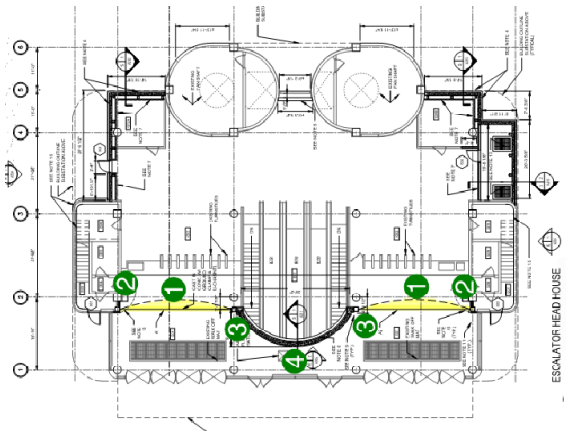
FEMA BFE	12.0 ft. +
Freeboard	2.0 ft. +
SLR Adjustment	3.0 ft. =
	17 ft. NAVD88*

** Approx. 7 ft. above grade*

PORT AUTHORITY NY NJ AIR LAND RAIL SEA

Exchange Place Headhouse

RESILIENT DESIGN SOLUTIONS



WATER

LAND

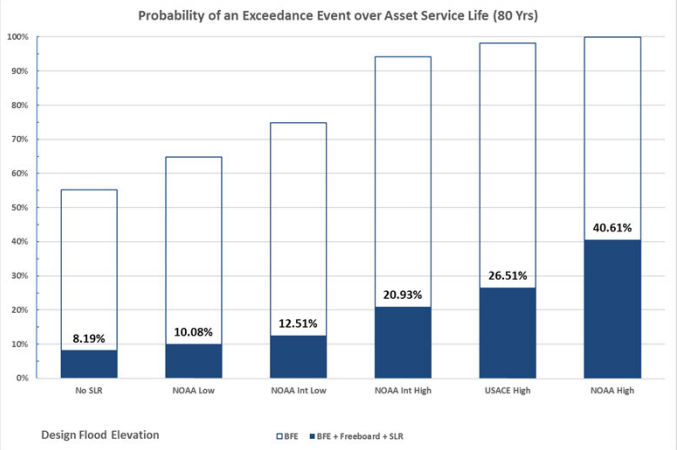
- Construct reinforced concrete flood wall (water side)
- Construct aquarium glass flood wall at escalator (land side)
- Install side-coiling flexible fabric flood barrier at turnstiles
- Install flood-rated exit doors
- Reinforce concrete vent shaft and stair shaft walls

Status: Stage IV (Construction)

PORT AUTHORITY NY NJ AIR LAND RAIL SEA

Risk Reduction Benefits

CUMULATIVE FAILURE RISK OVER ASSET LIFESPAN (ESTIMATED)



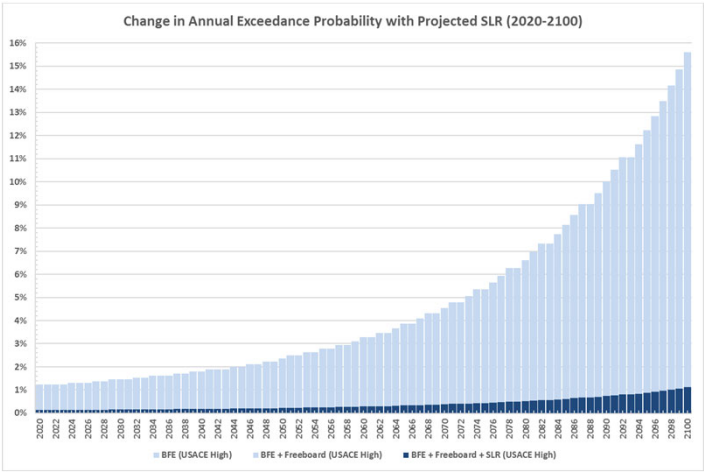
SCENARIO 1:
DESIGN TO PRESENT BASELINE FLOOD ELEVATION
(BFE) + 2 FT FREEBOARD (NO RISE)

DESIGN FLOOD ELEVATION
14 FT

PORT AUTHORITY NY NJ
AIR LAND RAIL SEA

Risk Reduction Benefits

ANNUAL EXCEEDANCE PROBABILITY OVER ASSET LIFESPAN (ESTIMATED)



SCENARIO 1:
DESIGN TO PRESENT BASELINE FLOOD ELEVATION
(BFE) + 2 FT FREEBOARD (NO RISE)

DESIGN FLOOD ELEVATION
14 FT

PORT AUTHORITY NY NJ
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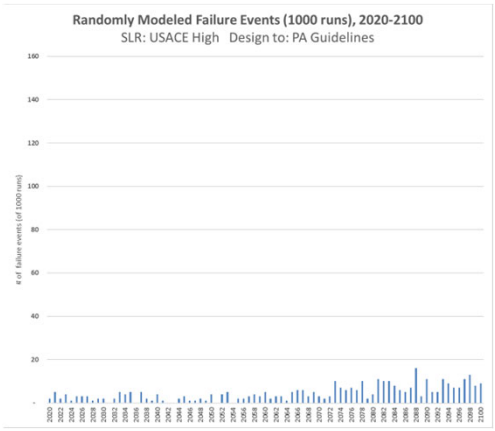
Risk Reduction Benefits

Randomly Modeled Failure Events (1000 runs)



2020 Failures
[redacted]

2100 Failures
[redacted]

Zero Failures (80-years)
[redacted]

Year of first failure (Average)
[redacted]

Year of first failure (Median)
[redacted]

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AIR LAND RAIL SEA

What's Next?

- **Fall 2020:** Minor CRG update to align with Envision (part of Sustainable Infrastructure Guidelines update)
- **2021:** Begin CRG update to introduce additional stressor types (e.g., extreme heat)
- **Ongoing:** Agency-wide Climate Risk Assessment to identify, characterize, and mitigate previously "undiscovered" climate risks
- **Ongoing:** Advance cross-departmental and inter-agency collaboration on climate-risk issues

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Thank You!

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U.S. Department of Transportation
Federal Highway Administration

FHWA Highway Resilience in Planning

Transportation Resilience Virtual Peer Exchange

August 17, 2020

Elizabeth Habic
Sustainable Transportation and Resilience
Federal Highway Administration

Extreme Weather Resilience Related Regulations

- Risk-based **asset management** plans must address risks associated with current and future environmental conditions (23 CFR 515)
- Assets requiring repeated repair require **evaluation of alternatives** (23 CFR 667)
- State and metropolitan **transportation planning** should now include resilience as a planning factor (23 USC 134, 23 CFR 450)
- **Metropolitan transportation plans** shall include an assessment of capital investment and other strategies to… reduce the vulnerability of the existing transportation infrastructure to natural disasters (23 CFR 450.324(f)(7))

U.S. Department of Transportation
Federal Highway Administration

Integrating Resilience in Transportation Planning

Project: Integrating Resilience into the Transportation Planning Process

- Workshops and Peer Exchanges
- Fact Sheet (January 2017)
- White Paper (May 2018)
- Handbook (Coming 2020)

https://www.fhwa.dot.gov/environment/sustainability/resilience/ongoing_and_current_research/planning/

U.S. Department of Transportation
Federal Highway Administration

What is the Handbook?

Resources include:

- A range of options for considering resilience throughout the transportation planning process.
- Information for every step in the planning process, including key resources.
- Real-world examples of how agencies are integrating resilience into transportation planning.

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Image from Google Earth

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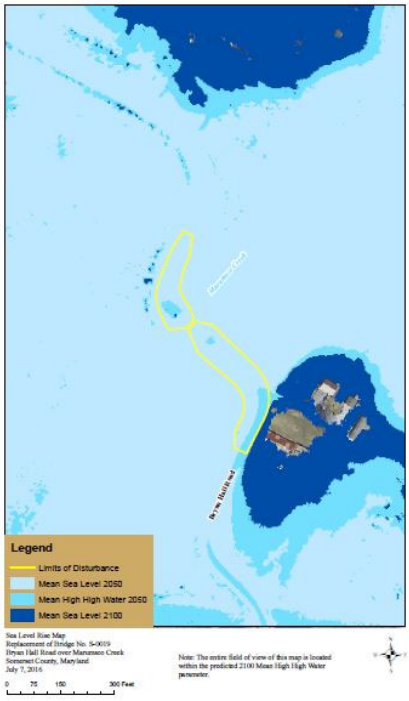


Excerpted from Programmatic Categorical Exclusion for the replacement of Bridge No. S-0019 Bryan Hall Road over Marumsco Creek, Somerset County, MD. Sept 27, 2016

U.S. Department of Transportation
Federal Highway Administration

Maryland SHA – Screening for SLR Impacts

Climate Change Impact Areas

Is this Project within an area potentially affected by Sea Level Change? Yes — Project must consider sea level change.

- ☒ Mean Sea Level 2050
- ☒ Mean Sea Level 2100
- ☒ Mean High High Water 2050
- ☒ Mean High High Water 2100

See attached Sea Level Change Map, if applicable

Is this a non-state Project located on State lands? No

Is this project involving construction of a new road or bridge, or reconstructing an existing road or bridge due to a storm event? No

Is this project involving construction of a new building/facility or reconstructing an existing building/facility due to a storm event? No

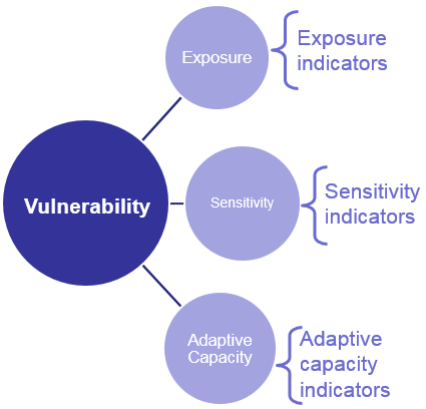
Notes: The hydraulics analysis determined that up to 100-year storm flooding events would not overtop the bridge. The roadway approaches to the bridge are being raised between 1 to 2.5 feet. Additional roadway improvements may be needed to address future flooding.

Excerpted from "Programmatic Categorical Exclusion for the replacement of Bridge No. S-0019 Bryan Hall Road over Marumsco Creek, Somerset County, MD." Sept 27, 2016

U.S. Department of Transportation
Federal Highway Administration

FHWA Vulnerability Assessment Scoring Tool (VAST)

- Excel-based tool
- Walks a user through completing an ***indicator-based*** vulnerability assessment
- User makes decisions, enters information at each step
- Tool provides step-by-step guidance through the process



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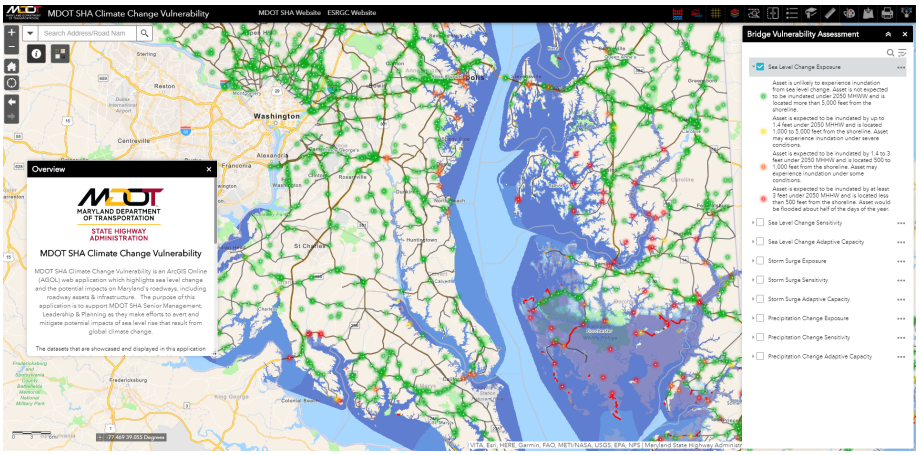
Federal Highway Administration

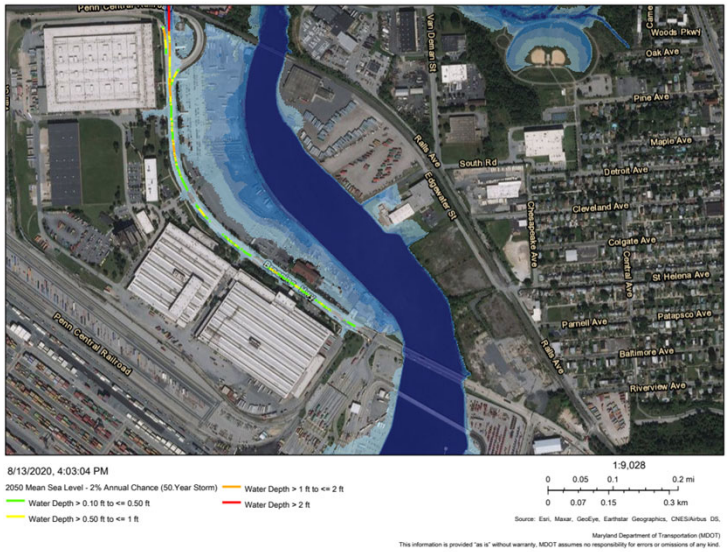
Maryland SHA - Early Planning Use of Vulnerability Data



Credit: Maryland DOT

U.S. Department of Transportation
Federal Highway Administration

MDOT SHA Viewer in Baltimore



U.S. Department of Transportation
Federal Highway Administration

https://maryland.maps.arcgis.com/apps/webappviewer/index.html?id=86b5933d2d3e45ee8b9d8a5f03a7030c

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THANK YOU!

Contact Information: Elizabeth.Habic@dot.gov

Website: https://www.fhwa.dot.gov/environment/sustainability/resilience/

U.S. Department of Transportation
Federal Highway Administration

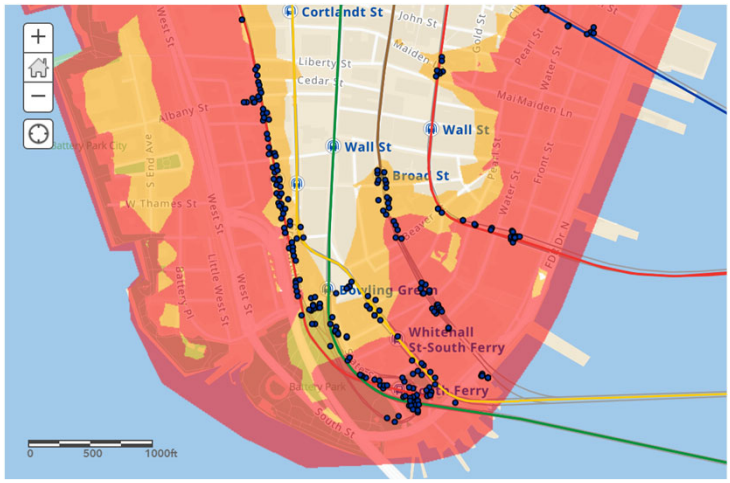
NYCT Coastal Storm Resiliency

Resilience Peer Exchange | August 17, 2020

MTA New York City Transit MTA Construction & Development

Assessing Vulnerability

- Criteria: SLOSH Category 2 + 3’ (for sea level rise, wave action, freeboard)
- Approximately 3,500 flood-vulnerable water ingress points to underground subway
- Also 10 subway yards, 34 power substations, 32 ventilation plants potentially vulnerable in Cat 2 storm

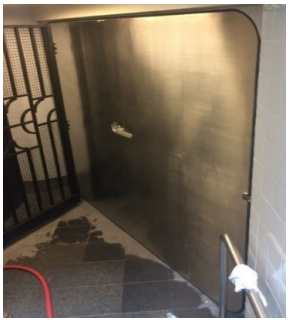


Mitigation Strategy + Solutions

Underground

1. **Keep water out!**
2. Enhance pumping system
3. Secondary protection for critical systems and facilities

FlexGate



Marine Door

Flood Logs

Mitigation Strategy + Solutions

Underground

1. **Keep water out!**
2. Enhance pumping system
3. Secondary protection for critical systems and facilities

Mechanical Closure Device (MCD)

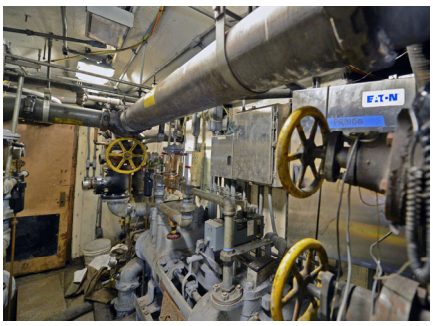
Watertight Hatch

Watertight Manhole Insert

Mitigation Strategy + Solutions

Underground

1. Keep water out!
2. **Enhance pumping system**
3. Secondary protection for critical systems and facilities




Pump rooms in Montague and Clark St Tubes

Mitigation Strategy + Solutions

Underground

1. Keep water out!
2. Enhance pumping system
3. **Secondary protection for critical systems and facilities**

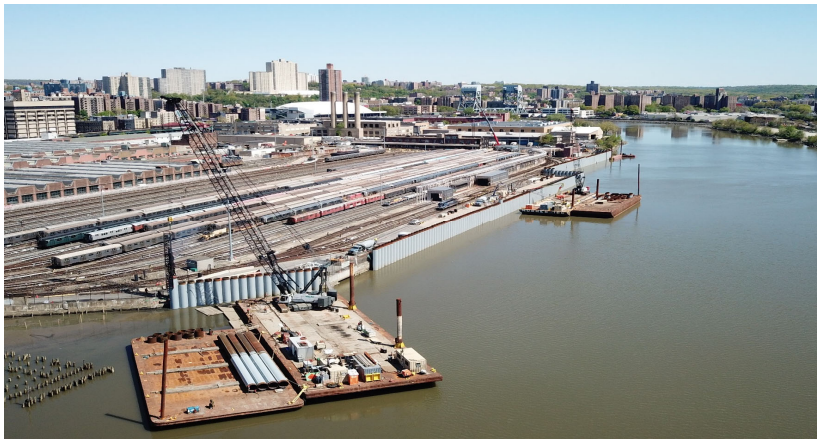
Marine door at Montague Tube circuit breaker house

Track level flood barrier outside South Ferry Terminal

Mitigation Strategy + Solutions

Above-Ground

1. **Keep water out!**
2. Where not feasible, preserve right-of-way and prioritize asset protection by criticality



Perimeter Flood Wall at 207 St Yard

Mitigation Strategy + Solutions

Above-Ground

1. **Keep water out!**
2. Where not feasible, preserve right-of-way and prioritize asset protection by criticality

New, watertight fan plant exterior above Canarsie Tube

Flood gates at Hammels Wye Campus on Rockaway Line

Mitigation Strategy + Solutions

Above-Ground

1. **Keep water out!**
2. Where not feasible, preserve right-of-way and prioritize asset protection by criticality

Elevated cable bridge at Coney Island Yard

Mitigation Strategy + Solutions

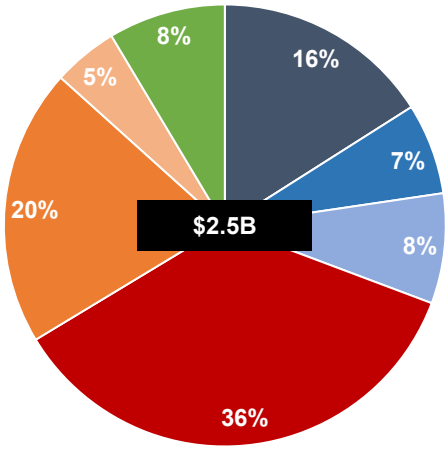
Above-Ground

1. Keep water out!
2. **Where not feasible, preserve right-of-way and prioritize asset protection by criticality**

Rockaway Line across Jamaica Bay

Mitigation Strategy

Funding Distribution



Underground

- Keep Water Out
- Enhance Pumping
- Secondary Protection

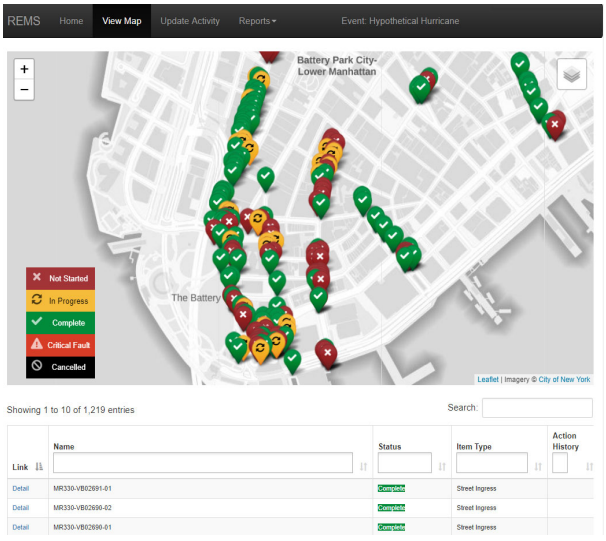
Above-Ground

- Keep Water Out (Yards)
- Keep Water Out (Other Facilities)
- Preserve Right-of-Way

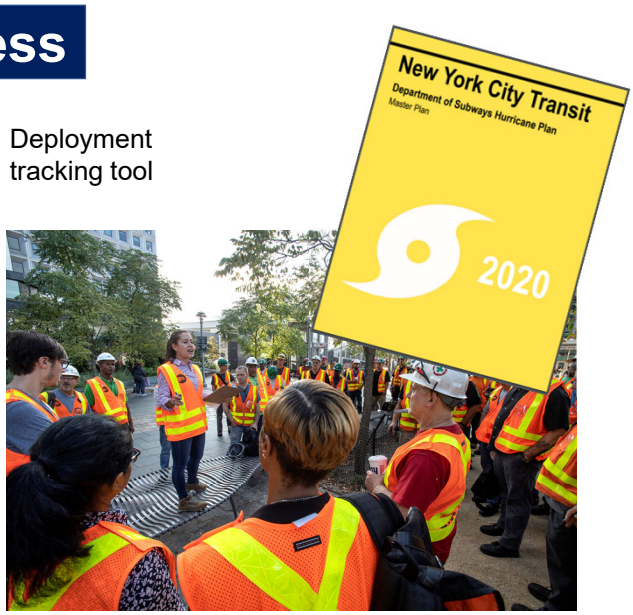
Other

- Additional Redundancy & Flexibility

Operational Preparedness



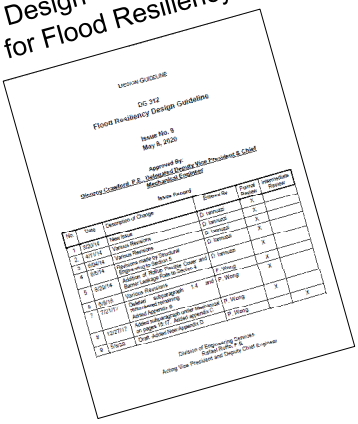
Deployment tracking tool

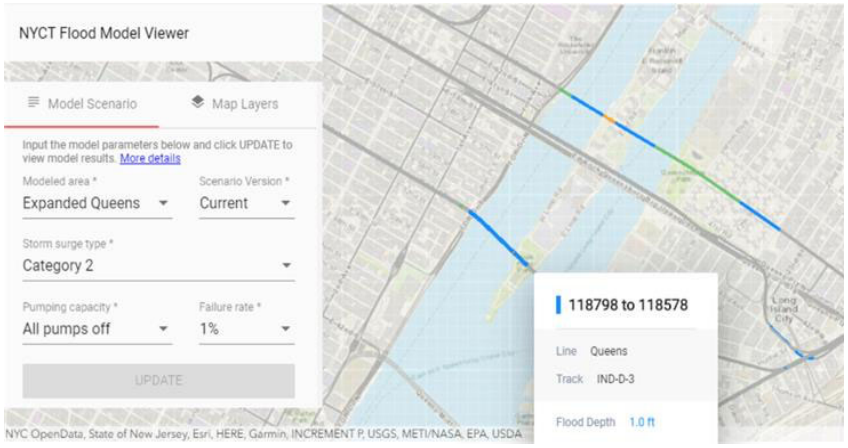


Deployment drill at South Ferry

Institutionalizing Resiliency

Design Guidelines for Flood Resiliency





Tunnel Flooding Model for future planning

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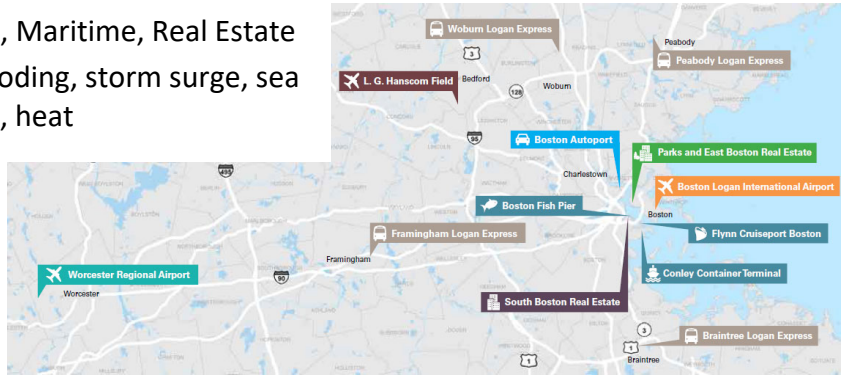
Massachusetts Port Authority (Massport) – Boston, MA

- **Agency Size**: Large, Logan Airport (40.9 m passengers annually), Port of Boston (1 million metric tons of cargo annually)
- **Location**: Northeast, USA
- **Business Lines**: Aviation, Maritime, Real Estate
- **Hazards:** Heavy rain, flooding, storm surge, sea level rise, winter storms, heat



Massport

Vulnerability Assessment

- Mod. THIRA framework to assess coastal flooding risk, across all business line assets
- Worst case approach – Cat 2-3 storm at high tide with SLR + 3' of freeboard
- Scenarios for 2030 and 2070
- Expanding assessments for heat, wind and heavy precipitation events

B-C / ROI Methodologies

- No formal B-C/ROI calculation process

Project Design and Construction

- Adopted Flood-proofing Design Guide,
- Two DFEs (existing & new structures), strategies and performance standards

Asset Management

- Use ArcGIS mapping tool to "flag" vulnerable assets
- More comprehensive treatment in emerging enterprise-wide TAM system

Project Identification/Prioritization

- Developed 5-yr capital plan to address 2030 vulnerabilities
- Prioritized based on probability, consequence and depth of flooding
- Primarily hardening with temporary and permanent flood proofing

Other

- Developed flood operations plans
- Annual inspection program

RUTGERS
Edward J. Bloustein School of Planning and Public Policy

Resilience Peer Exchange

WRAP UP & CLOSING REMARKS

FINDINGS

Each agency presentation provided insights into their approaches and methodologies for incorporating transportation resilience into capital planning. The Rutgers team reviewed the presentations and peer exchange notes and identified the following common trends and emerging best practices.

- **Vulnerability Assessments:** Multiple representatives emphasized the importance of conducting thorough vulnerability assessments to identify resilience needs and strategies. These assessments are often conducted at both system-wide and asset levels, considering various hazards and planning horizons.

- **Cost-Benefit Analysis:** Utilizing cost-benefit analysis to evaluate resilience strategies and prioritize projects can help agencies quantify and rank decisions. This helps organizations make informed decisions about resource allocations and project prioritization.

- **Enhanced Asset Management and Inspection Procedures:** Integrating resilience considerations into asset management processes is a common practice. This includes developing decision-support tools and incorporating resilience needs into maintenance schedules and useful life determinations. Implementing enhanced inspection procedures during construction and post-construction phases as part of an asset management program can ensure that resilience measures are properly deployed and maintained.

- **Resilience Design Standards:** Adopting resilience design and performance standards in project design is crucial for ensuring infrastructure can withstand extreme weather events particular to your location, such as flooding in coastal areas of New Jersey.

- **Interagency Cooperation:** Multiple representatives identified the value of coordinating resilience planning efforts with intergovernmental partners and considering interdependencies with other systems to ensure comprehensive resilience planning.

- **Training:** The need for training and workforce education to ensure preparedness and effective deployment of resilience measures was emphasized across organizations.

- **Monitoring and Evaluation:** Monitoring the performance of resilience measures and updating strategies based on observed outcomes was highlighted. This can allow agencies to enhance and update their plans based on real performance data over time.

CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the findings described above demonstrate some emerging common needs and best practices for transportation agencies in the Northeast region developing long-term capital plans that consider resilience and durability. This information can be used by regional transportation agencies to gauge their current planning programs. Additional stakeholder meetings and more feedback are necessary to generate an authoritative set of best practices, which is recommended for future research along this line of work.

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