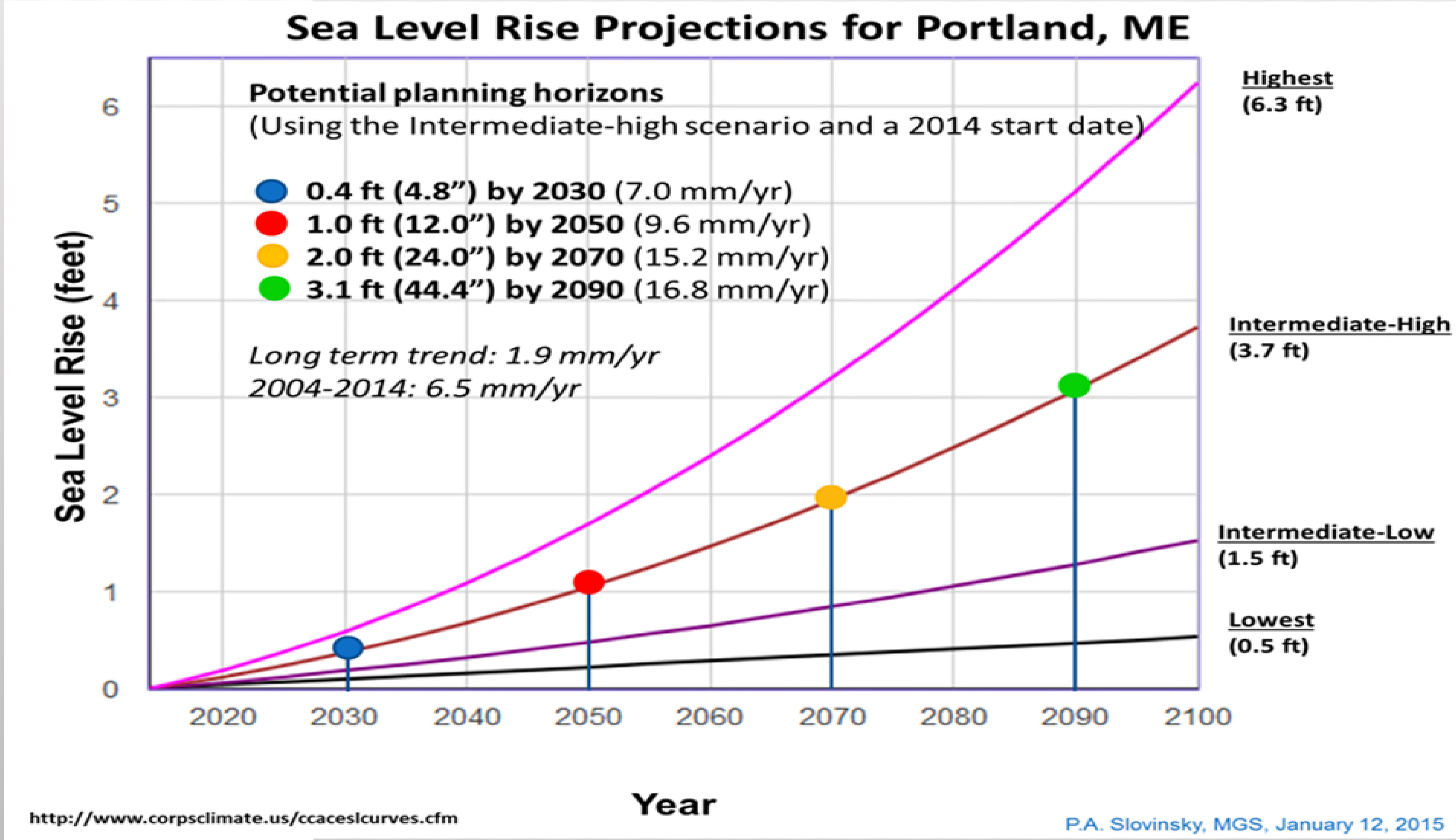
# The Changing Climate of Asset Management at MaineDOT

*Surge from Hurricane Sandy crashes over a sea wall in Kennebunk, Maine on October 29, 2012*

**Judy Gates, Director, Environmental Office**

**MAWS Annual Meeting, March 24, 2015**


Sea Level Rise Projections for Portland, ME
Potential planning horizons
(Using the Intermediate-high scenario and a 2014 start date)
0.4 ft (4.8”) by 2030 (7.0 mm/yr)
1.0 ft (12.0”) by 2050 (9.6 mm/yr)
2.0 ft (24.0”) by 2070 (15.2 mm/yr)
3.1 ft (44.4”) by 2090 (16.8 mm/yr)
Long term trend: 1.9 mm/yr
2004-2014: 6.5 mm/yr
Highest
(6.3 ft)
Intermediate-High
(3.7 ft)
Intermediate-Low
(1.5 ft)
Lowest
(0.5 ft)
Sea Level Rise (feet)
0
1
2
3
4
5
6
2020
2030
2040
2050
2060
2070
2080
2090
2100
Year
http://www.corpsclimate.us/ccaceslcurves.cfm
P.A. Slovinsky, MGS, January 12, 2015

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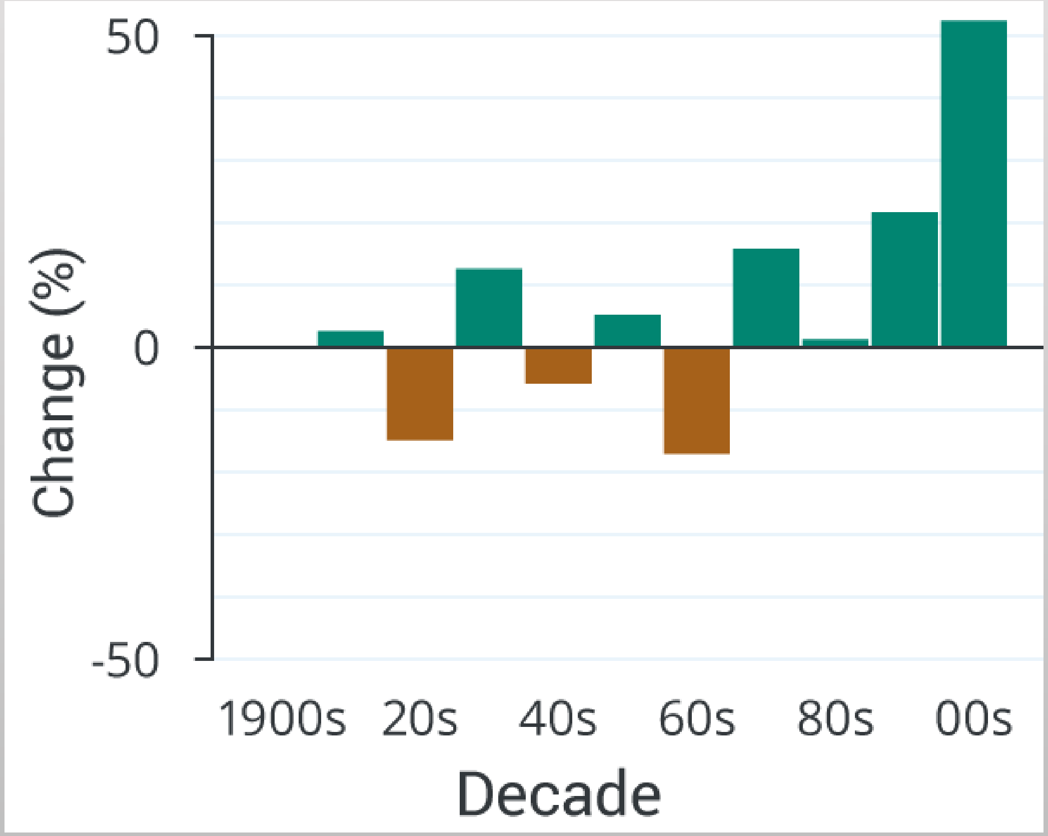
# Northeast Observed Change in Heavy Precipitation

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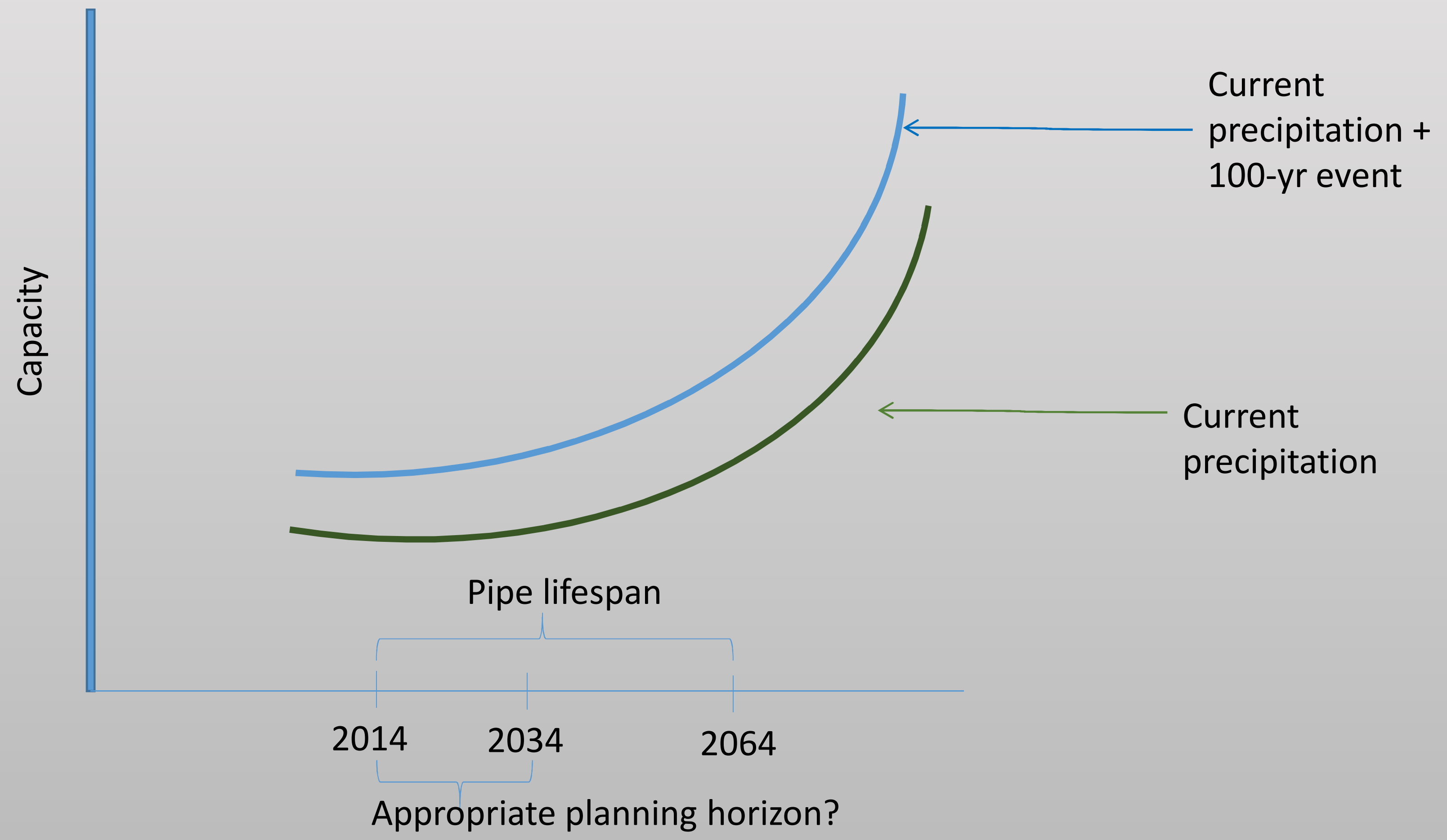
National Climate Assessment 2014

# 100-year precipitation event

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# The Lingo

**Capacity** = ability to convey precipitation; based on familiar hydrology

**Risk Management** = managing external “threat multipliers” to infrastructure and operations

**Resiliency** = ability to withstand precipitation, sea level rise, storm surge; paradigm shift

**Criticality** = function, e.g. emergency access, traffic volume, detour availability

**Vulnerability** = exposure, sensitivity, adaptive capacity

**Green Infrastructure** = using natural resources to protect built infrastructure

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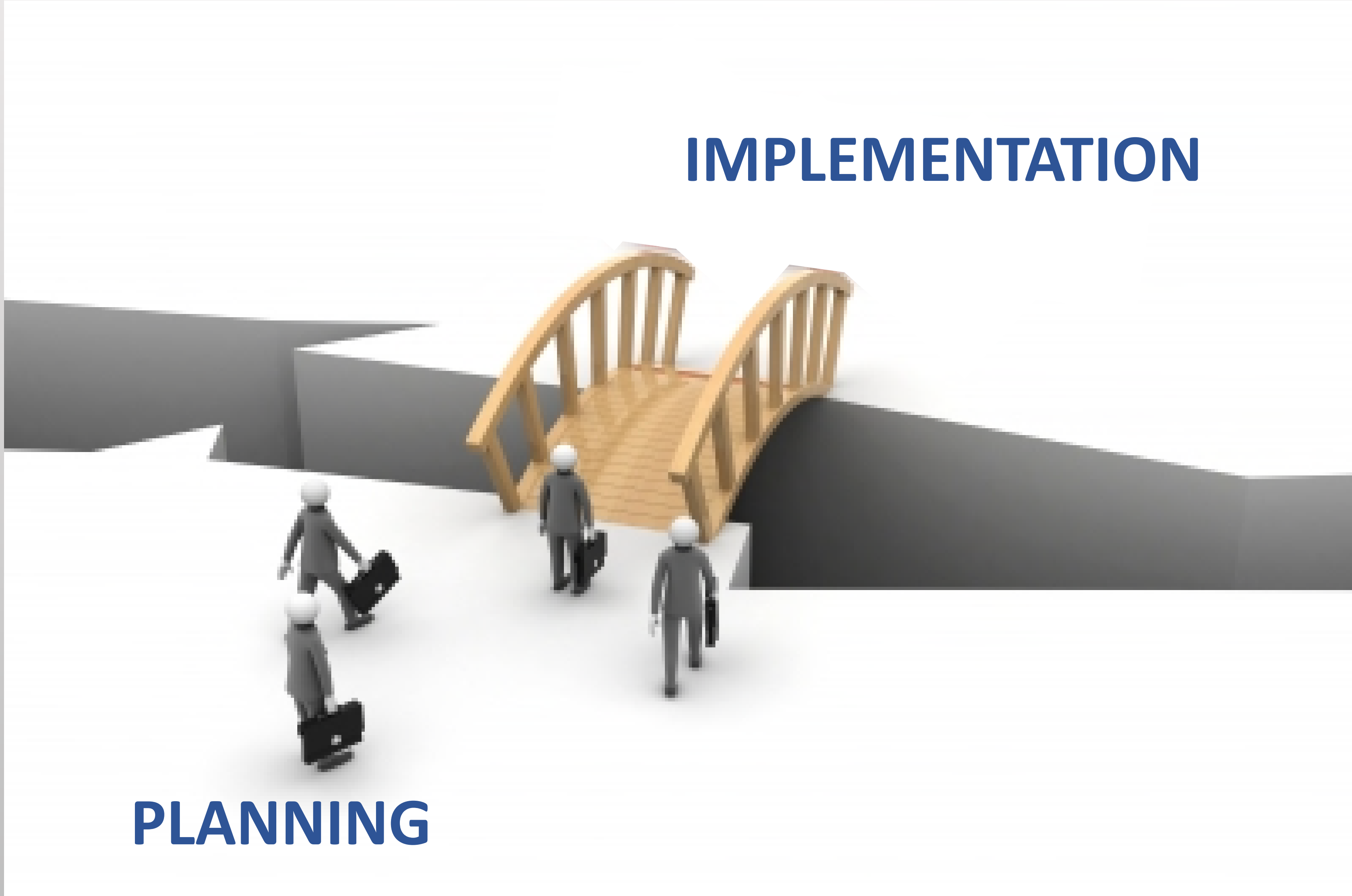


Image courtesy of Renjith Krishnan at FreeDigitalPhotos.net

# FHWA Order 5520, *Transportation System Preparedness and Resilience to Climate Change and Extreme Weather Events*

December 15, 2014

- **Integrates consideration of climate and extreme weather** risks into its planning, operations, policies and programs;
- Formalizes FHWA's **commitment** to this issue;
- Guides the agencies' implementation of **MAP-21**;
- Identifies how the agency intends to continue to lead the transportation industry in **making the nation's highways more resilient**.

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# EO 13690 (modifies EO 11988)

## *Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input*

January 30, 2015

- United States policy to **improve the resilience of communities and Federal assets against the impacts of flooding**;
- Reiterates anticipation of **climate change effects** on environment, economic prosperity, and public health and safety;
- Establishes a **new flood risk reduction standard** for federally funded projects;
- Help preserve the natural values of **floodplains**.

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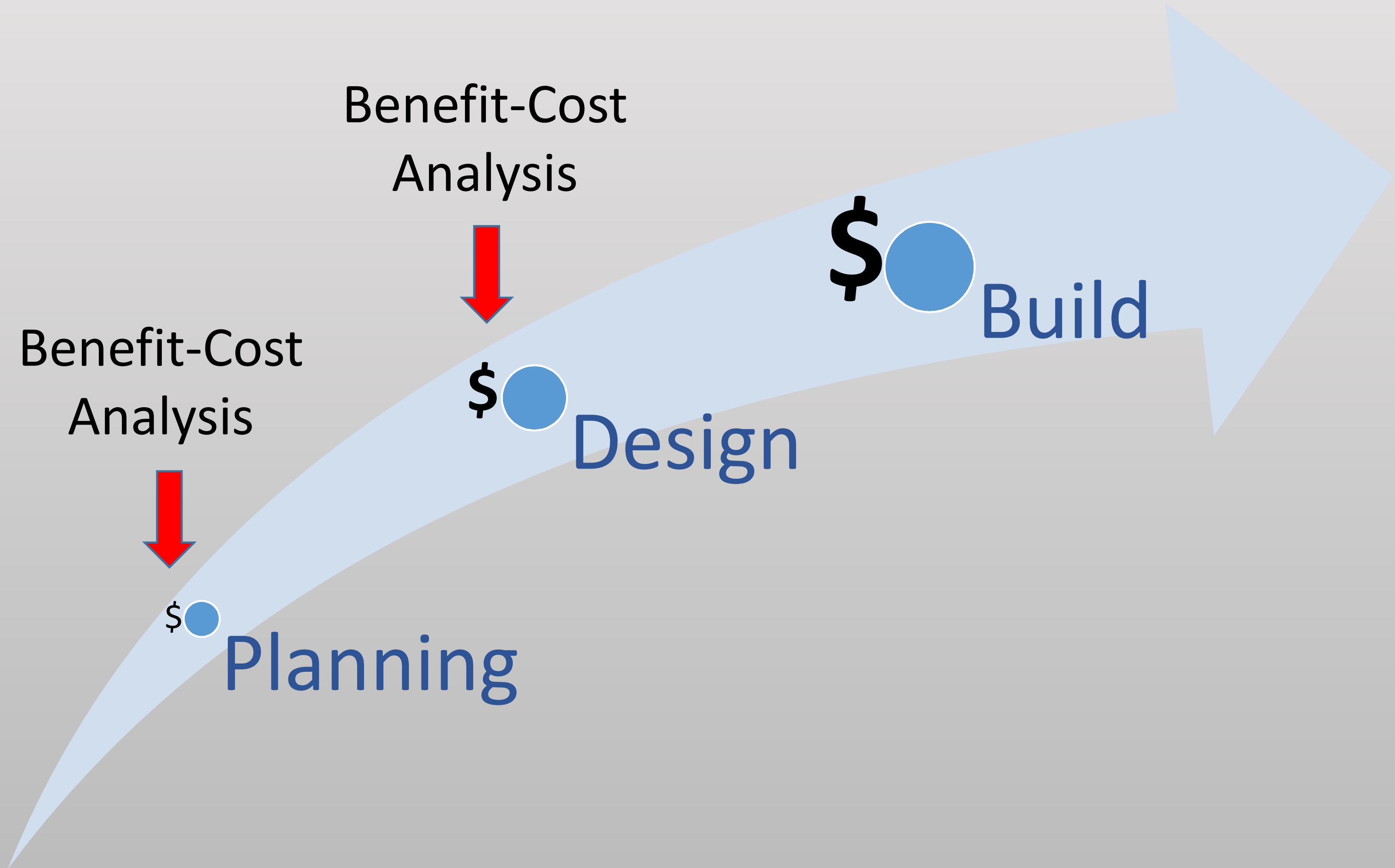
# Engineering Project Timeline



# Where are the "weak" spots?

**Potential Impact**: change in types, frequency, and intensity of hazards
**Vulnerabilities**: degree of preparedness, threats to resiliency, integrity, operation
**Consequences**: allocation & distribution of resources, inadequate design standards, strains disaster recovery

**Potential Impact**: increase in number of catastrophic storms, more frequent & widespread flooding, sea level rise, storm surges
**Vulnerabilities**: stresses vital infrastructure, decreases structural integrity
**Consequences**: requires upgrades or movement of infrastructure

**Potential Impact**: infrastructure damage and collapse
**Vulnerabilities**: increasingly unreliable delivery of services/emergency response
**Consequences**: interruptions in service, ripple effects, shortens asset lifespans

# What the conversation is really about…

- When will the next big storm hit?
- How do we know what to protect first?
- Who is going to tell us how to engineer our way out of this?
- What level of risk are “we” willing to accept?
- What are the customers’ expectations of the system?
- What is the budget tolerance?
- Are we willing to let someone else make the decisions (e.g. post-Irene VT)?

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# What we know…

- Stated end goal from President, Commissioner, DHS, FHWA is to incorporate climate variables (threats, uncertainty) into asset management
- Commissioner Bernhardt’s direction is to upsize pipes in anticipation of future, climate-related events
- Costs of upsizing replacement structures should be compared to appropriately designed given hydrology and best engineering practice, not status quo.
- Risk resistant is the goal, not risk-proof…”no regrets” decision-making
- Analysis paralysis is not effective asset management

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# Is this overly simplistic?

Boiling it down…

Consider **lifecycles and context** in planning and design decisions to make **even-handed, risk-based, consistent decisions** at a more predictable cost.


Untitled - COAST Damage Assessment Tool
File Model DST Help
COAST
Ready

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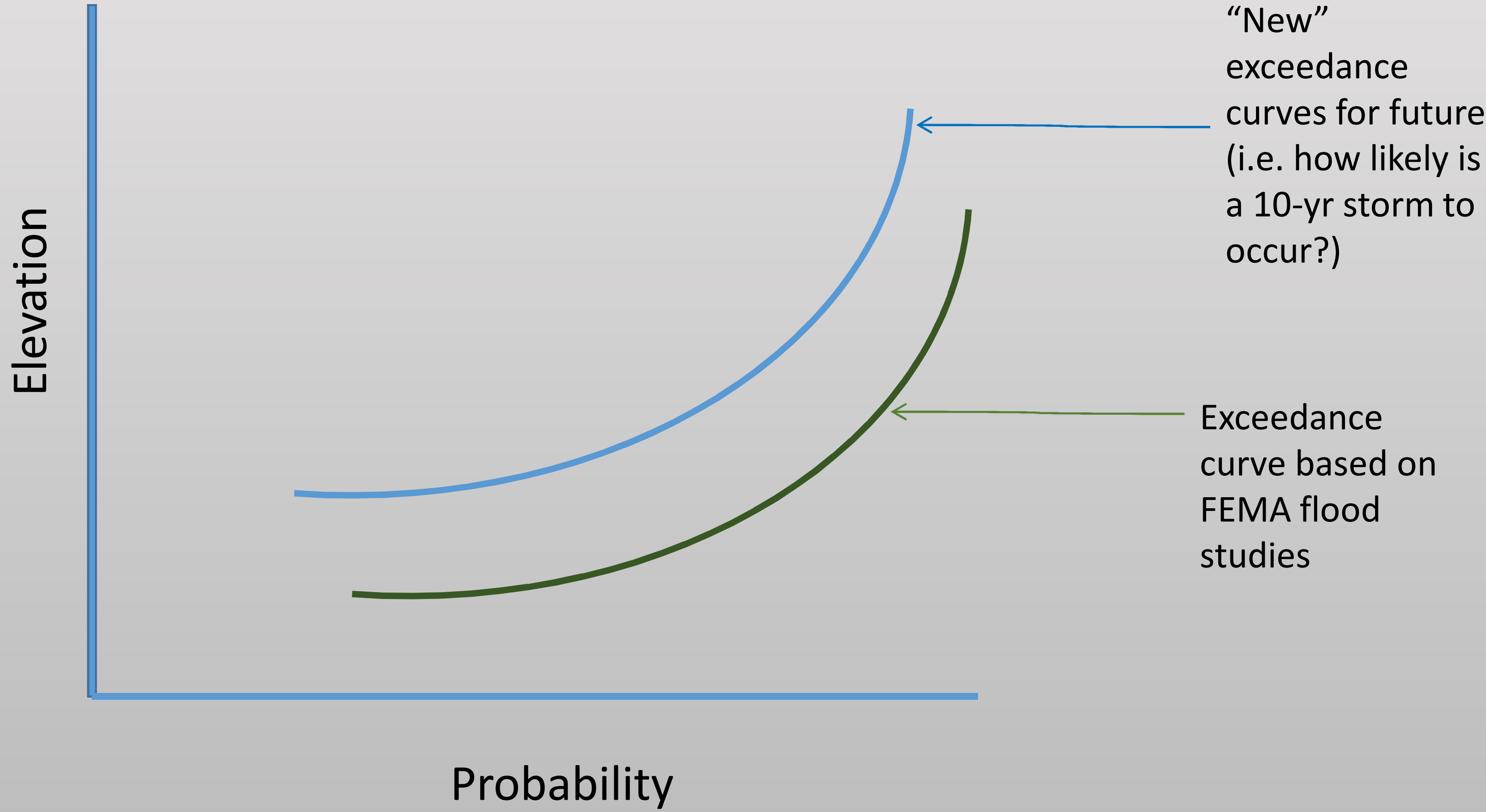
# Basis of COAST

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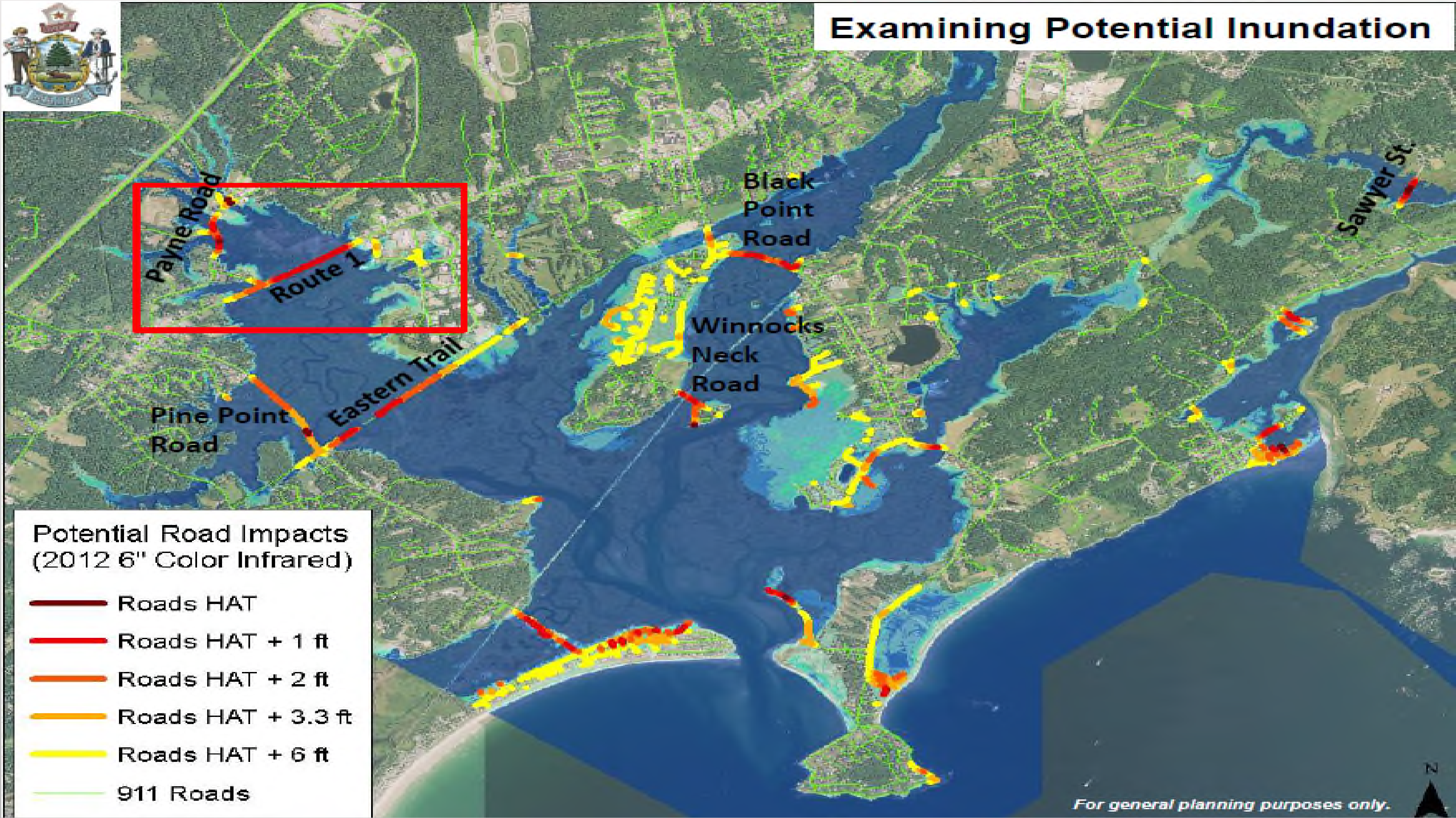

Examining Potential Inundation
Payne Road
Route 1
Black Point Road
Sawyer St.
Winnocks Neck Road
Eastern Trail
Pine Point Road
Potential Road Impacts (2012 6" Color Infrared)
Roads HAT
Roads HAT + 1 ft
Roads HAT + 2 ft
Roads HAT + 3.3 ft
Roads HAT + 6 ft
911 Roads
For general planning purposes only.
N

# Methods

- Selected the most critical transportation structures:
  - Developed a Decision Support Tool (DST) to rank criticality of sets of road or bridge data within each town.
    - Modified a matrix from the Gulf Coast Phase 2 study to populate fields in the DST with asset scores for vulnerability and sensitivity.
    - Added weighting fields for use by agency staff to indicate relative importance of each field for that asset.
    - The DST then ranks assets within each set to find highest priorities.

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# DST Data needs

SENSITIVITY

1. Feet of freeboard under bridge between lowest chord and 100 yr BFE or road segments ≤ 5 ft above 100 yr BFE
2. % of bridge length at height of lowest chord or degree culverts/drainage structures are prone to failure during rain/tidal storm events
3. Approaches flood or road included in TIP for rehab or reconstruction
4. Scour critical

VULNERABILITY

5. NBIS score ≥ 5 or road surface asphalt or concrete
6. Functional classification of roadway
7. Utilities/other modes associated with bridge or road
8. Roadway is identified evacuation route
9. Hospital, emergency access way?

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Tool - [C:\Program Files (x86)\COAST_2\SampleData\Bridges_wAssets.dstx]

| How many feet of freeboard are between the lowest chord of the bridge structure and the 100-year BFE? (1) | What percentage of the bridge length is at the height of the lowest chord, as answered in q1? (1) | Are the approaches to the bridge subject to flooding before the bridge structure itself is | Is the bridge indicated as scour critical at its latest inspection? (2) | Was the NBIS score at least 5 or above (FAIR CONDITION) at the last inspection? (3) |
|---|---|---|---|---|
| 4 - Between 0 and 1 foot | 3 - 34% to 66% | 5 - Yes | 0 - No | 3 - NBIS Score = 3 |
| 5 - Less than zero | 5 - Over 66% | 0 - No | 5 - Yes | 2 - NBIS Score = 4 |
| 2 - Between 1 and 5 feet | 3 - 34% to 66% | 5 - Yes | 0 - No | 3 - NBIS Score = 3 |

# Methods

- Selected the most critical transportation structures:
  - Developed a Decision Support Tool (DST) to rank criticality of sets of road or bridge data within each town.
    - Modified a matrix from the Gulf Coast Phase 2 study to populate fields in the DST with asset scores for vulnerability and sensitivity.
    - Added weighting fields for use by agency staff to indicate relative importance of each field for that asset.
    - The DST then ranks assets within each set to find highest priorities.
  - Highest priority assets have been selected in each of six towns.
    - 3 bridges
    - 2 culverts
    - 1 road

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# The Asset Features

- ~~ME Route 209, south of Sam Day Hill Rd, Phippsburg~~
- ~~ME Route 127, at Sequinland Rd, Georgetown~~
- ME Route 1 over Scarborough Marsh, Scarborough
- New Meadows Rd on Old Bath Road, Bath
- ME Route 25, Bowdoinham
- ~~Meadow Rd, Topsham~~

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# Methods

- Key elements of the approach:
  - For each asset, the software analyzed cost-benefit relationships of three alternatives:
    - Replace to current design standards
    - Replace with structure built to standards for 3.3’ of SLR
    - Replace with structure built to standards for 6.6’ of SLR

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# Methods

- Key elements of the approach:
  - For each asset, the software analyzed cost-benefit [illegible]
    - Replace in-kind
    - Replace with structure built to standards for 3.3′ of SLR
    - Replace with structure built to standards for 6.6′ of SLR
  - In general:
    - Costs:
      - Initial replacement or construction costs
      - Maintenance and repair over time, after each storm surge event
    - Benefits:
      - Avoided damages provided by each structure in the face of a range of SLR and storm surge scenarios – tallied cumulatively over time.

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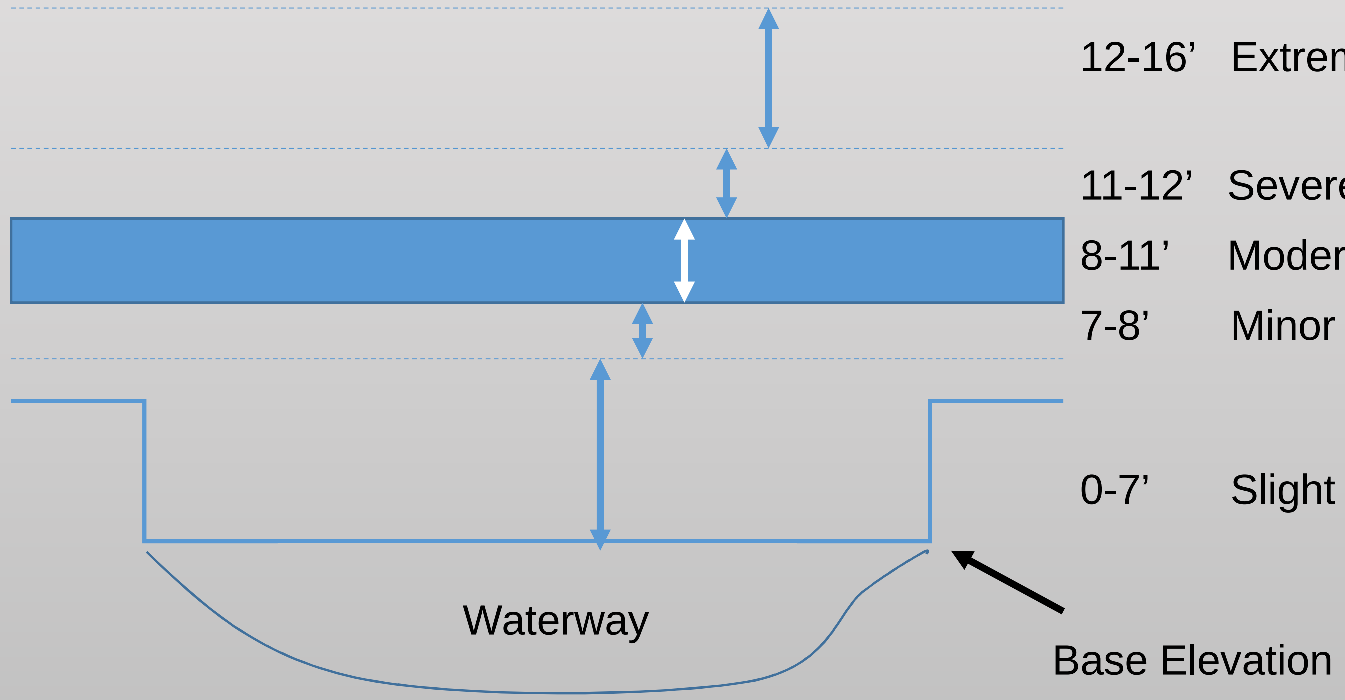
# Depth Damage Functions Designed for Each Structure

| Elev. | Damage | Cost |
|---|---|---|
| 12-16’ | Extreme | = $E/event |
| 11-12’ | Severe | = $D/event |
| 8-11’ | Moderate | = $C/event |
| 7-8’ | Minor | = $B/event |
| 0-7’ | Slight | = $A/event |



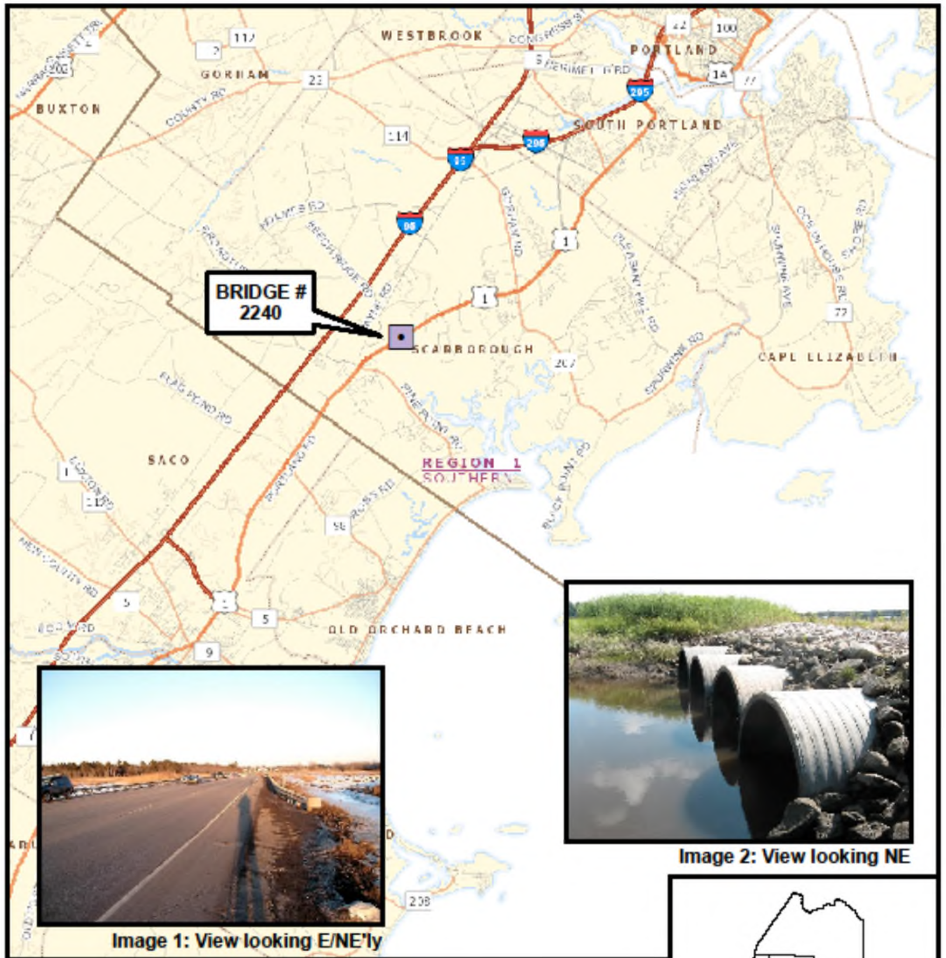


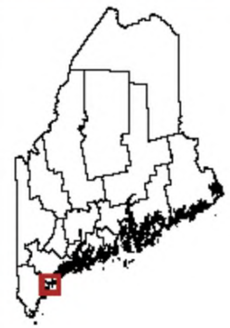

Image 1: View looking E/NE'ly

Image 2: View looking NE

**Figure 2: Scarborough**

Bridge #2240 carries US Routes 1 and 9 over the Dunstan River and associated marshlands. The crossing is comprised of four 8-foot diameter concrete culverts replaced in 2004, resulting in an excellent condition rating.

0 0.75 1.5 3 4.5 6 Miles



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# Scarborough Marsh


# SCARBOROUGH MARSH


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## Scarborough

| | Low Sea Level Rise (3.3') | | |
|---|---|---|---|
| | Initial Construction Costs | Total Damage/Repair Costs by 2100 | TOTAL LIFE CYCLE COST BY 2100 |
| **Replace in Kind** | $ 3,600,000 | $ 349,128 | **$ 3,949,128** |
| Replace with 3.3' SLR design | $ 4,300,000 | $ 181,330 | $ 4,481,330 |
| Replace with 6' SLR design | $ 6,000,000 | $ 3,323 | $ 6,003,323 |
| | **High Sea Level Rise (6')** | | |
| | Initial Construction Costs | Total Damage/Repair Costs by 2100 | TOTAL LIFE CYCLE COST BY 2100 |
| **Replace in Kind** | $ 3,600,000 | $ 823,325 | **$ 4,423,325** |
| Replace with 3.3' SLR design | $ 4,300,000 | $ 642,948 | $ 4,942,948 |
| Replace with 6' SLR design | $ 6,000,000 | $ 69,547 | $ 6,069,547 |

**Replace in Kind** was the most cost effective choice for both Low and High sea level rise scenarios.

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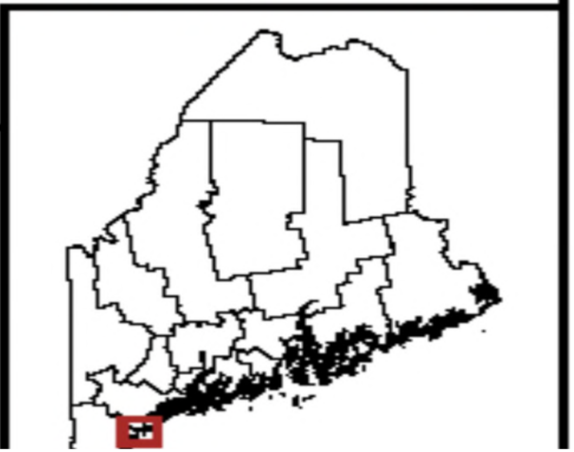
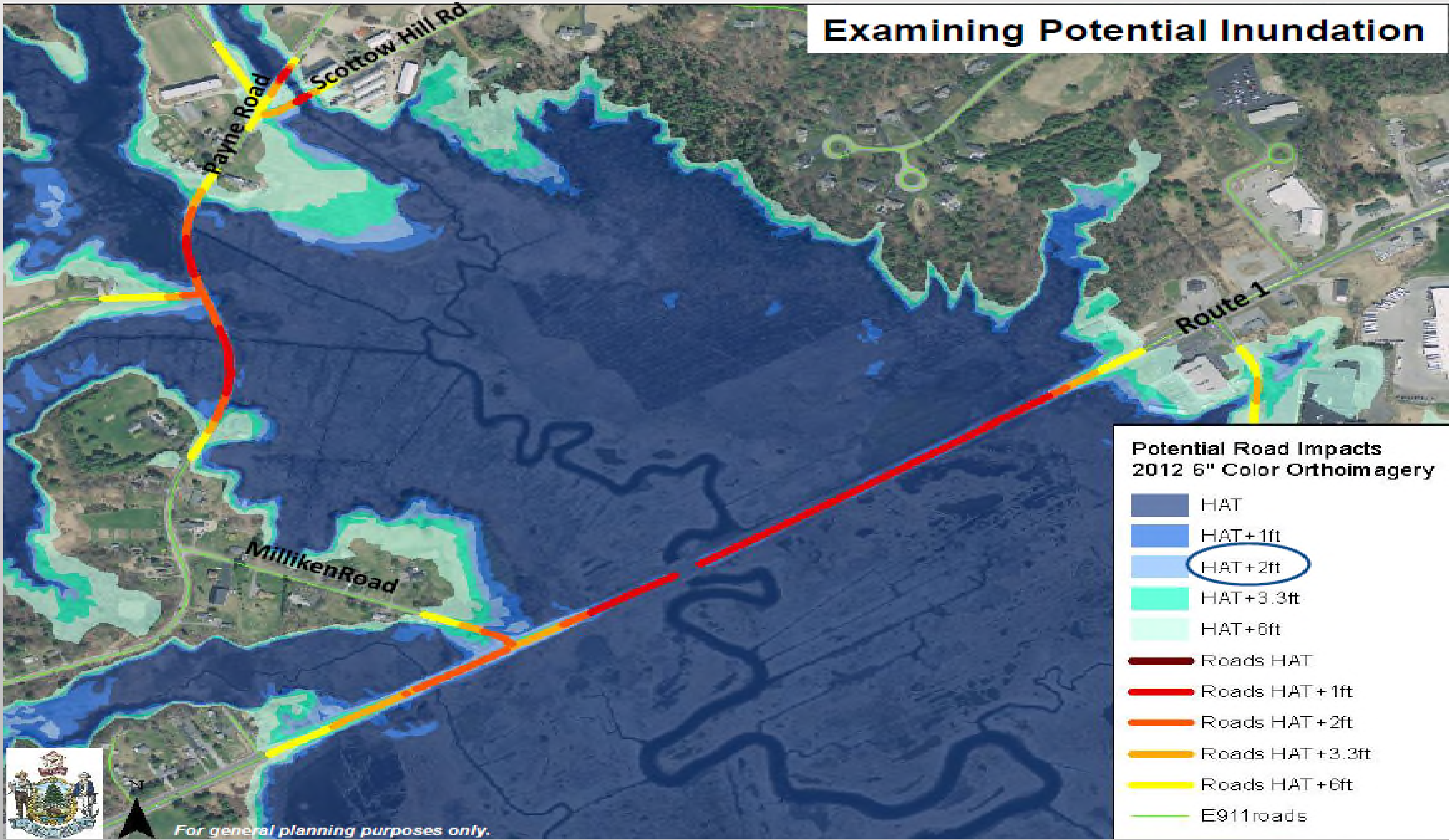
Image 1: View looking E/NE'ly

Image 2: View looking NE

## Figure 2: Scarborough

Bridge #2240 carries US Routes 1 and 9 over the Dunstan River and associated marshlands. The crossing is comprised of four 8-foot diameter concrete culverts replaced in 2004, resulting in an excellent condition rating.





Examining Potential Inundation
Scottow Hill Rd
Payne Road
Route 1
MillikenRoad
Potential Road Impacts
2012 6" Color Orthoimagery
HAT
HAT+1ft
HAT+2ft
HAT+3.3ft
HAT+6ft
Roads HAT
Roads HAT+1ft
Roads HAT+2ft
Roads HAT+3.3ft
Roads HAT+6ft
E911roads
N
For general planning purposes only.

# Getting at context and opportunity…

- Surrounding landscape (e.g., land cover, topography)
- Potential for downstream flooding, value of detention, regional context
- Ecosystem services (i.e. functions and values)
- Debris potential (e.g. large woody debris, bedloads)
- Risk of failure (i.e. condition ratings)
- Flooding history, criticality

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# Back to that conversation…

Q: When will the next big storm hit?

A: **Next week, next decade, next century…**

Q: How will we know what to protect first?

A: **Use the best data and know-how <u>available</u>**

Q: Who is going to tell us how to engineer our way out of this?

A: **Not it**

Q: What level of risk are "we" willing to accept?

A: **It depends who is footing the bill**

Q: What are the customers' expectations of the system?

A: **100% accessibility, 100% of the time**

Q: What is the budget tolerance?

A: **zip, zero, zilch**

Q: Are we willing to let someone else make the decisions (e.g. post-Irene VT)?

MaineDOT A: **Maybe…**




# Insanity

Doing the same thing over and over again and expecting different results.

Albert Einstein

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# Current Practices

**Bridges**:

- 90% full at Q50
- Check that Q100 runs full, but not over road surface
- Check scour to Q500

**Culverts**:

- ~~Sized for Q50 with headwater:depth up to 1.5~~

- 90% full at Q50
- Full at Q100
- Check 1.2 bank full width

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## Back to our friend Albert…

You can't solve a problem at the same level of consciousness that created it.

Albert Einstein

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# A few pesky realities…

- We get it
- Prioritizing is a many pronged fork
- Uncertainty is a fact of life
- Data will always be incomplete
- Money will always be a limiter
- It only takes a small adjustment to avoid the iceberg

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# The road ahead…

- See opportunity in necessity
- Understand that everything relies on benefit:cost
- Lack of catastrophe breeds complacency
- Be clear that not getting in the way is not the same as helping
- The "eaten by wolves" factor
- Rock those rose-colored glasses

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WE COULD DO THE PROJECT RIGHT FOR $100,000 OR DO IT WRONG FOR $25,000.
scottadams@aol.com
www.dilbert.com
I BELIEVE THAT THE WISE KING SALMON WOULD SAY TO SPLIT THE DIFFERENCE AND DO IT FOR $50,000.
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FISH ARE STUPID.