Town of Old Orchard Beach: A summary of sea level rise science, storm surge, and some highlighted results from SLAWG work efforts

October 15, 2013

Peter A. Slovinsky, Marine Geologist
Maine Geological Survey
Department of Agriculture, Conservation, and Forestry
peter.a.slovinsky@maine.gov
http://www.maine.gov/doc/nrimc/mgs/mgs.htm

Work funded by:

Why does sea level change?

<u>Global Sea Levels…</u>

Thermal Expansion (long term - the ocean heats up/expands as atmosphere warms)

Volumetric Increase (long term - volume increases with water from melting glaciers and land-based ice sheets)

Global climate variation (short term impacts of ENSO, El Nino/La Niña warming and cooling patterns in the Pacific Ocean)

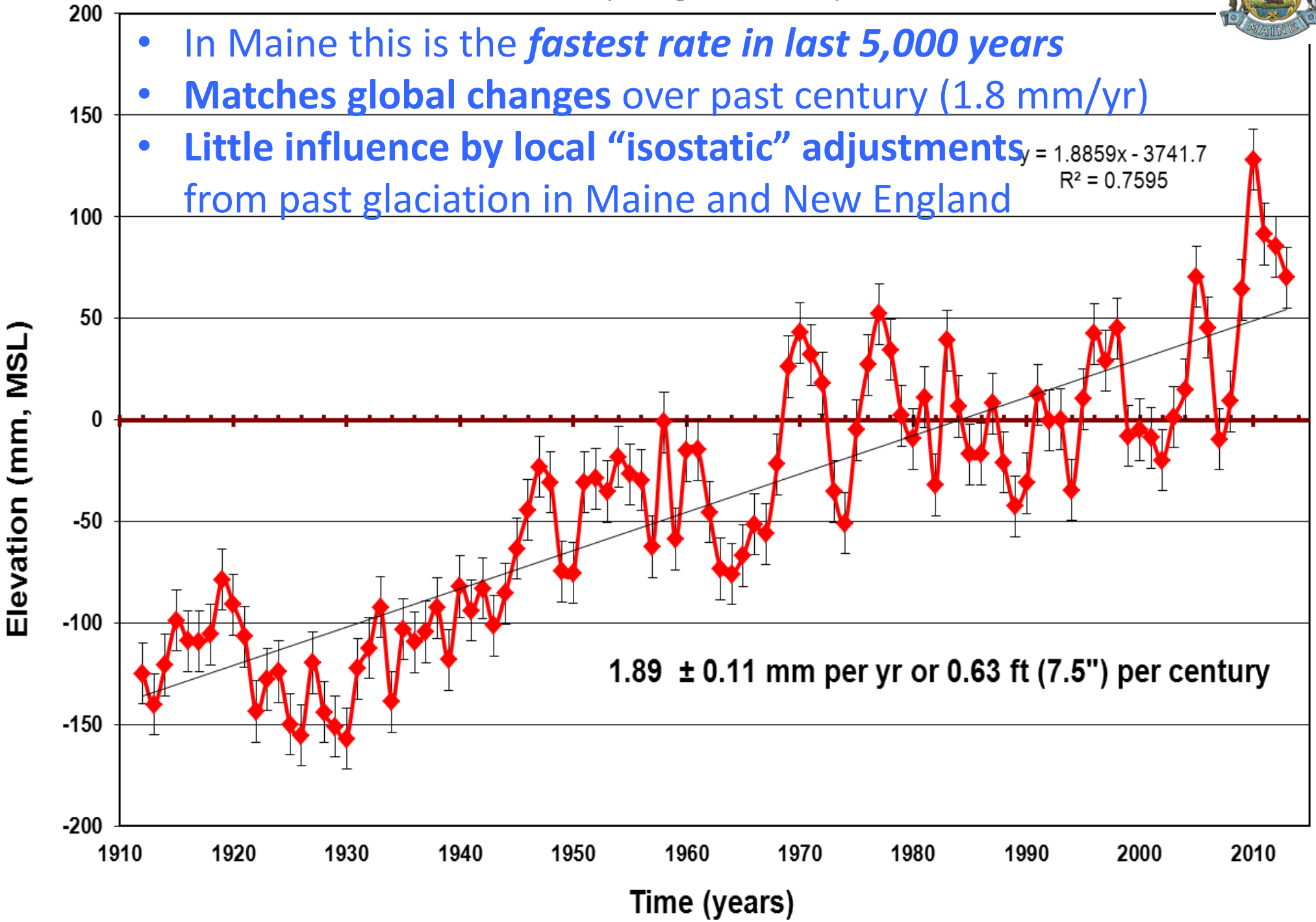
<u>Relative (or "Local") Sea levels…</u>

Isostatic rebound (response of the crust to glaciation)

Subsidence (sinking of the land due to other factors than isostasy)

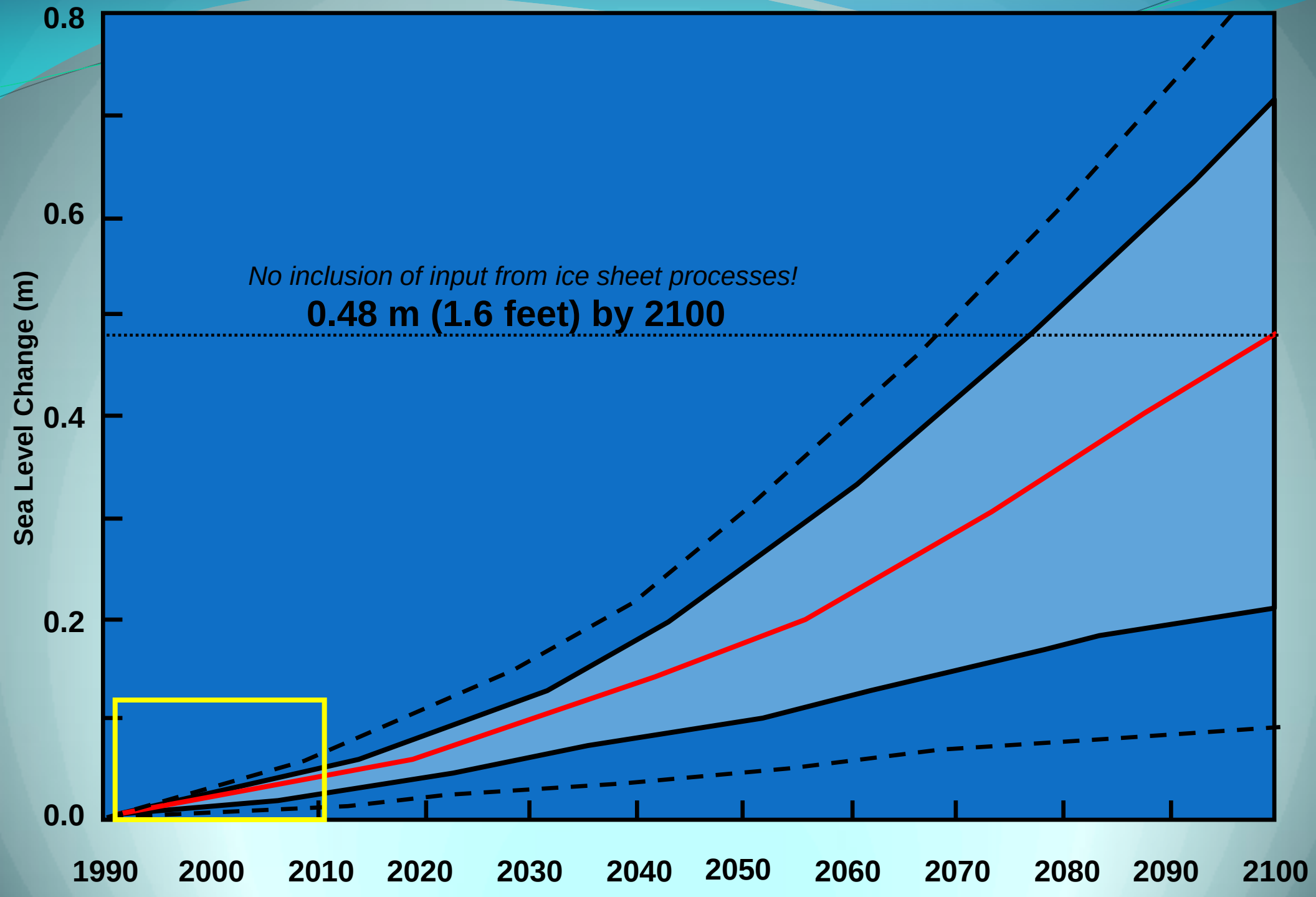
Sea Level, Portland, Maine

1912-2013 (through June, 2013)

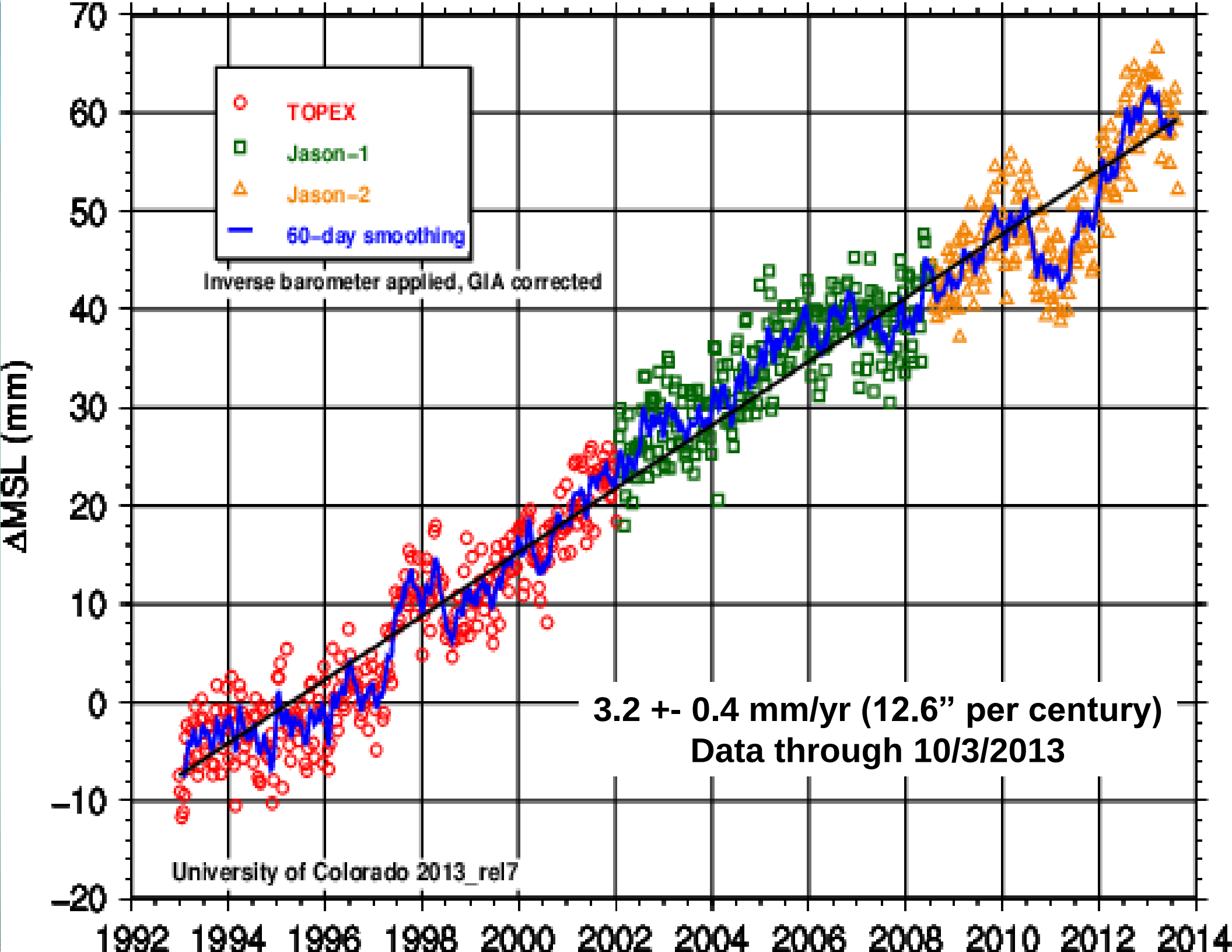


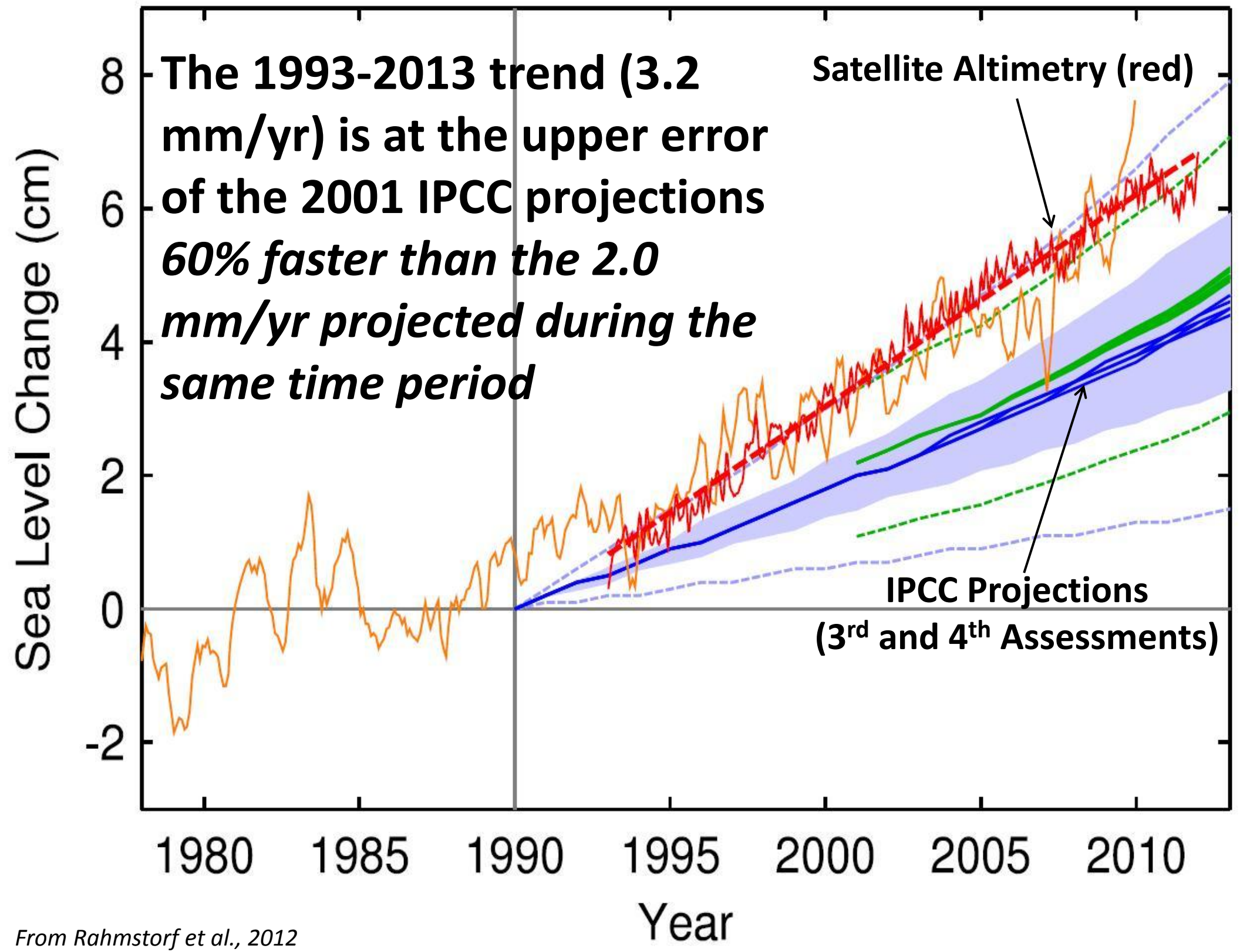
Data courtesy of NOAA CO-OPS, www.tidesandcurrents.nooa.gov

P.A. Slovinsky, Maine Geological Survey, August 20, 2013



Adapted from the IPCC 3rd Assessment (Tech. Summary of Working Group I Report, Fig. 24, p. 74., 2001)

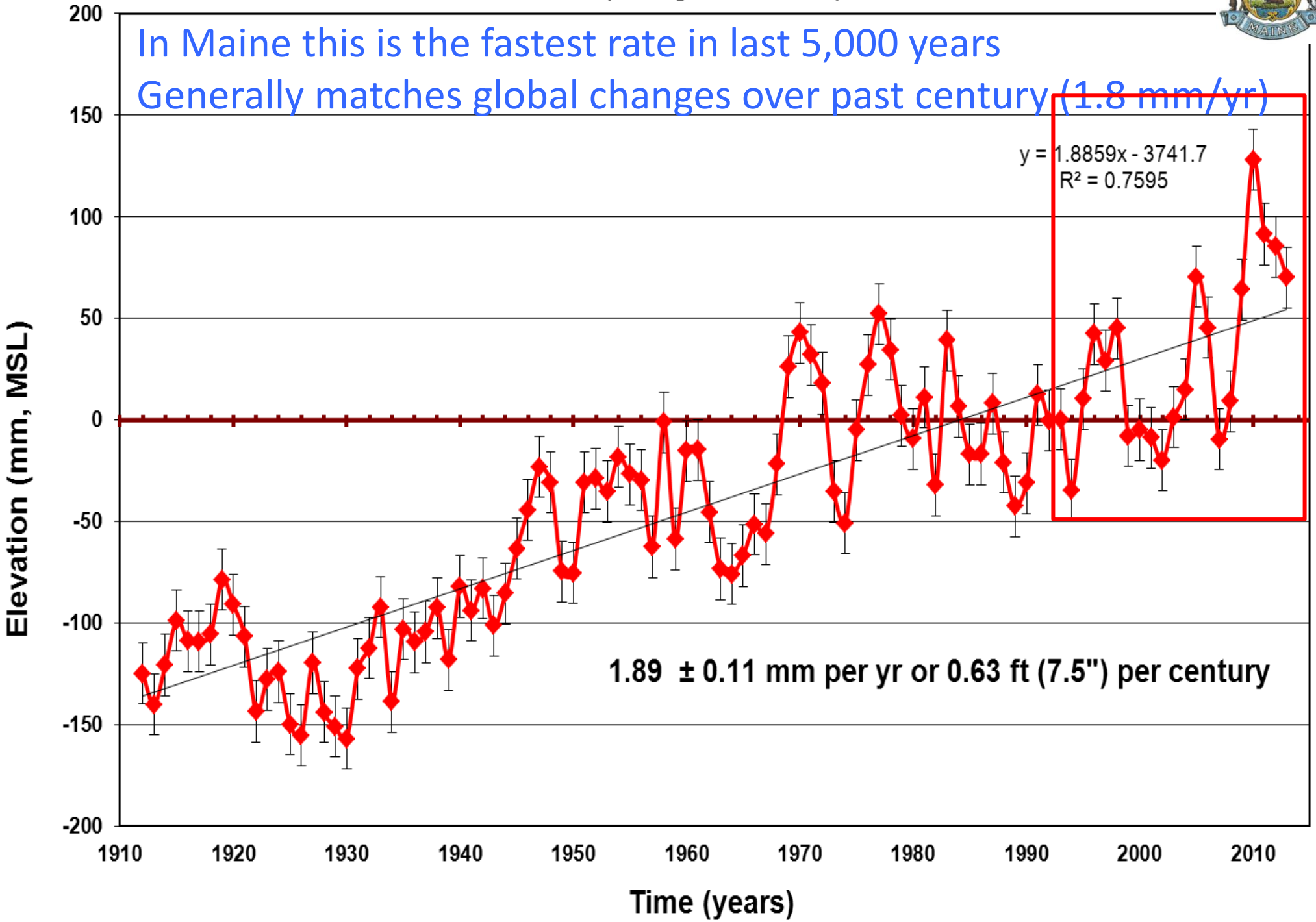

TOPEX
Jason-1
Jason-2
60-day smoothing
Inverse barometer applied, GIA corrected
3.2 +- 0.4 mm/yr (12.6" per century)
Data through 10/3/2013
University of Colorado 2013_rel7
ΔMSL (mm)
70
60
50
40
30
20
10
0
−10
−20
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014



From Rahmstorf et al., 2012

Sea Level, Portland, Maine

1912-2013 (through June, 2013)

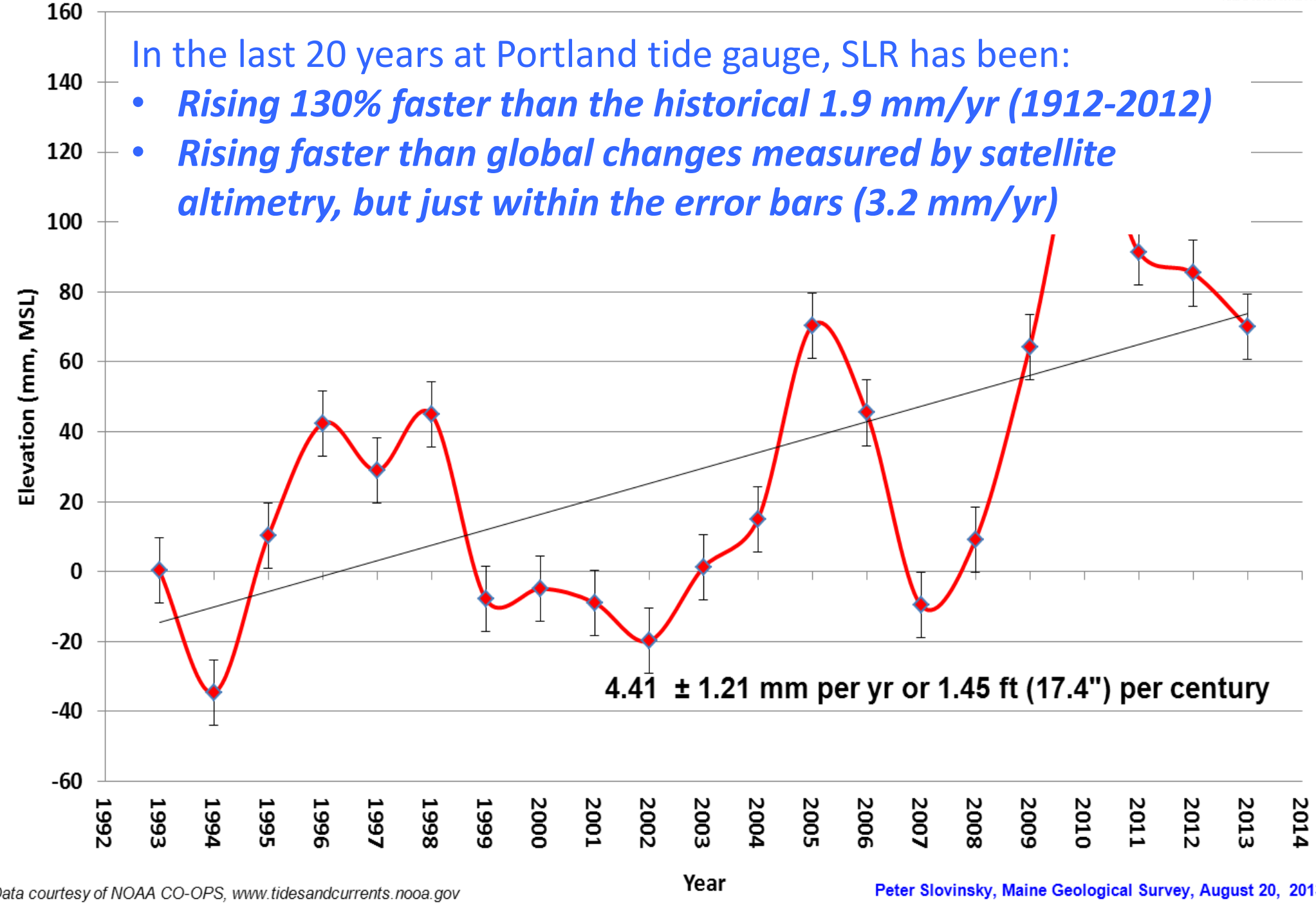


Data courtesy of NOAA CO-OPS, www.tidesandcurrents.nooa.gov

P.A. Slovinsky, Maine Geological Survey, August 20, 2013

Sea Level, Portland, Maine
1993-2013 (through June 2013)

MAINE GEOLOGICAL SURVEY



Data courtesy of NOAA CO-OPS, www.tidesandcurrents.nooa.gov

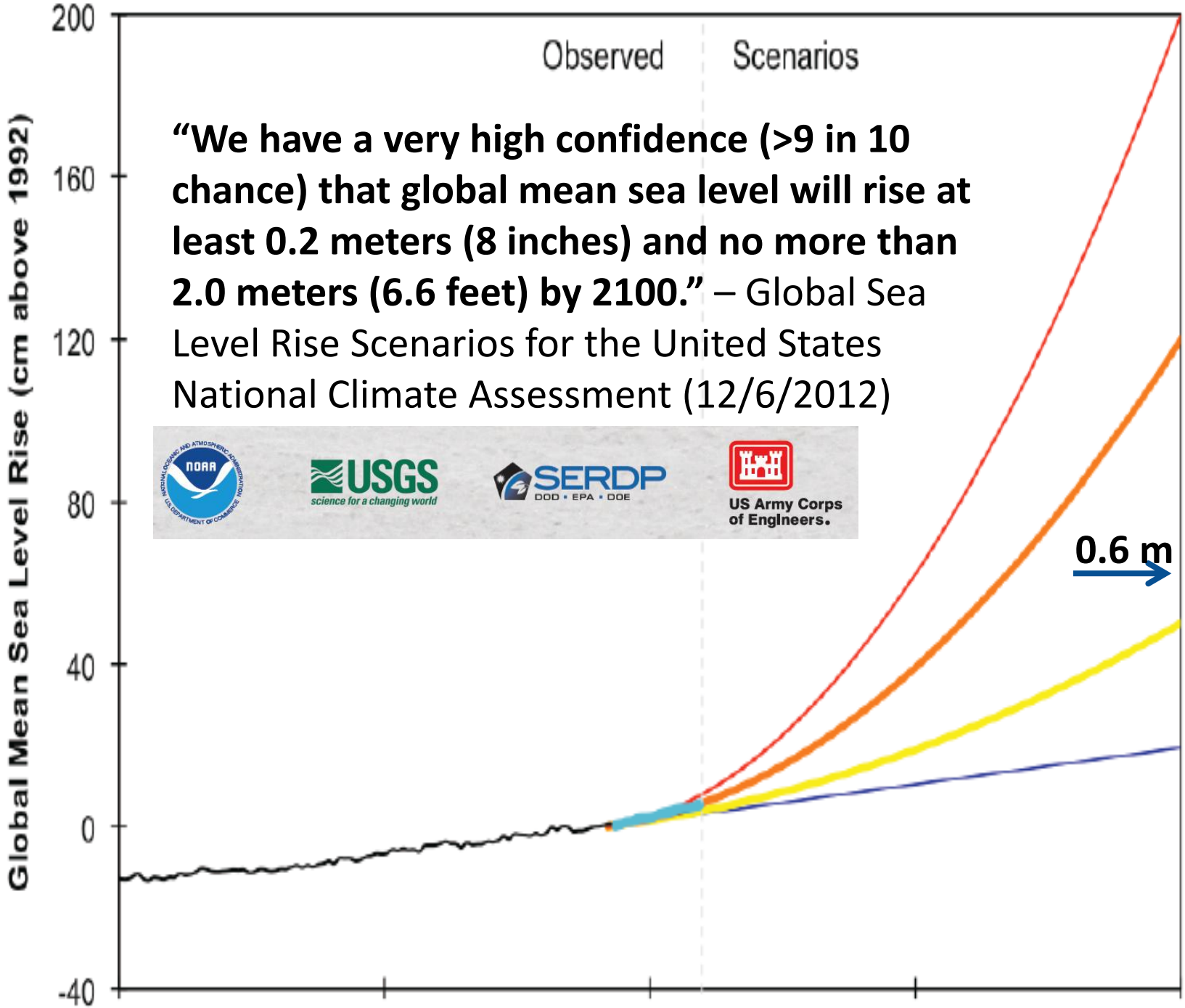
Peter Slovinsky, Maine Geological Survey, August 20, 2013

…if current [Antarctic and Greenland] ice sheet melting rates continue for the next four decades, their cumulative loss could raise sea level by 15 centimeters (5.9 inches) by 2050. When this is added to the predicted sea level contribution of 8 centimeters (3.1 inches) from glacial ice caps and 9 centimeters (3.5 inches) from ocean thermal expansion, total sea level rise could reach 32 centimeters **(12.6 inches) by the year 2050**.

Rignot and others, March 2011

http://www.agu.org/news/press/pr_archives/2011/2011-09.shtml

Image from www.swisseduc.ch



"We have a very high confidence (>9 in 10 chance) that global mean sea level will rise at least 0.2 meters (8 inches) and no more than 2.0 meters (6.6 feet) by 2100." – Global Sea Level Rise Scenarios for the United States National Climate Assessment (12/6/2012)

Highest
(2.0 m, 6.6 ft)
***Combines maximum warming, thermal expansion, and possible ice sheet loss from semi-empirical models.**

Intermediate-High
(1.2 m, 3.9 ft)
***Average of high end global predictions, combines recent ice sheet loss and thermal expansion**

Intermediate-Low
(0.5 m, 1.6 ft)
***Includes only thermal expansion from warming from IPCC AR4.**

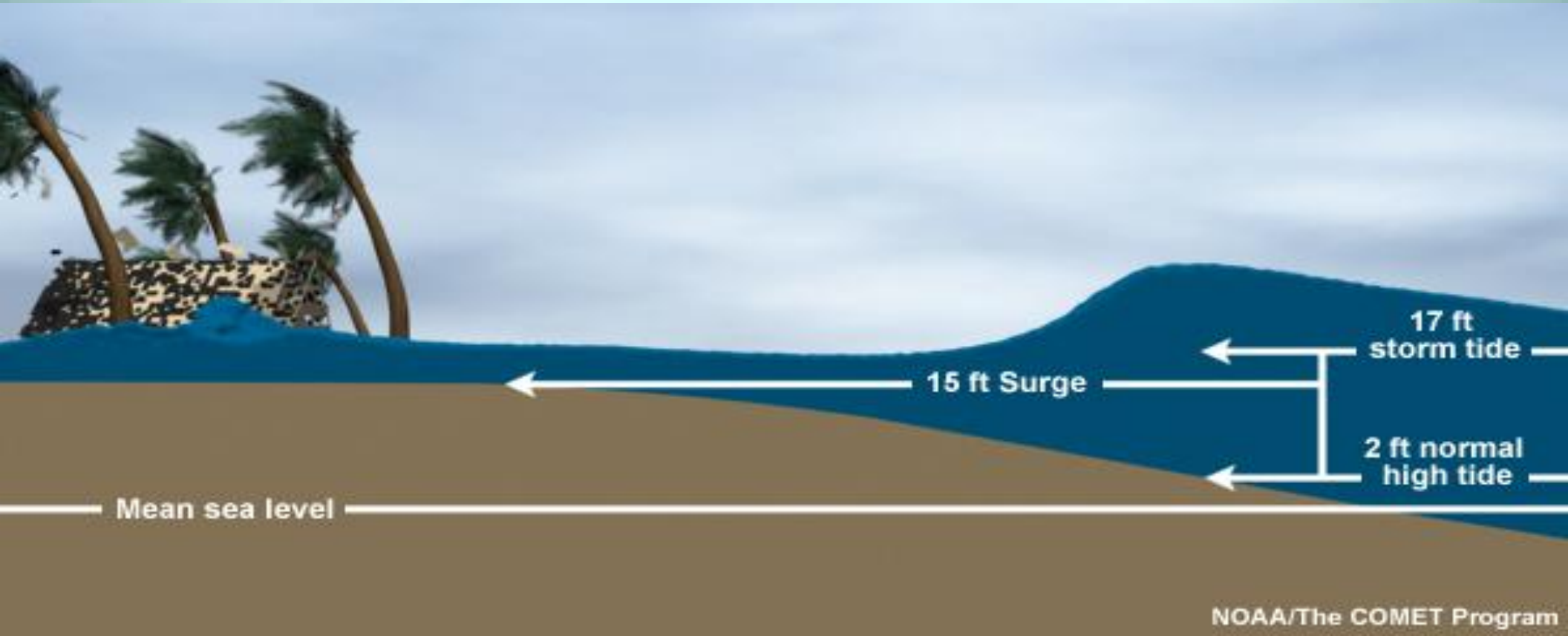
Lowest
(0.2 m, 0.7 ft)
*** Historical trend continued; no additional thermal expansion from warming**

Recommend using a "Scenario" Based Approach

What about storm tides and storm surges?

So what is storm surge?

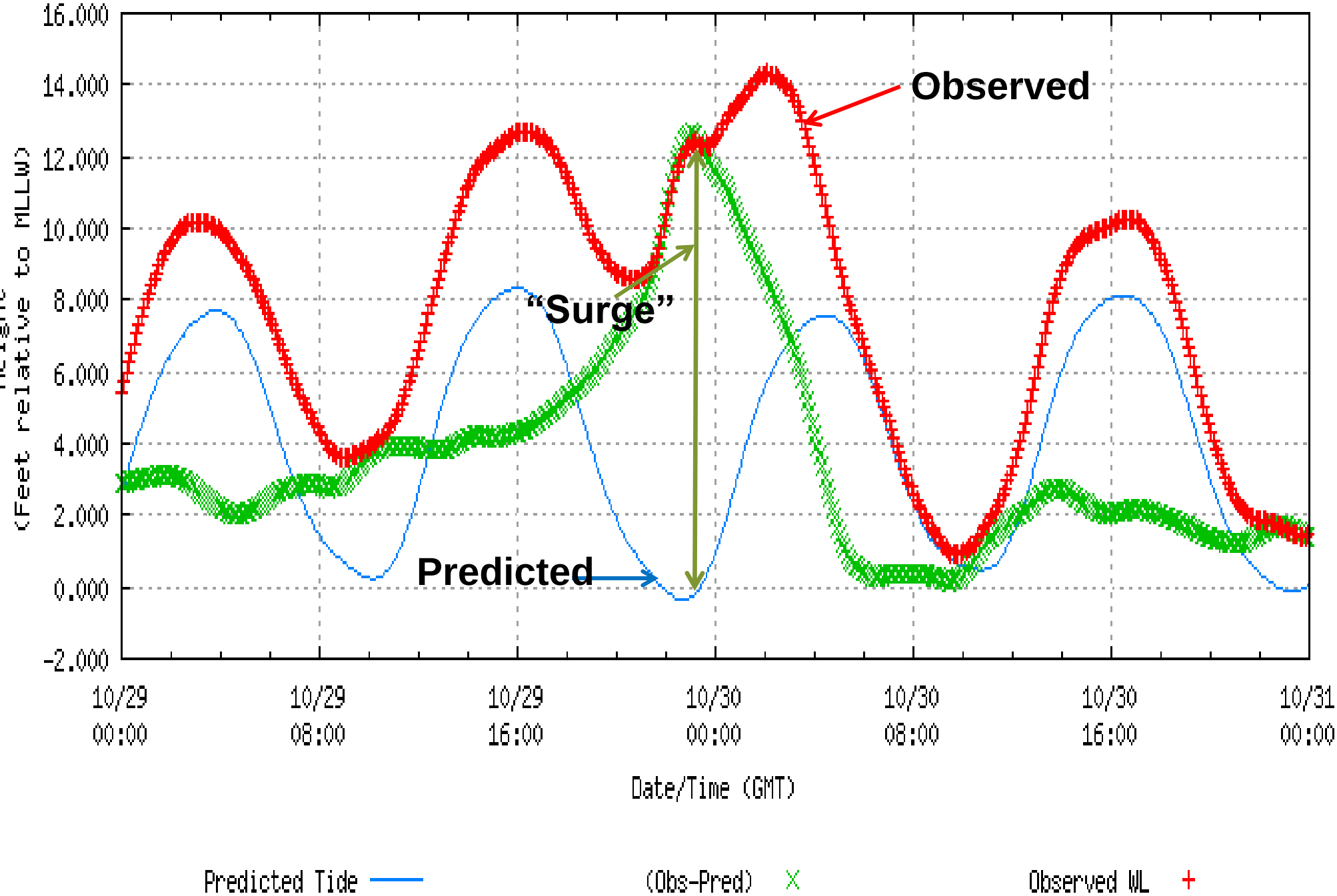
Storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tides. Storm surge should not be confused with storm tide, which is defined as the water level rise due to the combination of storm surge and the astronomical tide (National Hurricane Center)



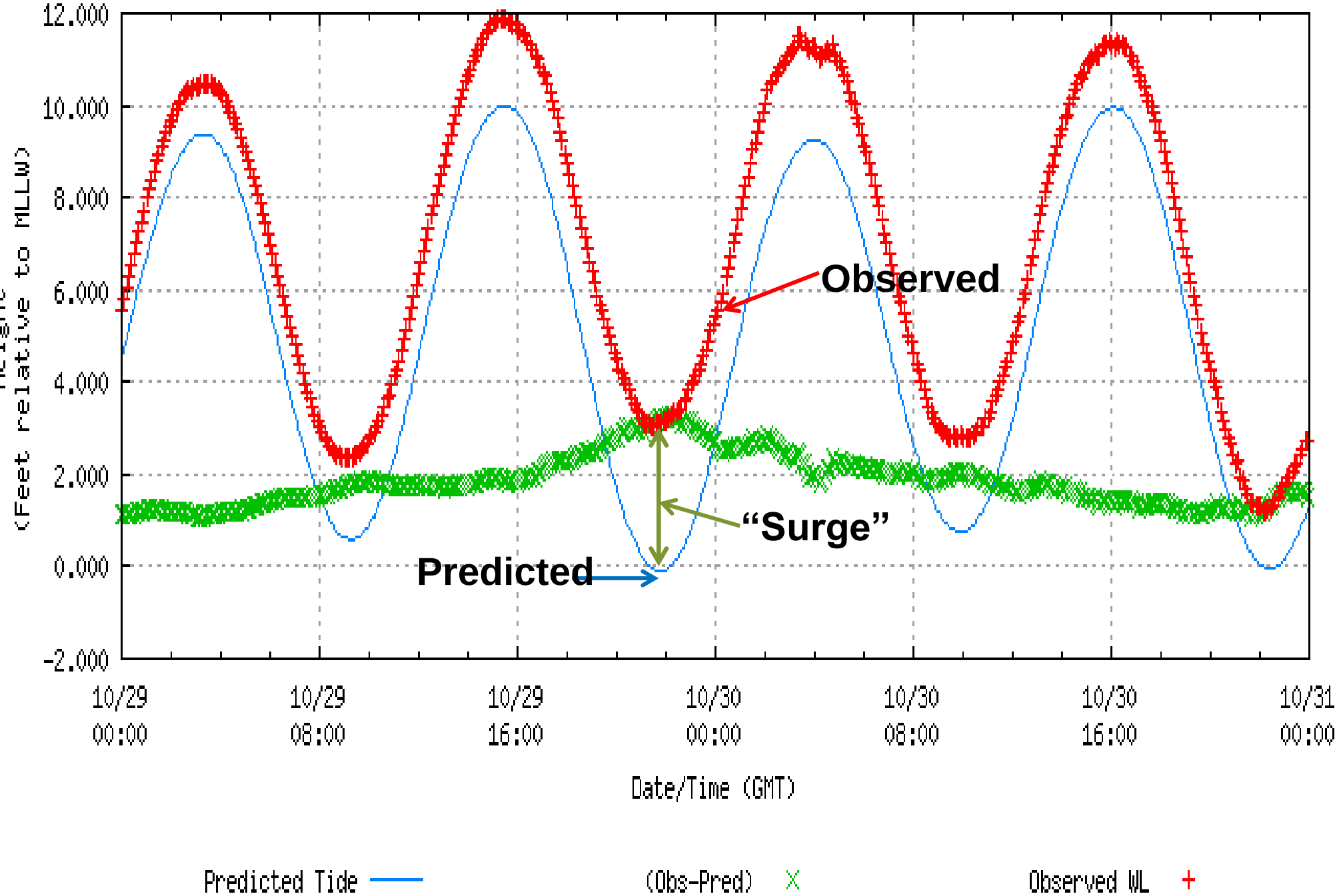
Storm Surge
"Superstorm Sandy"

NOAA/NOS/CO-OPS
Verified Water Level vs. Predicted Plot
8516945 Kings Point, NY
from 2012/10/29 - 2012/10/30

Kings Point, NY
10/29-10/30/2012



Storm Surge
"Superstorm Sandy"



Because of Maine's tidal variation, it's *the combination of astronomical tide and "storm surge" that are of concern* (NHC calls this overall water level the **"storm tide"**)

Portland Storm Surges, 1912-2012 (coinciding with mean high water or greater)

Interval (yrs)	Surge at MHW (ft)
1 (100 %)	1.1
5 (20%)	2
10 (10 %)	2.4
25 (4 %)	2.9
50 (2 %)	3.3
100 (1 %)	3.7

Portland Storm Surges, 1912-2012 (coinciding with mean high water or greater)

Interval (yrs)	Surge at MHW (ft)
1 (100 %)	1.1
5 (20%)	2
10 (10 %)	2.4
25 (4 %)	2.9
50 (2 %)	3.3
100 (1 %)	3.7

Correspond well with 1, 2, 3.3 foot SLR scenarios

Portland "Storm Tides", 1912-2012

Interval (yrs)	"Storm Tide" Level (ft, MLLW)
1 (100 %)	11.7
5 (20%)	12.6
10 (10 %)	12.9
25 (4 %)	13.4
50 (2 %)	13.7
100 (1 %)	14.1

Portland "Storm Tides", 1912-2012

Interval (yrs)	"Storm Tide" Level (ft, MLLW)
1 (100 %)	11.7
5 (20%)	12.6
10 (10 %)	12.9
25 (4 %)	13.4
50 (2 %)	13.7
100 (1 %)	14.1

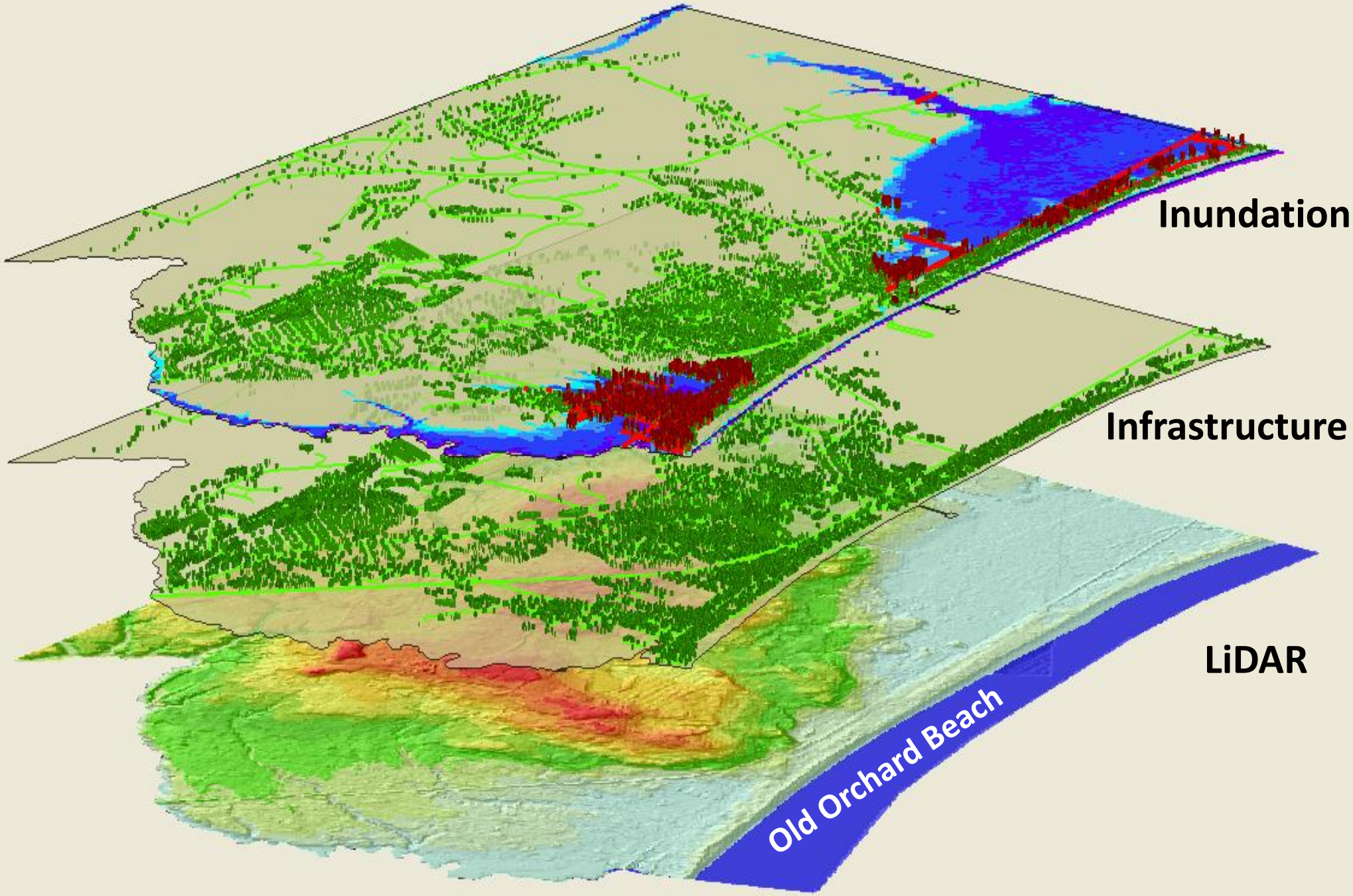
1 foot difference!

Sea Level and Storm Surge Summaries

- Latest scientific predictions for SLR: 1 ft 2050, 2-3 ft *but potentially more* by 2100; the **State of Maine has adopted 2 feet as a middle of the road prediction by the year 2100 for areas with regulated Coastal Sand Dunes**.
- There is only about a <u>one foot difference</u> between the "10 year" event and the "100 year" event ; thus, **a one-foot rise in sea level by 2050 would cause the "100 year" event to come about every 10 years because sea level rise significantly lowers the recurrence interval of storms.**
- For vulnerability and adaptation planning, we recommend using a **"Scenario Based Approach" using 1 foot, 2 feet, 3.3 feet, and 6 feet on top of the highest annual tide (HAT). These scenarios also correspond well with evaluating *potential impacts from storm surges that may coincide with higher tides today.***

So how have we used this data to complete a “Vulnerability Assessment” to sea level rise and storms?

Focus: GIS-based visualizations



Data and tools critical to communicating coastal vulnerability

The first effort: SLAWG Assessment

Sea Level Rise
And Potential Impacts by the Year 2100

A Vulnerability Assessment
for the Saco Bay Communities of
Biddeford, Saco, Old Orchard Beach, and Scarborough

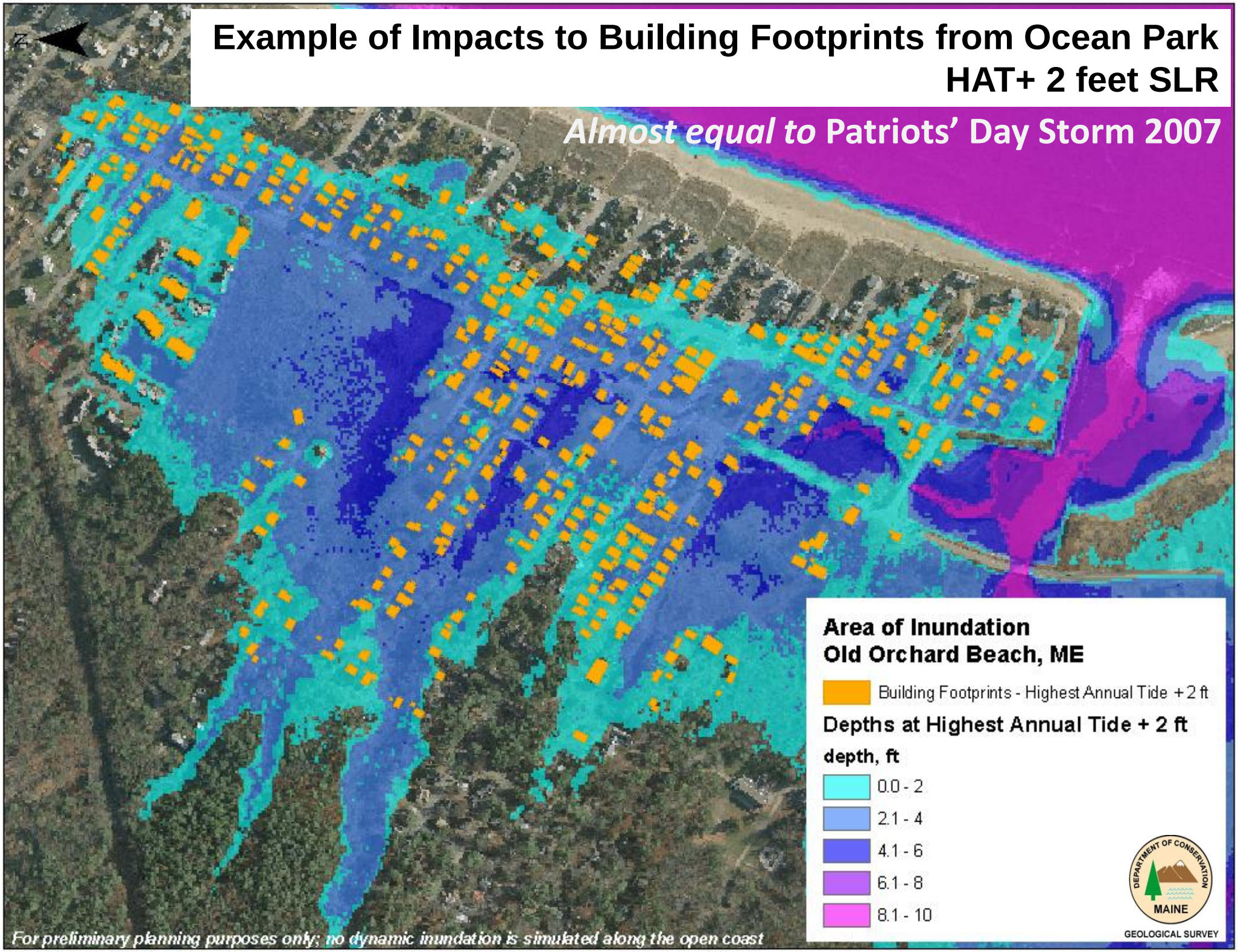
A Report of the Sea Level Adaptation Working Group
Original Report December 31, 2010
Revised May 4, 2011
With the Assistance of the
Maine Department of Conservation – Maine Geological Survey
and the
Southern Maine Regional Planning Commission
With Funding from the Maine State Planning Office & Maine Coastal Program
NOAA Grant Number NA09NOS4190081
and the Participating Partner Communities

Vulnerability Assessment of the built and natural environments to <u>2 feet of SLR</u> (agreed upon by the Group) on top of the Highest Annual Tide (HAT) and the historic 1% ("100-year") storm event (February 7, 1978 storm) for each community in Saco Bay.

Identified potentially <u>vulnerable buildings</u>, transportation infrastructure, and wetland migration areas.

Example of Impacts to Building Footprints from Ocean Park
HAT+ 2 feet SLR

Almost equal to Patriots' Day Storm 2007



For preliminary planning purposes only; no dynamic inundation is simulated along the open coast

Potential Building Footprint/Assessed Value Impacts from SLAWG 2010-11 Vulnerability Assessment

Building Footprint Impacts	HAT+2 ft SLR		1978Storm + 2 ft SLR	
	#	Value	#	Value
Scarborough	611	$34,275,100	1,119	$92,089,600
Old Orchard Beach	537	$71,878,400	877	$129,308,500
Saco	41	$4,277,400	201	$24,798,400
Biddeford	32	$5,109,800	209	$46,911,900
Saco Bay Total	**1221**	**$115,540,700**	**2406**	**$293,108,400**

Assessed building value only

Assumes complete loss of building value if building footprint intersected inundation

Does not include dynamic impacts (erosion, accretion, or wave runup)

Sea Level Adaptation Page - Mozilla Firefox

File

For More information from the 2010-11 Vulnerability Assessment

www.smrpc.org/Sea Level Adaptation/Sea Level Adaptation Working Group Page.htm

Background Reports:

- Presentation of JT Lockman & Peter Slovinsky at the Maine Beaches Conference - July 15, 2011
- SWIPA - "Snow, Water, Ice and Permafrost in the Arctic - May, 2011
- CoreLogic - "2011 Storm Surge Report"
- Presentation of J.T. Lockman & Peter Slovinsky at the American Planning Association National Planning Conference - April 11, 2011
- Vulnerability Assessment - Maps & Tables - May 4 Addition - Revised Appendix A
- Vulnerability Assessment - Text - May 4 Edition
- Cover Letter to Councils - Year End - December 30, 2010
- Creating a Process for Reviewing Developments of Regional Impact (DRIs) in Maine
- Ideal Group Size
- Little River/Jones Creek Flood Abatement Analysis - OOB - November 20, 2007 - Prepared by: Milone & MacBroom, Inc.
- Saco Bay Regional Beach Management Plan - Produced by the Saco Bay Planning Committee and staffed by SMRPC - February 2000
- Town Planners Take to the Sky

Action Plan for Slawg:

- May 6, 2011 Version

Biddeford Public Access Television Show:

- "The Wandering Road" with Pete Slovinsky & J.T. Lockman - April 14,2010

Note: You will need to wait about 10 seconds after you press the PLAY button

SPO Webinar:

start | Microsoft Ex... | 5 Microsoft... | 3 Microsoft ... | K:\Users\Slo... | 2 Adobe Re... | Sea Level Ad...

SLAWG Successes:

- First regional "Vulnerability Assessment" in Maine
- Legitimized process through community involvement
- Blazed the path for regional work with a municipal partnership approach
- Created a model of transferability
- Developed focused Implementation Strategies…or the "low hanging fruit" being implemented
  - Used highly-accurate LiDAR data to much more accurately set the regulatory Shoreland Zoning Boundaries (first communities in Maine – Old Orchard Beach and Saco)
  - Added sea level rise into existing Floodplain Management ordinances; 1 foot to 3 feet freeboard (first in Maine – Saco)

What have we done since? Updating the Vulnerability Assessment using a "Scenario Based" Approach

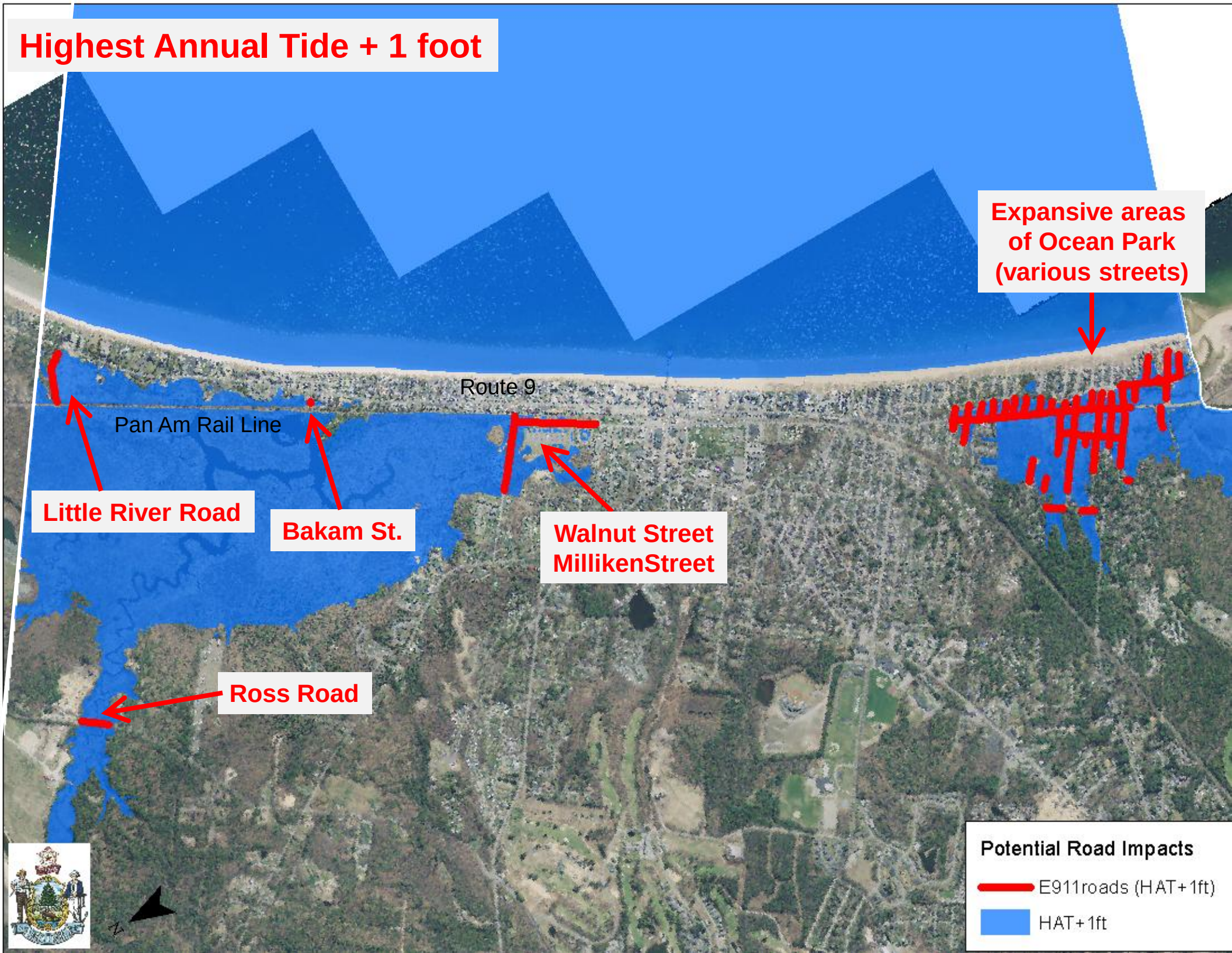
Scenario	Highest Annual	1% storm
Existing	11.5	14.1
0.3 m (1 foot) SLR	12.5	15.1
0.6 m (2 feet) SLR	13.5	16.1
1.0 m (3.3 feet) SLR	14.8	17.4
1.8 m (6.0 feet) SLR	17.5	20.1

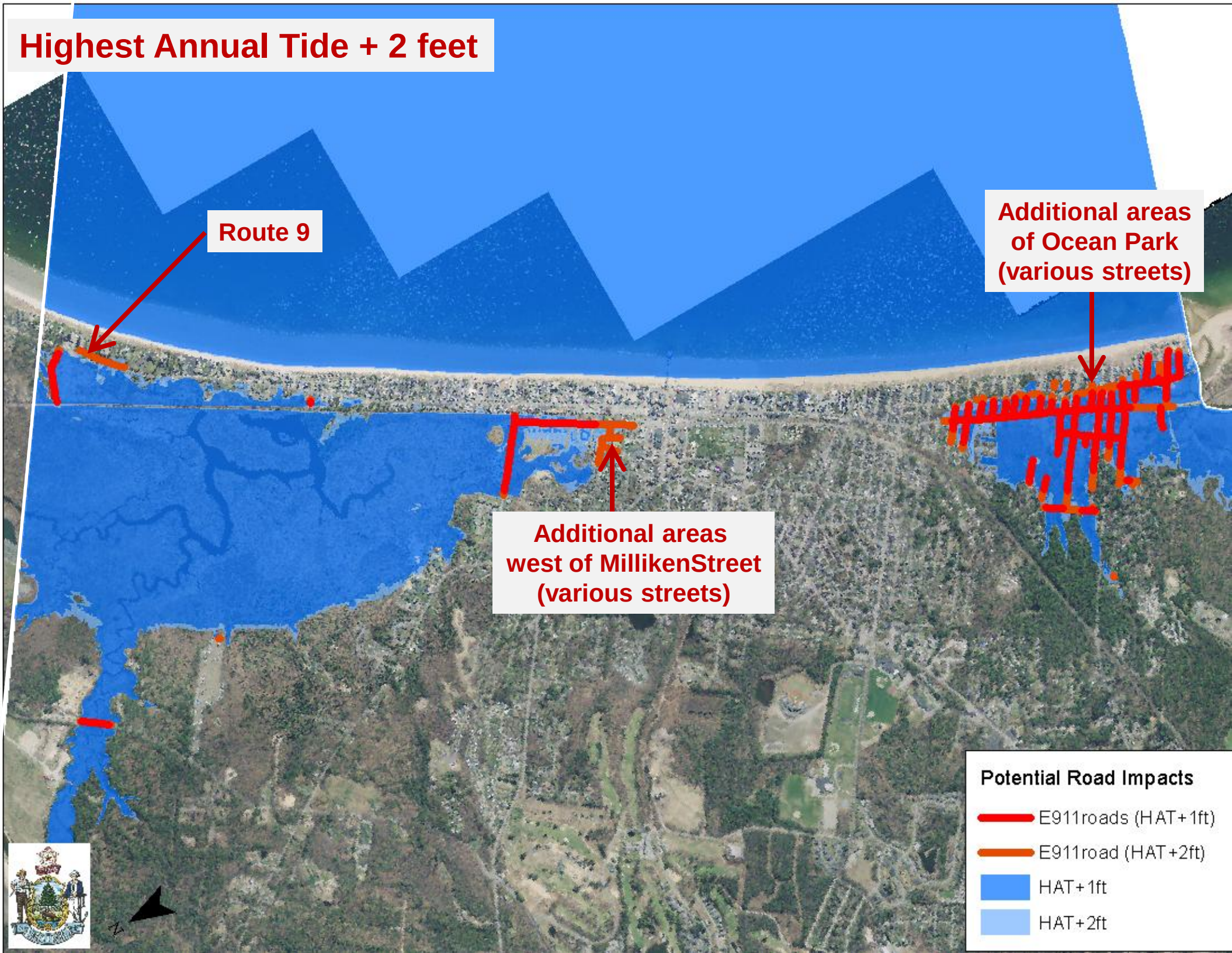
** data in feet, MLLW, mean lower low water*

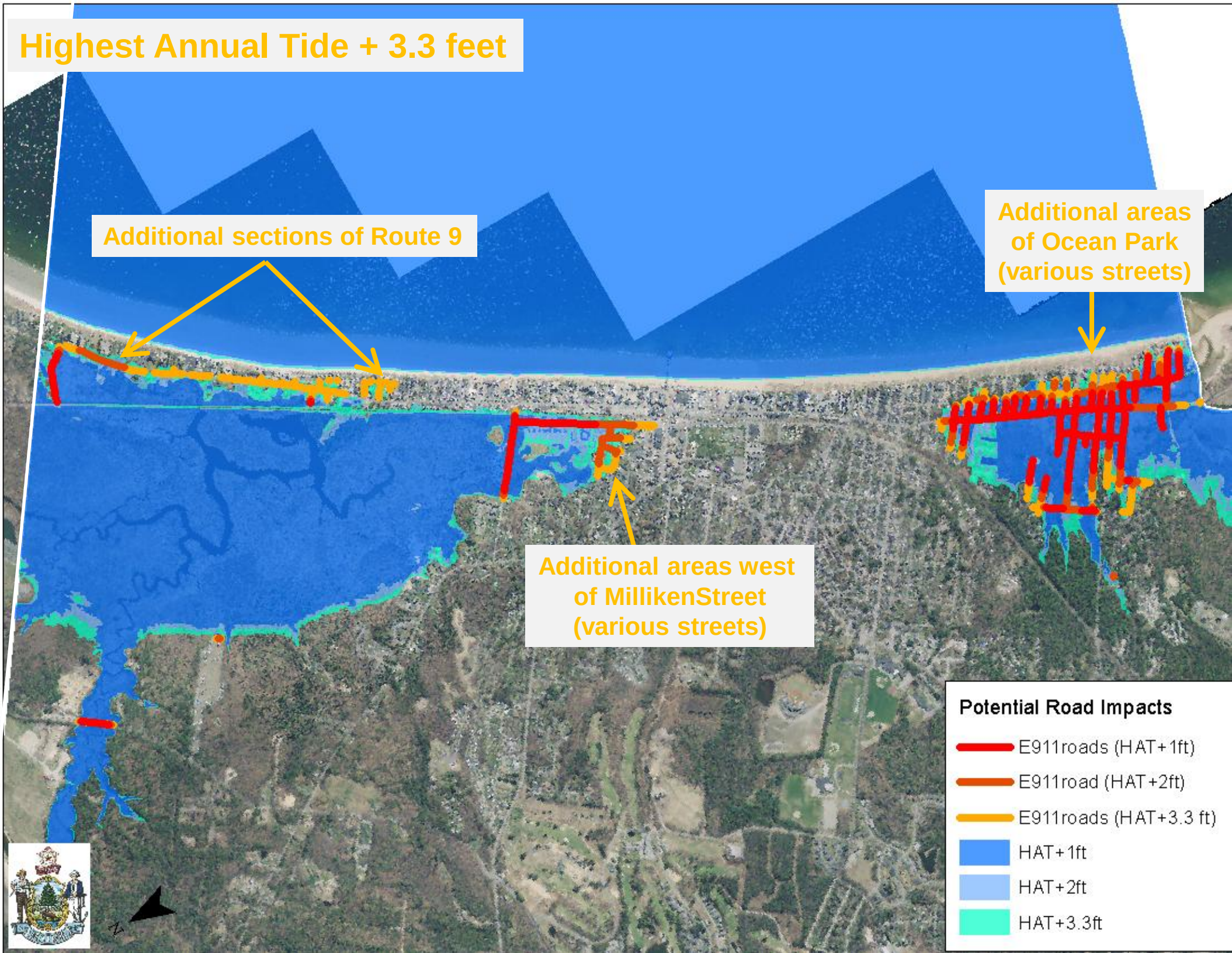
*** data converted from NAVD88-MLLW using NOAA VDATUM tool*

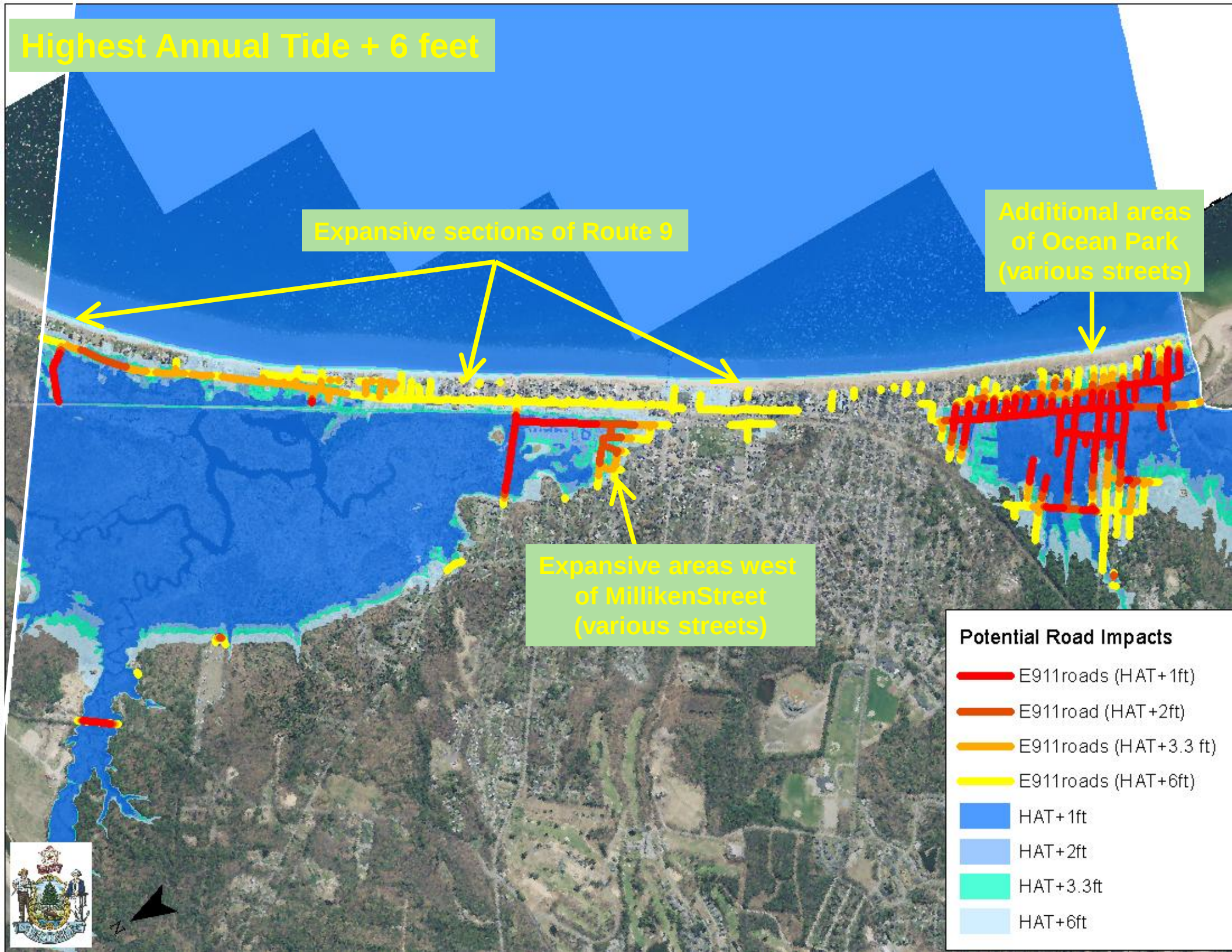
Image courtesy of Bill Edwards

Potential Impacts to Transportation Infrastructure


Highest Annual Tide + 1 foot
Expansive areas of Ocean Park (various streets)
Route 9
Pan Am Rail Line
Little River Road
Bakam St.
Walnut Street
MillikenStreet
Ross Road
Potential Road Impacts
E911roads (HAT+1ft)
HAT+1ft


Highest Annual Tide + 2 feet
Route 9
Additional areas of Ocean Park (various streets)
Additional areas west of MillikenStreet (various streets)
Potential Road Impacts
E911roads (HAT+1ft)
E911road (HAT+2ft)
HAT+1ft
HAT+2ft


Highest Annual Tide + 3.3 feet
Additional sections of Route 9
Additional areas of Ocean Park (various streets)
Additional areas west of MillikenStreet (various streets)
Potential Road Impacts
E911roads (HAT+1ft)
E911road (HAT+2ft)
E911roads (HAT+3.3 ft)
HAT+1ft
HAT+2ft
HAT+3.3ft

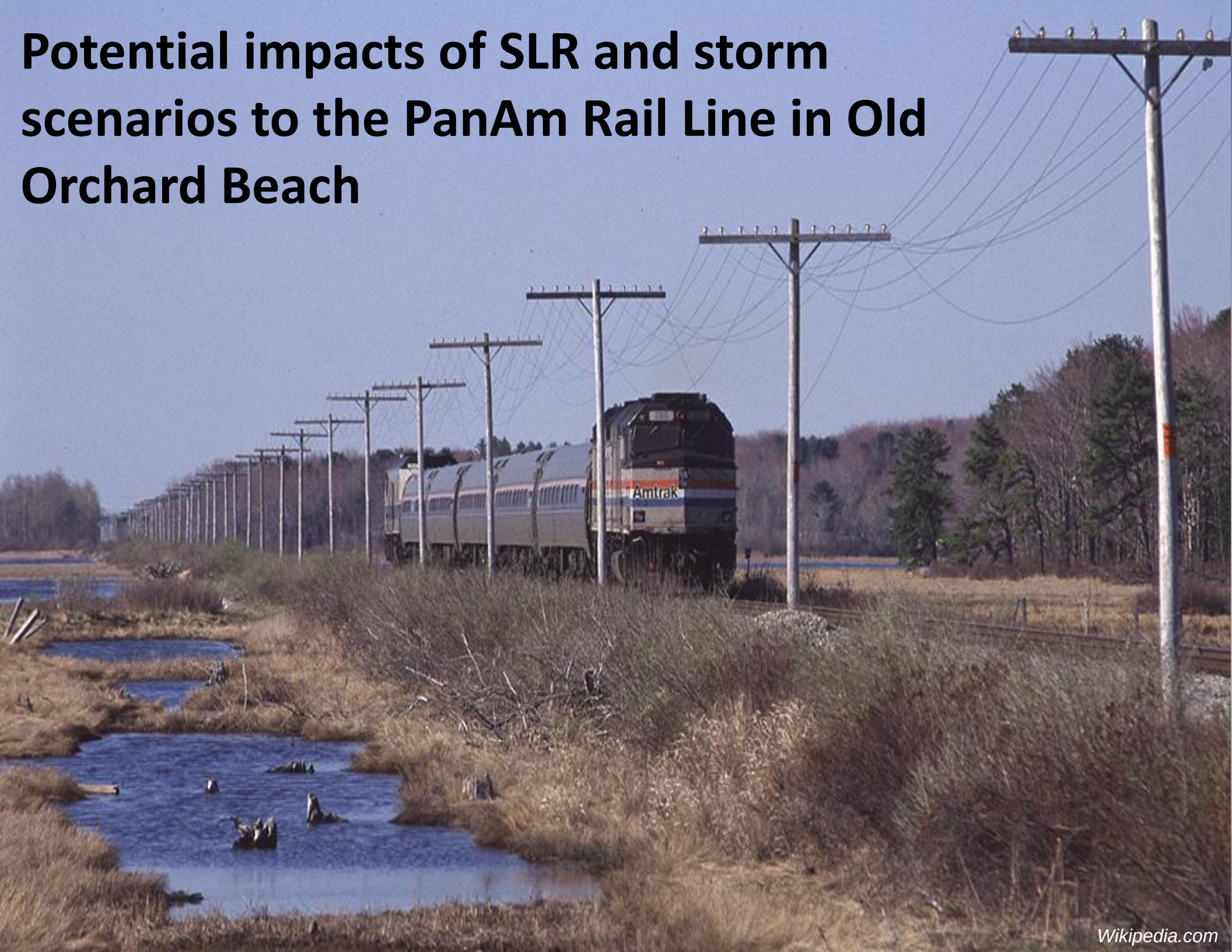

Highest Annual Tide + 6 feet
Expansive sections of Route 9
Additional areas of Ocean Park (various streets)
Expansive areas west of MillikenStreet (various streets)
Potential Road Impacts
E911roads (HAT+1ft)
E911road (HAT+2ft)
E911roads (HAT+3.3 ft)
E911roads (HAT+6ft)
HAT+1ft
HAT+2ft
HAT+3.3ft
HAT+6ft

Summary Table – Potential Impacts to Road Infrastructure

Scenario (HAT)	Infrastructure (miles)	
	Roads (66.8)	% impacted
0.3 m (1 foot) SLR	3.3	4.9%
0.6 m (2 feet) SLR	4.8	7.2%
1.0 m (3.3 feet) SLR	6.9	10.3%
1.8 m (6.0 feet) SLR	11.2	16.8%

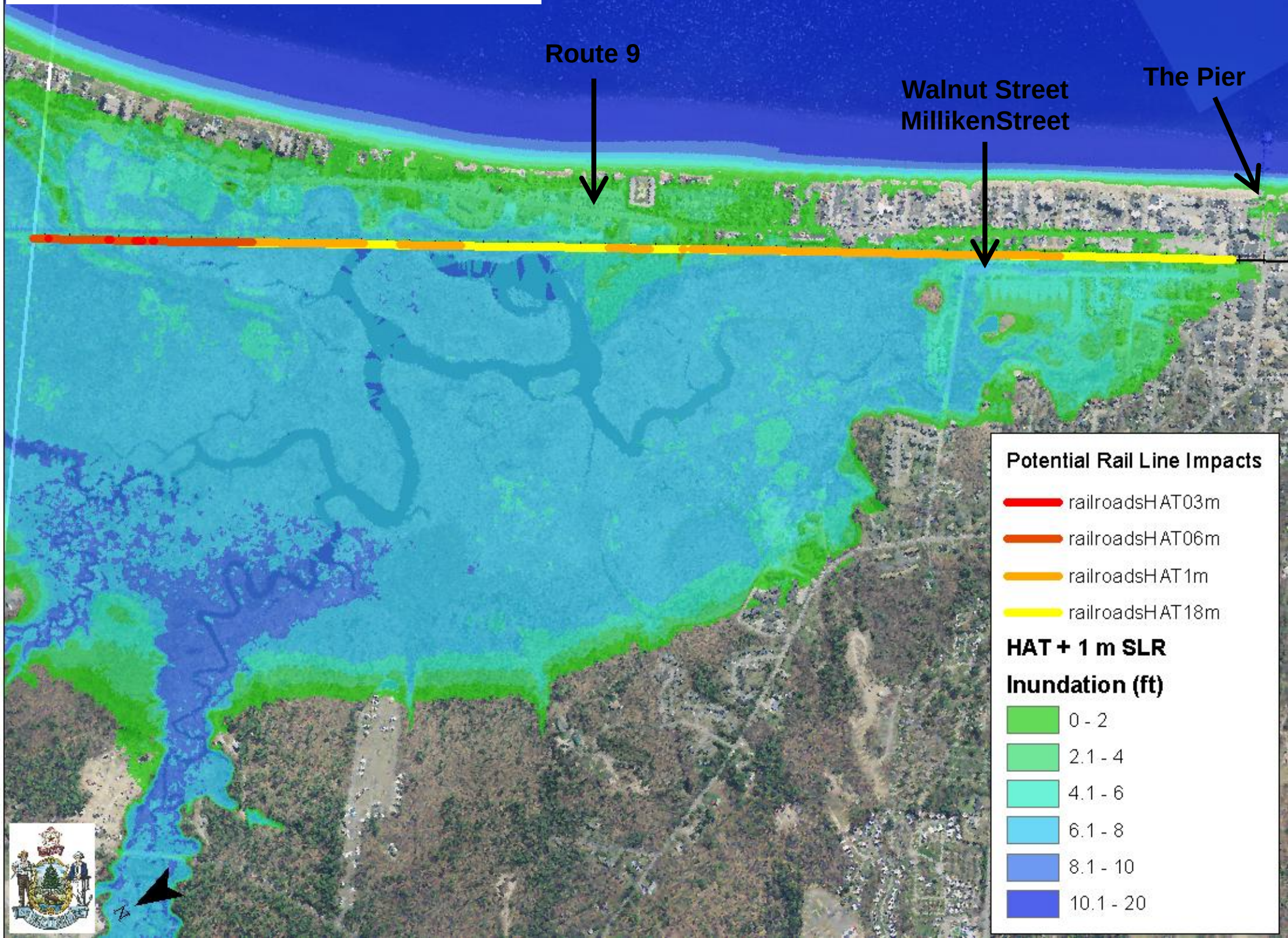
Take home point: Some of Old Orchard Beach's major transportation routes including designated evacuation routes are vulnerable under *1-2 ft scenarios* of SLR or storm surge on top of the highest tide.

Potential impacts of SLR and storm scenarios to the PanAm Rail Line in Old Orchard Beach

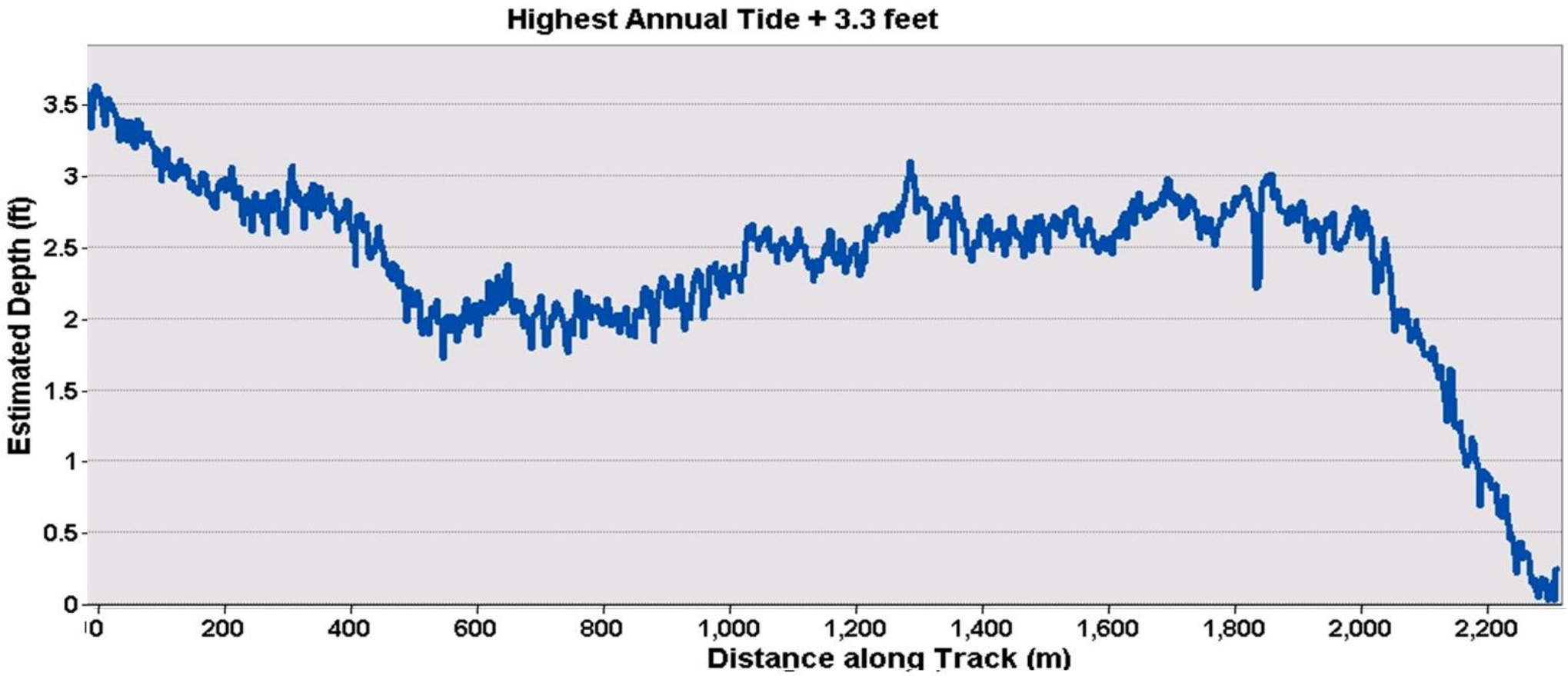


Wikipedia.com

Examining Inundation Depths



Examining Inundation Depths (Highest Tide + 3.3 feet)



Summary Table – Potential Impacts to Rail Infrastructure

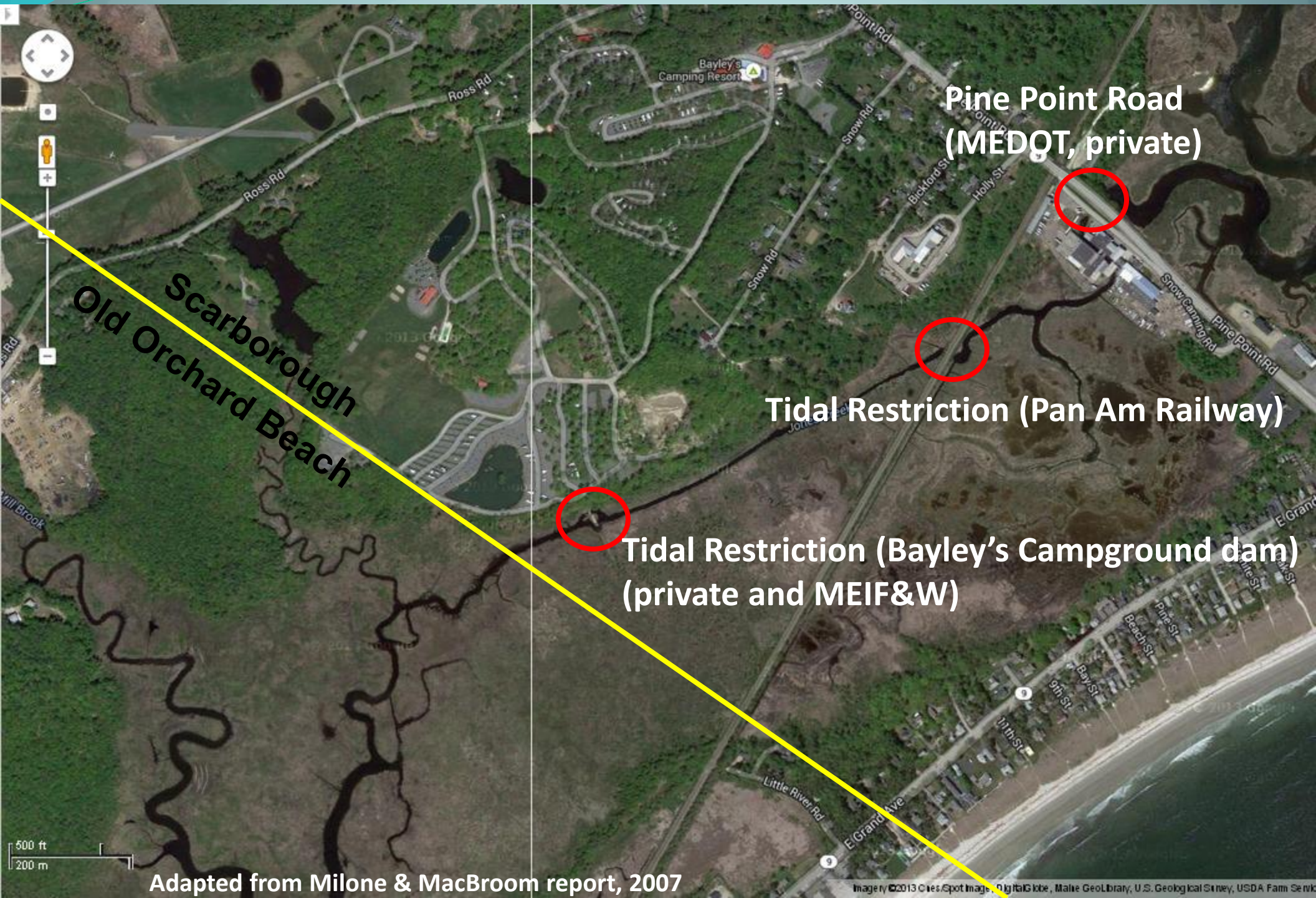
Scenario (HAT)	Infrastructure (miles)	
	Rails (10.5)	% impacted
Existing Conditions	0.0	0%
0.3 m (1 foot) SLR	0.0	0%
0.6 m (2 feet) SLR	0.3	6%
1.0 m (3.3 feet) SLR	1.1	22%
1.8 m (6.0 feet) SLR	1.7	35%

Take home point: The rail line will likely start to see significant potential impacts under 1 meter rise or surge at the time of highest tides in OOB.

So what are we doing now?

- Using “scenario based approach” Vulnerability Assessment results in conjunction with an infrastructure criticality matrix to **pinpoint critical transportation impacts** in each community
- Engaging with **community DPWs** to get a better handle on viable adaptation strategies for identified critical roads
- Working to start the conversation on how to address **identified regional issues** between Towns and private and state parties (i.e., Scarborough and Old Orchard from the 2007 Milone & MacBroom Report)

A Regional Approach to Tidal Restrictions?



Adapted from Milone & MacBroom report, 2007

Some suggestions for Moving Forward

- Impacts from existing storms and **SLR will be felt most at the local level**, regardless of what happens at the State or Federal government levels. Preparation needs to start with the **"ground zero" of potential impacts, <u>the municipalities</u>**

- **Establish a sound scientific groundwork for moving forward**; *arguing about "climate change" has no bearing on adaptation strategies to create more resilient communities*.

- Use a **"Scenario Based Approach"** to build on the concept of "no regrets actions" and **cover a range of scientific predictions and manageable planning horizons**

Some suggestions for Moving Forward

- Consider **working with neighboring communities** to pool resources, create parallel regulations, and leverage funding for capital improvements
- Consider all adaptation actions, but **bring planning time horizons and goals down to realistic levels**…you don't have to tackle it all at once!
- Shoot for the **"low hanging fruit"** in terms of planning or ordinance changes – something that has a definitive benefit in terms of creating resiliency for the "**storms of today and potential tides of tomorrow**"

Town of Old Orchard Beach:
A summary of sea level rise science, storm surge, and some highlighted results from SLAWG work efforts

Peter A. Slovinsky, Marine Geologist
Maine Geological Survey
Department of Agriculture, Conservation, and Forestry
peter.a.slovinsky@maine.gov