Preparing Portland for the Potential Impacts of Sea Level Rise

Peter Slovinsky, Marine Geologist
Maine Geological Survey, Department of Conservation

Presented to:
Transportation, Sustainability and Energy Committee

Project Partners:

GEOLOGICAL SURVEY

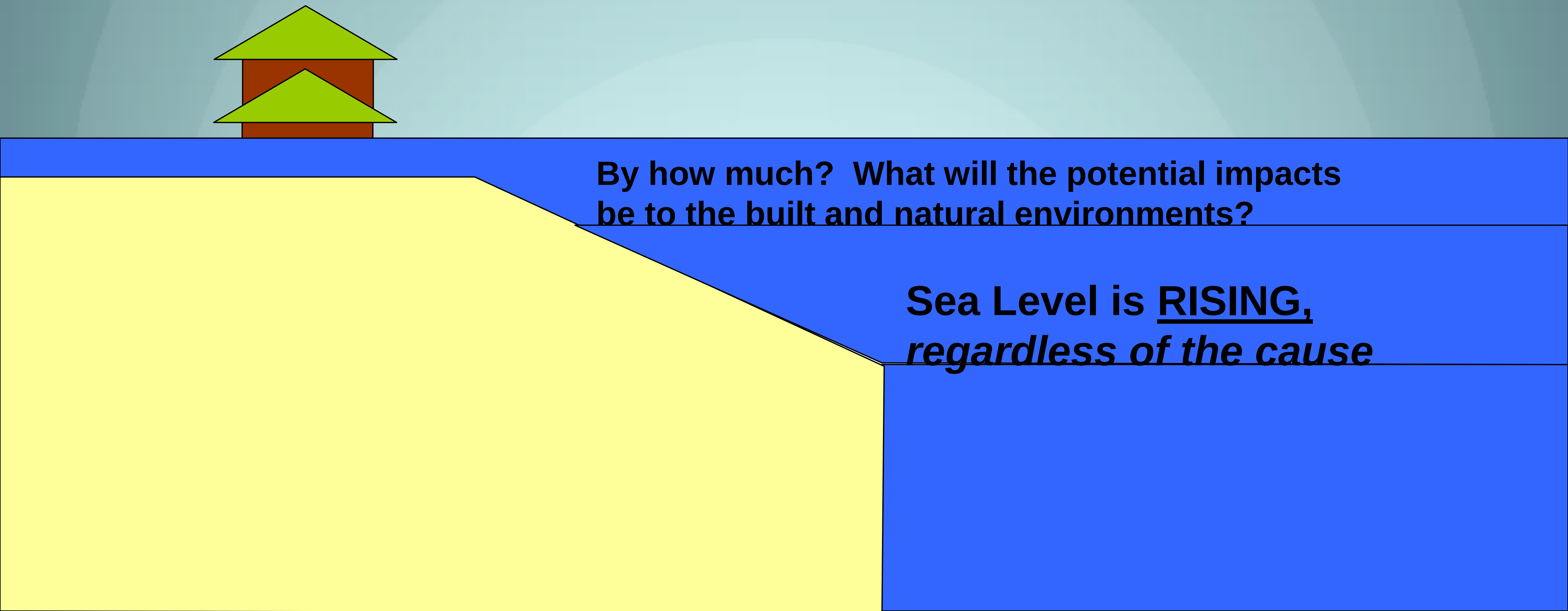
February 15, 2011

Project Funding from:

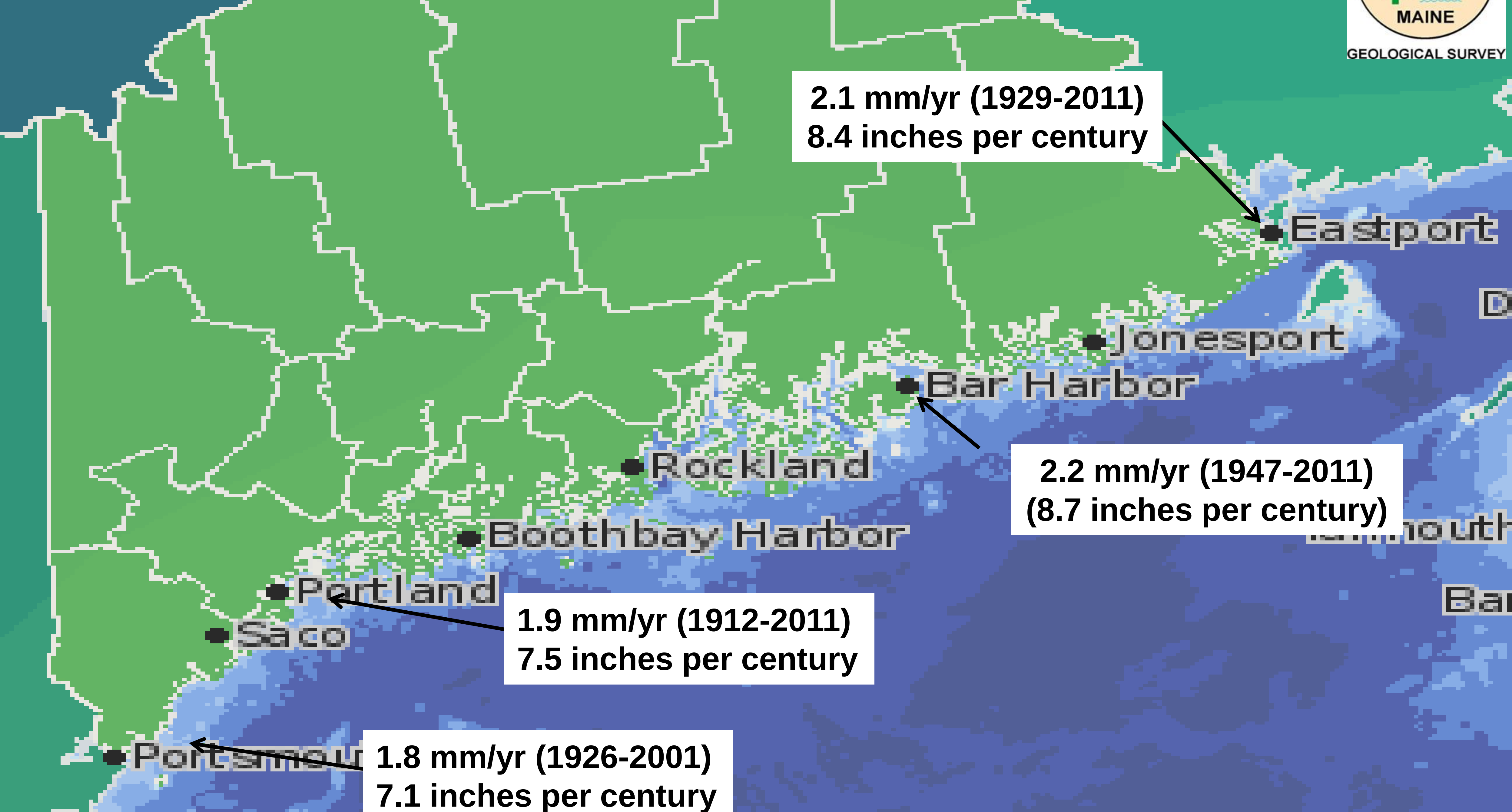
Maine Coastal Program

Framing the Problem

How will local communities respond?



Documented Sea Level Rise



Data courtesy of NOAA CO-OPS

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Sea Level, Portland, Maine

1912-2011 (through November 30, 2011)

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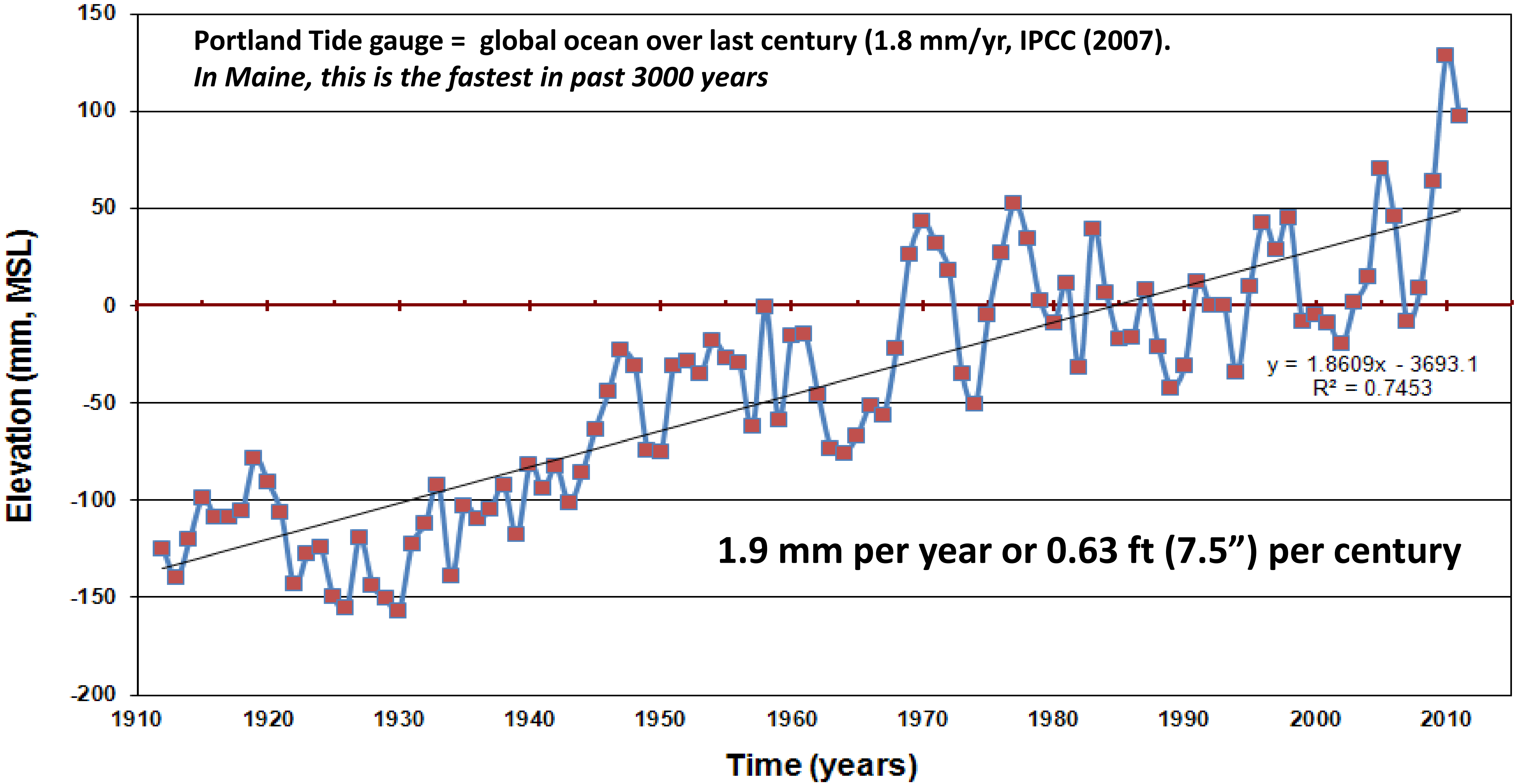
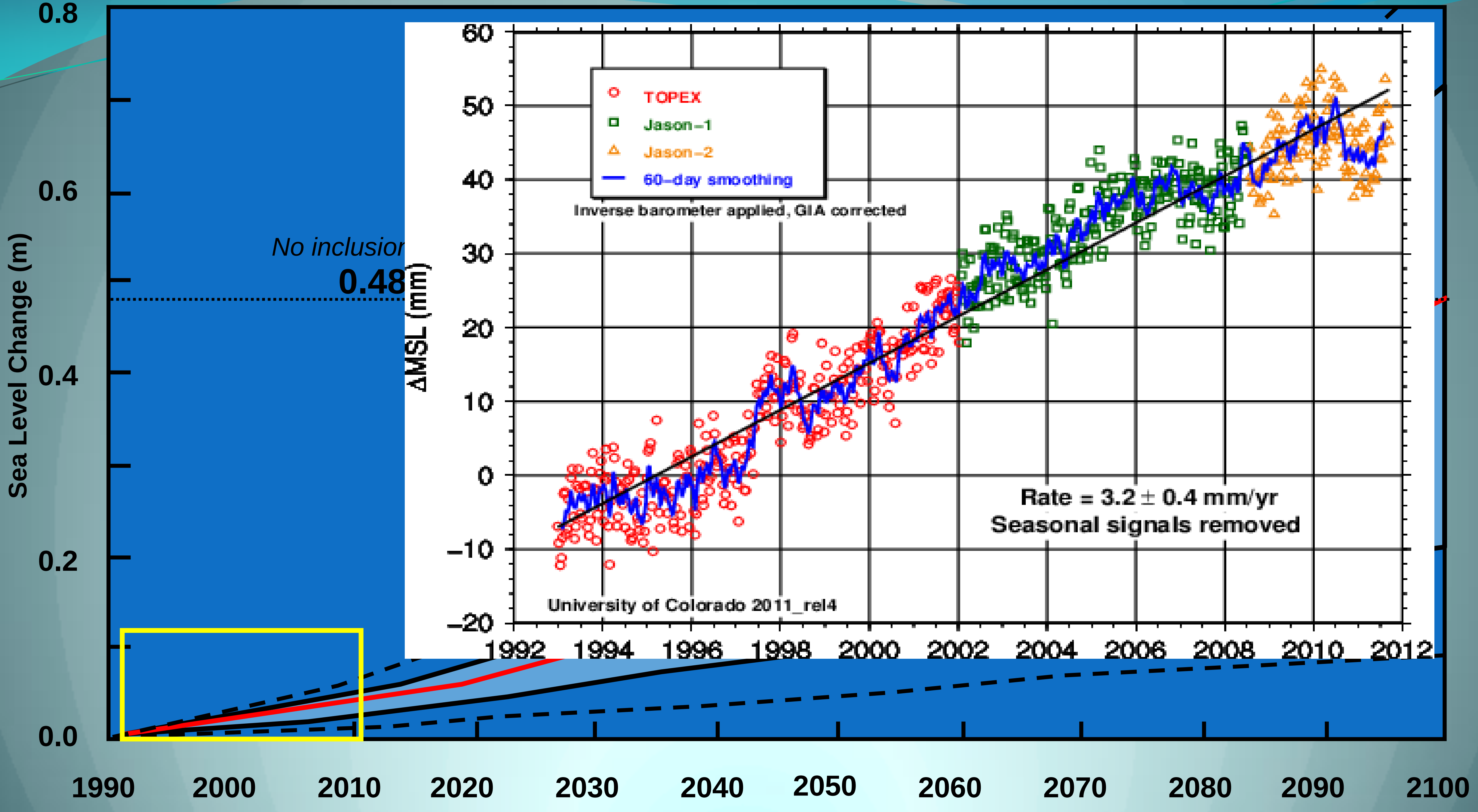
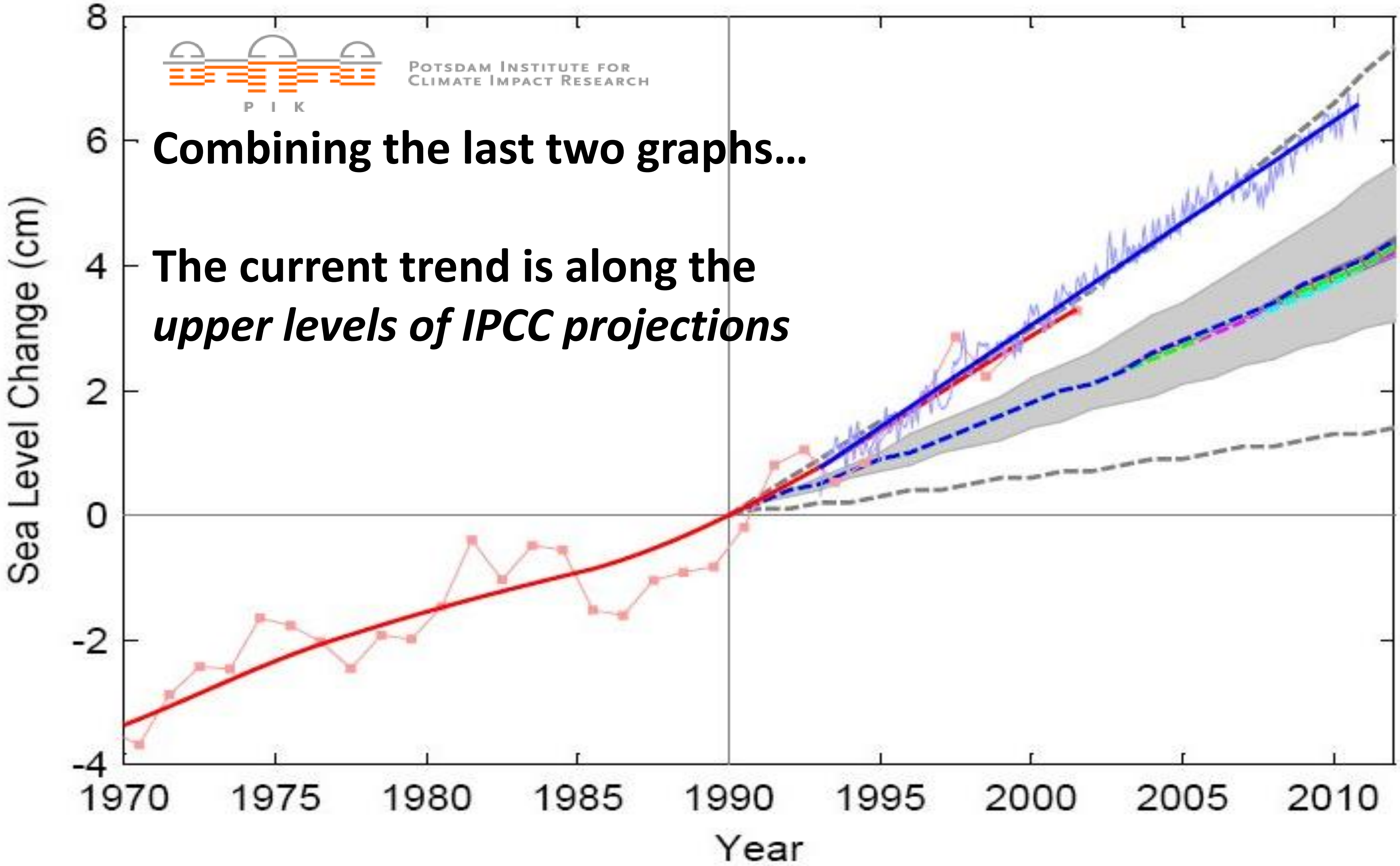


Data courtesy of NOAA CO-OPS, www.tidesandcurrents.noaa.gov

P.A. Slovinsky, Maine Geological Survey, January 3, 2012

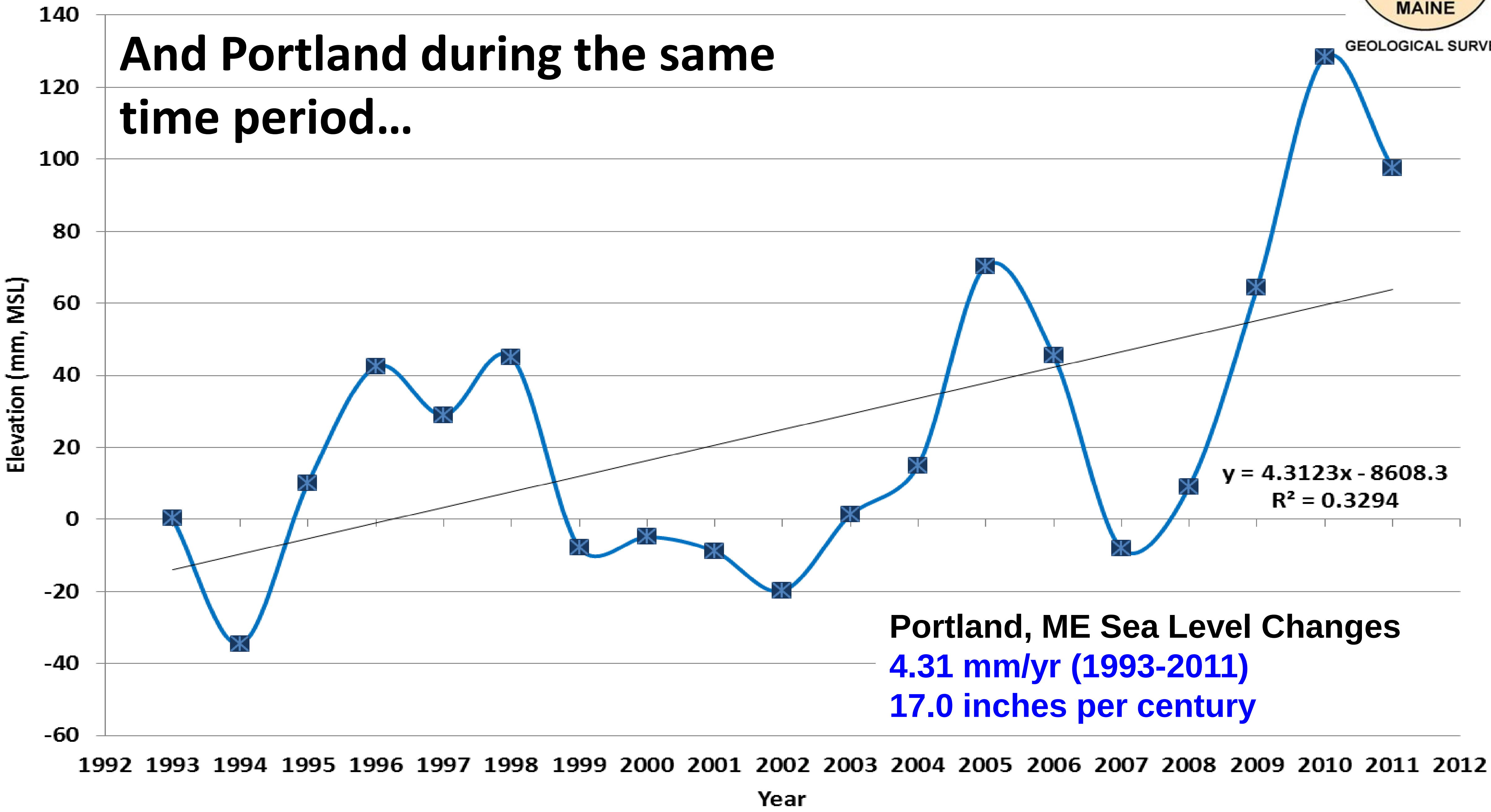


Adapted from the IPCC 3rd Assessment (Tech. Summary of Working Group I Report, Fig. 24, p. 74., 2001)


POTSDAM INSTITUTE FOR
CLIMATE IMPACT RESEARCH
P I K
Combining the last two graphs...
The current trend is along the
upper levels of IPCC projections
Sea Level Change (cm)
8
6
4
2
0
-2
-4
1970
1975
1980
1985
1990
1995
2000
2005
2010
Year

Sea Level, Portland, Maine
1993-2011 (through November 30, 2011)

And Portland during the same time period…



Portland, ME Sea Level Changes
4.31 mm/yr (1993-2011)
17.0 inches per century

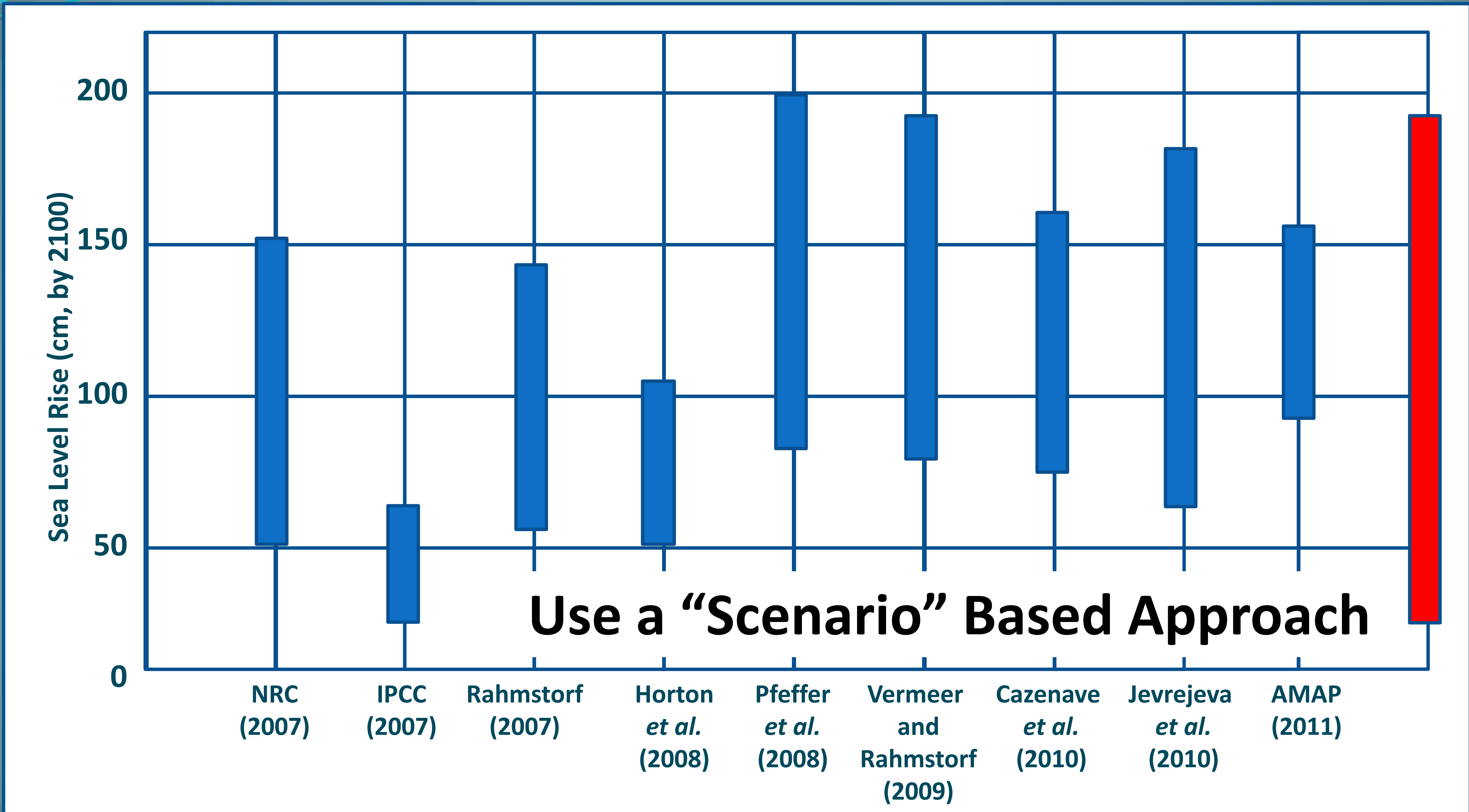
…if current [Antarctic and Greenland] ice sheet melting rates continue for the next four decades, their cumulative loss could raise sea level by 15 centimeters (5.9 inches) by 2050. When this is added to the predicted sea level contribution of 8 centimeters (3.1 inches) from glacial ice caps and 9 centimeters (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 (AGU, in press)

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

Image from www.swisseduc.ch

For a Range of Scenarios…



Adapted from Rahmstorf (2010); and Williams (2012)

Sea Level Rise Planning in Maine…

United States Environmental Protection Agency | Policy, Planning, And Evaluation (2122) | EPA-230-R-95-900 September 1995

EPA

Anticipatory Planning For Sea-Level Rise Along The Coast of Maine

This report a joint effort in cooperation with State of Maine's State Planning Office.

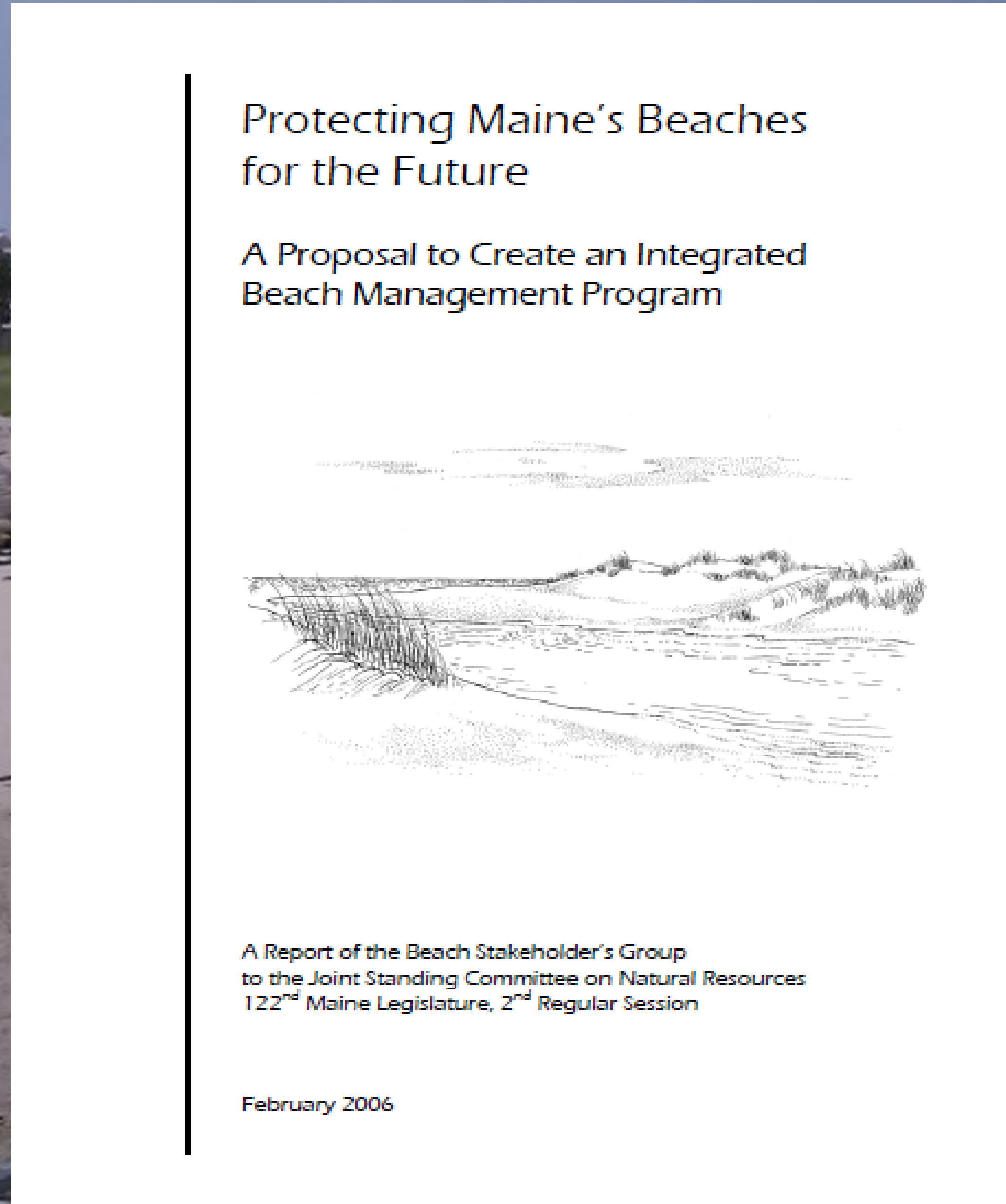
On the right track… in 1995!

But it was never <u>brought to the local level</u>

So it was LOST in the archives.

More reports…and updated sea level regulations

2006 - As the result of a 2 year stakeholder process, Maine adopted <u>2 feet of sea level rise over the next 100 years</u>, which was a “middle-of-the road” prediction for global sea level rise, into its NRPA.


Protecting Maine's Beaches for the Future

A Proposal to Create an Integrated Beach Management Program

A Report of the Beach Stakeholder's Group
to the Joint Standing Committee on Natural Resources
122nd Maine Legislature, 2nd Regular Session

February 2006

P.A. Slovinsky, MGS

PEOPLE AND NATURE
ADAPTING TO A CHANGING CLIMATE

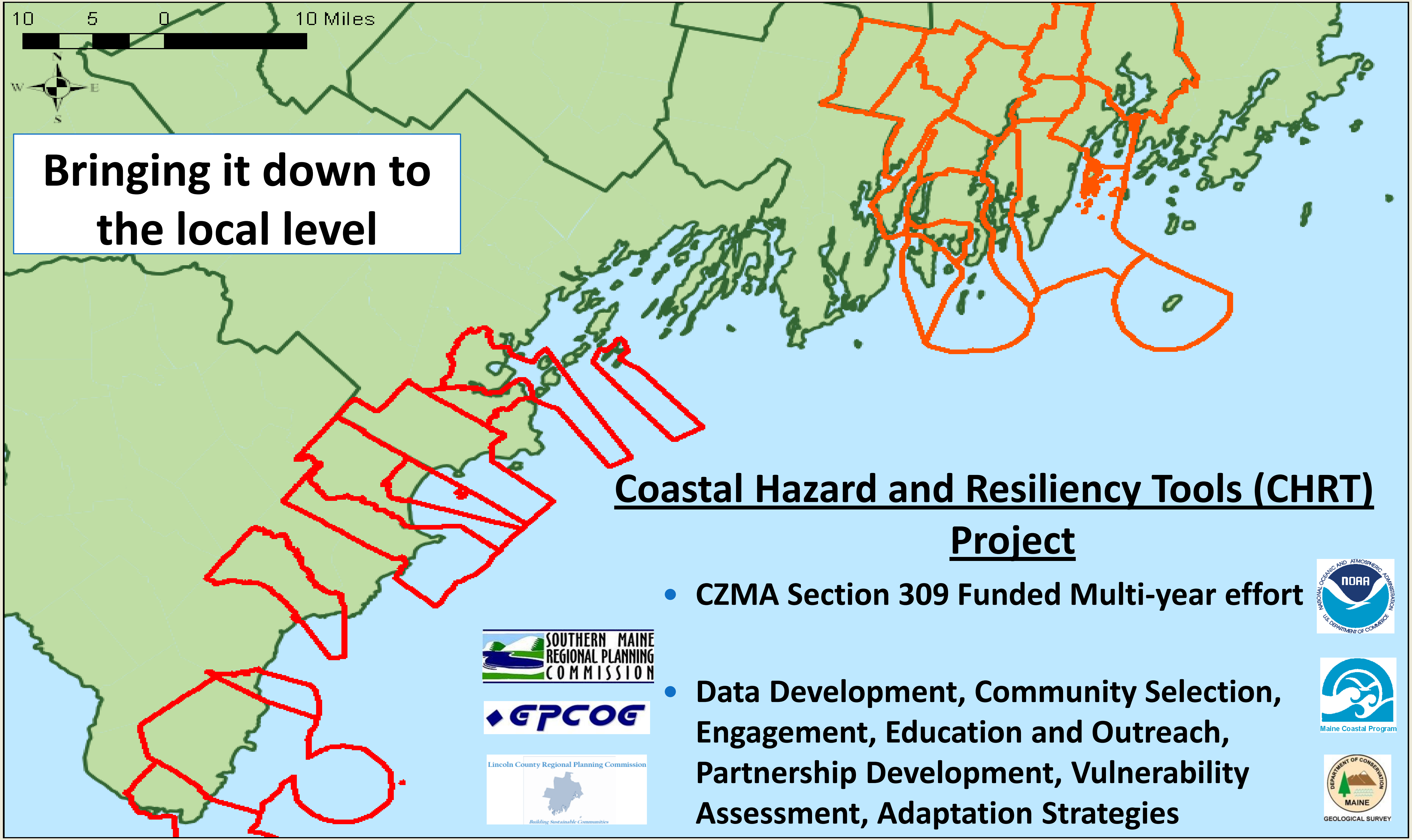
Even More recently…

<u>Working Groups:</u>

Built Environment
Coastal Environment
Natural Environment
Social Environment

- Year-long Stakeholder Process led to the production of a report in early 2010.
- Major recommendations related to ***bringing tools, models, and technical data to the local decision-making level relating to sea level rise planning.***

Resolves, Chapter 16, LD 460, "Resolve, To Evaluate Climate Change Adaptation Options for the State"



Bringing it down to the local level

Coastal Hazard and Resiliency Tools (CHRT) Project

- **CZMA Section 309 Funded Multi-year effort**
- **Data Development, Community Selection, Engagement, Education and Outreach, Partnership Development, Vulnerability Assessment, Adaptation Strategies**

SOUTHERN MAINE REGIONAL PLANNING COMMISSION

GPCOG

Lincoln County Regional Planning Commission

Maine Coastal Program

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Sea Level Adaptation Working Group

Developing a Regional Approach

Local Participation:

- Scarborough, Maine — Incorporated 1658
- Old Orchard Beach — Organized 1883
- City of Saco, Me. 1867 — Domine Dirige Nos
- City of Biddeford, Maine

Planning, Science, Technical Support:

- Southern Maine Regional Planning Commission
- Department of Conservation, Maine — Geological Survey

Additional Support Funding:

- Maine Coastal Program

Bringing the Issue to Portland

Local Participation

Regional Participation
Planning Support

Regional Participation
Economic Planning Support

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State Science/Technical Support

State Funding Support

Vulnerability Assessment

- Sea level rise scenarios (by 2100, or a "phased" approach):
  - **0.3 meters (1 foot)**
  - **0.6 meters (2 feet)**
  - **1.0 meters (3.28 feet)**
  - **1.8 meters (5.95 feet)**

"Scenario-based" Approach

- Scenarios **assume static topography** ('bathtub model').
- Scenarios **do not include** the effects of **freshwater runoff from rain events or waves.**
- The **Highest Annual Tide (HAT)** and the **1978 storm** stillwater elevation were used as a basis for simulating impacts to infrastructure.
- For assessing impacts to buildings, it was assumed that the **entire building was impacted** if inundation intersected the building footprint.
- For assessing impacts to roads, it was assumed that inundation of a road made it **impassable** but did not assume the road would be damaged.
- For assessing impacts to wetlands, tidal elevations were used as proxies for different marsh surfaces.

Using the Sea Level Rise Simulation Tool

<u>Steps</u>:

1) Groundtruth **LiDAR** data for representing ground conditions using RTK – GPS *(very accurate).*
2) Determine Tidal Elevations as proxies for existing marsh surfaces using nearby tide gauge data
3) Demonstrate accuracy in simulating **<u>existing conditions</u>** using **<u>tidal elevations</u>** to define marsh habitats and inundation
4) Simulate **<u>potential</u>** **<u>impacts of sea level</u>** rise on:
   a) Marsh Habitat
   b) Existing Buildings and Road Infrastructure
5) Identify areas potentially suitable for marsh migration and at-risk built infrastructure


Couldn't do it without LIDAR!
2006 LiDAR
Portland, ME
Elevation (ft, NAVD)
-21.6 - 0
0.1 - 10
10.1 - 20
20.1 - 30
30.1 - 40
40.1 - 50
50.1 - 60
60.1 - 70
70.1 - 80
80.1 - 180
0.5 0.25 0 0.5 Miles
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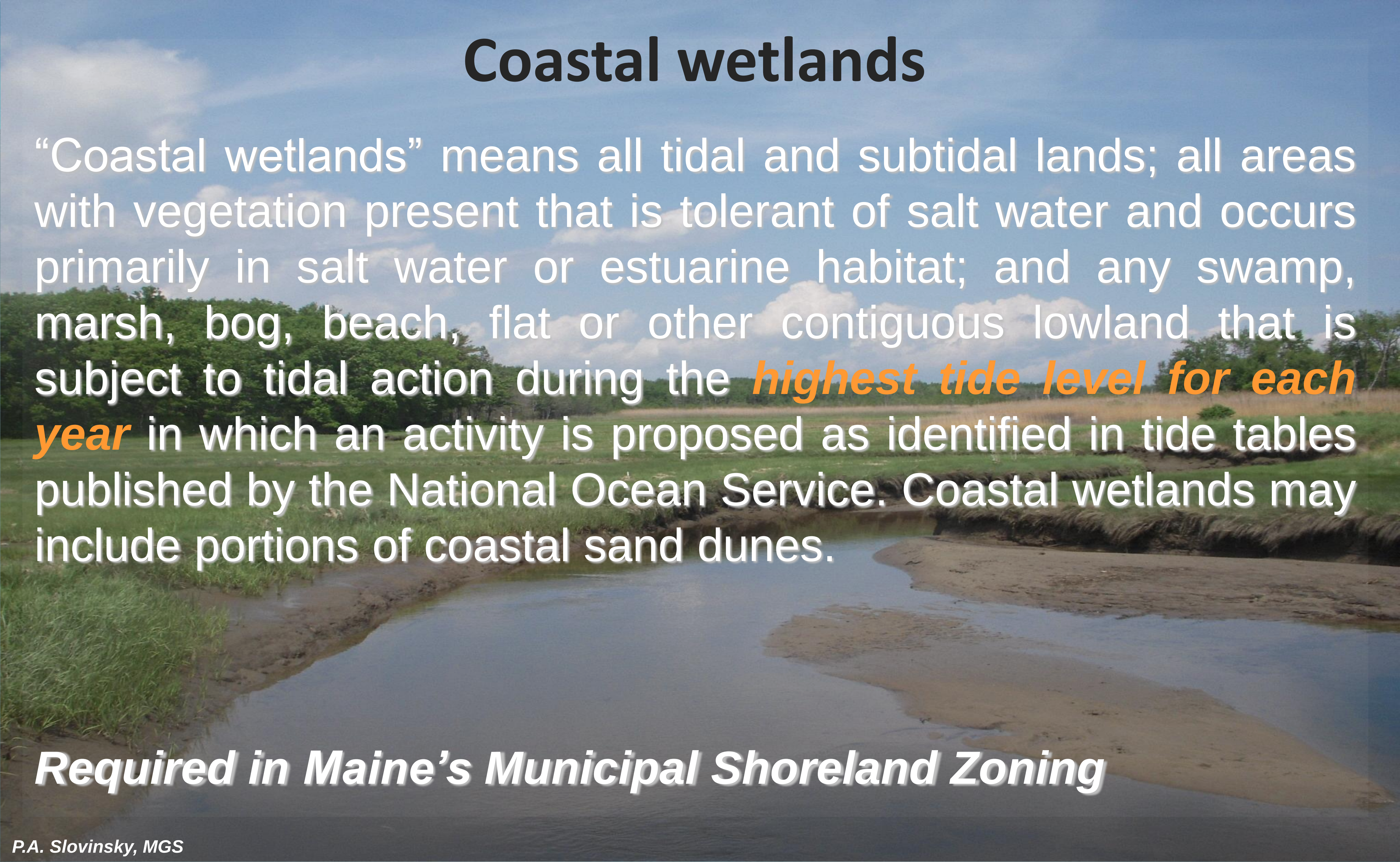
Coastal wetlands

"Coastal wetlands" means all tidal and subtidal lands; all areas with vegetation present that is tolerant of salt water and occurs primarily in salt water or estuarine habitat; and any swamp, marsh, bog, beach, flat or other contiguous lowland that is subject to tidal action during the ***highest tide level for each year*** in which an activity is proposed as identified in tide tables published by the National Ocean Service. Coastal wetlands may include portions of coastal sand dunes.

Required in Maine's Municipal Shoreland Zoning



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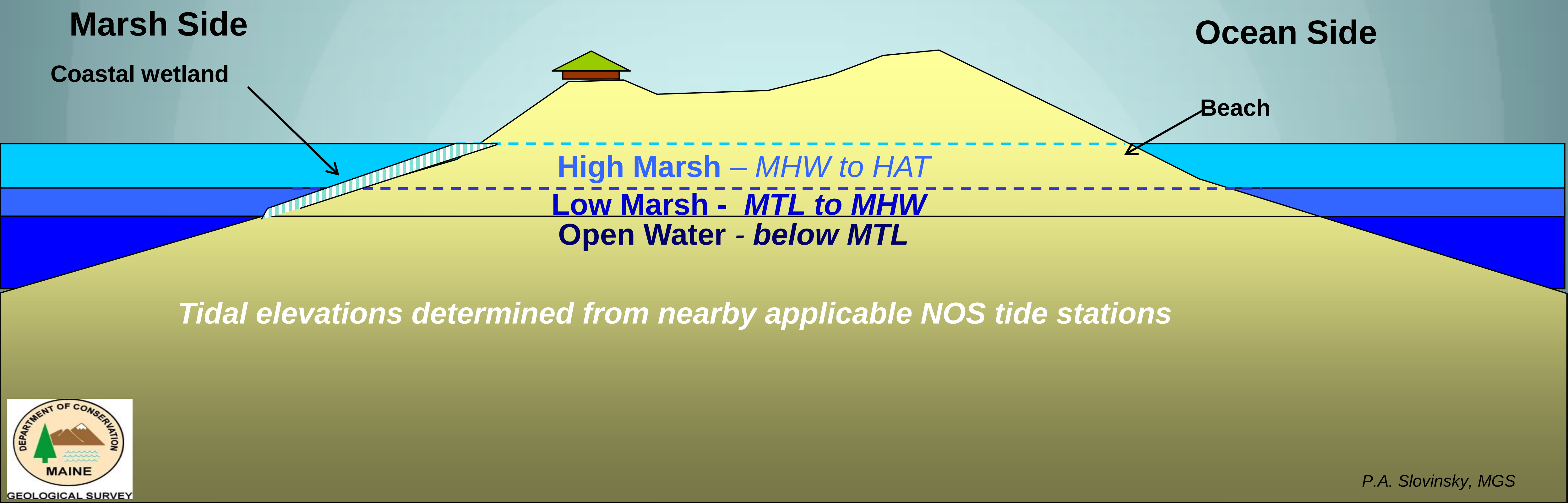
Setting the Stage with Tidal Elevations

Highest Annual Tide (HAT) - "spring" tide, the highest predicted water level for any given year but is reached within several inches numerous tides a year

Mean High Water (MHW) - the average normal high water level.

Mean Tide Level (MTL) = average height of the ocean's surface (between mean high and mean low tide).



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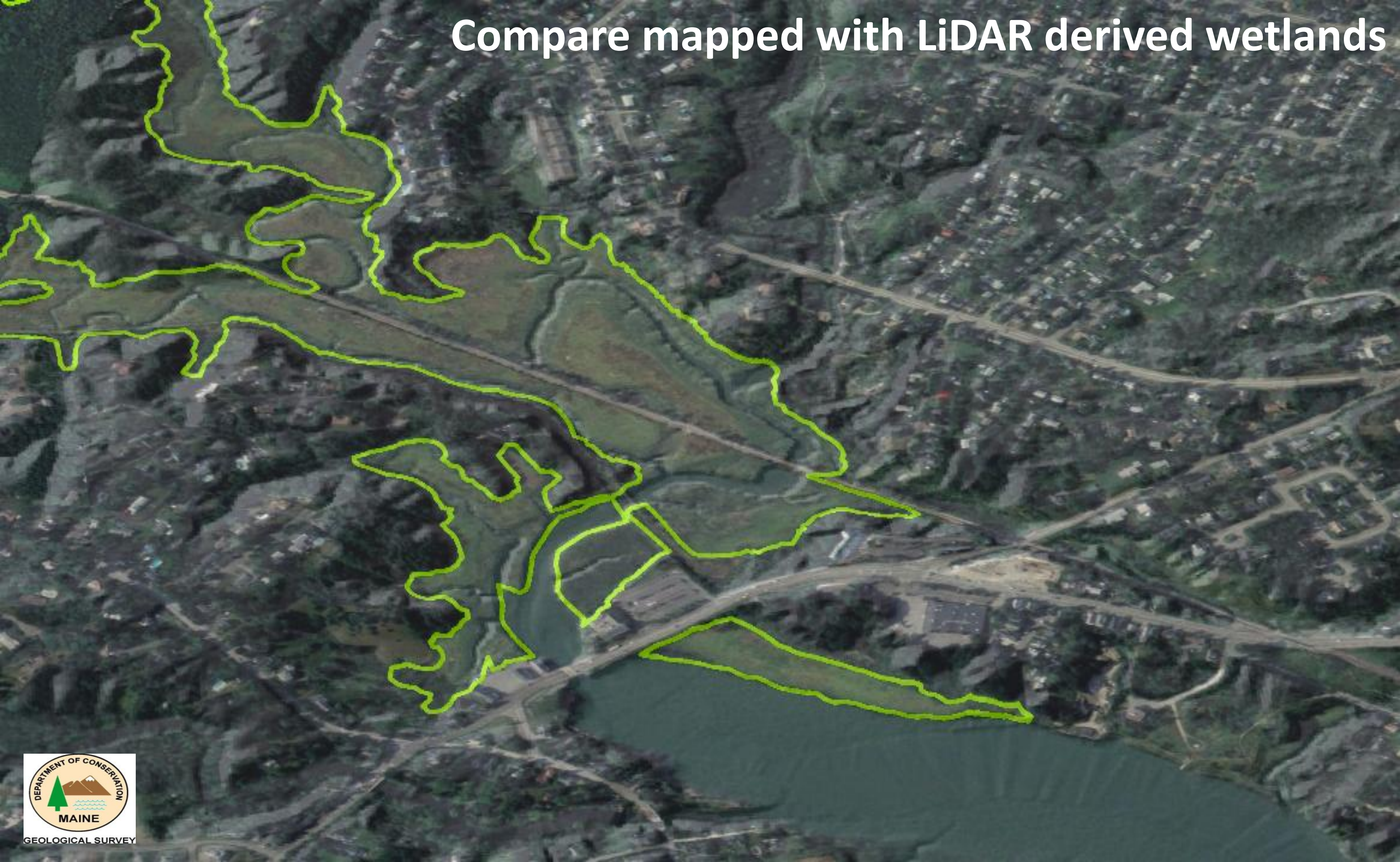
Compare mapped with LiDAR derived wetlands



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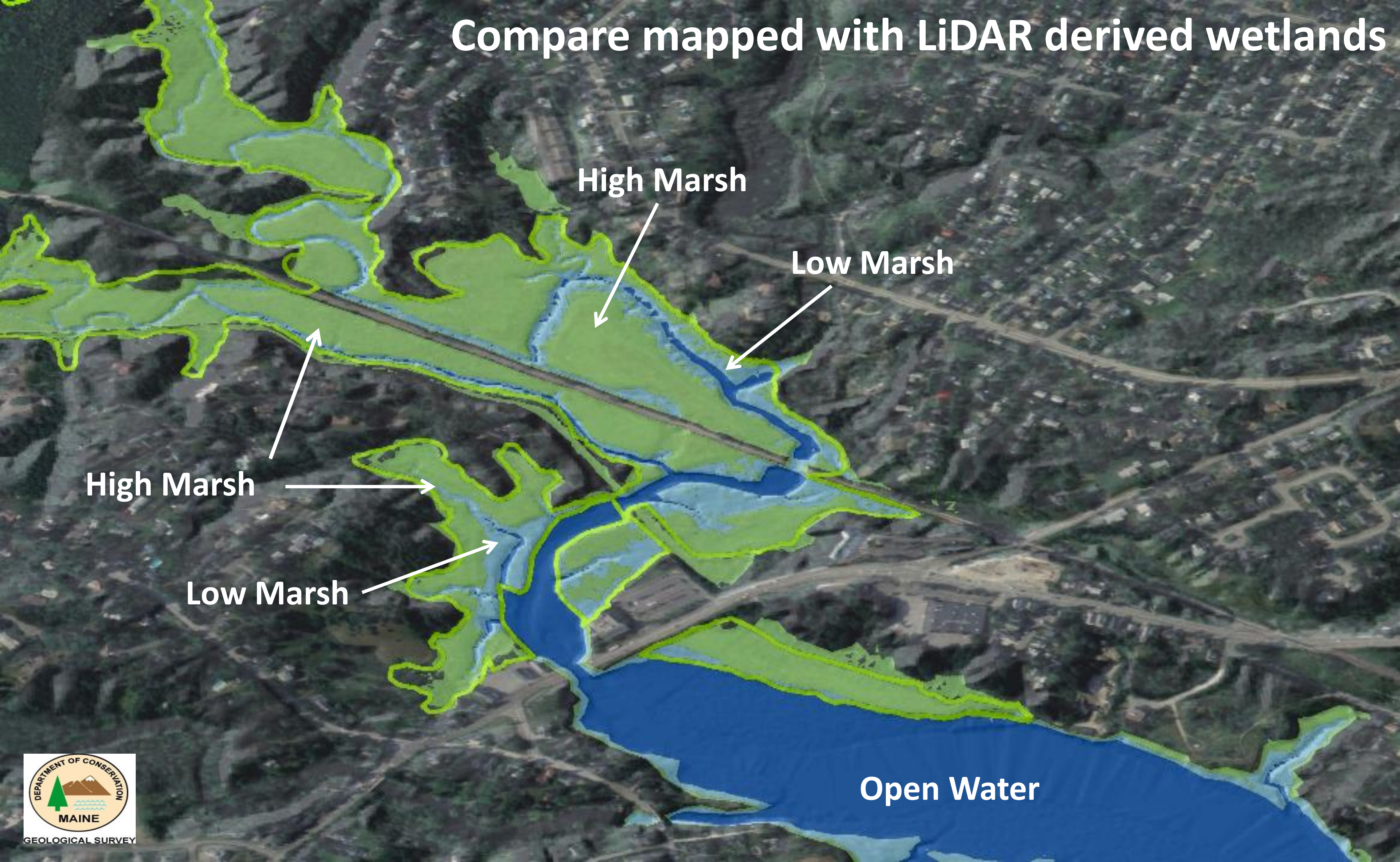


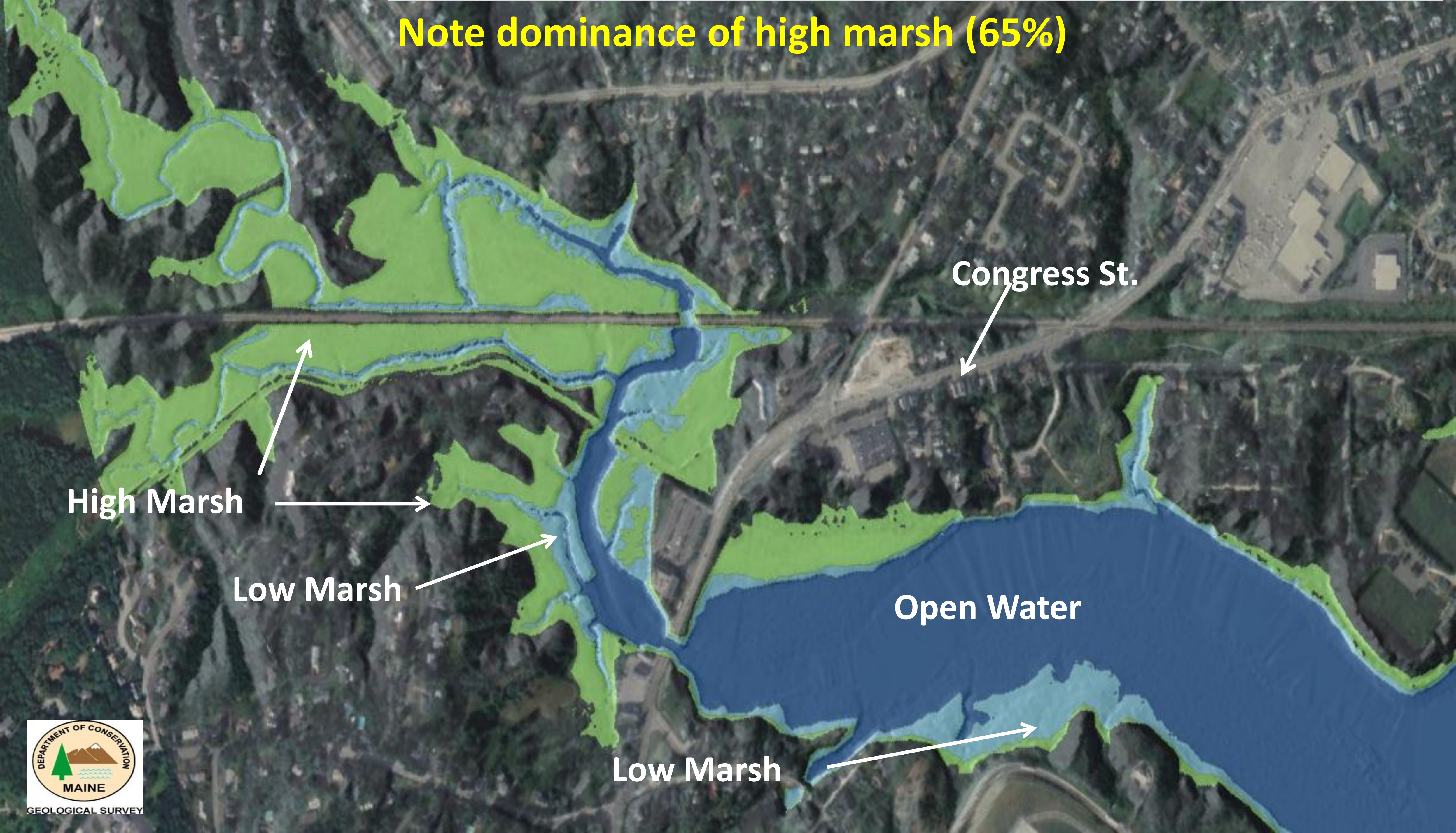
Examine Potential Impacts to Natural Resources
(Wetland Transgression?)

Example: Stroudwater, Fore River

Portland Trails

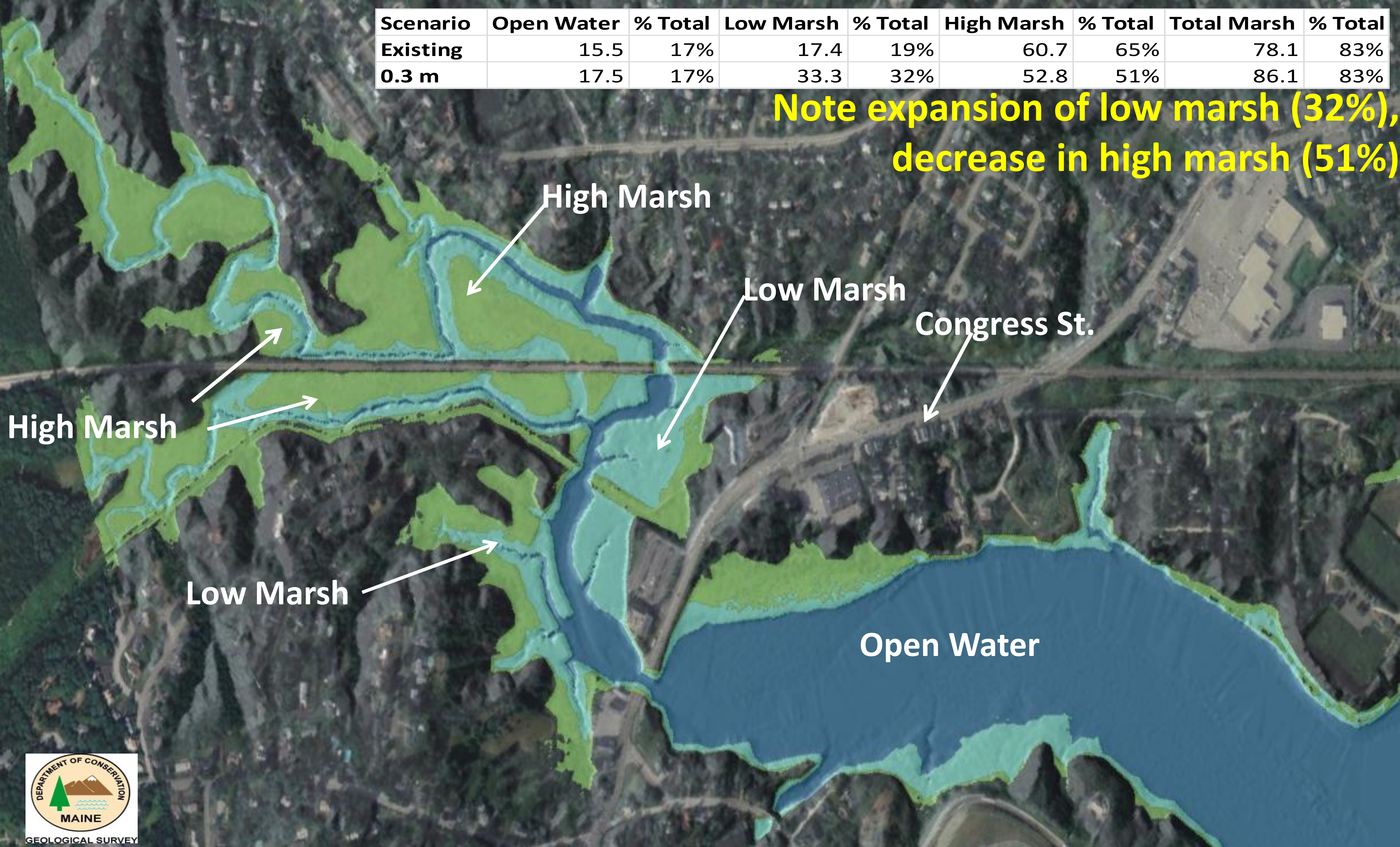
Scenario	Open Water	% Total	Low Marsh	% Total	High Marsh	% Total	Total Marsh	% Total
Existing	15.5	17%	17.4	19%	60.7	65%	78.1	83%

Note dominance of high marsh (65%)



Scenario	Open Water	% Total	Low Marsh	% Total	High Marsh	% Total	Total Marsh	% Total
Existing	15.5	17%	17.4	19%	60.7	65%	78.1	83%
0.3 m	17.5	17%	33.3	32%	52.8	51%	86.1	83%

Note expansion of low marsh (32%), decrease in high marsh (51%)



For general planning purposes only; simulation does not account for dynamic change.

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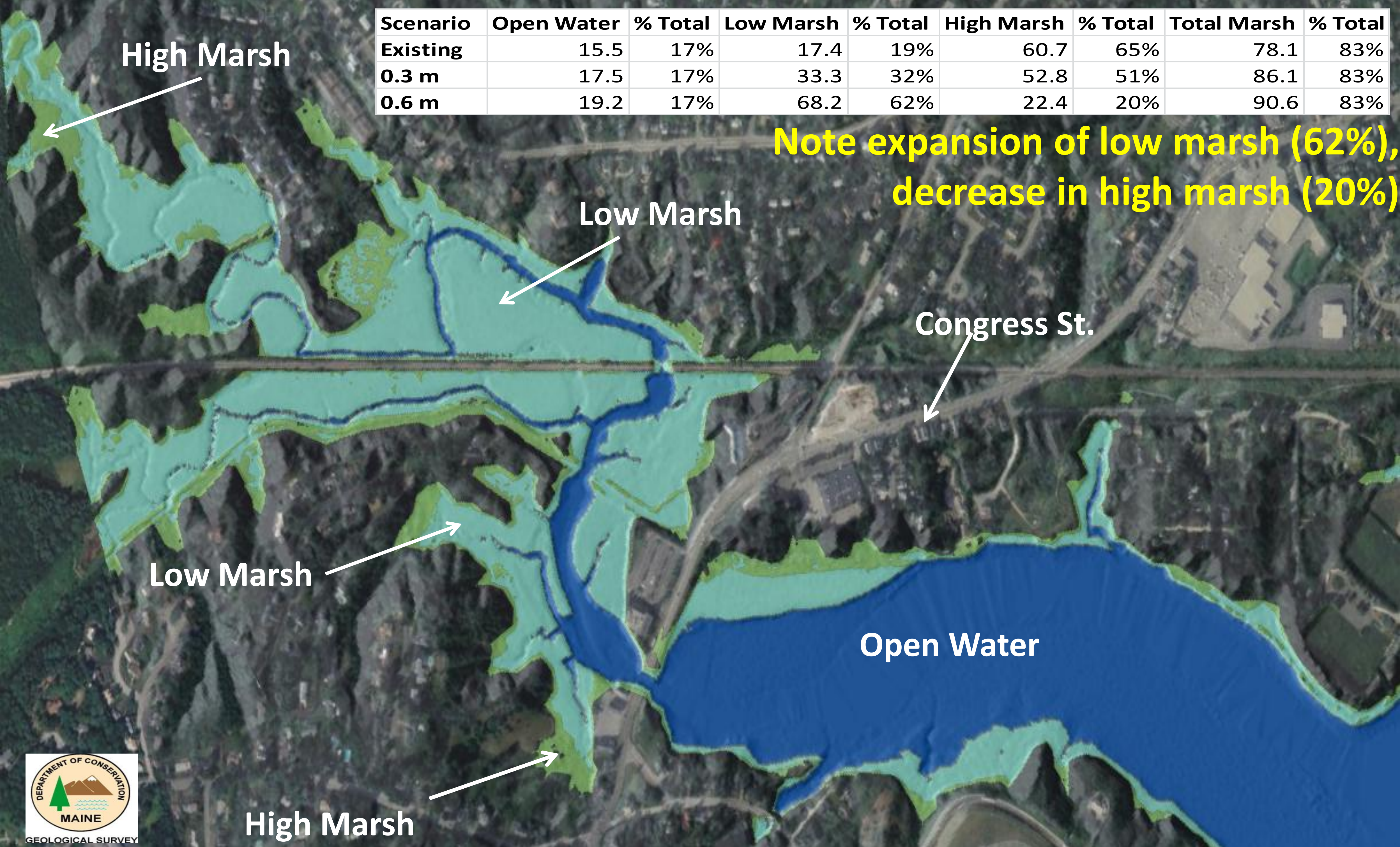
0.6 m	19.2	17%	68.2	62%	22.4	20%	90.6	83%

Note expansion of low marsh (62%), decrease in high marsh (20%)



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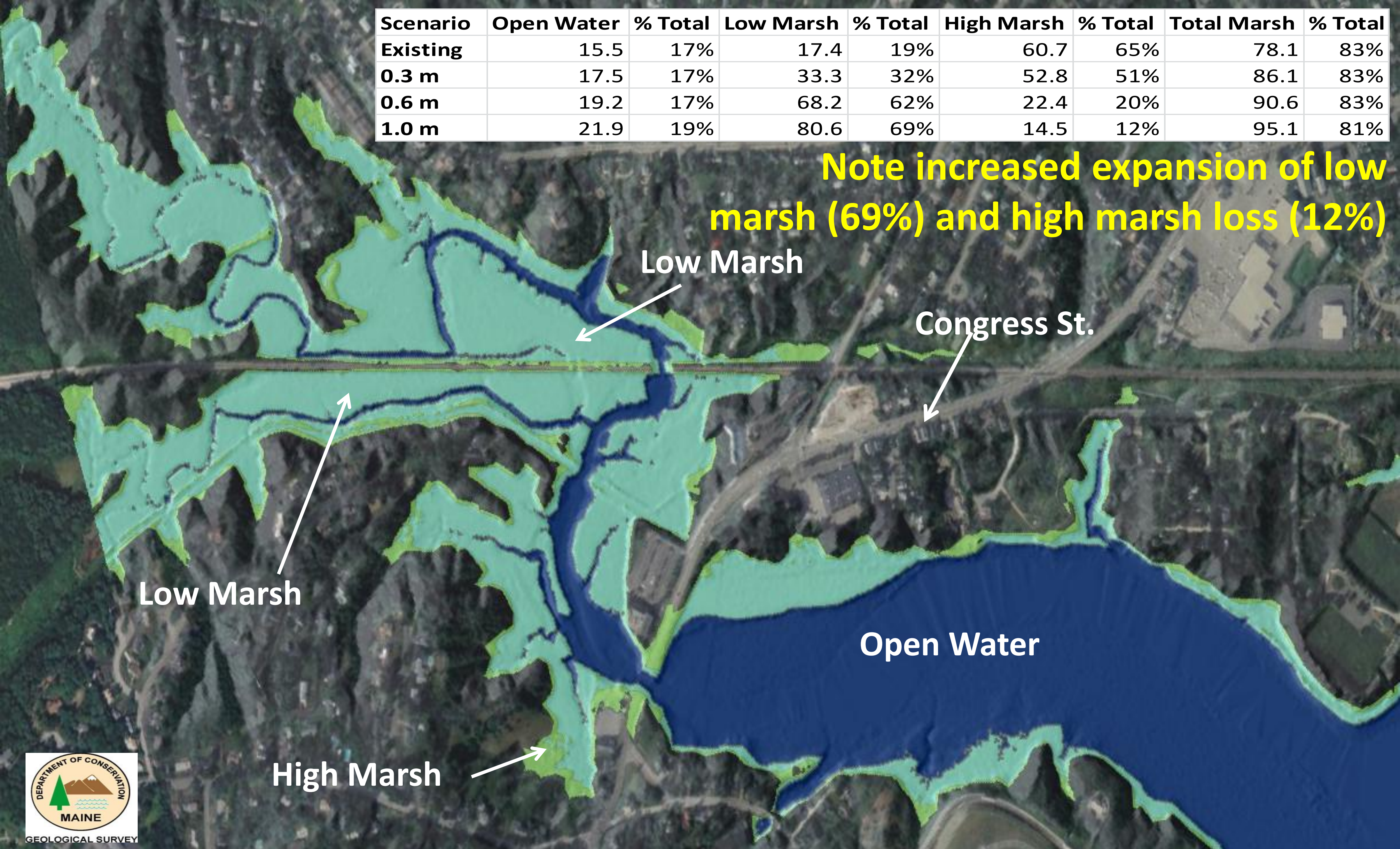
0.6 m	19.2	17%	68.2	62%	22.4	20%	90.6	83%
1.0 m	21.9	19%	80.6	69%	14.5	12%	95.1	81%

Note increased expansion of low marsh (69%) and high marsh loss (12%)



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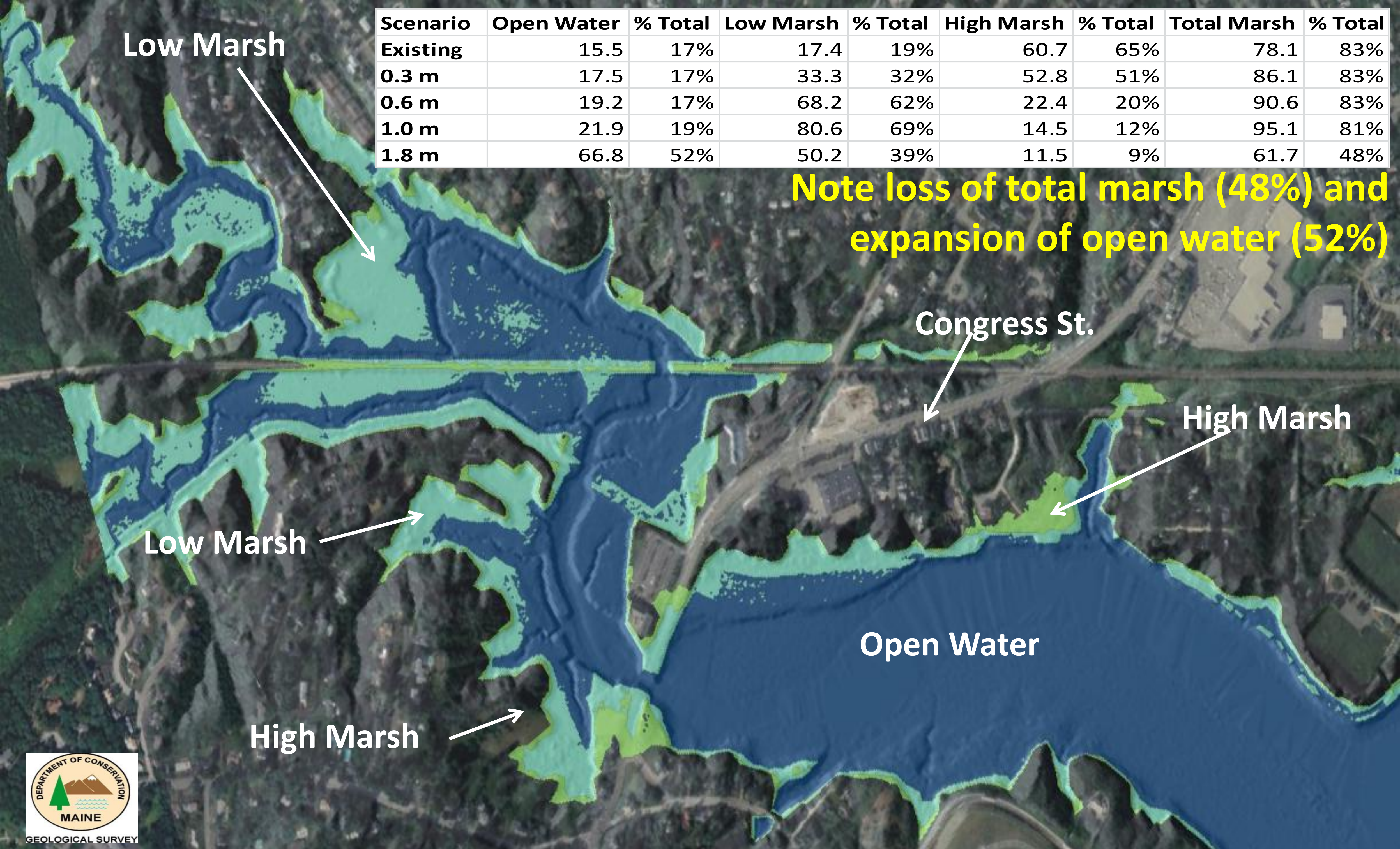
1.0 m	21.9	19%	80.6	69%	14.5	12%	95.1	81%
1.8 m	66.8	52%	50.2	39%	11.5	9%	61.7	48%

Note loss of total marsh (48%) and expansion of open water (52%)



For general planning purposes only; simulation does not account for dynamic change.

Potential Impacts on Stroudwater/Fore River

- There is some room for limited marsh expansion in 0.3, 0.6 m, and 1.0 m SLR scenarios (to about 90-95 acres) due to steeper sloped, developed uplands or transportation infrastructure. Expect conversion of high marsh to low marsh.

- Should a high SLR scenario occur (1.8 m) much of the marsh would be "pinched out" and converted to open water.

- Tool can be used to find areas of undeveloped low-lying uplands to allow marsh migration, or where development patterns have precluded marsh expansion.

Estimates do not account for erosion or sedimentation and assume static topography.

Infrastructure Vulnerability Assessment

Highest Annual Tide (HAT), is the highest predicted water level for any given year. For 2011, that was 6.6 ft NAVD88 (11.8 ft MLLW).

1978 Storm is the highest recorded water level at the Portland Tide Gauge which occurred on the February 7, 1978 Noreaster' Storm (~3.0 feet of surge). The "100-year" storm, 8.9 ft NAVD88, 14.1 ft MLLW).

Scenario	Highest Annual Tide	1978 Storm
Existing	6.6 feet	8.9 feet
+0.3 m (1 ft) SLR	7.6 feet	9.9 feet
+0.6 m (2 ft) SLR	8.6 feet	10.9 feet
+1.0 m (3.3 ft) SLR	9.9 feet	12.2 feet
+1.8 m (6.0 ft) SLR	12.5 feet	14.8 feet

All elevations referenced to NAVD88; 0 ft NAVD88 approximately 5.2 ft above MLLW.

Infrastructure Vulnerability Assessment

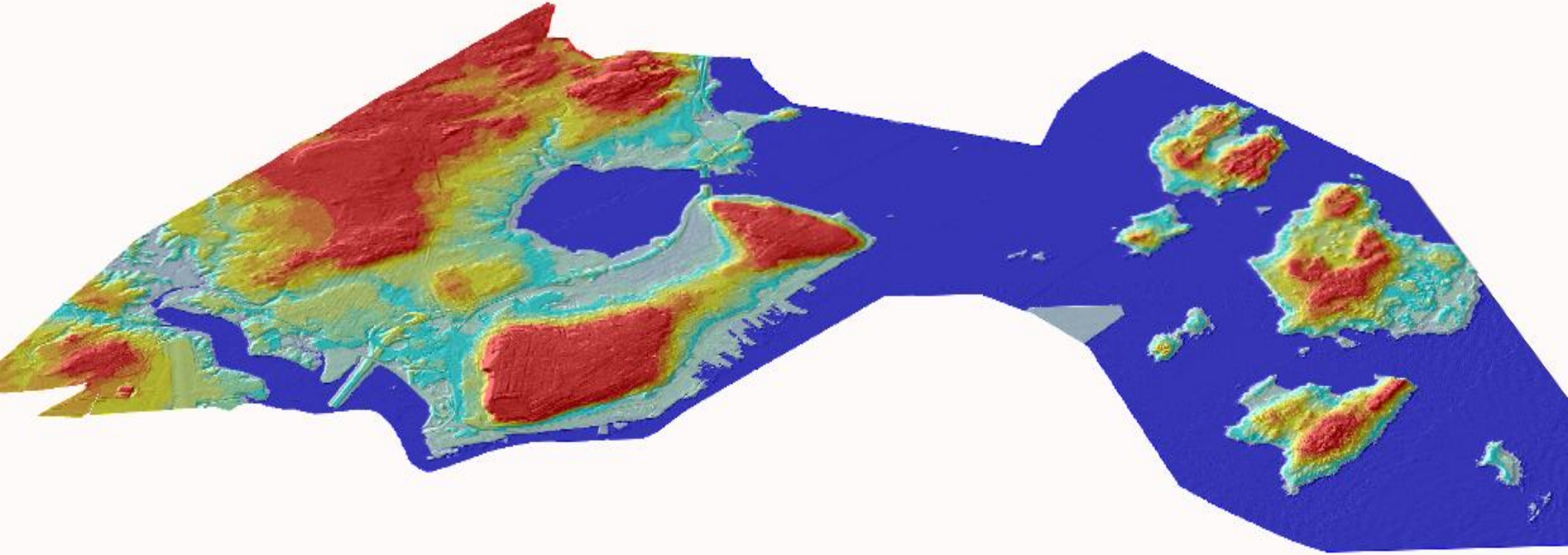
** Plan for **"Today's Storms and Tomorrow's Tides"** **

Surge Amount	Frequency	Last Occurred
3.0 feet or more*	1 in 7 years	Oct 30, 1991
3.5 feet or more*	1 in 14 years	Oct 30, 1991
4.0 feet or more*	1 in 47 years	Mar 3, 1947

***at time of high tide only; surges of these levels are much more frequent (i.e., February 26, 2010 had a surge of 4.4 feet but at mid-falling tide)*

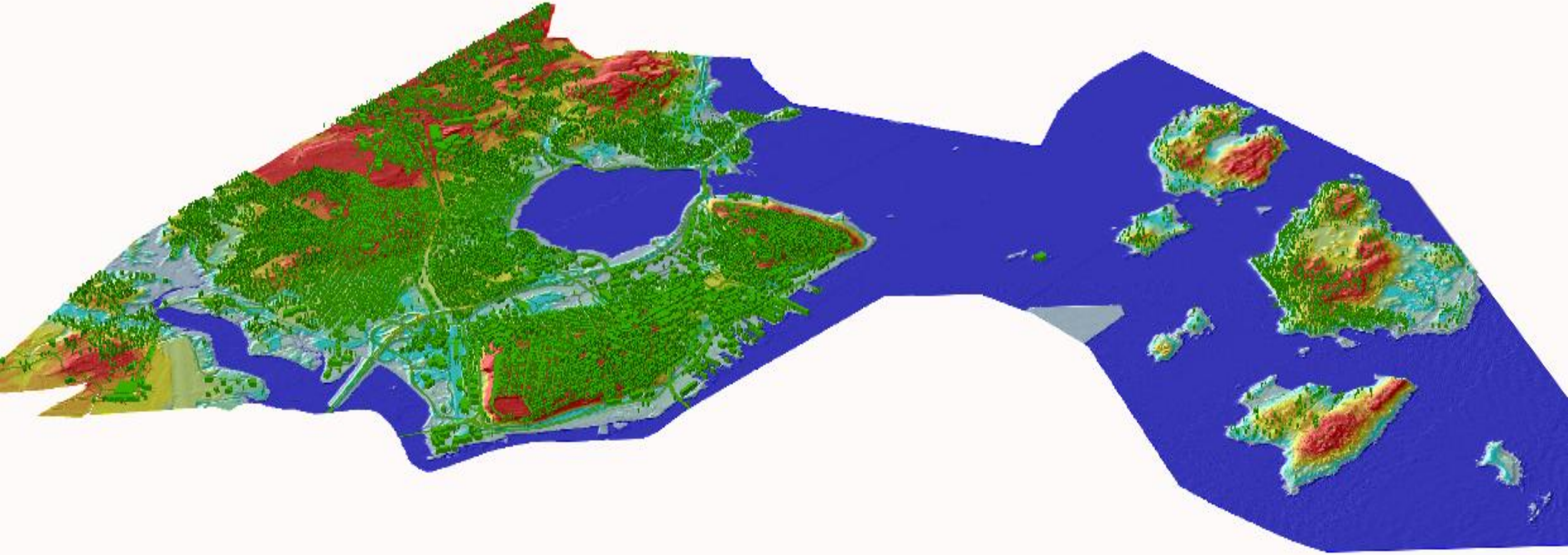
Source: John Cannon, NWS, Gray, Maine. May include storms through 2008.

Base LiDAR Data



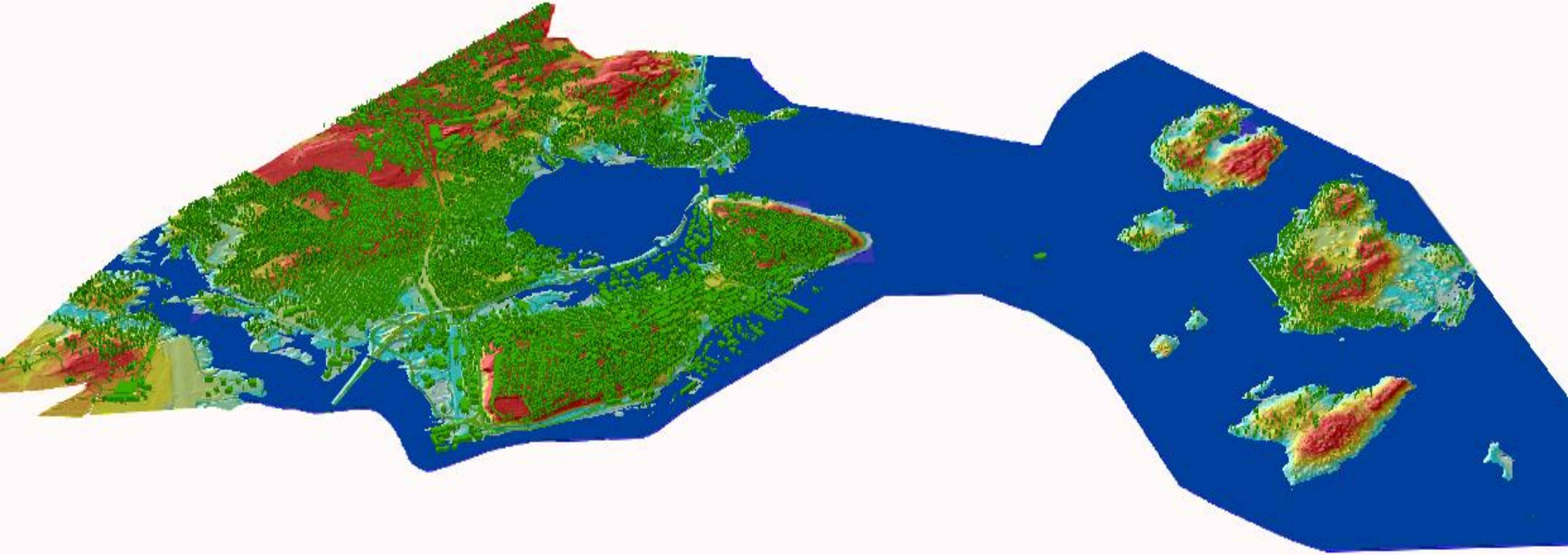
2006 LiDAR tiles (18 cm RMSE)
Mosaic and clip to municipal boundaries

Buildings and Transportation Infrastructure
(overlain onto Base LiDAR)



Add Polygon layers for buildings and roads (municipal)

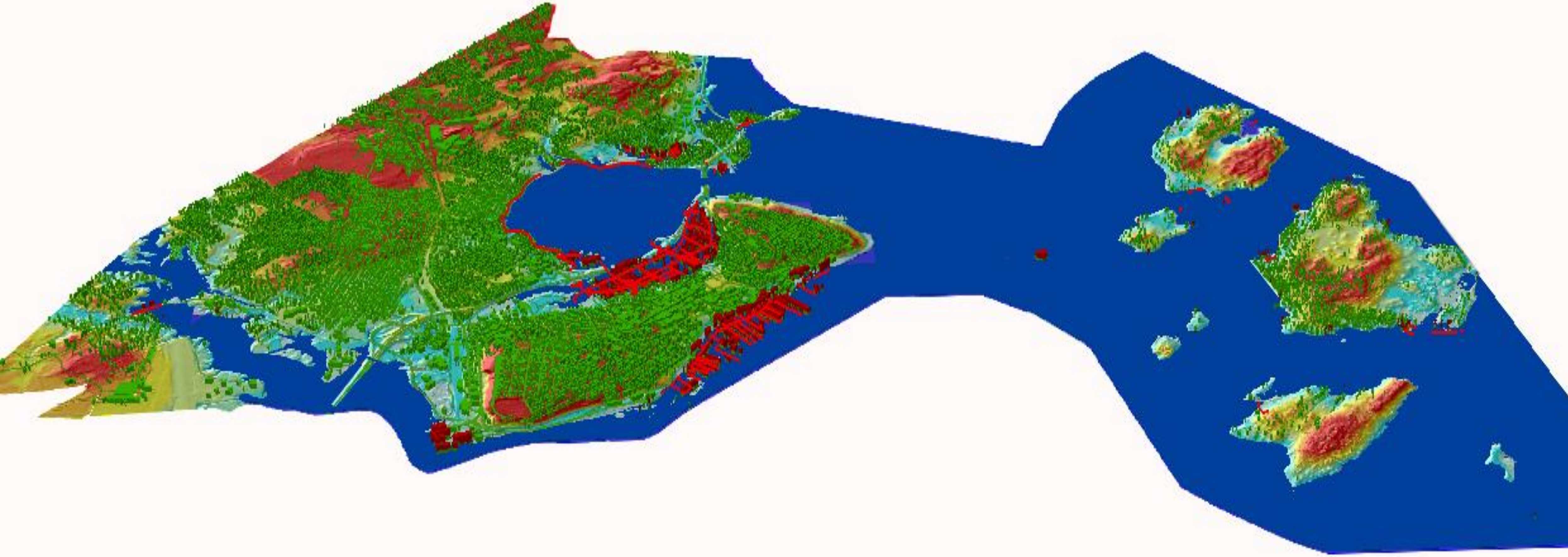
Simulate Inundation Levels



Determine future inundation levels under different scenarios

Raster queries to determine areas below certain water levels

Identify Potentially Inundated Infrastructure



Determine inundation impacts to buildings and infrastructure
Analysis completed includes Islands (not included in presentation)

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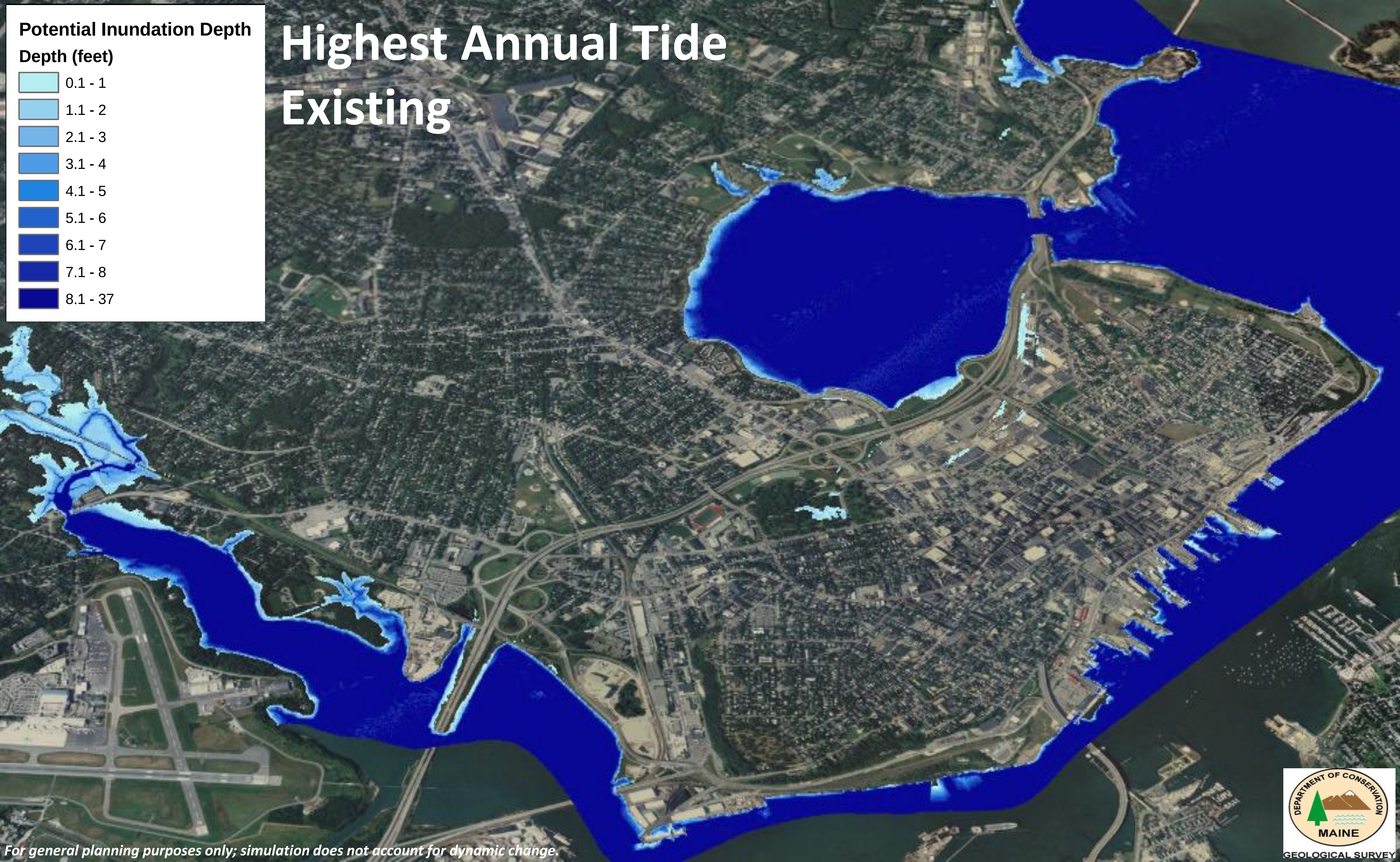
Analysis of Potential Inundation Depths
Highest Annual Tide

Jan 21, 2011
Tide Height 7.5 ft NAVD (12.7 ft MLLW)
Image from Portland Press Herald


Highest Annual Tide
Existing
Potential Inundation Depth
Depth (feet)
0.1 - 1
1.1 - 2
2.1 - 3
3.1 - 4
4.1 - 5
5.1 - 6
6.1 - 7
7.1 - 8
8.1 - 37
For general planning purposes only; simulation does not account for dynamic change.
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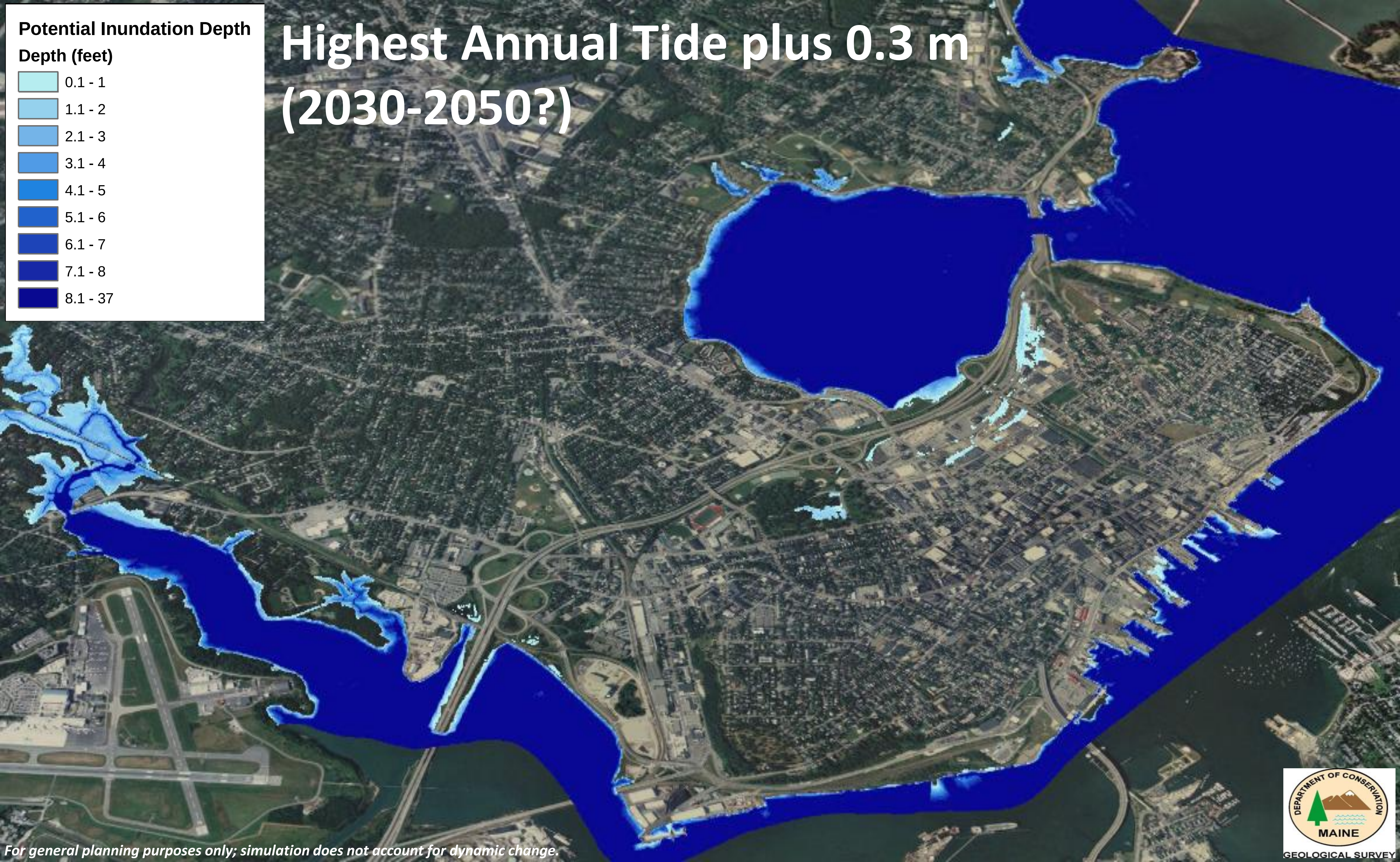
Highest Annual Tide plus 0.3 m
(2030-2050?)
Potential Inundation Depth
Depth (feet)
0.1 - 1
1.1 - 2
2.1 - 3
3.1 - 4
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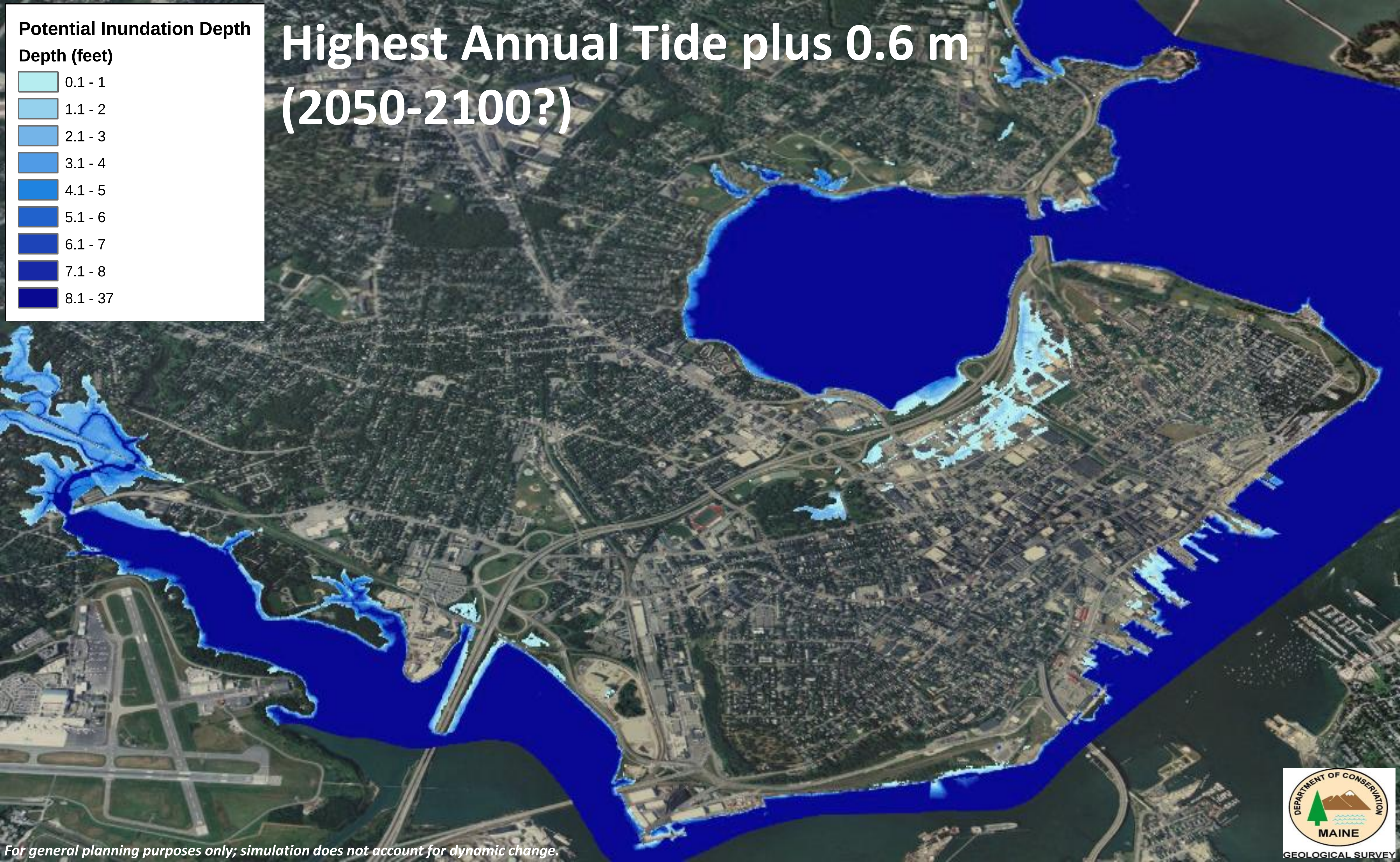
Highest Annual Tide plus 0.6 m
(2050-2100?)
Potential Inundation Depth
Depth (feet)
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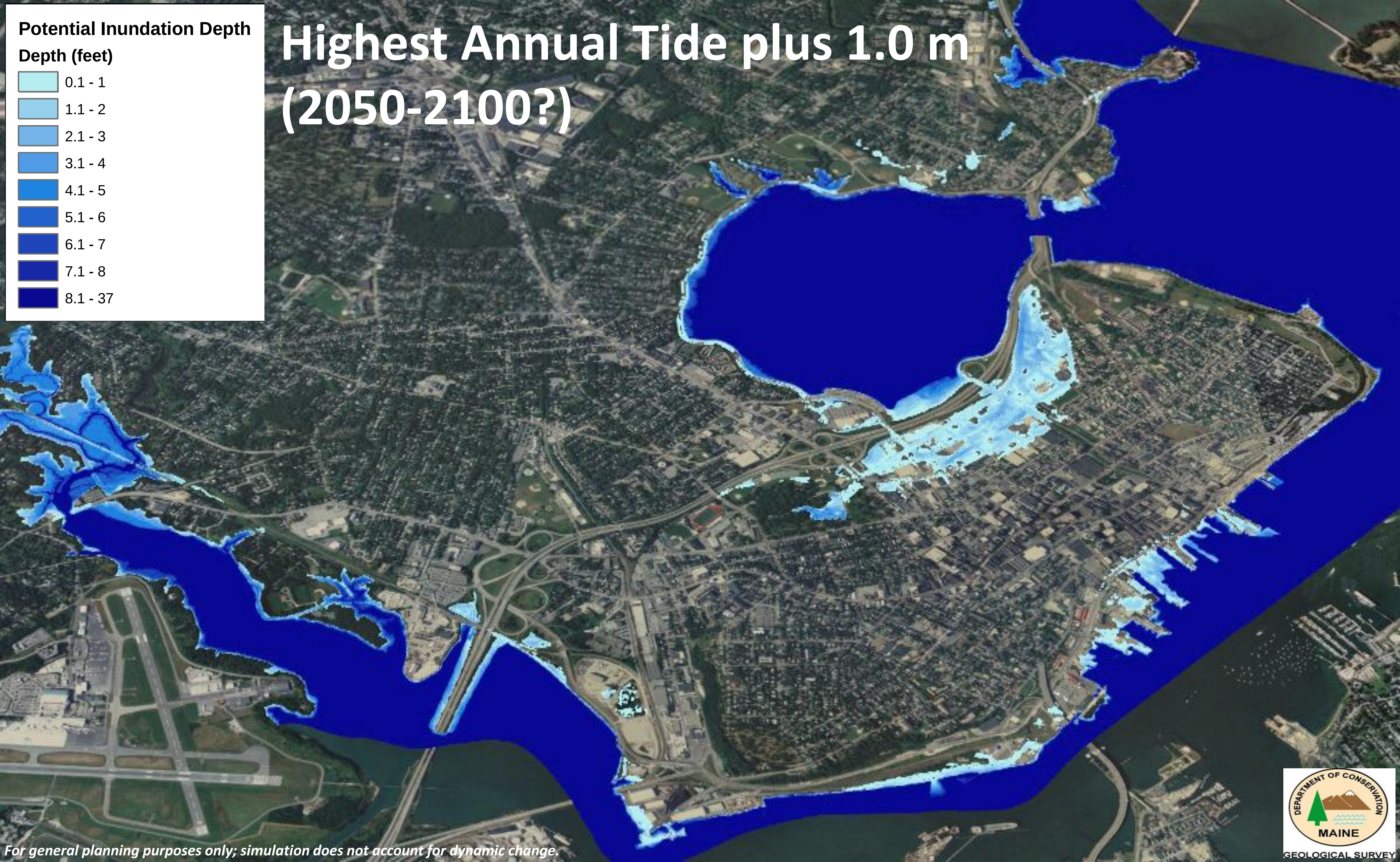
Highest Annual Tide plus 1.0 m
(2050-2100?)
Potential Inundation Depth
Depth (feet)
0.1 - 1
1.1 - 2
2.1 - 3
3.1 - 4
4.1 - 5
5.1 - 6
6.1 - 7
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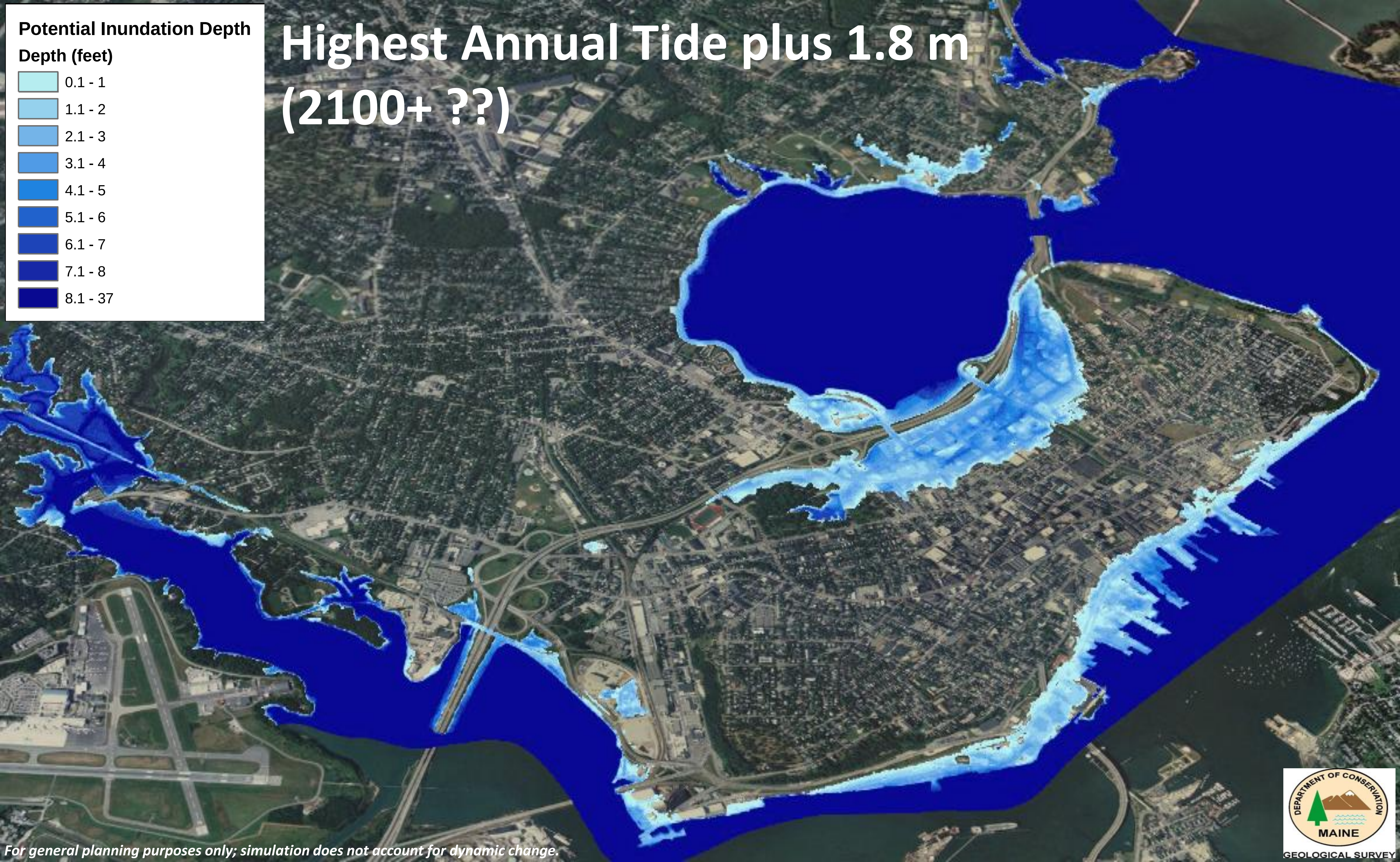
Highest Annual Tide plus 1.8 m (2100+ ??)



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Existing and Potential Future Flooding in Portland

Based on Flood Stage

Scenario	Flood Stage Elevation (MLLW)	# times flood stage exceeded	% of Total High Tides	Hours of Inundation (above flood level)
2011 Year	12 ft	11	1.6%	8
+0.3 m (1 ft) SLR	11 ft	98	13.9%	141
+0.6 m (2 ft) SLR	10 ft	281	39.8%	570
+1.0 m (3.3 ft) SLR	8.7 ft	612	86.7%	1759
+1.8 m (5.9) ft SLR	6.1 ft	702	99.4%	3782

- *Flood stage is indicated as 12 feet MLLW, including surge (source: NWS)*
- *Based only on data from 2011*
- *NOAA CO-OPs Inundation Analysis Tool*

Analysis of Potential Inundation Depths
Historic 1978 Storm Event

Patriots' Day Storm 2007
8.1 ft NAVD, 13.3 ft MLLW
(2.7 ft of surge)
Image from Tusconcitizen.com

Historic 1978 Storm
Potential Inundation Depth
Depth (feet)
0.1 - 1
1.1 - 2
2.1 - 3
3.1 - 4
4.1 - 5
5.1 - 6
6.1 - 7
7.1 - 8
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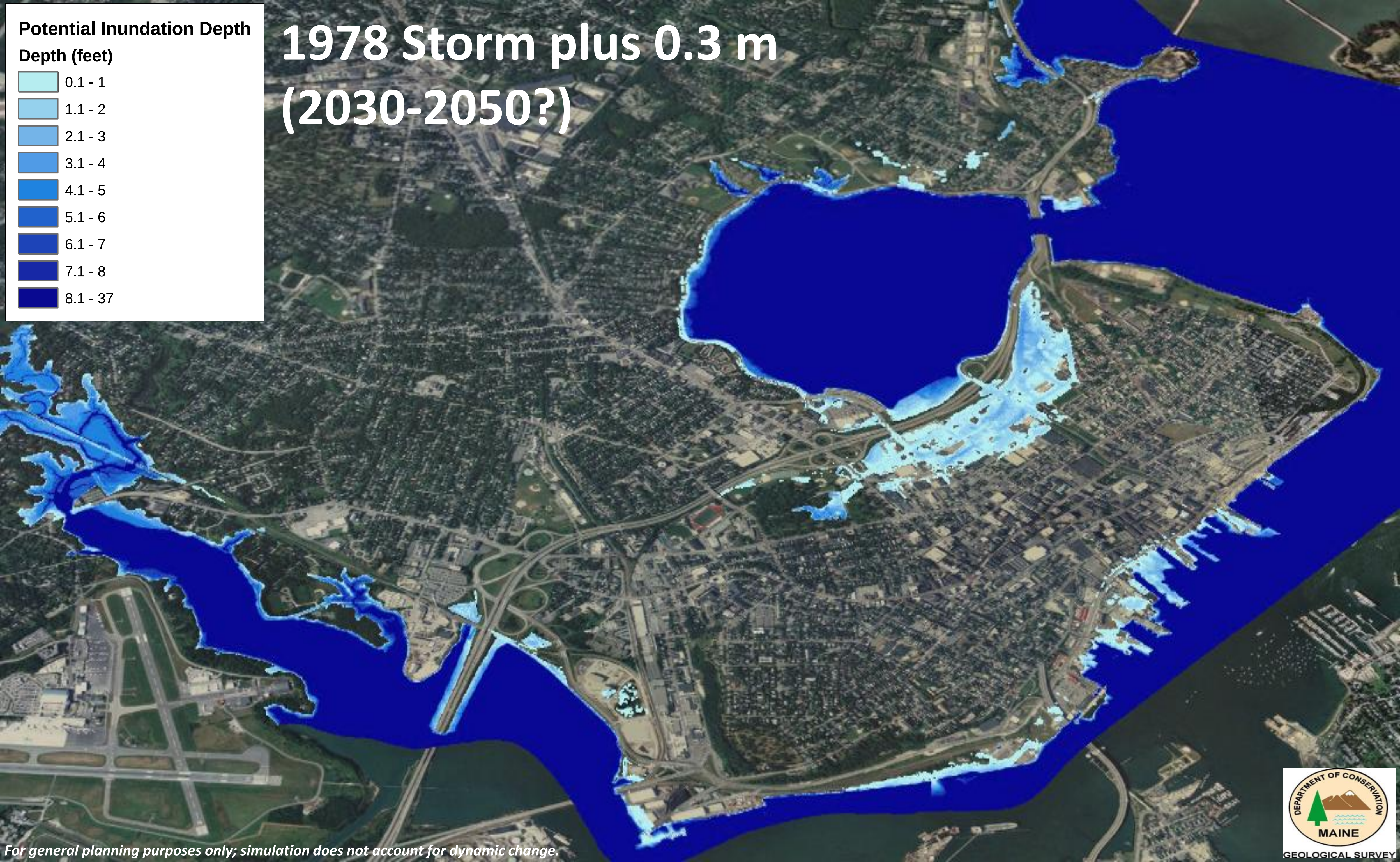
1978 Storm plus 0.3 m
(2030-2050?)
Potential Inundation Depth
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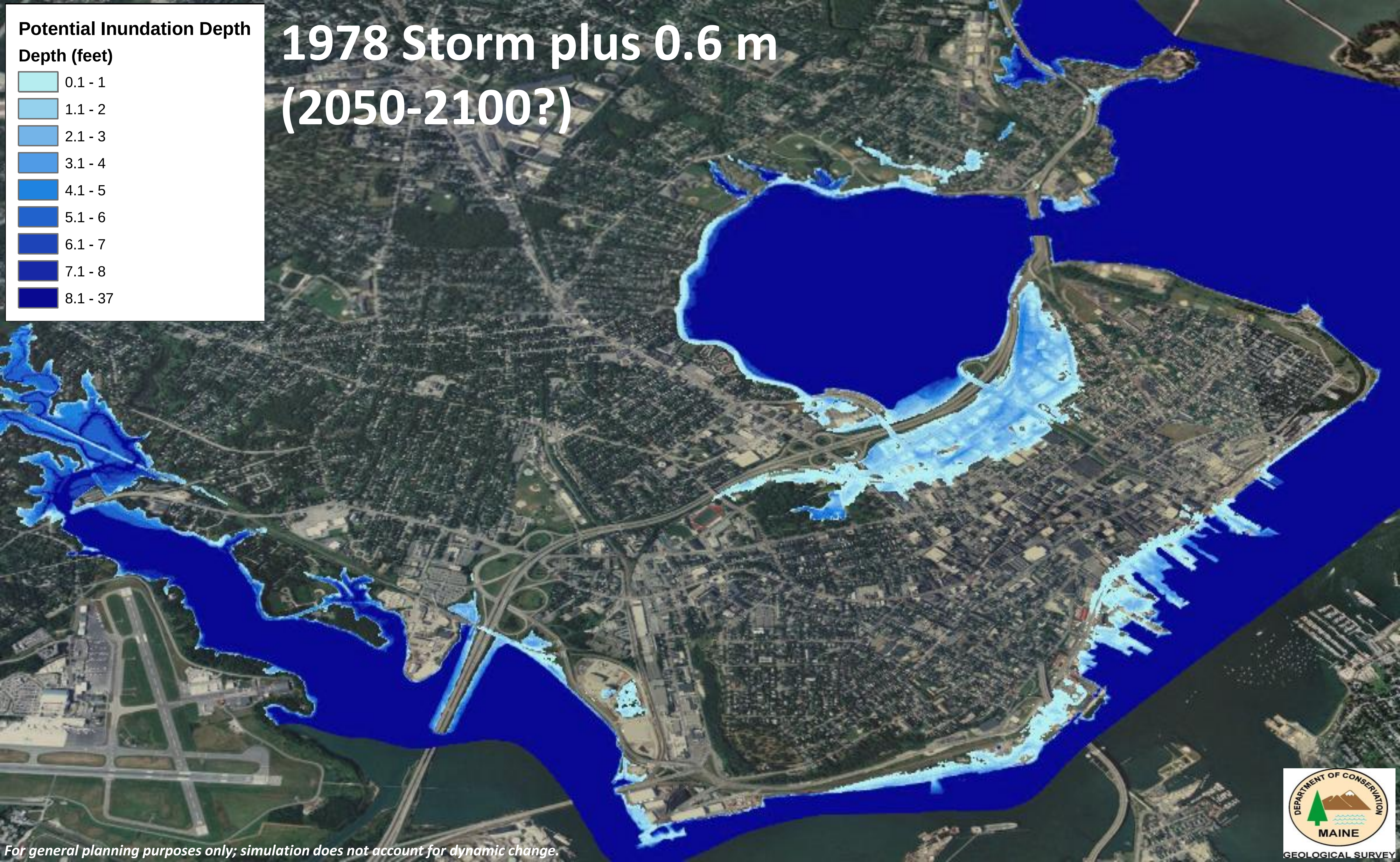
1978 Storm plus 0.6 m
(2050-2100?)
Potential Inundation Depth
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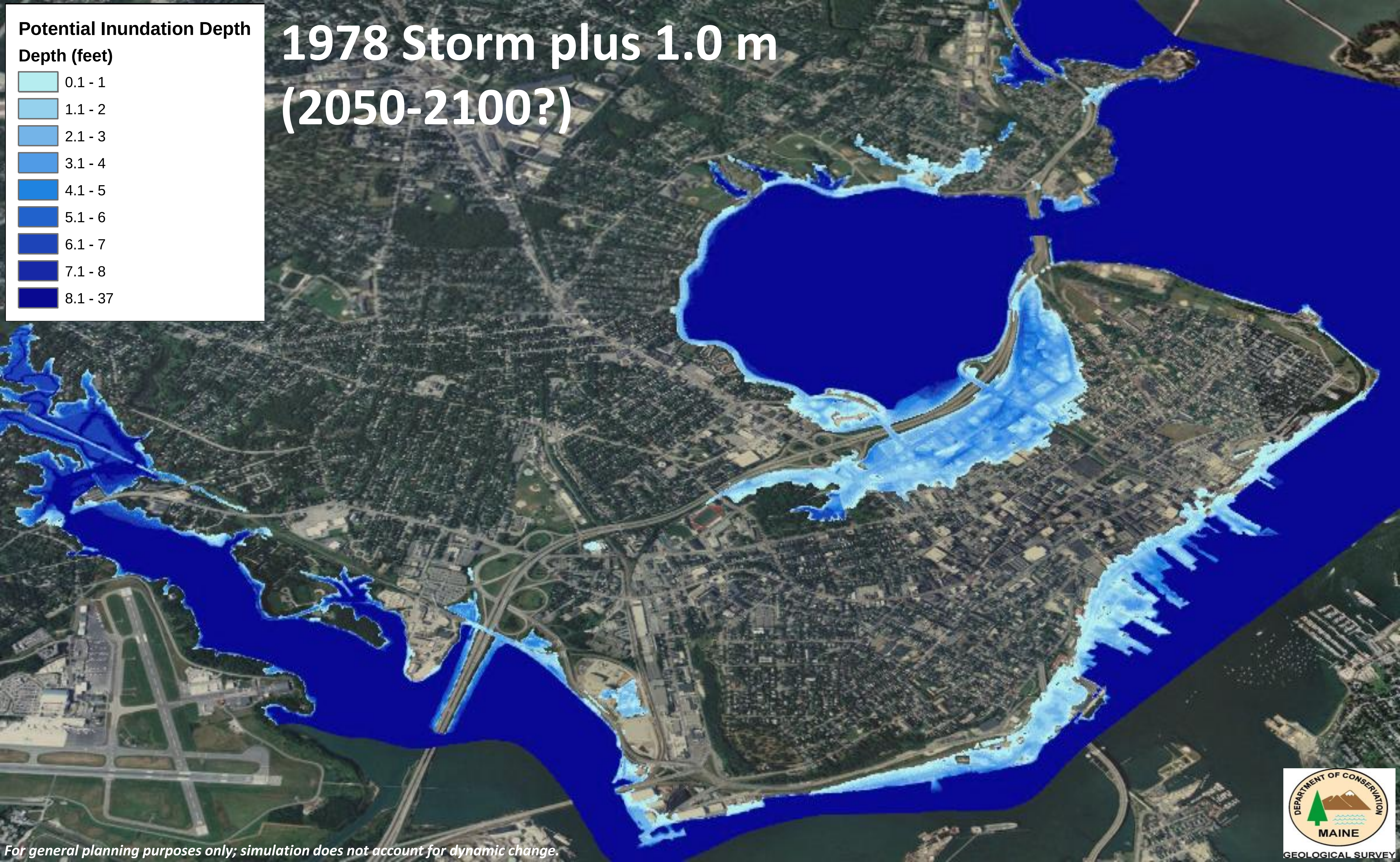
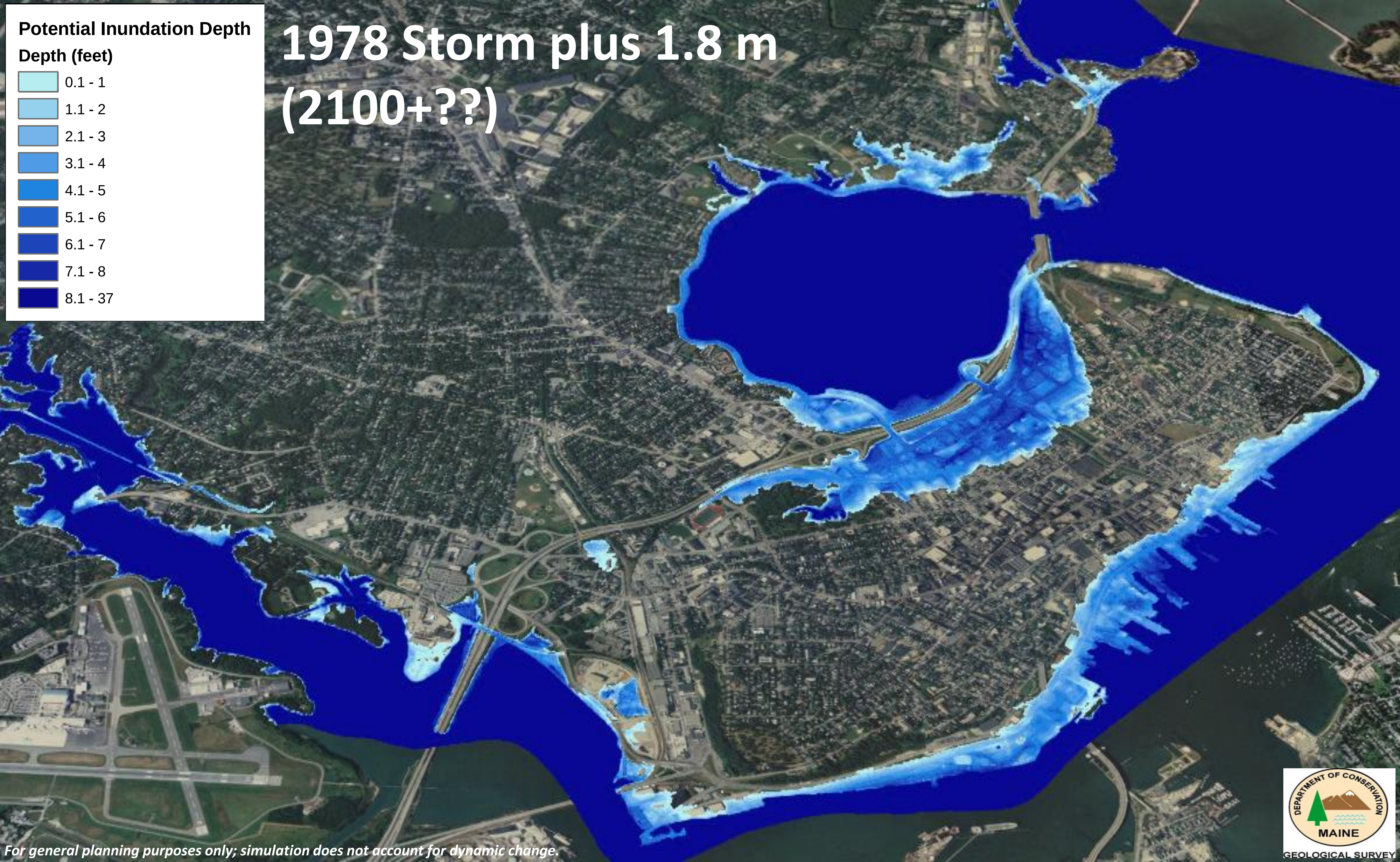

1978 Storm plus 1.0 m
(2050-2100?)
Potential Inundation Depth
Depth (feet)
0.1 - 1
1.1 - 2
2.1 - 3
3.1 - 4
4.1 - 5
5.1 - 6
6.1 - 7
7.1 - 8
8.1 - 37
DEPARTMENT OF CONSERVATION
MAINE
GEOLOGICAL SURVEY
For general planning purposes only; simulation does not account for dynamic change.


1978 Storm plus 1.8 m
(2100+??)
Potential Inundation Depth
Depth (feet)
0.1 - 1
1.1 - 2
2.1 - 3
3.1 - 4
4.1 - 5
5.1 - 6
6.1 - 7
7.1 - 8
8.1 - 37
For general planning purposes only; simulation does not account for dynamic change.
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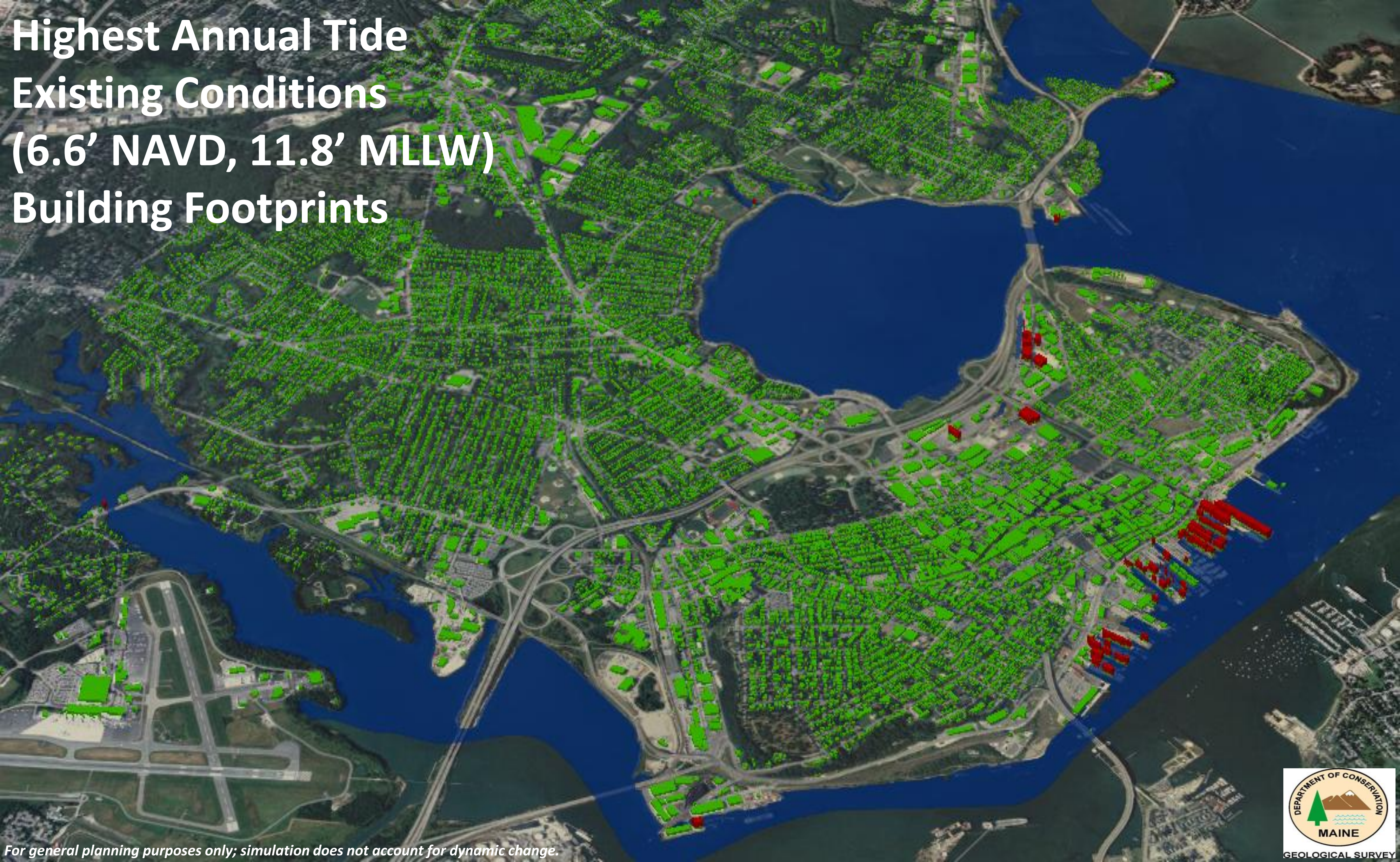
Potential Impacts to Buildings and Infrastructure

Somerset St., October 28, 2011; Curtis Bohlen, CBEP



Highest Annual Tide
Existing Conditions
(6.6’ NAVD, 11.8’ MLLW)
Building Footprints
For general planning purposes only; simulation does not account for dynamic change.
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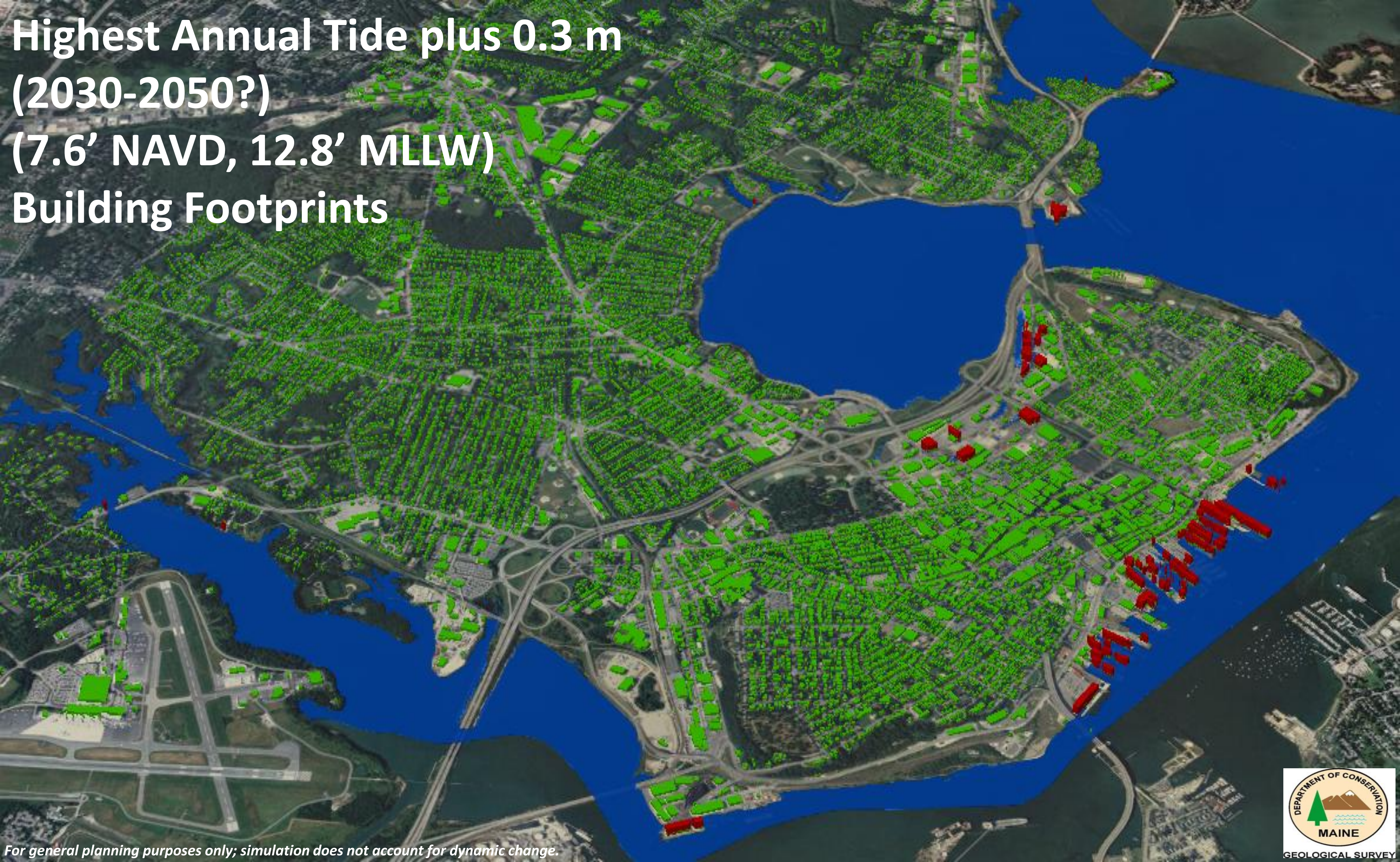
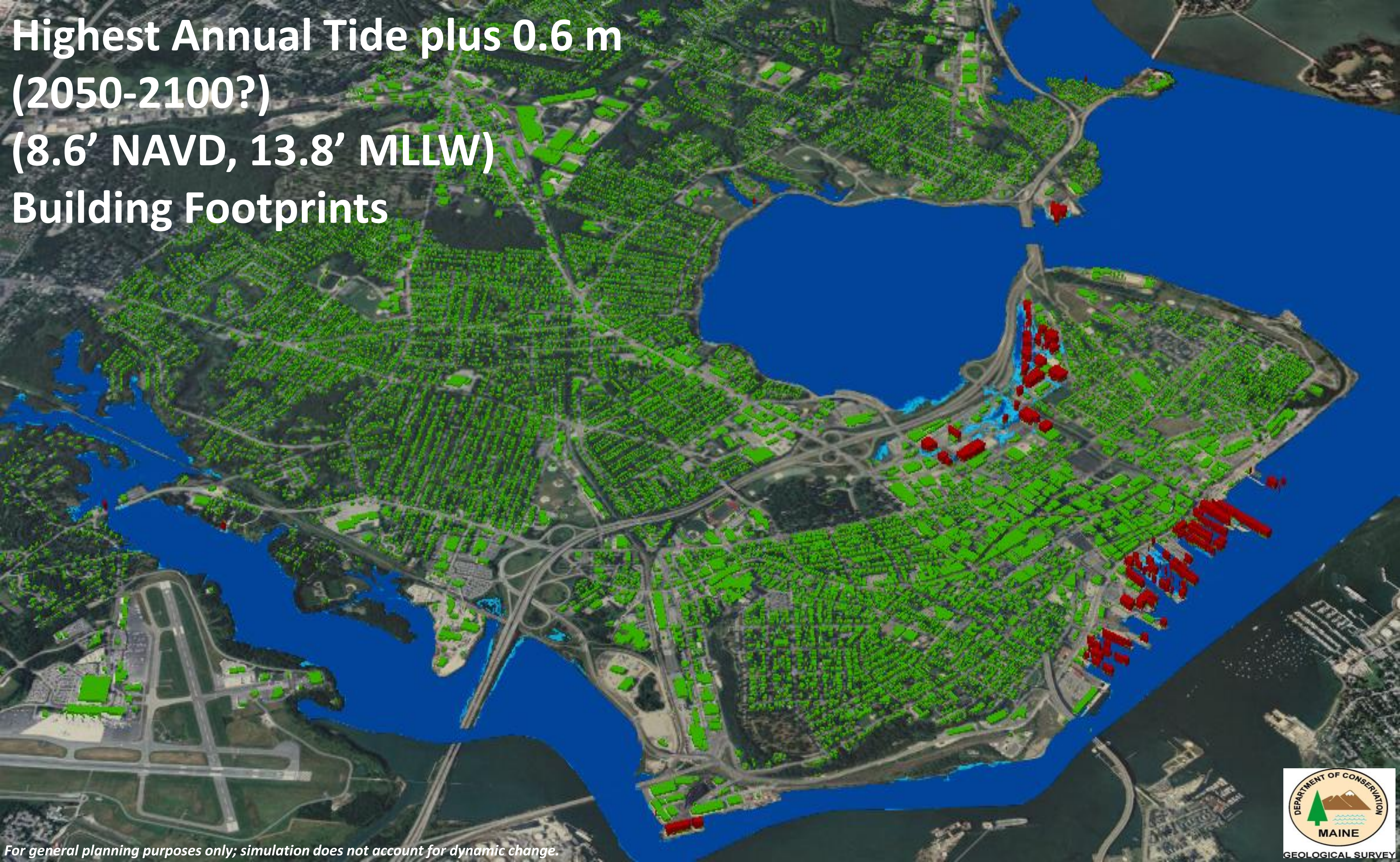
Highest Annual Tide plus 0.3 m (2030-2050?) (7.6’ NAVD, 12.8’ MLLW) Building Footprints



For general planning purposes only; simulation does not account for dynamic change.

DEPARTMENT OF CONSERVATION MAINE GEOLOGICAL SURVEY


Highest Annual Tide plus 0.6 m
(2050-2100?)
(8.6’ NAVD, 13.8’ MLLW)
Building Footprints
For general planning purposes only; simulation does not account for dynamic change.
DEPARTMENT OF CONSERVATION
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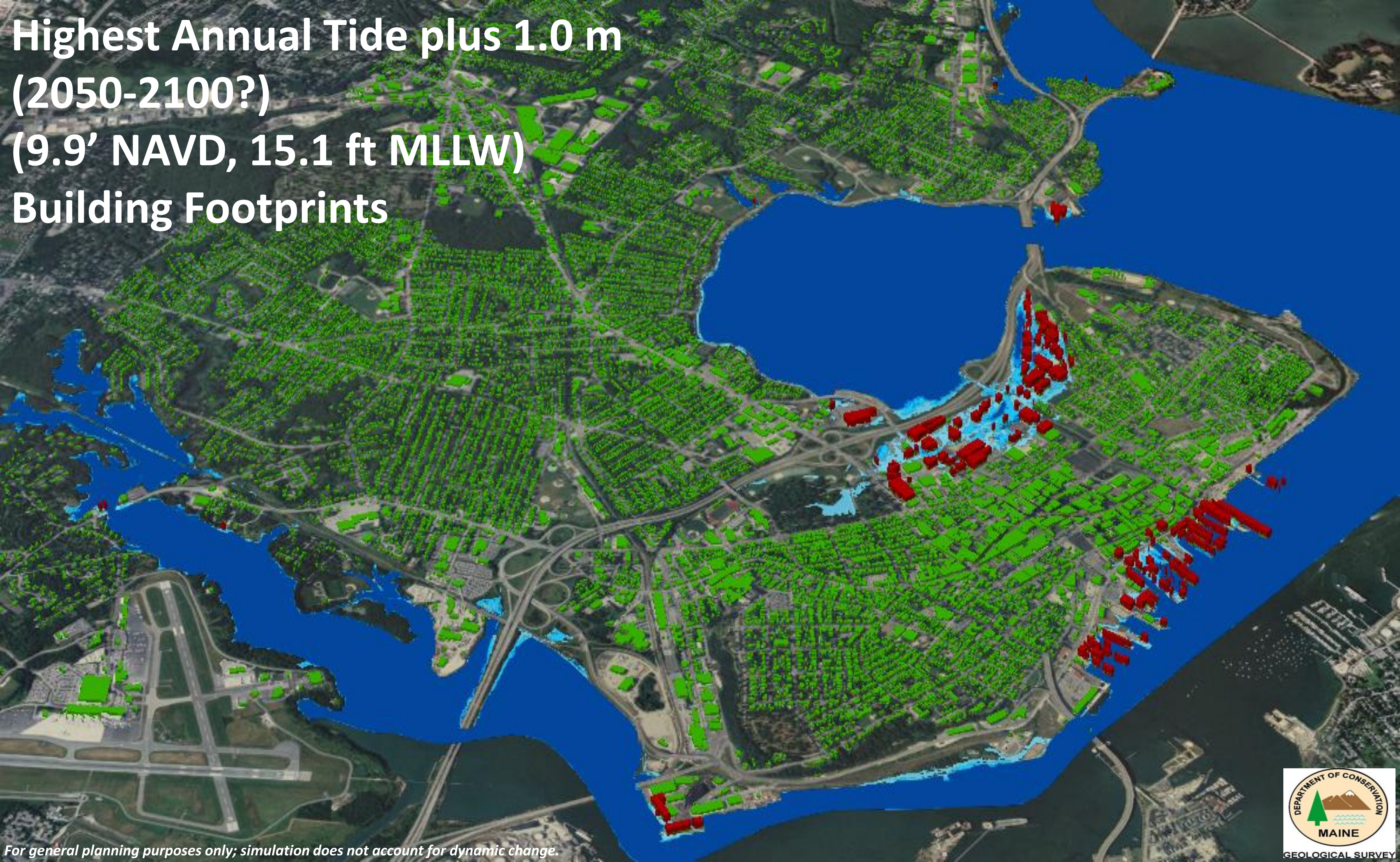
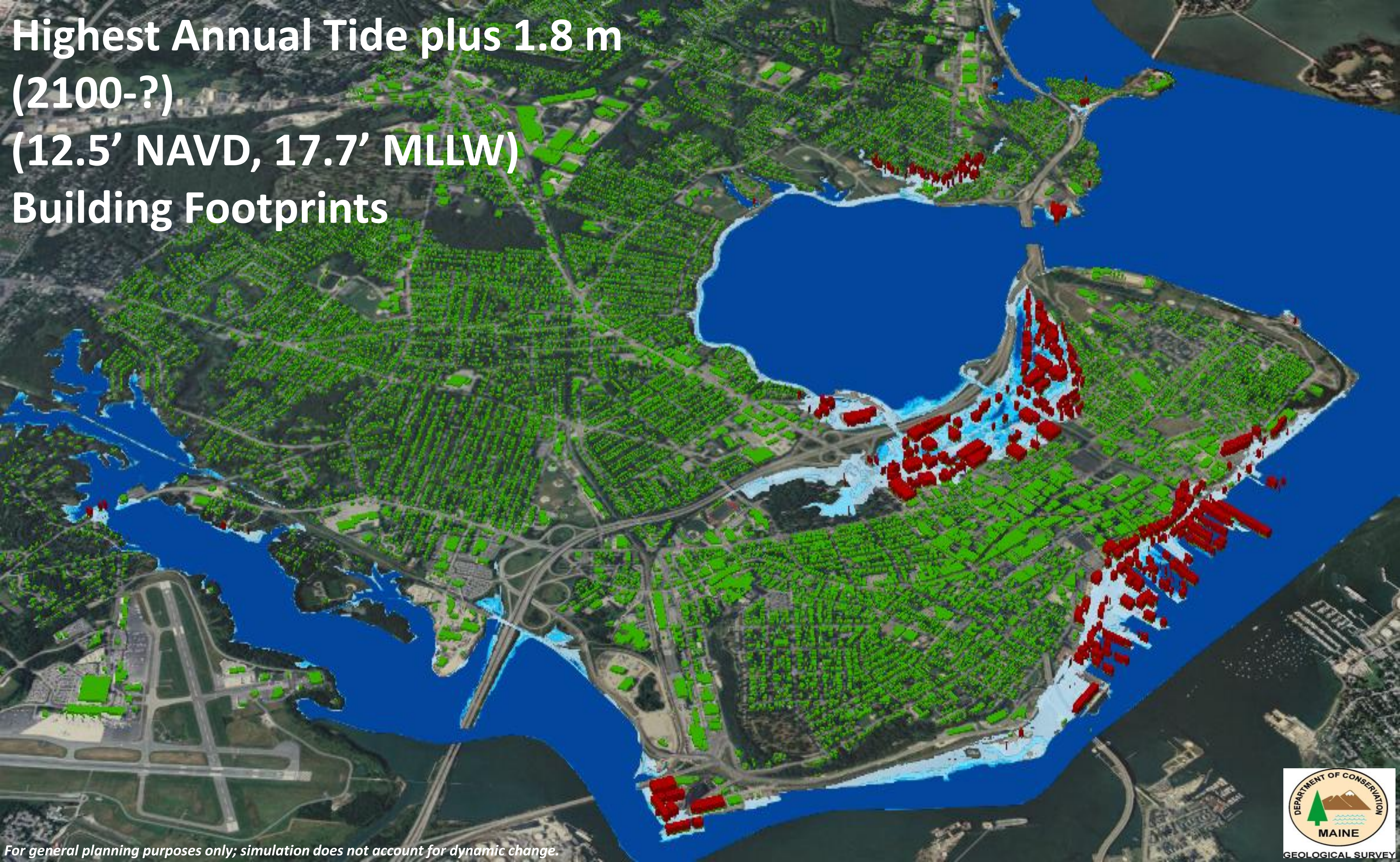
GEOLOGICAL SURVEY

Highest Annual Tide plus 1.0 m
(2050-2100?)
(9.9’ NAVD, 15.1 ft MLLW)
Building Footprints



For general planning purposes only; simulation does not account for dynamic change.

Highest Annual Tide plus 1.8 m (2100-?) (12.5’ NAVD, 17.7’ MLLW) Building Footprints



For general planning purposes only; simulation does not account for dynamic change.

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MAINE
GEOLOGICAL SURVEY


Historic 1978 Storm
(8.9’ NAVD, 14.1’ MLLW)
Building Footprints
For general planning purposes only; simulation does not account for dynamic change.
DEPARTMENT OF CONSERVATION
MAINE
GEOLOGICAL SURVEY


1978 Storm plus 0.3 m
(2030-2050?)
(9.9' NAVD, 15.1 ft MLLW)
Building Footprints
For general planning purposes only; simulation does not account for dynamic change.
DEPARTMENT OF CONSERVATION
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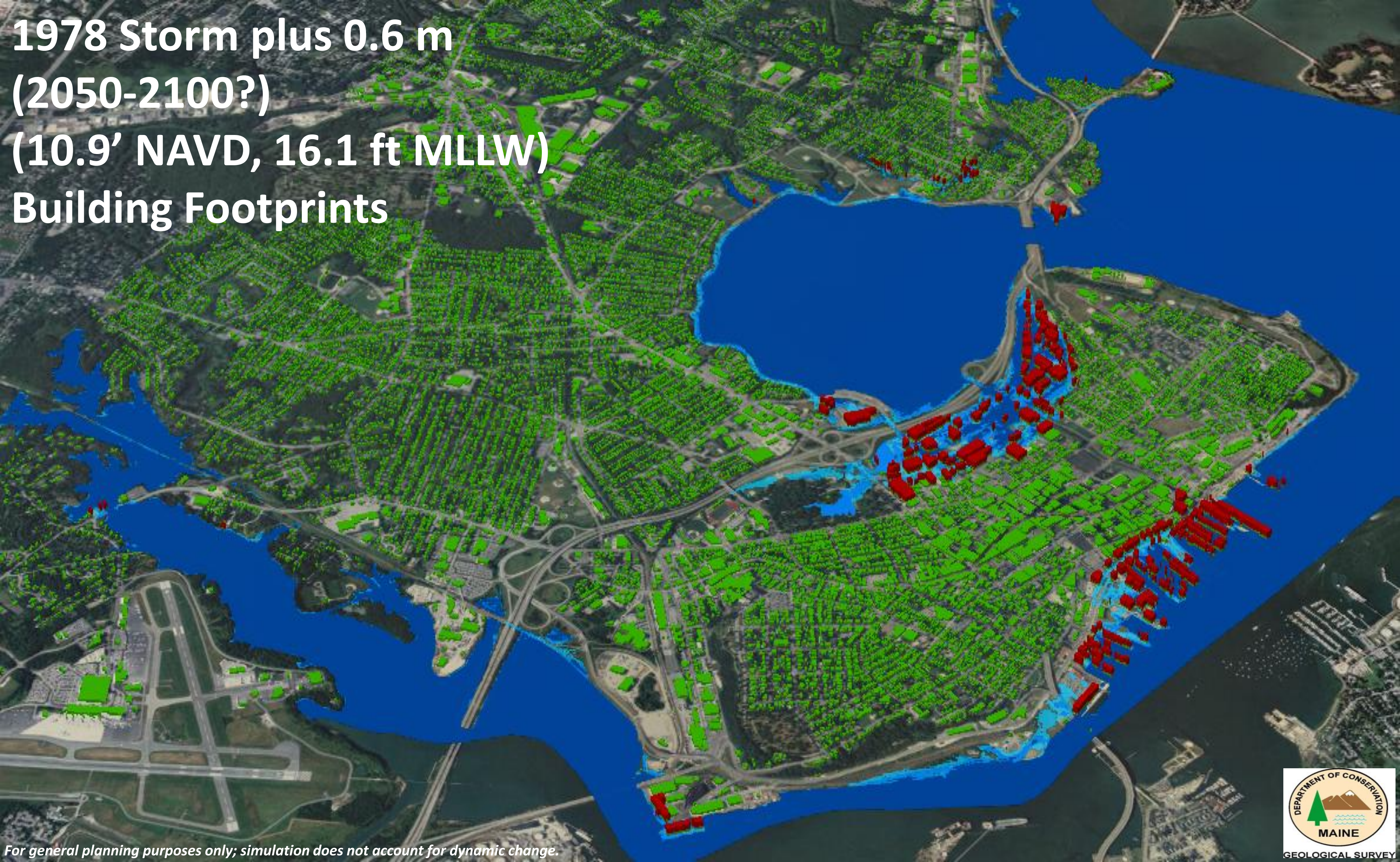
GEOLOGICAL SURVEY


1978 Storm plus 0.6 m
(2050-2100?)
(10.9’ NAVD, 16.1 ft MLLW)
Building Footprints
For general planning purposes only; simulation does not account for dynamic change.
DEPARTMENT OF CONSERVATION
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1978 Storm plus 1.0 m (2050-2100?) (12.2’ NAVD, 17.4’ MLLW) Building Footprints

For general planning purposes only; simulation does not account for dynamic change.

DEPARTMENT OF CONSERVATION MAINE GEOLOGICAL SURVEY

1978 Storm plus 1.8 m (2100-??) (14.8’ NAVD, 20.0’ MLLW) Building Footprints

For general planning purposes only; simulation does not account for dynamic change.

DEPARTMENT OF CONSERVATION MAINE GEOLOGICAL SURVEY

Summary of Vulnerable* Building Footprints

Scenario	Highest Annual Tide					1978 "100-year" Storm Event				
Land Use Index	**Exist**	**0.3 m**	**0.6 m**	**1.0 m**	**1.8 m**	**Exist**	**0.3 m**	**0.6 m**	**1.0 m**	**1.8 m**
Residential	13	28	31	50	149	41	66	93	135	232
Commercial or Industrial	103	128	175	271	524	202	284	395	502	597
Total Footprints	**116**	**156**	**206**	**321**	**673**	**243**	**350**	**488**	**637**	**829**

** Assumes "bathtub" flooding, static topography, and that a building footprint is "inundated" if the flooding scenario* ***intersects*** *the building footprint, regardless of the flooding depth. Does not assume complete loss of building or assign any kind of damage function.*

Potential Impacts to Transportation Infrastructure

Assumption: “impacted” = flooded

C. Bohlen, CBEP

Existing Highest Annual Tide (6.6’ NAVD, 11.8’ MLLW) Transportation Infrastructure

For general planning purposes only; simulation does not account for dynamic change.

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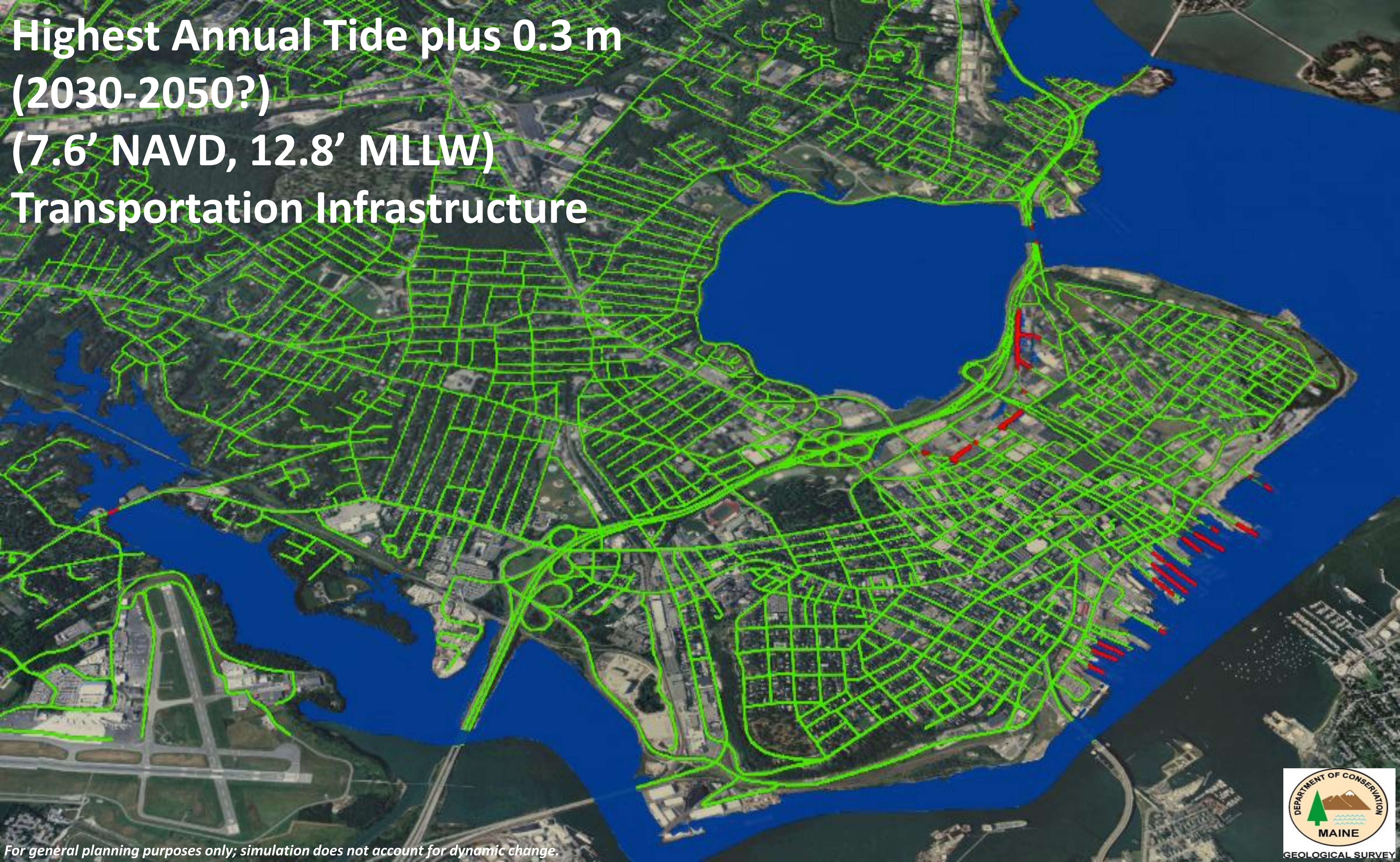
Highest Annual Tide plus 0.3 m (2030-2050?) (7.6’ NAVD, 12.8’ MLLW) Transportation Infrastructure



For general planning purposes only; simulation does not account for dynamic change.

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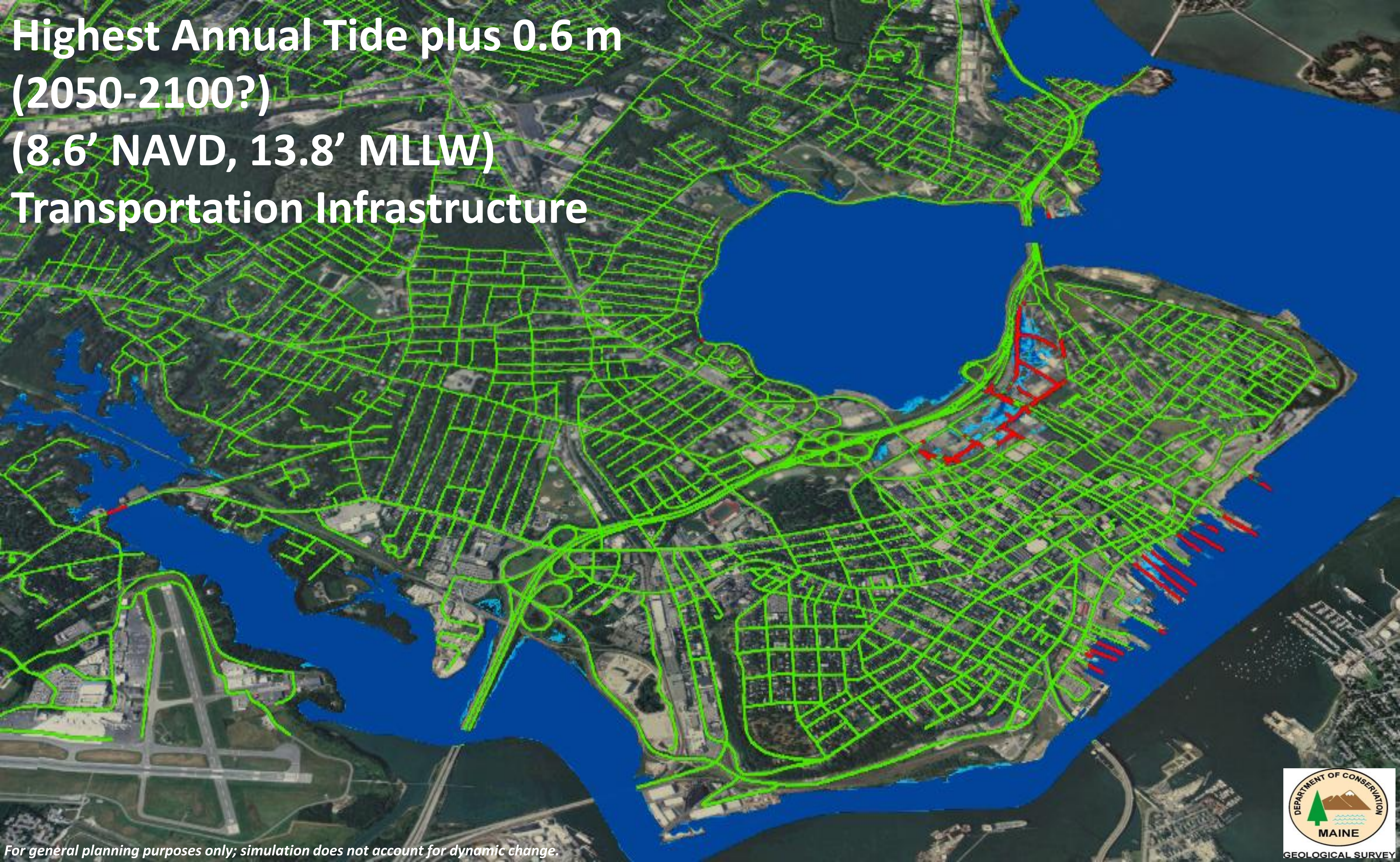
Highest Annual Tide plus 0.6 m
(2050-2100?)
(8.6’ NAVD, 13.8’ MLLW)
Transportation Infrastructure
For general planning purposes only; simulation does not account for dynamic change.
DEPARTMENT OF CONSERVATION
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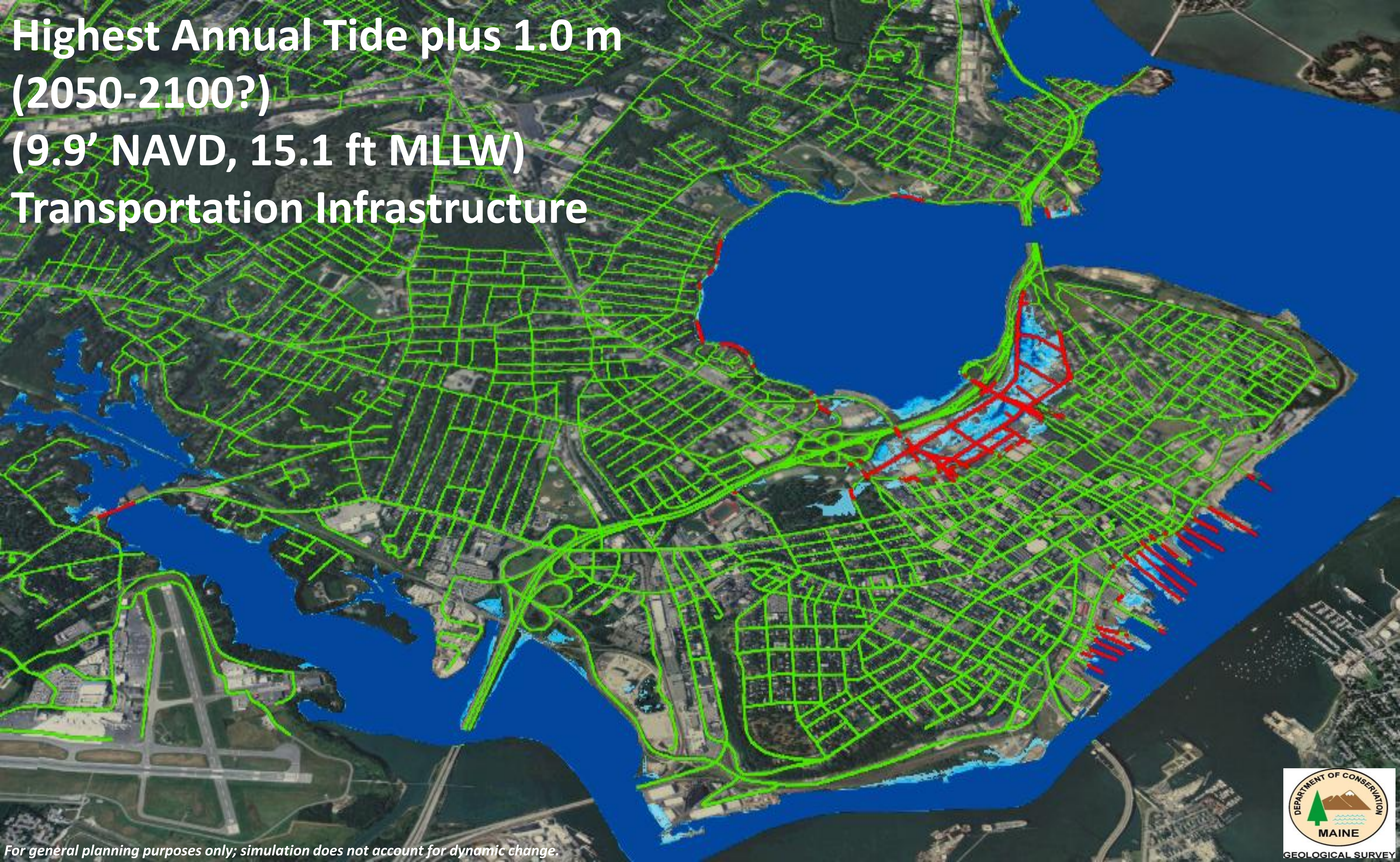
GEOLOGICAL SURVEY

Highest Annual Tide plus 1.0 m
(2050-2100?)
(9.9’ NAVD, 15.1 ft MLLW)
Transportation Infrastructure



For general planning purposes only; simulation does not account for dynamic change.

Highest Annual Tide plus 1.8 m
(2100-??)
(12.5’ NAVD, 17.7’ MLLW)
Transportation Infrastructure

For general planning purposes only; simulation does not account for dynamic change.

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GEOLOGICAL SURVEY


Historic 1978 Storm
(8.9’ NAVD, 14.1’ MLLW)
Transportation Infrastructure
For general planning purposes only; simulation does not account for dynamic change.
DEPARTMENT OF CONSERVATION
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GEOLOGICAL SURVEY


1978 Storm plus 0.3 m
(2030-2050?)
(9.9' NAVD, 15.1 ft MLLW)
Transportation Infrastructure
For general planning purposes only; simulation does not account for dynamic change.
DEPARTMENT OF CONSERVATION
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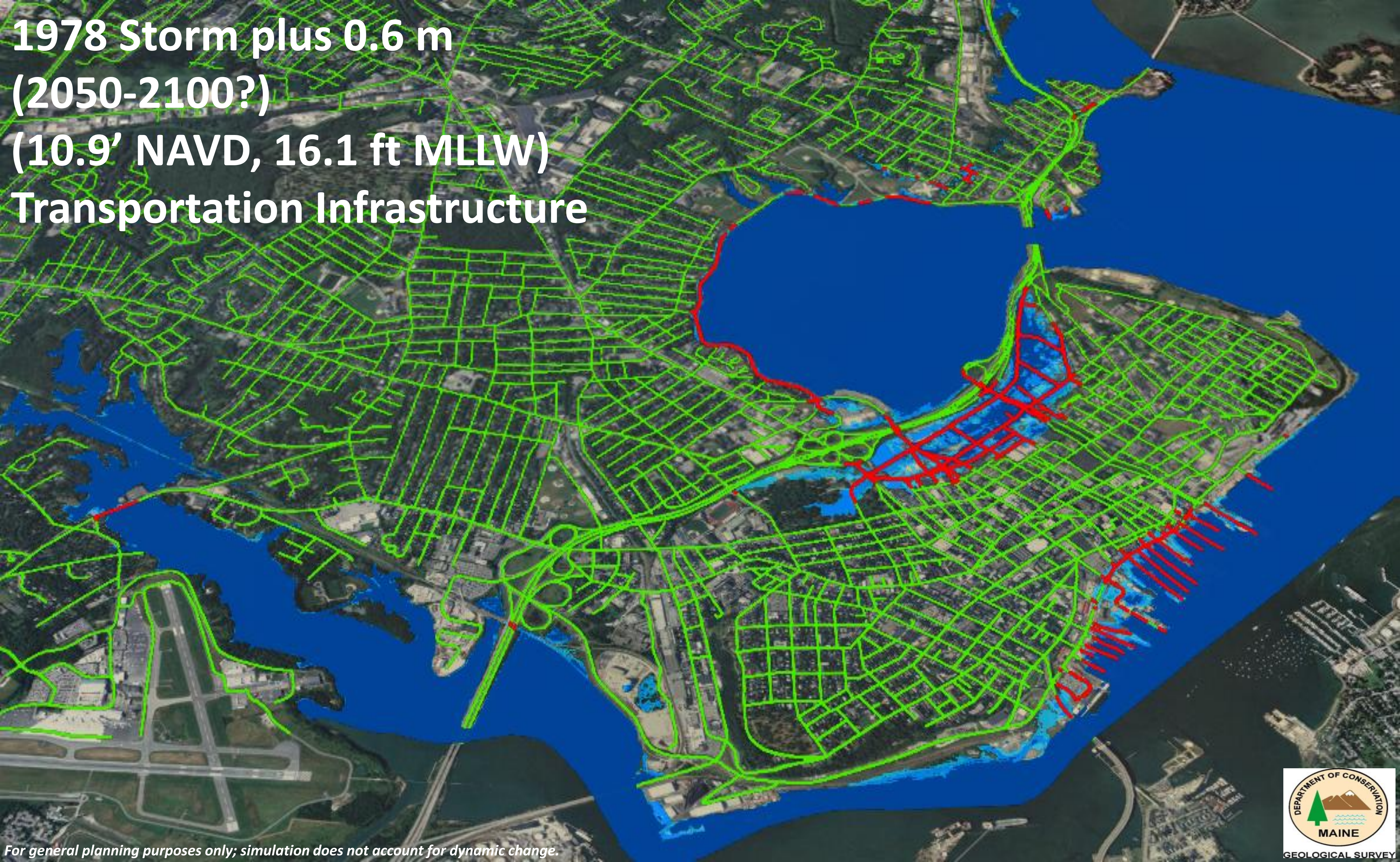
GEOLOGICAL SURVEY

1978 Storm plus 0.6 m (2050-2100?) (10.9’ NAVD, 16.1 ft MLLW) Transportation Infrastructure



For general planning purposes only; simulation does not account for dynamic change.


1978 Storm plus 1.0 m
(2050-2100?)
(12.2’ NAVD, 17.4’ MLLW)
Transportation Infrastructure
For general planning purposes only; simulation does not account for dynamic change.
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1978 Storm plus 1.8 m
(2100-??)
(14.8’ NAVD, 20.0’ MLLW)
Transportation Infrastructure
For general planning purposes only; simulation does not account for dynamic change.
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Summary of Potentially Vulnerable Road* Infrastructure

Scenario	Highest Annual Tide	1978 Storm
Existing	1.1 miles	3.6 miles
+0.3 m (1 ft) SLR	1.4 miles	6.4 miles
+0.6 m (2 ft) SLR	2.8 miles	10.7 miles
+1.0 m (3.3 ft) SLR	6.2 miles	13.9 miles
+1.8 m (6.0 ft) SLR	14.5 miles	17.8 miles

** Assumes "bathtub" flooding, static topography, and that a road is "inundated" if the flooding scenario* ***covers*** *the entire road, regardless of the flooding depth. Does not assign any kind of damage function.*

<u>Some Potential</u> Adaptation Techniques

Consider identifying areas of undeveloped uplands which may allow for the landward migration of coastal marshes.

Consider using natural and mixed buffers against erosion and flooding

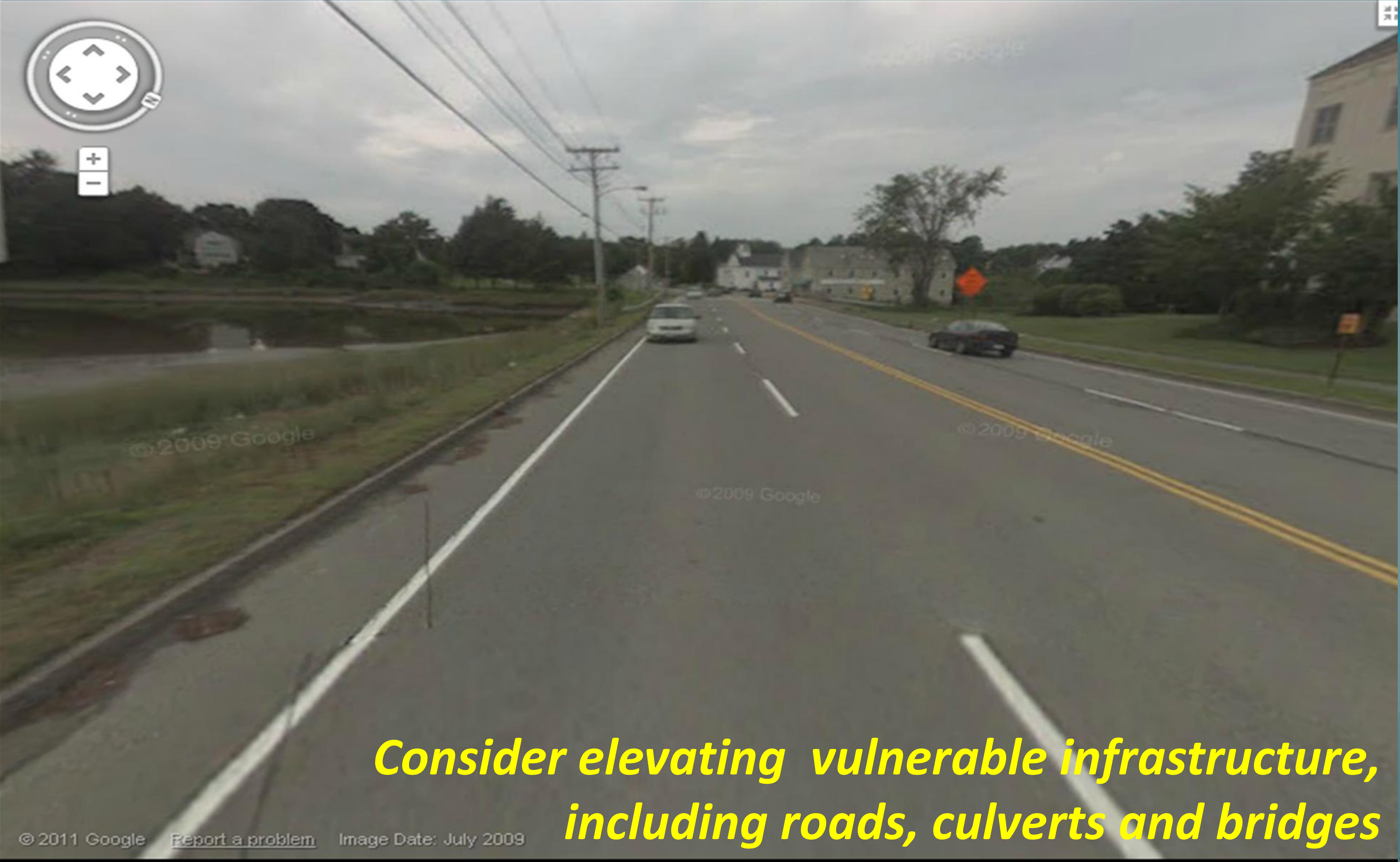

Consider engineering methods for storm surge protection
Stamford, CT
USACE

Consider emergency access rerouting

Consider the use of tidal flow control techniques

P.A. Slovinsky, MGS

Consider removing or enhancing tidal restrictions and ensure proper culvert sizing
© 2011 Google
Report a problem
Image Date: July 2009


Consider elevating vulnerable infrastructure,
including roads, culverts and bridges
©2009 Google
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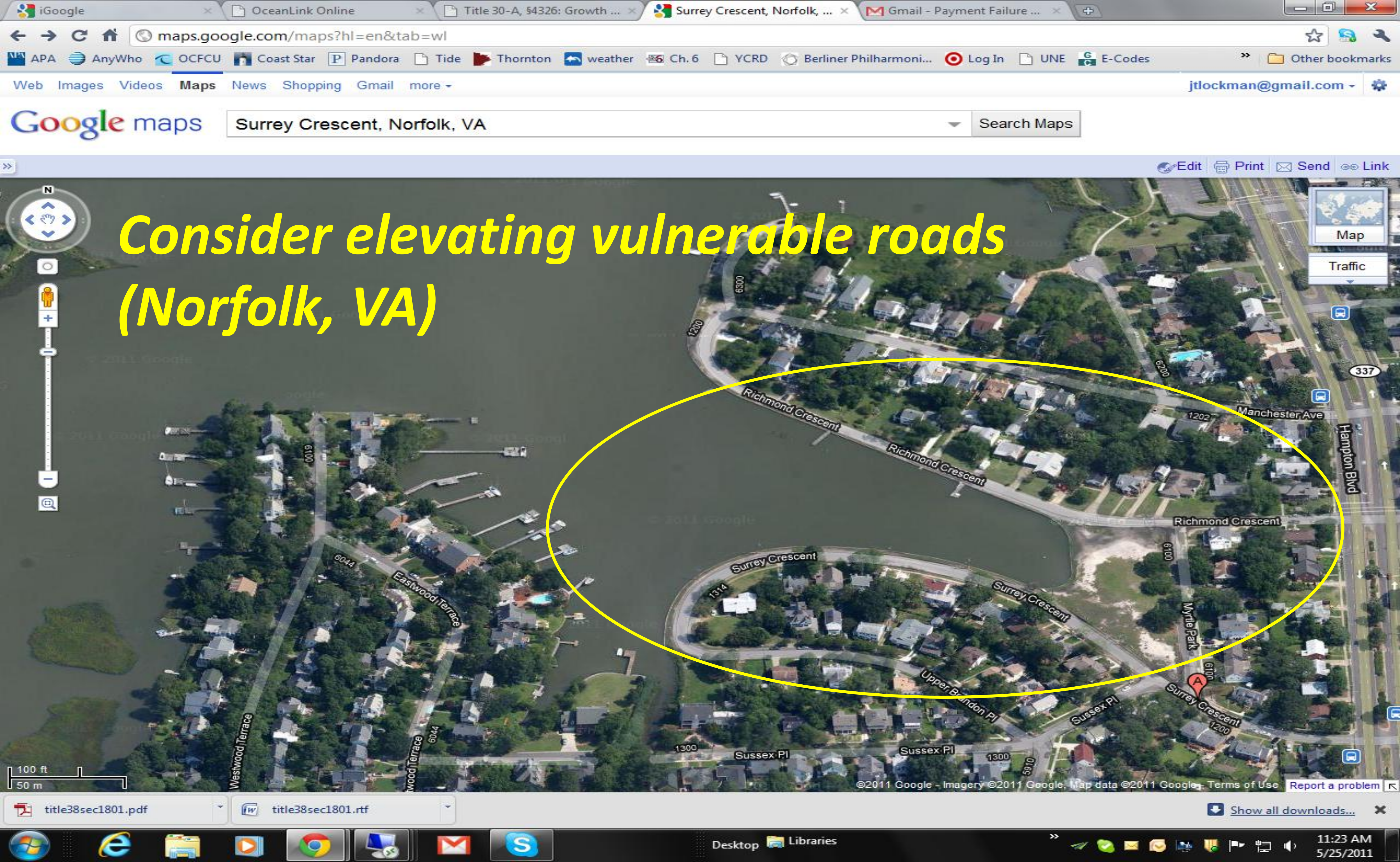
© 2011 Google
Report a problem
Image Date: July 2009

Consider elevating vulnerable roads (Norfolk, VA)




Consider elevating or retrofitting vulnerable infrastructure, including sewer pump stations, roads, culverts and bridges
© 2011 Google
Report a problem
Image Date: July 2009

Consider retrofitting storm drains against tidal flow

Curtis Bohlen, CBEP

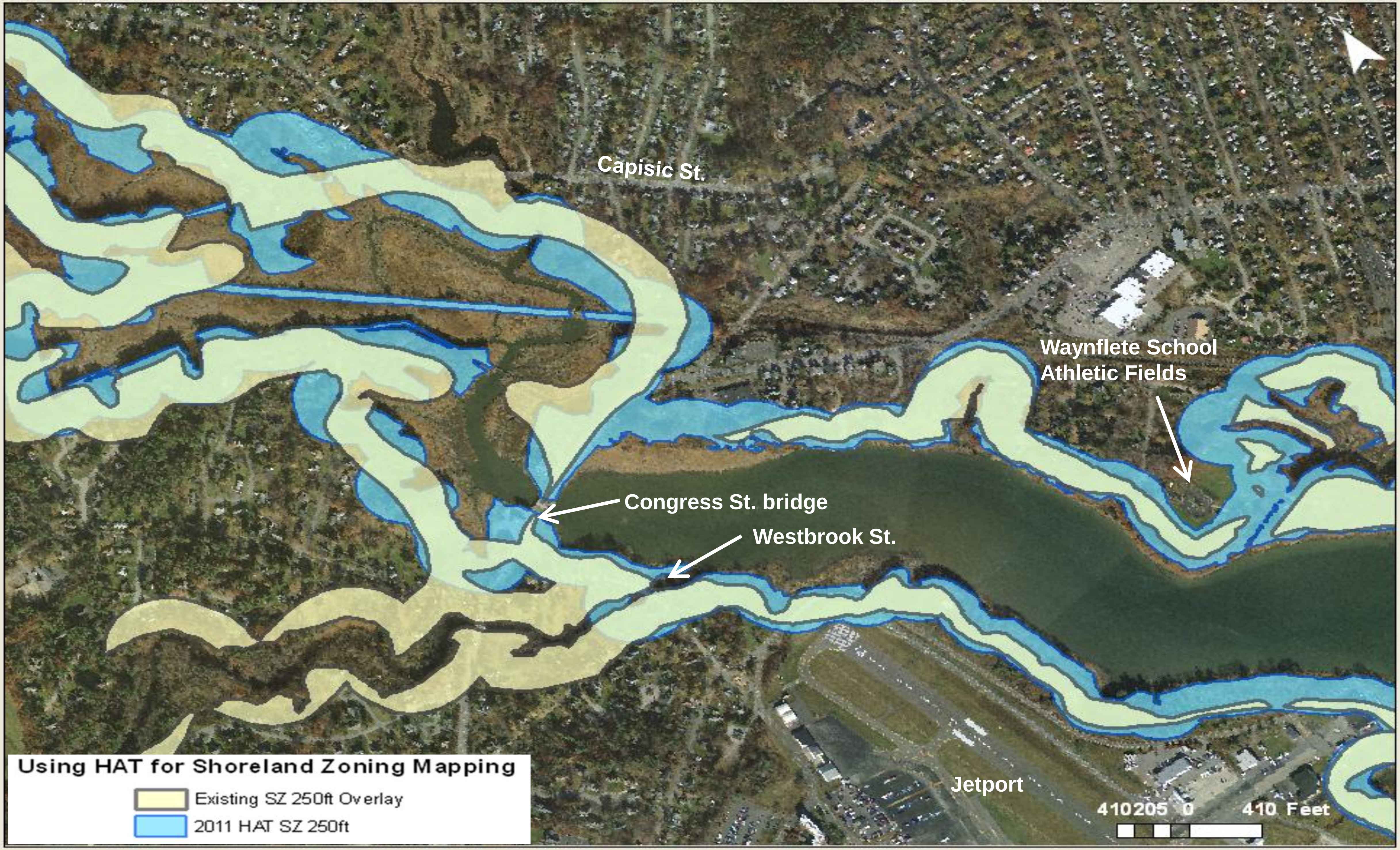

Consider ensuring that water-based infrastructure is adequately constructed
© 2011 Google
Report a problem
Image Date: July 2009

Focused Implementation Strategies… or the "low hanging fruit"

- ***Consider improving Shoreland Zoning Maps using LiDAR (Light Detection and Ranging) to set an accurate shoreline position***
- Shoreland Zone in Tidal Areas defined by the Highest Annual Tide (HAT) Level for each year
- OOB and Saco just adopted new SLZ maps with the shoreline defined using HAT from LiDAR

Old Orchard Beach – East Grand Avenue Area


Martin's Point Bridge (Route 1)
Route 295
Tukey's Bridge
Back Cove
Using HAT for Shoreland Zoning Mapping
Existing SZ 250ft Overlay
2011 HAT SZ 250ft
1,000500 0 1,000 Feet



Capisic St.
Waynflete School
Athletic Fields
Congress St. bridge
Westbrook St.
Jetport
410 205 0 410 Feet
Using HAT for Shoreland Zoning Mapping
Existing SZ 250ft Overlay
2011 HAT SZ 250ft


Current floodplain management ordinance requires structures to be elevated one foot above the 100-year Base Flood Elevation (BFE)
P.A. Slovinsky, MGS

Consider increasing Minimum Floodplain Requirements

Consider increasing "freeboard" to include sea level rise (i.e., 3 feet above the 100 year BFE); results in lower insurance policies!

P.A. Slovinsky, MGS

Lessons Learned

- Use a Scenario Based Approach (depending on infrastructure criticality)
- Use the concept of “no regrets actions”
- Use best science and tools available at the time and allow flexibility
- Consider working with neighbor communities to pool resources, create parallel regulations, and leverage funding for capital improvements
- Be willing to go over and above minimum ordinances or regulations
- Expect unforeseen delays. Expect to take your time!

Lessons Learned

- Don’t separate discussion of natural from built environment impacts – keep environmentalists, planners, architects, public works staff, and emergency personnel around the same table
- 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)
- **Plan for the “storms of today and tides of tomorrow”**

Preparing Portland for the Potential Impacts of Sea Level Rise

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

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