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Current and Future Coastal Flood Inundation of Roadways in New Jersey

RESEARCH BRIEF

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Introduction

Roadway flood inundation can impede travel to work, the distribution of goods, public access to essential services, and emergency response operations. Knowing where and when roads may flood is essential for emergency planning as well as the implementation of the infrastructure upgrades necessary for climate change adaptation to coastal flooding. Currently, coastal inundation layers, like those featured in the National Oceanic and Atmospheric Administration's (NOAA) Sea Level Rise Viewer, generally only show ground level inundation, because they are calculated using bare earth elevation, which does not include surfaces above the ground. While these layers can be useful for assessing the inundation of ground level transportation infrastructure, they are not useful for assessing the inundation of elevated roadways, which are higher than bare earth elevation, or bridges over water.

This report details a novel approach for estimating the extent and depth of roadway inundation using light detection and ranging (LiDAR) derived roadway surface elevations. A desktop analysis was conducted utilizing this approach to provide a first order assessment of flooding impacts under current and future flood scenarios. Four data layers produced from this analysis have been made publicly available and are detailed below. The findings of this analysis may be used by transportation and emergency planners, flood plain managers, and the public to understand the current and future flood risk potential posed to coastal roadways in New Jersey. Local knowledge and ground truthing, however, should be incorporated into local planning processes and further, this analysis should not be used in place of site-specific engineering or surveying requirements.

Methods

This analysis utilized both Esri's ArcGIS Pro software and ArcPy package for Python, as well as federal, state, and original Rutgers University data described below. All data sources and the full methodology are provided in the Appendix for reference.

Flood Scenarios

The following flood scenarios were used for this analysis:

1. Minor High Tide (Nuisance) Flooding
2. Mean Higher High Water (MHHW) + 2 feet (projected 2 feet of sea level rise by 2050)
3. Mean Higher High Water (MHHW) + 4 feet (projected 4 feet of sea level rise by 2100)

High Tide Flooding

The National Oceanic and Atmospheric Administration (NOAA) defines Minor High Tide Flooding as when water levels reach 1.8 feet above the average high tide. Also referred to as sunny day or nuisance flooding, this hazard can cause temporary street and business closures, and stormwater system overflow (NOAA, 2025a, 2025b). The *Minor High Tide Flooding Surface Elevation for New Jersey* layer, produced by Rutgers University for this analysis, was estimated using current NOAA tide gauge data and NOAA's *Coastal High Tide Flooding Mapping Methodology* (NOAA, 2018a).[1]

Sea Level Rise

According to the Rutgers 2025 Science and Technical Advisory Panel (STAP) report, under an intermediate emissions scenario in which current global emissions policies continue, relative to a year 2005 baseline, New Jersey's sea level is projected to rise 0.9 to 1.7 feet by 2050 and 2.2 to 3.8 feet by 2100 (Kopp, et. al., 2025). To estimate these two scenarios, 2 feet and 4 feet were added to the *Mean Higher High Water (MHHW) Surface for New Jersey* layer produced by Rutgers University.[2] The *Mean Higher High Water (MHHW) Surface for New Jersey* layer was created by first converting MHHW surface elevation to land surface elevation in the North American Vertical Datum of 1988 (NAVD88) using NOAA's VDatum tool, (NOAA, 2026) then interpolating a surface inland.

Estimating Roadway Surface Elevation and Inundation

For this analysis, roadway surface elevations were estimated from a statewide digital surface model (DSM) created by Rutgers University using the most recent publicly available light detection and ranging (LiDAR) data as of April 23, 2024. LiDAR is a remote sensing technology that uses a pulsing laser to measure the distance from its source to the Earth's surface (NOAA, 2024). These LiDAR data were downloaded from the New Jersey Geographic Information Network's (NJGIN) Open Data portal and from NOAA's Office for Coastal Management Digital Coast Data page. A list of all LiDAR datasets used is in the Appendix.

Roadway surface elevations were extracted from the DSM using the New Jersey Office of GIS's *Road Centerlines of NJ – Next Gen 911* layer. Using aerial photography, minor editing

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[1]The *Minor High Tide Flooding Surface Elevation for New Jersey* layer was created using only six data points, because there are only six tide gauge stations with high tide flooding threshold data for New Jersey. As a result, the resolution of this layer is coarser than that of the layers used to estimate projected sea level rise, which were created using a grid of data points covering the entire coastal area. This difference in resolution results in roadways showing as inundated in some areas during the high tide flooding scenario but not in the 2 feet of projected sea level rise in 2050 scenario.

[2] For sea-level rise projections, the 2025 STAP Report uses a 2005 baseline (averaging over 1995-2014). Rutgers University's *Mean Higher High Water (MHHW) Surface for New Jersey* layer, which was used to estimate these projections, was created using data from the current National Tidal Datum Epoch (NTDE), which averages sea levels measured between 1983 and 2001. To convert projections from the 2025 STAP report to the current NTDE, .21 feet were added, as per guidance in Table 4 of the STAP report. The projections become 1.9 feet by 2050 and 4 feet by 2100 (Kopp, et. al., 2025; NOAA, 2018b).

was done to this layer prior to extraction to correct for roadway lines that did not align properly with the DSM. Hurricane evacuation route surface elevations were extracted from the DSM using the Esri Federal User Community's *Hurricane Evacuation Routes (Archive)* layer.[3] Finally, roadway surface elevations were subtracted from the estimated surface elevations of the three flood scenarios to estimate the extent and depth of current and future roadway inundation. Image 1 shows the result of this analysis for Atlantic City area roadways under the projected sea level rise in 2050 (MHHW + 2 feet) and the projected sea level rise in 2100 (MHHW + 4 feet) scenarios.

Estimating Bridge Inundation

The New Jersey Department of Environmental Protection's *Land Use/Land Cover of New Jersey 2020* layer was used to identify bridge locations, because the *Road Centerlines of NJ – Next Gen 911* layer does not include bridge data. To estimate bridge inundation, "BRIDGE OVER WATER" was selected from the LABEL20 attribute field in the *Land Use/Land Cover of New Jersey 2020* layer. If any section of roadway along a bridge was determined to be inundated during one of the three flood scenarios, that bridge was determined to be inundated during that scenario as well. Image 2 shows Absecon area roadways and bridges potentially inundated by projected sea level rise in 2100 (MHHW + 4 feet).

Data Products

Four data layers produced from the above analyses by Rutgers University are publicly available on Esri's ArcGIS Online (AGOL) platform and listed in the Appendix. The *Coastal Flood Inundation Analysis for New Jersey Roadways* layer estimates the flooding of roadways in the state resulting from 1 through 20 feet of coastal inundation. The *Coastal Flood Inundation Analysis for New Jersey Hurricane Evacuation Routes* layer estimates the flooding of hurricane evacuation routes in the state resulting from 1 through 20 feet of coastal inundation. The *High Tide Flooding Inundation Analysis for New Jersey Roadways* layer estimates the flooding of roadways in the state resulting from minor high tide flooding. Finally, the *High Tide Flooding Inundation Analysis for New Jersey Hurricane Evacuation Routes* layer estimates the flooding of hurricane evacuation routes in the state resulting from minor high tide flooding.

Findings

The following three tables show potential roadway, hurricane evacuation route, and bridge inundation by county for each of the three flood scenarios used in this analysis. The "Road Miles" and "Hur Evac Miles" columns in each table show the miles of roadway and

[3] The Hurricane Evacuation Routes (Archive) layer includes evacuation routes designated by each county and the New Jersey Office of Emergency Management and may not include locally designated evacuation routes.

hurricane evacuation routes potentially inundated for each county. The "% Road Miles" and "% Hur Evac Miles" columns show the percentage of total roadway and hurricane evacuation route miles potentially inundated for each county. The "Bridges" column shows the number of bridges potentially inundated for each county. The "% Bridges" column shows the percentage of total bridges potentially inundated for each county.[4]

Minor High Tide (Nuisance) Flooding

Roadways, Hurricane Evacuation Routes, and Bridges Inundated by High Tide Flooding						
County	Road Miles	% Road Miles	Hur Evac Miles	% Hur Evac Miles	Bridges	% Bridges
ATLANTIC	4.72	0.19	0	0	1	0.94
BERGEN	19.19	0.54	0.59	1.12	2	0.75
BURLINGTON	1.63	0.04	0.00	0.00	2	1.16
CAMDEN	2.23	0.09	0.05	0.05	0	0
CAPE MAY	7.40	0.57	0.32	0.20	1	1.49
CUMBERLAND	30.87	2.05	0.71	0.47	12	15.79
GLOUCESTER	10.31	0.50	1.23	0.62	0	0
HUDSON	4.79	0.58	1.33	1.51	0	0
MIDDLESEX	1.11	0.03	0.01	0.02	0	0
MONMOUTH	6.95	0.15	0	0	0	0
OCEAN	53.90	1.41	3.94	1.17	0	0
SALEM	32.39	3.29	4.38	2.35	0	0

Table 1. Potential roadway, hurricane evacuation route, and bridge inundation from minor high tide (nuisance) flooding by county in New Jersey.

According to this analysis, during current high tide (nuisance) flooding, Ocean, Salem, and Cumberland counties have the most miles of roadway inundation, while Salem County has the highest percentage of roadway inundation, followed by Cumberland and Ocean. Salem and Ocean counties also have the most hurricane evacuation route inundation. With 12, or almost 16% of its total, Cumberland County has the most bridges inundated in this scenario, many of them in low-lying wetland areas.

[4] Counties with less than one mile of roadway or hurricane evacuation route inundation and no bridge inundation were not included in the tables.

Projected Sea Level Rise in 2050 (MHHW + 2 feet)

Roadways, Hurricane Evacuation Routes, and Bridges Inundated by 2ft of Sea Level Rise						
County	Road Miles	% Road Miles	Hur Evac Miles	% Hur Evac Miles	Bridges	% Bridges
ATLANTIC	23.90	0.96	0.59	0.23	1	0.94
BERGEN	22.88	0.65	0.73	1.38	1	0.37
BURLINGTON	1.55	0.04	0.00	0.00	2	1.16
CAMDEN	1.84	0.07	0	0	0	0
CAPE MAY	53.40	4.12	1.18	0.72	1	1.49
CUMBERLAND	32.42	2.16	0.50	0.33	13	17.11
GLOUCESTER	10.92	0.53	1.26	0.63	6	4.55
HUDSON	4.13	0.50	1.32	1.50	0	0
MIDDLESEX	1.26	0.03	0.04	0.06	0	0
MONMOUTH	9.49	0.21	0	0	0	0
OCEAN	69.97	1.83	4.15	1.23	0	0
SALEM	34.36	3.49	4.64	2.49	0	0

Table 2. Potential roadway, hurricane evacuation route, and bridge inundation from projected sea level rise in 2050 (MHHW + 2 feet) by county in New Jersey.

Ocean, Cape May, Salem, and Cumberland counties will potentially have the most roadway inundation by 2050 with a projected 2 feet of sea level rise, but Cape May County may have the highest percentage of roadway inundation, followed by Salem. Salem and Ocean counties again have the most potential hurricane evacuation route inundation, and Cumberland County again may have the most bridges inundated in this scenario.

Projected Sea Level Rise in 2100 (MHHW + 4 feet)

Roadways, Hurricane Evacuation Routes, and Bridges Inundated by 4ft of Sea Level Rise						
County	Road Miles	% Road Miles	Hur Evac Miles	% Hur Evac Miles	Bridges	% Bridges
ATLANTIC	170.24	6.87	9.12	3.63	12	11.32
BERGEN	78.71	2.23	5.34	10.07	6	2.24
BURLINGTON	23.35	0.62	2.55	1.19	5	2.89
CAMDEN	24.29	0.98	1.46	1.23	1	0.98
CAPE MAY	216.40	16.71	19.53	11.83	8	11.94
CUMBERLAND	59.87	3.98	4.02	2.66	22	28.95
ESSEX	1.73	0.08	0.52	1.43	0	0
GLOUCESTER	26.20	1.27	3.32	1.66	8	6.06
HUDSON	28.01	3.38	2.75	3.12	1	1.69
MIDDLESEX	7.13	0.20	0.44	0.79	0	0
MONMOUTH	73.92	1.64	2.32	0.90	0	0
OCEAN	404.81	10.57	26.17	7.77	0	0
SALEM	88.83	9.03	11.29	6.06	0	0
UNION	2.09	0.12	0	0	0	0

Table 3. Potential roadway, hurricane evacuation route, and bridge inundation from projected sea level rise in 2100 (MHHW + 4 feet) by county in New Jersey.

By 2100, with 4 feet of projected sea level rise, Ocean, Cape May, and Atlantic counties will have the most potential for roadway inundation, but Cape May again may have the highest percentage of total miles inundated. Ocean and Cape May counties will also potentially have the most hurricane evacuation route inundation, followed by Salem. With 22, or just under 29% of its total, Cumberland County once again may have the most bridges inundated in this scenario, mainly in low-lying wetland areas, followed by Atlantic and Cape May counties. The following two images show roadways potentially inundated in the Atlantic City area and roadways and bridges potentially inundated in the Absecon area during this scenario.

Image 1. Atlantic City area roadways potentially inundated by projected sea level rise in 2050 (MHHW + 2 feet) in blue and projected sea level rise in 2100 (MHHW + 4 feet) in purple.

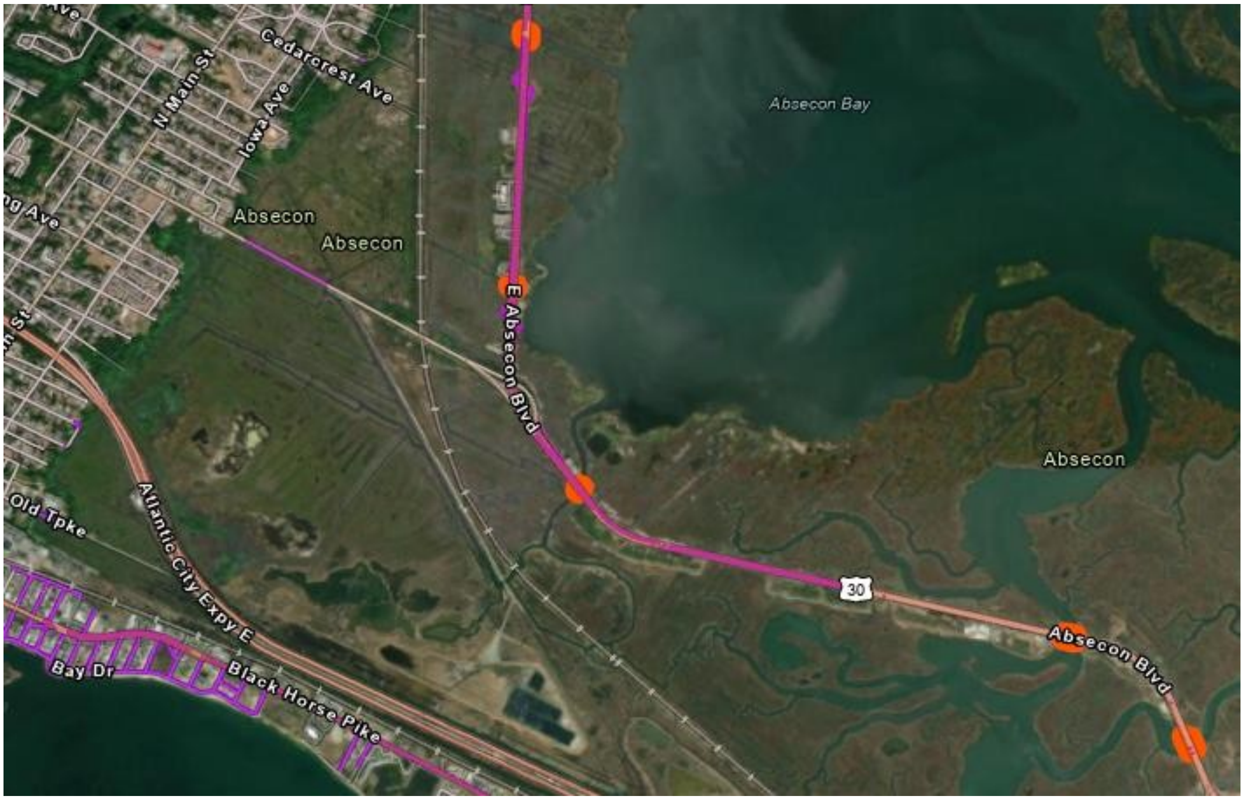

Image 2. Absecon area roadways (in purple) and bridges (in orange) along Absecon Blvd/Route 30 potentially inundated by projected sea level rise in 2100 (MHHW + 4 feet).

In general, the southern coastal counties of Ocean, Atlantic, Cape May, Cumberland, and Salem have the most roadways, hurricane evacuation routes, and bridges vulnerable to potential inundation in the three scenarios used in this analysis. The findings show these vulnerabilities continue to increase considerably in the potential miles and bridges inundated between the 2050 and 2100 scenarios. This suggests that preparing for projected 2 feet of sea level rise in 2050 alone may not sufficiently prepare NJ counties and municipalities for the significant increase in permanent inundation they may experience 50 years later.

The findings of this analysis may be used by transportation and emergency planners, flood plain managers, and the public to understand the current and future flood risk potential posed to coastal roadways and bridges in New Jersey. Applications of this analysis include emergency planning; identifying potential areas for roadway and bridge elevation; anticipating potential impacts on new roadway and bridge construction projects; and understanding the potential risks to individuals and motor vehicles at various roadway inundation depths. Building on this work, the NJ Climate Change Resource Center has begun work on expanding this analysis to include the inundation of inland roadways and bridges.

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NOAA (2026). Vertical Datum Transformation. https://vdatum.noaa.gov/

Appendix

Data Sources

Esri Federal User Community (2026). Hurricane Evacuation Routes (Archive). https://www.arcgis.com/home/item.html?id=29f5a1e6bf1e4394a692ba633d5c8af6

The following data were downloaded from the National Oceanic and Atmospheric Administration's (NOAA) Office for Coastal Management **Digital Coast Data** page (https://coast.noaa.gov/digitalcoast/data/) to create a statewide DSM:

> **2017 USACE NCMP Topobathy Lidar: East Coast (NY, NJ, DE, MD, VA, NC, SC, GA)**, provided by the U.S. Army Corps of Engineers, U.S. Army Corps of Engineers National Coastal Mapping Program (Metadata: https://www.fisheries.noaa.gov/inport/item/52444).
>
> **2020 USACE USGS Topobathy Lidar: Cape May & Atlantic City, NJ**, provided by the U.S. Army Corps of Engineers, U.S. Army Corps of Engineers National Coastal Mapping Program (Metadata: https://www.fisheries.noaa.gov/inport/item/66979).
>
> **2020 USACE NAN Topobathy Lidar: New Jersey and New York**, provided by the U.S. Army Corps of Engineers (Metadata: https://www.fisheries.noaa.gov/inport/item/58879).
>
> **2022 USACE USGS Topobathy Lidar: East Coast (NY, NJ)**, provided by the U.S. Army Corps of Engineers National Coastal Mapping Program (Metadata: https://www.fisheries.noaa.gov/inport/item/70177).
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> **2022 City of Philadelphia Lidar: Philadelphia, PA**, provided by the City of Philadelphia (Metadata: https://www.fisheries.noaa.gov/inport/item/70168).

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The following data were downloaded from the New Jersey Geographic Information Network's (NJGIN) **Open Data** portal (https://njogis-newjersey.opendata.arcgis.com/) to create a statewide DSM:

Northeast_NJ_Post-Sandy_2014_LiDAR_Tile_Grid_(Hosted): https://njogis-newjersey.opendata.arcgis.com/datasets/newjersey::northeast-nj-post-sandy-2014-lidarhttps://njogis-newjersey.opendata.arcgis.com/datasets/newjersey::northeast-nj-post-sandy-2014-lidar-tile-grid-hosted/abouttile-grid-hosted/about

DVRPC 2015 LiDAR Tile Grid (Hosted):

https://njogis-newjersey.opendata.arcgis.com/datasets/newjersey::dvrpc-2015-lidar-tile-grid-hosted/aboutgrid-hosted/about

Northwest NJ 2018 LiDAR Tile Grid (Hosted): https://njogis-newjersey.opendata.arcgis.com/datasets/northwest-nj-2018-lidar-tile-grid-hosted/explore

South NJ 2019 LiDAR Tile Grid (Hosted): https://njogis-newjersey.opendata.arcgis.com/datasets/south-nj-2019-lidar-tile-grid-hosted/explore

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Methodology

Esri's ArcGIS pro software and ArcPy package for Python were used to conduct the following analysis. Microsoft Excel was used for final table formatting.

1. New Jersey Office of GIS's *Road Centerlines of NJ – Next Gen 911* layer was edited to add municipal and county data and correct for misaligned or overlapping roadways.
2. The **Extract By Mask** tool was used to extract roadway surface elevations from the digital surface model (DSM).
3. The **Raster Calculator** was used to create roadway inundation depth rasters for each flood scenario by subtracting the extracted roadway surface elevations from the estimated flood surface elevation for each scenario.
4. The **Create Constant Raster** tool was used to create extent rasters from the depth rasters.
5. The **Raster to Polygon** tool was used to create a polygon feature class from each extent raster.
6. The **Pairwise Clip** tool was used to clip the edited *Road Centerlines of NJ – Next Gen 911* layer using each flood extent polygon feature class to get inundated roadways for each flood scenario.

7. The **Pairwise Erase** tool was used to erase the inundated roadways from the edited *Road Centerlines of NJ – Next Gen 911* layer to get roadways not flooded in each flood scenario.
8. The **Multipart to Singlepart** tool was used to separate roadway sections in the clipped *Road Centerlines of NJ – Next Gen 911* layer into separate sections.
9. The **Zonal Statistics as Table** tool was used to calculate the minimum, maximum, and mean depth of each separate roadway section in the clipped *Road Centerlines of NJ – Next Gen 911* layer for each flood scenario.
10. The statistics fields from each zonal statistic table were joined to the edited *Road Centerlines of NJ – Next Gen 911* layer.
11. Bridges were identified by selecting features with a 'BRIDGE OVER WATER' value in the LABEL20 field of the New Jersey Department of Environmental Protection's *Land Use/Land Cover of New Jersey 2020* layer.
12. The **Select by Location** tool was used to select bridges that intersected inundated roadways for each flood scenario to determine bridge inundation.