



Sea Level Rise and the Effects of Storm Surge on Lewis Bay, Cape Cod

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Reason for choosing this topic

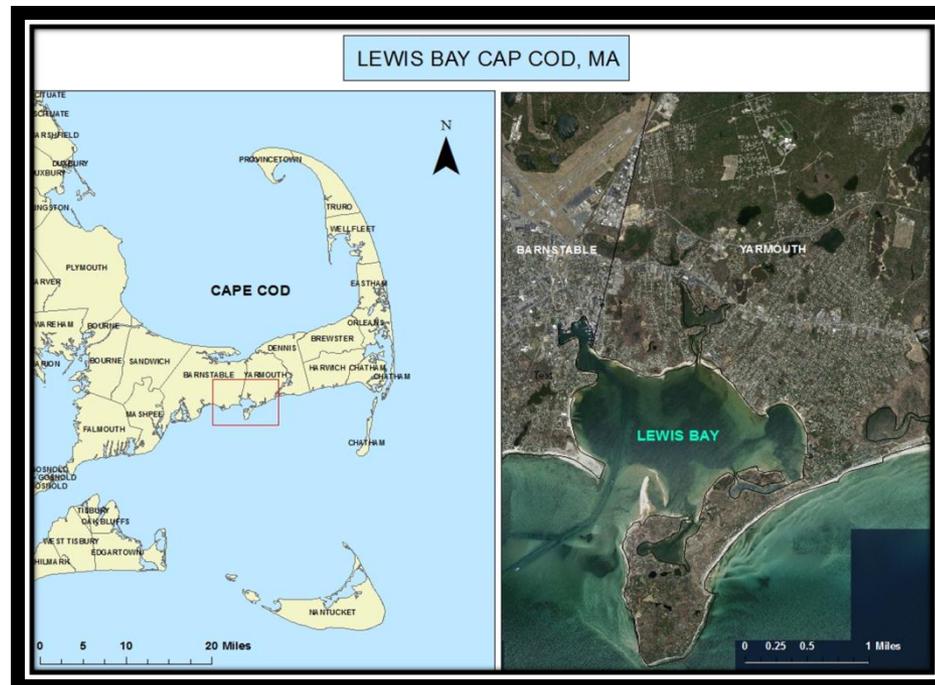


- Scientific studies have proven that global sea level has risen 7.1 inches in the past century and computer models have suggested that climate change will cause an additional rise of approximately 19 inches by the year 2100 (Theiler, R.E., Williams, S.J., and Beavers, R. 1).
- An MIT study has shown that the intensity of North American hurricanes has more than doubled in the past thirty years due to warmer ocean temperatures caused by global warming (O'Brien 1).
- Cape Cod has fallen victim to some 16 hurricanes since 1879 and if predictions hold true this number and strength of storms could increase exponentially (<http://www.hurricanecity.com/city/capecod.htm>).
- If sea level does continue to rise and if storms do become increasingly more powerful, how will this effect certain coastal areas?



Area of Focus

- Lewis Bay, Cape Cod
- Lewis Bay is situated within the towns of Barnstable and Yarmouth
- These towns have a combined population of 72,628 according to pop_2000 census data



LEWIS BAY CAP COD, MA



Why Lewis Bay?



- Susceptible to extreme weather



- South facing coastal area
- Low elevations
- Major tourism industry
- Infrastructure situated in areas of relatively low elevations

Types of Infrastructure



- Police Departments
- Fire Departments
- Airport
- Hospital
- Nursing Homes
- Schools
- Libraries
- Seaports
- Lighthouses
- Town Hall



<http://www.lightdreamer.com/lewisbay/h38ea0c8f#h38ea0c8f>

Objective



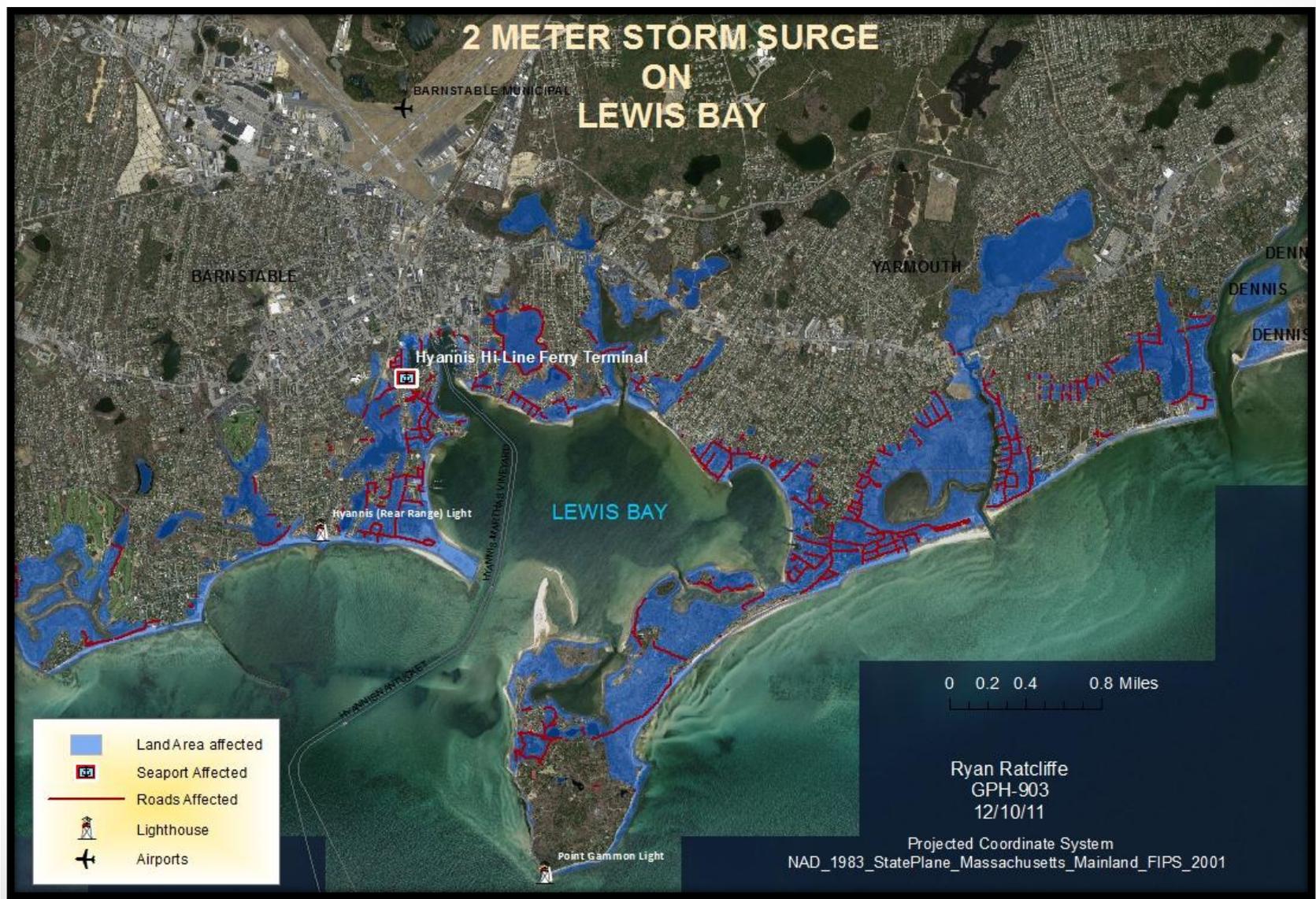
- The objective of this project is to display the area of Lewis Bay and how it, along with its infrastructure, would be impacted based on the 3 different scenarios:
 1. Category 1 hurricane with a 2 meter storm surge
 2. Category 3 hurricane with a 4 meter storm surge
 3. Category 4 hurricane with a 6 meter storm surge
- All three categories are taking into account a 2 foot sea level rise by the year 2100 (Wu 1).

Method



- There have been many ways to determine an area's susceptibility. The USGS's coastal vulnerability index or (CVI) uses the following 6 variables (Theiler, R.E., Williams, S.J., and Beavers, R. 1):
 1. Tidal range
 2. Wave height
 3. Coastal slope
 4. Historic shoreline change rates
 5. Geomorphology (erodability)
 6. Historic rates of sea level change
- I chose a more basic approach by determining elevations in the area and showing which areas fall within the three categories of storm surge.
- In order to do this I needed to import Digital Terrain Models (DTM) of the Lewis Bay area from MassGIS website.
- Once I imported the data files into ArcMap I could interpolate them using the IDW tool and in turn creating a raster dataset.
- Once I obtained a Digital Elevation Model (DEM), I used the raster calculator tool under map algebra to distinguish the 3 categories that I would be focusing on for this project; 2 meters, 4 meters, and 6 meters.
- Through the MassGIS website I also imported layers of town, roads, and specific types of infrastructure that fall within the area of study.
- With this information I could then display on my maps the areas subject to possible storm surge in each category.

2 Meter Storm Surge

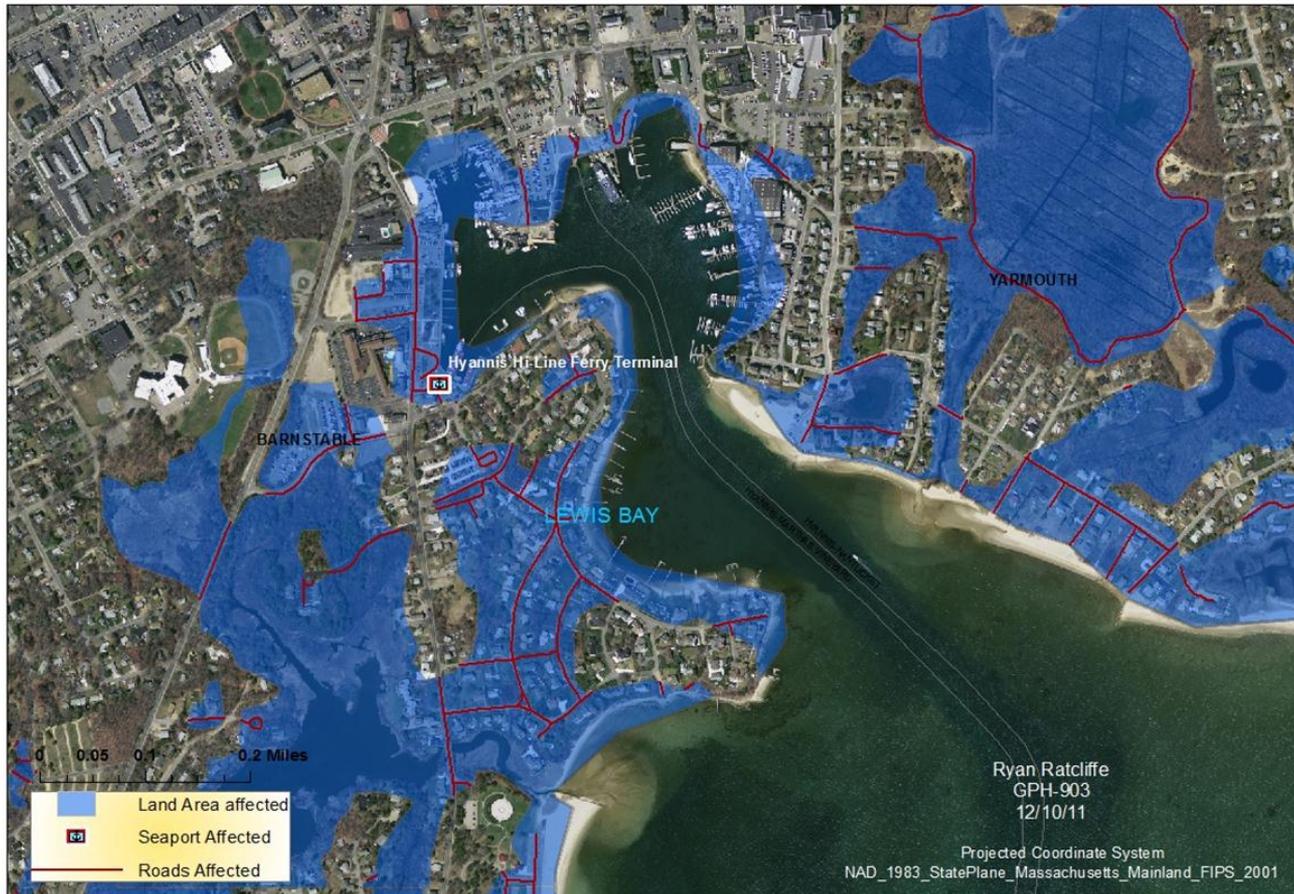


Impact on Lewis Bay with a 2 meter storm surge

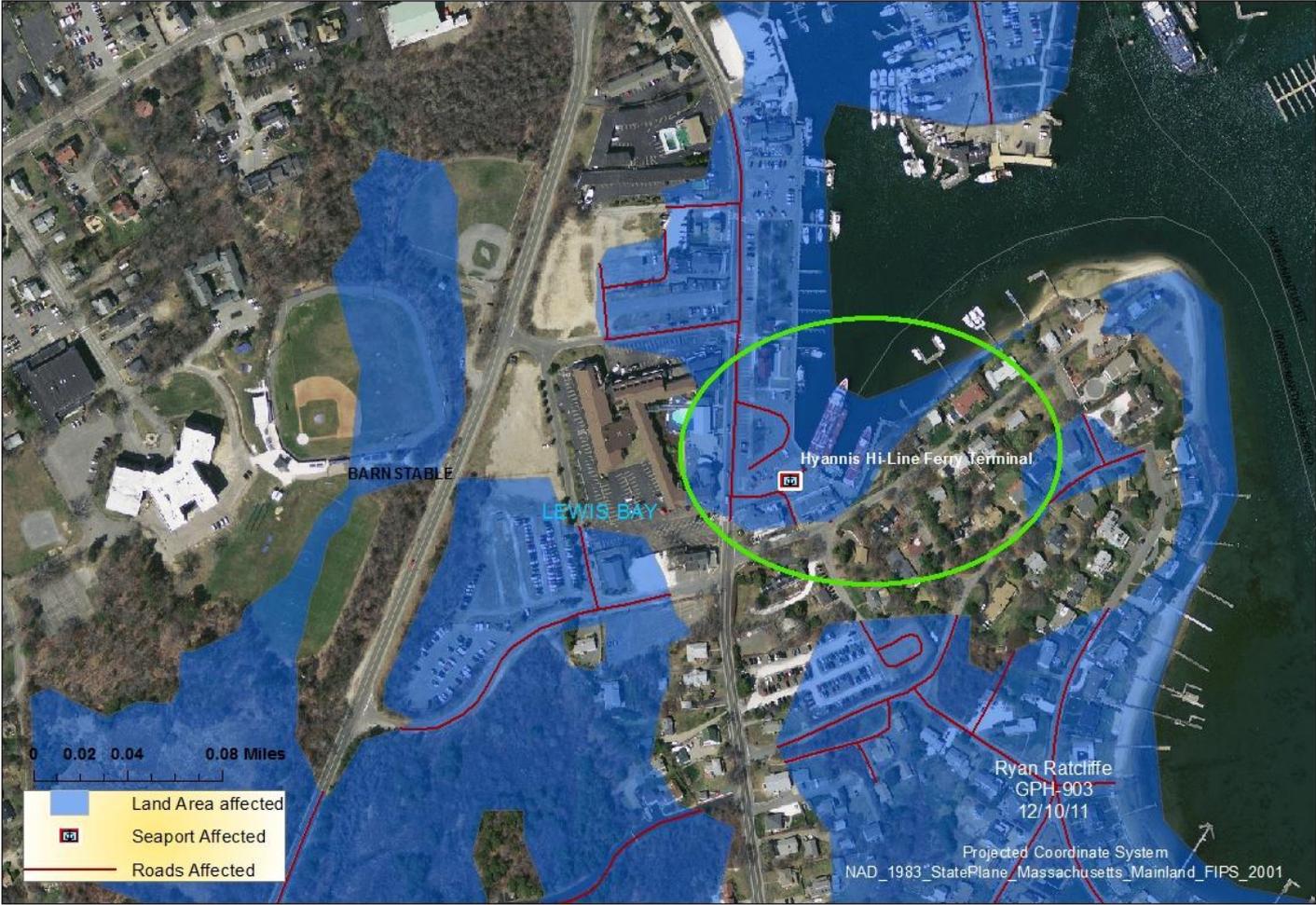


- **LAND AREA** - 3.58 square miles of land area, or 4% of total land area within Barnstable and Yarmouth were effected by the storm surge.
- **ROADS** - Also within this area of study, 29 miles of roads, or 2.9% of the total road length in Barnstable and Yarmouth combined, would be impacted.
- **INFRASTRUCTURE** - The Hyannis Hy-Line Ferry Terminal, which offers year-round ferry service to Nantucket via 800 passenger ferries, is in the 2 meter surge zone as well.

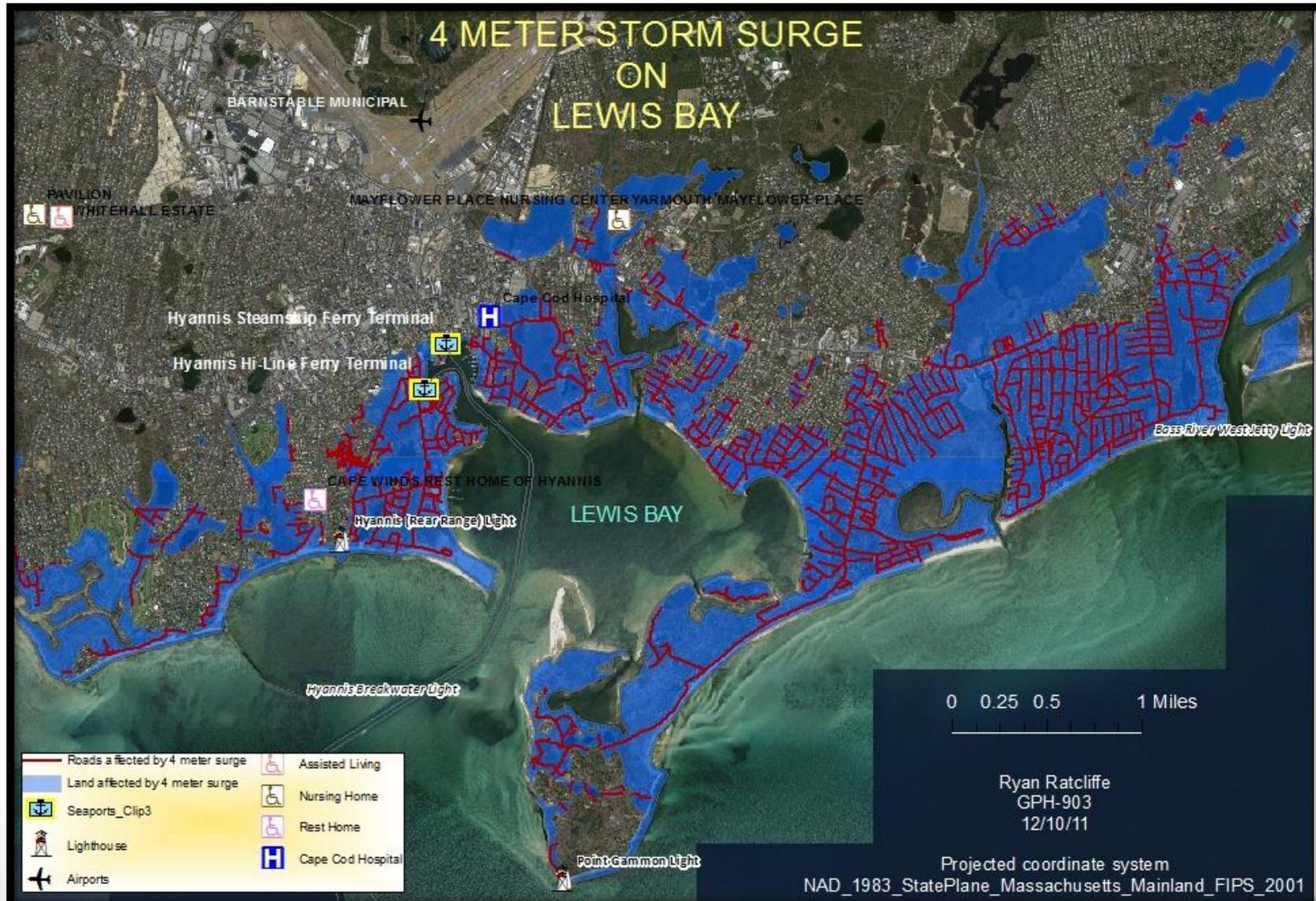
2 Meter Surge Impact on Infrastructure



2 Meter Surge Impact on Infrastructure



4 Meter Storm Surge

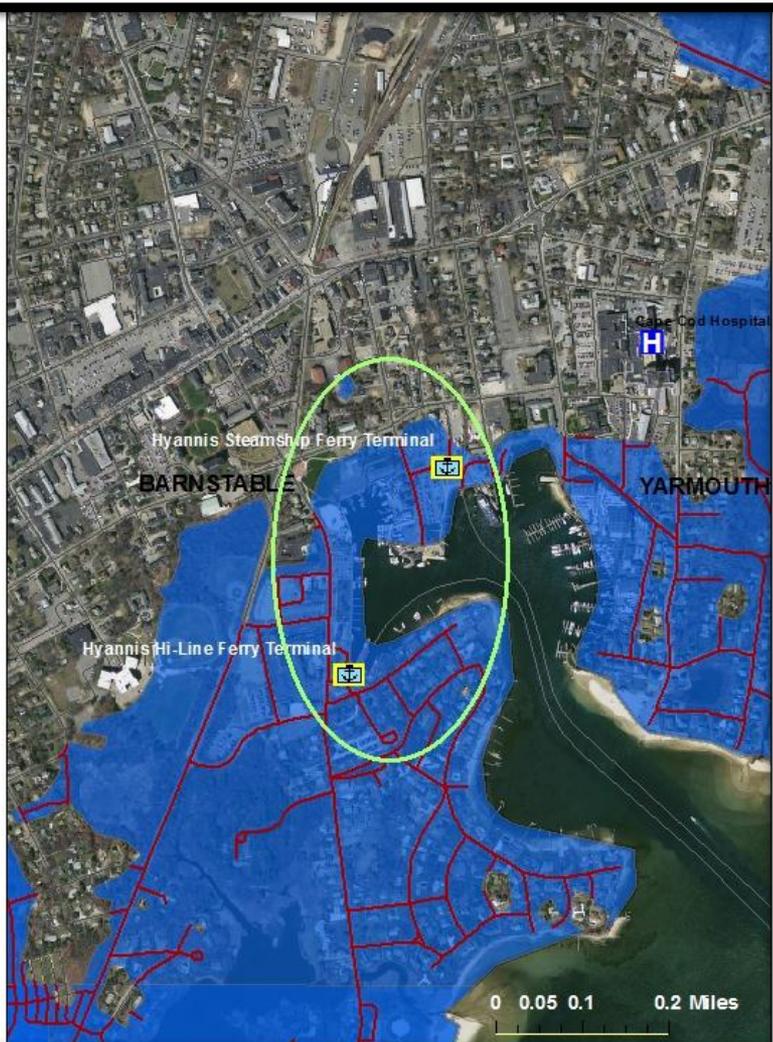
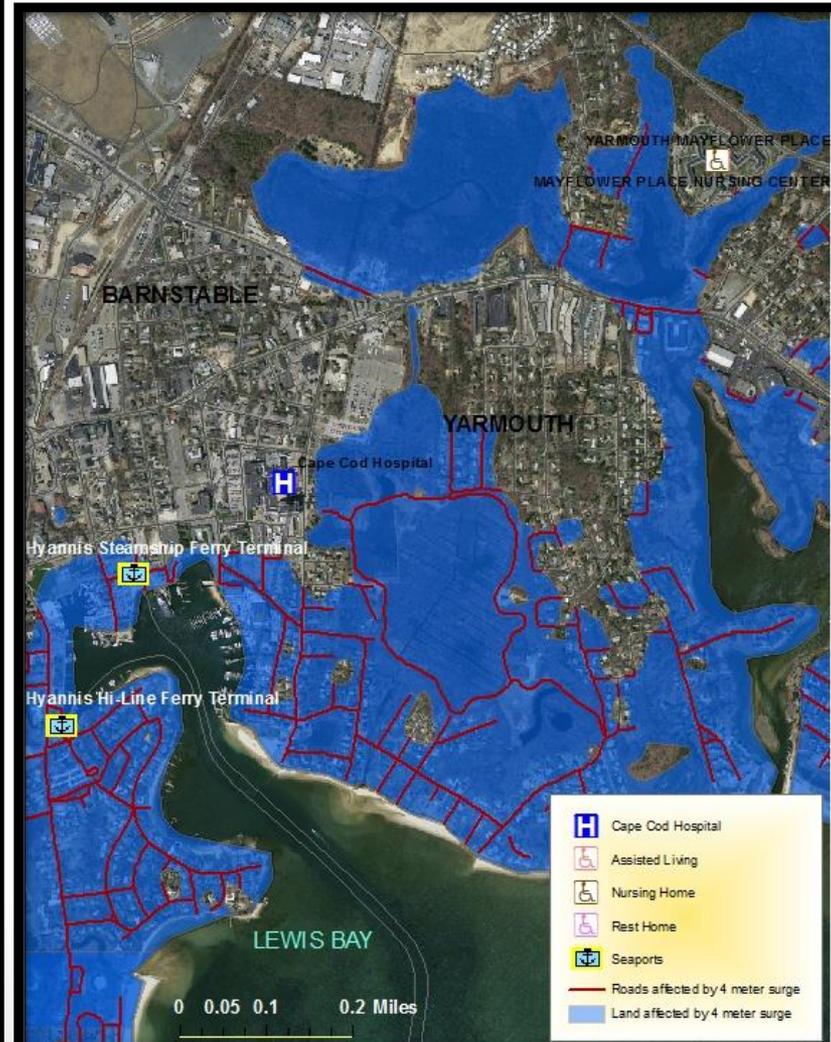


Impact on Lewis Bay with a 4 meter storm surge

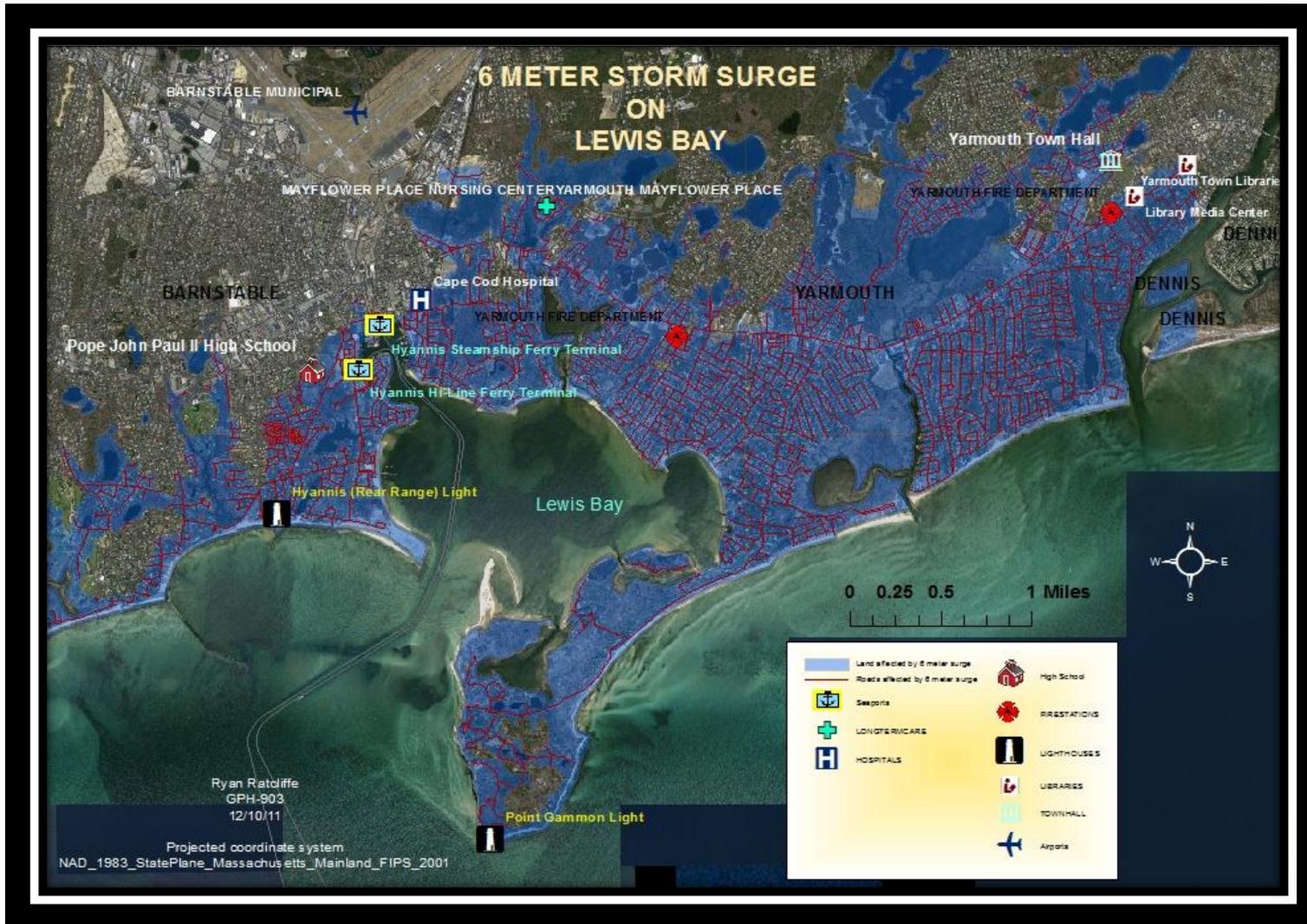


- **AREA** - 6.83 square miles, or 7.76% of land area is in the effected zone.
- **ROADS** - 91 miles of roads, or 9.3% of Yarmouth and Barnstable's roads, within the Lewis Bay area alone.
- **INFRASTRUCTURE** – Now includes the Hyannis Steamship Ferry Terminal, and although the Yarmouth Mayflower Place Nursing Center is not itself within the zone, is it isolated in an area surrounded by storm surge, which could create potential evacuation or access problems.

4 Meter Surge Impact on Infrastructure



6 Meter Storm Surge

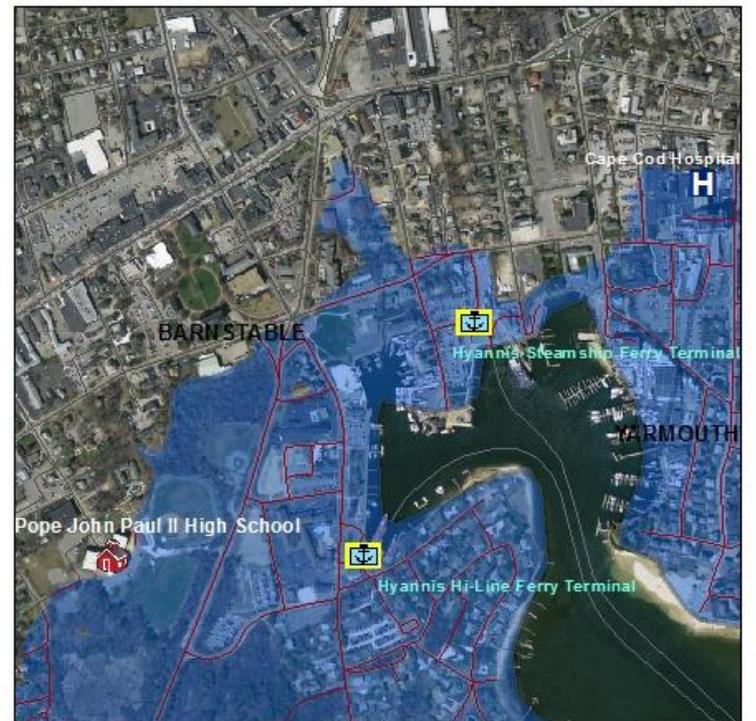


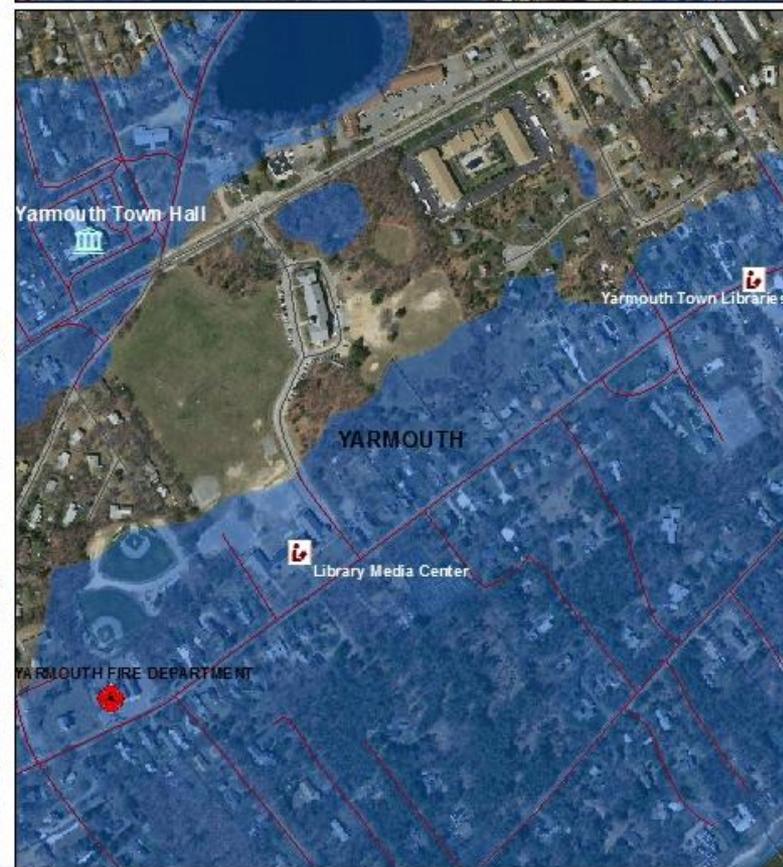
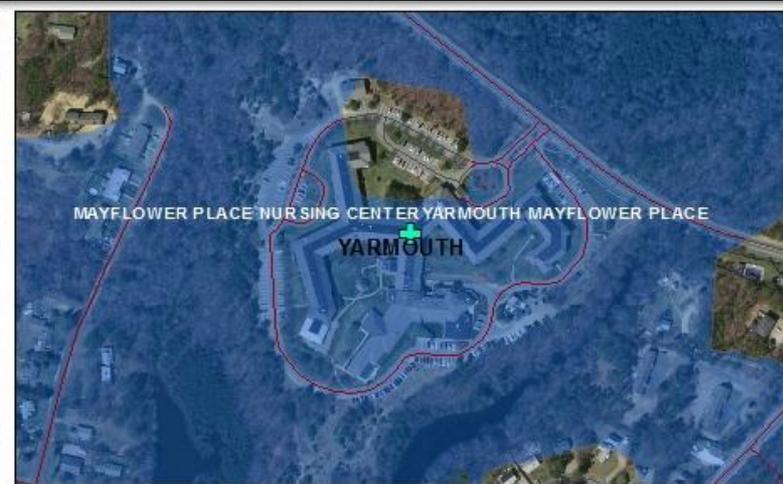
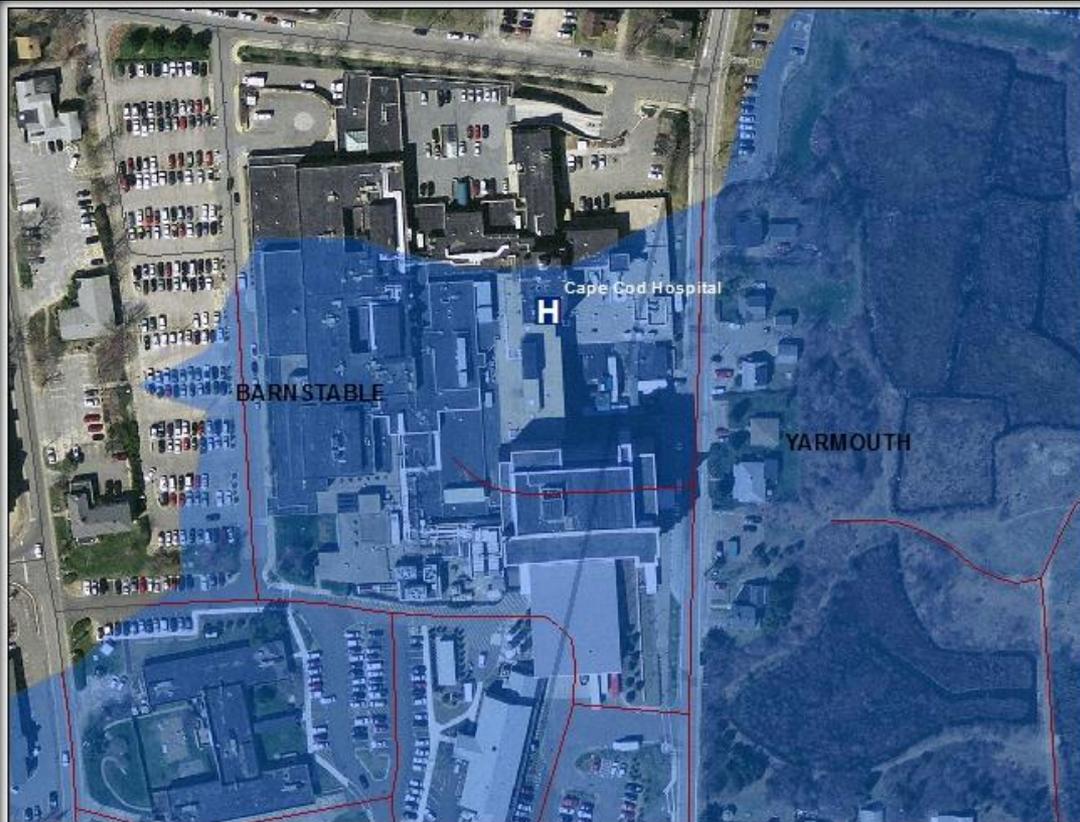
Impact on Lewis Bay with a 6 meter storm surge



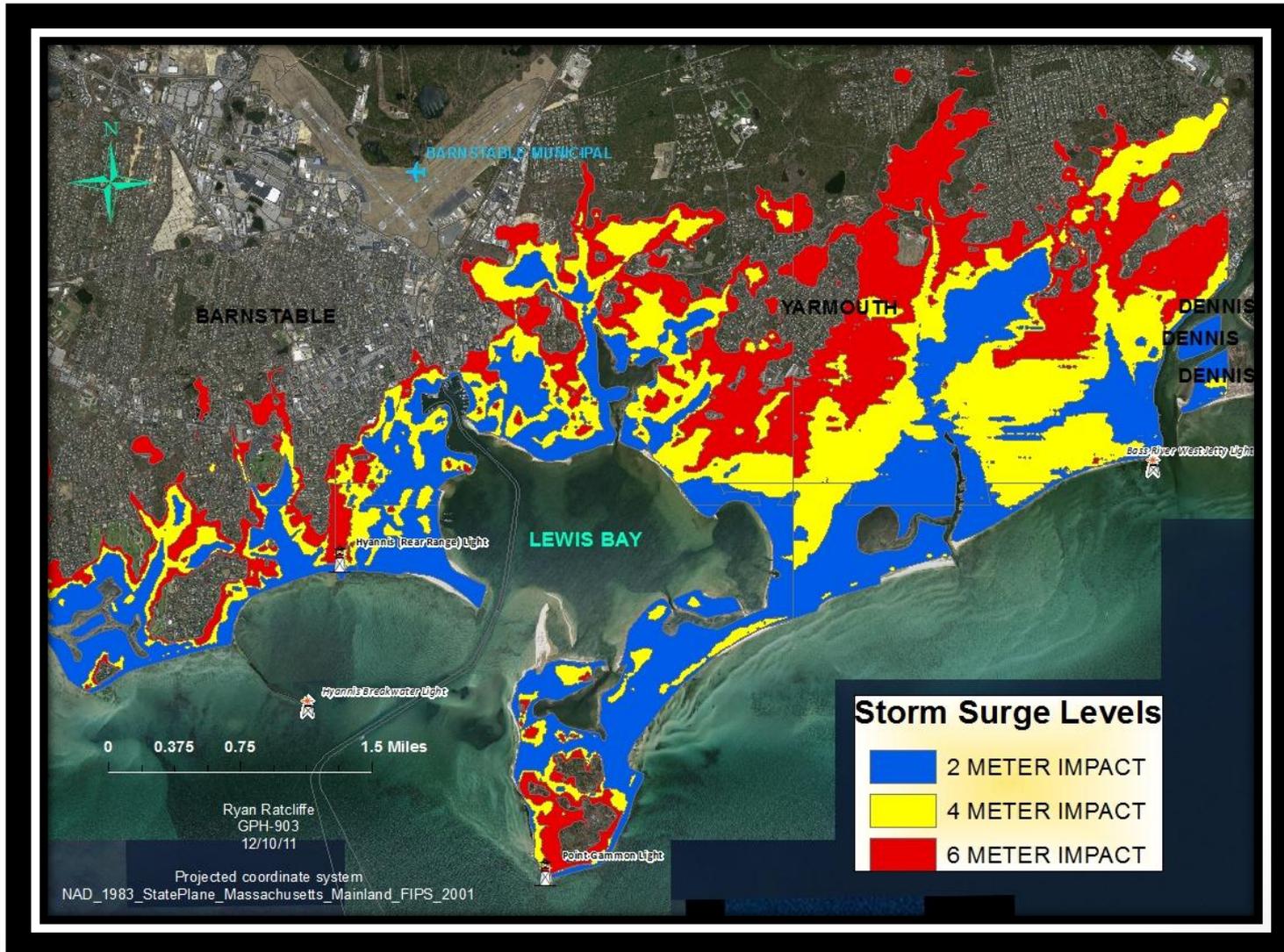
Of course the most extreme results were found in the event of a category 4 storm surge of 6 meters:

- **AREA** - In this case a total of 10.1 square miles, or 11.4% of land area in these two towns.
- **ROADS** -150 miles of roads (15.3%) are in the surge zone and susceptible to possible flooding, erosion, structural damage and salt water intrusion.
- **INFRASTRUCTURE** - The Cape Cod Hospital, which, according to capecodhealth.org, is a 259-bed acute care hospital that services to 84,000 patients on an annual basis, would now be completely within the storm surge zone. Other emergency services such as the police and fire department are also in the zone, which could cripple emergency response during such events especially being coupled with the hospital. Other infrastructure in the zone would include the town hall, library, Pope John Paul II High School grounds and 2 lighthouses which would be in the direct impact zone of this type of surge and possibly suffer major structural damage or possibly even destruction.





STORM SURGE LEVELS



Conclusion



- I found this project to be very interesting and a bit of an eye-opener, yet there are many factors that need to come into play for any of it to hold true. Based on my research and data alone I certainly wouldn't start evacuating the Lewis Bay area just yet.
- Global warming and sea level rise are merely predictions and although they appear to be occurring, nobody knows for sure the exact rate and level of the sea rise, so it would be impossible to produce accurate results based on this research.
- It is important to note that these results only account for the small area analyzed within and around Lewis Bay. The statistics I have acquired do not account for other areas of Barnstable and Yarmouth which would most likely also be effected by these surges therefore increasing the amount of land area, roads, and infrastructure that fall within possible surge zones.
- I feel as though research such as this could be used as a starting point for future projections and towns like Barnstable and Yarmouth could take these projections and use them as a guide for future planning and development of the area.
- For instance, town planners could start preparing for a future that could include such possible scenarios and determine ways to prevent destruction like the construction of ocean break walls and future building codes could demand construction of emergency infrastructure on higher ground out of harm's way.
- If I were to take my projections further my next step would be to determine the storm surges effects on housing units, population , and businesses.

References



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