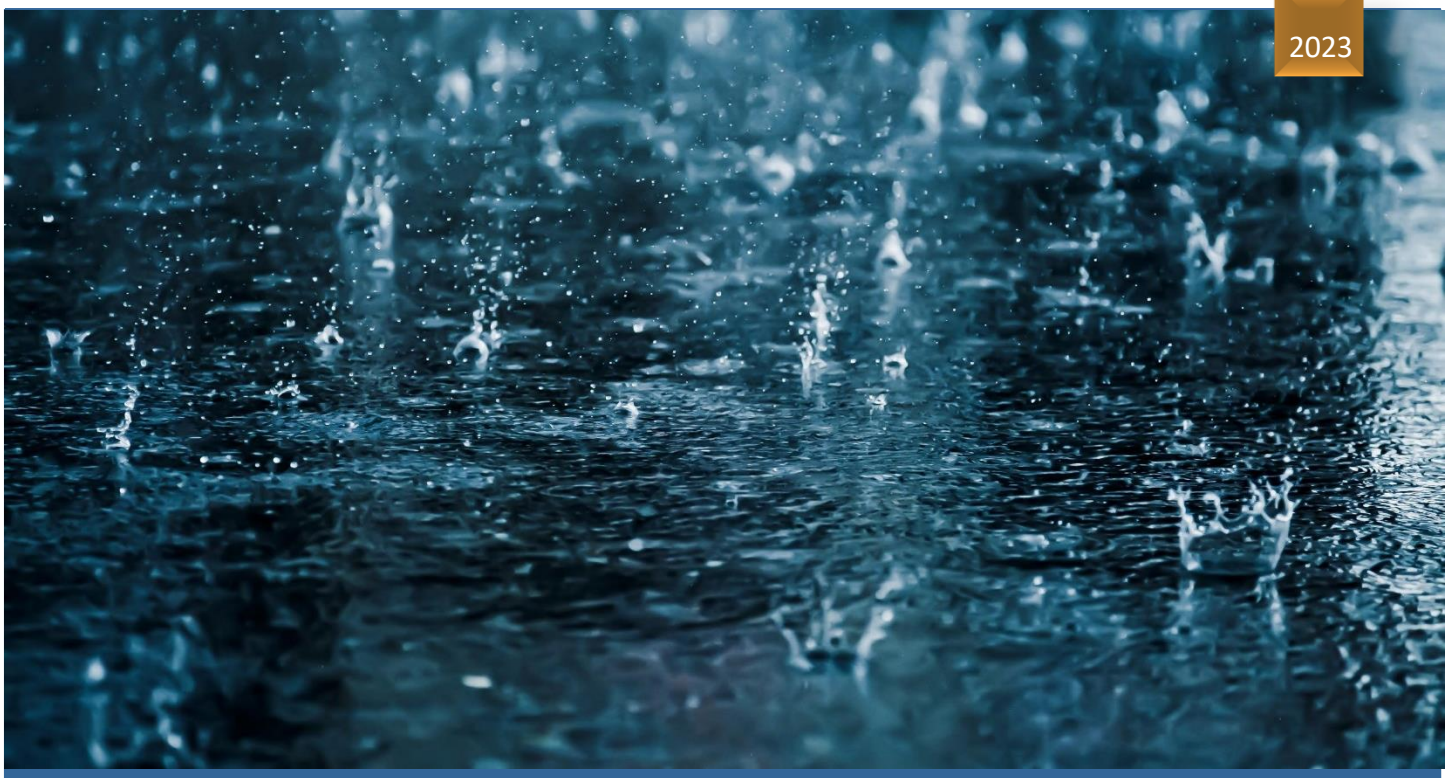
2023



Community Inundation Assessment and Alternatives Analysis

This project, Task # 44 was funded by the Virginia Coastal Zone Management Program led by the Virginia Department of environmental quality through grant # NA22NOS4190152 of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, under the Coastal Zone Management Act of 1972, as amended.
The views expressed herein are those of the authors and do not necessarily reflect the views of the U.S. Department of Commerce, NOAA, or any of its subagencies.

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Definitions

Mean High Water - The average of all the high-water heights observed over the National Tidal Datum Epoch.

Mean Low Water - The average of all the low water heights observed over the National Tidal Datum Epoch.

Mean Higher High Water - The average of the higher high-water height of each tidal day observed over the National Tidal Datum Epoch.

Introduction

Coastal communities along the eastern seaboard will experience inundation throughout their communities, including inundation of roads, critical infrastructure, residential structures, and utilities. According to the Virginia Resilience Master Plan:

> *Nearly six million people, or 70% of the state's population, call coastal Virginia home. Our coastal regions are thriving economic hubs, hold unique cultural resources, and offer unparalleled natural beauty, which collectively shape diverse landscapes and communities. However, coastal Virginia faces growing threats. Between rising sea levels and changing precipitation patterns, Virginia has already recorded changes to the frequency and intensity of floods that pose increasingly greater risks to our communities.*
>
> *Flooding affects many Virginians but does not do so equally. Each community faces varying levels of flood exposure, vulnerability to harm or damage, and associated risks, tied to its individual socioeconomic, historical, and physical context.*

With funding from the Virginia Coastal Zone Management Program, Middle Peninsula Planning District Commission (MPPDC) staff worked to develop a new methodology for conducting community flood inundation assessments and a strategic alternatives analysis. The methodology takes into consideration that water has been coming and will continue to come and that property owners (private and government) must manage against this slow-moving threat or lose considerable economic and functional value of land and improvements. Such slow-moving factors can contribute to the blight of rural areas.

Consequently, coastal property owners and local governments will experience pain points in an increasing manner that will influence homeowners' decisions to stay within their community or to move out, and government's ability to offer services in areas experiencing inundation.

What pain point will be the property owner's last straw? Will it be:

- Losing access to property due to flooded or inundated roads?
- Not having the ability to leave the property (i.e., To get to the grocery store, school, doctors appointments) due to flooded roads?
- Increased flood insurance premiums?
- The need for additional insurance to cover all property assets?
- Increased HMO insurance premiums?
- Loss of utilities, including power, air conditioning, well, or septic due to saltwater intrusion and/or high ground water?
- Salt patches in the yard due to standing sea water?
- Standing water within the foundation?
- The devaluation of the home?
- Not having the ability to sell the home?
- Personal safety due to impacts or threats of storm surge?
- Psychological or emotional distress associated with the impacts of the issues listed above?

Simultaneously governments experience pain points for inundated areas. To name a few:

- When are governmental services no longer provided to areas that may cause safety risk for personnel (i.e.. Inspectors, emergency management, etc.)? When road access inhibits passage? Or when homeowners no longer pay taxes?
- Should construction activities (i.e.. Building new homes) be restricted in areas that may become inundated to prevent loss in the future?
- Should there be investments in the area to reduce inundation?
- What are the tax revenue implications of inundated coastal areas with many of the highest valued homes? How will the tax burden shift and when?

Such pain points will leave property owners and governments with tough decisions on how to manage their properties and way of life.

Considering that responses to inundation will be extremely complex, challenging and involve many parties, this methodology is intended to serve as a clear, non-biased, and organized starting point for the consideration of all impacted parties.

Methodology

1. **Select a community** that is vulnerable to flooding and sea level rise.
2. Conduct a **community flood inundation assessment**.
   Road Assessment -
   a. First consider a "do nothing" scenario. If the community does not take action to mitigate or stop/reduce inundation, then when will transportation infrastructure be inundated and triggered a modal shift[1].
      i) Find or survey the elevation of road that is used to access the community of interest.
      ii) Find or calculate the water height at Mean High Water (MHW) and Mean Low Water (MLW) that will inundate the road.
      iii) Once the elevation of the road and the height of the water for inundation is found, then utilize a sea level rise modeling platform to determine the year in which the height of water reaches inundation levels. Below are 2 scenarios to consider in the inundation assessment that will assist in finding the year that modal shifts are expected to occur:

@ MHW - During what year are access roads inundated twice a day during high tides?
@ MLW During what year are access roads completely inundated during all tide cycles?

[1] Modal Shift - a switch from on form of transportation to another. In the pilot case when a road becomes impassable due to rising water, property owners will need to switch to boat in order to access their property.

b. Again, consider a "do nothing" scenario. If the community does not take action to mitigate or stop/reduce inundation, then when will properties become inundated with water (i.e.. Flooding during tidal events).
    i) Below are 2 scenarios to consider in the inundation assessment that will assist in finding the year that properties will become uninhabitable due to inundation in their yards:

@ MHW During what year are yards inundated twice a day during high tides?
@ MLW During what year yards become inundated during all tide cycles?

Parcel Inundation Assessment

a. First consider a "do nothing" scenario. If the community does not take action to mitigate or stop/reduce inundation, then when will parcels be inundated and become uninhabitable.
    i) Use a mapping tool to display parcels of selected area(s) and sea level rise.
    ii) Select the desired sea level rise scenario.
    iii) Evaluate the number of properties with no inundation, partial inundation, or complete inundation at various timeframes. MPPDC staff selected 2020, 2040, 2060, and 2080 to compare.

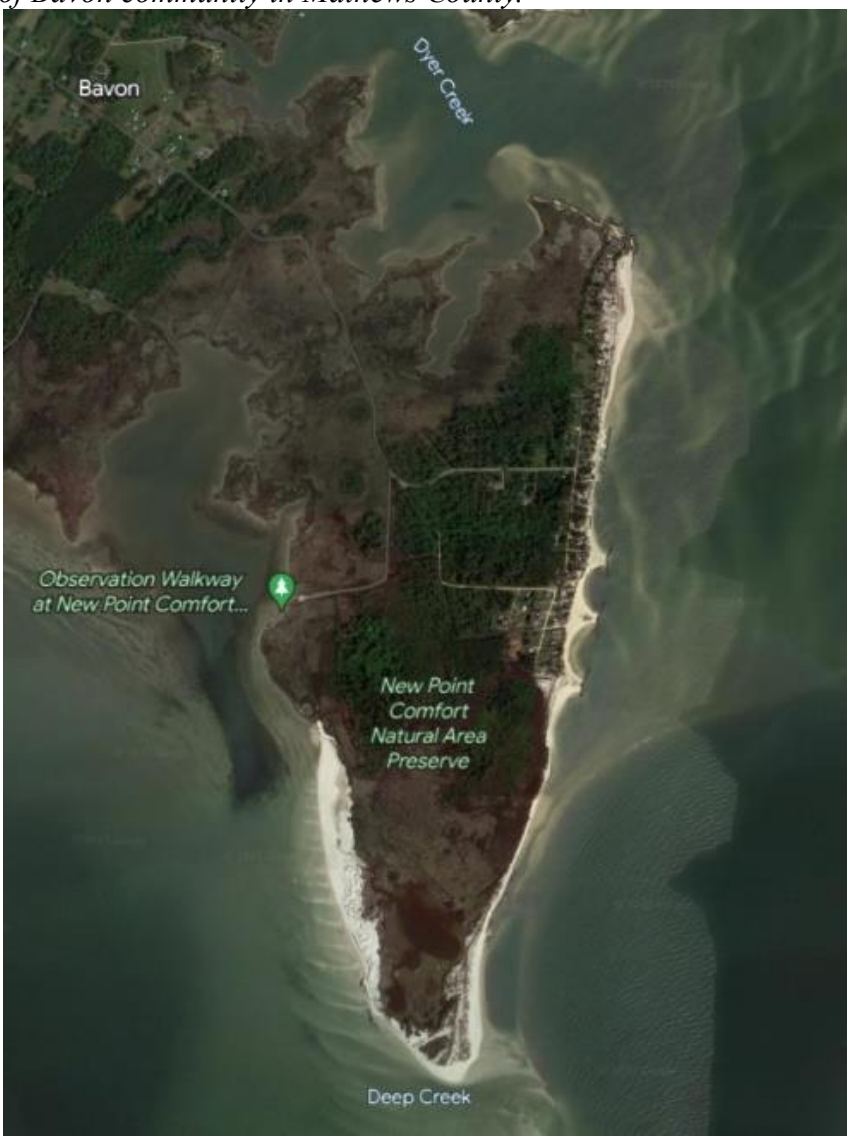
3. Conduct a **Comparative Assessment** –
    a. Gather total land values for the select community.
    b. Compare available land values. In this study 2005, 2011, and 2017 land values were assessed. This allowed MPPDC staff to understand land value trends over this course of time.

Community Impact Assessment Pilot – Bavon, Mathews County, VA

New Point Comfort is a beautiful coastal area located directly on the Chesapeake Bay in Mathews County, Virginia. New Point Comfort's stunning views and white sandy beaches have attracted people to its shores and made it a very sought-after community. The area consists of land elevations at or within a few feet of mean sea level with the highest elevations occurring on a subtle elevated ridge along the eastern side of the community. As the threat of sea level rise, recurrent flooding, storm surge and erosion become more imminent, the community of Bavon, an unincorporated community at New Point Comfort, has slowly begun to see and experience changes first-hand (**Figure 1**).

With the continuous and accelerating rise of sea level, increasing frequency and intensity of coastal storms, eroding shorelines, yard flooding, road flooding, and septic issues have become commonplace throughout the Bavon community. For these reasons, MPPDC staff selected the Bavon community as a pilot project area to apply the new methodology for conducting community flood inundation assessments and a strategic alternatives analysis.

Figure 1. *Map of Bavon community in Mathews County.*



Access Road Assessment & Modal Shift

The Bavon community is currently facing one of the greatest threats to coastal America, sea level rise. As sea level continues to plague Bavon, property owners, local and state governments, and the entire community will be faced with decisions on the future of the community; however since no legal or formal governmental structure exists for this unincorporated area, decisions are most likely to occur in a disjointed, disorganized and fragmented manner where independent parcel by parcel decisions and/or collective land use and emergency management policy decisions will be warranted. The high energy shorelines of Bavon are directly exposed to the Chesapeake Bay, putting the community at constant risk of flooding and erosion. Today, extreme high tides and storm events flood the state-owned road and right of way leading to Bavon from the west. This road is the sole road access to and from the community. The road functions as a causeway as it crosses low-lying tidal marsh areas before reaching the relatively higher elevations in Bavon. The road currently experiences both tidal flooding stemming from storm surges associated with coastal storms as well as atmospheric driven "sunny day flooding" and stormwater flooding from

precipitation events which flood the road due to the roadside ditches commonly being inundated with tidal waters. While specific data for flooding and inundation along this low-elevation segment of road does not exist, these road flooding events make it difficult for residents to leave their home to get groceries, go to work, or get to appointments an estimated 10 – 25 days on average with the flood frequency predicted to only increase in the future. Therefore, when considering a "do nothing" scenario where the community or individual property owners choose not to take action to mitigate, stop, or reduce inundation, it is critical to understand when the access road will be inundated and subsequently trigger a modal shift.

Road Elevation

To understand when a modal shift may occur due to inundation of the sole road accessing Bavon, the elevation of the road and the amount of water level rise needed to inundate the access road must be known. To do this, high resolution LiDAR elevation data acquired by VIMS (2019) was used to determine the elevation of Lighthouse Road leading into the Bavon community. In **Figure 2** Lighthouse Road is represented by road Section 3. The minimum, maximum, and average elevations of the road were determined relative to MHHW and MLW. The LiDAR data for Section 3 shows that at MHHW:

- The tide needs to rise 1.06 ft at the lowest (Min) spots of the road to be inundated;
- The tide needs to rise 1.68 ft at the highest (Max) parts of the road to be inundated;
- The tide needs to rise an average of 1.40 ft to inundate the road.

Using 1.40 ft as the average height that sea level will need to rise to flood Section 3, MPPDC staff will use available sea level rise models to capture a year when the modal shift may begin to occur. This will be triggered due to recurrent flooding that will occur at high tide on a daily basis, meaning that the road will be covered by tidal salt water for relatively short periods (< 1 hour – 3 hours) during the high tidal cycles twice a day.

The modal shift driven by the high tide datum will be largely controlled by the vehicle operator's tolerance and urgency for driving through salt water. Driving through any body of water is never advisable for obvious safety reasons and corrosion-related damage to vehicles, yet coastal citizens such as those living near sea level such as in Bavon, choose to do so on a regular and increasingly frequent basis due to personal necessities and priorities. The modal shift stemming from sea level flooding and inundation occurring from the mean high-water datum will vary from person to person and situation to situation. Someone needing to drive to the grocery store may choose to postpone their chores for a few hours and wait for the high tide to pass before doing so; whereas someone needing to drive a loved one to the hospital will not hesitate to drive through salt water to get to needed medical care.

Figure 2. *Aerial imagery showing the New Point Comfort area including the sole access road, Lighthouse Road represented as "Section 3".*

Table 1 provides a summary of the elevation data for the roads in the New Point Comfort Area and Bavon community. The orange highlighted cells are for the segment of road, Section 3 (Lighthouse Road) which serves as the sole access road for the Bavon community. The final column of data shows how high the water needs to rise to inundate the road at MLW meaning that salt water will be on the road surface 24 hours per day with shallower water occurring during low tide cycles and deepening during high tide cycles. The LiDAR data shows that for Section 3, with an average of 3.70 ft of sea level rise at MLW, the road will be inundated. This means that with 3.70 ft of sea level rise, at any given low tide, there will be water on the road leading into the Bavon community. The number 3.70 ft will be used to determine the MLW inundation date and the date for when standing water will be on Lighthouse Road.

Table 1. *Lidar data table showing the road sections and height of water when the road becomes inundated.*

Road Section	Min (ft MHHW)	Max (ft MHHW)	Avg (ft MHHW)	Avg (ft MLW)
1	0.86	1.77	1.25	3.55
2	0.93	1.73	1.25	3.55
3	1.06	1.68	1.40	3.70

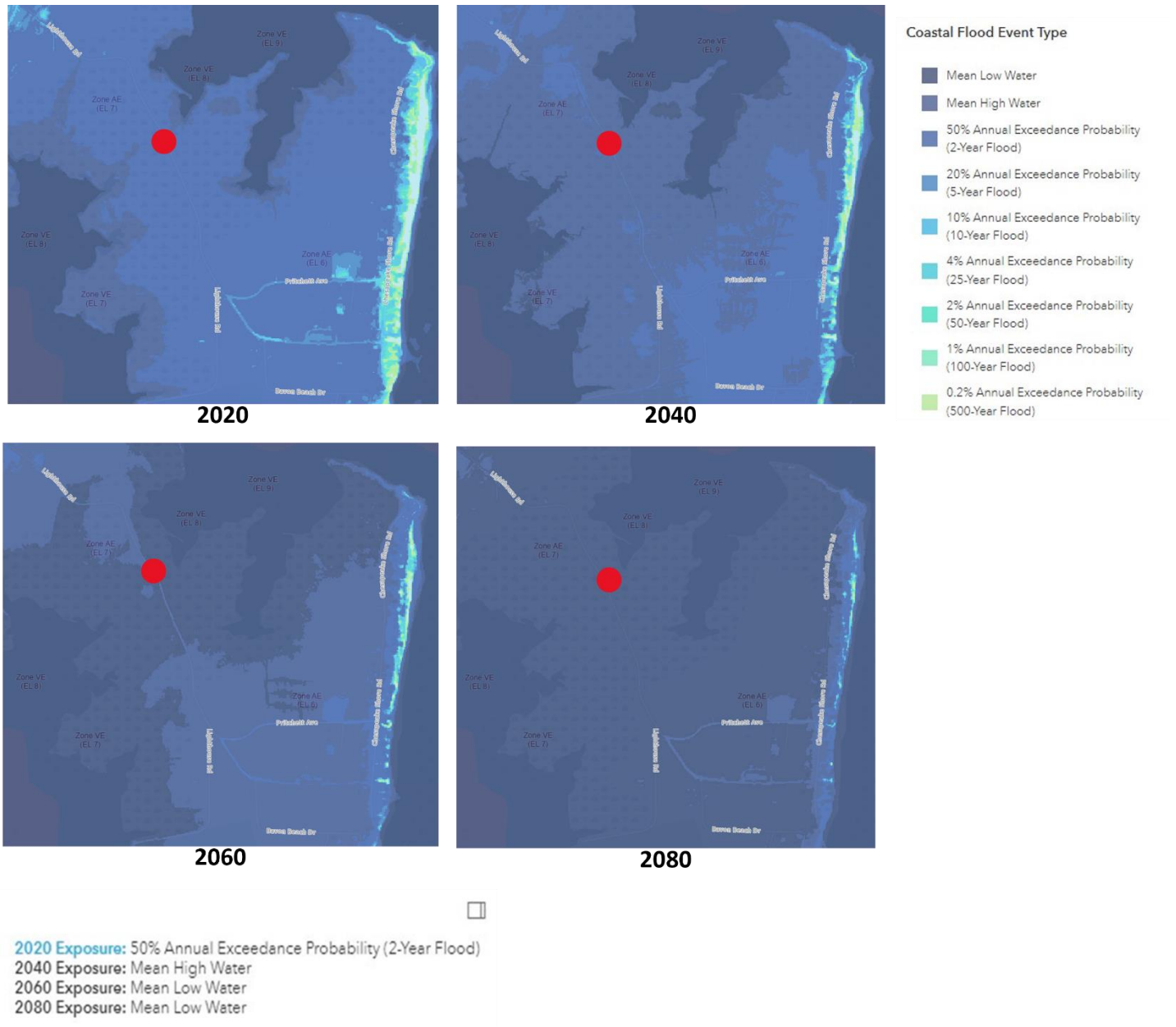
The Year of Inundation

MPPDC staff conducted an analysis using the Virginia Department of Conservation and Recreation (DCR) Virginia (VA) Coastal Resilience Web Explorer and the Virginia Institute of Marine Science (VIMS) VA Adapt Interactive Map to assess four time horizons: 2020, 2040, 2060, and 2080.

First, in the DCR Web Explorer, MPPDC staff analyzed Section 3 of Lighthouse Rd during each time horizon (**Figure 3**). Using a red point as a reference point for the average height of Lighthouse Road, Figure 3 shows that in 2020, there was a 50% annual probability of recurrent flooding. Using the same reference point on Lighthouse Road, in 2040 there is a darkening of the color indicating inundation of the road will occur at MHW, or during, leading up to, and following every high tide cycle. In 2060 and 2080, the area darkens again which indicates that Lighthouse Road will be inundated at MLW, or always. The flood hazard maps for both 2060 and 2080 show no difference between the two-time horizons of Lighthouse Rd.

In conclusion, based on this analysis using the DCR Web Explorer, Lighthouse Road will be inundated at MHW by ~2040 and at MLW by ~2060. This of course assumes that the Virginia Department of Transportation, who is the owner and responsible agency for maintaining the road, does nothing to elevate the road or mitigate the flooding in any way. Also, these are the years where a modal shift will occur. However, as mentioned previously this is largely dependent on the vehicle operator's tolerance and urgency for driving through salt water.

Figure 3. *Flooding during four horizons (DCR VA Coastal Resilience Web Explorer, 2023).*



Second, MPPDC staff used the AdaptVA mapping tool to assess the depth of water that will inundate Lighthouse Road when the sea level rise intermediate-high scenario, which is the scenario advised for long-term planning in Virginia, is considered. This scenario is consistent with the Virginia Coastal Resilience Master Plan. Also, to provide consistency between the DCR Web Explorer assessment and this assessment, the same four time horizons were analyzed (see **Figures 4 – 7**).

Figure 4. *2020 MHW Water Levels for the Intermediate-High Scenario. Lighthouse Road is labeled. (AdaptVA).*

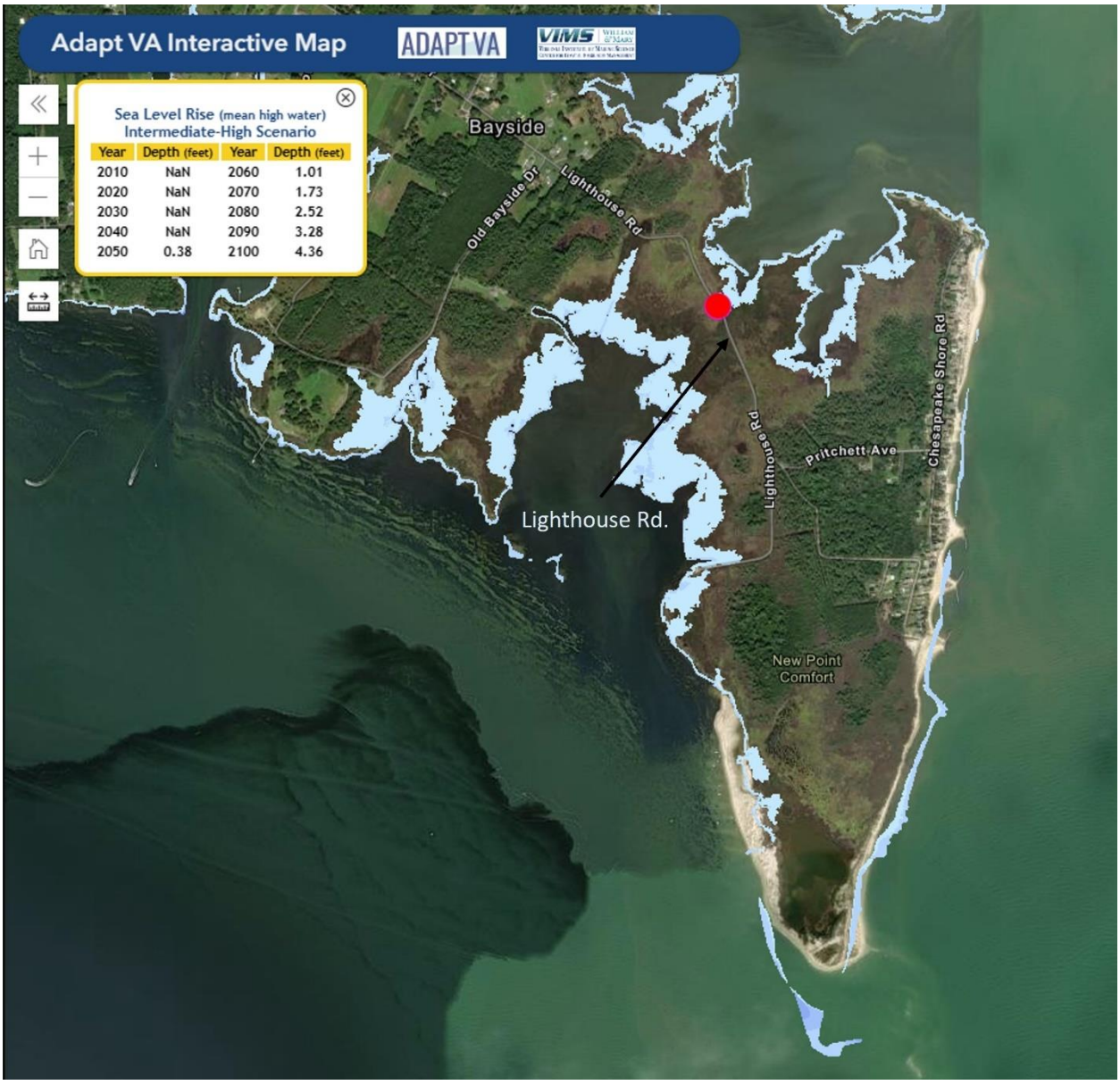


Figure 5. *2040 MHW Water Levels for the Intermediate-High Scenario. Lighthouse Road is labeled. (AdaptVA).*

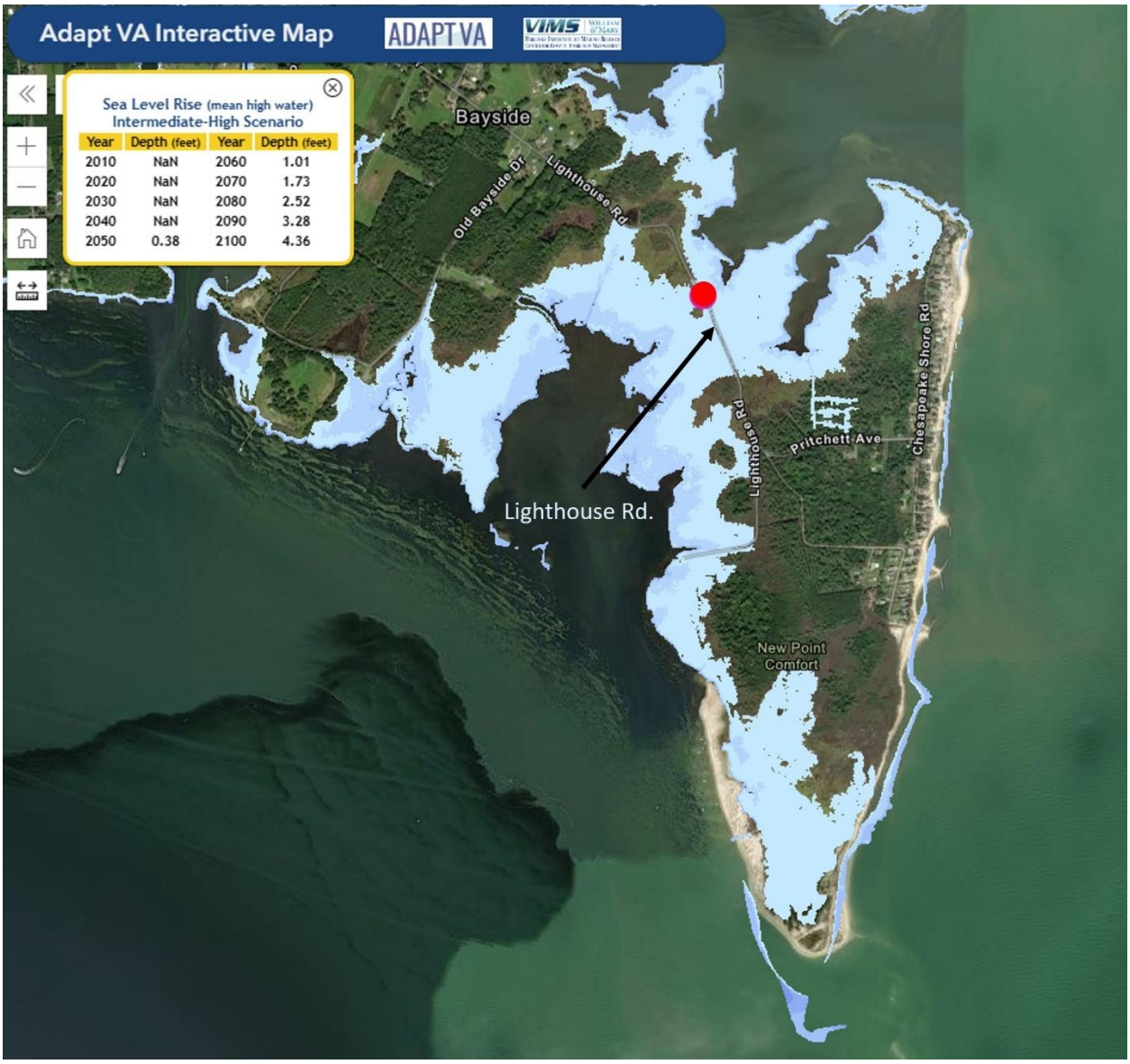


***Figure 6**. 2060 MHW Water Levels for the Intermediate-High Scenario. Lighthouse Road is labeled. (AdaptVA).*

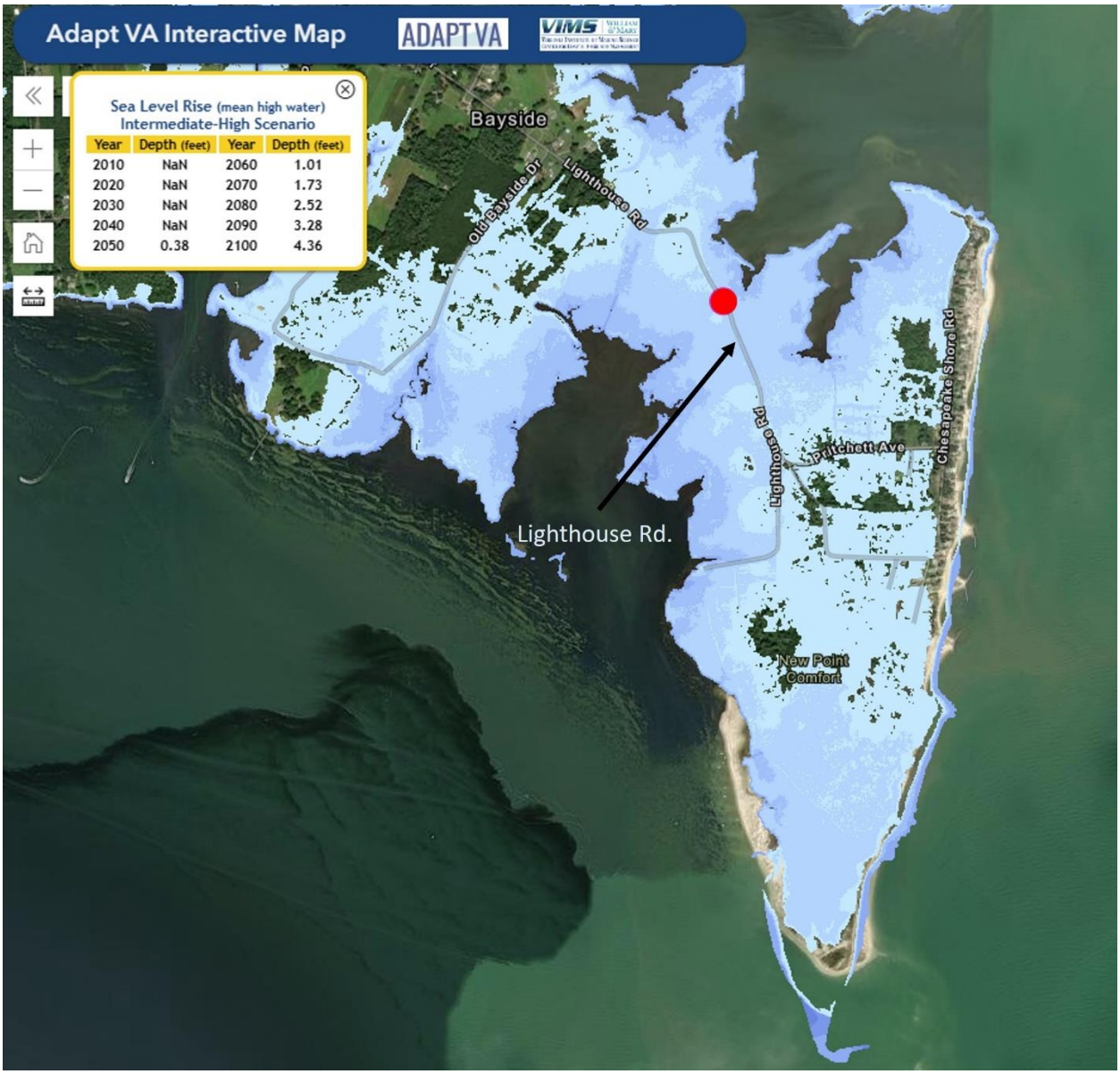
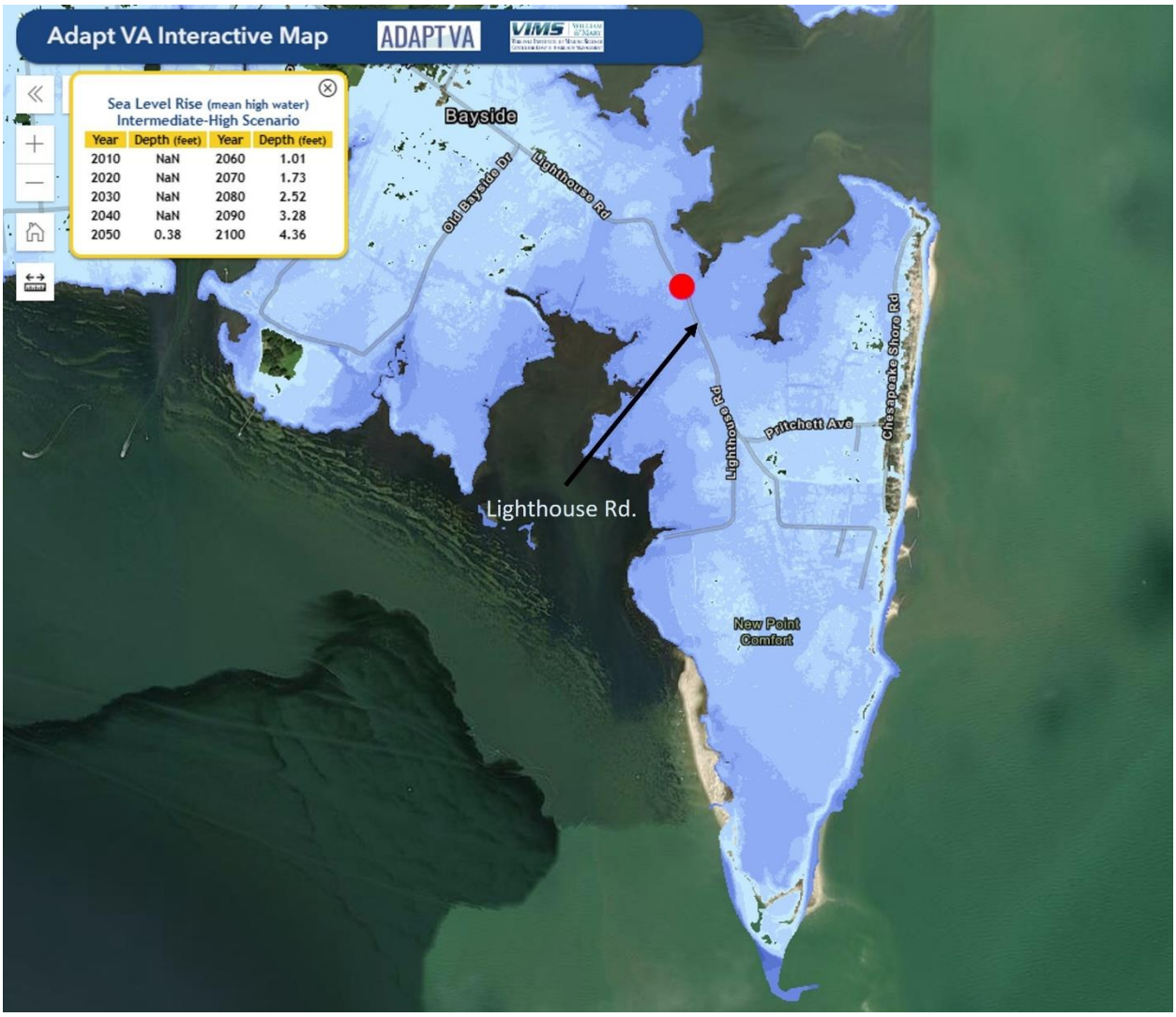


Figure 7. *2080 MHW Water Levels for the Intermediate-High Scenario. Lighthouse Road is labeled. (AdaptVA).*



Using the same location on Lighthouse Road and denoted by the red circle, MPPDC staff analyzed inundation of the road at four time horizons during the intermediate-high sea level rise scenario. In 2020 and 2040, the sea level depth is classified as "NaN" (not a number). By 2060, it is predicted that Lighthouse Rd will be inundated with 1.01 ft of salt water at MHW. Additionally, if 1.01 ft of salt water is present at MHW and considering that the tidal range in the area is 2.1 ft, this means that the road will be within 1.09 ft of flooding at MHW and that this section of road will have standing water for the majority of every day with the exception of the hours where the tide is lowest. Looking forward to 2080, it is predicted that 2.52 ft of sea level rise in the area. This is very close to the 3.70 ft of sea level rise needed to inundate the road at MLW. Given the small percentage difference and variation in calculation, the data suggests that at some time between 2060 and 2080, Lighthouse Road would be fully inundated at MLW and during all tidal cycles.

Using the data provided by the DCR and AdaptVA tools, the most likely two dates for when the model shift will occur during 2040 at MHW and sometime between 2060 and 2080 at MLW. This means at least twice a day, by the year 2040, at least one portion of Lighthouse Road will be under water and residents of the Bavon community will have to wait until low tide to navigate the road, drive through saltwater, or select another form of transportation (i.e., small watercraft) to reach their property or the mainland. This will be the start of the modal shift. Finally, by just after 2060 or sometime before the year 2080, Lighthouse Road will likely become inundated at MLW or at any given low tide meaning that Lighthouse Road will be under water at all tide cycles causing residents of the Bavon community to drive through saltwater or travel by boat.

- ***Pain Points –***

  Property Owner Perspective

  With the inundation of Lighthouse Road property owners within Bavon community will gradually lose safe and viable road access to and from their property due to inundation. Common activities such as going to the grocery store, school, doctors' appointments, and friend/family gatherings as well as access for emergency services will become increasingly challenging.

  While some of these homes are primary properties for families, there is a portion of the homes in this community that are owned and managed as second homes. It can be expected that pain points for second homeowners will be very different than the pain points experienced for primary homeowners within the community since second homeowners may not need to deal with road access issues as frequently.

  There are also many properties which have no development. The owners of the undeveloped property owners will experience different pain points than what is experienced by the primary and second homeowners. Some undeveloped property owners may only experience pain points related to their ability to develop the property in the future as challenges and costs associated with government regulations for development, taxes, and/or diminished value of the property on the real estate market negatively impacting the owner's ability to sell the property.

  Government Perspective

  With the inundation of Lighthouse Road government officials will need to consider investing in the elevation of this road or other mitigation solutions that would mitigate inundation on this road. Most likely, with limited funding available for such projects, local government will need to consider any policy changes that may reduce the risk to personnel if inspectors and/or emergency services need to access this portion of the County. What risks are they willing to take? For instance, driving a county owned car in salt-water if the road is inundated. How many times a month can this happen until it starts impacting the car? Or does the county invest in a boat to access such areas of the county?

Parcel Inundation Assessment

MPPDC staff continued the community assessment with focusing on the postage stamp parcels of Bavon community (**Figure 8**) and when, in a "do nothing" scenario, will the community become uninhabitable, meaning that parcels are inundated daily.

In the Bavon community, there are 228 individual parcels and of those 75 have constructed homes. This means that 153 parcels currently do not have homes constructed on them. It is also important to note that these undeveloped parcels may not be completely void of infrastructure especially with regards to septic systems as it is not uncommon for vacant parcels to have septic systems installed at the property. It is unknown exactly how many of the vacant parcels at Bavon have septic systems. Additionally, while actual counts on appurtenant structures and other infrastructure such as septic systems were not conducted for each Bavon parcel, it is important to note that many of the appurtenant structures, septic systems, etc. at the properties are of considerable value to property owners and play an important role in the decision-making process of property owners experiencing increased recurrent flooding and inundation such as those in Bavon. Finally, it is important to note that while the vulnerability of the Bavon community remains very high with regards to flooding, sea-level rise and erosion, the potential for additional development at this location remains high. This is especially true in the post-COVID era where many urban residents have sought to move to rural areas such as Mathews County. Therefore, while the current analysis is assuming a "no development" scenario for the future at Bavon, it is possible additional parcels could be developed despite the known risks, which if it were to occur, would further complicate the challenges described in this report for the Bavon community.

Figure 8. *Parcel map of the Bavon community. The yellow dots are "address points" within the community which refer to the location of homes.*

To begin, MPPDC staff needed an understanding of how the flooding throughout community changed between four flood time horizons, including 2020, 2040, 2060 and 2080. Using the DCR VA Coastal Resilience Web Explorer, **Figures 9-12** depict the sea level rise by each time horizon.

The DCR VA Coastal Resilience web explorer revealed where the Bavon community is currently and will continue to be impacted by sea level rise. The orange boxes on Figures 9-12 serve as a reference point for where there is still land above sea level throughout the community at MHW. The majority of the Bavon community homes on the Chesapeake Bay were built on a ridge which offers elevation; however, there are other homes located further inland on lower elevated land that have a greater potential for flooding and inundation at an earlier date than the homes on the ridge along the eastern side of the community.

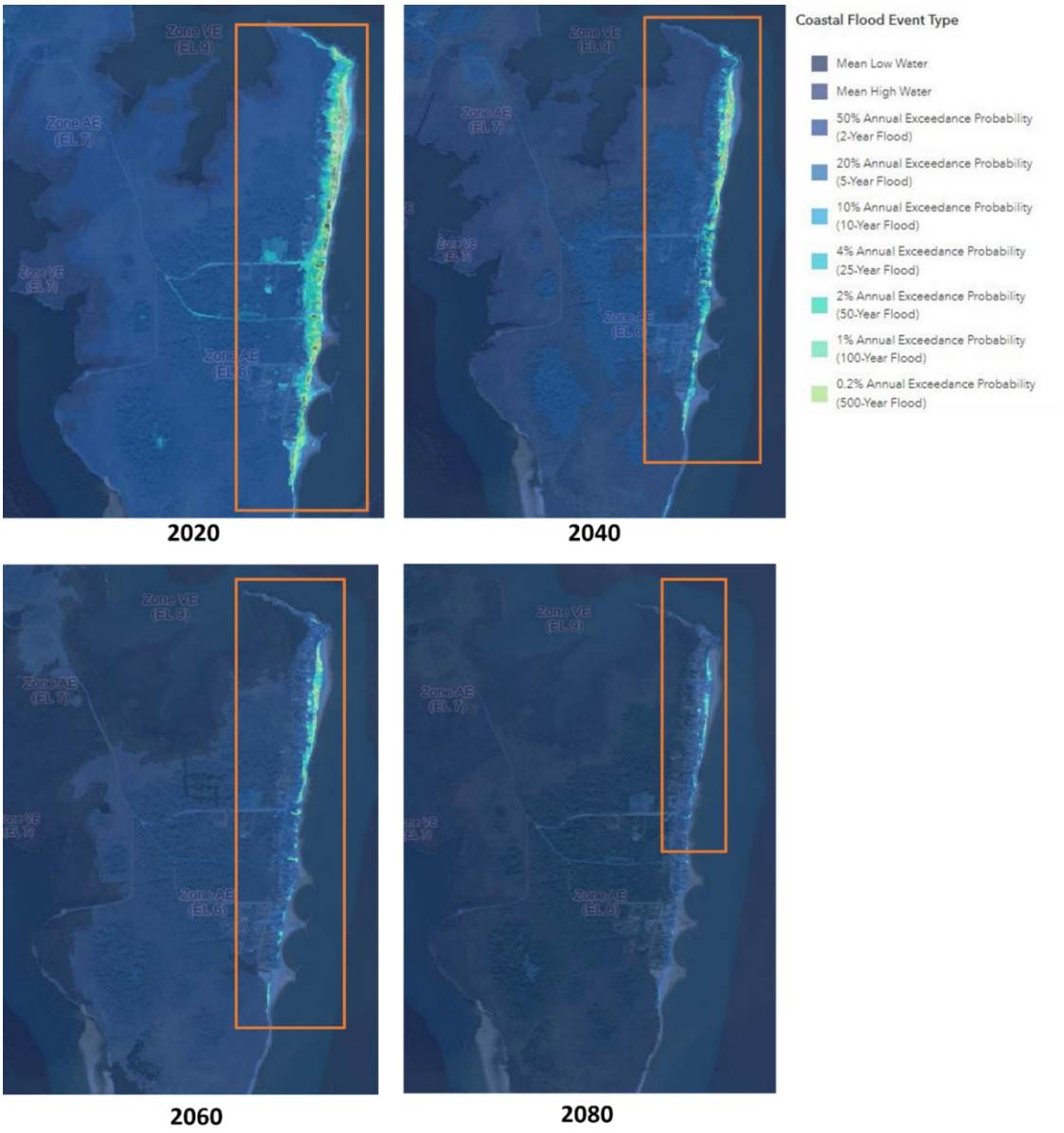
In 2020, the further inland properties experienced 50% annual exceedance probability of flooding at MHW which confirms what is currently experienced in those western areas of the community. The year 2040 shows no change compared to 2020, with inland properties continuing to experience 50% annual exceedance probability of flooding at MHW. The homes along the ridge on the eastern side of the community experiencing lesser vulnerability than the western side of the community. By the year 2060, many properties along the eastern side of the

community begin to experience 50% annual exceedance probability, while inland properties on the western side of the community experience partial to complete inundation at MHW. By 2080 virtually all the properties in the Bavon community will be affected by sea level rise. As the highest parts of the ridge will be above water, inland properties on the western side of the community will be fully inundated at MLW and properties on the eastern side of the community will be inundated at MHW.

While this DCR tool does not provide specific impacts on the built environment, it can be inferred that the threat to houses, appurtenances, and septic systems will increase in step with the conditions driven by elevated sea levels and increased flooding in the future.

It is important to note that these models do not factor in wave energy and erosion impacts that will occur with greater frequency and with greater impacts as sea levels rise. This is especially important for the easternmost Chesapeake Bay fronting properties which currently are battling erosion issues. It can be expected that the challenge and the associated costs to protect the high energy and dynamic shorelines along the eastern side of the community will only increase into the future, which will factor directly into the pain points for the eastern most property owners.

Figure 9. *Flooding of Bavon community dwellings during four flood time horizons (from DCR VA Coastal Resilience Master Plan web explorer).*



Probability Statistics along the Eastern Ridge area of Bavon

2020 Exposure: 1% Annual Exceedance Probability (100-Year Flood)
2040 Exposure: 10% Annual Exceedance Probability (10-Year Flood)
2060 Exposure: 50% Annual Exceedance Probability (2-Year Flood)
2080 Exposure: 50% Annual Exceedance Probability (2-Year Flood)

Probability Statistics on Inland Properties in the Western areas of Bavon

2020 Exposure: 50% Annual Exceedance Probability (2-Year Flood)
2040 Exposure: 50% Annual Exceedance Probability (2-Year Flood)
2060 Exposure: Mean High Water
2080 Exposure: Mean Low Water

Next MPPDC staff used the VIMS AdaptVA Interactive Map to find the height of water that will inundate yards in the Bavon community. MPPDC staff viewed the parcel lines on the map and analyzed the depth of water impacting inland and bayside properties during the same four time horizons for 2020, 2040, 2060, and 2080. **Figures 10 to 13** depict sea level rise maps from Adapt VA for each time horizon for inland properties and **Figures 14 to 17** depict sea level rise maps from Adapt VA for each time horizon for bayside properties.

MPPDC staff selected a sample location for inland properties. This is depicted as a red circle in **Figures 10-13**. In 2020 and 2040, the depth of water is categorized as "not a number." In 2060, the depth of water is ~0.12 ft and in 2080, the depth of water expected to be ~1.63 ft.

Figure 10. *Adapt VA Inland properties 2020 with parcel lines.*

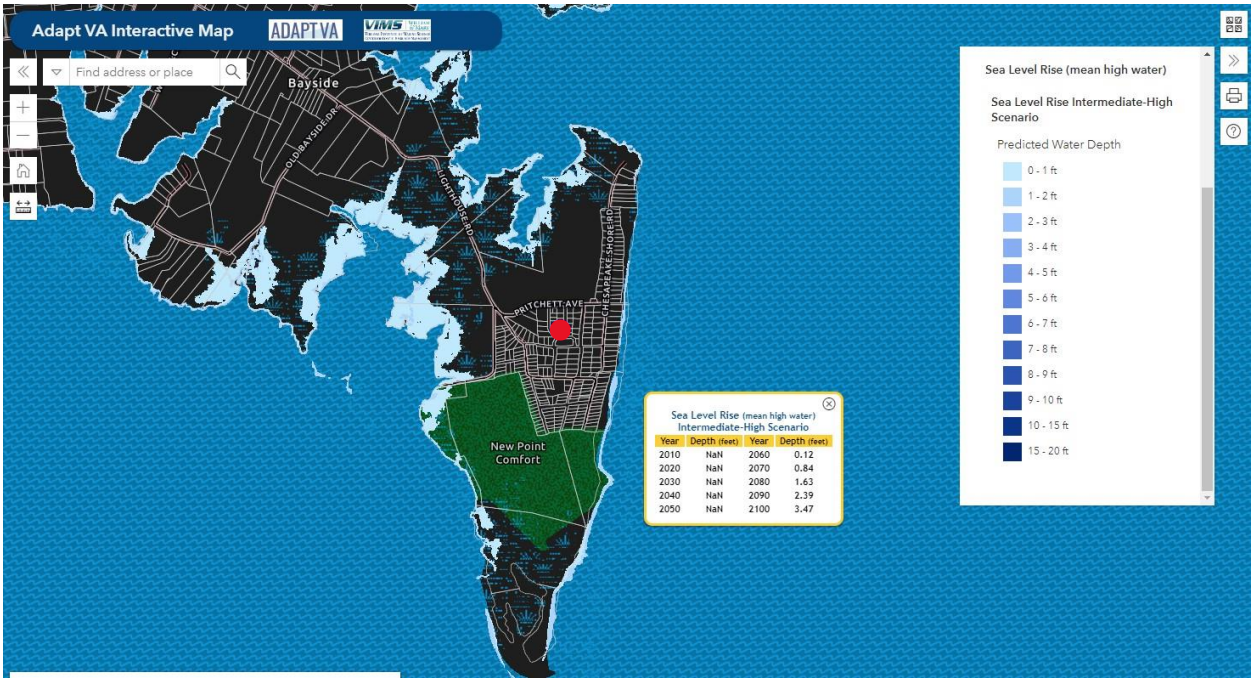


Figure 11. *Adapt VA Inland properties 2040 with parcel lines.*

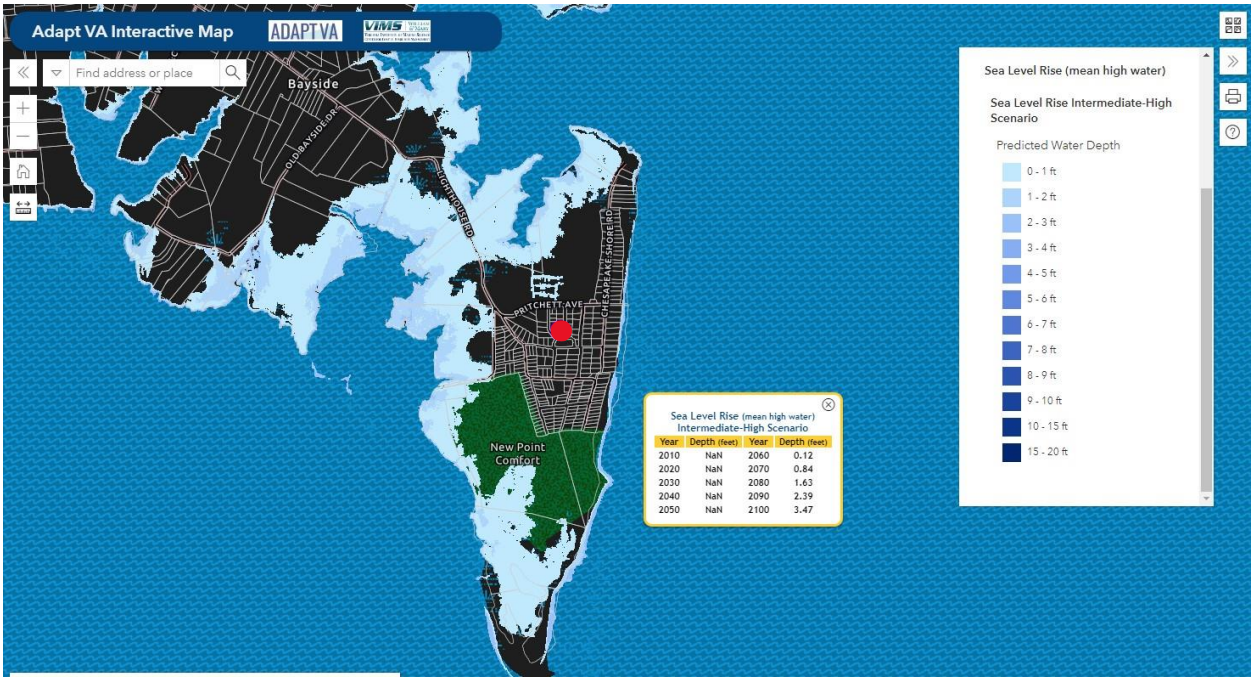


Figure 12. *Adapt VA Inland properties 2060 with parcel lines.*

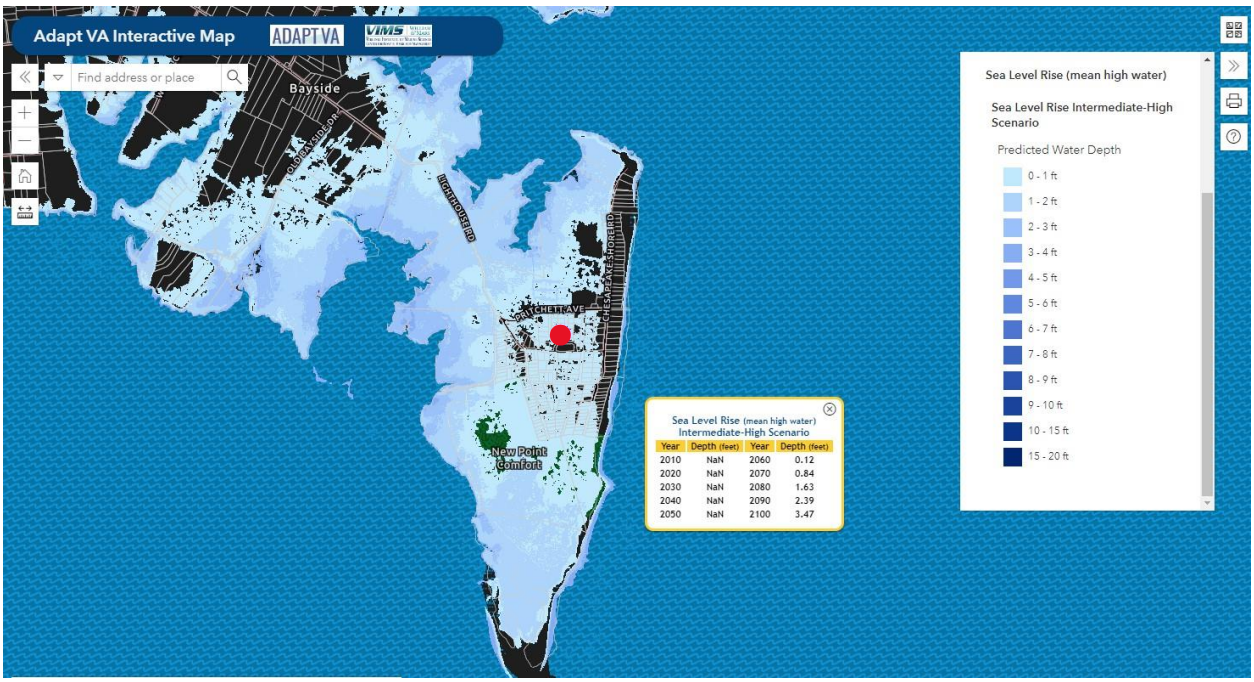
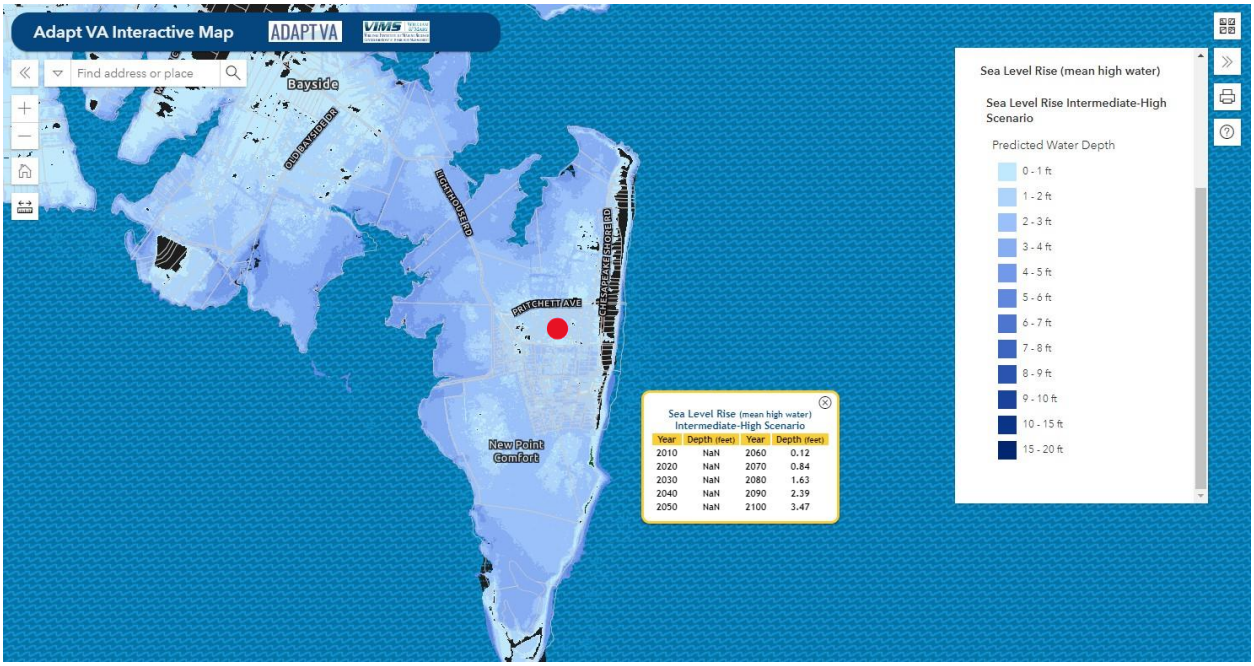


Figure 13. *Adapt VA Inland properties 2080 with parcel lines.*



For parcels on the bayside, MPPDC selected a sample location to find the depth of water that would inundate this area within a given year. In 2020, 2040, 2060, and 2080, the depth of water is categorized as "not a number."

Figure 14. *Adapt VA Bayside properties 2020 with parcel lines.*

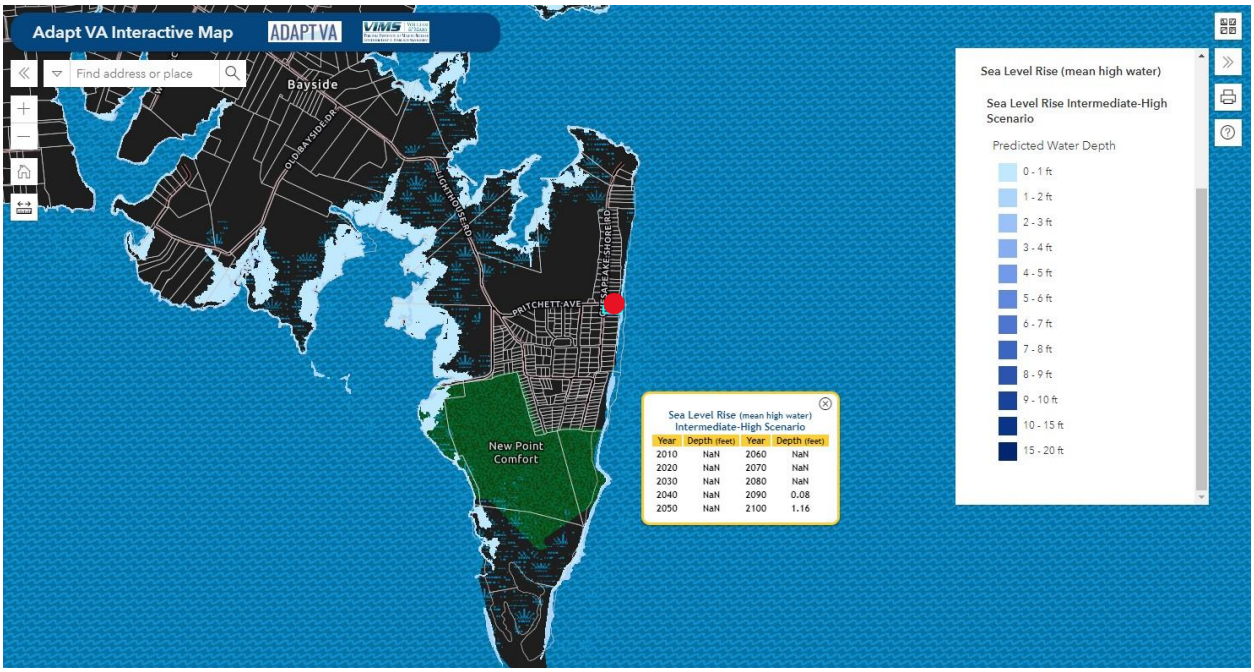


Figure 15. *Adapt VA Bayside properties 2040 with parcel lines.*

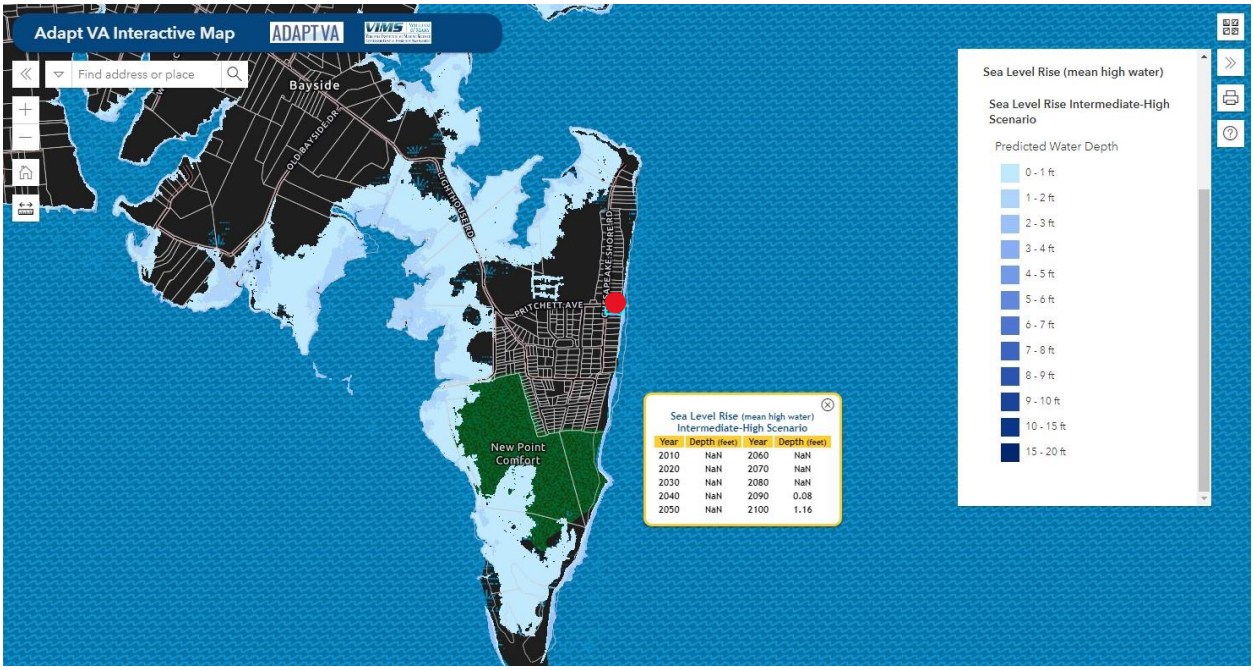


Figure 16. *Adapt VA Bayside properties 2060 with parcel lines.*

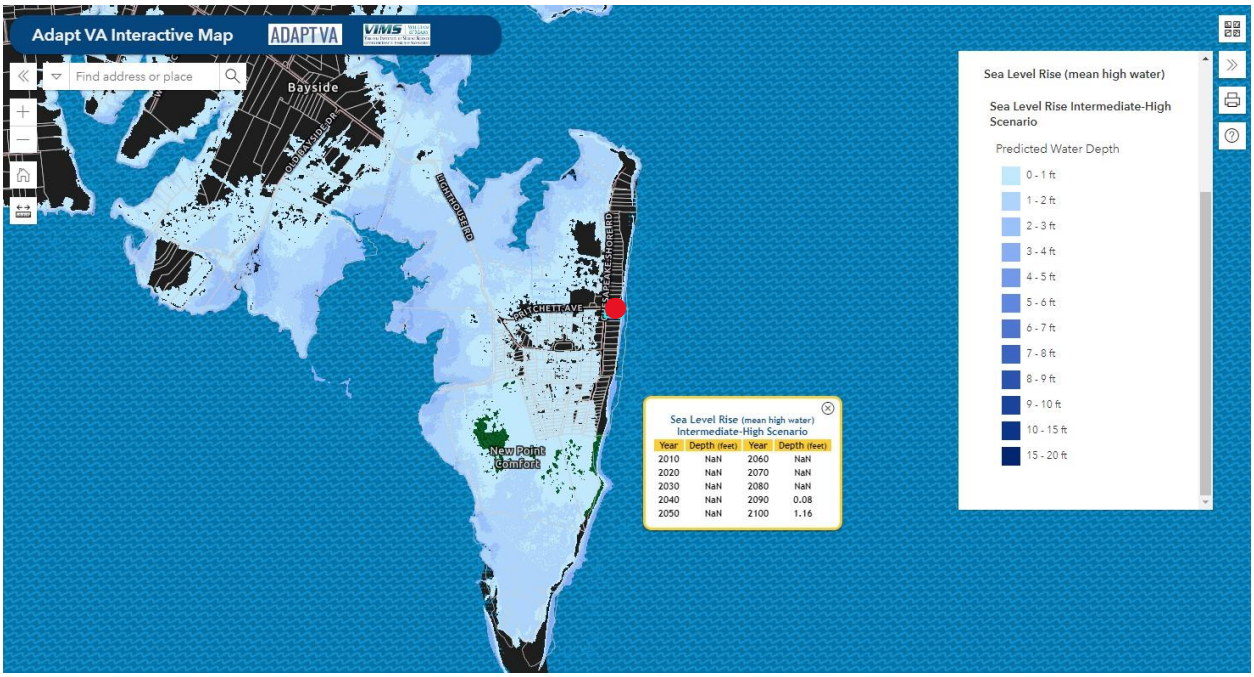
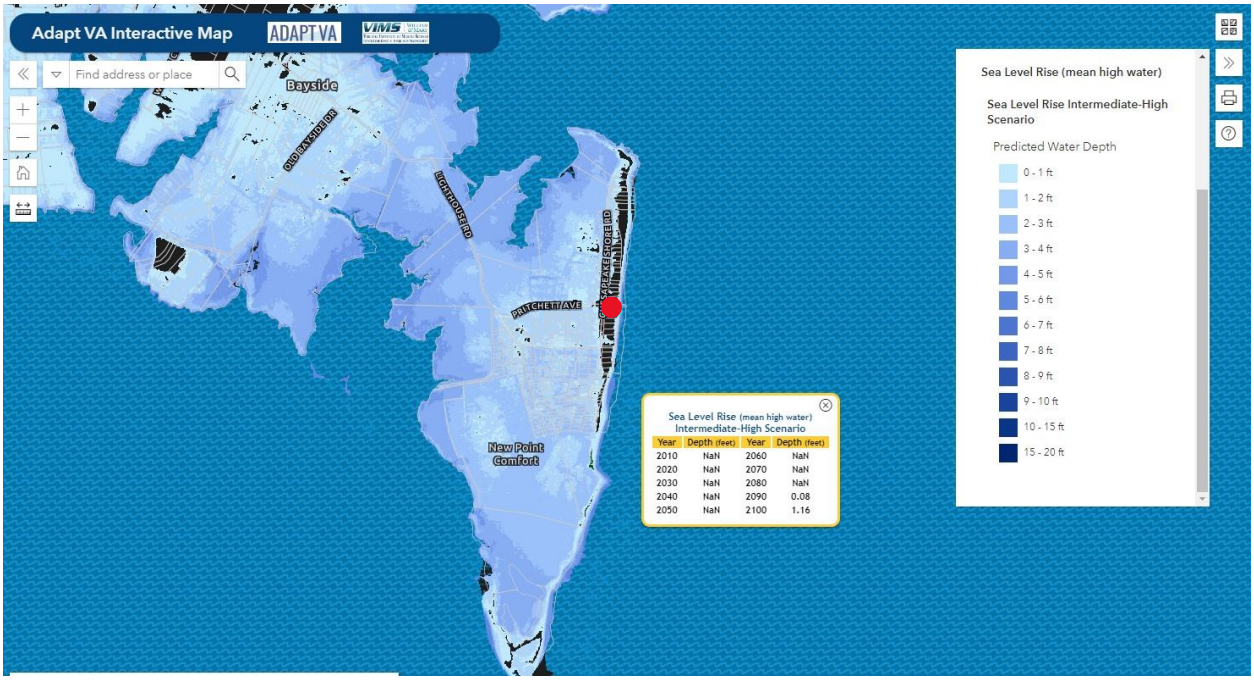


Figure 17. *Adapt VA Bayside properties 2080 with parcel lines.*



In 2020 and 2040 the model outputs shows no major flooding above MHW for the vast majority of Bavon parcels. By 2060, the western side of the community on undeveloped parcels including the New Point Comfort Natural Area Preserve and other low elevation and fringe marsh areas begin to become inundated at MHW. While the stillwater flooding depicted by this model appears to not flood the bayside properties of the community throughout the 2020-2060 time horizon at MHW, it should be noted that the flood risks related to storm surge and erosion will increase for these properties leading up to 2060. By 2080, the model shows ~1.63 ft of water at MHW will inundate most of the inland properties of the Bavon community at high tide. It can be expected that many of these areas will begin converting to tidal marsh under the "do-nothing" scenario which will all but negate any development potential these properties may have. Further, the roads within the community will begin to experience flooding during high tides which will create challenges for mobility within the community itself. The number of bayside properties experiencing flooding during high tide will also increase with the properties further south experiencing greater impacts than the properties in the central and northern areas along the bayside eastern ridge. Several of the bayside properties along the central and northern portions of the bayside eastern ridge will not experience flooding at high tide under stillwater conditions; however, many of the bayside properties are projected to experience ~0.3-0.5 ft of flooding with every high tide by the year 2080.

To analyze the impact of sea level rise throughout the Bavon community, MPPDC staff developed a map of the sub-categories of the Bavon community. The Bavon community was split up into four sub-categories: Central New Point, South Central New Point, Chesapeake Shore North, and Chesapeake Shore South (**Figure 18**). Central New Point and South-Central New Point consist of inland properties. Chesapeake Shore North and Chesapeake Shore South consist of the bayside properties along the ridge. All four sub-categories include parcels with houses.

MPPDC staff again utilized AdaptVA to collect the number of parcels within each sub-category of the community that experienced no inundation, partial inundation, or complete inundation were counted due to sea level rise (**Table 2**).

Figure 18. *Map of sub-categories of Bavon Community. The four sub-categories of interest include Central New Point, South Central New Point, Chesapeake Shore North, and Chesapeake Shore South.*

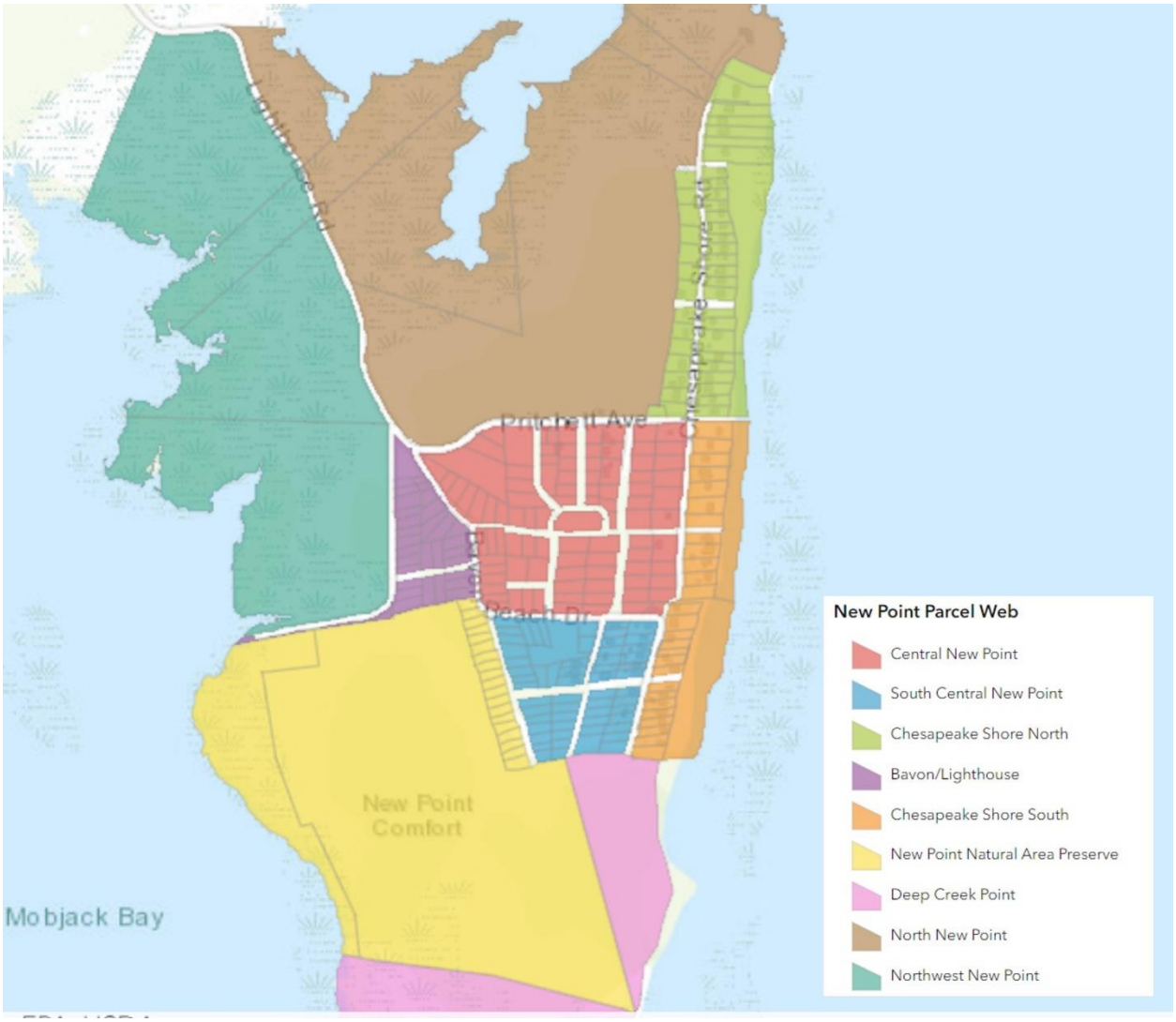


Table 2. *Inundation of Bavon community parcels at four time horizons.*

	Key			Number of parcels not inundated			Number of Parcels partially inundated			Number of Parcels completely inundated		
	INTERMEDIATE-HIGH SEA LEVEL RISE SCENARIO YEAR											
	2020			2040			2060			2080		
Chesapeake Bay North	45	0	0	41	4	0	23	16	6	0	35	10
Chesapeake Bay South	27	2	0	27	2	0	4	25	0	0	26	3
Central New Point	94	0	0	94	0	0	0	89	5	0	28	66
South Central New Point	60	0	0	60	0	0	0	60	0	0	0	60
Bavon Community	226	2	0	222	6	0	27	190	11	0	89	139

- **Pain Points**

  Property Owner Perspective

  When parcels in the Bavon community gradually become inundated, property owners will have a variety of decisions to make regarding the management and ownership of their property.

  For homeowners in the Bavon community inundation may result in loss of utilities. First septic tanks and drainfields will be inundated and will fail. Power may be lost and therefore air conditioning will not work. This could even trigger the growth of mold in such moist environments. Loss of power may also impact the functioning of wells. Additionally saltwater intrusion will impact the quality of water coming from wells and could corrode the mechanics of the well. The soil fails first as the soil turns to goo. The tanks and pipes still work as designed, but the soil is no longer dry enough to treat effluent. Additionally saltwater intrusion will impact the quality of water coming from wells, increasing salinity making the water no longer drinkable. Salt water could also corrode the mechanics of the well. With inundation, the house foundations could have standing water against the foundation and in the crawl space, further encouraging mold growth in the house.

  Government Perspective

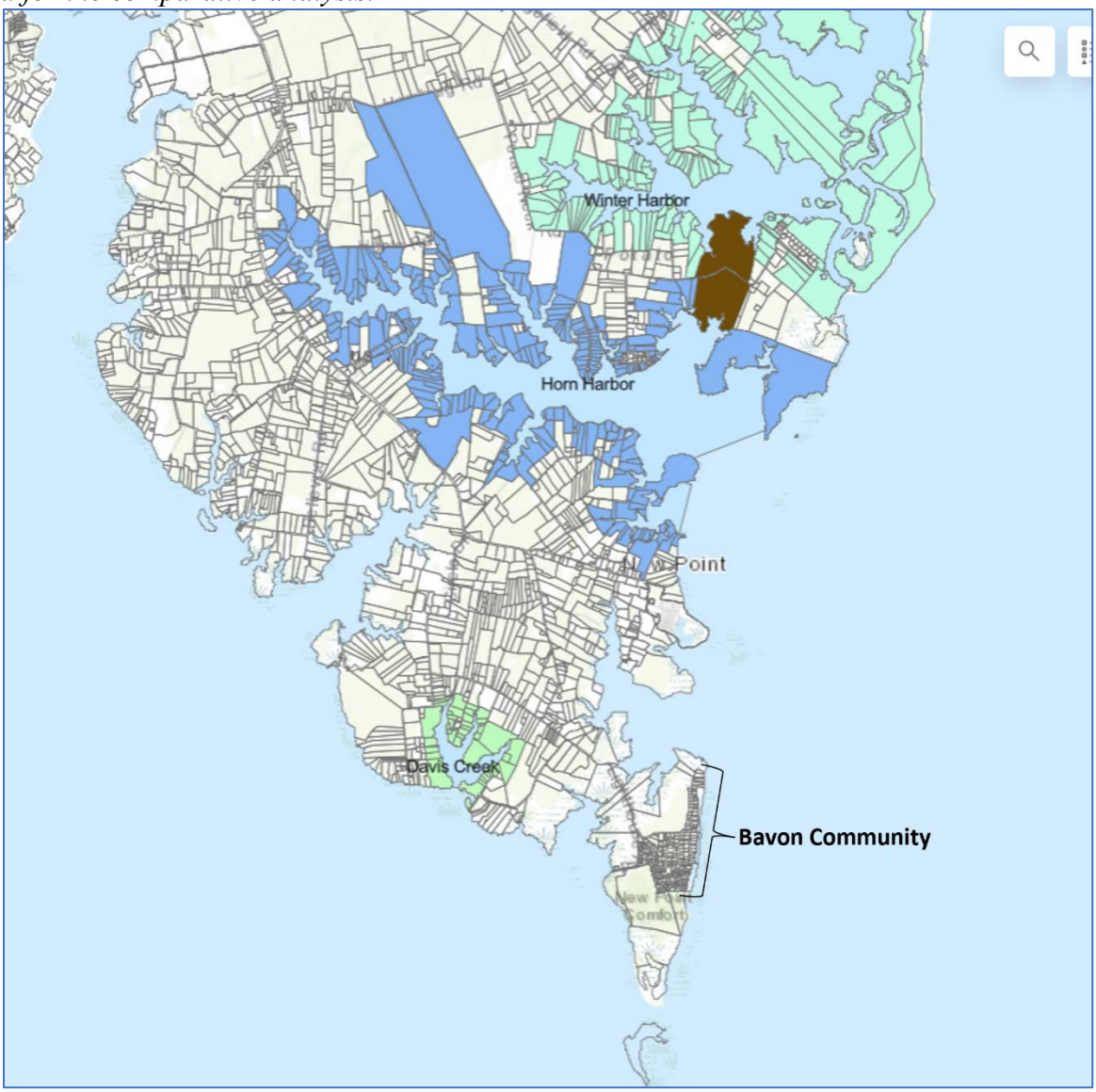
  How will inundated lands impact the residents and what is the government's role as water inundates their property and makes these properties inhabitable. What services can the local government continue to offer these residents and which services will need be terminated due to risk and safety concerns?

New Point Comparative Analysis

MPPDC staff conducted a comparative total land value assessment to show how land value is changing. Since there is no data for the New Point Bavon Community, MPPDC staff analyzed

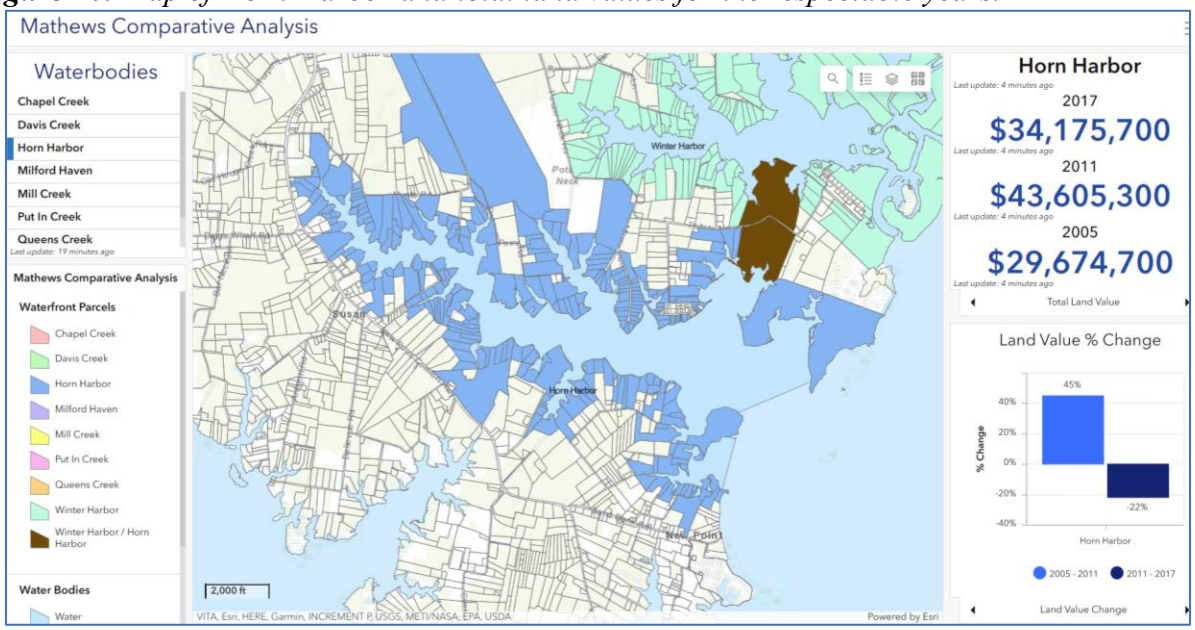
land value data from two communities – the Horn Harbor Community to the north of the Bavon Community and the Davis Creek to the west of Bavon Community (**Figure 19**).

Figure 19: *Map of communities within Mathews County. Horn Harbor and Davis Creek were used for the comparative analysis.*



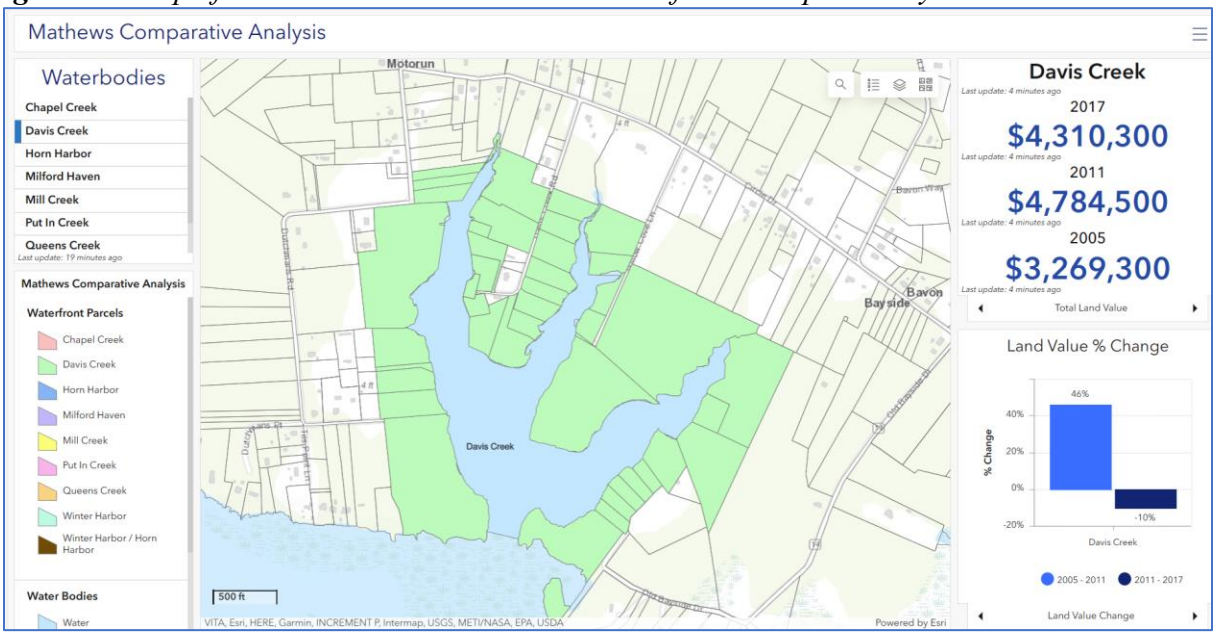
Horn Harbor is a community north of the Bavon Community. Based on the total land value data (**Figure 20**), between 2005 and 2011 there was an increase in total land value, with the land value jumping from $29,674,700 to $43,605,300. This was an increase of $13,930,600. Then between 2011 and 2017 there was a decrease in total land value, with land value decreasing to $34,175,700 which was a 21.6249% decrease.

Figure 20. *Map of Horn Harbor and total land values for the respectable years.*



Davis Creek is a community west of the Bavon Community. Based on the total land value data (**Figure 21**), between 2005 and 2011 there was an increase in total land value, with the land value jumping from $3,269,300 to $4,784,500. This was an increase of $1,515,200. Then between 2011 and 2017 there was a decrease in total land value, with land value decreasing to $4,310,300 which was a 9.91117% decrease.

Figure 21. *Map of Davis Creek and total land values for the respectable years.*



Consequently, there appears to be one trend of increasing land values between 2005 and 2011, and then a decreasing of land value between 2011 and 2017. Since the land value change is

consistent between the Horn Harbor and Davis Creek communities, MPPDC staff assumes that this will be the same for the Bavon Community.

- **Pain Points**

  Property Owner Perspective

  Property owners will need to address and strongly consider the individual economic burdens associated with owning a property in Bavon that will become inundated over time. Property owners will need to secure insurance to cover their assets, if available. If insurance is available, is it affordable? If insurance is not available, is it affordable to stay? Also, property owners will need to consider what it means for the land to be devalued as it becomes inundated. Also, will the ability to sell this property disappear and when?

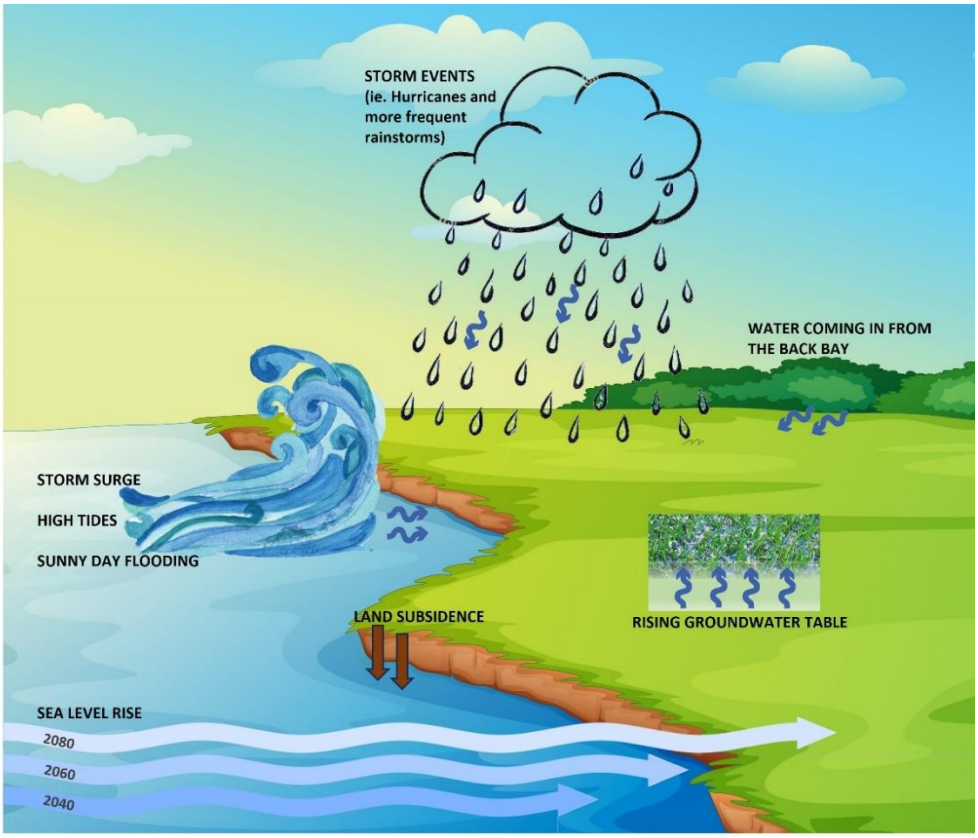
  Government Perspective

  As inundation of these properties devalues these homes, how will this impact tax revenue generation within the locality? How will the locality be able to recoup revenue losses? If local government does not adjust the levy, inland properties will be forces to cover the difference in lost revenue if waterfront parcels begin to devalue, making flooding a regressive tax structure.

Property Owner Decisions

Inundation encompasses a variety of factors that impact coastal communities (**Figure 22**). From rising groundwater levels to storms to sea level rise, water is, and will continue, to inundate coastal communities from all directions.

Figure 22. *Factors that encompass inundation.*



Inundation is a coastal cancer, that slowly eating away at land, and/or create waterlogged communities, which contributes to pain points for property owners, local governments, and local economies. At times many of these inundation factors exist simultaneously, which then exacerbates pain points even further. It's also important to note that property owners experience pain points well before inundation occurs on their property. For instance, the access road to the community may become flooded and impassable before inundation impacts one's property. Also, as the land subsides (at rates of 1.1 to 4.8 millimeters per year) and the groundwater levels rise then utilities such as drain fields and wells may become compromised prior into partial or complete inundation of the property.

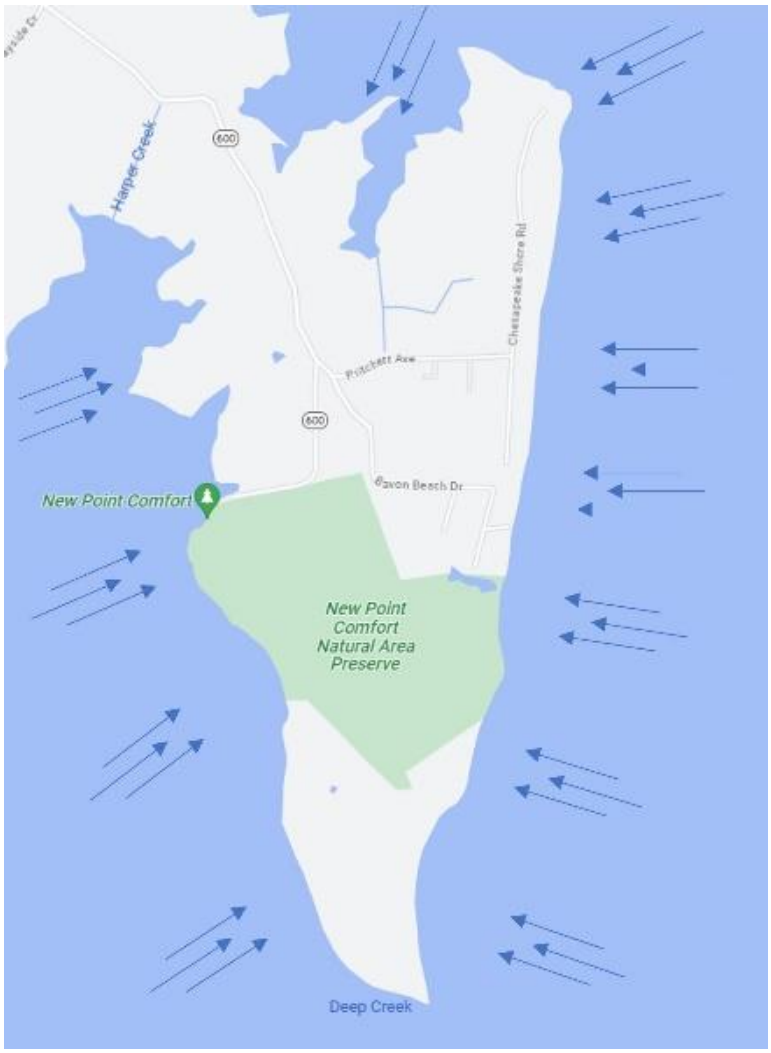
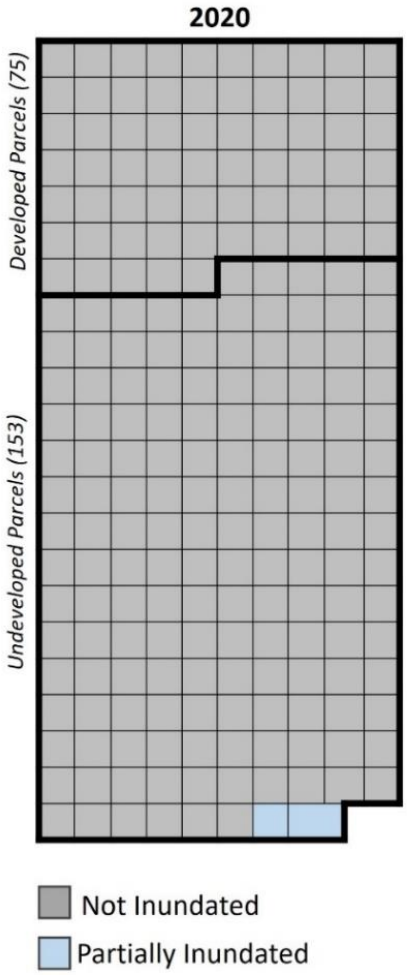


Figure 23. *Map of Bavon Community. The blue arrows show that water is impacting the community from all directions.*

As the Bavon Community experiences all the factors that contribute to inundation and from all directions (**Figure 23**), the property owners within the community, have an option to mitigate, or not. This will ultimately be dependent on the amount of inundation present on the given property and the amount of investment that the property owner is willing to make. **Figures 24-27** provide a graphic depiction of all parcels within the Bavon Community. Each block represents one parcel. The gray blocks represent parcels that are not inundated within the given time frame. The light blue blocks represent parcels with partial inundation and the dark blue blocks represent parcels that are completely inundated. To the right, are lists of options for managing property in the face of rising waters on developed and undeveloped parcels. Please note that this analysis assumes the status quo and does not take into consideration policy and regulation changes that may occur to address coastal inundation issues and management of this land and governmental services. For a definition of options please see Appendix A.

Figure 24: *Property owner options by 2020.*



Developed Parcels

With no inundation in 2020, the 75 owners of developed parcels have options to mitigate for flooding or not. Each will make a separate and individual decision – resulting in at least 75 independent and potentially different decisions within the Bavon Community for developed parcels.

Options for developed parcels with no inundation include:

1. DO NOTHING
2. STRUCTURAL MITIGATION
   - Home elevation
   - Mitigation Reconstruction
   - Floodproofing
3. SHORELINE/LANDSCAPE MANAGEMENT
   - Living Shoreline
   - Breakwater
   - Berm
4. SELL PROPERTY
5. DONATE LAND

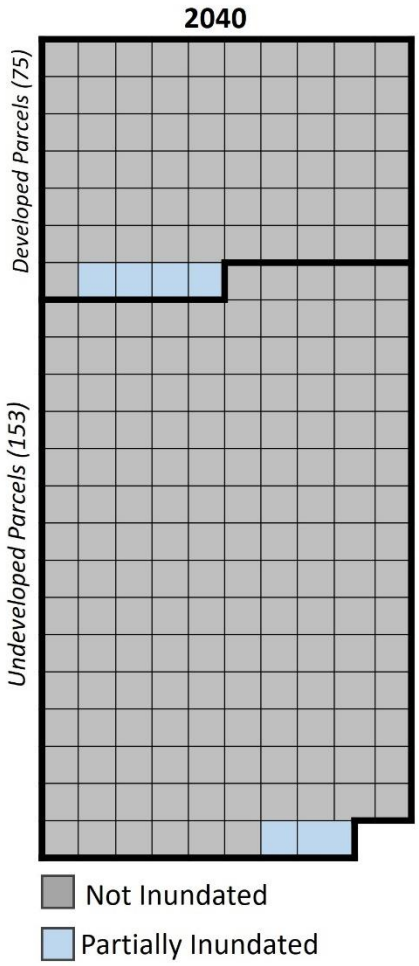
Undeveloped Parcels

With no inundation or partial inundation in 2020, the 151 owners of undeveloped parcels have options to mitigate for flooding or not. Each will make a separate and individual decision – resulting in at least 151 independent and different decisions within the Bavon Community for undeveloped parcels.

Options for undeveloped parcels with no inundation or partial flooding include:

1. DO NOTHING
2. DEVELOP PROPERTY
3. SHORELINE/LANDSCAPE MANAGEMENT
   - Living Shoreline
   - Breakwater
   - Berm
4. SELL PROPERTY
5. DONATE LAND

Figure 25: *Property owner options by 2040.*



Developed Parcels

With no inundation or partial flooding in 2040, the 75 owners of developed parcels have options to mitigate for flooding or not. Each will make a separate and individual decision – resulting in at least 75 independent and potentially different decisions within the Bavon Community for developed parcels.

Options for developed parcels with no and partial inundation include:

1. DO NOTHING
2. STRUCTURAL MITIGATION
   - Home elevation
   - Mitigation Reconstruction
   - Floodproofing
3. SHORELINE/LANDSCAPE MANAGEMENT
   - Living Shoreline
   - Breakwater
   - Berm
4. SELL PROPERTY
5. DONATE LAND

Note that while options may be the same for no inundation vs partial inundation the type of implementation of these options will be dependent on the amount of inundation.

Undeveloped Parcels

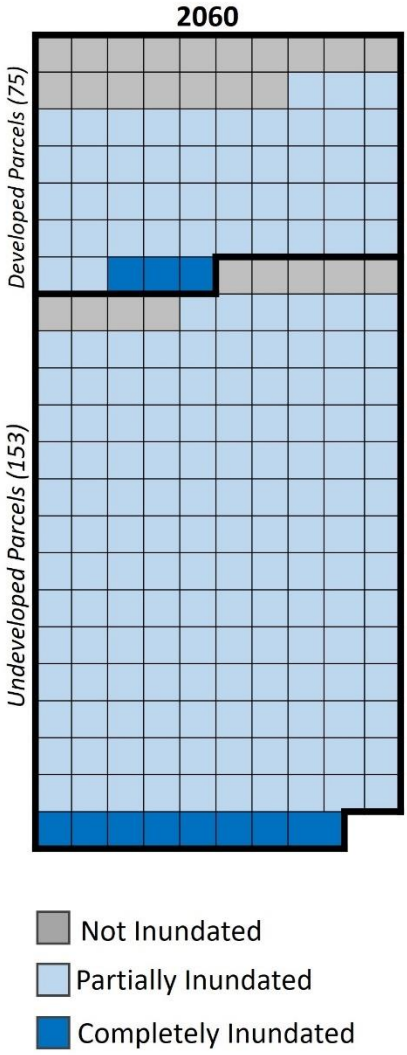
With no inundation or partial inundation in 2040, the 151 owners of undeveloped parcels have options to mitigate for flooding or not. Each will make a separate and individual decision – resulting in at least 151 independent and different decisions within the Bavon Community for undeveloped parcels.

Options for undeveloped parcels with no inundation or partial flooding include:

1. DO NOTHING
2. DEVELOP PROPERTY
3. SHORELINE/LANDSCAPE MANAGEMENT
   - Living Shoreline
   - Breakwater
   - Berm
4. SELL PROPERTY
5. DONATE LAND

Again, while options may be the same for no inundation vs partial inundation the type of implementation of these options will be dependent on the amount of inundation.

Figure 26: *Property owner options by 2060.*



Developed Parcels

With parcels that are not inundated, partially inundated, and fully inundated in 2060, the 75 owners of developed parcels have options to mitigate for flooding or not. Depending on the amount of inundation the be mitigation options will vary. Each will make a separate and individual decision – resulting in at least 75 independent and potentially different decisions within the Bavon Community for developed parcels.

Options for developed parcels with no inundation and partial inundation include:

1. DO NOTHING
2. STRUCTURAL MITIGATION
   - Home elevation
   - Mitigation Reconstruction
   - Floodproofing
3. SHORELINE/LANDSCAPE MANAGEMENT
   - Living Shoreline
   - Breakwater
   - Berm
4. SELL PROPERTY
5. DONATE LAND

Note that while options may be the same for no inundation vs partial inundation the type of implementation of these options will be dependent on the amount of inundation.

Undeveloped Parcels

With no inundation or partial inundation in 2020, the 151 owners of undeveloped parcels have options to mitigate for flooding or not. Each will make a separate and individual decision – resulting in at least 151 independent and different decisions within the Bavon Community for undeveloped parcels.

Options for undeveloped parcels with no or partial inundation include:

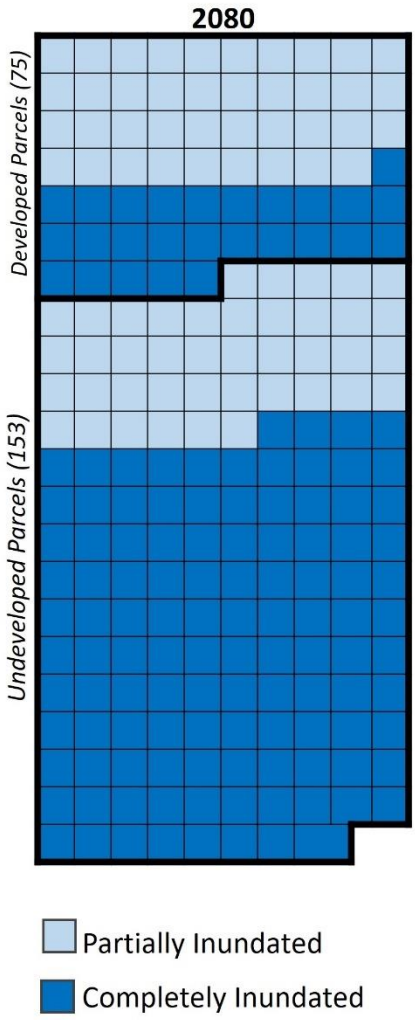
1. DO NOTHING
2. SHORELINE/LANDSCAPE MANAGEMENT
   - Living Shoreline
   - Breakwater
   - Berm
3. SELL PROPERTY
4. DONATE LAND

Note that while options may be the same for no inundation vs partial inundation the type of implementation of these options will be dependent on the amount of inundation.

Options for undeveloped parcels with complete inundation include:

1. DO NOTHING
2. SELL PROPERTY
3. DONATE LAND
4. ABANDON PROPERTY

Figure 27: *Property owner options by 2080.*



Developed Parcels

With partial and complete parcel flooding by 2080, the 75 owners of developed parcels have options to mitigate for flooding or not. Each will make a separate and individual decision – resulting in at least 75 independent and potentially different decisions within the Bavon Community for developed parcels.

Options for developed parcels with partial flooding include:

1. DO NOTHING
2. STRUCTURAL MITIGATION
   - Home elevation
   - Mitigation Reconstruction
   - Floodproofing
3. SHORELINE MANAGEMENT
   - Living Shoreline
   - Breakwater
   - Berm
4. SELL PROPERTY
5. DONATE LAND

Options for developed parcels with complete flooding include:

1. DO NOTHING
2. STRUCTURAL MITIGATION
   - Home elevation
3. SELL PROPERTY
4. DONATE LAND
5. ABANDON PROPERTY

Undeveloped Parcels

With no inundation or partial inundation in 2020, the 151 owners of undeveloped parcels have options to mitigate for flooding or not. Each will make a separate and individual decision – resulting in at least 151 independent and different decisions within the Bavon Community for undeveloped parcels.

Options for undeveloped parcels with complete flooding include:

1. DO NOTHING
2. SHORELINE/LANDSCAPE MANAGEMENT
   - Living Shoreline
   - Breakwater
   - Berm
3. SELL PROPERTY
4. DONATE LAND

Options for developed parcels with complete inundation include:

1. DO NOTHING
2. SELL PROPERTY
3. DONATE LAND
4. ABANDON PROPERTY

These diagrams above show potential chaos that may ensue, as there will be at least 228 independent and different decisions by property owners regarding would like to manage/protect their property at any given time to mitigate losses, or not. Additionally, if some of the undeveloped parcels owners decide to build on their properties this new construction could compound issues within the Bavon community. Permitting challenges will also arise as

environmental conditions change, but the reality is that the real estate value of those undeveloped lots will decrease as conditions worsen over coming decades and as the price lowers, it can attract more and more potential buyers looking to live near the beach no matter what the risk is and no matter for how short of a time their investment could last.

Conclusions

The slow demise is happening on the land in rural coastal Virginia is because of the threat of water. Rising water slowly kills businesses, land, and the way of life in coastal communities.

Responses to pain points due to inundation within coastal communities will be extremely complex, challenging and will involve many parties. MPPDC staff worked to develop methodology that recognizes that water has been coming and will continue to come and that private and government property owners must manage against this slow-motion threat or lose considerable economic and functional value of land and improvements.

MPPDC staff utilized the Bavon Community as a pilot community. Through the implementation of the methodology, it was found that there are critical aspects that may or may not influence property owner decisions:

1. **Access** to the Bavon community via Lighthouse Road -
    - ~2040 – Lighthouse Road will be inundated twice a day at MHHW.
    - ~2060 – Lighthouse Road will be inundated at MHHW and MLW.

2. **Inundated properties** -
    - Between 2020-2040 inland properties will experience 50% annual exceedance probability of flooding at MHW.
    - ~2080 virtually all the properties in the Bavon community will be affected by sea level rise. As the highest parts of the ridge will be above water, inland properties on the western side of the community will be fully inundated at MLW and properties on the eastern side of the community will be inundated at MHW.

3. **Land Value** - There is a drastic decrease in land value between 2011 and 2017.

Finally, dependent on the amount of inundation present on the given property and the amount of investment that the property owner is willing to make, there are a variety of alternatives/mitigation options to implement. Within the Bavon community there will be at least 228 independent and different decisions by property owners regarding would like to manage/protect their property at any given time to mitigate losses, or not.

This offers an overview of how inundation will impact coastal communities and some key aspects that property owners will need to address. Simultaneously, as private landowners are make decisions about their properties, government entities will be making decisions (i.e.. Creating policies, etc.) about their own serves which may also exacerbate the complexity of decisions that property owners need to make.

Loss of economic, environmental, and social capital constitutes a form of blight, including the loss of property values, economic stability, and quality of the environment. Drivers of blight can be slow, such as long-term decline in economic activity or depopulation, both of which are common in rural coastal locations. Rapid blight may also occur due to a sudden policy transition, or natural disasters such as flooding, erosion, or landslides. Therefore, communities like that of Bavon need to understand options to mitigate flooding and temporarily curb economic and social capital losses.

Appendix A: Owner Alternatives

1. **DO NOTHING -** Do not take any actions.

2. **DEVELOP PROPERTY -** New construction on properties that are undeveloped.

3. **STRUCTURAL MITIGATION –**
    a. **STRUCTURE ELEVATION -** Structure elevation is the physical raising and/or retrofitting of an existing structure. Elevation may be achieved through a variety of methods, including elevating on continuous foundation walls; elevating on open foundations, such as piles, piers, posts or columns; elevating on fill; and second-story conversion.

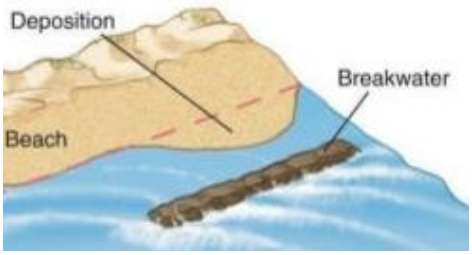
    b. **MITIGATION RECONSTRUCTION -** Mitigation reconstruction is the construction of an improved, elevated structure that conforms to the latest building codes on the same site where an existing structure and/or foundation has been partially or completely demolished or destroyed.

    c. **FLOODPROOFING -** Dry floodproofing techniques are applied to keep structures dry by sealing the structure to keep floodwaters out. Dry floodproofing projects are eligible for non-residential and historic residential structures under all HMA programs. Wet floodproofing consists of the use of flood-damage-resistant materials and construction techniques to minimize flood damage to areas below the flood protection level of a non-residential structure, which is intentionally allowed to flood. Wet floodproofing projects are eligible for non-residential structures under all HMA programs. Floodproofing may also include retrofitting.

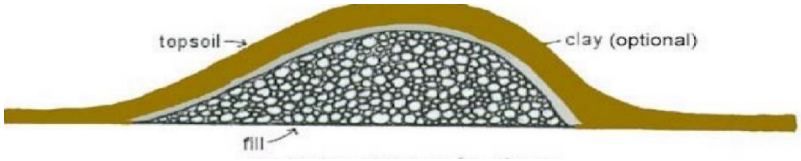
4. **SHORELINE/LANDSCAPE MANAGEMENT –** For coastal properties, shoreline management options are available, while inland property owners may opt for landscape improvements to mitigate flooding.

    a. **LIVING SHORELINES -** are nature-based approaches for shoreline protection. These stabilization techniques not only protect shorelines and infrastructure, they also conserve, create or restore natural shoreline habitats and ecosystem services.

    b. BREAKWATERS - a permanent structure constructed at a coastal area to protect against tides, currents, waves, and storm surges.



c. **BERMS** – a berm is mound of compacted early with sloping sides. Berms may service as a barrier to the flow of water, retaining flow and allowing infiltration, and directing the flow of water.



5. **SELL PROPERTY –** Sell property or seek a property by out by FEMA, or other agencies. Buyout may be an option as the value of properties decrease.

6. **LAND DONATION -** Donating land in the floodplain to a public or non-profit organization can become a community asset. The donated land may provide water supply protection, flood control, fish and wildlife habitat, recreation (hunting, fishing, hiking, wildlife watching, etc.), carbon sequestration, dilution of wastewater, and erosion control. Also, there may be benefits to the land donor. For example, if the land is donated to a public entity there may be deductions in your Federal and Virginia state income taxes.

7. **ABANDON PROPERTY –** Abandonment of properties might occur if no one wants to buy the property and when living conditions diminish due to inundation.