REPORT

SEA LEVEL RISE PREDICTIVE ANALYSIS

Milton, Delaware

Prepared For:

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Project Description

The purpose of this report is to prepare an updated sea level rise study and analysis of the Broadkill River and its tributaries impacting the Town of Milton. Pennoni prepared this report as an update to the 2016 Pennoni study to include revised predictive sea level rise models from the National Oceanic and Atmospheric Administration (NOAA). The additional study scope was prompted by a report titled "When Rising Seas Hit Home" (Union of Concerned Scientists, July 2017), and further publications and studies regarding sea level rise and related community impacts. This national study noted key findings to consider.

- By 2035, about 170 communities—roughly twice as many as today—will face chronic inundation and possible retreat from affected areas under the intermediate or high-water scenarios, with more than 100 communities seeing at least a quarter of their land chronically flooded.
- By 2060, about 270 communities will face chronic inundation with intermediate sea level rise. This number jumps to 360 under the high-water scenario. About 40 percent of chronically inundated communities in either scenario would see at least half of their land flooded.
- By 2100, about 490 communities—including roughly 40 percent of all oceanfront communities on the East and Gulf Coasts—will face chronic inundation and possible retreat with intermediate sea level rise, with nearly 300 seeing at least a quarter of their land chronically flooded. The number of communities jumps to about 670—including roughly 60 percent of all oceanfront communities on the East and Gulf Coasts—under the high-water scenario.

This report examines sea level changes from the Atlantic Ocean and the Delaware Bay that may impact the Town of Milton through the tidal influenced Broadkill River and its tributaries as these waterways traverse the landscape. This report reveals available data and information from government agencies and other noted sources.

History

The Town

As noted on the Town's website "Located at the head of the Broadkill River Milton was first settled in 1672 by English Colonists. The Town was known by various names until 1807, when it was named for the English poet, John Milton. The Delaware General Assembly passed the charter that recognized the Town of Milton as a municipality in 1945. History and Milton's shipbuilding heritage remain important to the town. Milton is home to some of the finest Victorian and Colonial architecture in Delaware. Many homes have been restored to their original form, particularly those on Union and Federal Streets. Milton has 198 structures on the Federal Register Historic District and its history is preserved in the Lydia Black Cannon Museum, the Governor James Carey home, the Chestnut Street Cemetery, and the Governor David Hazzard Mansion." The Broadkill River has been important to the history of the Town and will continue to have an impact on the Town as the water levels and channel depths change over time.

Figure 1 - Historic Milton Map

The Broadkill River

The Broadkill River is central to the identity, history, character, and economic wellbeing of the Town. Milton's protected inland location provided security from ocean storms and naval attacks that

plagued the bay-front towns in the early centuries. As the Town developed the access to lumber and locally raised farm products made the port central to the developing and prosperous shipping community. The river facilitated the development of several mills, resulting in streams being impounded to create the millponds.

The two impoundments located at the headwaters of the Broadkill River are Wagamons Pond and Diamond Pond. Wagamons Pond, shown as Mill Pond in Figure 1 - Historic Milton Map, is a dammed impoundment at the intersection of the Wagamon Branch and Ingram Branch. Diamond Pond located on Ingram Branch upstream of Wagamons Pond just south of Sand Hill Road within the comprehensive planning area of the Town. The Round Pole Branch of the Broadkill also winds its way through Milton crossing Front Street east of the Mt. Zion Holy Church, then across Atlantic Street, through the Dogfish Head Brewery parcel, and along Cannery Village and Heritage Creek subdivisions.

Today, the Broadkill River continues to be considered one of the Town's greatest assets along with its Historic District and its traditional downtown. However, the Broadkill River also poses a several challenges and flooding threats similar to those experienced in other tidal riverside communities.

Recent Flood Events

In October 2012, Hurricane Sandy caused major impact in New Jersey and to a lesser extent in Delaware. In Milton, Hurricane Sandy flooded several businesses on Federal Street, and the Public Library. Additionally, Front, Magnolia, and Union Streets all experienced temporary flooding and damages (Evans, 2012). In August 2011, Hurricane Irene dropped a recorded rainfall of 10.43 inches in Ellendale (Updated Rainfall Totals, 2011) and caused a tornado in Lewes.

In September 2003, Hurricane Isabel caused a 5-foot storm surge along the Delaware coast with winds up to 70 mph. Eventually resulting in the entire state being declared a disaster area. (FEMA, 2003). Additional storm information is listed at (List of Delaware Hurricanes, 2022).

Figure 2 - August 27, 2011, showing high water level at the docks. (Ellingsworth, 2011)

August 2016 Sea Level Rise Study

The 2016 Sea Level Rise Report prepared by Pennoni provided nine maps showing various impacts to sixteen key locations within the Town including a final flood risk map showing sea level rise coupled with category 4 hurricane conditions under high tide. The study maps showed impacts from various events on the sixteen key locations.

As concerns grew around the impacts of sea level rise the Town decided to proceed with this predictive analysis in consideration of updated calculations and hopes to continue to develop mitigation options and potential capital improvements to address the rising concerns impacting these and other facilities and infrastructure within the Town. The 2016 Pennoni study referenced the "Delaware Flood Risk Adaptation Map: Methods, Assumptions, and limitations (URS, February 2015).

Existing Conditions

Broadkill River

The tidal flow of the Broadkill River is impacted by waters of the Delaware Bay, the Delaware River Basin Watershed, and the Atlantic Ocean through the 110 square mile watershed flowing to its 13-mile length. The Town of Milton is at the headwaters of the Broadkill River beginning at the Wagamons Pond Dam being fed by the Ingram and Pemberton Branches. The Broadkill flows through wetlands and salt marshes in the Prime Hook National Wildlife Refuge before entering the Delaware Bay at Roosevelt Inlet in Lewes. The water quality for the Broadkill River and its watershed is monitored under the Citizen Monitoring Program through the University of Delaware College of Earth, Ocean, and Environment. Information regarding water quality is available through the website at https://www.citizen-monitoring.udel.edu/monitoring-programs/broadkill-river/ but the program does not currently monitor the water elevations near Milton. Delaware has an online flood planning tool available through the state website at

https://floodplanning.dnrec.delaware.gov/ .The flood planning tool shows aerial imagery with floodplain area overlays allowing parcel research with visible areas of possible flood impacts made possible with GIS planning tools and reference information.

Predictive Analysis

General Overview

Methodology

The methodology for this limited predictive study required sourcing the most current data to provide the Town of Milton a credible resource when determining the future risks associated with sea level rise and flooding. Sourced data for this study includes FEMA Floodplain Maps, Flood Risk Adaptation Map (FRAM), Storm Surge Inundation Maps, LiDAR base maps, Contour data, Sussex County parcel data, Digital Elevation Models, and Sea Level Rise Maps. This report considered data obtained from the Federal Emergency Management Agency (FEMA), the National Oceanic and Atmospheric Administration (NOAA), the National Ocean Service (NOS), National Hurricane Center (NHC) Delaware FirstMAP, Delaware Department of Transportation, the National Park Service, and the Department of Commerce (DOC). The Town of Milton provided data sources for historical sites and the Town's critical facilities.

The future effects of sea level rise within the Town were reduced to which parcels/facilities were impacted at different sea level rise scenarios. Using ArcMap, a licensed geospatial processing program provided by ESRI, Pennoni incorporated the stated data layers to create visual and tabular displays for the Town to use in future planning at their own discretion. This analysis does not account for erosion, subsidence, or any future changes in an area's hydrodynamics, as the maps only predict future sea/storm surge elevations. The maps prepared for this report are included in the Map Appendix.

Pennoni used a selection analysis tool to determine the sea level rise impacts by isolating parcels intersecting the sea level rise limits for scenarios at 1, 2, 4, 6, and 8 feet of sea level rise. Once isolated, the parcels were saved as individual layers to create impacted parcel layers for each sea level rise scenario. These layers allow for a clear picture of the potential impacts sea level rise could have in Town and identifies those parcels with the highest risk. After the impacted parcels were isolated, a second selection analysis isolated any of the identified twenty-one critical, public, or historical facilities existing on the impacted parcels. The critical, public, and historical facilities exist as point locations, that for buildings (including schools and homes) or facilities (including water towers or treatment plants) do not accurately represent the buildings exact physical footprints. This process of using the impacted parcel layers as the selection tool as opposed to the sea level rise layers effectively mitigates this issue and maintains a level of caution that should come when evaluating risks associated with important infrastructure.

Due to restrictions set by the authors of the FRAM, Storm Surge Inundation, and FEMA maps, geoprocessing and editing tools could not be used for the analysis. Therefore, a similar analysis to the one completed for the sea level rise layers was not feasible. Instead, Pennoni conducted a visual analysis for these maps to determine the critical infrastructure facilities impacted during each scenario. Furthermore, in comparing the extents of these maps to the sea level rise maps, the impacts of these scenarios could be estimated using the referenced existing contour information.

In this study, the original sixteen key locations were analyzed in addition to the new Shipbuilders Well (location), Mill Park, and seven notable historic locations specified by the Town, totaling 25 key locations. Affected parcels, roads, and historic district parcels were analyzed for the sea level rise scenarios. The analysis is shown on the maps included within this report. To bring perspective to the results, data from NOAA's Sea level rise viewer tool was used to create a chart displaying approximate timelines for each foot of rise 1-8 feet. The chart displays four sea level rise scenarios and their expected rise at each year. The scenarios, Intermediate Low, Intermediate, Intermediate High, and High are derived from the 2022 Sea Level Rise Technical report. (NOAA U. D., 2022). The intermediate scenario represents the current trajectory of sea level rise, where-as the alternate scenarios represent either more or less sea level rise based on projected global temperatures by greenhouse gas emission scenarios in the IPCC AR6 report (IPCC, 2022).

As shown in the Figure 3 - Sea Level Rise Scenarios Timeline Figure 3, one foot of sea level rise is expected to take place between 2032 and 2040. Two feet of sea level rise is projected around 2052-2075, four feet around 2075+, six feet around 2093+, and eight feet around 2100+. It should be noted that the general nature of the predictive analysis and potential accuracy is limited as represented in the figure by the wide range of the future prediction amplified to a 2.5-foot predictive range by 2080. Considerations for mitigations should start with the 1-2 rise predicted within the next 30-years. Map 3 – Elevation Map and Map 4 – Contour Map show the existing ground surface elevations for the areas prone to flooding and why these areas will be impacted by sea level rise.

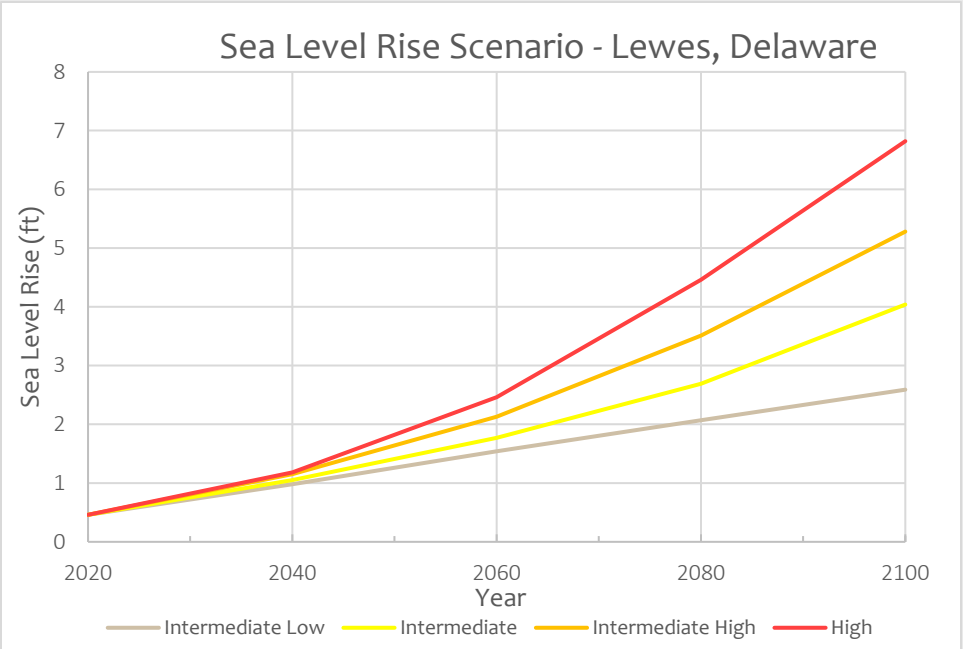

Figure 3 - Sea Level Rise Scenarios Timeline

Term Definitions

100-year flood - The 100-year recurrence interval means that a flood of that magnitude has a 1-percent chance of occurring in any given year. In other words, the chances that a river will flow as high as the 100-year flood stage this year is 1 in 100.

500-year flood - The 500-year recurrence interval means that a flood of that magnitude has a 0.2-percent chance of occurring in any given year. In other words, the chances that a river will flow as high as the 500-year flood stage this year is 1 in 500.

AEP - Annual Exceedance Probability

NAVD – North American Vertical Datum

Table 1 - Flood Risk Adaptation Zones

Zone Designation	Code Description	Zone Description	Flood Elevation or Depth
CE	Combined Flood Hazard Elevation	Elevation of 1%-annual-chance stillwater + 3 feet SLR + possible wave conditions	Elevation in feet relative to NAVD88
CD+	Combined Flood Hazard Depth	Sheet flow depth due to wave runup and overtopping of dunes/structures	Depth of water above the local ground
OS	Outside of SLR Floodplain	Areas of high ground that are not shown as inundated by the analysis but may be surrounded by inundated land	N/A

Corridor Analysis

Businesses, Residences, and Historic Sites

Businesses, residences, and historic sites are already being impacted by flooding and tidal waters. The 100-year flood or the 1% AEP FEMA recognizes as a Special Flood Hazard Area (SFHA) can be a temporary inundation represented by the mapped floodplain line, see Map 10 in the Map Appendix. The mapped floodplain lines cross parcels along the waterways of Milton with varied impacts due to the contour of the land and the water elevations. Table 2 - Facility Impact Summary lists twenty-one identified public, critical, and historical infrastructure locations within the Town of Milton and highlights the potential risk to each of these facilities as

identified by the FEMA, FRAM, Sea Level Rise Scenario, and Storm Surge Inundation maps. The "Y" indicates that the facility referenced may be impacted by the identified the risk event at the top of the column.

Table 2 - Facility Impact Summary

Facility Information		Asset Impact at Risk Event											
		Storm Events		FRAM	Sea Level Rise (ft)					Storm Surge Inundation			
Reference Name	Function	100-yr	500-yr	100-yr + 3ft SLR + Waves	1	2	4	6	8	Cat 1	Cat 2	Cat 3	Cat 4
Artesian Water Company WWTP	Wastewater Treatment	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Water Tower No. 1	Water Storage	Y	Y	Y			Y	Y	Y	Y	Y	Y	Y
Wells 2, 4, & 7	Water System/ Water Source	Y	Y	Y			Y	Y	Y	Y	Y	Y	Y
Potential WTP/Well Location	Water System	Y	Y	Y			Y	Y	Y		Y	Y	Y
Well 5	Water System/ Water Source	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
DPW[1] Building	DPW - Operations Building	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Magnolia Street Parking Lot	Municipal Parking Lot	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Memorial Park	Public Park	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Mill Park	Public Park		Y	Y				Y	Y		Y	Y	Y
Police Station	Milton Police Headquarters			Y								Y	Y
Milton Fire Dept., Inc.[2]	Milton FD Sta. 85 EMS/Fire		Y	Y					Y		Y	Y	Y
Milton ES	Elementary School	Y	Y	Y			Y	Y	Y		Y	Y	Y
118 Magnolia Street	(Historic Post Office location)	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y
Draper-Adkins Parcel	Historic Feature	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Milton Theatre	Historic Feature	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Milton Public Library	Public Facility	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Milton Historical Society / Museum	Historic Feature	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Facilities at Risk		14	16	17	9	10	14	15	16	12	16	17	17

The parcels identified in these tables do not account for the potential damage to utilities owned by private companies within the area of impact. Artesian Water Company and Delmarva Power each own facilities within the impact area.

[1] "DPW" is the Town of Milton Department of Public Works

[2] Milton Fire Department, Inc. is an independent entity and is not owned by the Town of Milton

Table 3 - Facilities Not Directly Impacted

Facility Information		Asset Impact at Risk Event											
Reference Name	Function	Storm Events		FRAM	Sea Level Rise (ft)					Storm Surge Inundation			
		100-yr	500-yr	100-yr + 3ft SLR + Waves	1	2	4	6	8	Cat 1	Cat 2	Cat 3	Cat 4
Well 8 (Shipbuilders)	Water System/ Water Source	Not directly impacted by rising water elevations due the ground surface elevations.											
Water Tower No. 2	Water System	Not directly impacted by rising water elevations due the ground surface elevations.											
Town Hall	Town Services	Not directly impacted by rising water elevations due the ground surface elevations.											
HO Brittingham ES	Elementary School	Not directly impacted by rising water elevations due the ground surface elevations.											
Mariner MS	Middle School	The house location is not directly impacted by rising water elevations due the location and ground surface elevation.											
Post Office	US Postal Service	Current location at 219 Milton Ellendale Highway is not impacted.											
Draper-Adkins House	Historic Feature	The house location is not directly impacted by rising water elevations due the location and ground surface elevation.											
Gov. James Ponder House	Historic Feature	The house location is not directly impacted by rising water elevations due the location and ground surface elevation.											
Hazzard House	Historic Feature	The house location is not directly impacted by rising water elevations due the location and ground surface elevation.											

Table 4 - Sea Level Rise Parcel Impacts displays the overall impacts sea level rise could have within the Town. This table includes the number of parcels and approximate acreage impacted at each scenario derived from the mapping using GIS tools. These impacts are visible on the provided "Impacted Parcels and Infrastructure Map" color coded by the sea level rise elevation levels, see Map 8 in the Map Appendix.

Table 4 - Sea Level Rise Parcel Impacts

Sea Level Rise Scenario	Number of Parcels Impacted	Approximate Acreage Impacted	Timeline Range of Impact
MHHW	44	143	
1ft	63	287	2034-2042
2ft	84	293	2052-2076
4ft	156	424	2075+
6ft	177	430	2092+
8ft	193	456	

Table 5 - Sea Level Rise Historic District Impact shows the percentage of historic district parcels potentially impacted at each sea level rise elevation. According to the GIS shapefile referenced from the National Register of Historic Places there are approximately 215 parcels designated as part of Milton's historic district. The analysis indicates between 10 and 25 percent of the Milton's historic parcels may be or are already experiencing some impacts due to sea level rise. The impact to each parcel would need to be reviewed independently with consideration to parcel elevations and site improvements to determine if the facilities are below the sea level rise elevations and whether the site would be accessible after the sea level rise impact. Additional mapping of the building locations against the mapped impacts would provide more information.

Table 5 - Sea Level Rise Historic District Impacts

Sea Level Rise Scenario	Percent of Impacted Historic District Parcels	Timeline Range of Impact
MHHW	10%	
1ft	15%	2034-2042
2ft	19%	2052-2076
4ft	21%	2075+
6ft	24%	2092+
8ft	25%	

According to the Delaware Office of State Planning Coordination, Milton's town center is composed of mostly residential, commercial, and park land. This area is also the center of Milton's historic district and contains the police station, Milton Fire Dept. Station 85, and, the Milton Public Library, the Department of Public Works, and Town Hall. Memorial Park borders the Broadkill and includes a boat ramp, six boat slips, as well as recreational open space, a playground, a bandstand, and miniature train (Inc., 2018). The town center area is built along the Broadkill River on both the north and south sides in close vicinity to the shoreline, and in some cases is constructed on bulkhead sheet piles. As a result, the analysis in this report shows significant risk to parcels within this area, summarized in Table 2 - Facility Impact Summary.

According to the analysis, well 5, the Department of Public Works, the municipal parking lot along Magnolia Street, Memorial Park, the Artesian Water Company WWTP, Tower No. 1, and Wells 2, 4, and 7, the Draper-Adkins Parcel, the Milton Theatre, Public Library, Historic Post Office, and Historical Society are all at high risk as they are impacted by a majority of the scenarios. After examination of Map 4 – Contour Map, most of these features besides Tower No. 1 and the Draper-Adkins parcel are shown between the 0-foot and 5-foot contour lines. Facilities with lower risks such as the police station and Milton Fire Dept. Sta. 85, Milton Elementary School, Town Hall, Mill Park and portions of the Milton Historic District are all at higher elevations along the edge of the Broadkill River and thus are not affected by as many scenarios.

The loss of these facilities would have considerable impacts to many of the Town's operational capabilities. The town center would experience consistent flooding, coupled with gradual erosion, further magnified during storm events or high tide conditions. The loss of Milton's Historic treasures, Memorial Park, portions of Mill Park and parking areas would impact many of the businesses in the area. For some businesses this may mean a complete relocation due to inundation, and for others this could mean reduced business activity due decreased foot traffic near flooded areas.

Possible mitigation efforts to protect these buildings would be to build up bulkheads along the shoreline of the Broadkill. It is important to consider that this effort would likely only offer protection against the FRAM, FEMA, and Storm Surge scenarios and may not provide permanent inundation mitigation against the threats posed by sea level rise. In a permanent scenario such as sea level rise, relocating critical infrastructure to locations of higher elevations or elevating the infrastructure itself, in place, are effective but costly mitigation techniques. In a proactive effort, the Town has already selected a potential location for a new WTP/Well facility on Federal Street as shown on the referenced maps, this location contains contours up to 25ft and down to sea level at the shoreline of the Ingram Branch. It is therefore critical that these new facilities be constructed at higher elevations to protect against the discussed events.

Methods of tracking sea level rise could be implemented to develop data for consideration and predictive analysis to develop future mitigation and capital planning to address flooding and sea level rise. Local tide level monitoring would help the Town create a baseline reference of tide elevations and build a historical database to reference for storm surges, and identify the mean sea level, high tide, and low tide each year.

Roadways/Bridges

The Broadkill River and its branches cross key roadways and travel corridors within the Town and there is a significant impact to these routes linking the north and south sides of Town for travelers, residents, businesses, municipal maintenance, and emergency services. There are bridge and culvert crossings at Union Street, Mulberry Street, Lavinia Street, Atlantic Street, and Front Street. In addition, there are several streets within or near the 100-year floodplain areas such as Magnolia, Front, and Chandler Streets.

Table 6 - Roadway Impact summarizes the linear footage of roadways potentially impacted during each sea level rise scenario as demonstrated by red highlighted roadways on Map 9 in the Map Appendix. This includes roadways impacted by floodplains and storm events during these scenarios.

Table 6 - Roadway Impacts – Sea Level Rise Scenarios

Sea Level Rise Scenario	Linear Footage of Impacted Roadways within the Town Limits	Timeline Range of Impact
1ft	1,100	2034-2042
2ft	2,095	2052-2076
4ft	3,584	2075+
6ft	4,417	2092+
8ft	6,267	

Table 7 - Roadway Impacts by Linear Foot summarizes the potential impacts of sea level rise as a linear footage sorted by road names. The roadways passing over and bordering the waterways are concerning. Especially in the case of Union, Front and Atlantic Streets due to their proximity to the waterway and the existing floodplain.

As shown in Table 6 and Table 7, sea level rise is predicted to inundate several existing roadways within the Town. Front Street, and portions of Chestnut and Collins Streets are severely impacted by both the Broadkill River and the Round Pole Branch tributary flooding. The entire length of Front Street from the Federal Street intersection to the eastern Town limit is impacted by flooding. This is concerning for a route the Town has identified in their Comprehensive Plan as an important entry to the Town.

Table 7 - Roadway Impacts by Linear Foot

Road Name	Linear Footage Impacted[3]
Town Roadways	
Behringer Avenue	54
Chandler Street	871
Chestnut Street	124
Collins Street	176
Front Street Ext.	198
Magnolia Street	704
Walnut Street	213
TOTAL PROJECTED IMPACT	2,340
DelDOT Roadways	
Atlantic Street (#88)	143
Cave Neck Road (#88)	100
Federal Street (#22)	214
Front Street (#89)	1,644
Lavinia Street (#250)	525
Mulberry Street (#197)	498
Union Street (#22)	801
TOTAL PROJECTED IMPACT	3,925

[3] Represents the sum of 1, 2, 4, 6, and 8ft sea level rise scenarios.

Chandler, Federal, Magnolia, and Union Streets are within the low elevations of the Town center along the Broadkill River near bulkhead, dock, and dam areas. Atlantic Street is impacted by Round Pole Brach flooding near the Town limit. The impacted roadways are travel routes between the north and south sides of Town for all activities. These routes are important to the vitality of the Town used by travelers, businesses, shipping, deliveries, and emergency services.

Resiliency for the FEMA conditions, category storms, and nor-easters should consider the potential for larger impacted areas, slower receding water levels, and additional clean-up. Consideration for warning signage and alternate flood routes may provide additional awareness. Preparation for resiliency should consider the potential eventuality of impassible roadways due to sea level rise inundation. These roadways and bridges may need to be modified, upgraded, or replaced unless alternative routes can be determined to provide traffic routing and travel. Nor-easters were not classified into the storm categories provided in the tables within this report.

1ft Sea Level Rise

The analysis shows that at one foot of sea level rise the Union Street bridge would be impassable due to flooding of the roadway approaches on either side of the bridge. The blockage of Union Street bridge would divert traffic to Mulberry or Lavinia Streets to replace the main route traversing between the southern and northern sides of Town. Due to the location of the first responders' headquarters on the south side of Town, this scenario would force the use of the detoured routes through Mulberry or Lavinia Streets increasing their response time and ability to service northern Milton. Mulberry Street intersection at Federal Street is an acute angle turn and may need to be reconfigured to create adequate turning radii for emergency vehicles approaching from the Milton Fire Dept. along Federal Street and turning north. This scenario divides Milton's main shopping, historic, and recreation areas for those walking or driving through Town adversely impacting businesses in this area. The use and access of public parking facility at Magnolia Street may be in jeopardy of loss in early scenarios due to the low-lying condition and its presence in the floodway and floodplain area.

2-6 ft Sea Level Rise

At two, four, and six feet of sea level rise the conditions worsen on Union, Federal, Chandler and Magnolia Streets. At Union Street the water levels are potentially overtopping the bridge at lower approach sections and inundating the roadway to Chandler Street. Federal Street is inundated from the Public Works garage to Collins Street. Chandler Street and Memorial Park will be inundated as well. Magnolia Street parking facility will no longer be of use and Magnolia Street will be impassible impacting the Bodie Market business and the town center. The north south routes of Mulberry and Lavinia Streets remain passible with limited impacts.

8ft Sea Level Rise

At eight feet of sea level rise both the Lavinia and Mulberry Street routes are likely impassable due flooded approach areas on either side of the bridges. In this scenario all routes within the town limits to pass between north and south Milton may be blocked. This will force a detoured route using Sand Hill Road, Route 30, and Route 16. To reach the Coastal Highway from southern Milton, a route using Cave Neck Road would serve as the most direct connection to the Coastal Highway, assuming the Round Pole Bridge on Round Pole Bridge Road is also impassible during this scenario.

The Delaware Department of Transportation owns and maintains Routes 16 and 30, Cave Neck Road, and Sand Hill Road (Transportation, 2022). As main detoured routes during the aforementioned scenarios, these routes would experience a significant traffic increase, especially during summer months. The significant traffic increase will prompt roadway improvements along each corridor to provide adequate vehicular capacity. Improvements could range from basic widening to multi-lane widening and traffic signalization. Moreover, Union Street, which is part of Route 5, may experience direct impacts from sea level rise at the one-foot sea level rise scenario. DelDOT notification and coordination will be shown in the mitigation consideration to address the risks noted here. This should be a consideration in the DelDOT Transportation Improvement District in development for the Milton area.

While sea level rise presents a threat of permanent roadway impacts, alternate scenarios including FEMA, Storm Surge, and FRAM represent semi-permanent impacts. Flood elevations may only be sustained for the duration of these storms, but the storms may have lasting impacts such as erosion of roadway subbases resulting in surface cracking of asphalt and roadway destruction. Many of the roadways within the flood area are Town streets and are an important consideration for Milton's planning and budgeting. The storm surge categories 2, 3, and 4, FRAM, and FEMA maps demonstrate inundation extents equal to or beyond the eight-foot sea level rise scenario. Therefore, similar impacts could be anticipated during these scenarios, although the initial surge from these storms could cause more damage than mentioned in the cases of sea level rise due to the quick rise and fast flow of water related to flooding and storm events.

Storm Sewers

Storm sewer outfalls to the Broadkill River are already impacted by tidal river. The outfall pipes are equipped with check valves at numerous locations to prevent tidal backflow into the storm sewer collection and conveyance system. When submerged by tidal river flow is elevated the check valves prevent the rising water from surcharging into the storm sewer system but also prevent storm water runoff from entering the Broadkill River unless the drainage system head pressure is created to open the check valves. In some cases, this differential head pressure is not reached thereby making the water level within the storm sewer system equal to that of the Broadkill River. As flood levels rise the required head condition increases preventing runoff from entering the system at low points during heavy rains. One of the reasons for frequent flooding at the Magnolia Street parking lot is that the parking lot is located within the 100-year floodplain and partially within the floodway of the Broadkill River. The Town is currently undertaking a project to provide flood relief for the parking lot to reduce the frequency of flooding.

Mitigation of stormwater flooding related to storm frequency and intensity is an ongoing process for which the Town partners with the Sussex Conservation District for enforcement of the State of Delaware stormwater regulations. Moving forward the Town may wish to consider additional stormwater regulations be codified to consider the unique circumstances of the Town in relation to stormwater management, flooding, and sea level rise. More stringent design criteria may be warranted as more of the Town infrastructure is impacted downstream of the development sites. Potential for additional flood control facilities may be a consideration for volume control although the volume control required may consume a significant area. Further analysis is warranted to consider mitigation options for flood control, temporary storage, and pipe capacity.

Public Water System

The Town of Milton provides potable water to the residents and businesses in the area from groundwater well sources. The ground water sources include five well locations connected to a water distribution system and two elevated water storage towers. There are three wells (2, 4, and 7) along Chandler Street near the Water Storage Tower No. 1, well 5 is located along Front Street. Shipbuilders well, the newest of the five, is located behind HO Brittingham Elementary School next to the Water Storage Tower No. 2. These facilities are listed in Table 2 - Facility Impact Summary showing the possible impacts from flooding and sea level rise, see Maps 7 and 8 in the Map Appendix.

As noted in the table wells 2, 4, 5, and 7 all have potential impacts from flooding and sea level rise resulting in limited use, limited access, or a flooded well condition due to overtopping of the well casing. Well 5 is already of concern due to past flood events and the Town is pursuing options to replace the well capacity at new locations such as the new well location behind HO Brittingham. As the sea level rise increases there are concerns regarding the availability of wells 2, 4, and 7 as well. Loss of these wells reduces the Towns available volume of potable water requiring the Town to seek capacity replacement to serve the growing population of the Town. New well locations and capacity are permitted through the Delaware River Basin commission and the State of Delaware at potential overall costs of $250,000 each in consideration of engineering, construction, and testing without including the costs for the associated treatment facility.

The water tower locations at Chandler Street and Mulberry Street are at different ground elevations but the operating elevations are the same. Tower No. 1 at Chandler Street is at a lower ground elevation and is impacted by flooding and sea level rise within the parcel limiting access and potentially causing foundation concerns if a prolonged submergence would occur. As the predictive sea level rise occurs the Town will likely need to replace Tower No. 1 with at a new location to provide the storage capacity. The Town is currently considering a potential water tower location and capacity consideration based on the demand from the expanding customer base for the growing community. Therefore, the mitigation for the tower risk may be addressed with the next capital planning cycle with consideration toward potential funding sources to cover the 2.5-to-5-million-dollar cost.

Consideration for the public water system may also include a demand increase to offset the impact of rising temperature on the growing season. The irrigation and residential customers could foreseeably increase demand for crop and lawn maintenance.

Other Public Utilities

Rising flood and tidal levels impact public utilities owned and operated by others serving the town to provide electric, communications, and sanitary sewer services. Electric facilities, owned by Delmarva Power, such as poles, transformers, switches, and meters could be submerged causing power outages for extended periods and potential for interrupted service throughout the Town. Wired communications facilities will be impacted similarly by rising water levels. The sanitary sewer system, owner by

Artesian Water Company (Artesian), currently flows to the wastewater treatment facility and pump station located on Front Street, already in a zone of impact from flood waters.

Sea level rise has the potential to render the wastewater treatment facility inoperable. Flood waters or rising sea level could cause river water to enter the treatment plant area and render the facility inaccessible to operations staff. After the recent ownership change, Artesian shelved plans by the prior owner for a new wastewater treatment facility along Sam Lucas Road and Artesian is currently evaluating options to decommission the treatment plant located along Front Street in favor of conveyance to one of their other owned facilities. This change would remove the concerns for the treatment plant viability during sea level rise predictive scenarios but would not account for the potential inflow and infiltration that accompanies flooding, groundwater level and sea level rise inundating facilities not constructed to current standards. Many types of manhole frames and covers do not prevent inflow when submerged. There is also a consideration for the collection and conveyance system age and increased potential for infiltration as the ground water level rises. We suggest the Town note their concerns for the sanitary sewer collection and conveyance to Artesian with the understanding that the Town is suggesting review of the facilities for consideration of upgrades or improvements to mitigate future risk for the benefit of the community at large.

Saltwater Intrusion

Saltwater intrusion can impact both ground and surface water. Ground water impacts happen through leaching when tidal waters rise against high groundwater levels. As the leaching becomes more prevalent with sustained elevations within a leaching zone the salt content of the groundwater will increase eventually adversely impacting vegetation in the area and possibly degrading shallow well systems used for irrigation and drinking water. Surface water impacts are more visible and occur as rising tidal flow encroaches into traditionally freshwater zones inundating coastal wetlands and moving to freshwater impoundments upstream. The current excavation at Magnolia Street parking lot and bulkhead rehabilitation project has shown evidence of the tidal water levels impacting the groundwater level along the bulkhead area under the existing parking lot.

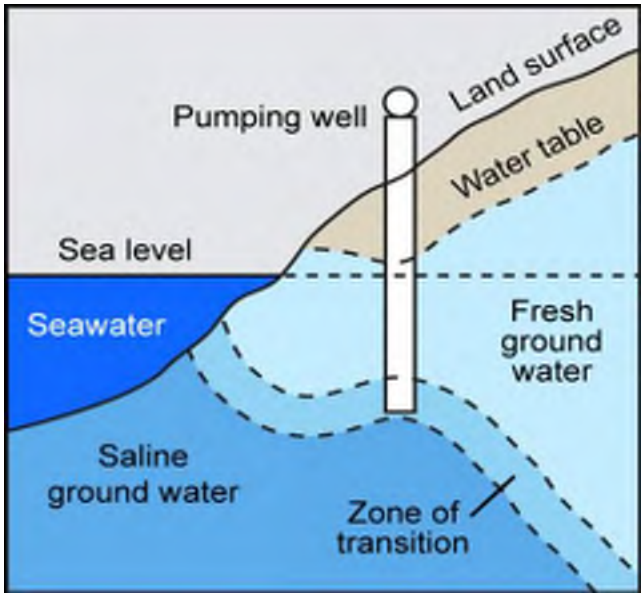

Figure 4 - Saltwater Intrusion (US EPA, n.d.)

Wagamons Pond Dam (DE00061) is a state regulated dam at the headwaters of the Broadkill River crossed by Mulberry Street. The elevation of the dam is approximately 6-foot mean sea level. The freshwater impoundment covers approximately forty-one acres with a maximum depth near the spillway of seven feet. As sea level rise approaches four feet the dam facility may be overtopped by tidal flow. Once overtopped by sea level rise the saltwater intrusion would alter the freshwater pond killing the vegetation and aquatic species as the salinity levels increase. At a 4-foot sea level rise the Wagamons Pond Dam would no longer be of use and the upstream reaches feeding the pond would become transitional zones vulnerable to salinity. As the salinity concentration increases in other areas concerns increase for flora and fauna dieback and permanent inundation. Loss of the freshwater impoundment impacts the Town by loss of habitat, loss of social and recreational activity, and loss of economic opportunity.

The location of well 5 exposes it to the potential for saltwater intrusion when the well is overtopped by rising sea levels. Salt intrusion could potentially render groundwater wells unusable due to elevated chlorine concentration. However, in this case well 5 is drilled to a large subsurface aquifer. Therefore, a more significant impact to the well quality from saltwater intrusion would be needed to impact the overall water quality. Although degradation of the water quality may eventually require additional filtering or treatment.

Value Assessment

This value assessment is based on the document titled Town of Milton: Assessed Value Listing by Map/Parcel/Unit. The value assessment is focused around the twenty-one identified public, critical, and historic infrastructure locations mentioned previously throughout the study. Table 8 - Value Assessment displays each property and parcel number with the assessed value attributed to each.

Table 8 - Value Assessment

Facility Information			
Reference Name	**Function**	**Parcel Number**	**Assessed Value**
WWTP	Wastewater Treatment	235-20.08-9.00	$ 294,000.00
Water Tower No. 1	Water Storage	235-14.19-148.00	$ 2,500,000.00
Wells 2, 4, & 7	Water System/ Water Source		$ 1,000,000.00
Potential WWTP/Well Location	Water System	235-20.11-9.00	$ 513,500.00
Well 5	Water System/ Water Source	235-20.08-5.00	$ 87,900.00
DPW Building	DPW - Operations Building	235-20.08-32.00	$ 500,600.00
Magnolia Street Parking Lot	Municipal Parking Lot	235-14.19-109.00	$ 278,500.00
Memorial Park	Public Park	235-14.19-179.00	$ 1,100,000.00
Mill Park	Public Park	235-20.07-58.00 235-20.07-62.00	$ 418,000.00
Police Station	Milton Police Headquarters	235-20.07-82.00	$ 240,000.00
Milton Fire Dept., Inc.	Milton FS Sta. 85 EMS/Fire	235-20.08-1.00	$ 1,885,600.00
Milton ES	Elementary School	235-20.11-3.00	$ 10,364,900.00
118 Magnolia Street	(Historic Post Office Location)	235-14.19-107.00	$ 379,000.00
Draper-Adkins Parcel	Historic Feature	235-20.07-63.00	$ 310,000.00
Milton Theatre	Historic Feature	235-14.19-112.00	$ 407,100.00
Milton Public Library	Historic Feature/ Public Facility	235-14.19-183.00 235-14.19-182.00	$ 2,700,800.00
Milton Historical Society / Museum	Historic Feature	235-14.19-(98.00, 99.00,100.00, 101.00,102.00)	$ 1,166,800.00
Shipbuilders Well (Well 8)	WS - Well/Potable Water Source	235-14.00-88.00	$ 800,000.00
Tower No. 2	WS - Water Storage Tower		$ 2,500,000.00
Town Hall	Town Services	235-20.07-88.00	$ 335,100.00
HO Brittingham ES	Elementary School	235-14.00-88.00	$ 12,053,000.00
Mariner MS	Middle School	235-20.00-56.01	$ 17,923,400.00
Post Office	US Postal Service	235-14.00-97.00	$ 1,778,900.00
Gov. James Ponder House	Historic Feature	235-20.07-17.00	$ 1,189,400.00
Hazzard House	Historic Feature	235-14.19-160.03	$ 361,103.00

The estimated damages were then totaled for each risk event to aid the town in budgeting for mitigation and resiliency in preparation for each of the events. Table 9 – displays these totals. The table does not display estimated total damages to parcels outside of the identified twenty-one parcels.

The ongoing changes in these impacted lands and facilities may have consequences to these values. If a parcel were to become inundated, the land and assets within the parcel may approach a total loss when access and use of the parcel are no longer feasible. Tables 7 & 8 assume that if the parcel is impacted a total loss of the property value occurs. While this is likely not the case with scenarios such as storms, the town should be prepared to take on the full costs of losing assets which are at high risk. For the sea-level rise scenarios, the budgeting for these events can be loosely guided by the timelines outlined in Figure 3 - Sea Level Rise Scenarios Timeline. The town has already begun preparing for these events with the Mulberry Street parking lot bulkhead rehabilitation project at a cost of about $1.2 million. As shown in Table 2 - Facility Impact Summary, the Town may lose the use of this parking lot during any storm event or at a level as low as 1 foot of sea level rise. This proactive planning will provide resiliency against the discussed events within this study and thus similar projects should be considered for other critical infrastructure at risk.

Table 9 – Value of Potential Losses

Event	Estimated Damages
100-yr	$ 21,603,100.00
500-yr	$ 23,906,700.00
FRAM	$ 24,146,700.00
1ft	$ 6,845,700.00
2ft	$ 7,224,700.00
4ft	$ 21,603,100.00
6ft	$ 22,021,100.00
8ft	$ 23,906,700.00
Cat 1	$ 11,036,700.00
Cat 2	$ 23,906,700.00
Cat 3	$ 24,146,700.00
Cat 4	$ 24,146,700.00

Path Forward

Continued Predictive Analysis and Data Gathering

The Town should continue to take a proactive role in reviewing the predictive analysis and modeling as impacts develop over time considering both national and local resources in effort the preserve the unique resources, homes, businesses, and facilities along the impacted shoreline. There is also an opportunity to gather relevant data locally for additional analysis and comparison to wider models.

The Town could consider the installation of monitoring equipment to establish data tracking for rainfall and tidal levels. The Town could install a water level data recorder for the tide and storm level measurements along the Broadkill. Similar USGS data stations have been installed at various locations in the State. An automated rainfall gauge could also be considered to gain more localized rainfall data. This equipment may be an opportunity to partner with research organizations or governmental programs, such as the University of Delaware, DNREC, or DelDOT.

Potential Mitigation

In the next phases of this this analysis Pennoni will analyze potential mitigation practices, improvements, and considerations for the Town of Milton. The suggested scope of services should include:

- Providing recommended changes to Chapter 125 of the Town Code regarding implementation of mitigation practices to be implemented for flooding and sea level rise.
- Providing recommended modifications to construction practice within the 100-year flood zone and possibly the 500-yr flood zone.
- Providing recommended modifications of existing residential or commercial building requirements within impacted and surrounding areas identified through this predictive analysis.
- Providing recommended infrastructure requirements for future improvements and modifications and repairs to existing facilities.
- Providing a summary regarding the potential impact, if any, for anticipated adjustments to federal flood insurance policies.
- Considering mitigation planning and implementation from other municipalities for potential solutions, such as groundwater recharge and more restrictive stormwater management requirements.
- Considering roadway improvements for Town streets to ensure traffic impacts can be appropriately managed.
- Considering stormwater management ordinance changes to implement additional local development requirements for

stormwater design and potential flood control.

- Considering additional stormwater management teaming opportunities with Sussex Conservation District and the State of Delaware for potential mitigation opportunities.
- Identifying potential roadway improvements related to alternative traffic and emergency routes with coordination and cooperation with the Delaware Department of Transportation.
- Identifying stormwater and flood management approaches to improve resiliency.
- Share the Sea Level Rise study with the Milton Fire Dept. as a reference for their consideration and planning in service of the Town.
- Considering improved outreach and educational opportunities for citizens, businesses, and representatives through meetings, handouts, and website information.

Capital Improvements for Mitigation

Pennoni will develop prioritized recommendations for improvements to existing infrastructure for flood mitigation and sea level planning with additional considerations to new improvements. The scope of this work includes:

- Providing a descriptive capital improvement list with high level estimated budgets in current year values based on past projects, industry references, and escalated pricing of current construction climate.
- Developing a recommended prioritized order for capital improvements to address potential changes to the geography and potential damage resulting from sea level rise and flooding.
- Identifying potential funding sources to offset the financial burden on the Town through:
    - Grant funding
    - Low interest loans
    - Public/Private partnerships
    - Effects of Sea Level Rise Program
- Identifying cooperation and coordination planning consideration with ongoing Federal, State, and County programs and future project planning related to flooding, sea level rise, and roadway improvements.
    - FEMA Flood Hazard Mitigation Grant Program https://www.fema.gov/grants/mitigation/floods
    - FEMA Hazard Mitigation Grant Program https://www.fema.gov/grants/mitigation/hazard-mitigation
    - Shoreline Health Oversight, Restoration, Resilience, and Enhancement Act (SHORRE Act) representing U.S. Army Corps of Engineers storm risk management and ecosystem restoration programs.
    - Shoreline Health Oversight, Restoration, Resilience, and Enhancement (SHORRE) Act

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Additional Resources

Coastal States Organization - https://www.coastalstates.org/

DNREC Delaware Sea Level Rise Advisory Committee

- https://dnrec.alpha.delaware.gov/coastal-programs/planning-training/adapting-to-sea-level-rise/advisory-committee/
- https://documents.dnrec.delaware.gov/coastal/Documents/SeaLevelRise/MappingForWeb.pdf
- https://documents.dnrec.delaware.gov/coastal/Documents/SeaLevelRise/AssesmentExecSumm.pdf

Delaware Emergency Management Agency - https://www.dema.delaware.gov/

Delaware Flood Planning Tool - https://floodplanning.dnrec.delaware.gov/

FEMA - https://www.FEMA.gov

FEMA Flood Map Service Center - https://www.msc.FEMA.gov/portal/home

FEMA Products and Tools - https://www.fema.gov/flood-maps/products-tools

NOAA Sea Level Rise Viewer - https://coast.noaa.gov/slr/

Sea Grant Delaware - https://www.deseagrant.org/

The Nature Conservancy - https://www.nature.org/en-us/

University of Delaware Coastal Flood Monitoring System - http://coastal-flood.udel.edu/current-conditions/

USGS Current Water Data for Delaware - https://waterdata.usgs.gov/de/nwis/rt

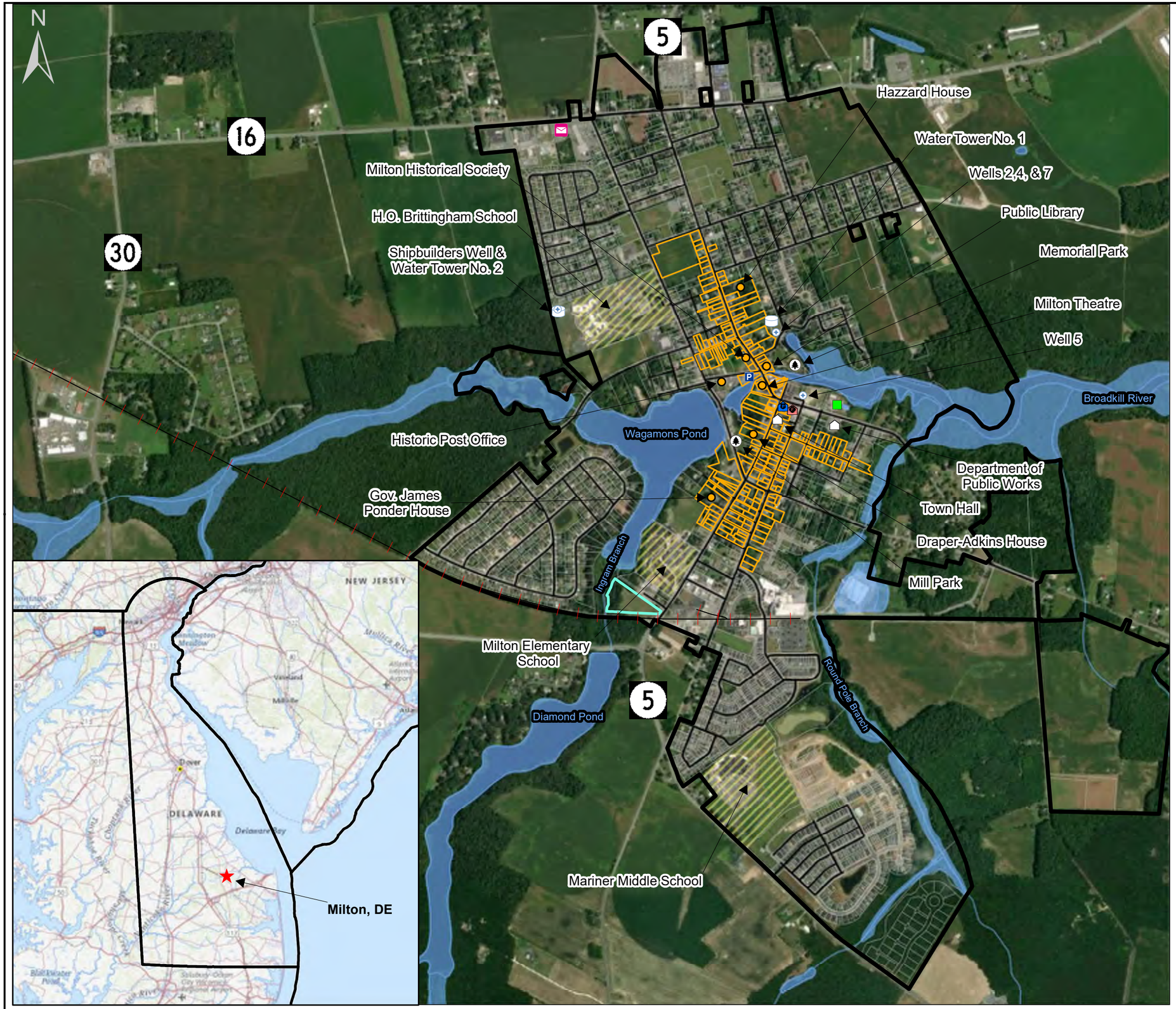
USGS Saltwater Intrusion - https://www.usgs.gov/mission-areas/water-resources/science/saltwater-intrusion

Map Appendix

1. Sea Level Rise Study Location Map
2. Broadkill River Watershed Map
3. Elevation Map
4. Contour Map
5. Wetlands Map
6. Water System Map
7. Sea Level Rise Scenarios Map
8. Impacted Parcels and Infrastructure Map
9. Impacted Roadways Map
10. FEMA Floodplain Map
11. Flood Risk Adaptation Map
12. Storm Surge Inundation Map Category 1 Storm
13. Storm Surge Inundation Map Category 2 Storm
14. Storm Surge Inundation Map Category 3 Storm
15. Storm Surge Inundation Map Category 4 Storm

Town of Milton Sea Level Rise Study Location Map

MTONN21010 - Sea Level Rise Study



- Municipal Parking Lot
- Town Parks
- Post Office
- Milton Historic Places
- Police Department
- Milton Fire Dept., Inc.
- Artesian Water Company WWTP
- Wells
- Water Towers
- Town Facilities
- Milton Historic District
- Potential WTP/Well Location
- Town of Milton
- Cape Henlopen School District Parcels
- Milton Parcels
- Railroads
- Roads

Data Sources: Delaware FirstMAP, National Park Service, Town of Milton

1 inch = 1,250 feet

1,250 625 0 1,250 Feet

Pennoni

Map 1 of 15.

Date: 8/24/2022

Document Path: U:\Accounts\MTONN\MTONN21010 - Sea Level Rise Study\DESIGN_GIS\Study Location Map2.mxd

Broadkill River Watershed Map

MTONN21010 - Sea Level Rise Study

1 inch = 10,000 feet

10,000 5,000 0 10,000Feet

Data Sources: Delaware FirstMAP, Delaware River Basin Commission, Department of Natural Resources and Environmental Control

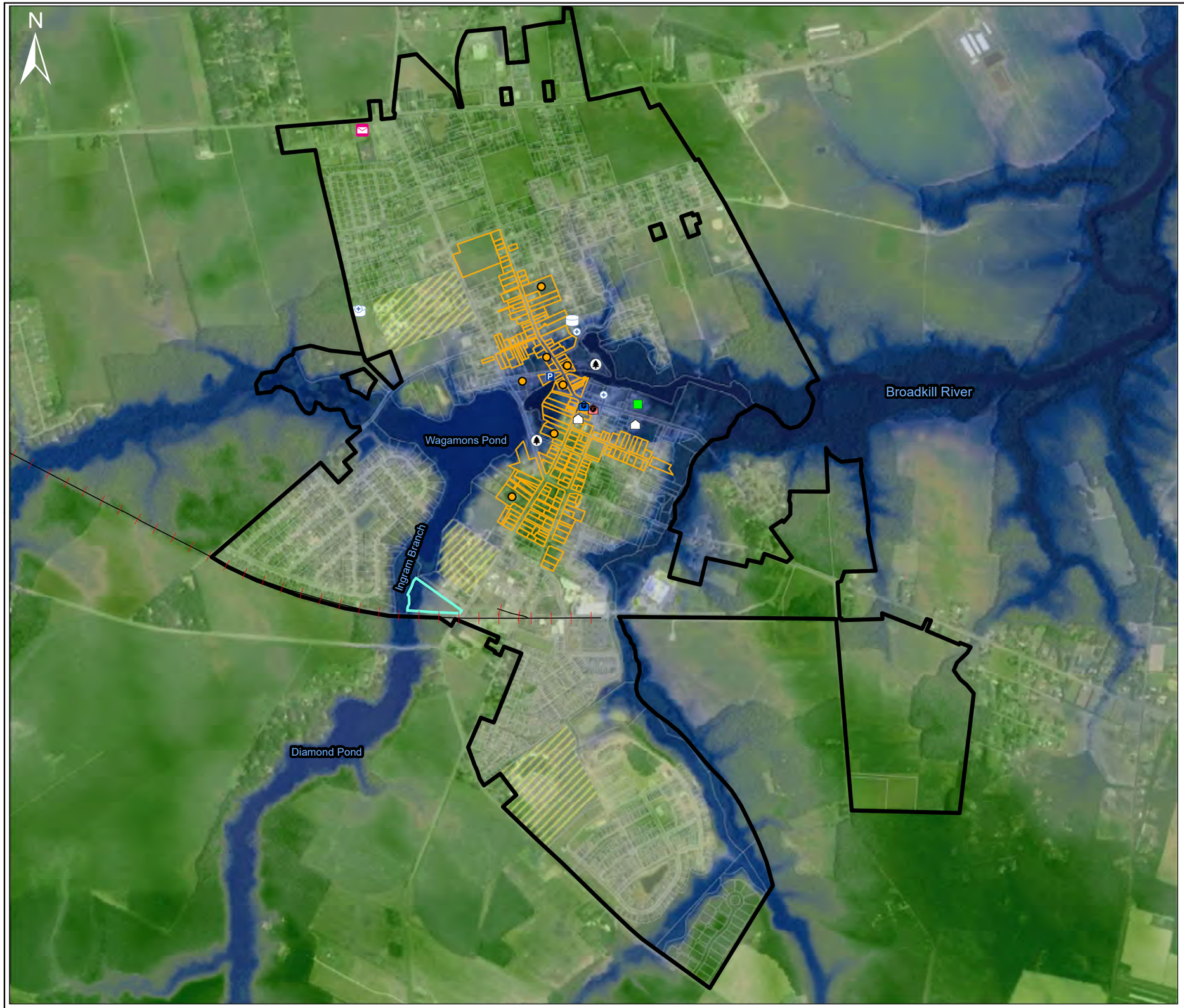
Basin Characteristics: **HUC-10**: 0204020706
Area: 68,623 acres, **Stream Miles**: 204
Headwater Segments: Ingram Branch, Martin Branch, Beaverdam Creek, Round Pole Branch, Pemberton Branch, and Primehook Creek.

Pennoni

Date: 7/18/2022 Document Path: U:\Accounts\MTONN\MTONN21010 - Sea Level Rise Study\DESIGN_GIS\Watershed Map.mxd

Town of Milton Elevation Map

MTONN21010 - Sea Level Rise Study



Digital Elevation Model

Elevation (ft)

High: 45

Low: 0

- Municipal Parking Lot
- Town Parks
- Post Office
- Milton Historic Places
- Police Department
- Milton Fire Dept., Inc.
- Artesian Water Company WWTP
- Wells
- Water Towers
- Town Facilities
- Milton Historic District
- Potential WTP/Well Location
- Milton Parcels
- Cape Henlopen School District Parcels
- Town of Milton
- Railroads

Data Sources: Delaware FirstMAP, National Park Service, Town of Milton

Pennoni

1 inch = 1,250 feet

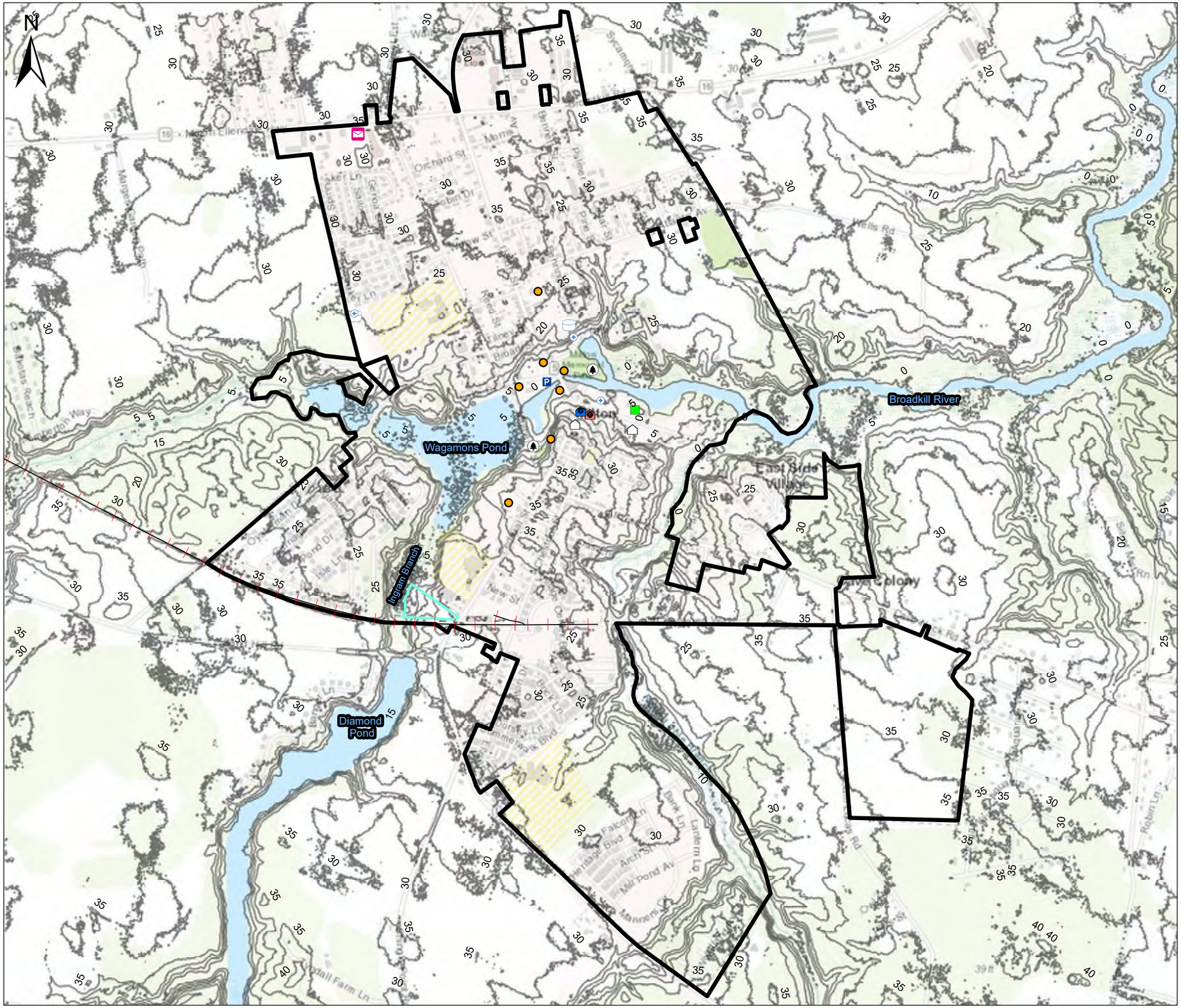
1,250 625 0 1,250 Feet

Date: 8/24/2022

Document Path: U:\Accounts\MTONN\MTONN21010 - Sea Level Rise Study\DESIGN_GIS\Elevation Map.mxd

Town of Milton Contour Map

MTONN21010 - Sea Level Rise Study



- Municipal Parking Lot
- Town Parks
- Post Office
- Milton Historic Places
- Police Department
- Milton Fire Dept., Inc.
- Artesian Water Company WWTP
- Wells
- Water Towers
- Town Facilities
- Potential WTP/Well Location
- Town of Milton
- Cape Henlopen School District Parcels
- Railroads
- 5 foot Contours

Data Sources: Delaware FirstMAP, National Park Service, Town of Milton

1 inch = 1,250 feet

1,250 625 0 1,250 Feet

Pennoni

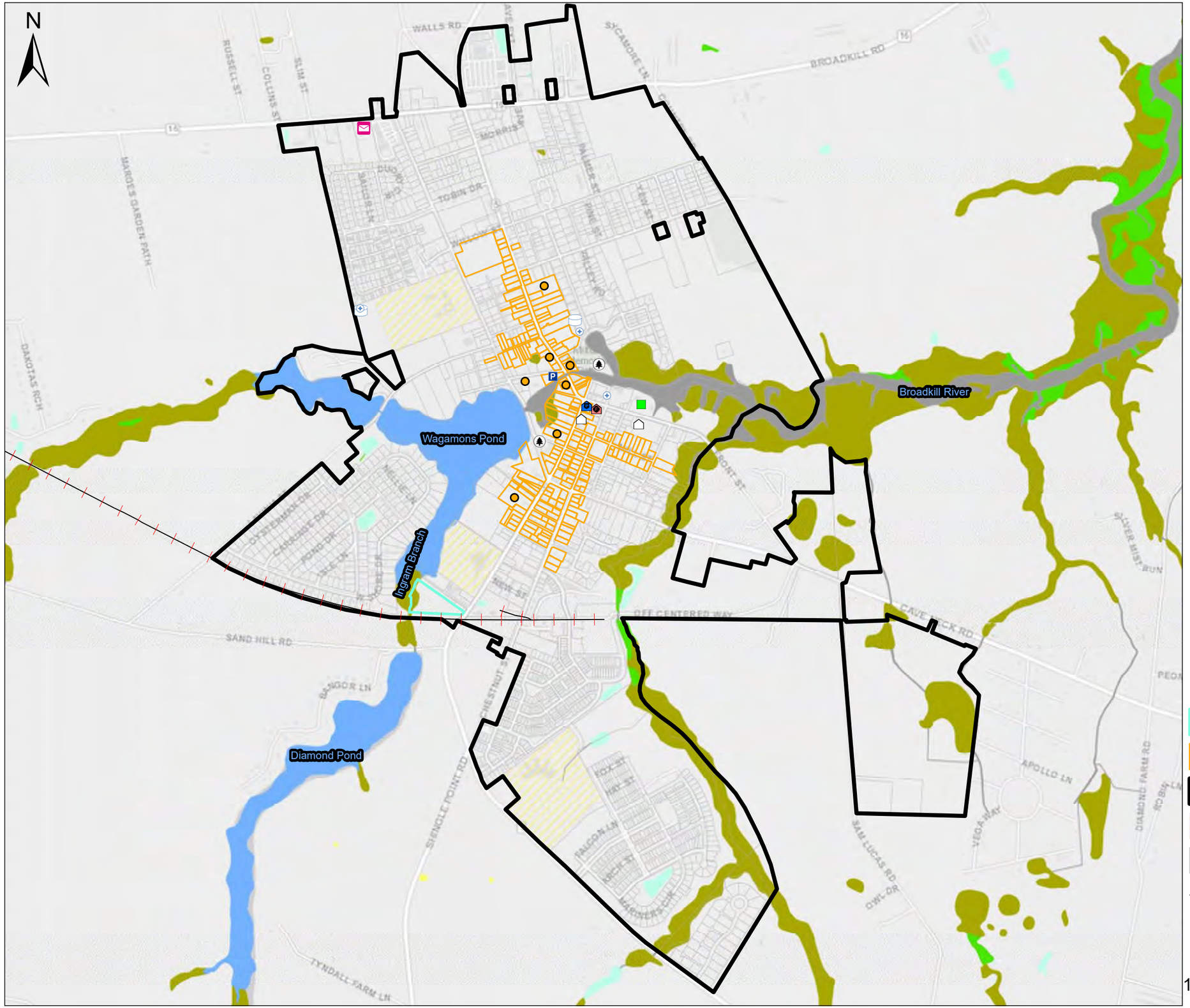
Map 4 of 15.

Date: 8/25/2022

Document Path: U:\Accounts\MTONN\MTONN21010 - Sea Level Rise Study\DESIGN_GIS\Contour Map.mxd

Town of Milton Wetlands Map

MTONN21010 - Sea Level Rise Study



Wetland Type

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Palustrine Farmed
- Riverine
- Municipal Parking Lot
- Town Parks
- Post Office
- Milton Historic Places
- Police Department
- Milton Fire Dept., Inc.
- Artesian Water Company WWTP
- Wells
- Water Towers
- Town Facilities
- Potential WTP/Well Location
- Milton Historic District
- Town of Milton
- Cape Henlopen School District Parcels
- Milton Parcels
- Railroads

Data Sources: Delaware FirstMAP, National Park Service, Town of Milton

Pennoni

1 inch = 1,250 feet

1,250 625 0 1,250 Feet

Date: 8/25/2022

Document Path: U:\Accounts\MTONN\MTONN21010 - Sea Level Rise Study\DESIGN_GIS\Wetlands Map.mxd

Town of Milton Water System Map

MTONN21010 - Sea Level Rise Study

Pipe Diameter

- 4"
- 6"
- 8"
- 10"
- 12"

- Water Towers
- Wells
- Fire Hydrants
- Potential WTP/Well Location
- Town of Milton
- Milton Parcels

Data Sources: Delaware FirstMAP, National Park Service, Town of Milton

1 inch = 1,250 feet

1,250 625 0 1,250 Feet

Pennoni

Date: 8/29/2022

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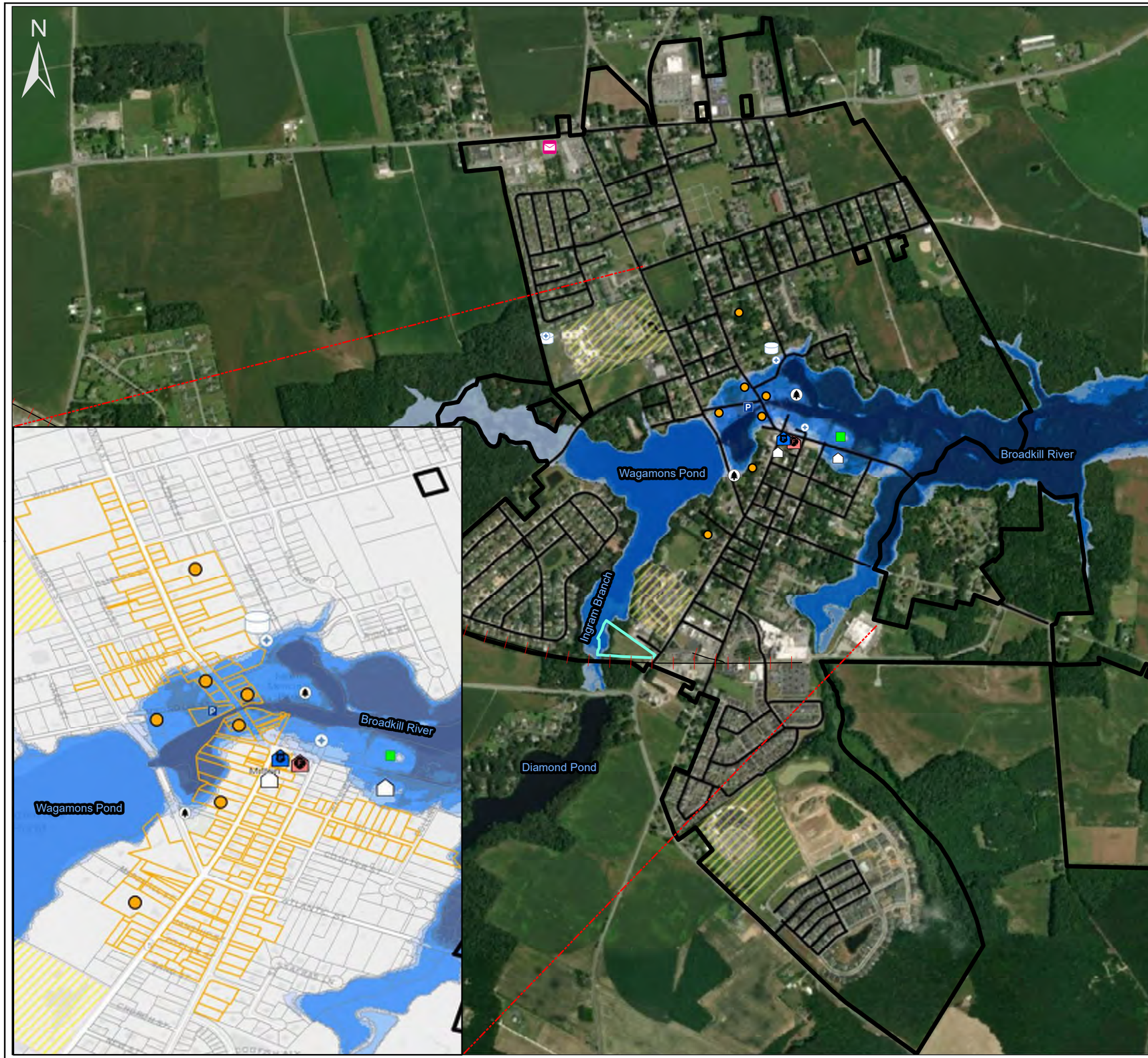
Town of Milton
Sea Level Rise Scenarios Map

MTONN21010 - Sea Level Rise Study



Sea Level Rise Scenarios

- MHHW
- 1 ft
- 2 ft
- 4 ft
- 6 ft
- 8 ft
- Municipal Parking Lot
- Town Parks
- Post Office
- Milton Historic Places
- Police Department
- Milton Fire Dept., Inc.
- Artesian Water Company WWTP
- Wells
- Water Towers
- Town Facilities
- Potential WTP/Well Location
- Milton Parcels
- Cape Henlopen School District Parcels
- Milton Historic District
- Town of Milton
- Railroads
- Roads

Data Sources: NOAA Office for Coastal Management, Department of Commerce (DOC), National Ocean Service (NOS), Delaware FirstMAP, National Park Service, Town of Milton

Pennoni

1 inch = 1,250 feet

1,250 625 0 1,250 Feet

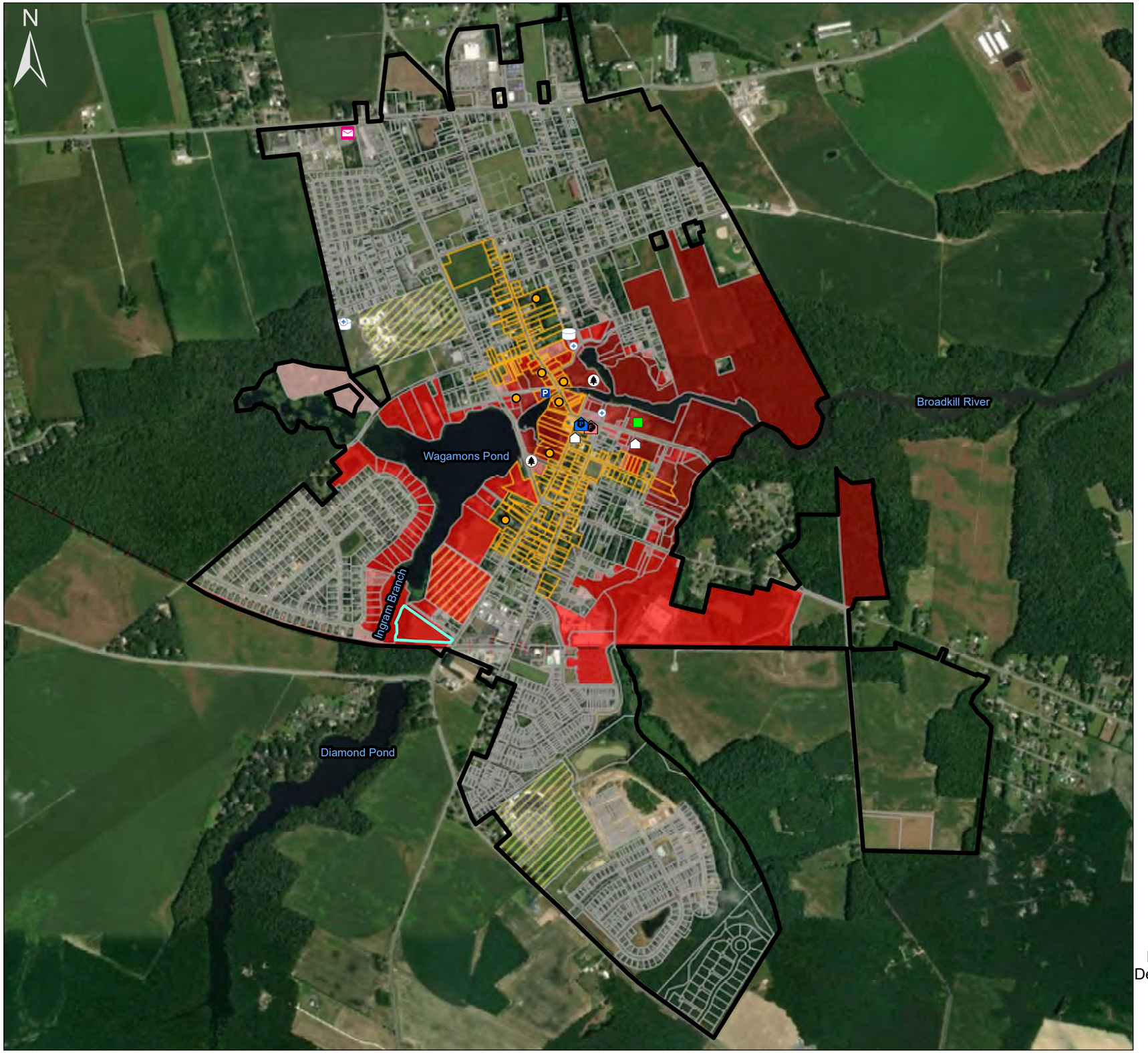
Map 7 of 15.

Date: 8/26/2022

Document Path: U:\Accounts\MTONN\MTONN21010 - Sea Level Rise Study\DESIGN_GIS\Sea Level Rise Scenario Map.mxd

Town of Milton Impacted Parcels and Infrastructure Map

MTONN21010 - Sea Level Rise Study



Sea Level Rise Scenarios

- Impacted Parcels - 1 ft
- Impacted Parcels - 2 ft
- Impacted Parcels - 4 ft
- Impacted Parcels - 6 ft
- Impacted Parcels - 8 ft
- Municipal Parking Lot
- Town Parks
- Post Office
- Milton Historic Places
- Police Department
- Milton Fire Dept., Inc.
- Artesian Water Company WWTP
- Wells
- Water Towers
- Town Facilities
- Potential WTP/Well Location
- Cape Henlopen School District Parcels
- Milton Historic District
- Milton Parcels
- Town of Milton
- Railroads

Data Sources: NOAA Office for Coastal Management, Department of Commerce (DOC), National Ocean Service (NOS), Delaware FirstMAP, National Park Service, Town of Milton

Pennoni

1 inch = 1,250 feet

1,250 625 0 1,250 Feet

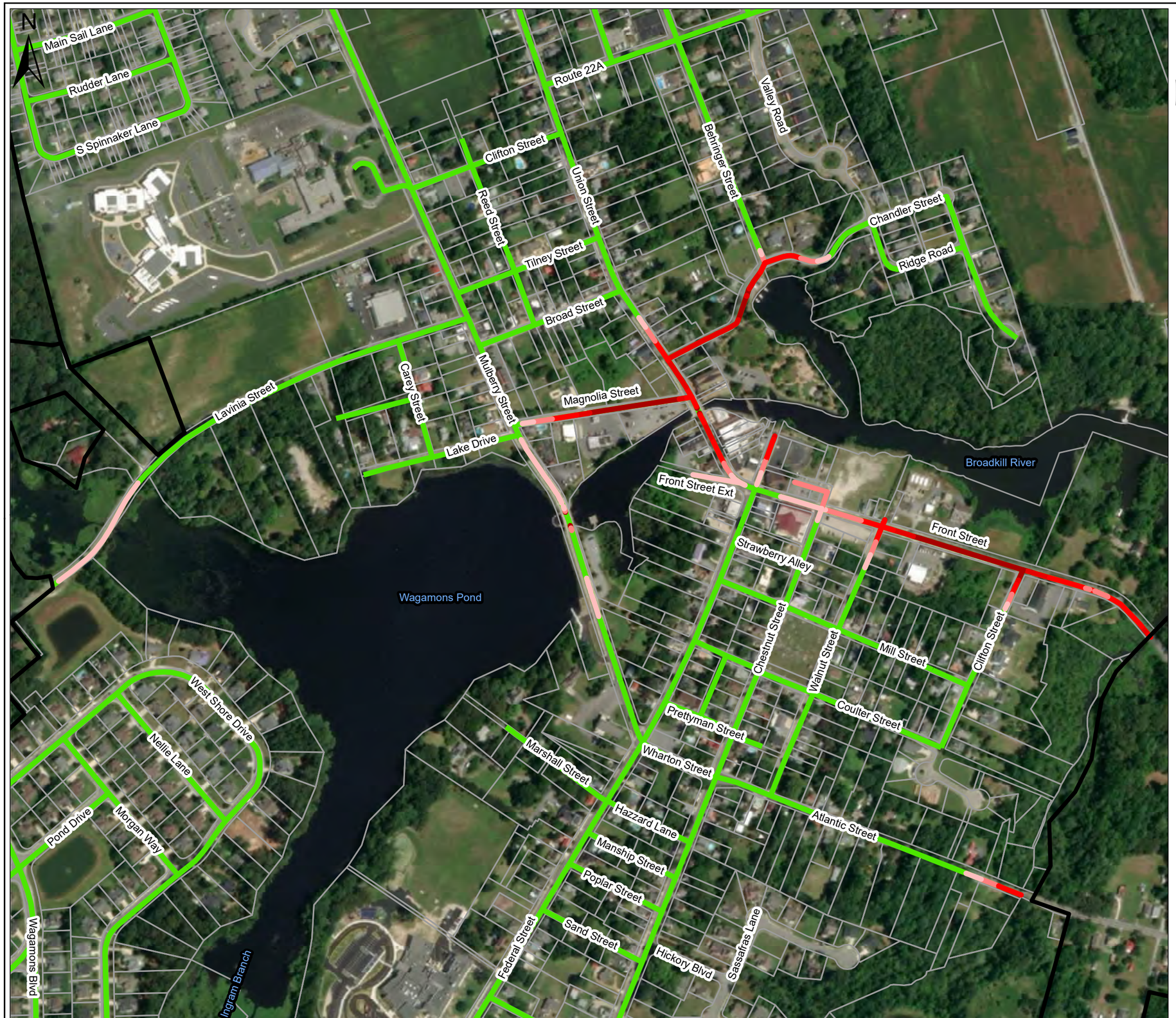
Map 8 of 15.

Date: 8/26/2022

Document Path: U:\Accounts\MTONN\MTONN21010 - Sea Level Rise Study\DESIGN_GIS\Impacted Infrastructure Map.mxd

Town of Milton
Impacted Roadways Map

MTONN21010 - Sea Level Rise Study



Sea Level Rise Scenarios

- Impacted Roadways - 1 ft
- Impacted Roadways - 2 ft
- Impacted Roadways - 4 ft
- Impacted Roadways - 6 ft
- Impacted Roadways - 8 ft

- Roadways
- Milton Parcels
- Town of Milton

Data Sources: NOAA Office for Coastal Management, Department of Commerce (DOC), National Ocean Service (NOS), Delaware FirstMAP, National Park Service, Town of Milton

1 inch = 400 feet

400 200 0 400 Feet

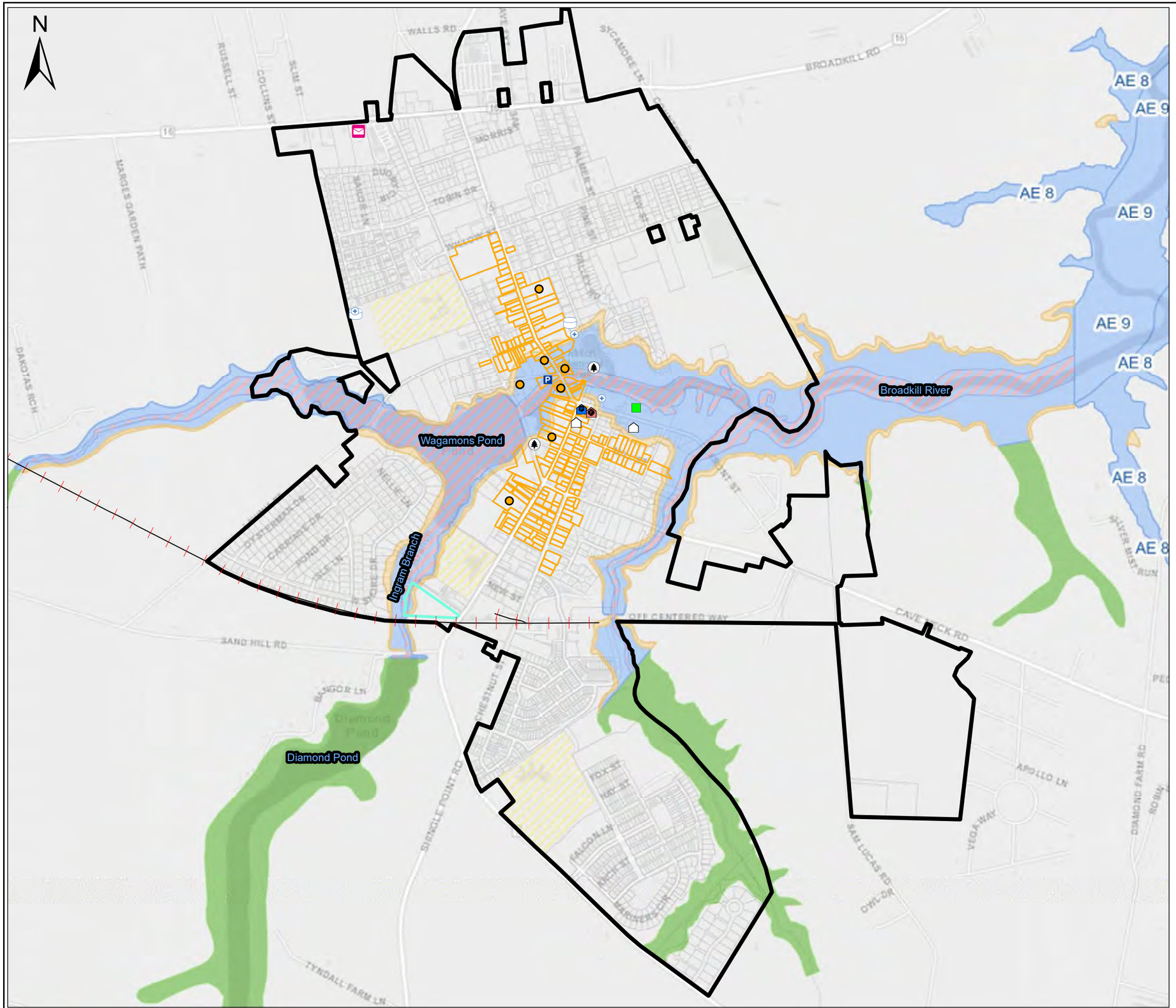
Pennoni

Date: 8/19/2022

Document Path: U:\Accounts\MTONN\MTONN21010 - Sea Level Rise Study\DESIGN_GIS\Impacted Roadways Map.mxd

Town of Milton
FEMA Floodplain Map

MTONN21010 - Sea Level Rise Study



FEMA Flood Maps

Flood Zone

- A
- AE
- AE, FLOODWAY
- AO
- VE
- X, 0.2 PCT ANNUAL CHANCE FLOOD HAZARD
- Municipal Parking Lot
- Town Parks
- Post Office
- Milton Historic Places
- Police Department
- Milton Fire Dept., Inc
- Artesian Water Company WWTP
- Wells
- Water Towers
- Town Facilities
- Potential WTP/Well Location
- Milton Historic District
- Town of Milton
- Cape Henlopen School District Parcels
- Milton Parcels
- Railroads

Data Sources: FEMA Flood Map Service
Delaware FirstMAP, National Park Service, Town of Milton

1 inch = 1,250 feet

1,250 625 0 1,250 Feet

Pennoni

Map 10 of 15.

Date: 8/26/2022

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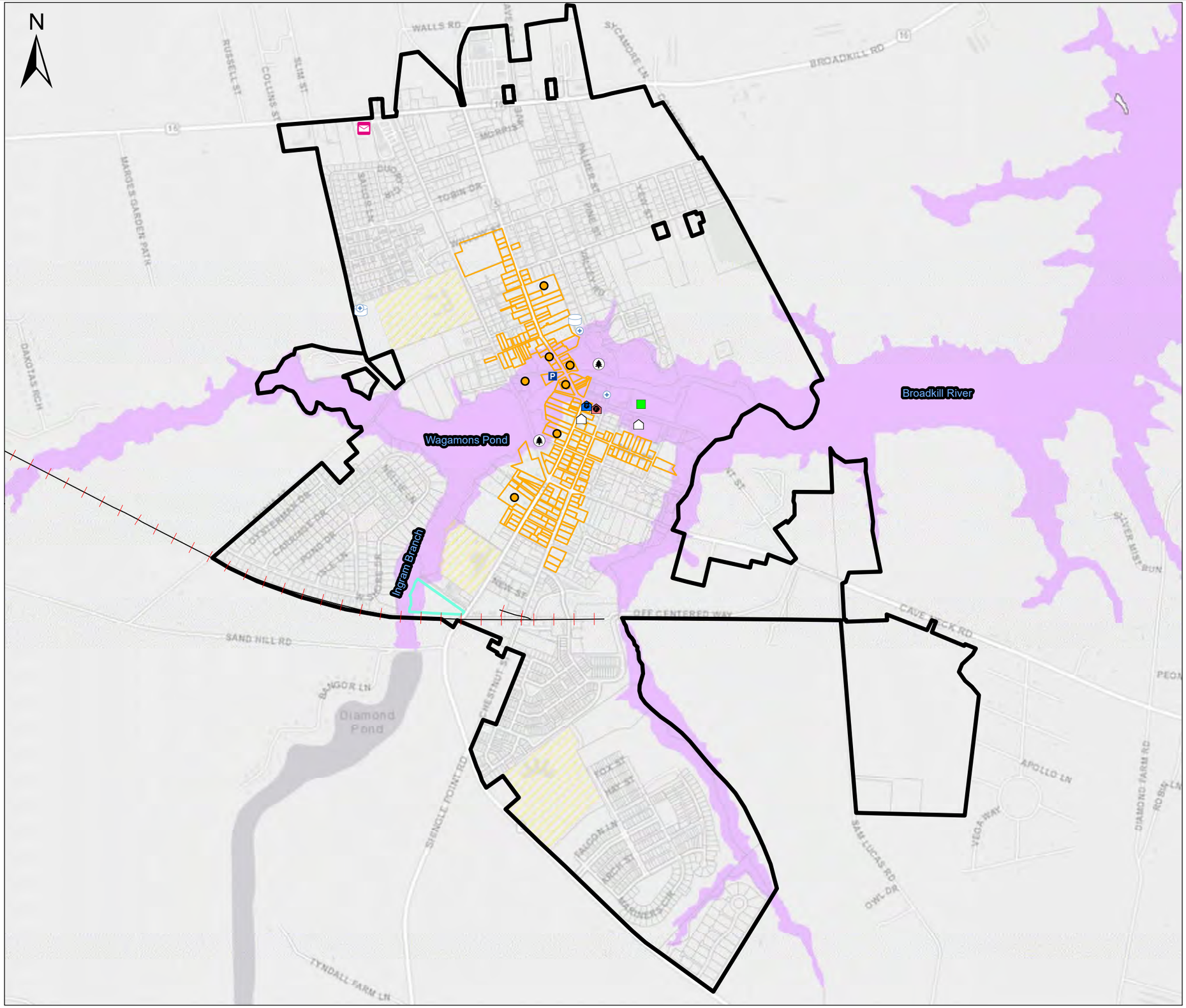
Town of Milton Flood Risk Adaptation Map

MTONN21010 - Sea Level Rise Study



Flood Risk Adaptation Zones

- CD+
- CE
- OS

- Municipal Parking Lot
- Town Parks
- Post Office
- Milton Historic Places
- Police Department
- Milton Fire Dept., Inc.
- Artesian Water Company WWTP
- Wells
- Water Towers
- Town Facilities
- Potential WTP/Well Location
- Milton Historic District
- Town of Milton
- Cape Henlopen School District Parcels
- Milton Parcels
- Railroads

Data Sources: Delaware Department of Transportation, Delaware FirstMAP, National Park Service, Town of Milton

Pennoni

1 inch = 1,250 feet

1,250 625 0 1,250 Feet

Map 11 of 15.

Date: 8/26/2022

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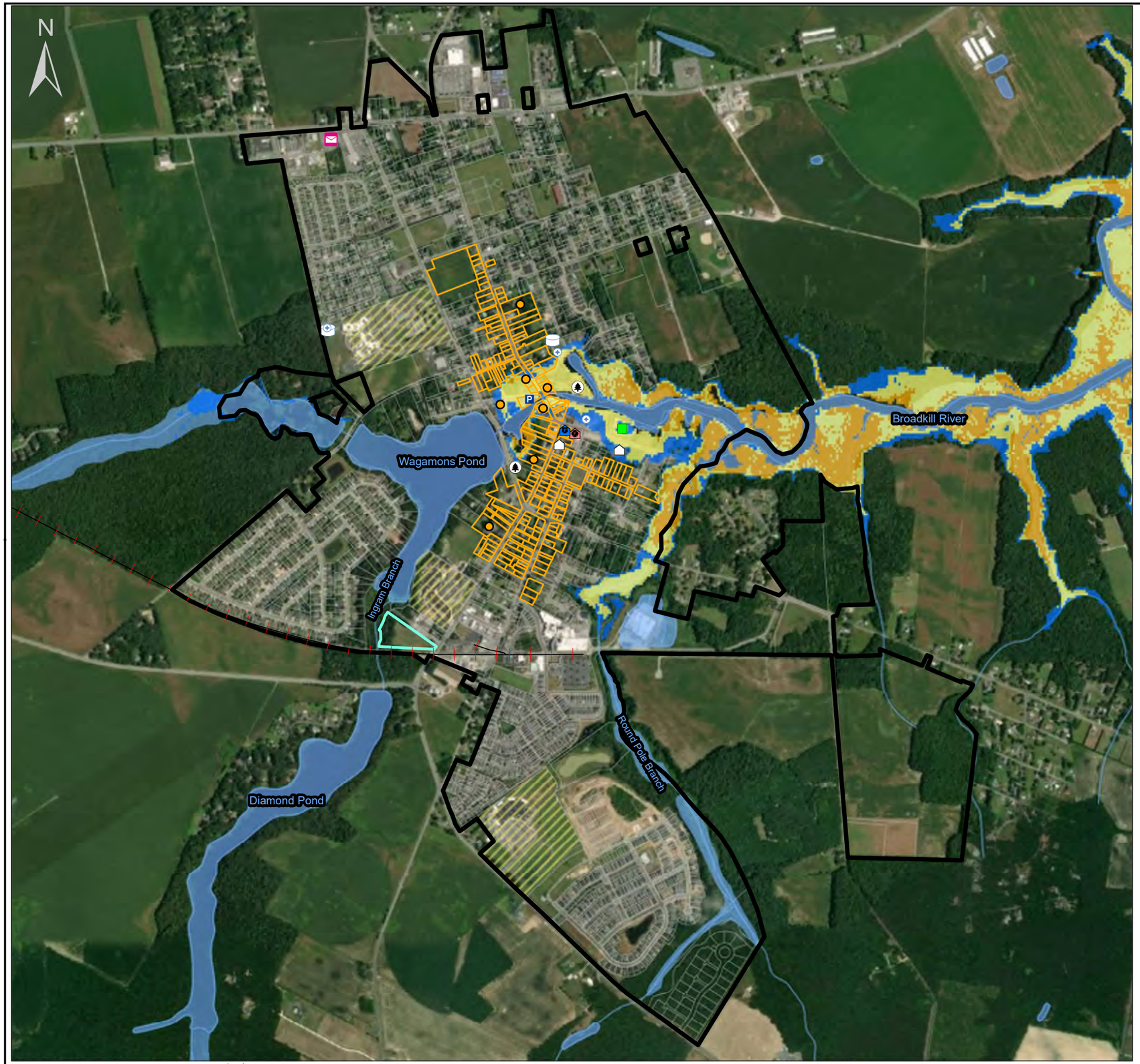
Town of Milton
Storm Surge Inundation Map
Category 1 Storm

MTONN21010 - Sea Level Rise Study



Inundation Height

- Up to 3 feet above ground
- Greater than 3 feet above ground
- Greater than 6 Feet above ground
- Greater than 9 feet above ground
- Levee Areas - Consult Local Officials for flood risk

- Municipal Parking Lot
- Town Parks
- Post Office
- Milton Historic Places
- Police Department
- Milton Fire Dept., Inc.
- Artesian Water Company WWTP
- Wells
- Water Towers
- Town Facilities
- Potential WTP/Well Location
- Milton Historic District
- Town of Milton
- Cape Henlopen School District Parcels
- Milton Parcels
- Railroads

Data Sources: NOAA/NWS/NHC/Storm Surge Unit, NOAA/NOS/Office for Coastal Management, Delaware FirstMAP, National Park Service, Town of Milton

Pennoni

1 inch = 1,250 feet

1,250 625 0 1,250 Feet

Map 12 of 15.

Date: 8/26/2022

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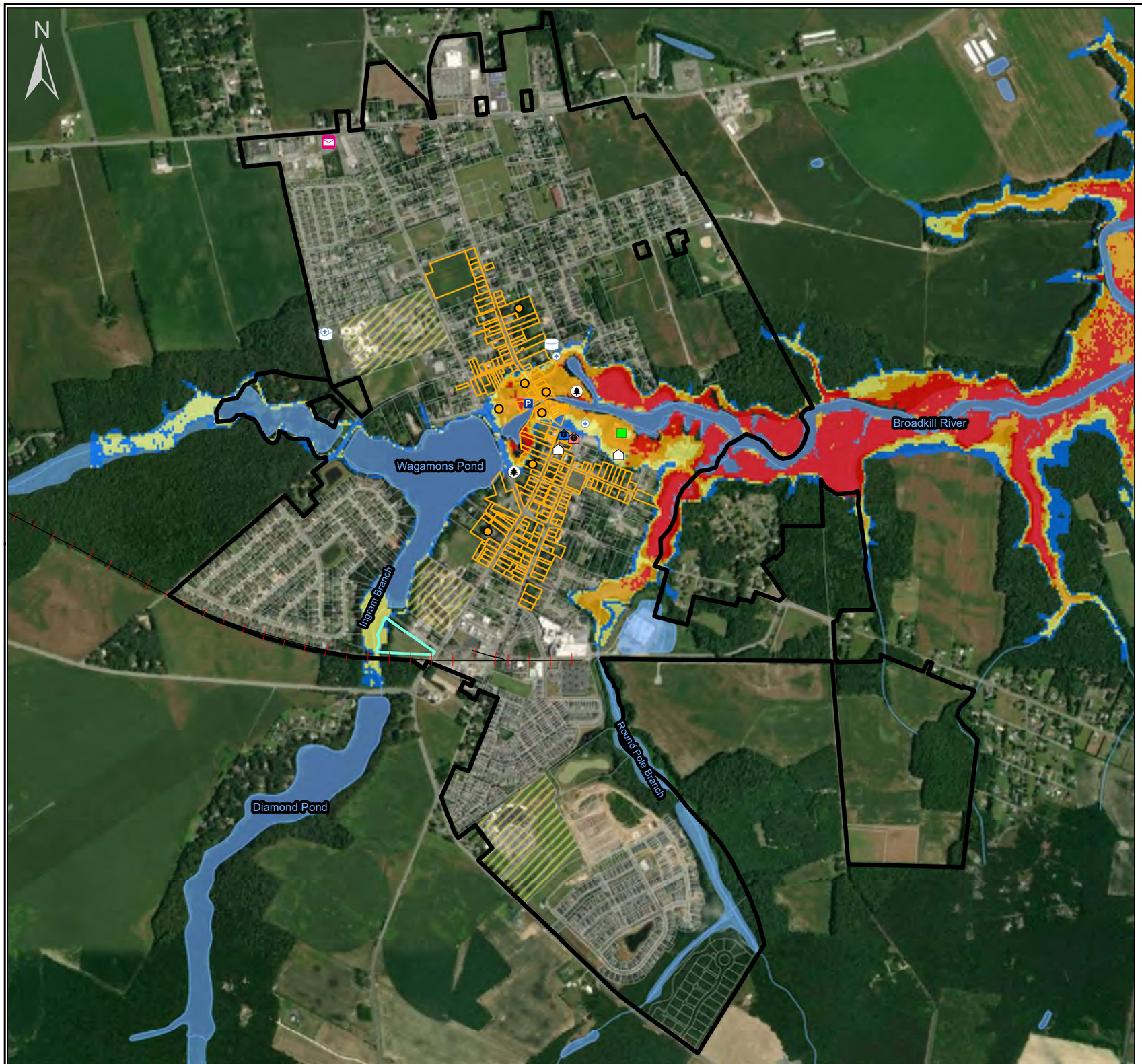
Town of Milton
Storm Surge Inundation Map
Category 2 Storm

MTONN21010 - Sea Level Rise Study



Inundation Height

- Up to 3 feet above ground
- Greater than 3 feet above ground
- Greater than 6 feet above ground
- Greater than 9 feet above ground
- Levee Areas - Consult Local Officials for flood risk

- Municipal Parking Lot
- Town Parks
- Post Office
- Milton Historic Places
- Police Department
- Milton Fire Dept., Inc.
- Artesian Water Company WWTP
- Wells
- Water Towers
- Town Facilities
- Potential WTP/Well Location
- Milton Historic District
- Town of Milton
- Cape Henlopen School District Parcels
- Milton Parcels
- Railroads

Data Sources: NOAA/NWS/NHC/Storm Surge Unit, NOAA/NOS/Office for Coastal Management, Delaware FirstMAP, National Park Service, Town of Milton

Pennoni

1 inch = 1,250 feet

1,250 625 0 1,250 Feet

Map 13 of 15.

Date: 8/26/2022

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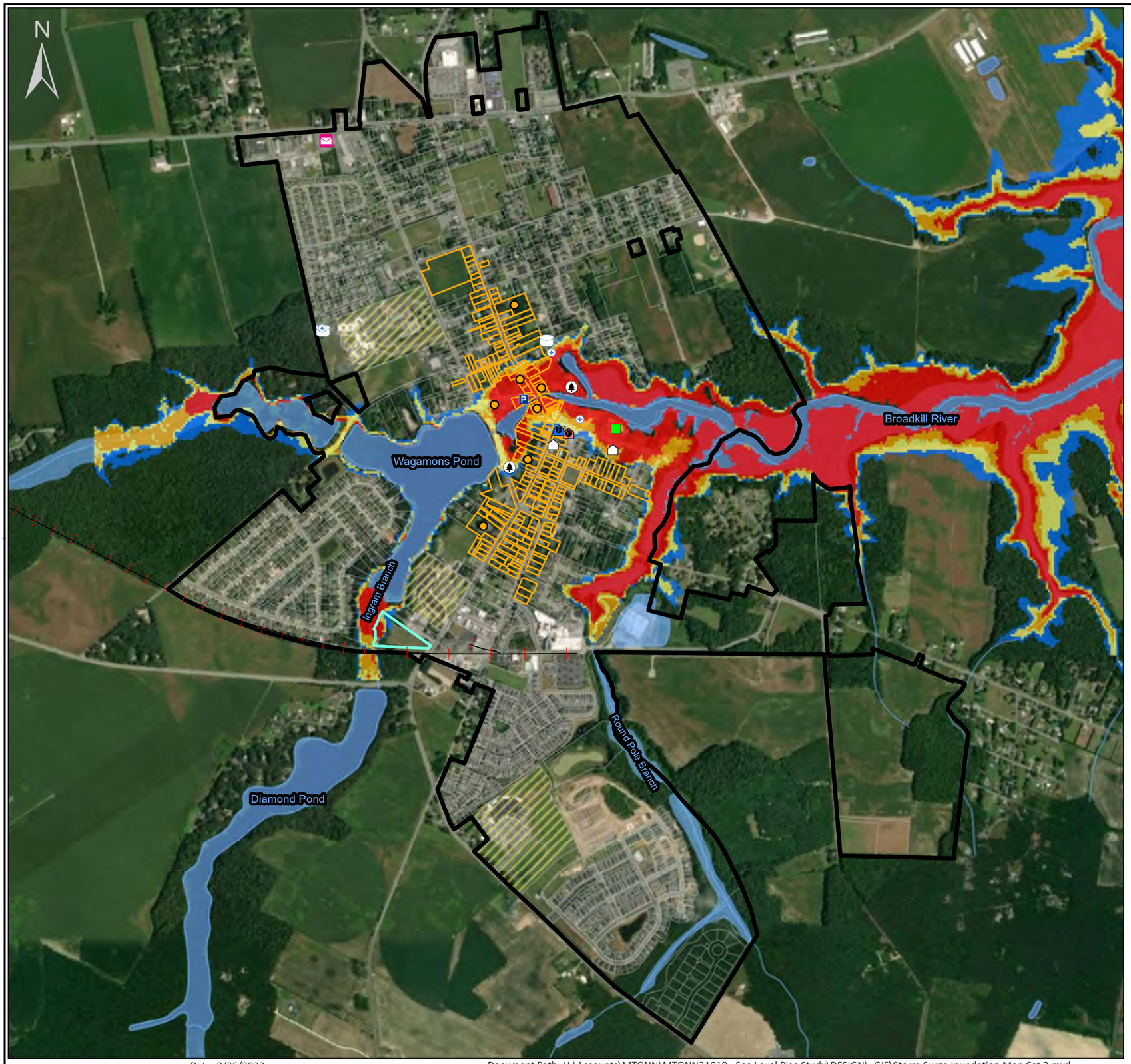
Town of Milton
Storm Surge Inundation Map
Category 3 Storm

MTONN21010 - Sea Level Rise Study



Inundation Height

- Up to 3 feet above ground
- Greater than 3 feet above ground
- Greater than 6 feet above ground
- Greater than 9 feet above ground
- Levee Areas - Consult Local Officials for flood risk
- Municipal Parking Lot
- Town Parks
- Post Office
- Milton Historic Places
- Police Department
- Milton Fire Dept., Inc.
- Artesian Water Company WWTP
- Wells
- Water Towers
- Town Facilities
- Potential WTP/Well Location
- Milton Historic District
- Town of Milton
- Cape Henlopen School District Parcels
- Milton Parcels
- Railroads

Data Sources: NOAA/NWS/NHC/Storm Surge Unit, NOAA/NOS/Office for Coastal Management, Delaware FirstMAP, National Park Service, Town of Milton

Pennoni

1 inch = 1,250 feet

1,250 625 0 1,250 Feet

Map 14 of 15.

Date: 8/26/2022

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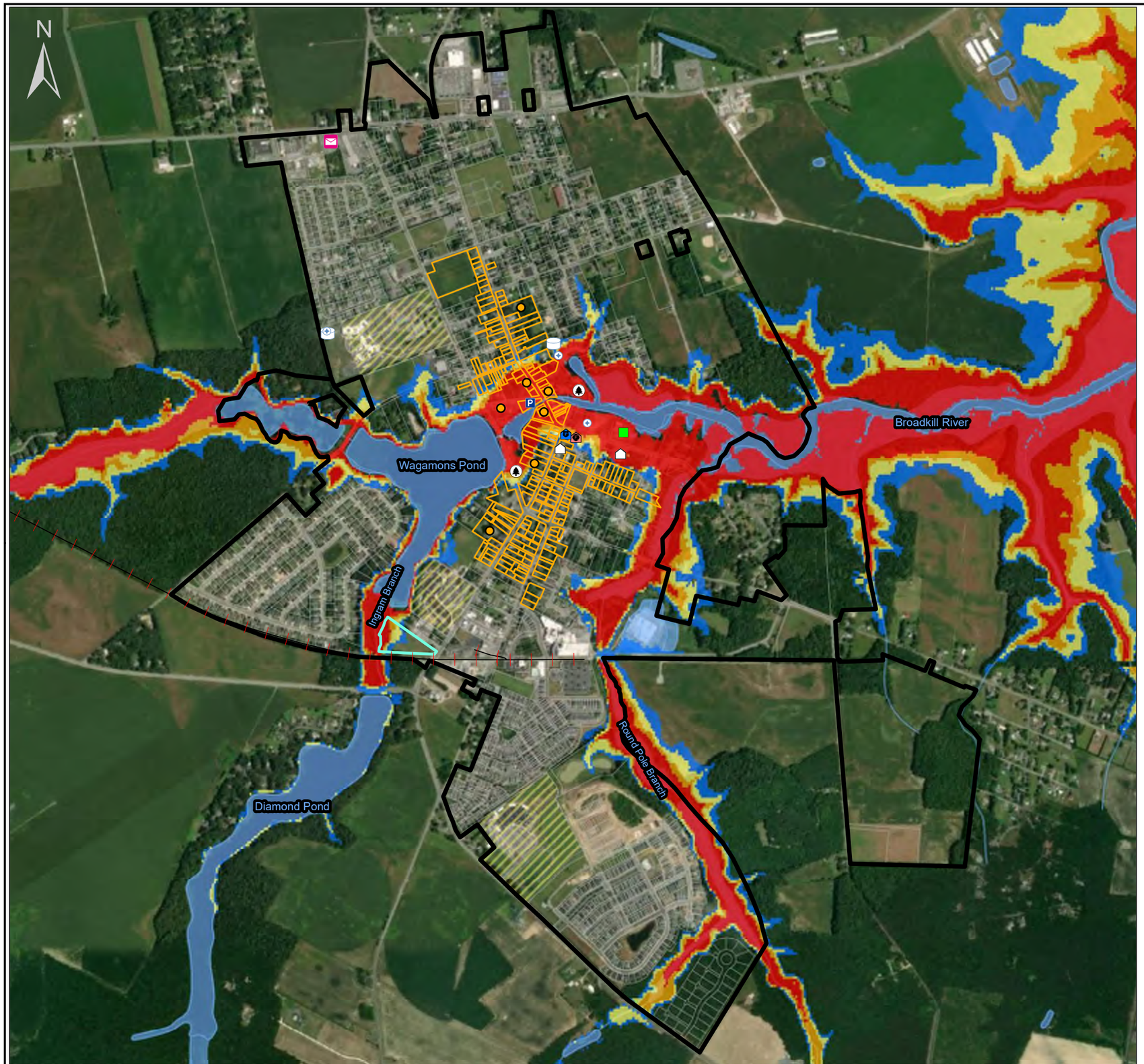
Town of Milton
Storm Surge Inundation Map
Category 4 Storm

MTONN21010 - Sea Level Rise Study



Inundation Height

- Up to 3 feet above ground
- Greater than 3 feet above ground
- Greater than 6 feet above ground
- Greater than 9 feet above ground
- Levee Areas - Consult Local Officials for flood risk

- Municipal Parking Lot
- Town Parks
- Post Office
- Milton Historic Places
- Police Department
- Milton Fire Dept., Inc.
- Artesian Water Company WWTP
- Wells
- Water Towers
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- Potential WTP/Well Location
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- Milton Parcels
- Railroads

Data Sources: NOAA/NWS/NHC/Storm Surge Unit, NOAA/NOS/Office for Coastal Management, Delaware FirstMAP, National Park Service, Town of Milton

1,250 625 0 1,250 Feet

Pennoni

1 inch = 1,250 feet

Map 15 of 15.

Date: 8/26/2022

Document Path: U:\Accounts\MTONN\MTONN21010 - Sea Level Rise Study\DESIGN_GIS\Storm Surge Inundation Map Cat 4.mxd