City of Nautilus

Mock Case Study for Steps to Resilience

This case study was developed to demonstrate the use of the resources supporting the Steps to Resilience Framework.

Background

Welcome to the City of Nautilus!

This coastal community is known for its beaches, recreation opportunities, retail shopping, and local eateries.

The city consists of a mainland and a populated island connected by two bridges.

The city is considering how it will adapt to climate change and the risks to its neighborhoods, recreation, natural resources, and economy.

A planning team has formed to work on the issue and develop an adaptation strategy to identify short, mid, and long term solutions.

The Challenge

There is a **growing problem of beach erosion** on the island and near Beach Road on the mainland. Beach erosion has always been an issue, but older local residents are clear the situation has worsened in recent years.

During and after major storms, Beach Road **floods easily** and at times becomes impassable resulting in restricted traffic between the island and mainland. **Once or twice a year flooding** in The Enclave affects several houses, a nursing home, and the water treatment facility.

Five years ago, there was **a major storm causing significant erosion** along Nautilus Beach. The erosion threatened the historic Founders Church cemetery near the south end of the island.

What's already being done?

The U.S. Army Corps of Engineers completed a study just last year to assess the feasibility of a beach nourishment project to address the erosion issue and protect the businesses along Nautilus Beach. Measures have been taken to "patch" the damage to Beach Road, but these seem to be temporary fixes.

A local non-profit, Grassroots Leadership, started a program to provide assistance to service workers experiencing disruption in employment after storm events. They have minimal funding to maintain the program in the long term, and are exploring options for sustaining and expanding the effort.

Risk Assessment

Get Started

Planning Team

Practitioner's Guide Resource: 1.1 Planning Team Contacts - Worksheet

Name	Organization	Organization Type	Role
Eliza	City of Nautilus	Local Government	Sustainability Director (*Government Champion*)
Joe	City of Nautilus	Local Government	Transportation Planner
Beverly	City of Nautilus	Local Government	City Planner
Sarah	Improve Nautilus! Non-Profit	Nonprofit Organization	Community Engagement Specialist (*Community Champion*)
Samuel	Nautilus Chamber of Commerce	Local Government	Lead, Workforce Partnerships

Vision, Values and Goals

Practitioner's Guide Resource: 1.3 Vision, Values, and Goals - Worksheet

The City's **vision** is to build and foster a more resilient community that can more easily adapt to changing realities and be a great place to live and work, now and in the future.

The City **values**...

- its beaches, recreation opportunities, retail shopping, and local eateries.
- its citizens.
- being rated as a great place to live.
- its vibrant economy with good jobs across many sectors.
- its natural systems and beauty.

The City's **Resilience** goals are...

- Protect the health, safety, and welfare of those who live, work, and recreate in the City of Nautilus.
- Prevent the disruption of key community services by protecting critical infrastructure.
- Protect the environmental value of the area by preserving habitat, water quality, and endangered species.
- Build organizational and community capacity so stakeholders can work collaboratively to address future conditions.

Examples of inappropriate (out of scope and or out of context) goals...

- The goal of this team is not to develop a greenhouse gas mitigation plan *unless climate adaptation and resilience are explicitly included*. When greenhouse gas mitigation and climate adaptation are both addressed, the resulting effort is often called a “climate action plan.”
    - **Suggested edit:** Develop a city wide greenhouse gas mitigation plan.
- Work towards city-wide sustainability goals, such as affordable housing or energy conservation.
- Updating Nautilus’s Emergency Management and Comprehensive plans.
- Develop future buildout and infrastructure plans based on guidance provided in the resilience adaptation plans.

Understand Exposure

Community Asset Themes

Practitioner's Guide Resource: 2.3 Community Asset Themes - Worksheet

Residential Property

The Enclave

- **Older residential area towards the southern end of the mainland**
- Mixture of rental properties and year-round residences
- Neighborhood was developed in the 1960's, average age of the home is 50 years

Census Block groups around this neighborhood indicate:

- High % of renters
- High % of residents over 65 years of age (presence of Nautilus Eldercare nursing home)
- High % of households without cars, resulting in more dependence on public transit
- High % of english as second language (four languages spoken in households in this area)

Water's Edge

- **New upscale and gated neighborhood towards the northern end of the mainland**
- Large footprint homes, with most being over 2500 sq ft
- Neighborhood is still being developed, average age of home is seven years

Census Block groups around this neighborhood indicate:

- High % of home ownership
- Average resident is 42 years old
- Average cars per household is two

Nautilus Island

- **Small populated island off the mainland**
- Mixture of second homes and short term rentals
- Types of homes tend towards small cottage or multi-unit residential

Census Block groups around this neighborhood indicate:

- High % of renters
- Low % of full time residents
- Average cars per household is one

Natural Areas

State Nature Reserve

- Located at the southern end of the island
- Home to threatened species and critical habitats

Wetlands

- Located in front of the Enclave and at the southern tip of the State Nature Reserve
- Wetland area in front of the Enclave provides multiple benefits, including protection from waves and flooding to the lower income neighborhood

Nautilus Beach

- Popular tourist destination and a major economic hub
- Rare species nest along the sandy shore, and can result in beach access restrictions during nesting season

Lighthouse Park

- Located at the northern end of the island
- Visitors can take lighthouse tours
- Marina access

West Nautilus State Forest

- Located to the west of the city
- Features diverse mix of old-growth and new-growth trees
- Vital ecological asset and plays a crucial role in the local economy through its timber management program
- Provides recreational opportunities for residents and visitors, including hiking, bird watching, and educational programs about local flora and fauna
- Borders the Water's Edge community

Cultural

Nautilus Point Lighthouse

- Built in 1892
- Located in Lighthouse Park at the northern end of the island

Historic Founders Church and Cemetery

- Built in 1888
- Located towards the southern end of the island
- Cemetery with many historic gravesites

First Nautilus Church

- Located on the mainland, near the Firehouse
- Serves as evacuation center during storms and as a cooling center during high heat events
- During the last storm event, power to the building was interrupted due to basement flooding
- Power and utilities infrastructure to the building haven't been updated in 20 years.
- Offers services in Spanish three times a week

Commercial

Outdoor shopping mall

- Built eight years ago
- Has a number of high end shops that draw people from surrounding communities

The Roast

- Local coffee shop and restaurant that offers live music
- A local hangout for college students and tourists
- Community gathering spot

Critical Infrastructure

Key Bridge

- Located at the northern part of the city
- Six-lane bridge connecting to Beach road on the mainland

Morris Bridge
- Two-lane bridge connecting to a smaller inland road on the mainland

Beach Road
- Six-lane main state road that lies 30 to 50 feet from the shoreline

County Water Treatment Facility
- Located south of the Enclave (not pictured)
- Services the City of Nautilus, a neighboring inland community, and the unincorporated parts of the county

Firehouse
- Located in the southern part of the city, across the street from First Nautilus Church and the Roast

Nautilus College
- Located on the mainland, between Water's Edge and the new outdoor shopping mall

Elementary School
- Located on the island

Middle and High School
- Both located on the mainland, fairly far inland (not pictured)
- High School serves as an evacuation center during events

Social

KNAU Community Radio Station
- KNAU has been on the air since 1962 and hosts both music and new shows as well as a community calendar of local events

Nautilus News
- Local community newspaper established in 1922

Neighborhood Groups
- The Enclave and Water's Edge neighborhoods both have organized groups that advocate for their neighborhoods with the City Council and hold social events

Community Groups
- The First Nautilus and Founders churches have been active in supporting charities and providing assistance to Latinx and elderly residents respectively

- Grassroots Leadership is a local community group that advocates for service industry workers rights

Nautilus Land Trust

- The land trust has small holdings on Nautilus Island adjacent to the beach and state reserve. They also hold title to the Enclave wetlands and several larger parcels in the western part of the City.

Nautilus Merchant Association

- Membership organization that supports the interests of local businesses

Hazards and Stressors

Practitioner's Guide Resource: 2.5 Evaluate Hazards and Stressors - Worksheet

Climate Report

- Nautilus College Climatology Program conducted a future climate impacts study. The report includes projections for temperature, rainfall, and fluctuating coastal water levels.
- Based on the recommendations from the technical advisory panel, projections were analyzed for low and high greenhouse gas emissions scenarios.

Additional Datasets

- Parcel data was taken from county records
- Floodplain data was taken from FEMA

Overall Climate-Stressors and Hazards

Climate-Stressor: Temperature
Hazard: Extreme Heat

- The rise in temperature exacerbates several hazards. Heatwaves become more frequent and severe, leading to health risks such as heat stroke and exacerbation of cardiovascular diseases. Elevated temperatures can also stress local ecosystems, impacting biodiversity and the services ecosystems provide, such as cooling urban areas and supporting fisheries.

Climate-Stressor: Precipitation Increase (Rainfall)
Hazard: Flooding Rainfall-induced

- Changes in rainfall patterns can lead to flooding, especially in areas with inadequate drainage or where natural water absorption is hindered by urban development. On the other hand, decreased rainfall can lead to droughts, affecting water supply for domestic, agricultural, and industrial use, and increasing the risk of wildfires.

Climate-Stressor: Water Levels
Hazard: Flooding Coastal Inundation

- Rising water levels pose a direct threat to coastal or shoreline communities through increased erosion, salinization of freshwater resources, and more frequent and severe coastal flooding. These effects can damage infrastructure, displace communities, and disrupt local economies, especially those reliant on tourism, fisheries, and agriculture.

Climate-Stressor: Precipitation Decrease (water scarcity)
Hazard: Wildfires

- Drought conditions in the West Nautilus State Forest significantly increase the susceptibility of the area to wildfires. Prolonged periods of below-average rainfall reduce soil moisture and dry out the vegetation, turning the forest into a tinderbox. This condition, coupled with the mixed age of the forest, where new growth can provide abundant fuel for fires, creates a heightened risk for wildfires.

Demo Data Based on Climate-stressors

Temperature

Big picture takeaways

- Extreme heat events are expected to increase in frequency, duration, and intensity
- More summer warming than winter
- More inland warming than along coast
- More nighttime warmth

		2050		2100	
Indicator	**Baseline (1970-2010)**	**Low Scenario**	**High Scenario**	**Low Scenario**	**High Scenario**
Extreme heat days (at or above 90°F)	7 to 10 days per year	18 to 24 days per year	18 to 30 days per year	40 to 55 days per year	>70 days per year
Average annual max temperature	88°F	+3.3 to 3.8°F	+3.6 to 4.1°F	+5.1 to 6.8°F	+7.6 to 8.5°F
Nights above 75°F	18	+12 to 16	+12 to 18	+40 to 52	+68 to 83

Rainfall (In-land Flooding Version)

Big picture takeaways

- Rainfall models tend to show more variability in annual rainfall totals.
- Rainfall models indicate an increase in higher intensity storm events where heavier rains in shorter amounts of time could lead to increased flooding problems. Record setting floods like the January 2008 event that resulted in four inches of rainfall in 24 hours will become more common.
- On average, summers are projected to become drier and other seasons to become wetter.

		2050		2100	
Indicator	**Baseline (1970-2010)**	**Low Scenario**	**High Scenario**	**Low Scenario**	**High Scenario**

Average annual rainfall totals		46.5 inches	+0.7 inches	+0.9 inches	+1.3 inches	+2.8 inches
Annual Number of Heavy Rain Events	20-year storm	6.3 events per year	8 events per year	12 events per year	10 events per year	18 events per year
	50-year storm	3.8 events per year	5 events per year	8 events per year	6 events per year	9 events per year

Rainfall (Drought Version)

Big picture takeaways

- Rainfall models show a significant decrease in the amount of precipitation received annually.
- The decrease in average annual rainfall contributes directly to the worsening of drought conditions as there is less water available for replenishing groundwater, lakes, rivers, and reservoirs.
- The lower frequency of heavy rain events further exacerbates the drought conditions. Fewer heavy rain events mean less opportunity for substantial replenishment of water stocks during the wetter periods of the year.
- The revised data suggests that the area will experience more prolonged dry periods, leading to severe drought conditions. This scenario will likely impact water availability for agriculture, human consumption, and natural ecosystems, necessitating the implementation of comprehensive water conservation measures and strategies for drought mitigation.

			2050		2100	
Indicator		**Baseline (1970-2010)**	**Low Scenario**	**High Scenario**	**Low Scenario**	**High Scenario**
Average annual rainfall totals		46.5 inches	-1.5 inches	-2.5 inches	-3.5 inches	-6.0 inches
Annual Number of Heavy Rain Events	20-year storm	6.3 events per year	5 events per year	4 events per year	3 events per year	2 events per year
	50-year storm	3.8 events per year	3 events per year	2 events per year	1 events per year	<1 event per year

Wildfires pose a direct hazard to the West Nautilus State Forest, particularly during drought conditions when the risk is exponentially increased. Wildfires can rapidly spread through the dry, combustible vegetation, threatening the forest's biodiversity and ecological integrity, the nearby residential areas, and the forest's economic contributions through timber. The management of the forest for timber involves practices that could either mitigate or exacerbate the fire risk, such as clearing underbrush or creating fire breaks. However, during severe droughts, the effectiveness of these practices is challenged by the overwhelming potential for ignition from natural causes, like

lightning, or human activities. Addressing this hazard requires a comprehensive fire management strategy that includes monitoring drought conditions, enforcing fire bans, and engaging in controlled burns to reduce fuel loads in a controlled and safe manner.

Rainfall (Coastal Flooding Version)

Big picture takeaways

- Higher water levels increase the damage from wind-driven storms that push huge waves up into the shoreline and increase erosion.
- Rising water levels will cause flooding to occur more frequently, and last for a longer duration of time. This is compounded by the increase in rainfall.

Indicator	Baseline (1970-2010)	2050		2100
		Low Scenario	High Scenario	Low Scenario
Rising water level range	+6 to 16 inches	+12 to 30 inches	+28 to 46 inches	+36 to 58 inches
50% probability or best estimate rise	22 inches (1.8 ft)		42 inches (3.5 ft)	
Annual Number of Floods	60	85	100	220

The shaded areas indicate areas impacted by coastal flooding (such as tidal flooding) presently, 2050, and 2100. Notice the increasing impacts on natural areas, residential neighborhoods, and other things the community values.

Potential Impacts Matrix

Practitioner's Guide Resource: 2.6 Potential Impacts Matrix - Worksheet

The following potential impacts matrix was developed based on stakeholder input and community reports.

Stakeholder and Community Reports

Overall Data

- Extreme high water levels and increased precipitation events will occur more often, leading to more frequent flooding in flood-prone areas that could cause disruptions of emergency services and access to power, water, food, and medical care.
- Higher water levels especially during storm events will flood larger areas for longer periods of time. Flooding will expand into areas that currently do not experience this issue.
- Rising water levels will cause areas not currently exposed to flooding to be inundated, resulting in the need to either protect or move people and infrastructure, and the loss of trails, beaches, and other shoreline recreation areas.
- Higher water levels will cause changes in wave energy, leading to increased shoreline erosion.
- As the coastal waters rise, groundwater levels will increase, affecting water supplies along the shoreline, damaging below- or at-grade infrastructure, requiring additional pumping and costly maintenance and repairs of stormwater and flood control facilities.
- Higher daytime and nighttime temperatures will cause increasing stress to vulnerable populations.
- As average and extreme temperatures increase, children and elderly populations that live without air conditioning will be increasingly vulnerable to heat-related injuries. Increased temperatures will also put a higher demand on the city's power grid, with the potential for blackouts, further putting stress on these populations.

Residential

Community Services

- Homeowners rely on public and private roads, electricity, food, water, wastewater, and telecommunication infrastructure. If these services are damaged or disrupted residents may not be able to stay in their homes until repairs or upgrades are completed.

Transportation Evacuation Routes

- More frequent flooding of evacuation routes near Nautilus Eldercare and The Enclave by 2050.

Homes in The Enclave

- 42 single-family residential parcels are within the 100-year floodplain, 35 of which are at risk of more frequent or extensive flooding by 2100 due to rising water levels and increased precipitation. The majority of those homes are located within The Enclave. An additional 74

single-family residential parcels not currently at risk of flooding (e.g., not within the 100-year floodplain) could be exposed to flooding as water levels rise.

Homes in Water's Edge

- 87 single-family residential parcels border the West Nautilus State Forest, with 52 classified as high-risk due to their proximity to the forest and the increased likelihood of wildfires under drought conditions.

Natural Areas

Nautilus Beach

- Nautilus Beach will experience increased erosion and sand loss with more frequent storms and higher water levels. As little as 5 to 6 inches of rise in coastal water levels will narrow the beach by 15 to 20 feet and the increased wave run-up from storms will have significant impacts on adjacent property and infrastructure.

State Nature Reserve Wetlands

- Increased inundation and potential erosion of the wetlands in the State Nature Reserve will become apparent at 10 inches of rise in water levels. The wetland will be completely inundated at 15 inches without further sediment supply.

The Enclave Wetlands

- Increased inundation and potential erosion of the wetlands near the Enclave will become apparent at six inches of rise in water levels. The wetland will be completely inundated at 12 inches of rise in water levels without further sediment supply.

Cultural

Nautilus Point Lighthouse

- The foundation of the lighthouse at Nautilus point will begin to experience significant exposure to wave run-up from storms by 2050. Once water levels exceed 36 inches of rise, the lighthouse will need to be moved or demolished.

First Nautilus Church

- The cemetery at First Nautilus Church will start experiencing more frequent flooding at 12 inches of rise in water levels. This will become especially pronounced at 24-36 inches of rise. The power to the building is located in the basement, and is therefore at significant risk of damage and interruption, reducing the services provided during evacuations. Due to the age of the utilities infrastructure, the facility is at significant risk during heat events as well.

Historic Founders Church and Cemetery

- The cemetery at Founders Church will start experiencing more frequent flooding at 22 inches of rise in water levels. This will become especially pronounced at 42 to 48 inches of rise.

Commercial

Water Recreation Access

- The Marina and boat launch will begin seeing impacts from increase in coastal water levels by 2050, with complete inundation of the boat launch by 2100.

Shopping Areas
- This is expected to increase with higher water levels and increased rainfall.

Businesses
- Tourist-based businesses, particularly on Nautilus Island, will be impacted by the erosion of Nautilus Beach.

Critical Infrastructure
Beach Road
- Beach Road will increasingly become inundated and or undercut as water levels rise. Engineers estimate that more frequent repairs will be necessary at 6 to 8 inches of rise, with major design changes to sections of the roadway at 15 to 18 inches of rise.

Wastewater Treatment Plant
- The county wastewater treatment plant in the project area is either completely or partially within the existing 100-year floodplain. The plant may also experience more frequent or extensive flooding with a rise in water levels of 12 to 36 inches. Wastewater plants often have electrical and mechanical components, including pumps and control panels, at or below grade that are not waterproofed.

Stormwater System
- Stormwater outfalls for the city will become inundated by 2080. This will result in frequent “sunny day” flooding and will severely impact the stormwater drainage system during storm events, resulting in street flooding.

Nautilus Elementary School
- The elementary school on the Island will start to experience increasing flooding by 2050. Significant portions of the school grounds will be inundated by 2100.

Nautilus College Hospital
- Located on the island just a few meters above sea level (in the FEMA Zone VE), the hospital is extremely susceptible to storm surge flooding caused by hurricanes. Rising sea levels due to climate change further increase the risk of saltwater inundation.
- The island experiences heavy seasonal rainfall, and the hospital’s aging drainage system struggles to handle intense downpours, leading to frequent flash floods that can overwhelm the ground floor. The hospital building is only 50 meters from the shoreline, and strong waves and storm surges during high tides constantly threaten the foundation.

Social
Affordable housing
- A significant amount of affordable and rental housing is located within the southern portion of the city, primarily in The Enclave. These neighborhoods are some of the most vulnerable

in town with populations least able to prepare for, respond to and recover from climate related impacts such as flooding and heat.

English as a Second Language (ESL) Residents

- City residents who are not native English speakers have less access to information and resources tied to hazard preparation and response.

Heat Related Mortality and Morbidity

- Socially isolated, children (under the age of 6), and the elderly were found to have high susceptibility to heat mortality and morbidity. Rate of heat deaths, hospitalizations, and emergency room visits during summer months is expected to double by 2100

Harmful Algal Blooms

- Increased temperatures (both air and coastal waters) and nutrient runoff (from increased heavy rainfall events) will lead to increased incidents of harmful algae blooms (HABs), which produce nerve and liver toxins. These harmful algae blooms are expected to be longer in duration, of greater intensity and result in increased human exposure through drinking water contamination and recreational exposure.

Loss to the Economy

- Wildfires pose a significant threat to the local economy, particularly through the potential loss of timber production in the West Nautilus State Forest. In the event of a major wildfire, the destruction of valuable timber resources could lead to substantial economic losses for the timber industry, impacting jobs and revenue generation. Additionally, the loss of trees would negatively affect the forest's ecological services, such as carbon sequestration and soil stabilization, further compounding the economic impact. The disruption of recreational activities in the forest due to wildfires could also result in a decline in tourism-related revenue for local businesses.

Potential Impacts Matrix Table

	Hazards			
Community Assets	**Flooding Rainfall-Induced**	**Flooding Coastal Inundation**	**Extreme Heat**	**Wildfire**
Residential Property	x	x		x
Natural Areas	x	x		x
Cultural	x	x	x	
Commercial	x	x		
Critical Infrastructure	x	x		

Social	x	x	x	x

Impact Pairs
Residential Property x Flooding Rainfall-Induced
Residential Property x Flooding Coastal Inundation
Residential Property x Wildfire
Natural Areas x Flooding Rainfall-Induced
Natural Areas x Flooding Coastal Inundation
Natural Areas x Wildfire
Cultural x Flooding Rainfall-Induced
Cultural x Flooding Coastal Inundation
Cultural x Extreme Heat
Commercial x Flooding Rainfall-Induced
Commercial x Flooding Coastal Inundation
Critical Infrastructure x Flooding Rainfall-Induced
Critical Infrastructure x Flooding Coastal Inundation
Social x Flooding Rainfall-Induced
Social x Flooding Coastal Inundation
Social x Extreme Heat
Social x Wildfire

The remainder of this case study will focus only on the following three impact pairs:
Commercial x Flooding Coastal Inundation
Critical Infrastructure x Flooding Coastal Inundation

Assess Vulnerability and Risk

Background

Vulnerability Summary Report
The City of Nautilus hired a consulting firm to complete a broad-brush, city-wide vulnerability assessment for rising coastal water levels, rainfall, and temperature.

Due to the limited budget and timeline, the scope of work directed the consultant to use readily available data - including the climate report completed by the Nautilus College Climatology Program, and some GIS data on the key land use types (residential, commercial, natural areas, infrastructure, cultural and society).

Additionally, there were two public workshops held to gather input from community members.

REMINDER: The remainder of this case study will focus only on the following two impact pairs:

- Commercial x Flooding Coastal Inundation
- Critical Infrastructure x Flooding Coastal Inundation

Type of Assessment

Practitioner's Guide Resource: 3.1 Determine Assessment Type - Worksheet

Commercial and Flooding Coastal Inundation

Spatial assessment

Potential Impact: Flooding impact on commercial districts.
Hazard Data Availability: Yes, floodplain data is available, offering detailed risk assessments.
Community Asset Data Availability: Yes, commercial properties are documented within the city's GIS database, including property type and use.
Parcel-level or Screening-level?: Parcel-level analysis to identify specific commercial properties at risk.
Adaptive Capacity, Sensitivity: Business type and economic data can help assess sensitivity. Building codes and flood protection measures inform adaptive capacity.

Narrative assessment

Nautilus's commercial sector, particularly its waterfront businesses, has been periodically affected by flooding, disrupting operations and causing economic losses. The flood event of 2015 notably impacted the local economy, with many small businesses struggling to recover. With climate models predicting sea-level rise and increased precipitation, the future outlook suggests that these challenges will only intensify, potentially leading to more frequent business disruptions, higher operational costs, and challenges in securing insurance. Investing in flood defenses, such as seawalls and elevated structures, along with business continuity planning, is vital for sustaining the commercial sector's resilience.

Critical Infrastructure and Flooding Coastal Inundation

Spatial assessment

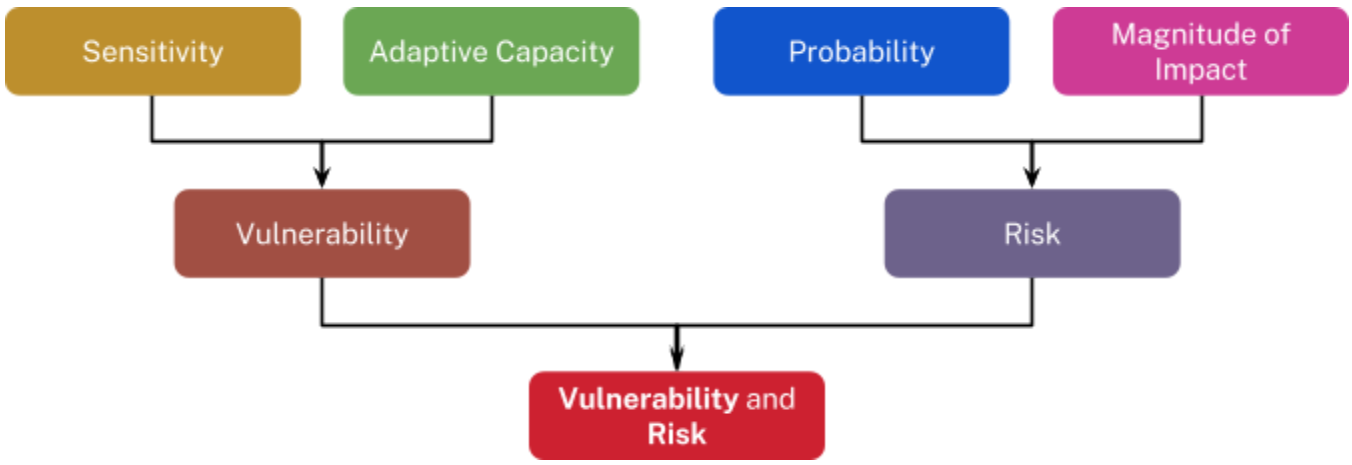
Potential Impact: Flooding impact on critical infrastructure.
Hazard Data Availability: Yes, FEMA provides flood risk data suitable for analysis.
Community Asset Data Availability: Yes, critical infrastructure such as utilities, bridges, and roads are mapped in GIS, often at a detailed scale.
Parcel-level or Screening-level?: Parcel-level for precise risk assessment to specific infrastructure components.
Adaptive Capacity, Sensitivity: Infrastructure age, condition, and design details provide insights into adaptive capacity and sensitivity.

Narrative assessment

The resilience of Nautilus's critical infrastructure, including utilities, roads, and bridges, to flooding has been tested several times in the past decades. The 2015 storm season notably demonstrated vulnerabilities, particularly in the wastewater treatment facility, which was overwhelmed, leading to environmental and public health concerns. As climate change is expected to increase the intensity of storm events and sea-level rise, the risk to critical infrastructure components is anticipated to grow, potentially resulting in more frequent service disruptions and higher maintenance and repair costs. Prioritizing the upgrade and fortification of critical infrastructure to withstand these challenges is crucial for maintaining public safety and community functionality.

Rulesets and Assess Vulnerability and Risk

Practitioner's Guide Resources: 3.3 Ruleset Library - Guidance and 3.4 Ruleset Development - Worksheet



Commercial and Flooding Coastal Inundation

Sensitivity and Adaptive Capacity Ruleset

	Sensitivity	Adaptive Capacity
Low	Commercial properties on elevated ground with minimal flooding risk.	Businesses without flood preparedness or insurance.
Medium	Commercial properties in the 500-year floodplain or occasionally affected by surface water flooding.	Businesses with flood insurance and emergency preparedness plans.
High	Commercial properties in the 100-year floodplain, especially those critical to the local economy.	Commercial buildings designed with flood resilience in mind (such as waterproofing, elevated utilities).

Vulnerability

Sensitivity	High	Medium	Low
High	Commercial properties in the 100-year floodplain, especially those critical to the local economy designed with flood resilience in mind (such as waterproofing, elevated utilities).	Commercial properties in the 100-year floodplain, especially those critical to the local economy with flood insurance and emergency preparedness plans.	Commercial properties in the 100-year floodplain, especially those critical to the local economy without flood preparedness or insurance.
Medium	Commercial properties in the 500-year floodplain or occasionally affected by surface water flooding designed with flood resilience in mind (such as waterproofing, elevated utilities).	Commercial properties in the 500-year floodplain or occasionally affected by surface water flooding with flood insurance and emergency preparedness plans.	Commercial properties in the 500-year floodplain or occasionally affected by surface water flooding without flood preparedness or insurance.
Low	Commercial properties on elevated ground with minimal flooding risk that are designed with flood resilience in mind (such as waterproofing, elevated utilities).	Commercial properties on elevated ground with minimal flooding risk with flood insurance and emergency preparedness plans.	Commercial properties on elevated ground with minimal flooding risk without flood preparedness or insurance.
	High	**Medium**	**Low**
	Adaptive Capacity		

Probability and Magnitude of Impact Ruleset

	Probability	Magnitude of Impact
Low	Commercial areas outside flood-prone zones.	Minimal economic impact, with businesses remaining operational.
Medium	Commercial areas within the 500-year floodplain.	Moderate economic impact, with some businesses temporarily affected.
High	Commercial areas within the 100-year floodplain.	Significant economic losses, business closures, and infrastructure damage.

Risk

Probability	Magnitude of impact: Low	Magnitude of impact: Medium	Magnitude of impact: High
High	Commercial areas within the 100-year floodplain, minimal economic impact, with businesses remaining operational.	Commercial areas within the 100-year floodplain, moderate economic impact, with some businesses temporarily affected.	Commercial areas within the 100-year floodplain, significant economic losses, business closures, and infrastructure damage.
Medium	Commercial areas within the 500-year floodplain, minimal economic impact, with businesses remaining operational.	Commercial areas within the 500-year floodplain, with some businesses temporarily affected.	Commercial areas within the 500-year floodplain, significant economic losses, business closures, and infrastructure damage.
Low	Commercial areas outside flood-prone zones, minimal economic impact, with businesses remaining operational.	Commercial areas outside flood-prone zones, with some businesses temporarily affected.	Commercial areas outside flood-prone zones, significant economic losses, business closures, and infrastructure damage.

Vulnerability and Risk

Risk	Low	Medium	High
High	Commercial properties in the 100-year floodplain, especially those critical to the local economy designed with flood resilience in mind (such as waterproofing, elevated utilities), will have minimal economic impact, with businesses remaining operational.	Commercial properties in the 100-year floodplain, especially those critical to the local economy with flood insurance and emergency preparedness plans moderate economic impact, with some businesses temporarily affected.	Commercial properties in the 100-year floodplain, especially those critical to the local economy without flood preparedness or insurance, significant economic losses, business closures, and infrastructure damage.
Medium	Commercial properties in the 500-year floodplain are occasionally affected by surface water flooding designed with flood resilience in mind (such as waterproofing, elevated utilities) minimal economic impact, with businesses remaining operational.	Commercial properties in the 500-year floodplain are occasionally affected by surface water flooding with flood insurance and emergency preparedness plans moderate economic impact, with some businesses temporarily affected.	Commercial properties in the 500-year floodplain are occasionally affected by surface water flooding without flood preparedness or insurance, significant economic losses, business closures, and infrastructure damage.
Low	Commercial properties on elevated ground with minimal flooding risk that are designed with flood resilience in mind (such as waterproofing, elevated utilities) minimal economic impact, with businesses remaining operational.	Commercial properties on elevated ground with minimal flooding risk with flood insurance and emergency preparedness plans moderate economic impact, with some businesses temporarily affected.	Commercial properties on elevated ground with minimal flooding risk without flood preparedness or insurance significant economic losses, business closures, and infrastructure damage.
	Low	**Medium**	**High**
	Vulnerability		

Sensitivity and Adaptive Capacity Ruleset

	Sensitivity	Adaptive Capacity
Low	Infrastructure on elevated ground or outside flood-prone areas.	Infrastructure with no flood protection or limited emergency preparedness.
Medium	Infrastructure occasionally affected by flooding but with redundant systems in place.	Infrastructure with some level of emergency preparedness for flooding.
High	Infrastructure within the 100-year floodplain that is critical for community function (such as water treatment plants, hospitals).	Infrastructure with built-in flood protection measures and redundancy.

Vulnerability

Sensitivity	Adaptive Capacity: High	Adaptive Capacity: Medium	Adaptive Capacity: Low
High	Infrastructure within the 100-year floodplain that is critical for community function (such as water treatment plants, hospitals) with built-in flood protection measures and redundancy.	Infrastructure within the 100-year floodplain that is critical for community function (such as water treatment plants, hospitals) with some level of emergency preparedness for flooding.	Infrastructure within the 100-year floodplain that is critical for community function (such as water treatment plants, hospitals) with no flood protection or limited emergency preparedness.
Medium	Infrastructure occasionally affected by flooding but with redundant systems in place with built-in flood protection measures and redundancy.	Infrastructure occasionally affected by flooding but with redundant systems in place with some level of emergency preparedness for flooding.	Infrastructure occasionally affected by flooding but with redundant systems in place with no flood protection or limited emergency preparedness.
Low	Infrastructure on elevated ground or outside flood-prone areas with built-in flood protection measures and redundancy.	Infrastructure on elevated ground or outside flood-prone areas with some level of emergency preparedness for flooding.	Infrastructure on elevated ground or outside flood-prone areas with no flood protection or limited emergency preparedness.

Adaptive Capacity

Probability and Magnitude of Impact Ruleset

	Probability	Magnitude of Impact
Low	Critical infrastructure in areas rarely affected by flooding.	Minimal impact, with services largely remaining operational.
Medium	Critical infrastructure near flood-prone areas, with occasional exposure.	Moderate disruptions, with some services temporarily affected.
High	Critical infrastructure located in high-risk flood zones.	Major disruptions to essential services, requiring extensive repairs.

Risk

Probability	Low	Medium	High
High	Critical infrastructure located in high-risk flood zones, minimal impact, with services largely remaining operational.	Critical infrastructure located in high-risk flood zones, moderate disruptions, with some services temporarily affected.	Critical infrastructure located in high-risk flood zones, major disruptions to essential services, requiring extensive repairs.
Medium	Critical infrastructure near flood-prone areas, with occasional exposure, minimal impact, with services largely remaining operational.	Critical infrastructure near flood-prone areas, with occasional exposure, moderate disruptions, with some services temporarily affected.	Critical infrastructure near flood-prone areas, with occasional exposure, major disruptions to essential services, requiring extensive repairs.
Low	Critical infrastructure in areas rarely affected by flooding, minimal impact, with services largely remaining operational.	Critical infrastructure in areas rarely affected by flooding, moderate disruptions, with some services temporarily affected.	Critical infrastructure in areas rarely affected by flooding, major disruptions to essential services, requiring extensive repairs.
	Low	**Medium**	**High**

Magnitude of impact

Vulnerability and Risk

Risk	Vulnerability: Low	Vulnerability: Medium	Vulnerability: High
High	Infrastructure within the 100-year floodplain that is critical for community function (e.g., water treatment plant, hospital) with built-in flood protection measures and redundancy, minimal impact, with services largely remaining operational.	Infrastructure within the 100-year floodplain that is critical for community function (e.g., water treatment plant, hospital) with some level of emergency preparedness for flooding, moderate disruptions, with some services temporarily affected.	Infrastructure within the 100-year floodplain that is critical for community function (e.g., water treatment plant, hospital) with no flood protection or limited emergency preparedness, major disruptions to essential services, requiring extensive repairs.
Medium	Infrastructure occasionally affected by flooding but with redundant systems in place with built-in flood protection measures and redundancy, minimal impact, with services largely remaining operational.	Infrastructure occasionally affected by flooding but with redundant systems in place with some level of emergency preparedness for flooding, moderate disruptions, with some services temporarily affected.	Infrastructure occasionally affected by flooding but with redundant systems in place with no flood protection or limited emergency preparedness, major disruptions to essential services, requiring extensive repairs.
Low	Infrastructure on elevated ground or outside flood-prone areas with built-in flood protection measures and redundancy, minimal impact, with services largely remaining operational.	Infrastructure on elevated ground or outside flood-prone areas with some level of emergency preparedness for flooding, moderate disruptions, with some services temporarily affected.	Infrastructure on elevated ground or outside flood-prone areas with no flood protection or limited emergency preparedness, major disruptions to essential services, requiring extensive repairs.

Preliminary Assessment

The Government Champion and Climate Adaptation Practitioner conducted workshops with stakeholders to review preliminary vulnerability and risk assessments. This involved the Planning Team, including representatives from the City of Nautilus and community organizations. Feedback from these workshops will refine the vulnerability and risk classifications and ensure they reflect both the quantitative data and community members' experiences and perceptions.

Impact Statements

Practitioner's Guide Resource: 3.10 Develop Impact Statements - Worksheet

Commercial and Flooding Coastal Inundation

Physical community asset and hazard, and exposure

Community asset, sector, service: Nautilus Downtown Commercial District

Hazard: Coastal Flooding

Scale (a particular transportation corridor, neighborhood, entire project or study area): Along the coastal commercial corridor, encompassing the downtown shopping and business area

Primary function (what is disrupted by impacts, why do these functions matter): This area serves as the economic heart of Nautilus, housing a diverse range of businesses from retail shops and restaurants to professional services that support local employment and the city's economic vitality.

Exposure (defined as the presence of people and community assets in places where they could be adversely affected by hazards): Businesses in the Downtown Commercial District are experiencing an increasing amount of "high tide flooding" events each year that not only damage the physical buildings but also close the businesses for several hours/days after the flooding event.

Types and causes of vulnerability and risk

What are the key ways in which the community asset(s) is (are) vulnerable/ at risk to impacts? The Nautilus Downtown Commercial District is particularly vulnerable due to its location within the 100-year floodplain (specifically the tidal flooding part of this floodplain), making it prone to significant flooding events (high tide flooding). This vulnerability is exacerbated for properties critical to the local economy that lack flood preparedness measures or insurance.

Describe the physical vulnerabilities (what makes it a high potential impact, low adaptive capacity, exposure)? Approximately 60% of commercial properties in this district are designed without flood resilience in mind, such as waterproofing or elevated utilities, increasing the potential for significant economic losses, business closures, and infrastructure damage during flood events.

Describe the social vulnerabilities and the causes (is the neighborhood historically marginalized? Is the population primarily low-income, older, something else?) The economic ripple effect of flooding in this district can lead to job losses and reduce access to essential services for the wider community, particularly impacting low-income residents.

Impact Statement

In Nautilus's Downtown Commercial District, a significant portion of businesses critical to the city's economy are situated within the 100-year floodplain (specifically the tidal flooding part of this floodplain) and lack adequate flood resilience measures. The absence of flood preparedness or

insurance among these businesses heightens the risk of considerable economic disruption, threatening job security, local livelihoods, and the overall economic stability of Nautilus. Efforts to enhance flood resilience in this key commercial corridor are essential to safeguarding the city's economic health against the increasing threat of coastal flooding.

Critical Infrastructure and Flooding Coastal Inundation

Physical community asset and hazard, and exposure #1

Community asset, sector, service: Nautilus College Hospital

Hazard: Coastal Flooding

Scale (a particular transportation corridor, neighborhood, entire project or study area): Infrastructure located within and adjacent to the 100-year floodplain (both high tide flooding and stormwater related flooding), critical for maintaining public health and safety

Primary function (what is disrupted by impacts, why do these functions matter): This facility provides medical services, especially during emergency situations.

Exposure (defined as the presence of people and community assets in places where they could be adversely affected by hazards): The hospital is experiencing an increasing amount of "high tide flooding" events and "heavy rainfall" flooding events that overwhelm the existing stormwater system. These floods not only damage the physical buildings but also limit access for several hours/days during the flooding event.

Types and causes of vulnerability and risk #1

What are the key ways in which the community asset(s) is (are) vulnerable/ at risk to impacts? The hospital is within the 100-year floodplain and exhibits high vulnerability due to its essential functions and the catastrophic consequences of their failure during flood events.

Describe the physical vulnerabilities (what makes it a high potential impact, low adaptive capacity, exposure)? The hospital does not possess built-in flood protection measures or have limited emergency preparedness, placing them at high risk of operational disruption.

Describe the social vulnerabilities and the causes (is the neighborhood historically marginalized? Is the population primarily low-income, older, something else?) The disruption of these services during flooding can have profound health and safety impacts on the entire Nautilus community, especially affecting vulnerable populations who rely heavily on these essential services.

Impact Statement #1

The Nautilus College Hospital is within the 100-year floodplain and faces heightened risks of disruption due to coastal flooding (both high tide flooding and stormwater related flooding). The

lack of comprehensive flood protection and emergency preparedness among this facility poses a significant threat to public health and safety, underscoring the urgent need for strategic investments in resilience measures to protect this vital asset and ensure the continuity of critical services during and after flood events.

Physical community asset and hazard, and exposure #2

Community asset, sector, service: Water Treatment Facility

Hazard: Coastal Flooding

Scale (a particular transportation corridor, neighborhood, entire project or study area): Infrastructure located within and adjacent to the 100-year floodplain (both high tide flooding and stormwater related flooding), critical for maintaining public health and safety

Primary function (what is disrupted by impacts, why do these functions matter): This facility is indispensable for ensuring clean water supply, especially during emergency situations. Additional functions include water quality control, supply regulation, firefighting support, and support for various economic activities (such as agriculture).

Exposure (defined as the presence of people and community assets in places where they could be adversely affected by hazards): The water treatment facility is exposed to coastal flooding due to its location within the 100-year floodplain, making it vulnerable to inundation from storm surges and sea-level rise.

Types and causes of vulnerability and risk #2

What are the key ways in which the community asset(s) is (are) vulnerable/ at risk to impacts? The Water Treatment Facility is within the 100-year floodplain and exhibits high vulnerability due to its essential functions and the catastrophic consequences of their failure during flood events.

Describe the physical vulnerabilities (what makes it a high potential impact, low adaptive capacity, exposure)? The Water Treatment Facility does not possess built-in flood protection measures or have limited emergency preparedness, placing them at high risk of operational disruption.

Describe the social vulnerabilities and the causes (is the neighborhood historically marginalized? Is the population primarily low-income, older, something else?) The disruption of these services during flooding can have profound health and safety impacts on the entire Nautilus community, especially affecting vulnerable populations who rely heavily on these essential services.

Impact Statement #2

The Water Treatment Facility is within the 100-year floodplain and faces heightened risks of disruption due to coastal flooding (both high tide flooding and stormwater related flooding). The

lack of comprehensive flood protection and emergency preparedness among this facility poses a significant threat to public health and safety, underscoring the urgent need for strategic investments in resilience measures to protect this vital asset and ensure the continuity of critical services during and after flood events.

Vulnerability and Risk Synthesis Report

Practitioner's Guide Resource: 3.11 Vulnerability and Risk Synthesis Report - Template

Risk Management

Investigate Options

Once the Vulnerability and Risk Assessment was complete the Planning Team moved from Risk Assessment (Steps 1-3) to Risk Management (Steps 4-6).

Developing Resilience Objectives

Practitioner's Guide Resource: 4.2 Develop Resilience Objectives - Worksheet

The City Council engaged with the Nautilus community to consider future options for their community. The council hopes to identify and build acceptance for future options that will protect the community and avoid costly repairs to the road and beach now and in the future.

After initial one-on-one discussions with key community members and meetings with community groups, a workshop with the wider community was organized. The goal was to bring together residents and the council to identify and explore the development and conservation priorities of the community for the future. The discussions were informed by the local climate study and the vulnerability assessment.

Residents identified the importance of staying within the Nautilus community and maintaining a thriving retail and service economy. It was also clear that the community valued the State Nature Reserve both as a recreational space and for conserving local wildlife, and would not tolerate the loss of that area.

Nautilus Resilience Objectives

1. **Enhance Flood Resilience of Commercial Districts:** Strengthen the structural and operational resilience of businesses in the downtown commercial district to minimize economic disruption during coastal flooding events. This objective targets the key challenge of protecting the local economy and ensuring job security within flood-prone areas.

    Reducing Vulnerability: By strengthening the physical resilience of businesses through structural adaptations (such as waterproofing, elevated utilities), and operational resilience through continuity planning, businesses are less likely to suffer catastrophic damage in flood events. This minimizes economic disruptions and supports the rapid recovery of the local economy.

    Reducing Risk: Implementing flood resilience measures decreases the likelihood of significant economic losses and infrastructure damage during coastal flooding, thereby reducing the overall risk to the commercial sector.

2. **Fortify Critical Infrastructure Against Coastal Flooding:** Implement robust flood protection measures for critical infrastructure, including water treatment facilities and healthcare institutions, to ensure continuity of essential services during and after flood events. This

directly addresses the challenge of maintaining public health, safety, and welfare in the face of coastal flooding.

Reducing Vulnerability: Upgrading flood defenses for critical infrastructure like the water treatment facility and hospital ensures these essential services continue operating during and after flood events. Enhanced protection measures directly reduce the physical vulnerability of these assets.

Reducing Risk: With critical infrastructure safeguarded against flooding, the risk of service disruption is significantly lowered. Ensuring the continuity of essential services mitigates the potential for widespread health and safety impacts on the community.

3. **Promote Equitable Flood Preparedness and Recovery:** Develop and implement strategies that ensure all community members, especially those in vulnerable populations, have the resources and support necessary for effective flood preparedness and swift recovery. This objective aims to address social vulnerabilities and enhance community capacity to collaboratively tackle future conditions.

   Reducing Vulnerability: Equipping all community members, especially the most vulnerable, with knowledge, resources, and support for flood preparedness and recovery strengthens the social fabric of Nautilus. This reduces social vulnerabilities by ensuring equitable access to information and resources.

   Reducing Risk: A well-prepared community is less likely to experience severe disruptions during flooding. By promoting equitable recovery strategies, the city reduces the risk of prolonged economic and social impacts post-event, ensuring a more resilient recovery for all.

4. **Preserve Environmental Values Through Sustainable Management:** Incorporate green infrastructure and sustainable land use practices in flood-prone areas to reduce flood risk while preserving habitat, water quality, and the natural beauty of Nautilus. This aligns with the goal of protecting environmental values and supporting a vibrant economy.

   Reducing Vulnerability: Green infrastructure and sustainable land use practices help mitigate flood risks by enhancing natural water absorption and reducing runoff. These measures protect natural habitats and maintain water quality, addressing environmental vulnerabilities.

   Reducing Risk: By integrating natural systems into flood management, Nautilus reduces its risk of flood damage and associated environmental degradation. Sustainable management practices contribute to long-term resilience against flooding and other climate-related hazards.

5. **Foster Community and Organizational Resilience:** Build organizational and community capacity for resilience planning and implementation, emphasizing stakeholder collaboration, information sharing,

and inclusive decision-making processes. This objective reflects the vision of fostering a resilient community adept at adapting to changing realities.

Reducing Vulnerability: Building community and organizational capacity for resilience planning increases the city's ability to respond and adapt to flooding and other challenges. Engaging stakeholders in collaborative processes ensures diverse perspectives are considered, enhancing the city's adaptive capacity.

Reducing Risk: A community that is well-informed, engaged, and prepared is more resilient to hazards. Strengthening organizational capacities ensures that Nautilus can effectively manage and mitigate risks associated with coastal flooding, leading to a safer, more resilient community.

Research and Identify Options

Following the community workshops and discussions, City officials consulted with adaptation experts and researched what other communities are considering or already implementing. Adaptation options include ideas to build capacity, projects to build or put in the ground, and new policies and regulations that would help guide climate-informed decisions for the future. Information gathered about each option covers a description, relative cost, longevity (how long the option is effective or what the long-term outcomes of the option might be), and lead time (length of time from initiating the action until it is implemented).

Practitioner's Guide Resource: 4.5 Inventory of Community Options - Worksheet

Resilience Objective 1: **Enhance Flood Resilience of Commercial Districts**

Option ID	Option	Action	How is Vulnerability Reduced?	Timescale	Lead Department, Agency, or Partners	Costs
EFRCD-001	Conduct vulnerability assessments to identify business areas most at risk and determine the most effective resilience measures	Capacity Building - Analysis and Research	Identifying most at-risk business areas allows interventions to be strategically located minimizing flood exposure Target critical infrastructure and sensitive business operations for enhanced protection measures Provides information needed to prepare/ adapt to flood risks	6-12 months for initial assessments, with periodic updates every 2 to 3 years or after significant events to reflect changes in risk and vulnerabilities	Local Department of Economic Development, Office of Emergency Management, local business associations, and community organizations focused on disaster resilience and recovery	$$ - $$$: reflects need for detailed data collection and analysis (includes geographic information system (GIS) mapping, risk modeling, and community engagement efforts) While significant, costs are manageable within context of municipal budgeting for disaster resilience and economic development
EFRCD-002	Implement flood warning systems and invest in flood-resistant technologies for businesses	Capacity Building - Analysis and Research	Ensures businesses have early warnings of flood events and can protect assets with resistant technologies	1 to 2 years for full implementation and integration	Department of Technology, Office of Emergency Management, and local business associations	$$ - $$$
EFRCD-003	Green Infrastructure: Install permeable pavement and green roofs to reduce runoff and absorb rainwater	Capital Improvements	Reduces exposure by managing stormwater onsite, mitigating flood risks for the community and environment	2-3 years for significant installations across key areas	Department of Environmental Protection, Department of City Planning, and local businesses	$$$ - $$$$
EFRCD-004	Gray Infrastructure: Elevate buildings and infrastructure, construct sea walls and flood barriers around commercial districts	Capital Improvements	Protects sensitive assets and reduces exposure by physically preventing floodwaters from damaging property	5-10 years, given the complexity and scale of construction projects	Department of Infrastructure, in collaboration with private construction firms and engineering experts	$$$$ - $$$$$

Option ID	Option	Action	How is Vulnerability Reduced?	Timescale	Lead Department, Agency, or Partners	Costs
EFRCD-005	Offer grants and low-interest loans for businesses to invest in flood resilience measures	Funding and Finance	Increases adaptive capacity by providing financial resources for businesses to implement resilience measures	Ongoing, with initial program setup within 1 year	Department of Economic Development, local financial institutions, and grant-making bodies	$$ - $$$ (for program setup and initial funding, potentially higher depending on the scale of funding provided)
EFRCD-006	Develop and rehearse flood emergency response plans specific to the commercial sector	Preparedness and Response	Increases adaptive capacity by ensuring businesses know how to respond to flooding, protecting both assets and employee safety.	6-12 months for development and initial training, ongoing for rehearsals and updates	Office of Emergency Management, local business associations	$ - $$
EFRCD-007	Workshops and materials on flood preparedness tailored for business owners and employees	Public Education and Outreach	Increases adaptive capacity by educating business owners and employees on flood risks and preparedness strategies	Ongoing, with initial workshops starting within 3-6 months	Department of Community Resilience, Chamber of Commerce, and local NGOs	$ - $$

Resilience Objective 2: **Fortify Critical Infrastructure Against Coastal Flooding**

Option ID	Option	Action	How is Vulnerability Reduced?	Timescale	Lead Department, Agency, or Partners	Costs
FCIACF-001	Green Infrastructure: Enhance natural floodplains and wetlands to buffer against storm surges	Capital Improvements	Reduces exposure by using natural landscapes to absorb and divert floodwaters, protecting infrastructure and communities	5-7 years, to account for the restoration and enhancement of natural areas	Department of Environmental Protection in partnership with local environmental NGOs and community organizations	$$$ - $$$$, depending on the scale of the projects and the need for land acquisition or restoration efforts
FCIACF-002	Fortify water treatment facilities and hospitals with floodwalls and elevate critical systems	Capital Improvements	Protects sensitive assets by physically shielding them from floodwaters and ensuring they remain operational during and after flood events	3-5 years, for the planning, design, and construction of floodwalls and elevation projects	Department of Public Works and Health Department, with engineering firms specializing in flood mitigation	$$$$ - $$$$$, given the critical nature of the infrastructure and the complexity of the engineering solutions required
FCIACF-003	Create redundancy in essential services (such as alternative water sources) to ensure continuity during disruptions	Planning and Management	Increases adaptive capacity by ensuring essential services can continue without interruption, even if primary systems fail	4-6 years, to develop and implement alternative systems and ensure they are integrated with existing infrastructure	Multiple departments (such as Water, Health, Energy) in coordination with state and federal emergency management agencies	$$$ - $$$$, depending on the extent of the redundancies created and the technologies employed
FCIACF-004	Update building codes and standards for critical infrastructure to meet higher resilience benchmarks	Policy, Codes, and Standards	Protects sensitive assets by ensuring new and retrofitted infrastructure is built to withstand flood events, reducing both exposure and susceptibility	1-2 years for the development and adoption of new codes, with ongoing implementation as buildings are constructed or retrofitted	Department of Building Inspection in collaboration with environmental and infrastructure experts, as well as local and state legislators	$$ - $$$ for the development and enforcement of new codes; however, costs to infrastructure owners could be significant depending on the required upgrades

Resilience Objective 3: **Promote Equitable Flood Preparedness and Recovery**

Option ID	Option	Action	How is Vulnerability Reduced?	Timescale	Lead Department, Agency, or Partners	Costs
PEFPR-001	Establish community centers as hubs for resources and information on flood resilience and recovery	Community Resources	Increases adaptive capacity by providing a centralized location for education, resources, and support, especially for vulnerable populations	1-2 years for establishment and operational setup	Department of Community Services in partnership with local NGOs, faith-based organizations, and community groups	$$ - $$$, depending on the scale of the centers and the range of services offered
PEFPR-002	Collaborate with NGOs and community organizations to reach and support vulnerable populations effectively	Partnerships and Collaboration	Protects sensitive assets and reduces social vulnerabilities by ensuring targeted outreach and support services are available to those most in need	Ongoing collaboration, with specific programs and initiatives developed within 6-12 months	Office of Emergency Management, Department of Social Services, in collaboration with a wide range of NGOs and community organizations focused on social equity and disaster resilience	$ - $$, leveraging existing resources and partnerships to minimize costs
PEFPR-003	Develop inclusive, accessible information campaigns on flood risks and preparedness, emphasizing resources available for vulnerable groups	Public Education and Outreach	Increases adaptive capacity by ensuring all community members, especially vulnerable populations, are informed about flood risks and preparedness strategies	6-12 months for the development and launch of initial campaigns, with ongoing updates and outreach efforts	Department of Public Information, Office of Emergency Management, community organizations, and local media outlets	$ - $$, depending on the scope of the campaigns and the variety of outreach methods used

Resilience Objective 4: **Preserve Environmental Values Through Sustainable Management**

Option ID	Option	Action	How is Vulnerability Reduced?	Timescale	Lead Department, Agency, or Partners	Costs
PEVTSM-001	Implement zoning regulations that restrict development in flood-prone areas and promote conservation	Land Use, Land Conservation, and Zoning	Reduces exposure by preventing new development in high-risk areas, thereby protecting both human and natural communities	2-3 years for the development, adoption, and implementation of new zoning regulations	Department of City Planning collaboration with environmental agencies, community organizations, and the general public	$ - $$, primarily associated with the planning process and public outreach efforts
PEVTSM-002	Invest in urban green spaces, rain gardens, and restoration of natural floodplains to manage stormwater and preserve ecosystems	Land Use, Land Conservation, and Zoning	Reduces exposure and enhances the community's adaptive capacity by utilizing natural and semi-natural systems to manage flood risks and enhance biodiversity	3-5 years for significant projects, with ongoing smaller projects and maintenance	Department of Environmental Protection partnership with local parks departments, environmental NGOs, and community volunteer groups	$$$ - $$$$, depending on the scale and scope of the green infrastructure projects implemented
PEVTSM-003	Integrate environmental considerations into urban and regional planning efforts to ensure sustainable growth and conservation	Planning and Management	Increases adaptive capacity and protects sensitive assets by ensuring development is guided by principles of sustainability and resilience, taking into account long-term environmental health and climate change impacts	Ongoing, with policies and frameworks developed within 1-2 years and continuous integration thereafter	Department of City Planning, collaboration with environmental agencies, the Department of Economic Development, and community stakeholders	$ - $$ for the development of policies and integration frameworks, with potential higher costs depending on specific initiatives undertaken as part of this holistic planning approach

Resilience Objective 5: **Foster Community and Organizational Resilience**

Option ID	Option	Action	How is Vulnerability Reduced?	Timescale	Lead Department, Agency, or Partners	Costs
FCOR-001	Community Resources: Strengthen local organizations and community groups through funding and training to support resilience-building activities	Capacity Building	Increases adaptive capacity by empowering local organizations and community groups with the resources and knowledge they need to support resilience efforts	1-2 years for initial setup and ongoing support	Department of Community Services, in partnership with local NGOs and community-based organizations	$$ - $$$, depending on the extent of the funding and training programs
FCOR-002	Staff Capacity: Train city staff and stakeholders in resilience planning and implementation techniques	Capacity Building	Protects sensitive assets and increases adaptive capacity by enhancing the knowledge and skills of city staff and key stakeholders involved in resilience planning	6-12 months for development and rollout of training programs, with ongoing updates and refresher courses	Office of Resilience and Emergency Management, collaboration with academic institutions and professional development organizations	$ - $$, for the creation and delivery of training materials and workshops
FCOR-003	Foster multi-sector partnerships to leverage resources, expertise, and networks for resilience building	Partnerships and Collaboration	Increases adaptive capacity by pooling resources, expertise, and networks across sectors to address complex resilience challenges in a holistic manner	Ongoing, with formal partnerships established within 1-2 years	Office of the Mayor, collaboration with private sector partners, NGOs, academic institutions, and community organizations	$ - $$, primarily related to coordination and partnership development efforts
FCOR-004	Develop a city-wide resilience strategy that includes stakeholder engagement, risk assessments, and adaptive management practices	Planning and Management	Increases adaptive capacity by creating a comprehensive strategy that identifies risks, sets priorities, and outlines actionable steps for building resilience across the community	2-3 years for strategy development and initial implementation, with ongoing adaptation	Office of Resilience, collaboration with all city departments, external stakeholders, and the community	$$$ - $$$$, for comprehensive planning, engagement processes, and implementation of strategic priorities
FCOR-005	Engage the community (workshops, forums, and digital platforms) to increase awareness and participation in resilience efforts	Public Education and Outreach	Increases adaptive capacity by raising awareness among community members and encouraging active participation in resilience-building activities	Ongoing, with initial outreach efforts starting within 3-6 months	Department of Public Information, Office of Resilience, community organizations, and local media	$ - $$, for the development and delivery of outreach and engagement initiatives

Prioritize and Plan

Given the findings from the vulnerability and risk assessment, the Nautilus planning team prioritized resilience strategies and developed a detailed implementation plan based on the guidance provided.

Practitioner's Guide Resources: 5.1 Criteria for Evaluating Options - Worksheet and 5.2 Community Options Prioritization Table - Worksheet

		CRITERIA					
		Reduction of vulnerability and risk		Ability to implement			
ID	Strategy	Co-Benefits?	Meet social equity goals?	Staff capacity?	Political will?	Funding available (now or future)?	Long-Term Sustainability
	Conduct vulnerability assessments to identify business areas most at risk and determine the most effective resilience measures	😁	😁	😕	😕	😕	😁
	Implement flood warning systems and invest in flood-resistant technologies for businesses	😁	😕	😕	😁	😕	😁
	Install permeable pavement and green roofs to reduce runoff and absorb rainwater	😁	😕	😕	😁	😕	😁
	Elevate buildings and infrastructure, and construct sea walls and flood barriers around commercial districts	😁	😕	😕	😁	😕	😁
	Offer grants and low-interest loans for businesses to invest in flood resilience measures	😁	😕	😁	😁	😕	😁
	Develop and rehearse flood emergency response plans specific to the commercial sector	😁	😁	😕	😁	😁	😁
	Workshops and materials on flood preparedness tailored for business owners and employees	😁	😁	😁	😁	😁	😁

		CRITERIA					
		Reduction of vulnerability and risk		Ability to implement			
ID	Strategy	Co-Benefits?	Meet social equity goals?	Staff capacity?	Political will?	Funding available (now or future)?	Long-Term Sustainability
	Enhance natural floodplains and wetlands to buffer against storm surges	😁	😁	😕	😁	😕	😁
	Fortify water treatment facilities and hospitals with floodwalls and elevate critical systems	😁	😕	😕	😁	😕	😁
	Create redundancy in essential services (e.g., alternative water sources) to ensure continuity during disruptions	😁	😁	😕	😁	😕	😁
	Update building codes and standards for critical infrastructure to meet higher resilience benchmarks	😁	😁	😁	😁	😁	😁
	Establish community centers as hubs for resources and information on flood resilience and recovery	😁	😁	😕	😁	😕	😁
	Collaborate with ngos and community organizations to reach and support vulnerable populations effectively	😁	😁	😁	😁	😁	😁
	Develop inclusive, accessible information campaigns on flood risks and preparedness, emphasizing resources available for vulnerable groups	😁	😁	😁	😁	😁	😁
	Implement zoning regulations that restrict development in flood-prone areas and promote conservation	😁	😕	😕	😕	😁	😁
	Invest in urban green spaces, rain gardens, and restoration of natural floodplains to manage stormwater and preserve ecosystems	😁	😁	😕	😁	😕	😁

ID	Strategy	CRITERIA					
		Reduction of vulnerability and risk		Ability to implement			
		Co-Benefits?	Meet social equity goals?	Staff capacity?	Political will?	Funding available (now or future)?	Long-Term Sustainability
	Integrate environmental considerations into urban and regional planning efforts to ensure sustainable growth and conservation	😁	😁	😁	😁	😁	😁
	Strengthen local organizations and community groups through funding and training to support resilience-building activities	😁	😁	😁	😁	😕	😁
	Train city staff and stakeholders in resilience planning and implementation techniques	😁	😁	😁	😁	😁	😁
	Foster multi-sector partnerships to leverage resources, expertise, and networks for resilience building	😁	😁	😁	😁	😁	😁
	Develop a city-wide resilience strategy that includes stakeholder engagement, risk assessments, and adaptive management practices	😁	😁	😕	😁	😕	😁
	Engage the community through workshops, forums, and digital platforms to increase awareness and participation in resilience efforts	😁	😁	😁	😁	😁	😁

Resilience Plan Outline for the City of Nautilus

Practitioner's Guide Resource: 5.8 Resilience Plan Outline and Guiding Questions - Guidance

Background Information - The Why?

- The City of Nautilus is a coastal community facing increasing threats from climate change, including sea-level rise, storm surges, flooding, and wildfires.
- These hazards pose significant risks to the city's beaches, residential areas, critical infrastructure, economy, and natural environment.
- The city aims to develop a fundable, comprehensive resilience plan to adapt to these challenges and ensure the long-term well-being of its residents and environment.

Who Was Involved?

- **City Council:** Engaged with the community and experts to develop the plan.
- **Nautilus Chamber of Commerce:** Represented the interests of local businesses.
- **Local Environmental NGOs:** Provided expertise on environmental impacts and solutions.
- **Nautilus College:** Conducted climate studies and offered technical assistance.
- **Nautilus Residents:** Participated in workshops and provided valuable input.

Visions, Values, and Goals

- **Vision:** To build a resilient community that can adapt to changing realities and remain a great place to live and work.
- **Values:** Beaches, recreation, local businesses, citizens, natural systems, and a vibrant economy.
- **Goals:**
    - Protect the health, safety, and welfare of residents.
    - Prevent disruption of key community services.
    - Preserve environmental value.
    - Build community capacity for collaboration.

Science - Hazards Chosen for Risk Assessment

- **Coastal Flooding:** Due to sea-level rise and storm surges, threatening infrastructure, businesses, and homes.
- **Flooding (Rainfall-Induced):** Increased precipitation and inadequate drainage pose risks to inland areas.
- **Extreme Heat:** Rising temperatures threaten vulnerable populations and increase energy demands.
- **Wildfires:** Drought conditions and forest management practices increase the risk of wildfires in the West Nautilus State Forest.

Prioritized Actions

- **Enhance Flood Resilience of Commercial Districts:**
    - Conduct vulnerability assessments.

    - Implement flood warning systems and resistant technologies.
    - Invest in green and gray infrastructure solutions (permeable pavements, seawalls).
    - Offer financial incentives for businesses to adapt.
    - Develop and rehearse emergency response plans.
    - Provide public education and outreach.
- **Fortify Critical Infrastructure Against Coastal Flooding:**
    - Enhance natural floodplains and wetlands.
    - Construct floodwalls and elevate critical systems in hospitals and water treatment facilities.
    - Create redundancy in essential services.
    - Update building codes and standards.
- **Promote Equitable Flood Preparedness and Recovery:**
    - Establish community resource centers.
    - Collaborate with NGOs to support vulnerable populations.
    - Develop inclusive information campaigns.
- **Preserve Environmental Values Through Sustainable Management:**
    - Implement zoning regulations to restrict development in flood-prone areas.
    - Invest in green spaces and restore natural floodplains.
    - Integrate environmental considerations into urban planning.
- **Foster Community and Organizational Resilience:**
    - Strengthen local organizations through funding and training.
    - Train city staff in resilience planning.
    - Foster multi-sector partnerships.
    - Develop a city-wide resilience strategy.
    - Engage the community through workshops and digital platforms.

Funding and Finance Options

- **Grants:** Seek federal, state, and foundation grants for resilience projects.
- **Low-Interest Loans:** Offer loans to businesses and homeowners for flood resilience measures.
- **Public-Private Partnerships:** Collaborate with private sector entities to share costs and expertise.
- **Budget Allocations:** Dedicate a portion of the city budget to resilience initiatives.

Accountability and Transparency

- **Regular Monitoring and Reporting:** Track progress on resilience actions and report to the public.
- **Community Feedback Mechanisms:** Establish channels for community input and feedback.
- **Independent Evaluation:** Periodically assess the effectiveness of the resilience plan.
- **Adaptive Management:** Adjust the plan based on monitoring results and community feedback.

Take Action

After planning, it was crucial for the Government Champion and Planning Team to implement, monitor, and iterate based on the identified actions (see the Resilience Plan) taken.

Implement: The responsible teams began executing prioritized projects, starting with those that addressed the most urgent risks and had broad community support. The team ensured ongoing communication with stakeholders helping to keep the community informed and engaged.

Monitoring and Evaluation: The responsible teams established indicators of success and implemented a monitoring plan to track progress against these metrics. This effort helped with assessing the effectiveness of implemented actions and identifying areas for improvement.

Iterative Adaptation: The teams are planning to use the data collected through monitoring to inform future actions. This will help in case strategies need adjusting due to new information, changing conditions, or unforeseen challenges. This iterative process is key to building and maintaining resilience in the face of uncertainty.

Community Engagement: The Planning Team stressed that continuous involvement of the community and stakeholders in the implementation and evaluation process was key to the success of accomplishing the identified actions. The community's input and support are essential for the long-term success of resilience efforts.

Communications Plan for Nautilus Resilience Plan

Practitioner's Guide Resource: 6.1 Communications Plan - Guidance

Community Name: City of Nautilus

Intended Audiences

- **Residents:** General public, specific neighborhoods (The Enclave, Water's Edge), vulnerable populations (elderly, low-income, non-English speakers).
- **Businesses:** Downtown commercial district, tourism sector, industries affected by wildfires.
- **Community Organizations:** NGOs, faith-based groups, neighborhood associations.
- **City Officials and Staff:** Ensure understanding and buy-in for the plan.

Participating Entities: City Council, Nautilus Chamber of Commerce, Local Environmental NGOs, Nautilus College, and the Nautilus residents.

Focal Community Assets: Beaches, Residential Areas, Critical Infrastructure (e.g., Water Treatment Facility), and the State Nature Reserve.

Primary Climate Hazards: Sea-level rise, increased frequency of storm surges, and beach erosion.

Identified Vulnerabilities: Increased risk of flooding affecting residential areas, critical infrastructure, and economic activities; loss of biodiversity and recreational spaces.

Adaptation Plan Overview:
An adaptation plan was developed to mitigate the identified climate risks, focusing on constructing seawalls and implementing wetland restoration projects. These actions aim to reduce the vulnerability of the City of Nautilus to flooding and beach erosion while preserving the natural and recreational value of the area.

Link to Full Plan: City of Nautilus Adaptation Plan

Actions and Metrics for Effectiveness:

- Action: Construct sea walls along vulnerable coastlines.
    - Metric: Reduction in instances of flooding and property damage during storm surges, measured by local government staff.
- Action: Implement wetland restoration projects adjacent to sea walls.
    - Metric: Increase in biodiversity indices and improvement in water quality, monitored by environmental NGOs and reported quarterly.

Monitoring Frequency and Communication Channels
Metrics will be monitored quarterly and shared through the city's official website, newsletters, and social media platforms. Special community forums will also be held bi-annually to present progress, gather feedback, and discuss potential adjustments to the adaptation actions.

Engagement and Modification Process
Monitoring results will be reviewed in collaboration with the initial planning participants and the broader community. This collaborative review process may lead to the modification of adaptation actions to enhance their effectiveness or address emerging challenges. Additional stakeholders identified during the implementation and monitoring phases will also be consulted to ensure a comprehensive and inclusive approach to adapting to climate change.

Communication and Engagement Goals
The primary goal of this communication plan is to keep the Nautilus community informed and engaged in the climate adaptation process. By sharing regular updates and metrics, the plan aims to build a sense of ownership and participation among residents, fostering a community-wide commitment to resilience against climate change. The ultimate objective is to ensure that Nautilus becomes a more resilient, informed, and proactive community in the face of climate-related challenges.