PUERTO RICO
PLANNING BOARD
GOVERNMENT OF PUERTO RICO

2026

LOCAL HAZARD MITIGATION PLAN

Municipality of Añasco

LOCAL HAZARD MITIGATION PLANS

Protect Through Planning

PROFESSIONAL LICENSED PLANNER CERTIFICATION

As per Act 160-1996 as amended (20 L.P.R.A § 3501 - 20 L.P.R.A § 3515), I _____, who bears Puerto Rico professional planning license number___, certify that this document has been prepared using the best available sources and is in accordance with the best practices of the planning profession as of _____, 2026. And I certify this herewith my professional seal.

FEMA Approval

This Local Hazard Mitigation Plan for the Municipality of Añasco was approved by FEMA on

_____

Statement of Funding

This Local Hazard Mitigation Plan was prepared for the Municipality of Añasco and the Puerto Rico Planning Board by the consulting firm AtkinsRéalis Caribe, LLP as per the stipulations of contract number 2026-000032 and any amendment thereof, duly registered in Puerto Rico's Office of the Comptroller.

Language Requirement

In Accordance with Presidential Executive Order #14224, the 2026 version of the Añasco Local Hazard Mitigation Plan has been prepared in English for submission and consideration of FEMA.

A non-certified translation of the final draft for public discussion and the final approved LHMP to Spanish was prepared for the benefit of the population that is not English proficient.

Should any discrepancy arise between the English and the Spanish text, the English one shall prevail.

Statement on maps

The maps presented on this document are related to a planning exercise. It is not the intention of these maps to establish any regulatory requirement, procedure or benefit.

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List of Commonly Used Acronyms

ABFE	Advisory Base Flood Elevation
ACS	American Community Survey
AMMED	Municipal Agency for Disaster and Emergency Management, by its Spanish Acronym
BLE	Base Flood Engineering
BRIC	Building Resilient Infrastructure and Communities
CDBG-DR	Community Development Block Grant - Disaster Recovery
CDBG-MIT	Community Development Block Grant - Mitigation
CEACC	Comité de Expertos y Asesores sobre Cambio Climático
COR3	Central Office for Recovery, Reconstruction and Resiliency
DHS	Department of Homeland Security
DNER	Department of Natural and Environmental Resources
DPS	Department of Public Safety
DTPW	Department of Transportation and Public Works
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
GIS	Geographic Information System
HAZUS	
HMGP	Hazard Mitigation Grant Program
HUD	U.S. Department of Housing and Urban Development
ICS	
IFRC	International Federation of the Red Cross
IRRM	Interim Risk Reduction Measures
LHMP	Local Hazard Mitigation Plan
LUMA	Luma Energy
MHHW	Mean Higher High Water
mph	Miles per hour
NDRF	National Disaster Recovery Framework
NIMS	National Incident Management System
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NTHMP	National Tsunami Hazard Mitigation Program
OMME	Municipal Emergency Management Office
OPM	Municipal Public Works, by is Spanish acronym
PRASA	Puerto Rico Aqueduct and Sewers Authority

PREMB	Puerto Rico Emergency Management Bureau
PREPA	Puerto Rico Electric Power Authority
PRHTA	Puerto Rico Highway and Transportation Authority
PRPB	Puerto Rico Planning Board
PRSN	Puerto Rico Seismic Network
PT	Territorial Plan, by its Spanish acronym
PUT-PR	Puerto Rico Land Use Plan, by its Spanish acronym
SHMO	State Hazard Mitigation Officer
SFLA	Southern Federal Land Assessment
UHI	Extreme Heat Island
USACE	United States Army Corps of Engineers
USDOT	United States Department of Transportation
USGS	United States Geological Survey
VSL	Value of Statistical Life
WUI	Wildland-Urban Interface

Executive Summary

Introduction and Background

This document constitutes the 2026 update of the Local Hazard Mitigation Plan (LHMP) for the Municipality of Añasco, Puerto Rico. The plan was prepared to identify natural hazards affecting the municipality, evaluate associated risks and vulnerabilities, and establish mitigation strategies that reduce future losses while enhancing community resilience. Maintaining a FEMA-approved LHMP allows the municipality to remain eligible for a variety of federal hazard mitigation funding programs.
The primary objectives of this plan are to:

- Identify and evaluate natural hazards affecting the municipality.
- Reduce risks to life, property, critical infrastructure, and essential services.
- Strengthen coordination among government agencies, stakeholders, and the public.
- Support risk-informed land use and development decisions.
- Increase community resilience through mitigation investments and preparedness actions.

Planning Process

The LHMP was developed through a collaborative planning process involving municipal officials, the Puerto Rico Planning Board, stakeholders, community organizations, and residents. The process included the formation of a Planning Committee, stakeholder outreach, public participation activities, hazard identification and risk analysis, capability assessment, and development of mitigation strategies. FEMA Community Lifelines were incorporated throughout the planning process to evaluate potential impacts on critical services and infrastructure.

Municipal Profile

Geography

Añasco is located on the western coast of Puerto Rico and encompasses approximately 39.6 square miles (102.55 km²). The municipality is divided into twenty-three barrios and includes a diverse landscape characterized by coastal lowlands, river valleys, and mountainous terrain. The Río Grande de Añasco watershed is the

municipality's dominant hydrologic feature and plays a significant role in local flood and drought conditions.

Demographics

According to the 2020-2024 American Community Survey (ACS), Añasco has an estimated population of 25,094 residents. The municipality continues to experience population decline while exhibiting an aging demographic profile.
Key demographic indicators include:

- Population: 25,094
- Residents age 65 or older: 5,876 (23.42%)
- Residents age 19 or younger: 4,372 (17.42%)
- Population considered vulnerable based on age: 10,248 residents (40.83%)

Socioeconomic Conditions

Socioeconomic conditions play an important role in disaster vulnerability and recovery capacity.
Key indicators include:

- Labor force participation rate: 46.5%
- Unemployment rate: 6.1%
- Population below the poverty level: 40.4%
- Median household income: $24,436
- Households receiving food assistance: 56.3%

These indicators suggest that a substantial portion of the population may face challenges in preparing for, responding to, and recovering from natural disasters.

Housing

The municipality contains approximately 12,640 housing units, of which 24.7% are vacant. Approximately 96.7% of the housing stock was built before adoption of the most recent building code standards, increasing vulnerability to earthquakes, hurricanes, and flooding.

Critical Infrastructure

Critical infrastructure was evaluated using FEMA Community Lifelines, including:

- Safety and Security
- Food, Hydration, and Shelter

- Health and Medical
- Energy
- Communications
- Transportation
- Hazardous Materials
- Water Systems

These facilities were mapped and assessed to determine hazard exposure and service disruption potential.

Hazard Assessment Summary

The 2026 LHMP evaluates the following hazards:

- Earthquake
- Landslide
- Tsunami
- Flooding
- Tropical Cyclones and Extreme Winds
- Storm Surge
- Extreme Heat
- Drought
- Wildfire
- Long-Term Coastal Dynamics
- High Hazard Potential Dams
- Pandemic/Epidemic

Earthquake

Due to Puerto Rico's tectonic setting, earthquakes represent one of Añasco's most significant natural hazards. The entire municipality is exposed to earthquake impacts, including ground shaking and liquefaction susceptibility in coastal and alluvial areas. FEMA National Risk Index data indicate an estimated annualized earthquake loss exceeding $5.5 million.

Landslides

Landslide susceptibility is greatest within the municipality's mountainous northern, eastern, and southeastern sectors, including portions of Corcovada, Humatas, Río Arriba, Casey Arriba, and Casey Abajo. Heavy rainfall events remain the primary

trigger of slope failures. Hurricane María demonstrated the municipality's vulnerability to widespread landslide activity and associated transportation disruptions.

Tsunami

Tsunami hazards are concentrated along the municipality's coastal areas, particularly Playa, Añasco Abajo, and portions of Añasco Arriba. Añasco maintains TsunamiReady certification and continues to support evacuation planning, public education, warning systems, and designated assembly areas.

Flooding

Flooding remains one of the most significant hazards affecting Añasco due to its extensive floodplains and coastal lowlands associated with the Río Grande de Añasco watershed.
Estimated flood exposure includes:

- $439.7 million in exposed building value
- Approximately 3,639 exposed residents
- Extensive impacts to developed areas within Playa, Añasco Abajo, Añasco Arriba, Barrio Pueblo, Carreras, and Espino.

Añasco participates in the National Flood Insurance Program (NFIP).

Tropical Cyclones and Extreme Winds

Tropical cyclones are among the most frequent and damaging hazards affecting Añasco. Historical events such as Hurricanes Hugo, Georges, Irma, María, Fiona, and Tropical Storm Ernesto have demonstrated the municipality's vulnerability to strong winds, flooding, infrastructure damage, and prolonged service interruptions. The entire municipality is exposed to hurricane-related impacts.

Storm Surge

Storm surge risk is concentrated within the municipality's low-lying coastal areas, including Playa, Añasco Abajo, and portions of Añasco Arriba. The extent and depth of inundation increase significantly under higher hurricane intensity scenarios. Critical facilities, transportation networks, and residential areas located within the coastal plain remain vulnerable to storm surge impacts.

Extreme Heat

Extreme heat is an emerging hazard influenced by increasing temperatures and changing climate conditions. Vulnerable populations include older adults, individuals with chronic medical conditions, outdoor workers, and socially vulnerable populations. Future climate trends indicate increasing exposure to heat-related impacts.

Drought

Drought remains a recurring hazard that can affect water resources, agriculture, natural ecosystems, and municipal operations. Because Añasco relies on watershed systems extending beyond municipal boundaries, drought conditions elsewhere within the watershed may affect local water supplies and water availability.

Wildfire

Although wildfire occurrence is lower than in southern Puerto Rico, Añasco contains areas with moderate to high wildfire susceptibility. Drought conditions, vegetation stress, and human activities may contribute to future wildfire occurrence in susceptible areas.

Long-Term Coastal Dynamics

Añasco's coastline experiences ongoing coastal change influenced by erosion, accretion, sediment transport, storms, and sea-level rise. Post-Hurricane María studies documented measurable shoreline change along portions of the municipality's beaches. These processes pose long-term risks to coastal infrastructure, natural resources, recreational assets, and future development.

High Hazard Potential Dams

The municipality contains two High Hazard Potential Dams:

- Ajíes Dam (PR00072)
- Dagüey Dam (PR00073)

Dam breach modeling indicates potential inundation impacts extending through portions of Añasco Abajo, Playa, Hatillo, Piñales, Carreras, Espino, and adjacent floodplain areas. Critical infrastructure, residential populations, and recent development are located within mapped dam breach impact areas.

Upstream in the tributaries of the Grande de Añasco River are two dams that if breach could create flooding downstream (Prieto and Guayo dams.)

Pandemic and Epidemic

Pandemic and epidemic hazards affect the entire municipal territory. Recent experiences with COVID-19 highlighted the importance of healthcare capacity, continuity of operations, emergency communications, and public health preparedness.

Hazard Prioritization

Based on risk assessment results, historical impacts, and Planning Committee input, the municipality identified the following hazard priorities:

- **High Priority**
- Earthquake
- Landslides
- Flooding
- Tropical Cyclones and Extreme Winds
- **Medium Priority**
- Tsunami
- Storm Surge
- Drought
- **Lower Priority**
- Extreme Heat
- Wildfire
- Long-Term Coastal Dynamics
- Pandemic/Epidemic

Mitigation Strategy

The Mitigation Action Plan includes strategies organized into six categories:

- Prevention
- Property Protection
- Natural Resource Protection
- Structural Improvements
- Emergency Services
- Education and Outreach

These strategies focus on reducing hazard exposure, protecting critical infrastructure, improving emergency preparedness and response capabilities, strengthening natural systems, and increasing public awareness and resilience.

Conclusion

The 2026 Añasco Local Hazard Mitigation Plan provides a comprehensive framework for reducing disaster risk, protecting critical facilities and infrastructure, preserving natural resources, and improving community resilience. Through continued coordination among municipal agencies, stakeholders, and residents, the municipality will pursue mitigation actions designed to reduce future losses, enhance preparedness, and strengthen Añasco's ability to withstand, respond to, and recover from natural hazards.

1. Introduction and Background

The Municipality of Añasco and the Puerto Rico Planning Board (PRPB) are dedicated to protecting the well-being of Puerto Ricans by fostering cultural, social, and economic growth while prioritizing public health and safety. In this effort, the Municipality and the PRPB have agreed on a joint effort to update the Municipality's Local Hazard Mitigation Plan (LHMP). The LHMP provides a structured and comprehensive approach to reducing risks associated with natural hazards and strengthening overall community resilience. In recent years, Añasco has faced considerable impacts from natural disasters, emphasizing the urgent need for proactive actions to reduce vulnerabilities and safeguard critical infrastructure. These experiences highlight the importance of implementing a coordinated and systematic hazard mitigation strategy that is consistent with federal, state, and local policies.

An LHMP identifies and evaluates potential natural hazards and defines actions designed to reduce or eliminate risks to people, property, and the environment. The plan supports the municipality's land use planning efforts by establishing measures that assist Añasco in achieving its long-term sustainability and resilience objectives.

This LHMP complies with the requirements set forth by the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) and the federal regulations derived from it. Under this legislation, local governments in states and territories are required to develop and formally adopt a hazard mitigation plan as a condition for eligibility to receive certain types of funding administered by the Federal Emergency Management Agency (FEMA).

Risk mitigation plays a critical role in guiding future development and enhancing existing municipal infrastructure. To ensure an effective mitigation strategy, the LHMP is regularly updated to reassess natural hazards that may threaten the lives and property of residents and to incorporate appropriate and responsive mitigation measures.

This document represents the second revision of the LHMP for the Municipality of Añasco. The original plan received FEMA approval in 2006, followed by the first update in 2013, and a second revision in July 2020. This 2026 update reflects evolving conditions and circumstances that have influenced the municipality over the past five years and incorporates newly enacted laws, programs, and regulatory requirements.

Through this update, Añasco aims to preserve its eligibility for federal mitigation funding prior to future catastrophic events and to present a strengthened plan aligned with current standards and best practices.

The development of this plan was conducted through a coordinated process that incorporated input from state and local agencies, non-governmental organizations, and the public. The overarching goal is to enhance the municipality's capacity to anticipate, reduce, and effectively respond to natural hazards that may affect its jurisdiction.

1.1 Applicable Public Policies

This section outlines the relevant federal and state public policies that guide the development of the 2026 Añasco LHMP. The overview provided is not intended to be comprehensive. Additional public policies are referenced throughout the document, particularly in Section 5.1.

1.1.1 Federal Policies

1.1.1.1 Federal Laws

Stafford Act and Disaster Mitigation Act of 2000

The Stafford Act is primarily aimed at reducing loss of life and property, alleviating human suffering, minimizing economic impacts, and lowering the costs associated with disaster assistance. In 1988, Congress amended the Act to create the Hazard Mitigation Grant Program (HMGP), which became the principal source of federal mitigation funding following a disaster declaration by the President of the United States. Through this program, funds are made available to states and territories to implement cost-effective measures that reduce the risk of damage and losses from future hazard events.

Disaster Mitigation Act of 2000

Enacted on October 30, 2000, the Disaster Mitigation Act of 2000 (DMA 2000) further amended the Stafford Act to enhance disaster planning, response, and recovery at all levels of government. This legislation establishes eligibility requirements for municipalities to access federal mitigation funding, including the preparation and

adoption of a Local Hazard Mitigation Plan (LHMP). An LHMP demonstrates a jurisdiction commitment to reducing risks associated with natural hazards and serves as a decision-making tool for implementing preventive and mitigation actions. It also provides a framework for the State to deliver technical assistance and establish funding priorities.

In accordance with DMA 2000 requirements, this LHMP is comprehensive and coordinated, incorporating the participation of state, local, and regional agencies, non-governmental organizations, and members of the public.

National Flood Insurance Act

The National Flood Insurance Act established the National Flood Insurance Program (NFIP) to provide affordable flood insurance coverage to homeowners, businesses, and renters located in flood-prone areas. The program was designed to reduce the financial burden on individuals and the federal government in the aftermath of flood-related disasters.

The Act also encourages participating communities to adopt and enforce minimum floodplain management standards aimed at reducing future flood risks. Communities that comply with these requirements become eligible for NFIP benefits and programs.

Access to flood insurance enables property owners to recover more rapidly following flood events without relying solely on federal disaster assistance. Supporting legislation, such as the Flood Disaster Protection Act of 1973, further requires federally regulated lenders to mandate flood insurance coverage for properties located in high-risk flood zones and financed through federally backed mortgages.

The Federal Emergency Management Agency (FEMA) has recognized the Municipality as part of the region that is within the PRPB's coverage within the National Flood Insurance Program. The municipality can request updates and amendments to flood hazard maps utilized by the NFIP through the PRPB.

Additionally, through participation in the Flood Mitigation Assistance Program, the municipality has identified specific mitigation strategies to reduce flood-related risks. Funding has also been allocated for the acquisition of structures located in high-risk flood areas as part of ongoing efforts to decrease vulnerability and exposure to future flood events.

1.1.1.2 Federal Regulations

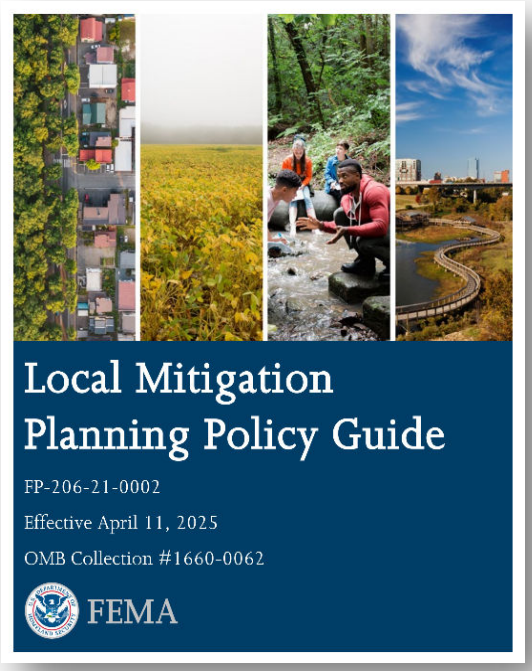
Mitigation Planning - 44 CFR Part 201

This section of the Code of Federal Regulations describes the rules and procedures governing hazard mitigation planning as mandated under the Stafford Act. It outlines the requirements for the preparation and adoption of mitigation plans, which serve as the primary tool for reducing risks posed by natural hazards at the local level. Additionally, this section establishes the policies and planning processes that guide hazard mitigation efforts, underscoring the role of mitigation plans in directing the effective allocation of resources for disaster risk reduction.

FEMA Local Hazard Mitigation Planning Guide

The Local Hazard Mitigation Planning Policy Guide published by FEMA establishes the official framework and guidance that local governments are required to follow when preparing, reviewing, and updating their Local Hazard Mitigation Plans (LHMPs). This guidance is designed to ensure compliance with the requirements set forth in the Code of Federal Regulations (44 CFR Part 201).

Figure 1: Cover of FEMA's Local Mitigation Planning Policy Guide



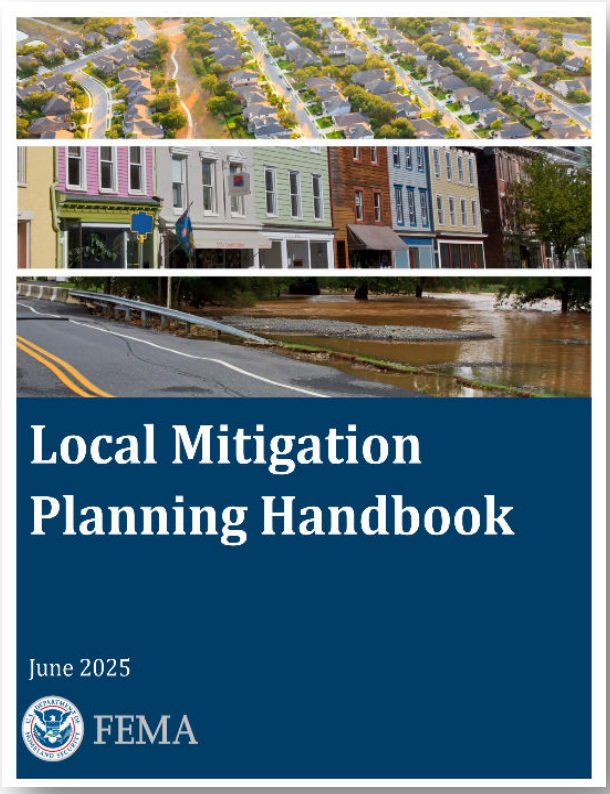
The policy guide emphasizes data-driven planning tailored to local capacities, while prioritizing equity and inclusive stakeholder participation. It encourages communities to integrate hazard mitigation into broader planning and decision-making processes, thereby strengthening long-term resilience and reducing vulnerability to natural hazards (FEMA, Local Mitigation Planning Policy Guide, 2025).

The guide identifies the essential components that every mitigation plan is required to address. In addition, it provides practical resources such as resolution templates, checklists, and plan review criteria to support local governments throughout the planning process. The guide also explains FEMA's plan review and approval process, which may result in full approval, conditional approval pending formal adoption, or

return of the plan for revisions and corrections.

Local Mitigation Planning Handbook

Figure 2: Cover of FEMA's Local Mitigation Planning Handbook



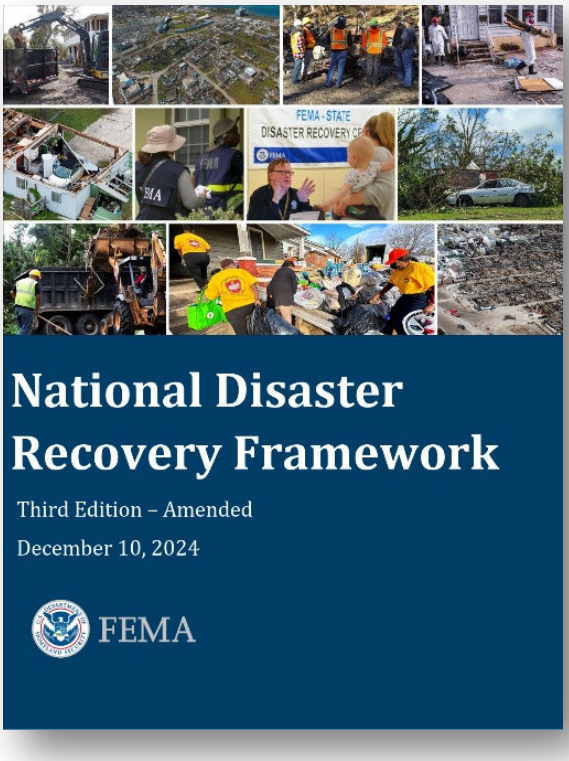
The *Local Mitigation Planning Handbook* is an operational resource developed by FEMA to assist local governments, including municipalities and special districts, in the development or update of their Local Hazard Mitigation Plans. This handbook serves as a companion to FEMA's mitigation planning policy guidance and offers a detailed, step-by-step methodology for complying with the requirements outlined in Title 44 of the Code of Federal Regulations, Part 201.

The primary purpose of the handbook is to support communities in identifying the natural hazards they face, evaluating institutional and administrative capabilities, and formulating effective strategies to reduce disaster-related impacts (FEMA, 2025). Ultimately, the handbook promotes the creation of safer and more resilient communities that are better prepared to anticipate, withstand, and recover from adverse events.

National Disaster Recovery Framework

The National Disaster Recovery Framework (NDRF) is a guide created by FEMA in the United States that establishes how recovery should be organized and coordinated after a disaster. Its main objective is to help affected communities rebuild in a stronger, more equitable, and more resilient way, involving all levels of government—local, state, tribal, territorial, and federal—along with private and community organizations.

Figure 3: National Disaster Recovery Framework Cover



This framework promotes recovery that not only restores what was lost but also improves pre-disaster conditions. To achieve this, the NDRF defines guiding principles, specific roles for the actors involved, and coordination structures that facilitate collaboration among agencies. It also emphasizes the importance of planning before a disaster occurs and ensuring that recovery goals are defined by the affected communities themselves.

National Flood Insurance Program

The National Flood Insurance Program (NFIP), administered by FEMA, provides affordable flood insurance coverage to property owners, renters, and businesses while encouraging effective floodplain management practices to reduce future flood risks. Established in 1968, the NFIP supports communities in minimizing flood-related losses by requiring the adoption and enforcement of local floodplain management regulations. The program also offers insurance coverage for both structures and their contents in more than 22,000 participating communities nationwide.

Because most standard homeowners' insurance policies do not cover flood damage, the NFIP plays a critical role in protecting lives and property while reducing long-term disaster recovery costs. Additional information regarding the Municipality of Añasco participation in the NFIP is provided in Section 4.2 of this plan.

National Earthquake Hazards Reduction Program

The National Earthquake Hazards Reduction Program (NEHRP) was established under the Earthquake Hazards Reduction Act of 1977 to advance the development, dissemination, and application of knowledge, tools, and practices that reduce risks associated with seismic events. This objective is achieved through coordinated, multidisciplinary, and interagency collaboration among NEHRP's participating federal agencies and partners, including local jurisdictions such as the Municipality of Añasco.

The National Institute of Standards and Technology (NIST), within the U.S. Department of Commerce, serves as the lead agency for NEHRP. The program is further supported by three cooperating federal agencies: the Federal Emergency Management Agency (FEMA), the National Science Foundation (NSF), and the United States Geological Survey (USGS). Each agency contributes expertise and complementary activities related to research, preparedness, mitigation, and public safety.

National Dam Safety Program

The National Dam Safety Program (NDSP), administered by FEMA, works collaboratively with states, federal agencies, tribal governments, and other partners to improve dam safety and reduce risks to people, property, and the environment. Created in 1996, the program provides grants, technical assistance, research, and training to strengthen state dam safety programs and support the rehabilitation of high-hazard potential dams.

The NDSP also emphasizes public education, emergency preparedness, and risk communication. In support of these efforts, FEMA maintains resources such as the National Inventory of Dams, which assists in monitoring dam conditions and enhancing resilience to prevent catastrophic dam failures nationwide.

National Incident Management System

The National Incident Management System (NIMS) is a standardized framework developed by the U.S. Department of Homeland Security and administered by FEMA to guide incident management across the nation. Its purpose is to enable effective coordination and cooperation among governmental agencies, private sector organizations, and community-based entities at all jurisdictional levels during the prevention, preparedness, response, and recovery phases of emergencies and disasters.

NIMS establishes a common organizational structure, terminology, and set of processes to ensure seamless coordination regardless of the incident's type, size, or complexity. Core components of the system include resource management, interoperable communications, ongoing preparedness activities, and the Incident Command System (ICS), which defines clear roles, responsibilities, and command structures during emergency operations.

Implementation of NIMS is also a prerequisite for jurisdictions seeking access to certain federal preparedness and response funding. By adopting NIMS, jurisdictions enhance operational efficiency, reduce duplication of efforts, and promote the effective and coordinated use of available resources.

1.1.2 Government of Puerto Rico Policies

1.1.2.1 Puerto Rico Laws

Act No. 161-2009, as Amended

Act No. 161-2009, known as the *Puerto Rico Permits Reform Act*, establishes a modern legal and administrative framework designed to comprehensively restructure the Commonwealth's permitting system. The primary goal of the Act is to create a transparent, efficient, and streamlined process for the submission, evaluation, approval, or denial of permits issued by the Government of Puerto Rico.

To accomplish this objective, the law created the Office of Permits Management (OPM), consolidating permitting responsibilities that were previously distributed across multiple agencies. This centralization reduced procedural delays and improved consistency in the application of permitting standards. The Act also introduced specialized roles—including Authorized Professionals, Permit Managers, Service Representatives, and Permit Officers—each with defined responsibilities intended to expedite reviews and professionalize the permitting process.

A further objective of Act No. 161-2009 is to enhance oversight, accountability, and transparency within the permitting system. By strengthening internal controls and standardizing procedures, the Act seeks to ensure compliance while reducing administrative inefficiencies.

From a public policy perspective, the Act aims to promote economic development while safeguarding environmental protection. Legislative intent emphasizes that an efficient permitting system is essential to attract investment, encourage construction activity, support long-term job creation, and eliminate bureaucratic barriers that previously hindered economic growth. Analyses of the Act also highlight its role in centralizing governmental functions and implementing an Integrated Permitting System to reduce fragmentation, improve interagency coordination, and ensure regulatory uniformity throughout Puerto Rico.

Act No. 33-2019, as Amended

Act No. 33-2019 establishes the public policy of the Government of Puerto Rico regarding mitigation, adaptation, and resilience in response to observed variations in temperature and precipitation patterns. The legislation formally recognizes the need for integrated governmental action, including at the municipal level, to address the impacts of environmental instability.

This Act calls for the incorporation of concrete mitigation, adaptation, and resilience measures into territorial and land use planning instruments. By doing so, it promotes a proactive approach that strengthens communities' capacity to withstand environmental stressors and reduces long-term risks to public safety, infrastructure, and natural resources.

Act No. 107-2020, as Amended

Act No. 107-2020, as amended, known as the *Puerto Rico Municipal Code*, significantly expands the authority, responsibilities, and operational autonomy of municipal governments. The Code promotes local self-governance and enhances municipalities' capacity to manage their own affairs, including disaster preparedness and risk reduction.

Among the responsibilities granted to municipalities is the authority to design and implement programs and measures to prevent, respond to, and recover from emergencies, natural disasters, catastrophic accidents, and other hazardous events. This expanded role reinforces the importance of municipal governments in protecting public safety and community well-being.

The Municipal Code also grants municipalities enhanced autonomy over land use regulation within their jurisdictions. This authority includes the application of tools such as the transfer of development rights and the evaluation and issuance of construction permits, enabling municipalities to incorporate hazard mitigation principles directly into development decisions. These powers are essential for reducing exposure to natural hazards and safeguarding lives and property.

Overall, the Municipal Code recognizes territorial planning as a critical instrument for risk mitigation and establishes a legal framework that enables municipalities to take proactive, locally tailored actions to protect their communities from natural hazards and other adverse events.

1.1.2.2 Puerto Rico Regulations

Puerto Rico Land Use Plan (PUT-PR by its Spanish acronym) - 2015

In compliance with Act No. 550-2004, as amended, the Puerto Rico Land Use Plan (PUT, by its Spanish acronym) constitutes the primary territorial planning instrument prepared by the Puerto Rico Planning Board. The Plan is intended to direct land use, development, and conservation activities throughout the island in a coordinated, sustainable, and resilient manner, guided by a long-term planning horizon of ten (10) years (PRPB, 2015).

Figure 4: PUT-PR Coversheet



One of the primary functions of the Puerto Rico Land Use Plan (PUT) is to classify land throughout the Commonwealth into specific land use categories. Land classification serves as a land administration framework that establishes the types of zoning districts and allowable uses that may be applied to individual parcels. Under the PUT, land is classified according to the following scheme:

- Urban Land (SU, by its Spanish acronym):
  This category includes areas that are already developed and served by the necessary infrastructure and public services.
- Land for Development:
  This classification applies to land identified as suitable for future development and is subdivided into two categories:
  - Programmed Development Land (SUP, by its Spanish acronym): Land scheduled for development under established programs or plans.
  - Non-Programmed Development Land (SUNP, by its Spanish acronym): Land available for development that has not yet been assigned to a specific development program.
- Rustic Land:
  Rustic lands are designated for protection, conservation, or limited use due to their environmental, agricultural, or ecological value. This classification is

further subdivided into:

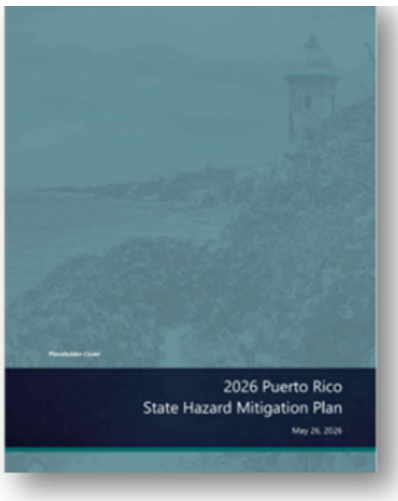
- Common Rustic Land (SRC, by its Spanish acronym): Areas suitable for limited, low-intensity uses.
- Specially Protected Rustic Land (SREP, by its Spanish acronym): Areas subject to heightened protection due to their environmental, natural, or cultural significance.

The PUT-PR aims to coordinate and harmonize land use planning efforts among state agencies and municipalities. It serves as the foundation for the preparation of municipal Land Use Plans (Planes de Ordenación Territorial, POT, by its Spanish acronym), which are adopted for an eight-year planning period (PRPB, 2015).

Currently, the PUT-PR is in the process of being updated for the 2026 -2032 planning cycle. This revision will incorporates robust citizen participation, clearly defined compliance and performance metrics, and an inclusive planning approach that integrates economic development, green infrastructure, sustainable transportation systems, and the conservation of natural resources.

Puerto Rico State Natural Hazard Mitigation Plan (2026)

Figure 5: Puerto Rico SHMP Cover



Just as with the requirements applicable to local jurisdictions, the Stafford Act requires states and territories to develop a hazard mitigation plan that covers their entire jurisdiction. In the case of Puerto Rico, the most recent State Hazard Mitigation Plan was completed in 2021. The 2021 Puerto Rico State Natural Hazard Mitigation Plan establishes long-term strategies to address natural hazards that have the potential to disrupt daily activities, damage property, and threaten human life. These hazards may become disasters that affect not only individuals, but also entire communities, with broad impacts on public health, infrastructure, economic stability, and natural ecosystems (NMEAD, 2021).

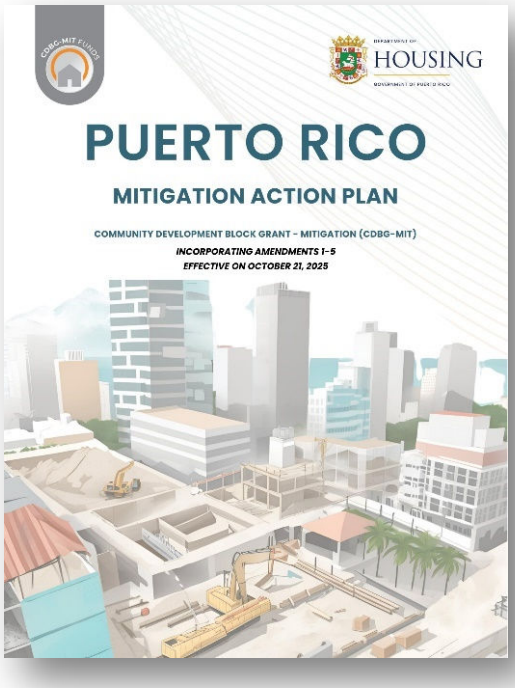
This plan provides a comprehensive framework for identifying risks and implementing actions aimed at reducing vulnerability to these hazards. Through its emphasis on mitigation, the plan seeks to increase community resilience, protect

critical infrastructure and systems, and promote sustainable development throughout Puerto Rico (NMEAD, 2026).
The Municipality of Añasco reviewed the 2026 Puerto Rico State Hazard Mitigation Plan during the preparation of this LHMP update. The relevant risk profiles, state capabilities, mitigation goals, and state actions were considered during the risk assessment, capability assessment, and development of the municipal mitigation strategy.

Puerto Rico Mitigation Action Plan, CDBG-DR MIT (2021, 2025)

Originally approved by the U.S. Department of Housing and Urban Development (HUD) in 2021 and subsequently amended in August 2025, the Puerto Rico Mitigation Action Plan for the Community Development Block Grant–Mitigation (CDBG-MIT) Program is a strategic planning document prepared by the Puerto Rico Department of Housing (DV). The plan establishes the framework for the administration and management of federal mitigation funds allocated by HUD under the CDBG-MIT program.
Its primary objective is to reduce risks and vulnerabilities to future disasters by enhancing the resilience of infrastructure, communities, and critical systems. Although these funds were appropriated by Congress to Puerto Rico following Hurricanes Irma and María in 2017, CDBG–MIT funding differs from CDBG–Disaster Recovery (CDBG-DR) in that it is specifically focused on preventing and mitigating future impacts. Accordingly, CDBG-MIT resources are directed toward sustainable, high-impact mitigation projects and are not required to be directly linked to disaster recovery activities associated with those hurricanes (PRDOH, 2025). This plan is designed to reduce exposure to hazards, safeguard lives and property, and enhance emergency response capabilities through targeted investments in infrastructure, housing, and land-use planning (PRDOH, 2025).

Figure 6:: Puerto Rico Mitigation Action Plan Cover



Other relevant planning regulations will be discussed as part of subchapter 5.1

1.1.3 Municipal Policies

Añasco Local Hazard Mitigation Plan (2020)

Figure 7: 2020 Hazard Mitigation Plan Cover



Approved by FEMA on July 27, 2020, the Añasco Local Hazard Mitigation Plan (2020) provides a comprehensive assessment of natural hazards affecting the municipality and establishes strategies to reduce future losses of life, property, infrastructure, and environmental resources. The plan was developed in accordance with the Disaster Mitigation Act of 2000 (DMA 2000) and FEMA requirements for local hazard mitigation planning.

The update was prepared through a collaborative process involving municipal departments, state and federal agencies, technical specialists, and community stakeholders. Public participation was incorporated through planning committee meetings, community workshops, public notices, and opportunities for public review and comments. The planning process emphasized identifying local vulnerabilities, evaluating risks, and developing practical mitigation actions to improve community resilience.

The plan identifies the following significant natural hazards affecting Añasco:

- Climate Change and Sea Level Rise
- Drought
- Earthquakes and Liquefaction
- Flooding
- Landslides
- Tropical Cyclones and Extreme Winds
- Tsunamis
- Storm Surge
- Coastal Erosion
- Wildfires

These hazards were evaluated based on their probability of occurrence, potential impacts on people and infrastructure, environmental consequences, and future conditions. The plan identifies flooding, drought, earthquakes, strong winds, tsunamis, storm surge, and wildfires as high-priority hazards for the municipality.
The plan also includes a detailed inventory of critical facilities, municipal assets, emergency services, schools, government buildings, public safety facilities, and utilities that support community operations during and after disasters. Vulnerability assessments were conducted using GIS-based analyses, HAZUS modeling, historical records, and local knowledge to estimate potential impacts and losses associated with each hazard.

Some of the mitigation strategies proposed by this plan are:

- **Flooding:** Improvement of stormwater drainage systems, channelization and maintenance of waterways, replacement of culverts and drainage infrastructure, and implementation of flood mitigation projects in vulnerable communities.
- **Strong Winds and Hurricanes:** Installation of backup power systems at critical facilities, strengthening of public infrastructure, protection of critical facilities through shutters and structural improvements, and undergrounding of utility systems were feasible.
- **Earthquakes:** Structural reinforcement of buildings, promotion of seismic-resistant construction practices, public education, and identification of facilities vulnerable to liquefaction hazards.
- **Tsunamis:** Maintenance of tsunami evacuation planning, support for TsunamiReady certification, installation and maintenance of warning systems, and identification of vertical evacuation options.
- **Storm Surge and Coastal Hazards:** Restriction of development in high-risk coastal areas, shoreline protection projects, and implementation of land use policies to reduce exposure.
- **Drought:** Development of rainwater collection and water storage systems, protection of water resources and aquifers, and public education on water conservation.
- **Landslides:** Slope stabilization measures, vegetation planting, erosion control practices, and identification of high-risk areas for monitoring and mitigation.
- **Wildfires:** Public awareness campaigns, wildfire prevention education, inventory and tracking of wildfire incidents, and coordination with emergency management and fire response agencies.

- **Climate Change and Sea Level Rise:** Integration of hazard information into land use planning, protection of critical facilities, preservation of open space, and limitation of development in areas vulnerable to future inundation and coastal impacts.
-

The overall goal of the plan is to increase the resilience of Añasco through hazard mitigation, risk-informed planning, protection of critical facilities and natural resources, enhancement of emergency management capabilities, and continued public outreach and education. The plan remains in effect through June 2025 and serves as the municipality's primary framework for hazard mitigation and eligibility for FEMA mitigation funding programs.

Añasco Municipal Recovery Plan

As part of the CDBG-DR funds assigned by Congress to Puerto Rico in the aftermath of hurricanes Irma and María, municipalities were able to develop a recovery plan to guide recovery efforts and resiliency in the event of future stressors. In essence the Municipal Recovery Plans:



Figure 8: Municipal Recovery – Plan Cover

- Identify local post-disaster needs created or worsened by Irma and María
- Establish short-, medium-, and long-term recovery priorities
- Integrate resilience and hazard mitigation strategies
- Serve as a policy and project roadmap for future funding decisions

Each Municipal Recovery Plan has a list of recovery and resiliency projects that might be considered as new mitigation strategies for the LHMP.

1.2 Scope and Previous Versions

1.2.1 Primary Objectives

The primary objectives of the LHMP are to:

- Identify and assess natural hazards that pose a risk to the municipality.
- Develop strategies and actions to reduce or eliminate long-term risks to life, property, and essential services.
- Promote interagency coordination and community engagement in disaster preparedness and mitigation efforts.

1.2.2 Previous FEMA Comments

Element A6

FEMA Comment

The Plan includes general goals and approximate timelines for performing monitoring, evaluation, and updating activities. Please consider preparing a more specific schedule for each activity to identify concrete dates by month or quarter and responsible parties. This will facilitate enforcement and follow up of the necessary milestones for complying with this element.

Municipality's Response

We thank you for the comment, however the municipality understands that it cannot at this time bring a more detailed revision itinerary. However, the municipality will strive for the yearly revision period to coincide with the period in which the LHMP received final approved by FEMA.

Element B3

FEMA Recommendation

Economic losses are foreseen for flood and earthquake risks. However, losses from other hazards are presented in terms of area, population affected or more generally. Providing additional estimates of dollar losses or economic impacts on all hazards that threaten the municipality will prepare the municipality for the possibility of future natural disasters affecting it and may advance the process of applying for and receiving financial assistance through the various programs available.

Municipality response

This LHMP revision provides economic losses estimate for all hazards that can be modeled thorough HAZUS 6.1 (earthquake, tropical cyclone/strong winds , tsunami and flooding. Other hazards are not currently estimated by FEMA's HAZUS software.

Element B4

FEMA Recommendation

The municipality will need to update the RL and SRL, NFIP information as soon as is available as stated in the plan. "The Municipality of Añasco Mitigation Plan shall be amended to include the required NFIP information once the JP and the Municipality of Añasco are able to retrieve the data under the insurance referral reporting tool. The NFIP information shall include properties that are covered by the NFIP and that have suffered repeated losses and severe repeated losses because they are in areas identified by the program as flood hazard zones. This information should include the type of structure, i.e., residential, commercial, institutional, and other. This information aids in understanding the vulnerability of flood-affected properties in the jurisdiction and provides greater likelihood of qualifying for flood control or prevention grants through programs such as Flood Mitigation Assistance (FMA), the Hazard Mitigation

Grant Program (HMGP), the U.S. Department of Housing and Urban Development (HUD) programs, the Community Development Disaster Recovery Grant Program (CDBG-DR), and others."

Municipality's Response

NFIP information was included in the LHMP as it is provided by the Planning Board. NFIP information is current up to May 29, 2026.

Element E1

FEMA Comment

The jurisdiction approved the Municipal Ordinance number 03-JEM, series 2020-2021 on July 21, 2020. That Municipal Ordinance adopts the Mitigation Plan for Municipality of Añasco. Municipal Ordinance should be incorporated to the Plan when final version is submitted to FEMA

Municipality's Response

Copy of the ordinance was included as part of Appendix A of the 2020 LHMP.

1.3 LHMP Organization

Table 1 shows the layout for the 2026 of Añasco LHMP. To help LHMP reviewers and the public understand compliance, the table includes a column specifying which FEMA-required element (FEMA, 2025) is addressed by each section.

Table 1: LHMP Organization

Chapter #	Title	Description	Review Tool Elements met
N/A	Executive Summary	This section summarizes the most important findings from the planning process and explains how they are addressed in the LHMP.	Local Element

Chapter #	Title	Description	Review Tool Elements met
Chapter 1:	Introduction and Background	This chapter discusses the planning background for Añasco It explains the organization of the LHMP and the most significant changes in the 2026 version compared to the 2020 version. It also addresses the public policies relevant to the update of the LHMP, and the planning process followed, including citizen participation and stakeholder involvement.	E2-a, A1-a, A1-b, A4-a, A2-a, A3-a
Chapter 2	Planning Process	Describes the process to prepare and update the LHMP. It discusses the planning committee, stakeholder involvement, public participation efforts, hazard data sources, and the incorporation of FEMA Community Lifelines into the planning process.	A1-a, A1-b, A2-a, A3-a, A4-a.
Chapter 3	Municipal Profile	The municipal profile describes the municipality's relevant characteristics, including physical features, infrastructure, and demographic and socioeconomic traits.	E1-a
Chapter 4	Hazard Profiles and Risk Analysis	This section is the most extensive in the plan. It covers the hazards identified for Añasco and examines the risks associated with each one.	B-1a, B-1b, B1-c, B1-d, B-e, B2-a, B2-b, E1-a
Chapter 5	Mitigation Capabilities	This chapter elaborates on the municipality's capabilities to implement the mitigation strategies that will be proposed in Chapter 6.	C1-a, C-1b
Chapter 6	Mitigation Action Plan	This chapter establishes the mitigation goals of the Plan and the actions the municipality will take to reduce the risks associated with the identified natural events. It also serves to update the status of the mitigation actions included in the 2019 Plan.	C3-a, C4-a, C4-b, C5-a, C5-b, E2-b
Chapter 7	Plan Maintenance	This chapter addresses the process for evaluating the effectiveness of the plan. It also explains the procedure for making modifications or updates to the plan.	D1-a, D2-a, D2-6, D2-c, E2-c

Chapter #	Title	Description	Review Tool Elements met
Chapter 8	Adoption and Approval	This section includes information on the adoption of the plan by the municipality, FEMA's approval, and the expiration date of the 2026 Local Hazard Mitigation Plan.	F1-a, F1-b
N/A	Selected References	This section presents the sources used in updating the plan.	A4-a
N/A	Appendixes	This section includes all appendices and supplementary information related to the planning process of the Plan.	

1.4 Changes to the Añasco LHMP (E2-a)

Table 2 shows the most significant changes that the 2026 version has from the 2020 version.

Table 2: Changes to the Añasco LHMP

Element	Justification
Plan Language	Following Presidential Executive Order #14224, the 2026 version of Añasco LHMP has been originally prepared in English for submission and consideration of FEMA. An official translation of the final draft for public discussion and the final approved LHMP to Spanish will be prepared for the benefit of the population that are not English proficient.
Plan organization	The organization and chapters of the document have been modified to follow the template used in local mitigation plans prepared by the Puerto Rico Planning Board. However, this template has been adapted in the current plan to comply with current federal public policy.
Discussion of FEMA Lifelines	As per the Local Hazard Mitigation Policy, FEMA Lifelines are discussed as well as the strategies to mitigate hazard impacts on them.
Elimination of non-applicable public policy	For clarity and better readability, references to redundant public policy have been removed.
Change to the name of extreme winds	The hazard identified in the 2020 Plan as "extreme wind" has been changed to "Tropical Cyclones" to the current HAZUS capability to model tropical cyclones for Puerto Rico.
Update of census data	The municipality and PRPB have chosen to use the most recent version of the American Community Survey for evaluating demographic data. In this case it has chosen to evaluate the data sets from the 2024 five-year American community survey.
New Hazard: High Hazard Potential	Given the age of dams upriver from the municipality and the

Element	Justification
Dams	experience with the partial dam collapse of the Guajataca dam after hurricane María, the municipality considers appropriate to include the assessment of this hazard.
Action Plan	The tables of mitigation strategies that were in different sections in the 2020 Plan are now located in a single section (section 6.2). The table format has been modified to be easier to read, and several columns have also been added to provide valuable information for the reader.
All the LHMP	Attention has been given to ensure that the content of the Plan does not reveal any personally identifiable information (PII).
Other changes can be included in the plan progress.	

2. Planning Process

2.1 Planning Process Regulation

This LHMP was updated following the above-mentioned applicable public policies and procedures mentioned in Chapter 1.
This LHMP seeks to aid municipality in the task of preventing loss of life and property by the effects of natural hazards. Chapter 1 serves as a general introduction, Chapter 2 discusses the planning process followed, as well as stakeholder and public participation involvement. The LHMP identifies a general profile of the municipality using information provided by the US Census, such as population distribution, employment, housing stock, etc. (see Chapter 3 for more information). After describing the Municipalities general profile, the Plan goes on to evaluate all identifiable natural hazards that can affect the municipality and its population, including the effects on lifelines, properties, population exposure, natural resources, etc. (see Chapter 4 for more information).

Chapter 5 defines the capabilities that the municipality has for implementing the LHMP. While Chapter 6, establishes the mitigation actions that the municipality will execute for the next five years. Chapter 7 discusses the provisions for LHMP Maintenance and Chapter 8 discusses the adoption and approval of the LHMP. The various appendixes hold supporting information.

2.2 History of the LHMP

The original LHMP was approved by FEMA in 2006. The first revision was completed in 2013 and the second in 2020. This new 2026 version responds to changes in conditions and circumstances that have affected the municipality over the past five years. It also reflects Changes based on updated FEMA Guidelines published in 2025.

2.3 Plan Preparation, Revision Schedule and Methodology (A1-A)

The Municipality in accordance with the Planning Board followed the natural hazard mitigation planning process established by FEMA in the *Local Mitigation Planning Policy Guide* and the *Local Mitigation Planning Handbook*, as well as

recommendations provided by COR3's mitigation planning staff.

The planning process for the 2026 update of the San Germán Local Hazard Mitigation Plan (LHMP) officially began with the execution of a Letter of Agreement between the Municipality of San Germán and the Puerto Rico Planning Board (PRPB), which was signed on December 16, 2025. A copy of the signed agreement is included in Appendix B. Subsequently, a kickoff meeting was held on February 9, 2026, bringing together representatives from the Municipality and the PRPB to discuss the planning process, project objectives, and coordination efforts. Later a consulting firm, AtkinsRéalis Caribe LLP, was retained by the PRPB to support the mitigation planning efforts.

The revision phase concluded with the formal submission of the final draft to the State Hazard Mitigation Officer within the Central Office for Recovery, Reconstruction, and Resiliency (COR3) on **[date]**. From December 16, 2025 kickoff meeting through the submission of the final draft, the planning and revision process lasted **[number] days**.

Planning Process Methodology

This section outlines the six-phase process for updating, reviewing, adopting, and implementing the Local Hazard Mitigation Plan (LHMP). The process integrates municipal coordination, public and stakeholder participation, hazard and risk assessment, mitigation strategy development, and state and federal review to produce a compliant and locally informed plan. Figure _ below details the sequential order of the LHMP development phases.

Phase 1 – Initiation and Committee Formation

- Execute the agreement between the municipality and the Puerto Rico Planning Board (PRPB).
- Establish the Municipal Planning Committee.
- Conduct the initial Planning Committee meeting. During this meeting, begin reviewing and updating the mitigation strategies included in the 2020 Local Hazard Mitigation Plan (LHMP).

Phase 2 – Public and Stakeholder Engagement[1]

[1] Note that for the 2020 revision the Municipality and the PRPB used the roundtable discussion methodology mainly for data gathering from stakeholders. For the 2026 revision both municipality and PRPB decided not to use roundtables because in comparison to 2020 data from stakeholders was more available and forthcoming.

- Conduct an initial public meeting to announce the LHMP update process and provide an opportunity for community input.
- Notify stakeholders of the LHMP update process and issue requests for information.

Phase 3 – Municipal and Hazard Assessment

- Update the municipal profile.
- Review the natural hazards evaluated in the previous LHMP and determine whether they remain relevant to the municipality.
- Determine whether additional hazards or updated analyses should be included.
- Prepare the revised hazard profiles and risk analyses.

Phase 4 – Mitigation Strategy Review

- Apply the STAPLEE methodology to evaluate and update the mitigation strategies.
- Identify any mitigation strategies that should be withdrawn and document the reasons for their withdrawal.
- Identify new mitigation strategies that should be added, including appropriate recommendations received from the public and stakeholders.

Phase 5 – Draft Preparation and Public Review

- Prepare the initial LHMP update draft for public and stakeholder review. The draft, considered approximately 90 percent complete, must include a non-certified Spanish translation.
- Publish digital English and Spanish versions on the PRPB website. Make Spanish hard copies available at designated municipal facilities and at the PRPB's main office. Include the location and availability of all digital and printed copies in the public meeting notice.
- Submit a digital courtesy copy of the initial draft to the State Hazard Mitigation Officer (SHMO). During this review period, the SHMO functions are administered through the Central Office for Recovery, Reconstruction and Resiliency (COR3).
- Coordinate a public meeting to discuss the LHMP and publish notice of the meeting in a local newspaper at least 15 days before the meeting.
- Provide additional notice through the municipality's social media platforms. The

municipality and PRPB must also send notification letters to stakeholders.

- Conduct the public meeting. Provide participants with an opportunity to validate local conditions and the hazard analysis prepared by the technical team and to prioritize hazards using the planning-poker technique.
- Provide the public and stakeholders with a seven-calendar-day period to submit written comments.
- Review all comments received and determine whether changes to the LHMP draft are necessary.
- Incorporate approved revisions and prepare the final draft.

Phase 6 – State and Federal Review, Adoption, and Implementation

- Submit the final draft to the SHMO for review.
- Address any changes or clarifications requested by the SHMO before the plan is forwarded to the Federal Emergency Management Agency (FEMA).
- Obtain FEMA's Approved Pending Adoption (APA) determination, subject to any additional revisions or clarifications requested by FEMA.
- After receiving the APA determination, formally adopt the LHMP through a resolution of the Municipal Legislature or an executive order issued by the mayor. Submit proof of adoption to FEMA.
- Obtain FEMA's final LHMP approval letter.
- Prepare the final administrative record, including the final English version, FEMA's approval letter, documentation of municipal adoption, and the final Spanish version. Submit the required English-language record to FEMA; publish the English and Spanish versions on the PRPB website; provide digital copies to the municipality; and retain Spanish hard copies at the municipality and PRPB.
- Implement the monitoring, evaluation, public-participation, and revision procedures established in Chapter 7 until the next five-year comprehensive update.

Completion of these six phases results in a formally adopted and federally approved LHMP that reflects local conditions, community priorities, and applicable planning requirements. Continued monitoring, evaluation, and public engagement will support implementation of the mitigation strategy and keep the plan current until the next five-year update.

Figure 9. LHMP Development Phases



2.4 Planning Committee (A1-a, A1-b)

To support the revision of the Añasco LHMP, a Planning Committee was established, comprised of representatives from several municipal dependencies who were designated to guide the process. The members of the Committee are:

Table 3: LHMP Planning Committee

Name	Position
Jennifer Rosario Rivera	Vice mayor
Daniel Feliciano Claudio	Executive Officer
Héctor Soto	OMME Director
Brendalee Torrellas	Consultant

The designation letter for the Planning Committee is included in Appendix B. This appendix also compiles the meeting minutes, documentation of the materials discussed throughout the process, and accompanying photographic evidence.

The function of this Planning Committee is to support and coordinate the update, implementation, and monitoring of the Municipality of San Germán's Hazard Mitigation Plan, while providing guidance on risk reduction strategies, ensuring compliance with mitigation requirements, and promoting community participation to strengthen municipal resilience.

The designation letter for the Planning Committee is included in Appendix B. This appendix also compiles the meeting minutes, documentation of the materials discussed throughout the process, and accompanying photographic evidence.

The details of the official meetings are:

First official meeting

- Place: Roberto Sánchez Vilella Government Center San Juan, PR
- Date: February 5, 2026
- Purpose – Initiate Mitigation Committee Activities. Provide update on status of mitigation strategies, prioritize hazards using "planning poker" technique

Second official meeting

- Place: TBD
- Date: TBD
- Purpose – Provide input and impressions of the second public meeting, discuss new mitigation strategies suggested by the public or by consultants.

2.5 Citizen participation (A3-a)

2.5.1 Community Outreach and Public Participation Strategies

The public participation approach selected for this LHMP revision incorporated the following activities:

- **Distribution of notification letters** to agencies, neighboring municipalities, community leaders, nonprofit organizations, neighborhood associations, business or industrial groups, and other interested stakeholders, informing them that the LHMP revision process had commenced and inviting their input. Documentation of these communications is included in Appendix C.
- **Publication of notices on the Municipality's website and official social media platforms** to inform the public that the LHMP revision was underway. These postings also provided an email address for submitting comments and made available a virtual survey to gather information regarding the community's experiences with natural hazards.
- **Convening an initial community meeting** to introduce the LHMP revision process. This step involved:

- Issuing a public announcement in a newspaper, on the Municipality's website, and across official social media channels at least 15 days before the meeting.
- Providing notice of an additional 15-day period for the public to submit comments or suggestions via email or hand – delivered to the municipality.

- **Holding a second community meeting** to present the draft LHMP for public review and discussion. This stage included:
  - Publishing a newspaper announcement and posting notices on the Municipality's website and official social media outlets at least 15 days before the meeting.
  - Confirming in the announcement that the draft plan was available for review in printed and online versions.
  - Providing an additional 7-day comment window for the community to offer feedback, either by email or by visiting the designated address.

2.5.2 Community Outreach and Public Participation Results

First Public Meeting Results

A public meeting notification announcing the initiation of the LHMP update process was published on 2/26/2026 via public notice issued by the Puerto Rico Planning Board in the Primera Hora Newspaper. The notification informed the public that the meeting would be held on 3/10/2026 in the Municipal Legislature and Mayor's Office, Municipality of Añasco, Puerto Rico at 10:00AM.

During this meeting, participants identified several hazard-related concerns affecting different areas of the municipality. The issues discussed included coastal erosion along PR-115 in the Playa Almirante sector; flooding conditions in Barrio Playa, Sector La Grúa (Barrio Ovejas), Sector Cuevas del Río (Barrio Cidra), Parcelas Marías, PR-402 in Barrio Piñales, and PR-109 in Barrio Miraflores. Participants also identified several landslide-prone areas, including Barrio Caracol Arriba, the vicinity of the landfill along PR-110, Sector Seguinot, Barrio Humatas (PR-495), Corcovada (PR-4109), and Barrio Ovejas (PR-4430). In addition, participants recommended elevating the bridge located at PR-109 km 2.0 to reduce flood risk.

In response to the concerns identified by the public, the Municipality incorporated the information collected during the meeting into the hazard identification and risk assessment process for the 2026 LHMP update. The hazards and locations identified

by participants were documented, georeferenced through the map-marking exercise, and considered during the evaluation of flooding, landslide, and coastal erosion risks. The information provided by the public also assisted in validating local hazard data and identifying areas requiring additional consideration during the development of mitigation strategies. Appendix C includes the meeting notes, maps, survey results, and supporting documentation collected during the public participation process. All documentation complies with personally identifiable information (PII) protection requirements.

Second Public Meeting Results

A public meeting notification to present to present the draft of LHMP was published on Click or tap to enter a date. via _____. The notification informed the public that the meeting would take place on Click or tap to enter a date. in _____ at _____. It also stated that a printed copy of the draft LHMP would be available at _____ during regular work hours. Additionally, the public had the option of accessing the draft LHMP through the webpage www.jp.gov.pr. Copies of the public notification are included in Appendix C.

During this meeting, participants expressed the following concerns: _____
The Municipality took the following measures to address these concerns: _____. Appendix C includes the notes documented by the planning consulting firm during the activity, along with supporting evidence. All documentation complies with PII protection requirements.

2.6 Stakeholder involvement (A2-a)

The Municipality carried out outreach efforts to external stakeholders, including government agencies and neighboring municipalities, through formal correspondence addressed to agency heads and mayors. Copies of these invitation letters are provided in Appendix D. Stakeholders were encouraged to submit input either via email or by participating in the public involvement process.

Input from internal stakeholders was obtained through the Planning Committee. Appendix D also includes any written responses or correspondence received from stakeholders during this outreach process.

The Municipality carried out outreach efforts to external stakeholders, including government agencies and neighboring municipalities, through formal correspondence addressed to agency heads and mayors. Copies of these invitation letters are provided in Appendix D. Stakeholders were encouraged to submit input either via email or by participating in the public involvement process. Any official communications from the stakeholders are also included in Appendix D.

After joint evaluation between the Municipality and the PRPB, it was determined that the stakeholders in this planning process were

- Neighboring municipalities
    - Aguada
    - Rincon
    - Mayaguez
    - Las Marias
    - San Sebastián
- Central Government Agencies
    - Puerto Rico Highways and Transportation Authority
    - Puerto Rico Department of Education
    - Puerto Rico Department of Health
    - Puerto Rico Department of Housing
    - Puerto Rico Department of Agriculture
    - Puerto Rico Department of Public Safety
    - Puerto Rico Department of Natural and Environmental Resources
    - Puerto Rico Emergency Management Bureau
    - US Environmental Agency
- Utilities Operators
    - Puerto Rico Aqueducts and Sewers Authority (PRASA)
    - Puerto Rico Electric Power Authority (PREPA)
    - Luma Energy
    - GeneraPR

Academic and Research Institutions

- TBD

- Not for profit organizations
    - TBD

Input from internal stakeholders was obtained through the Planning Committee. Appendix D also includes any written responses or correspondence received from

stakeholders during this outreach process.

2.7 Hazard Analysis Data Sources

The following table presents the datasets utilized for the evaluation of each hazard. Table 4 identifies the hazards considered in this LHMP and the corresponding data sources used to support their assessment.

Table 4: Hazard and Risk Assessment of Data Sources

Hazard	Data Sources	
Earthquake	USGS, FEMA	HAZUS 6.1 used
Landslides	USGS	
Tsunami	NOAA, FEMA	HAZUS 6.1 used
Flooding	FEMA	HAZUS 6.1 used
Tropical Cyclone/Extreme Winds	FEMA	HAZUS 6.1 used
Storm Surge	NOAA	
Extreme Heat	NOAA	
Drought	NDIM	
Wildfires	Puerto Rico Fire Bureau	
Long – Term Coastal Dynamics	NOAA, UPR- COREPI	
Pandemic/Epidemic	PR Department of Health	
High Hazard Potential Dams	NID	

2.8 FEMA Lifelines

The *Local Mitigation Planning Handbook* and the *Local Hazard Mitigation Planning*

Policy Guide highlight the importance of integrating critical lifelines into the hazard mitigation planning process. FEMA defines lifelines as essential services that sustain public safety, economic stability, and the continuity of government and daily life before, during, and after an emergency or disaster. These lifelines serve as a framework for prioritizing resources and actions that are essential to reducing loss of life and property and supporting efficient and rapid recovery following hazard events (FEMA, 2023).

FEMA identifies eight (8) primary lifelines:

- **Safety and Security**: Includes law enforcement, fire services, search and rescue operations, government services, and community safety functions.
- **Food, Hydration, and Shelter**: Encompasses food systems, water access, emergency shelter, and agricultural resources.
- **Health and Medical**: Includes medical care, public health services, patient movement, medical supply chains, and healthcare facility management.
- **Energy**: Covers the electrical power grid and fuel supply systems.
- **Communications**: Includes communications infrastructure, responder communications, alert and warning systems, financial services, 911 operations, and emergency dispatch.
- **Transportation**: Encompasses highways, motor vehicle systems, mass transit, railways, aviation, and maritime transportation.
- **Hazardous Materials**: Includes facilities and systems associated with hazardous materials, pollutants, and contaminants.
- **Water Systems**: Includes potable water infrastructure and wastewater collection and treatment systems.

Each of these lifelines is supported by sub-lifelines that allow jurisdictions to more precisely identify vulnerabilities and prioritize recovery actions. Together, they enable emergency managers and decisionmakers to rapidly assess conditions, focus response operations on the most critical needs, and coordinate actions that directly affect human life and community stability.

By monitoring the status and functionality of lifelines, jurisdictions can respond more effectively during emergencies, minimize cascading impacts, and accelerate more resilient recovery. A detailed discussion of lifelines and their relevance to the Municipality of Añasco is provided in Section 4.5.

3. Municipal Profile

The Municipality of Añasco is located in the western coastal region of Puerto Rico and forms part of the Mayagüez Functional Area, sharing borders with Rincón, Aguada, and Moca to the north; San Sebastián and Las Marías to the east; Mayagüez to the south; and the Mona Passage to the west. The municipality encompasses 102.55 km² (26,091.74 cuerdas), divided into 23 wards (barrios), each with distinct characteristics relevant for hazard assessment (Municipality of Añasco, 2020), (Municipality of Añasco, 2025).

The primary transportation network includes PR-2, PR-108, PR-109, PR-115, and PR-402, which are essential for evacuation, emergency response, and continuity of FEMA lifelines. These corridors link the coastal areas with the mountainous interior where several communities reside (Municipality of Añasco, 2020) (Municipality of Añasco, 2025).

Map 1 shows the municipality of Añasco and geographic location. Map 2 shows the adjacent municipalities and boundaries. Map 3 shows the Añasco physiography.

3.1 Data Sources for Municipal Profiles

The Añasco LHMP has been updated using the most current demographic and socioeconomic data available. Municipal profiles and risk assessments rely primarily on the 2020–2024 Five-Year American Community Survey (ACS). When specific information is not available through the ACS, alternative data sources are identified and cited in the corresponding footnotes.

In addition, the plan reflects the most up-to-date knowledge on hazards and mitigation practices. References to relevant plans, studies, and technical reports are provided in page-level footnotes and consolidated in the References section.

GIS layers included in Chapter 3 were mostly provided by the PRPB's GIS Office.

3.2 Brief Historical Background

The Municipality of Añasco's settlement originated along the fertile alluvial plain flanking the Río Grande de Añasco, where agriculture and coastal access supported

early growth; later road building catalyzed expansion into interior barrios while the administrative core remained concentrated in Barrio Pueblo (Municipio de Añasco, 2020).

Historic hazard events significantly shaped local development patterns and risk awareness. Major hurricanes—San Ciriaco (1899), San Felipe II (1928), San Ciprián (1932), Hugo (1989), Georges (1998), and María (2017)—as well as the 1918 earthquake and tsunami, produced widespread flooding, landslides, and infrastructure disruption across Añasco's coastal plain and uplands (Municipio de Añasco, 2020).

Most recently, Hurricane María (2017) triggered more than 1,300 landslides within Añasco and expanded mapped flood extents relative to pre-event FIRMs, findings that now guide drainage upgrades, slope stabilization, and land-use controls in hazard-prone barrios (Municipio de Añasco, 2020).

3.3 Geography

The Municipality of Añasco covers an area of 26,091.74 cuerdas1, equivalent to 39.60 square miles. Añasco combines a southwestern coastal alluvial plain with mountainous terrain to the north and east, creating two primary hazard environments: (1) flood-prone lowlands where riverine, coastal, and compound flooding occur, and (2) landslide-prone uplands characterized by steep slopes and shallow, saturated soils.

The municipality's 23 barrios are: Añasco Abajo, Añasco Arriba, Barrio Pueblo, Caguabo, Caracol, Carreras, Casey Abajo, Casey Arriba, Cerro Gordo, Cidra, Corcovada, Dagüey, Espino, Hatillo, Humatas, Marías, Miraflores, Ovejas, Piñales, Playa, Quebrada Larga, Río Arriba, and Río Cañas. The largest by area are Miraflores (9.58 km²), Corcovada (8.66 km²), and Humatas (7.66 km²), together account for roughly one-quarter of the municipal territory and include interior slopes where access and emergency response times can be constrained during severe weather (Municipality of Añasco, 2025)2.

Map 1: Geographic Area

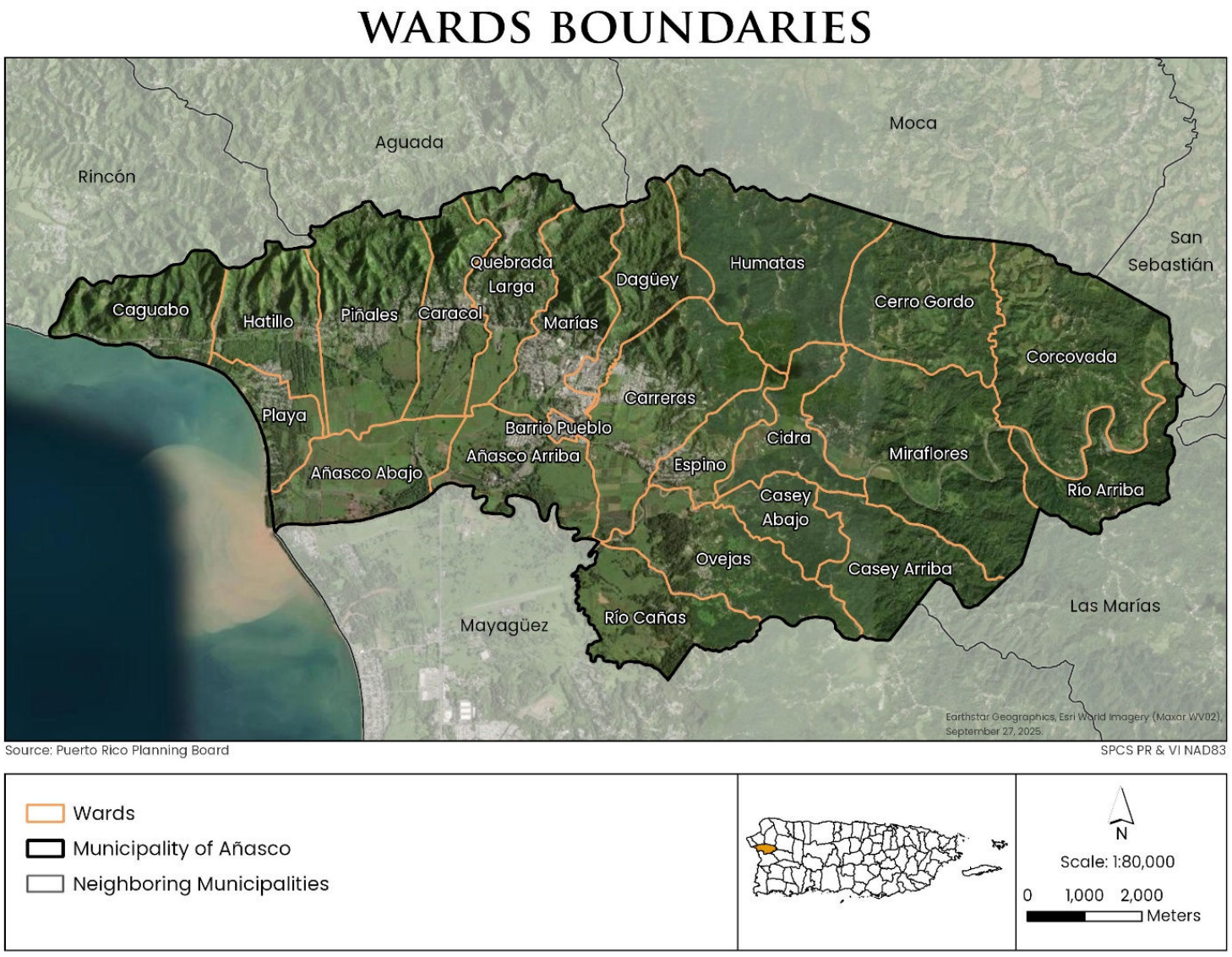
GEOGRAPHIC AREA



Source: Puerto Rico Planning Board

SPCS PR & VI NAD83

Map 2: Wards Subdivision



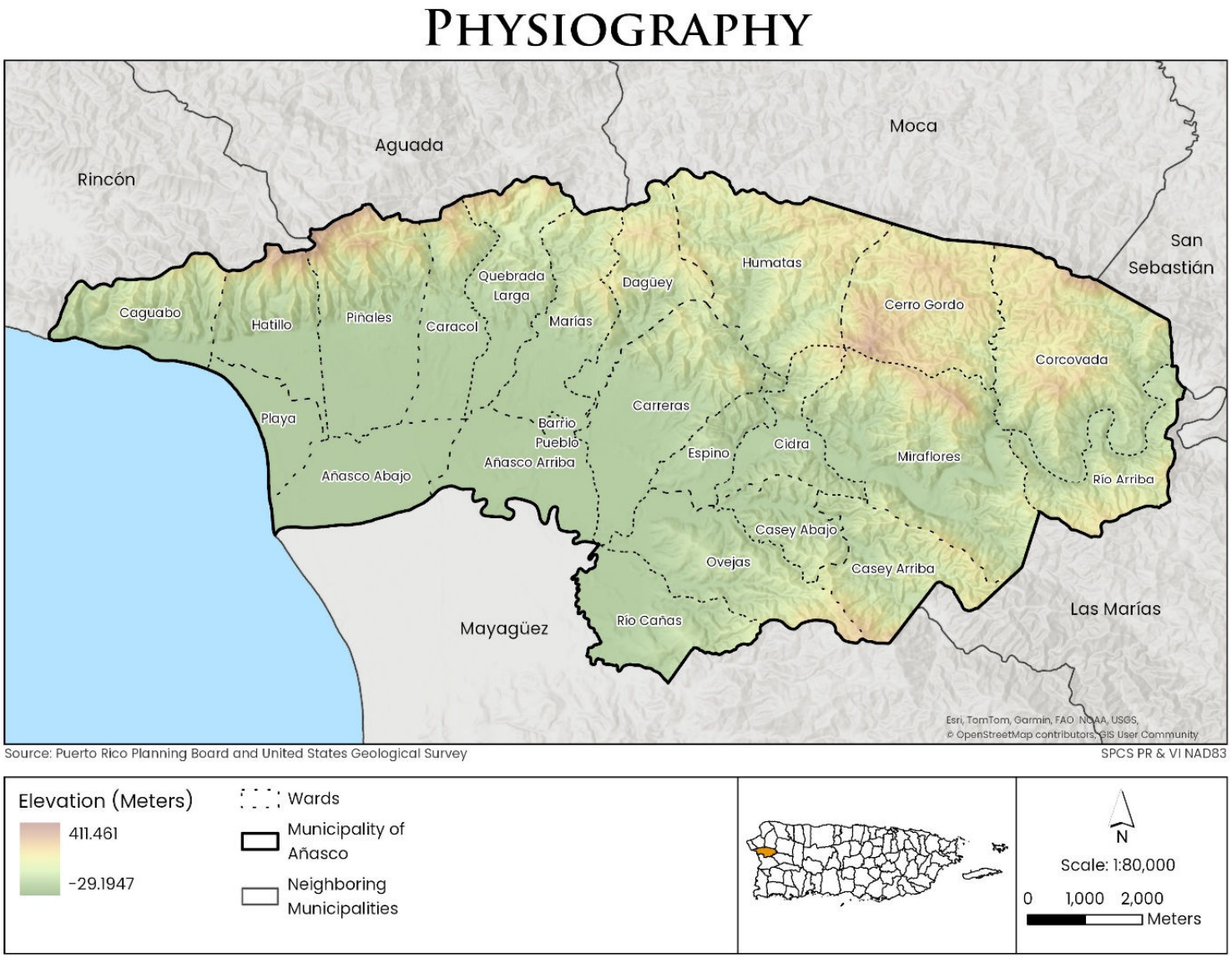
3.3.1 PHYSIOGRAPHY

The Municipality of Añasco topography grades from near sea level at the coast to interior summits reaching about 340–370 meters. Notable elevations include Canta Gallo (~370 m, Barrio Piñales), Cerro Gordo (~340 m, Barrio Cerro Gordo), and Pichón (~340 m, Barrio Corcovada). Steep slope belts in the north and east exhibit high susceptibility to rainfall-triggered landslides; the coastal plain features low slopes and broad overbank areas that store floodwaters during peak events. Map 4 shows the elevation for the Municipality of Añasco (Municipality of Añasco, 2025).

This terrain patterns translate into differentiated mitigation needs—slope stabilization and drainage controls in uplands, and stormwater conveyance, structure-level floodproofing, and conservation of flood storage in lowlands (Municipality of Añasco, 2020).

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Map 3: Physiography



3.3.2 Geology

The Municipality of Añasco's uplands are underlain by Mesozoic volcanic, intrusive, and sedimentary bedrock, transitioning toward the coast to Quaternary alluvial and marine deposits. The coastal plain's water-saturated sediments confer high liquefaction potential, notably in Playa, Caguabo, Añasco Abajo, Hatillo, Piñales, and Río Cañas, while clay-rich, weathered materials on steep interior slopes contribute to landslide susceptibility during intense rainfall (Municipality of Añasco, 2020).
The 2017 experience confirmed these geotechnical conditions: widespread slope failures and subgrade instability disrupted transportation and lifeline services, reinforcing the need for site-specific geotechnical investigation and resilient design standards in identified corridors (Municipality of Añasco, 2020).

3.3.3 Soils

The predominant soils within the Municipality of Añasco belong primarily to the Coloso, Toa, Aguadilla, and Caguabo soil series, which occupy much of the municipality's alluvial valleys, coastal lowlands, and upland areas.

The Coloso series consists of very deep, poorly drained soils formed in alluvial deposits and is commonly found in low-lying floodplain areas where slopes range from 0 to 2 percent. These soils are characterized by slow permeability and a high-water table, making them susceptible to flooding and ponding conditions. The Toa series includes deep, well-drained alluvial soils that occur on river terraces and valley floors with nearly level slopes generally ranging from 0 to 5 percent. These soils are among the most agriculturally productive in Puerto Rico due to their favorable drainage and fertility.

The Aguadilla series comprises well-drained soils formed from weathered volcanic materials and is typically located on gently sloping to moderately steep uplands.
Finally, the Caguabo series consists of deep soils derived from alluvial deposits that occur on floodplains and low terraces adjacent to major drainage channels.

Collectively, these soil types reflect the municipality's diverse landscape, ranging from the extensive floodplain of the Río Grande de Añasco to the rolling uplands in the southern portion of the municipality, and influence local flood, erosion, agricultural, and land development conditions (USDA NRCS Web Soil Survey, 2023).

3.3.4 Hydrography

The Municipality of Añasco's drainage network totals 282.45 km of mapped channels. The Río Grande de Añasco originates in the Central Cordillera (Adjuntas) and flows 64 km to the Mona Passage, receiving flows from tributaries including Río Dagüey, Río Humatas, Río Hondo, Río Casey, and Río Cañas. Map 4 shows the hydrographic system of the Municipality of Añasco. Major rivers and creeks are identified by name (Municipality of Añasco, 2025).
The municipality recognizes 13 sub-watersheds, the largest being Río Grande de Añasco (41.05 km²), Caño La Puente (28.34 km²), and Río Humata (12.56 km²). These sub-basins fall within the USGS Culebrinas–Guanajibo hydrologic unit and control flood routing, sediment delivery, and stormwater retention opportunities across the floodplain. Map 5 shows the watershed basins for the Río Grande de Añasco and related sub-watersheds (Municipality of Añasco, 2025) (Municipality of Añasco, 2020).

Low-lying barrios—Playa, Hatillo, Piñales, Añasco Abajo, and Caracol—are particularly exposed to compound flooding, where high river discharge coincides with storm surge and tidal influence. These dynamics, observed during recent hurricanes, underpin the municipality's focus on stormwater upgrades, river corridor management, and coordinated coastal measures (Municipality of Añasco, 2020).

Map 4: Hydrography shows the hydrographic system of the Municipality of Añasco. Major rivers and creeks are identified by name. Map 5: Watershed shows the watersheds in the municipality, while Map 6: Sub Watersheds shows the sub-watershed basins.

Map 4: Hydrography

HYDROGRAPHY



Source: Puerto Rico Planning Board and United States Geological Survey

SPCS PR & VI NAD83

Hydrography
Reservoirs
Municipality of Añasco
Neighboring Municipalities

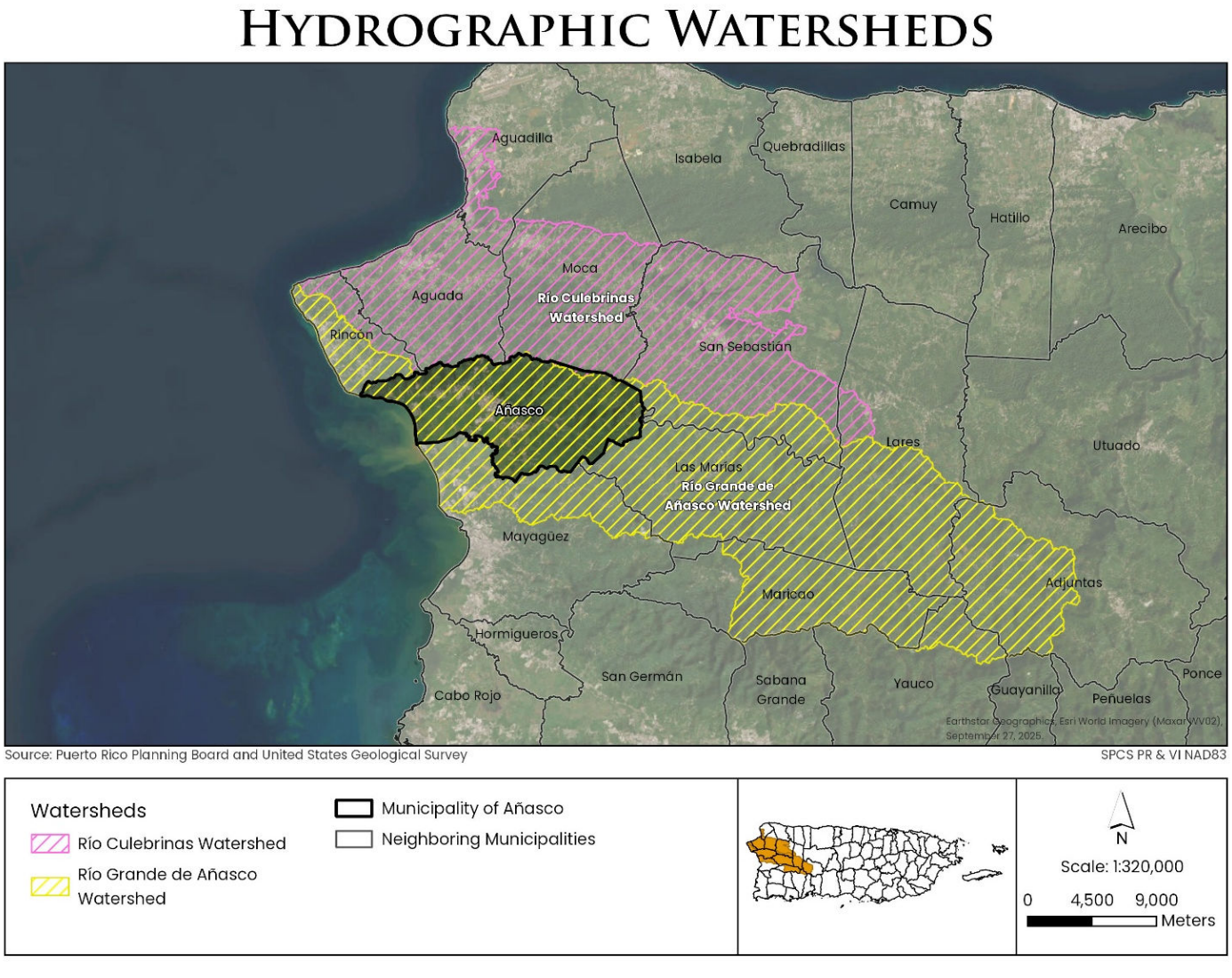


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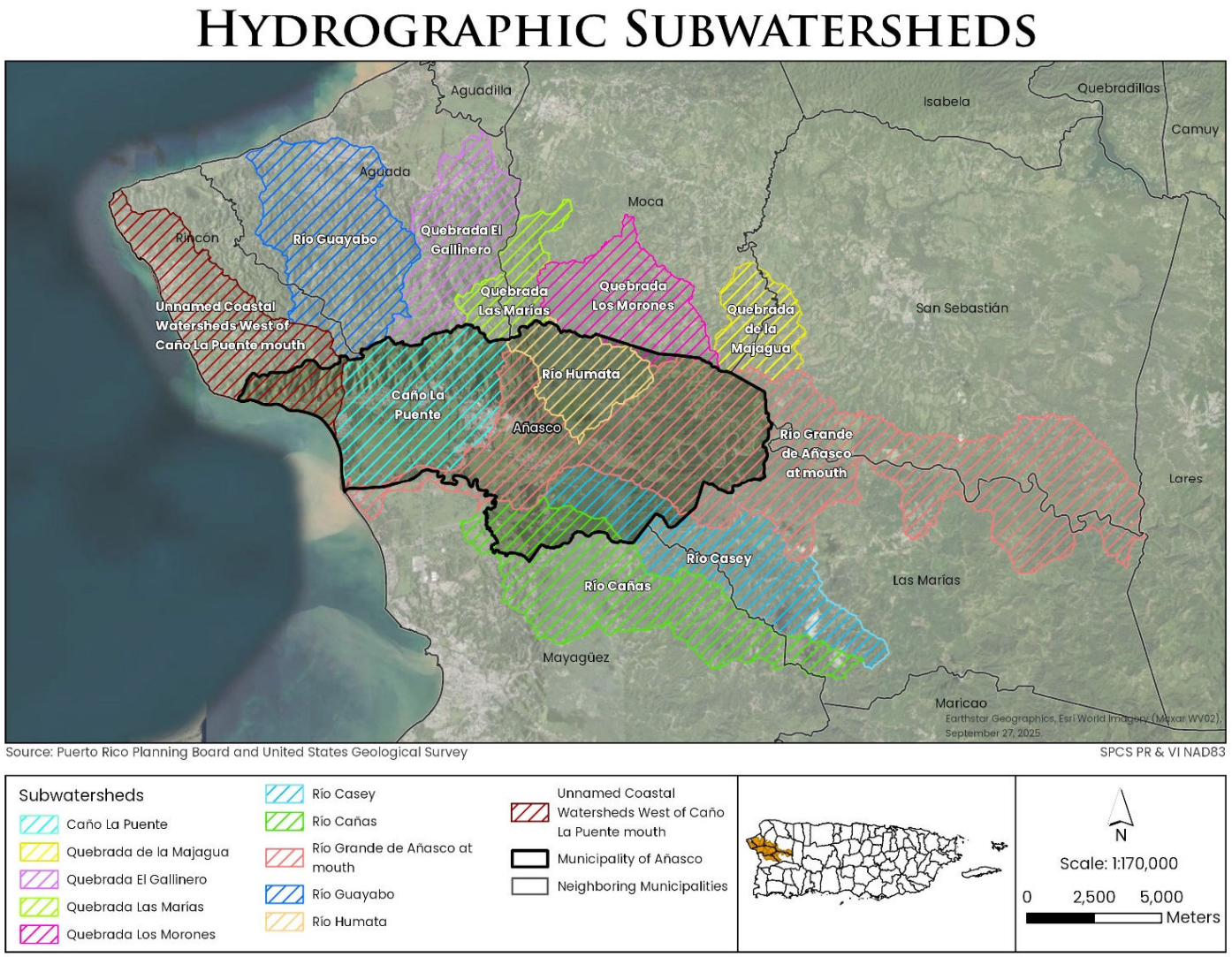
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Map 5: Watershed



Map 6: Sub Watersheds



3.3.5 Precipitation

In Puerto Rico, the period of greatest precipitation generally occurs between August and November, although rainfall patterns are influenced by topography, prevailing trade winds, tropical systems, and local climatic conditions. Unlike the more arid southern coast of Puerto Rico, the western region where Añasco is located receives comparatively higher precipitation due to its proximity to the Cordillera Central and the influence of moist air masses moving inland from the Atlantic Ocean and the Mona Passage.

The Municipality of Añasco is located within a humid tropical region characterized by abundant annual rainfall and numerous river and stream systems. Precipitation supports agricultural activities, public water supplies, wetlands, forests, and other natural resources throughout the municipality. However, prolonged periods of below-normal rainfall may reduce streamflow within the Río Grande de Añasco watershed and affect water availability for residential, commercial, agricultural, and environmental uses.

3.3.6 Temperature

The Municipality of Añasco experiences a tropical climate characterized by warm temperatures throughout the year. Based on available climate data, the annual average temperature is approximately 81.2°F. The warmest month is September, when the average high temperature reaches approximately 86.1°F, while the coolest month is February, when the average low temperature is approximately 74.1°F. These relatively warm temperatures, combined with periods of reduced precipitation, can increase evapotranspiration rates and exacerbate drought conditions by accelerating water loss from soils, vegetation, and surface water resources.

3.3.7 Natural Resources

The Municipality of Añasco contains a diverse variety of natural resources, including beaches, coastal habitats, river corridors, agricultural lands, and forested upland areas. The municipality is strongly influenced by the Río Grande de Añasco watershed, one of the principal river systems in western Puerto Rico, which supports ecological functions, water resources, and agricultural activities.

The coastal zone of Añasco contains important beach and shoreline resources. According to the Coastal Resilience and Planning Initiative of Puerto Rico (CoRePI-PR, 2020), the municipality's coastline extends approximately 6.7 kilometers. About 63.5 percent of the coastline is composed of beaches, approximately 3.4 percent is classified as anthropogenic coastline, and approximately 33 percent was not classified in the assessment. The study also documented ongoing shoreline change processes, including erosion, accretion, and inland waterline migration, demonstrating the dynamic nature of the municipality's coastal environment.

Additionally, Añasco contains important agricultural lands distributed throughout its interior and lowland areas. These lands support local agricultural activities and contribute to the municipality's economy. The municipality also includes riverine and riparian ecosystems associated with the Río Grande de Añasco and its tributaries, which provide habitat for wildlife, support biodiversity, improve water quality, and contribute to flood attenuation and groundwater recharge.

According to the USGS Coastal Change Hazards Portal, portions of the Añasco coastline exhibit both erosional and accretional trends, indicating that coastal change remains an active process along the municipality's shoreline. Although much of the coastline appears relatively stable, localized areas of shoreline retreat and advancement have been documented. These coastal resources may be affected by erosion, storms, sea-level rise, sediment transport processes, and future development pressures.

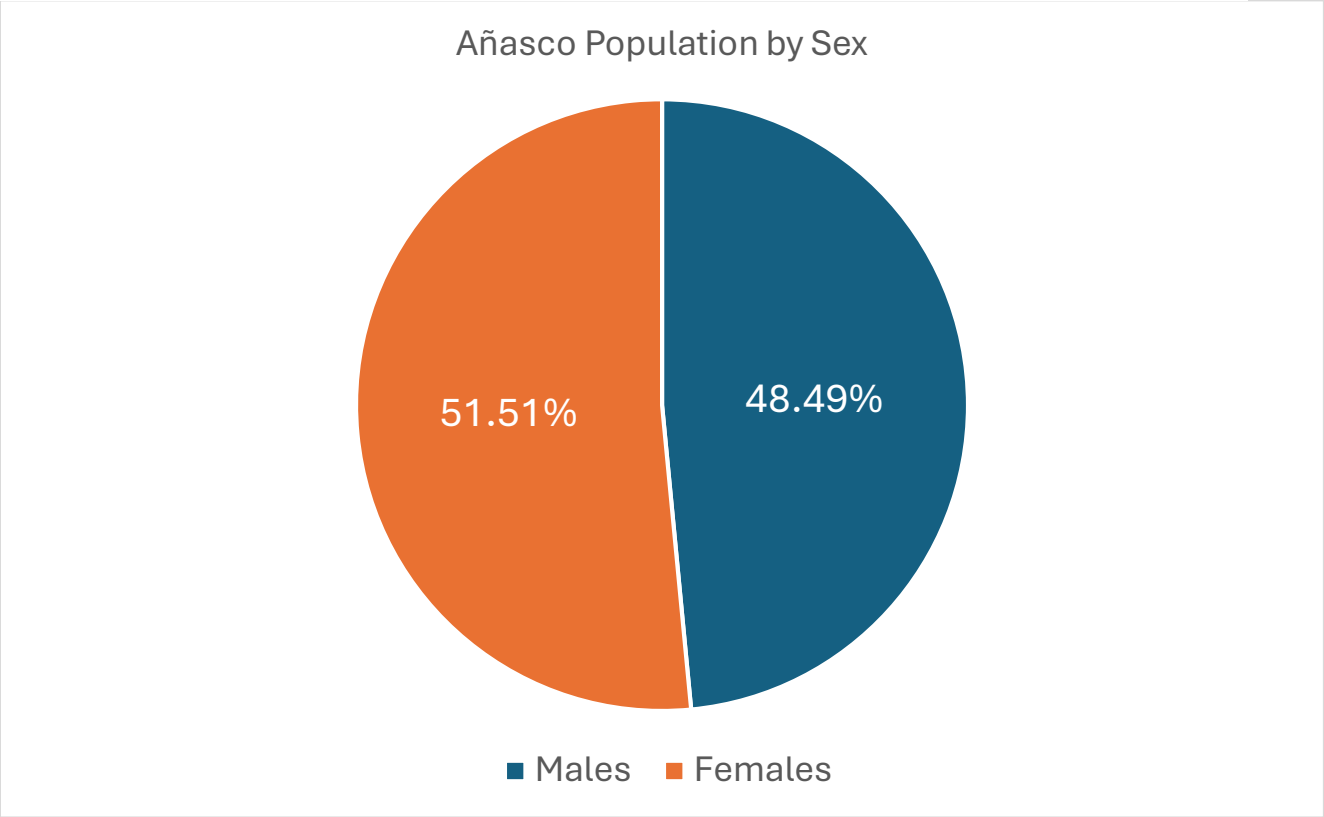
3.4 Demographics

3.4.1 Current Population

According to the 2020-2024 American Community Five Year Survey (ACS 2024)[2] the total population of Añasco is 25,094. Of these, 12,167 individuals are male and 12,927 are female. The percentage split is 48.49% male, 51.51% female. The sex ratio is of 94.12 males per 100 females (US Census Bureau, 2025).

[2] Unless otherwise stated, all data and analysis are from the 2024 Five Year American Community Survey (ACS) Data Set for Añasco.

Figure 10: Population by Sex (2024 ACS)



According to the 2024 ACS a total of 5,876 individuals in Añasco were 65 or older. This constitutes over a fifth (23.42%) of the total population of Añasco. While 4,280 individuals (17.06%) of the population are 75 years old or older.
On the younger age groups, Añasco has 4,372 (17.42%) individuals that are 19 years old or younger. Of those 1,753 (7.00%) are 9 years old or younger. This LHMP considers people younger than 19 and older than 65 as vulnerable. As such, we find that 10,248 residents of Añasco (40.83% of the population) are especially vulnerable to the effects of a natural disaster.

Table 5 distributes the current population of Añasco by age groups as established in Table DP05 ACS Demographic and Housing Estimates of the ACS.

Table 5 Population by Age Group 2024 ACS vs 2019 ACS

Age Cohort	Population 2024	Percentage 2024	Population 2019	Percentage 2019	Net change	Rate of change
Under 5 years	673	2.70%	1028	3.80%	-355.00	-34.53%
5 to 9 years	1,080	4.30%	1343	5.00%	-263.00	-19.58%

Age Cohort	Population 2024	Percentage 2024	Population 2019	Percentage 2019	Net change	Rate of change
10 to 14 years	1,186	4.70%	1602	5.90%	-416.00	-25.97%
15 to 19 years	1,433	5.70%	1750	6.50%	-317.00	-18.11%
20 to 24 years	1,544	6.20%	1850	6.90%	-306.00	-16.54%
25 to 29 years	1,722	6.90%	1712	6.40%	10.00	0.58%
30 to 34 years	1,602	6.40%	1492	5.50%	110.00	7.37%
35 to 39 years	1,466	5.80%	1,640	6.10%	-174.00	-10.61%
40 to 44 years	1,494	6.00%	1,782	6.60%	-288.00	-16.16%
45 to 49 years	1,640	6.50%	1,892	7.00%	-252.00	-13.32%
50 to 54 years	1,803	7.20%	1,962	7.30%	-159.00	-8.10%
55 to 59 years	1,668	6.60%	1,830	6.80%	-162.00	-8.85%
60 to 64 years	1,907	7.60%	1,700	6.30%	207.00	12.18%
65 to 69 years	1,596	6.40%	1,795	6.70%	-199.00	-11.09%
70 to 74 years	1,454	5.80%	1,296	4.80%	158.00	12.19%
75 to 79 years	929	3.70%	1,245	4.60%	-316.00	-25.38%
80 to 84 years	1,104	4.40%	620	2.30%	484.00	78.06%
85 years and over	793	3.20%	395	1.50%	398.00	100.76%
Total	25,094		26,934			

Also Table 5 shows that, in Añasco, the largest negative rate changes by age group occurred in Under 5 years (-34.53%), followed by 10 to 14 years (-25.97%) and 20 to 24 years (-16.54%). The largest positive rate changes were observed in 80 to 84 years (+78.06%) and 85 years and over (+100.76%), followed by 70 to 74 years (+12.19%). Overall, the municipality experienced a net decrease of 1,840 people (-6.83%) between 2019 and 2024.

Figure 11: Population Pyramid (2024 ACS)

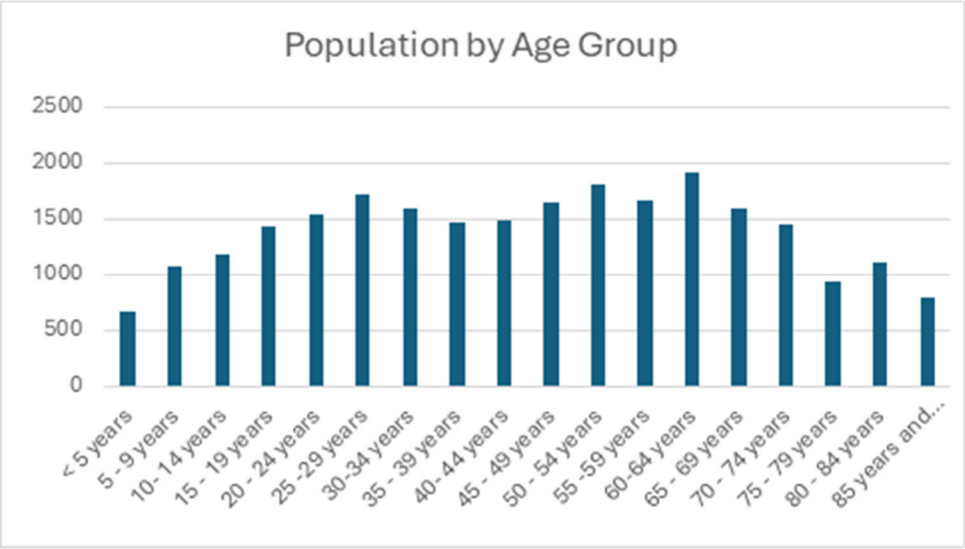
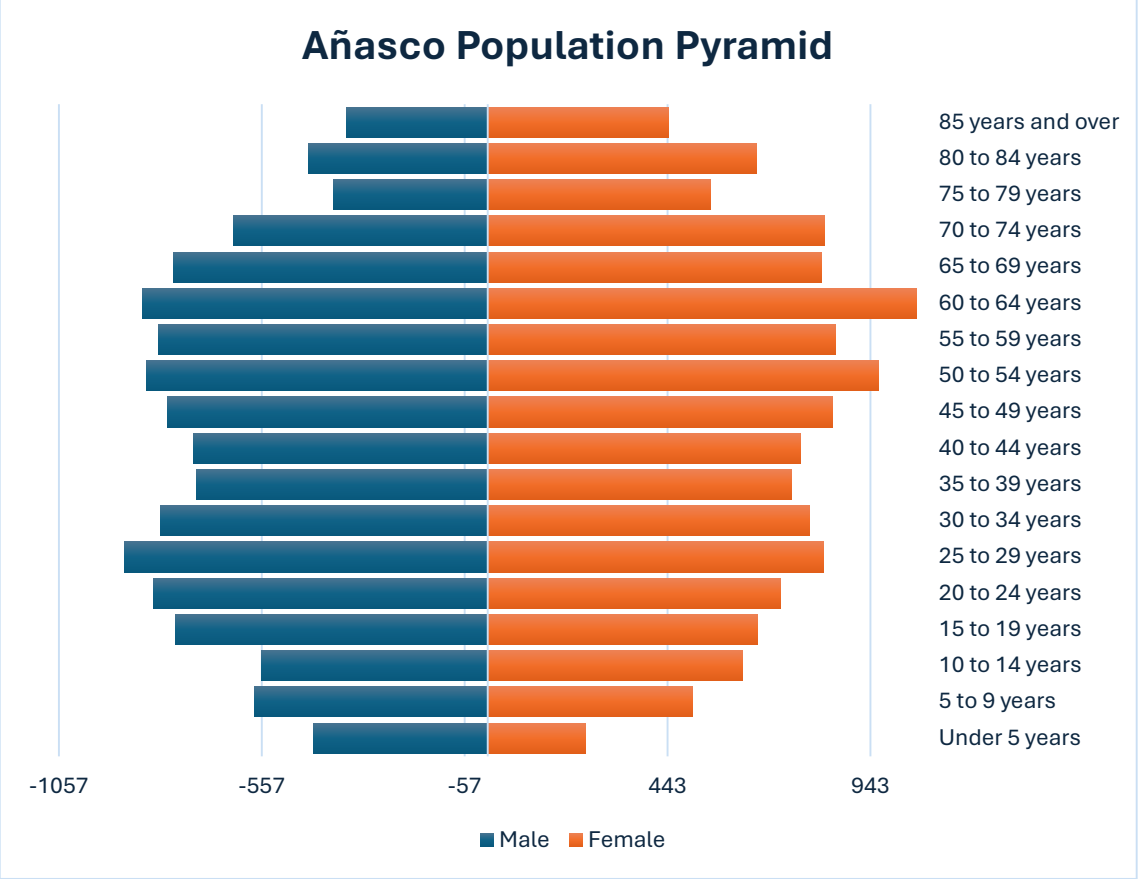
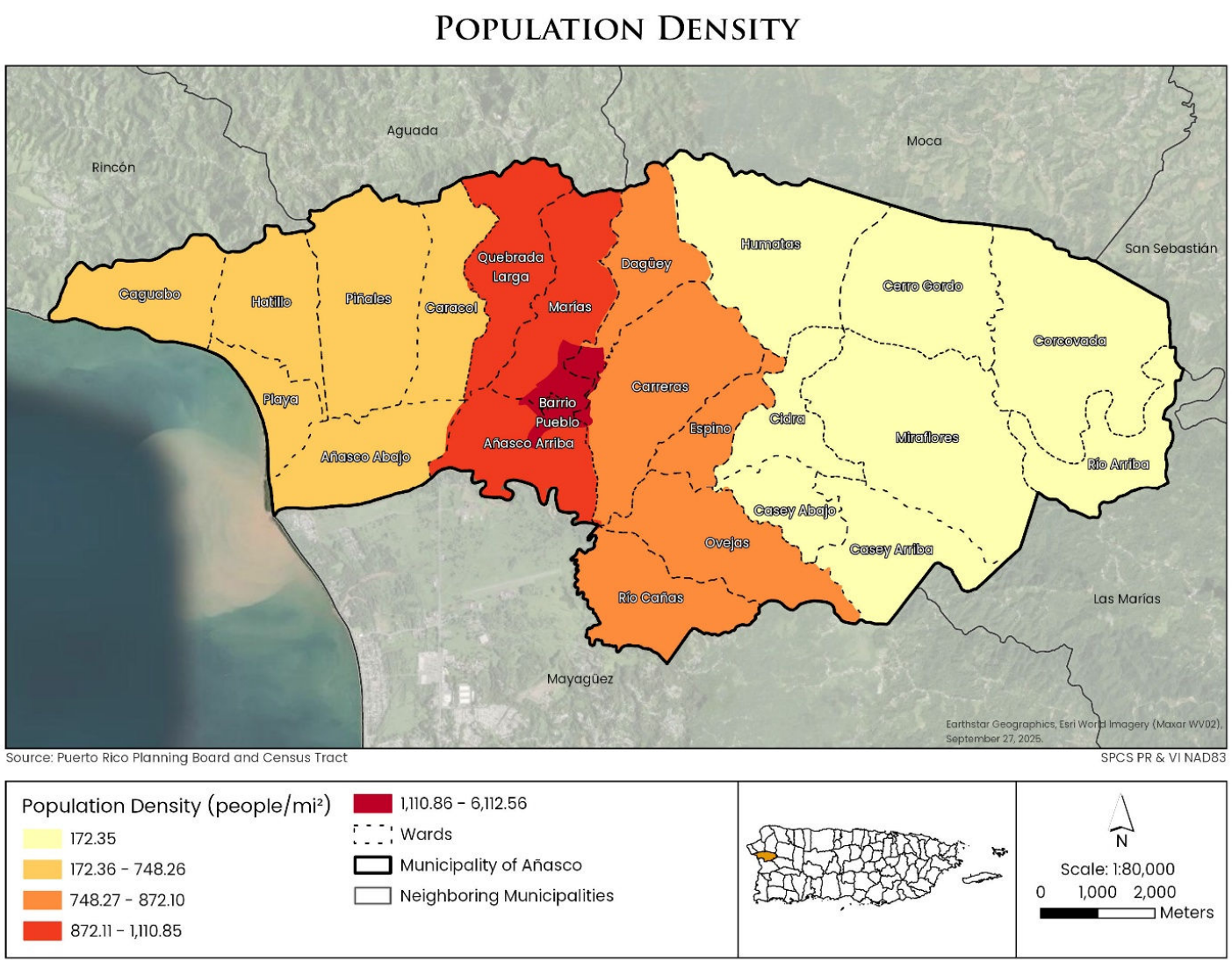


Figure 10 shows the age group distribution in a bar chart form and Figure 11 displays the population pyramid, showing the distribution of males and females across age cohorts. As shown in this figure, the pyramid reveals an irregular structure, with a noticeably larger proportion of older adults compared to younger groups, highlighting the municipality's ongoing demographic aging.

Figure 12 Population Pyramid (2024 ACS)



Map 7: Population Density by Census Tract



3.4.2 Socio-economic Characteristics

3.4.2.1 Employment

Table 6 shows the employment status for the municipality according to the 2020 - 2024 Five-Year ACS.

Table 6: Current Labor Force Statistics[3]

Variable	Estimate	Percentage
Population 16 years and over	21,965	
In Labor Force	10,211	46.50%
Civilian Labor Force	10,211	46.50%
Employed	9,584	43.60%
Unemployed	627	2.90%
Armed Forces	0	0.00%
Not in Labor Force	11,754	53.50%
Unemployment rate		6.10%

Source: US Census

The ACS 2020–2024 data indicate that, in Añasco, 10,211 residents who are 16 years of age and over are in the labor force, representing 46.50% of the civilian population who are 16 years of age and over, while 11,754 residents (or 53.50%) are not in the labor force. When compared with the 2015–2019 five-year ACS, the labor force participation rate shows an increase (46.50% in 2020–2024 vs. 40.60% in 2015–2019). In relation to the Commonwealth overall, Añasco's participation rate is very similar (46.50% in Añasco vs. 46.40% in Puerto Rico).

The ACS 2020–2024 data indicate that the unemployment rate in Añasco is 6.10%, which represents 627 unemployed residents within a civilian labor force of 10,211. This figure reflects a significant improvement when compared with the 2015–2019 ACS unemployment estimate (23.8%). Compared with Puerto Rico as a whole, Añasco's unemployment rate is lower (6.10% in Añasco vs. 10.7% in Puerto Rico).

3.4.2.2 Employment by Industry

The following table presents employment by industry within the municipality, comparing data from the 2020–2024 Five-Year ACS with the 2015-2019 Five-Year ACS. The final column reflects the percentage change in employment by industry between

[3] US Census Table DP03: Selected Economic Characteristics

the two survey periods.

Table 7: Employment by Industry 2024 ACS vs 2019 ACS

Industry	ACS 2024 Five Year	Percentage 2024	ACS 2019 Five Year	Percentage 2019	Delta between 2024 and 2019[4]
Agriculture, Forestry, fishing and hunting and mining	152	1.60%	172	2.0%	-11.63%
Construction	544	5.70%	541	6.4%	0.55%
Manufacturing	1,715	17.90%	1,720	20.4%	-0.29%
Wholesale Trade	134	1.40%	138	1.6%	-2.90%
Retail Trade	940	9.80%	1,302	15.4%	-27.80%
Transportation and warehousing, and utilities	237	2.50%	179	2.1%	32.40%
Information	73	0.80%	145	1.7%	-49.66%
Finance and Insurance, and real estate and rental and leasing	400	4.20%	193	2.3%	107.25%
Professional, scientific, and management, and administrative and waste management services	1,045	10.90%	705	8.4%	48.23%
Educational services, health care and social assistance	2,001	20.90%	1,424	16.9%	40.52%
Arts, entertainment, recreation, and accommodation and food services	1,011	10.50%	1,103	13.1%	8.34%
Other services, except public administration	744	7.80%	392	4.7%	89.79%
Public administration	588	6.10%	415	4.9%	41.69%
Total employee Population 16 years and over	9,584		8,429		13.70%

Source: US Census

Table 7 shows the following employment characteristics for Añasco:

- The industry with the highest level of employment in Añasco. in 2024 is "Educational services, health care and social assistance," which accounts for 20.90% of Añasco's employed residents. This aligns with the numerous

[4] Rate of percentage change is calculated as $Percentage\ Change = \frac{new\ value - original\ value}{original\ value} \times 1$

healthcare facilities identified under the Health and Medicine Lifeline in Section 3.5.3.

- Compared with the 2015–2019 ACS, "Educational services, health care and social assistance" remained the largest employer and grew by 40.52% (from 1,424 to 2,001 employed residents). It did not experience a net negative change over this period.
- The other industries that represent around or above one-tenth of total employment in 2024 are:
  - Professional, scientific, and management, and administrative and waste management services (10.90%).
  - Retail trade is just below that threshold at 9.80%.
- Industries with negative growth from 2015–2019 to 2020–2024 (rate of change, %) include:
  - Retail trade, which decreased from 1,302 to 940 employed residents (a reduction of 362 residents and a rate of change of -27.80%).
  - Information, which declined from 145 to 73 employed residents (a reduction of 72 residents and a rate of change of -49.66%).
  - Wholesale trade, which moved from 138 to 134 employed residents (a reduction of 4 residents and a rate of change of -2.90%).
  - Manufacturing, which moved from 1,720 to 1,715 employed residents (a reduction of 5 residents and a rate of change of -0.29%).
  - Arts, entertainment, recreation, and accommodation and food services, which decreased from 1,103 to 1,011 employed residents (a reduction of 92 residents and a rate of change of -8.34%).
- The industry with the highest net growth in number of employed residents is "Educational services, health care and social assistance", which increased by 577 residents, corresponding to a rate of change of +40.52%. Other notable increases include:
  - Professional, scientific, and management, and administrative and waste management services, which increased from 705 to 1,045 employees (an increase of 340 residents and a rate of change of +48.23%).
  - Other services, except public administration, increased from 392 to 744 employed residents (an increase of 352 residents and a rate of change of +89.79%).
  - Finance and insurance, and real estate and rental and leasing, which increased from 193 to 400 employed residents (an increase of 207 residents and a rate of change of +107.25%).
  - Transportation and warehousing, and utilities, which increased from 179 to 237 employed residents (an increase of 58 residents and a rate of change

of +32.40%).
    - Construction, which increased from 541 to 544 employed residents (an increase of 3 residents and a rate of change of +0.55%).
- Overall, the total number of employed residents in Añasco increased from 8,429 to 9,584, which is an increase of 1,155 residents and a rate of change of +13.70%.
- With respect to "Agriculture, forestry, fishing and hunting, and mining," employment decreased from 172 to 152 employed residents, which is a reduction of 20 residents and a rate of change of -11.63%. This sector represents 1.60% of total employment in 2024 and remains a relatively small share of the municipality's employment base.

3.4.2.3 Poverty Level

The table below shows the estimated percentage of poverty status for individuals over the past twelve (12) months. This information is used to evaluate the economic well-being of individuals and families. The table is essential for understanding the economic conditions of different groups and for guiding the development and implementation of policies aimed at reducing poverty as well as the vulnerability of the population.

Table 8: 2024 ACS Poverty Level

Total Population	Number of Individual below the poverty level during the last 12 months	Percentage of the Population below the poverty level in the last twelve months
24,978	10,727	40.40%

Source: US Census

3.4.2.4 Income

According to the 2024 ACS the median household income for Añasco was $24,436, while the mean household income was of $34,933. The following table shows the estimated income and benefits for households in the municipality.

Table 9: 2024 ACS Income and Benefits per Household

Category	Number of Households	Percentage
Less than $10,000	1,605	16.90%
$10,000 to $14,999	1,130	11.90%
$15,000 to $24,999	2,190	23.00%
$25,000 to $34,999	1,404	14.70%

Category	Number of Households	Percentage
$35,000 to $49,999	1,444	15.20%
$50,000 to $74,999	839	8.80%
$75,000 to $99,999	497	5.20%
$100,000 to $149,999	167	1.80%
$150,000 to $199,999	124	1.30%
$200,000 or more	124	1.30%
Total households	9,524	100%

Source: US Census

Table 9 shows that 16.90% of all households in Añasco earn less than $10,000 per year. While 51.80% of households earn less than $25,000 per year. In comparison for 2015-2019 ACS, 24.8% of households earn less than $10,000 and 59.9% of households earn less than $25,000.

3.4.2.5 Population with disabilities

Table 10 presents data on individuals living with disabilities based on the 2020–2024 and 2015–2019 Five-Year American Community Survey datasets. The results show that the Municipality of Añasco experienced a net decrease of 523 individuals living with a disability during this period, which represents a 7.77% overall reduction. Most age groups experienced declines, including the 5 to 17 years group (-35.03%), the 35 to 64 years group (-34.78%), and adults 65 to 74 years (which nevertheless grew by 19.41%). Two age groups showed increases: individuals 18 to 34 years (+9.93%) and those 75 years and over, which recorded the largest increase at 19.96%. Understanding these trends is critical for the LHMP update, as the disaster-planning literature consistently indicates that people with disabilities face heightened vulnerability during natural hazard events, particularly related to evacuation challenges, access to medical care, and continuity of essential services.

Table 10: Population living with disabilities

Age Group	2024	2019	Net change	Rate of change
Under 5 years	0	0	0	n/a
5 to 17 years	191	294	-103	-35.03%
18 to 34 years	321	292	29	9.93%
35 to 64 years	1,986	3,045	-1,059	-34.78%
65 to 74 years	1,809	1,515	294	19.41%
75 years and over	1,899	1,583	316	19.96%
Total Population living with a disability	6,206	6,729	-523	-7.77%

Source: US Census

3.4.2.6 Population receiving supplemental nutritional support

Error! Reference source not found. provides information on households in Añasco that receive food assistance, based on data from the 2020–2024 and 2015–2019 American Community Survey (US Census Bureau, 2025).

Table 11: Population receiving food aid

Data Set	2024	2019	Net Change	Rate of Change
Total Households in the municipality	9,524	8,848	676	7.64%
Households receiving food assistance	5,365	4,171	1,194	28.63%
Percent of Households receiving food assistance	56.30%	47.10%	_	_

Source: US Census

As shown in this table the number of households in Añasco receiving food assistance is of 5,365. The total number of households receiving food assistance has increased by 28.63% since 2019 ACS. The table shows that 56.30% of households in Añasco receive food assistance and thus can be considered as experiencing food insecurity.

3.4.2.7 Health Insurance Coverage

The next table shows the 2020-2024 health insurance coverage for the municipality

Table 12: 2025 ACS Health Insurance Data

Variable	Estimate	Percentage
Civilian noninstitutionalized population	24,978	
With health insurance coverage	23,571	94.40%
With private health insurance	8,511	34.10%
With public coverage	16,490	66.00%
No health insurance coverage	1,407	5.60%

The data shows that 1,407 people (5.60%) in Añasco have no health insurance at all. While almost three quarters (66.00%) depend on public health coverage. This data will

be revisited when discussing the hazard of pandemic/epidemic.

3.4.3 Housing stock and other related details

According to the 2024 ACS Añasco had a total of 12,640 housing units of those a total of 3,116 were vacant. This constitutes almost a quarter (24.70%) of the total housing stock of the municipality. According to the 2024 ACS of the 9,524 occupied housing units, 6,781 units were occupied by owners and 2,743 by renters.

Table 13 shows the year of construction of the housing units by range.

Table 13: 2024 ACS - Housing Units Year of Construction

Year Structure Built	Housing Units	Percentage
Built 2020 or later	30	0.20%
Built 2010 to 2019	388	3.10%
Built 2000 to 2009	1,440	11.40%
Built 1990 to 1999	1,543	12.20%
Built 1980 to 1989	1,949	15.40%
Built 1970 to 1979	4,071	32.20%
Built 1960 to 1969	2,417	19.10%
Built 1950 to 1959	615	4.90%
Built 1940 to 1949	88	0.70%
Built 1939 or earlier	99	0.80%
Total	12,640	100%

Source: US Census

The 2024 ACS shows that more than half of the housing stock was built between 1970 and 1999. The latest Building Code was adopted by the government of Puerto Rico in 2018, before that the most recent version of the Building Code was adopted in 2011. This means that at least 96.70% of the housing stock was built before the current and immediately previous building code.

Finally, Table 14 shows the vehicle available per occupied housing units.

Table 14: 2024 ACS - Vehicle per occupied housing unit

Variable	Occupied Housing Units	Percentage
No vehicle available	867	9.10%
1 vehicle available	4,121	43.30%
2 vehicles available	3,147	33.00%
3 or more vehicles available	1,389	14.60%
Total Occupied Housing Units	9,524	

Source: US Census

The 2024 ACS shows that there are 867 housing units that do not have available vehicles. This represents a critical matter since the development pattern in the municipality is rural and/or suburban, where vehicular transportation is necessary for mobility.

3.5 Critical Infrastructure

Infrastructure refers to the essential physical and organizational systems that support the effective functioning of a society or economy. It includes critical networks such as transportation systems (roads, bridges, railways), energy generation and distribution, water supply, telecommunications, and other services that sustain economic activity and daily life. Collectively, infrastructure serves as the foundational framework that enables communities and economies to operate reliably and efficiently (NIST, n.d.). Infrastructure is commonly classified into two categories: hard infrastructure and soft infrastructure.

Hard infrastructure refers to the physical facilities and networks that underpin the functioning of a modern society and economy. This includes transportation systems such as roads, bridges, railways, and airports, as well as water systems, electrical grids, and telecommunications networks. These tangible assets enable the movement of people and goods, the distribution of energy and water, and the transmission of information.

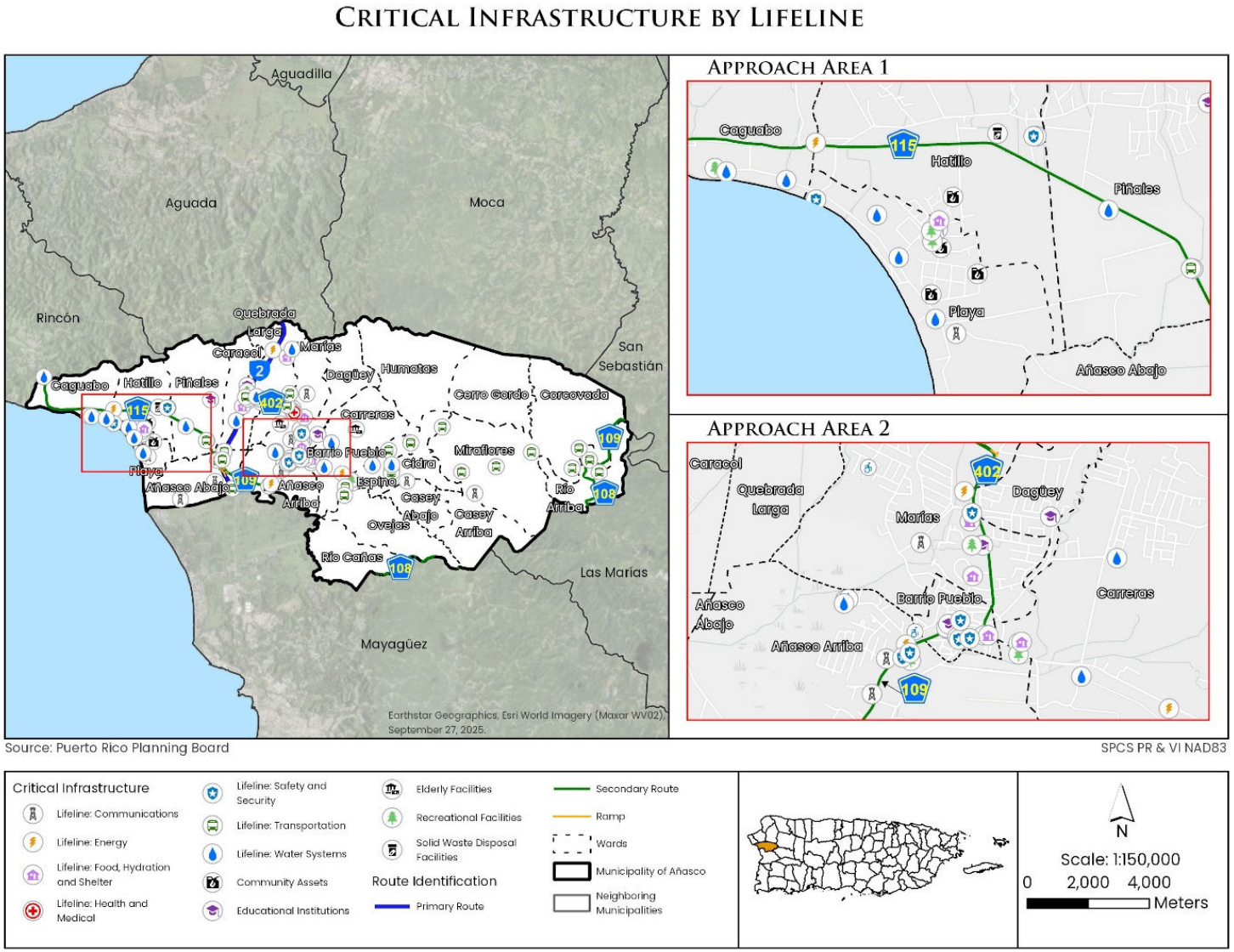
Soft infrastructure refers to the institutions, services, and systems that support economic stability, public health, social order, and cultural development. This category includes educational institutions, healthcare systems, law enforcement agencies, emergency response services, parks, and recreational facilities. Unlike hard infrastructure, soft infrastructure is characterized by organizational frameworks and human-centered services that contribute to community well-being and effective governance.

As described in Section 2.3.1, FEMA defines *Community Lifelines* as the most essential services and systems necessary to sustain the uninterrupted operation of critical government and business functions, while also protecting public health, safety, and economic security. These lifelines constitute the fundamental components of a community and, once stabilized, enable all other sectors of society to function

effectively. During disaster events, any disruption to these lifelines requires immediate and coordinated action to restore stability and reduce cascading impacts. Accordingly, the assessment of existing infrastructure will be conducted in alignment with FEMA's Community Lifelines framework.

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Map 8: Critical Infrastructure by Lifeline



3.5.1 Lifeline: Safety and Security



The purpose of the Safety and Security Lifeline is to protect life and property while maintaining social stability during emergency situations. This lifeline focuses on reducing immediate risks to public safety and personal security through the operation of public safety agencies, controlled access to affected areas, and the prevention of crime, civil unrest, and violence. It also encompasses ensuring safety and security at emergency shelters, distribution centers, and other critical facilities during disaster response and recovery operations.

FEMA indicates that disruption of this lifeline can result in social disorder and heightened community vulnerability, making rapid restoration a critical priority. Response actions require close coordination among federal, state, and local agencies, the deployment of security personnel, the implementation of traffic control measures, and the protection of critical infrastructure.

Map 8 illustrates the location of safety and security facilities within the Municipality of Añasco, including police facilities, emergency management functions, and fire protection assets. Most of these facilities are concentrated within and around the municipality's urban center, particularly in Barrio Pueblo, Añasco Arriba, Marías, and adjacent developed sectors located along the PR-2, PR-109, and PR-115 transportation corridors. This distribution reflects the concentration of population, commercial activities, governmental services, and critical infrastructure within the central portion of the municipality.
Several police, emergency response, and public safety facilities are located near the junction of PR-2, PR-109, and PR-115, providing relatively efficient access to the municipality's coastal communities as well as the interior barrios. However, residents in the more mountainous eastern and northeastern sectors of the municipality, including portions of Humatas, Río Arriba, Casey Arriba, Casey Abajo, Corcovada, Miraflores, Cerro Gordo, and Quebrada Larga, may experience longer emergency response times due to the greater distance from public safety facilities and the presence of winding roads, steep slopes, and terrain constraints.

Maintaining reliable access along major transportation corridors such as PR-109, PR-402, and local roads connecting the urban center with the upland communities is therefore essential to ensuring continuity of emergency response operations during natural hazard events. Disruptions caused by flooding, landslides, hurricanes, or earthquakes could affect access to these communities and potentially impact

emergency service delivery. Consequently, the protection of transportation infrastructure and the continuity of operations of safety and security facilities remain important considerations for hazard mitigation planning in Añasco.

3.5.2 Lifeline: Food, Hydration and Shelter



The Food, Hydration, and Shelter Lifeline is intended to ensure that disaster-affected populations have prompt access to essential necessities, including food, potable water, and safe shelter. This lifeline encompasses the provision of ready-to-eat meals, water distribution, the establishment of temporary shelters, and coordination with governmental and volunteer organizations to meet basic human needs. Disruptions to this lifeline pose an immediate threat to life; therefore, rapid response actions are prioritized to restore food availability and housing stability as quickly as possible.

Map 8 shows the designated emergency shelters across Añasco. As shown on the map, shelter facilities are concentrated primarily within and around Barrio Pueblo, Marías, Añasco Arriba, Playa, and Hatillo, providing coverage for both the municipality's urban center and nearby coastal communities. Several shelters are located near major transportation corridors, including PR-2, PR-109, and PR-115, facilitating access during emergency evacuations. The distribution of these facilities supports emergency sheltering operations throughout the municipality while maintaining accessibility to residents living in both coastal and inland communities.

3.5.3 Lifeline: Health and Medicine



The purpose of this lifeline is to ensure the continuity of essential medical services and the protection of public health during emergencies and disasters. It focuses on stabilizing healthcare delivery, ensuring access to hospitals, clinics, medications, and healthcare personnel, and maintaining the capacity to respond effectively to life-threatening conditions

FEMA indicates that disruption of this lifeline can have serious consequences; therefore, priority actions focus on restoring medical facilities, deploying emergency response teams, ensuring the availability of critical medical supplies, and coordinating efforts among federal, state, and local agencies.

Map 8 shows the healthcare facilities inside of the municipality of Añasco. As can be seen on the Map there is a concentration of healthcare facilities near the traditional urban center (*casco urbano*) along the PR-2 corridor.

3.5.4 Lifeline: Energy



Energy Lifeline is designed to ensure the reliable and safe delivery of electricity, gas, and essential fuels during emergencies and disaster events. This lifeline is vital to sustaining the operation of critical facilities and services, including hospitals, water and wastewater systems, telecommunications, and other infrastructure that depend on uninterrupted energy supply.

FEMA recognizes that disruptions to energy services pose a direct threat to life safety and community stability. Accordingly, priority response actions include the rapid restoration of the electrical grid, the deployment of generators to critical facilities, coordination with fuel suppliers, and the implementation of temporary measures to maintain service continuity.

3.5.5 Lifeline: Communications



The purpose of this lifeline is to ensure the availability and reliability of essential communication systems during emergencies and disaster events. These systems include telephone networks, internet services, radio, television, and public alert and warning platforms, all of which are critical for coordinating response activities, disseminating timely information, and maintaining communication between authorities and the public.

FEMA indicates that disruption of the Communications Lifeline can severely impair life-saving operations and effective resource management. Accordingly, priority actions include the restoration of telecommunications infrastructure, deployment of temporary communication solutions such as satellite systems, ensuring redundancy within critical networks, and maintaining accessible communication channels for the public.

A communication infrastructure shapefile was not able to be located to be included in this LHMP.

3.5.6 Lifeline: Transportation



The purpose of the Transportation Lifeline is to ensure the safe and efficient movement of people, goods, and essential services during emergencies and disaster events. This lifeline supports the continued operation or rapid restoration of land, air, and maritime transportation routes, enabling access to critical resources such as food, potable water, medical care, and emergency response equipment.

FEMA indicates that disruptions to transportation systems directly affect the ability to save lives and distribute essential supplies. Accordingly, priority actions include reopening roadways, repairing damaged bridges, restoring airport and port operations, and coordinating with state and private entities to maintain the logistics chain. Map 9 illustrates the roadway network of the Municipality of Añasco. The primary transportation corridors within the municipality are described below.

Northwest-Southeast Corridor. The principal transportation corridor in Añasco is PR-2, which traverses the municipality and serves as the primary connection to the municipalities of Aguada, Rincón, and Mayagüez. PR-2 also functions as the municipality's main commercial corridor and provides access to residential, governmental, commercial, and industrial areas located throughout the urbanized portion of Añasco.

North-South Corridors. Several routes connect the coastal plain and urban center with the interior portions of the municipality. These include PR-109, which provides access to Añasco Arriba, Marías, and other central sectors of the municipality, and PR-402, which serves communities located within Piñales, Hatillo, and adjacent areas. Additional municipal and secondary roads provide access to upland barrios such as Humatas, Río Arriba, Corcovada, Miraflores, Casey Arriba, Casey Abajo, and Cidra. These routes are particularly important for emergency response and evacuation activities.

Coastal Corridor. PR-115 serves as an important coastal transportation route connecting the municipality's northern and western coastal communities, including Playa, Hatillo, and Piñales, while also facilitating access to recreational areas, tourism facilities, and neighboring municipalities along Puerto Rico's west coast.

A transportation challenge within the municipality is maintaining connectivity between the coastal plain and the mountainous interior during extreme weather events. Flooding along the Río Grande de Añasco floodplain and landslides in the northern and eastern upland areas can affect portions of PR-109, PR-402, and local

roads, potentially disrupting access to communities and critical facilities. Consequently, maintaining roadway functionality and protecting transportation infrastructure remain important considerations for hazard mitigation and emergency management efforts in Añasco.

3.5.7 Lifeline: Hazardous Materials



The purpose of this lifeline is to prevent hazardous material releases, control spills, and protect communities located near industrial facilities, chemical plants, and hazardous materials transportation corridors.

FEMA indicates that disruption or failure of the Hazardous Materials Lifeline can result in severe consequences, including widespread contamination and the impairment of essential services. Accordingly, priority actions include identifying hazardous materials, activating specialized Hazardous Materials (HazMat) response teams, coordinating with federal and state agencies, and implementing rapid response protocols. Although hazardous materials may be present throughout the municipality, incidents involving hazardous materials are more likely to occur within industrial areas.

Map 8 shows the location of critical infrastructure associated with community lifelines in the Municipality of Añasco. With respect to the Hazardous Materials Lifeline, the map identifies the concentration of transportation corridors, energy facilities, water system infrastructure, and community assets that could be affected by or involved in a hazardous materials incident. The highest concentration of these facilities is located within the urbanized areas of Barrio Pueblo, Añasco Arriba, Marías, Playa, Hatillo, and Piñales, particularly along the PR-115, PR-109, and PR-402 corridors highlighted in Approach Areas 1 and 2. Because hazardous materials incidents are most likely to occur along major transportation routes and near facilities that store, use, or distribute regulated substances, these areas represent the portions of the municipality where preparedness, emergency response coordination, and hazardous materials management are particularly important.

3.5.8 Lifeline: Water Systems

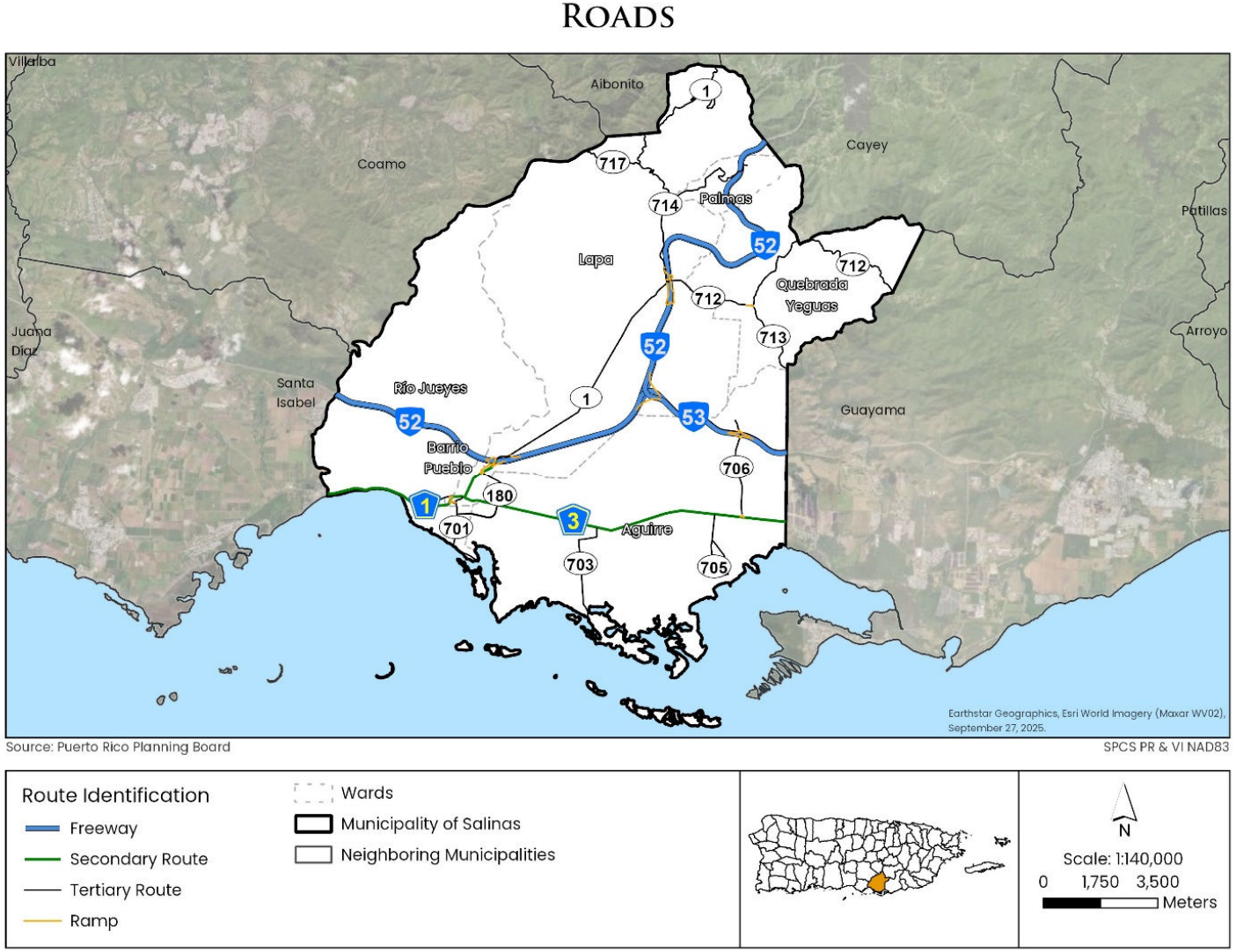


This lifeline highlights the critical role of water infrastructure in disaster response and recovery. Its primary objective is to ensure reliable access to and the timely restoration of drinking water and wastewater services, which are essential to public health, safety, and economic stability. The Water Systems Lifeline is structured around two core components: Potable Water Infrastructure, which includes water intake, treatment, storage, and distribution; and Wastewater Management, encompassing the collection, storage, treatment, and discharge of wastewater. By prioritizing the protection and functionality of water systems, FEMA seeks to maintain sanitation, support healthcare services, and minimize cascading impacts on food safety and overall community resilience.

Map 8 shows the potable water infrastructure in Añasco. As expected, there are a considerable number of pump stations and water tanks in the mountainous south of the municipality. Añasco also has a filtration plant in Barrio Nuevo. While map shows the wastewater management infrastructure.

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Map 9: Roadways



3.6 Recent Development (E1-a)

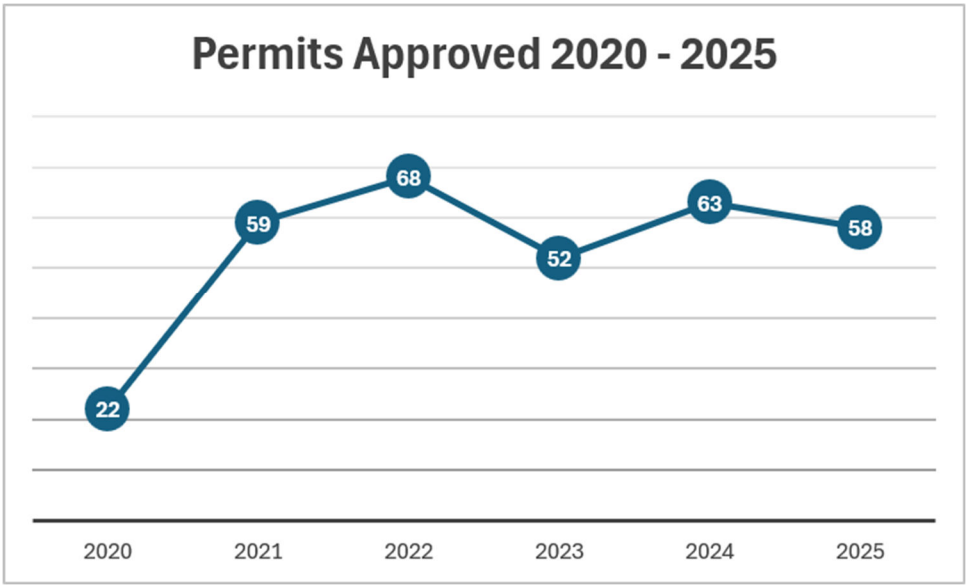
Hazard mitigation planning must also account for future development conditions. To assess anticipated development trends within the municipality, historical patterns were evaluated using data on construction permits approved between 2020 and 2026. This period begins with the year following approval of the previous hazard mitigation plan. It should be noted that data for 2026 are completed through June 30, 2026.

The data indicate a notable increase in construction activity during the COVID-19 pandemic period (2020–2023). This rise in permit approvals may be associated with the availability of federal stimulus funding provided during that time; however, additional analysis would be required to confirm any direct relationship. Based on the available data, the Municipality of Añasco records an average of 51 and a median of 59 construction permits approved per year. Table 15 and **Error! Reference source not found.** present the number of construction permits approved between 2020 and 2025. Map 10 and Map 11 illustrate the spatial distribution of these permits. To enhance legibility, the permits are depicted on two separate maps: one showing permits issued from 2020-2023, and another showing permits issued from 2024-2026.

Table 15: Approved Construction Permits 2020-2026

Approved Construction Permits 2020-2025	
Year	**Permits Approved**
2020	22
2021	59
2022	68
2023	52
2024	63
2025	58

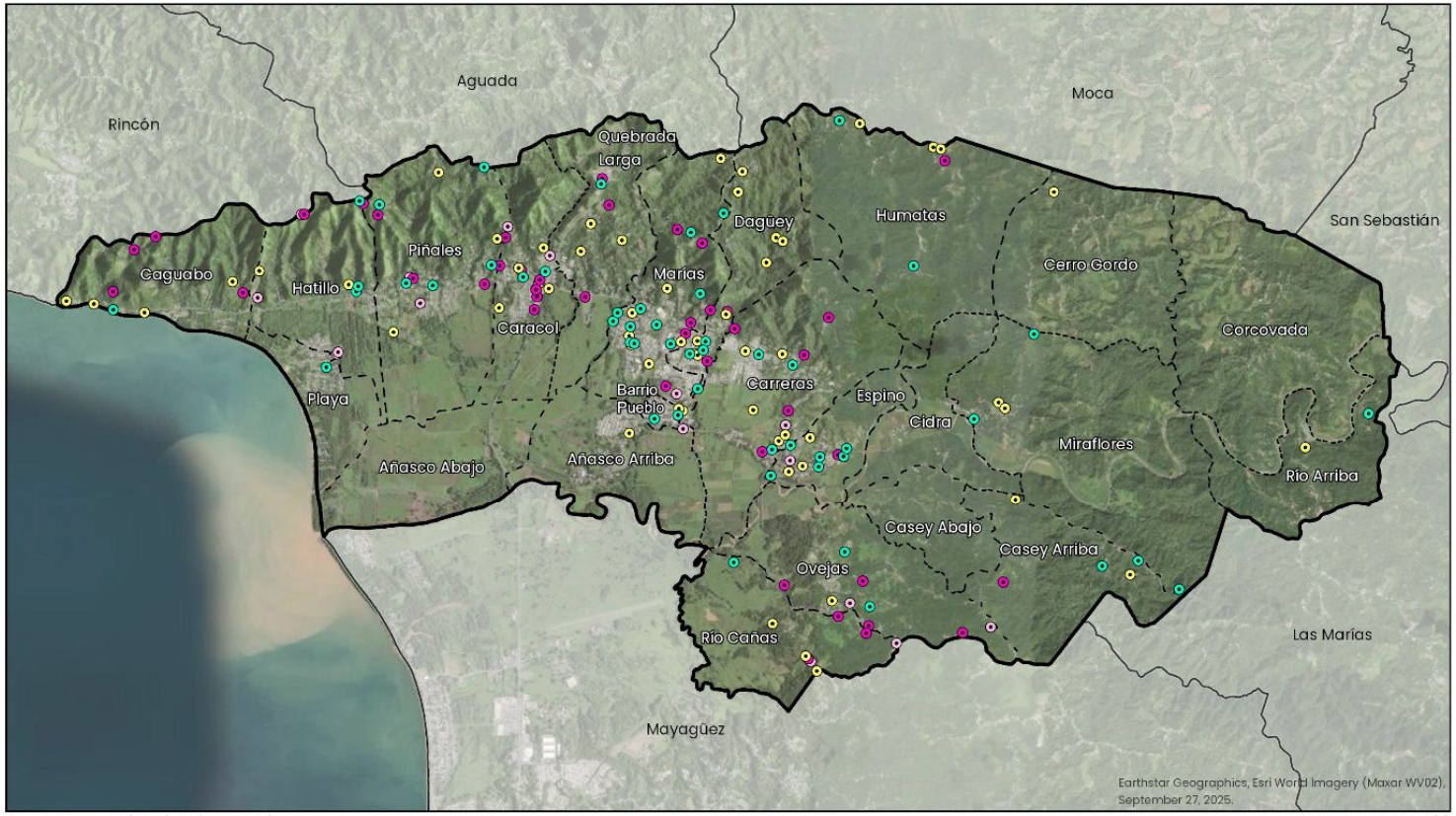
Figure 13: Approved Construction Permits 2020-2025



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Map 10: Recent Developments 2020 - 2023

Recent Development 2020 - 2023



Source: Puerto Rico Planning Board

SPCS PR & VI NAD83

Construction Permits Granted

Year Created and Count

- 2020 (23)
- 2021 (55)
- 2022 (68)
- 2023 (52)
- Wards
- Municipality of Añasco
- Neighboring Municipalities

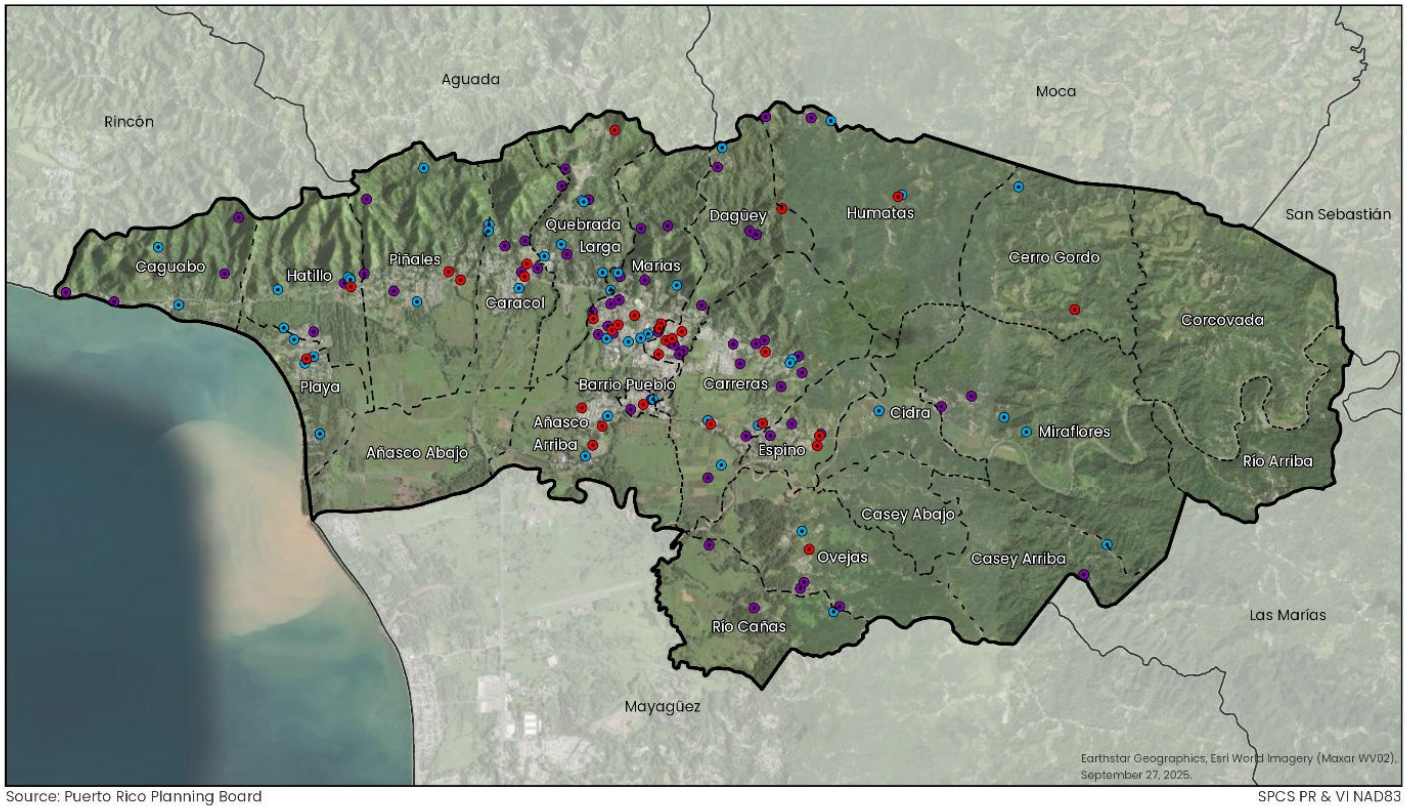
N

Scale: 1:80,000

0 1,000 2,000 Meters

Map 11: Recent Developments 2024 - 2026

Recent Development 2024 - 2026



Source: Puerto Rico Planning Board

SPCS PR & VI NAD83

4. Hazard Profiles and Risk Assessment

4.1 Note on the Discussion of Hazards

The 2020 LHMP divided the discussion of the considered hazards into two separate and non-continuous sections. This arrangement made the analysis of the hazard cumbersome since the reader had to go back and forth between two different sections of this large document. In order to improve this, this new LHMP discusses both the profile of the hazard and the risk associated in one single section.

4.2 Regulatory Requirements

Federal regulation 44 C.F.R. § 201.6(c)(2) establishes the requirements related to hazard identification and risk assessment for LHMP. The Plan LHMP must include the following:

- An assessment that provides the basis for identifying the proposed activities aimed at reducing losses associated with the identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses related to the identified hazards. The hazard assessment must include:
    - A description of the type, location, and extent of all natural hazards that may affect the jurisdiction. It must contain information on previous occurrences of hazard events and the probability of future hazards.
    - A description of the jurisdiction's vulnerability to the identified hazards. This description must include a comprehensive summary of each hazard and its impact on the community. This Plan must describe vulnerability in terms of:
        - The number of existing structures, infrastructure, and critical facilities located within identified hazard areas;
        - An estimate of the potential monetary losses to structures identified as vulnerable, along with a description of the methodology used to prepare the estimate; and, lastly,
        - A general description of land use and development patterns within the community so that mitigation options can be considered in future land-use decisions.

- A description of all structures insured under the National Flood Insurance Program (NFIP) that have experienced repetitive damage from different flood events. It must explicitly indicate whether the community participates in the NFIP and complies with its regulations. It must also include a table showing repetitive property losses along with a table of NFIP claims and losses.

4.3 Hazards that can Affect the Municipality

To determine the hazards to be addressed in this LHMP, the Municipality reviewed and integrated information from the 2021 Puerto Rico State Hazard Mitigation Plan, the 2020 Añasco Local Hazard Mitigation Plan, and the latest LHMP's of the municipalities that share a boundary with Añasco. The following table summarizes the hazards addressed in these Hazard Mitigation Plans. A check mark indicates that the hazard was included in the corresponding plan, while an "X" denotes that it was not.

Table 16: Hazards Inventories

Hazard	2021 PRSHMP	2020 Añasco LHMP	Neighboring Municipalities
Earthquake/Liquefaction	✓	✓	✓
Landslides	✓	✓	✓
Tsunami	✗	✓	✓
Flooding	✓	✓	✓
Storm Surge	✗	✓	✓
Coastal Erosion	✗	✓	✓
Sea Level Rise	✗	✓	✓
Tropical Cyclone/Extreme Winds	✓	✓	✓
Extreme Heat	✗	✓	✓
Drought	✓	✓	✓
Wildfire	✗	✓	✓
Pandemic/Epidemic	✗	✗	✗
Anthropogenic Hazards	✗	✗	✗

After reviewing the hazard profiles contained in these documents, the Municipality of Añasco determined that the following hazards shall be assessed and evaluated as part of the 2026 LHMP:

Table 17: Hazards to be included in the Añasco 2026 LHMP

Hazard	Included in Añasco 2026 LHMP?	Comments
Earthquake	Yes	It is included given Puerto Rico's location among major fault lines and the 2020 Seismic activity.
Landslides	Yes	It is included given the high propensity for landslides in Añasco's territory.
Tsunami	Yes	It is included given Puerto Rico's location among major fault lines and the 2020 Seismic activity.
Flooding	Yes	It is included given the presence of extensive flood zones in the municipality that host critical infrastructure.
Tropical Cyclone/Extreme Winds	Yes	Included as part of the discussion on tropical cyclones.
Storm Surge	Yes	It is included given the presence of extensive coastal flood plains and critical infrastructure that is exposed to this hazard.
Long – Term Coastal Modification	Yes	It is included given there is critical infrastructure that is exposed to this hazard.
Extreme Heat	Yes	A new inclusion, various of Añasco neighboring communities included this hazard. The Municipality understands that the inclusion

Hazard	Included in Añasco 2026 LHMP?	Comments
		of this hazard in the updated LHMP is warranted.
Drought	Yes	It is included given the 2014-2016 droughts and recent periods of moderate drought
Wildfire	Yes	A new inclusion, various of Añasco neighboring communities included in this hazard. The Municipality understands that the inclusion of this hazard in the updated LHMP is warranted.
Pandemic/Epidemic	Yes	The municipality of Añasco included this in the previous AHMP. It will be considered by the LHMP update given the COVID -19 emergency declaration of 2020.
High Hazard Potential Dam	Yes	It is included because the municipality has direct risk exposure within it's territory or from neighboring municipalities.

For the rest of this document, the hazards shall be evaluated in the following order:

Table 18: Order of Hazards to be Assessed[5]

Classification	Hazard
Geological Hazards	Earthquake
	Landslides
	Tsunami
Hydrological Hazards	Flooding
	Tropical Cyclone/Extreme Winds

Meteorological Hazards	Extreme Heat
	Drought
Environmental Hazards	Wildfire
	Long Term Coastal Modifications
Biological Hazards	Pandemic/Epidemic
Anthropogenic Hazards	High Hazard Potential Dam

4.4 Chronology of Events

To prevent duplication of data and for easy reference in the discussion of each hazard profile the reader will find a chronology of events in the discussion of the hazard itself.

4.4.1 High Hazard Potential Dams

Please refer to Section 4.15.2.1 for details regarding the methodology used to assess high hazard potential dam risks.

4.5 Risk Assessment Methodology

This section describes the methodologies employed to evaluate the identified hazards. Given that each hazard presents distinct characteristics, data needs, and levels of uncertainty, multiple analytical approaches were utilized to ensure a thorough, accurate, and comprehensive risk assessment.

4.5.1 HAZUS 6.1

HAZUS is a Geographic Information System (GIS)–based risk assessment tool developed by FEMA to estimate potential losses associated with natural hazards. The software applies scientific modeling and spatial datasets to evaluate the impacts of events such as earthquakes, floods, hurricanes, and tsunamis on buildings, infrastructure, population, and the local economy. HAZUS generates detailed estimates of physical damage, economic losses, and social consequences, thereby supporting hazard mitigation planning, emergency preparedness, and recovery efforts. By integrating data on hazard intensity, exposure, and vulnerability, HAZUS enables decision-makers to prioritize mitigation strategies and allocate resources

effectively. The following hazards were evaluated using the HAZUS 6.1 platform:

- Earthquake
- Tropical Cyclone/Extreme Winds
- Tsunami
- Flooding

4.5.2 Alternative GIS modeling

Certain hazards are not currently modeled in HAZUS; however, they can be evaluated using alternative GIS-based techniques. ESRI® ArcGIS Pro™ 3.6 was utilized to assess hazard vulnerability by incorporating digital risk datasets and the hazard information database previously described. Using these spatial data layers, vulnerability was estimated by identifying the number of critical facilities and buildings located within hazard-prone areas. It is important to note that this method may overestimate exposure levels. In this LHMP, the following hazards were assessed using this GIS-based approach:

- Landslides
- Storm surge

4.5.3 Stochastic Risk Assessment

The stochastic risk assessment methodology was applied to evaluate hazards that are not addressed by existing hazard models or GIS-based analyses. This method is particularly appropriate for hazards that lack defined geographic boundaries and therefore cannot be reliably examined through spatial analysis. The approach allows for the incorporation of estimated annual losses and impact data; however, the accuracy of the results is highly dependent on the availability and quality of the underlying datasets.

In the case of this LHMP, the hazards evaluated using this methodology are:

- Long-Term Coastal Dynamics
- Extreme Heat
- Drought
- Wildfire
- Pandemic/Epidemic

4.6 Earthquake

4.6.1 Description (B1-a)

An earthquake is a sudden movement of the Earth's crust generated by seismic waves that propagate outward in all directions from the focus, or point of origin (FEMA, 1997). The focus is the location within the Earth where the displacement of rocks along a fault initiates, while the epicenter refers to the point on the Earth's surface situated directly above the focus (Puerto Rico Seismic Network, 2019). Earthquakes may occur due to changes in pressure within the Earth's crust, including tectonic plate movement, rock rupture, volcanic activity, landslides, or the collapse of underground cavities.

Most earthquakes result from the release of accumulated stress generated by the displacement of rocks along faults within the Earth's outer crust. These faults are generally located along the boundaries of the planet's major tectonic plates. The highest levels of tectonic instability occur at plate margins where slow, opposing movements create substantial pressure due to plates traveling in different directions and at varying speeds. This deformation along plate boundaries causes stress to build in the surrounding rock. When the accumulated stress surpasses the strength of the rock, a rupture occurs, releasing stored energy in the form of seismic waves that propagate outward and produce an earthquake (NMEAD, 2021).

Earthquakes can impact extensive geographic areas, causing tens of billions of dollars in property damage, significant loss of life, numerous injuries, and widespread disruption to the social and economic stability of affected communities. Most structural damage and earthquake-related fatalities result from building collapse triggered by ground shaking (NMEAD, 2021). The severity of impacts depends on the amplitude and duration of seismic shaking, which are influenced by factors such as earthquake magnitude, proximity to the fault rupture, and the local and regional geologic conditions (NMEAD, 2021). Additional hazards associated with earthquakes include landslides where soil and rock masses move downslope and liquefaction, a process in which saturated soils lose their rigidity and behave like a fluid. Liquefaction can cause foundations and structures that rely on soil stability to shift, tilt, or collapse. Puerto Rico is located near the boundary between the North American and Caribbean tectonic plates, within a subduction zone where one plate gradually descends beneath the other. This tectonic environment is characterized by significant seismic activity and lateral displacement. The relative movement between these two plates is

approximately 2 centimeters per year (Puerto Rico Seismic Network, 2019). According to the Puerto Rico Seismic Network, seismic activity in the region is concentrated in eight (8) primary zones:

- The Puerto Rico Trench to the North,
- The North and South Slope Faults of Puerto Rico,
- The "Sombrero Zone", to the Northeast,
- The Mona Passage to the West,
- The Mona Canyon to the West,
- The Virgin Islands and Anegada depressions to the East,
- The Muertos Trough to the South,
- In the southwest of Puerto Rico

To describe earthquake size, seismology uses three (3) primary terms: intensity, magnitude, and ground acceleration. Intensity measures the level of shaking experienced by structures and the natural environment at a specific location. It varies based on the distance from the earthquake's focus and the duration of the shaking. Magnitude refers to the amount of energy released during the event, as recorded by seismometers. Ground acceleration expresses the force of the seismic waves acting on the ground and is commonly used to characterize the severity of an earthquake (PRSN, 2019).

Earthquakes can generate a variety of secondary hazards, including liquefaction, landslides, seismic wave amplification, and tsunamis. For the purposes of this analysis, the primary secondary hazard of concern is earthquake-induced liquefaction, as it is a condition for which mitigation strategies can be effectively developed once susceptible areas are identified and mapped. Liquefaction refers to the process in which certain saturated soils temporarily lose their structural strength and behave like a dense fluid, significantly reducing their load-bearing capacity (PRSN, 2019). Liquefaction typically occurs in areas underlain by medium- to fine-grained sandy soils that are saturated with water and of relatively recent geologic origin. These conditions are most found along river margins and within Quaternary (Q) alluvial deposits. Another secondary hazard associated with earthquakes is the amplification of seismic waves. Seismic wave amplification occurs in thick alluvial deposits where seismic waves decelerate, increasing their oscillation and causing the ground to experience stronger and more prolonged shaking.

4.6.1.1 Affected Area (B1-B)

The following maps measure the spectral acceleration and spectral displacement in HAZUS run scenarios.

Spectral Acceleration is a measure used mainly in earthquake engineering to describe how strongly the ground motion from an earthquake would accelerate a structure with a specific natural period. This measure answers the question "If a building (or any structure) vibrates naturally at a certain period, how much acceleration would it experience during an earthquake?" or, how hard the ground is pushing on the building at a specific vibration period? The higher the spectral acceleration, stronger the forces acting on the structure will be, which can cause structural failure if the building isn't designed for it (USGS, 2019).

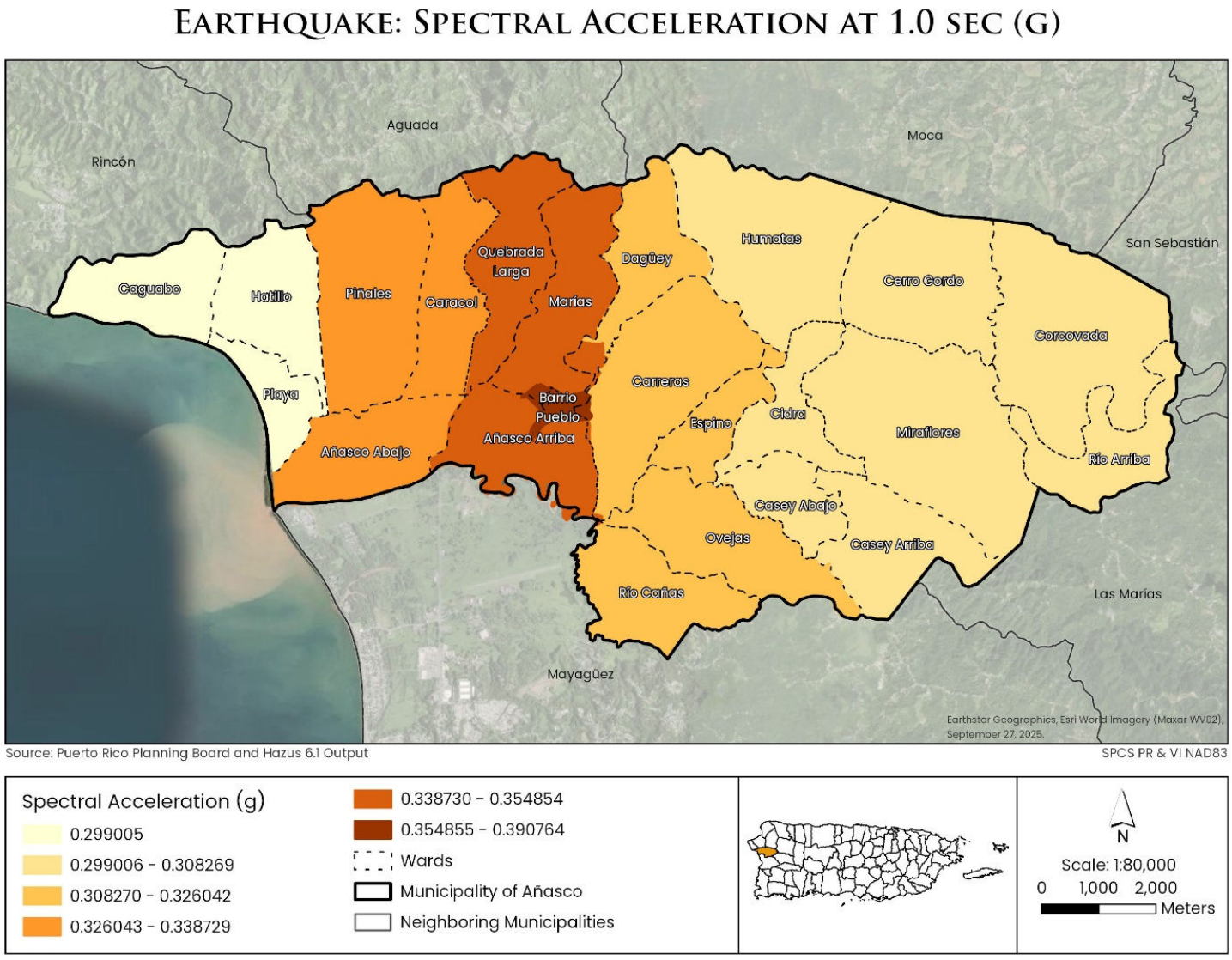
Spectral Displacement measures how far a structure is expected to move (deform) during an earthquake, based on its natural vibration period and damping, in other words, it answers: "For a building with a given natural period, what is the maximum displacement it would experience during earthquake shaking?" (National Institute of Building Sciences, 2020).

Furthermore, the maps show the HAZUS scenario for .03 seconds and 1.0 seconds. The difference relates to how an earthquake impacts different types of structures based on the natural vibration period the building. The maps showing the 0.3-second scenario can affect buildings that are short, stiff structures like 1 or 2-story buildings. These buildings are rigid, so they vibrate quickly when the ground shakes. While the 1.0-second scenario that is more important for buildings are taller, more flexible structures, like mid- to high-rise buildings. These buildings are taller and less stiff and therefore sway more slowly (over a longer period) during an earthquake (FEMA, Hazus Earthquake Model User Guidance, 2024).

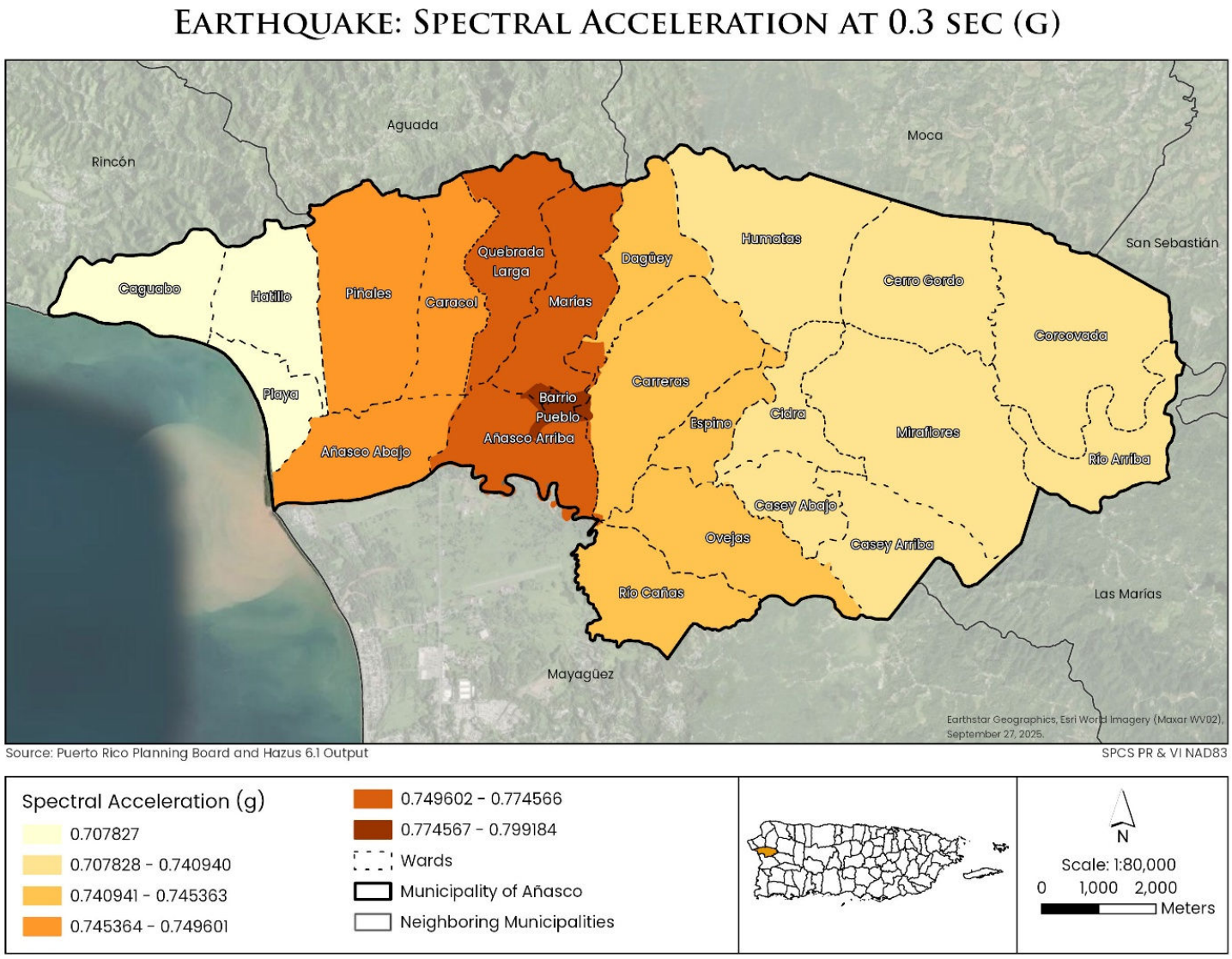
Map 12-15 shows the distribution of earthquake spectral acceleration and spectral displacement values throughout the Municipality of Añasco based on Hazus 6.1 outputs. As shown on the maps, the highest acceleration and displacement values are concentrated in the central portion of the municipality, particularly within Barrio Pueblo, Quebrada Larga, and Marías, with elevated values also extending into portions of Añasco Arriba. Moderate values are observed in Carreras, Dagüey, Espino, Ovejas, Río Cañas, Piñales, Caracol, and Añasco Abajo. Lower values occur across the eastern and western portions of the municipality, including the barrios of Humatas, Cerro Gordo, Corcovada, Miraflores, Río Arriba, Cidra, Casey Arriba, Casey Abajo, Caguabo,

Hatillo, and Playa. According to the Hazus 6.1 outputs, spectral acceleration ranges from approximately 0.7078 g to 0.7992 g at 0.3 seconds and from 0.2990 g to 0.3908 g at 1.0 second, while spectral displacement ranges from approximately 0.6243 to 0.7049 inches at 0.3 seconds and from 2.9303 to 3.8295 inches at 1.0 second. These results indicate variation in anticipated earthquake ground-motion response throughout the municipality, with the highest modeled values concentrated in the central barrios of Añasco.

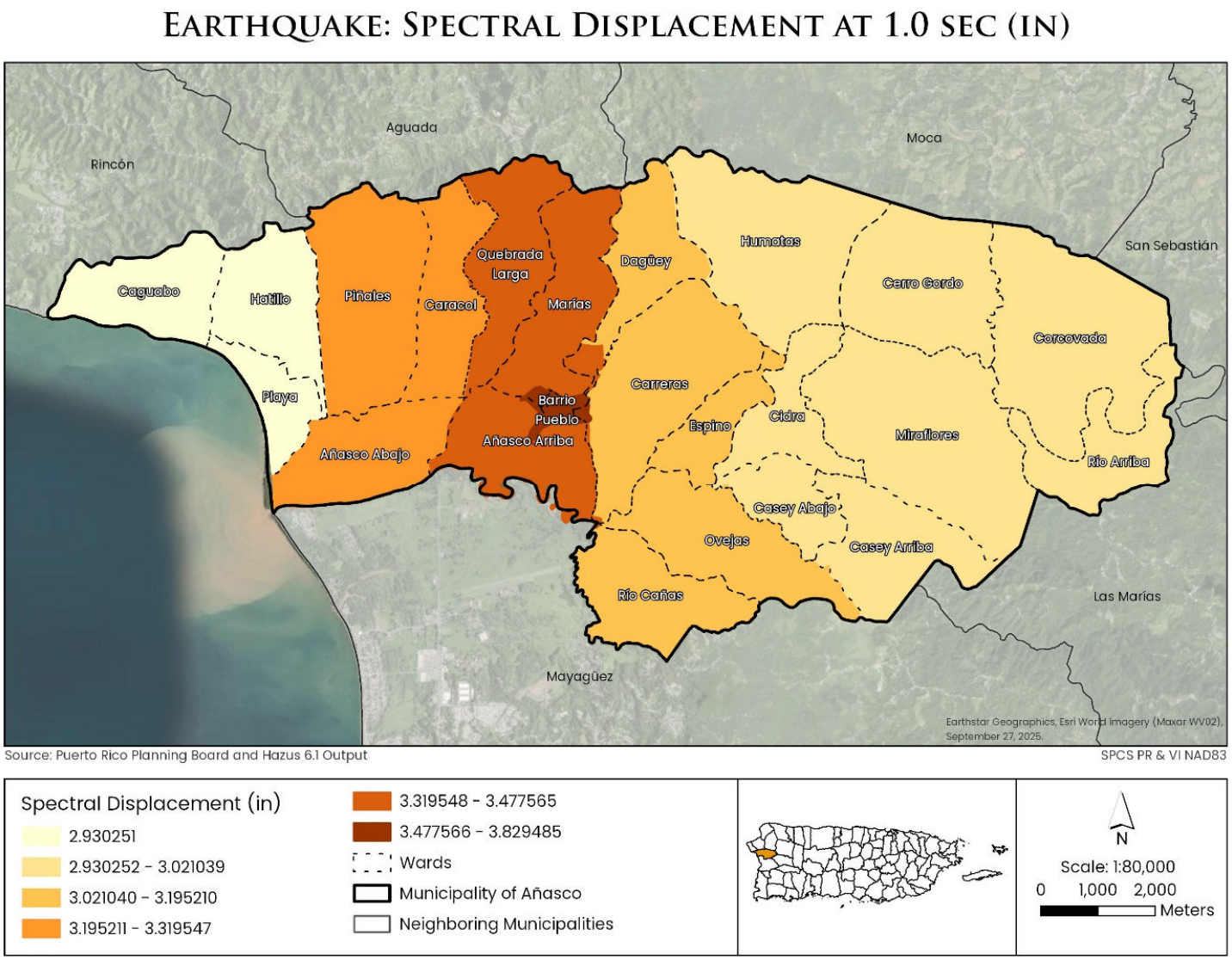
Map 12: Earthquake: Spectral Acceleration at 1.0 sec



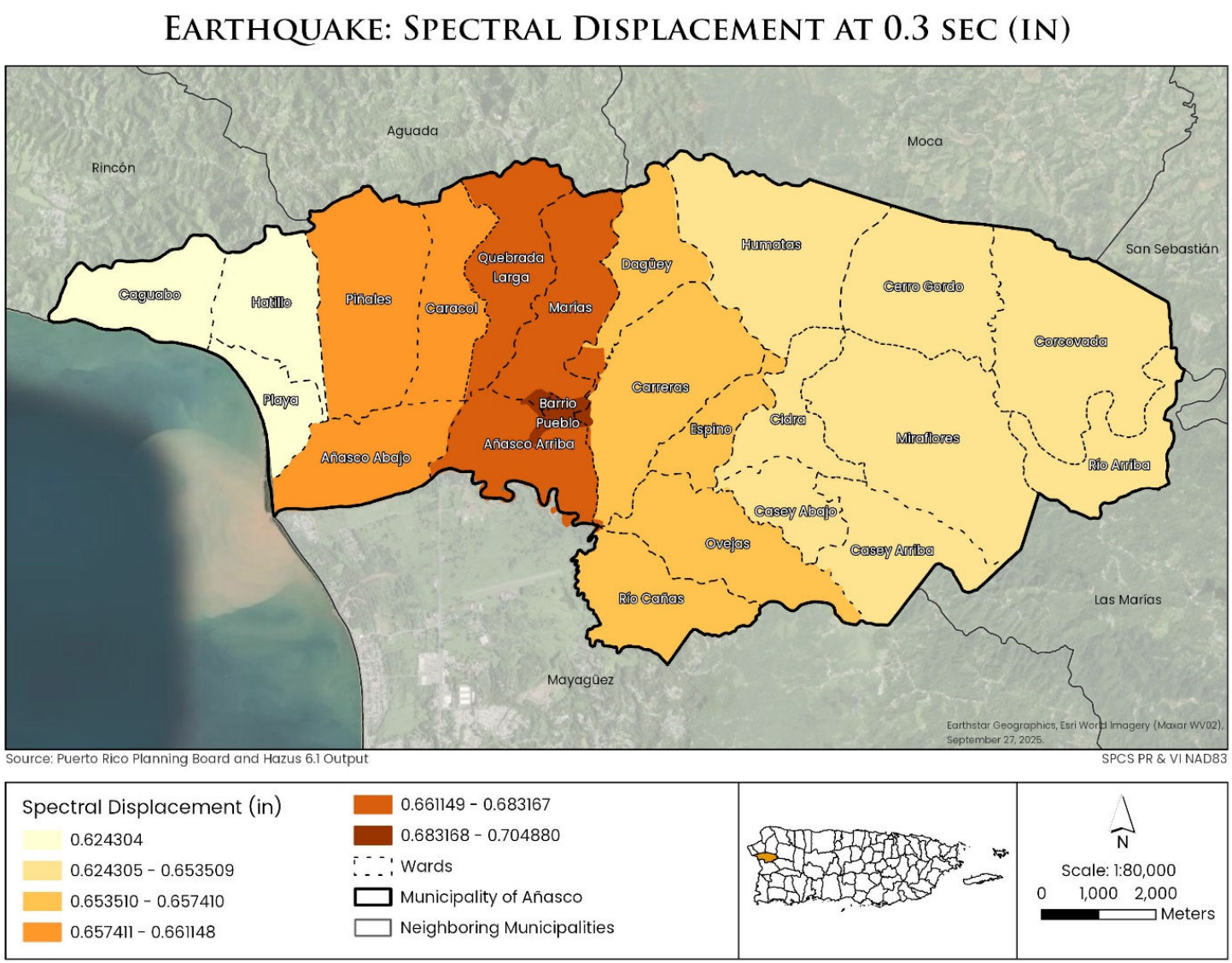
Map 13: Earthquake: Spectral Acceleration at 0.3 sec



Map 14: Earthquake Spectral Displacement at 1.0 sec



Map 15: Earthquake: Spectral Displacement at 0.3 sec



4.6.1.2 Risk Magnitude (B1-C)

The size of an earthquake, commonly associated with the Richter Scale, is widely recognized but often misunderstood. The concept of a logarithmic magnitude scale was first introduced by Charles Richter in the 1930s to measure earthquakes in Southern California using high-frequency recordings from nearby seismograph stations. This original scale, designated as ML where "L" stands for "local" eventually became known as the Richter magnitude.

As global seismic monitoring networks expanded, it became evident that the Richter method was accurate only within specific frequency and distance ranges. To accommodate a broader range of seismic signals recorded worldwide, additional magnitude scales were developed as extensions of Richter's original concept, including the body-wave magnitude (Mb) and the surface-wave magnitude (Ms). Each of these scales applies to a particular frequency range and type of seismic waves, and within their respective valid ranges, they provide magnitudes equivalent to the Richter scale (USGS, 2024).

Due to the limitations of the ML, Mb, and Ms scales, a more universally applicable scale moment magnitude (Mw) was developed. For large-magnitude earthquakes, Mw provides the most accurate and reliable estimate of earthquake size.

Moment is a physical quantity proportional to the amount of slip that occurs along a fault multiplied by the area of the fault surface that undergoes rupture. It reflects the total energy released by an earthquake. Moment can be derived from seismogram data and geodetic measurements and subsequently converted into a magnitude value using a standardized formula. The resulting measure, known as moment magnitude, provides a consistent and comparable estimate of earthquake size across the full range of magnitudes a capability that earlier scales do not offer (USGS, 2024). Table20 below shows the Moment – Magnitude scale.

Table 19: Moment - Magnitude Scale[6]

Range	Description
Mw < 3.0	Usually not felt by people.
Mw 3.0 – 4.9	Minor earthquakes, often felt but rarely cause damage.
Mw 5.0 – 5.9	Moderate can cause slight damage to poorly built structures.
Mw 6.0 – 6.9	Strong can cause significant damage in populated areas.
Mw 7.0-7.9	Major, serious damage over large areas.
Mw ≥ 8.0	Great earthquakes, catastrophic damage over very large regions.

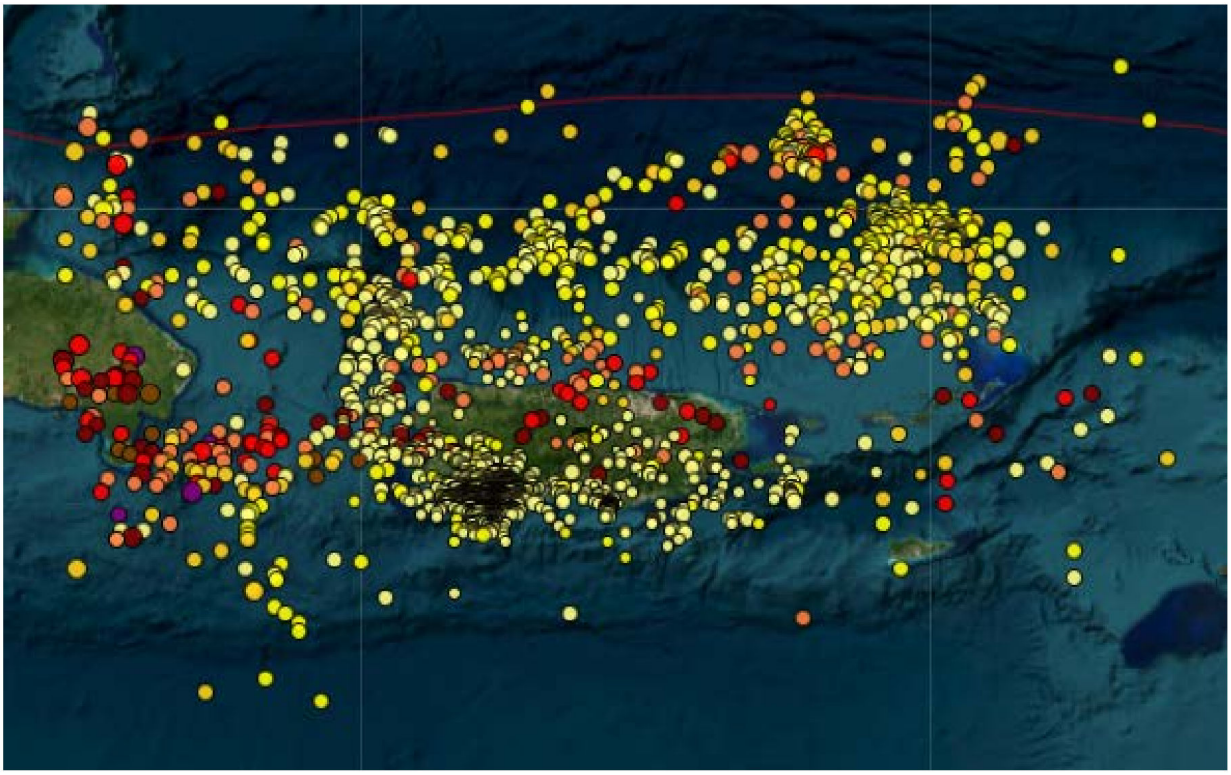
4.6.1.3 Past Events (B1-D)

Earthquakes occur naturally daily, and their impacts increase significantly with greater magnitude. High-magnitude events can be particularly destructive, causing extensive property damage, loss of life, and severe disruption to affected regions. Puerto Rico is located near several active seismic zones including the Puerto Rico Trench, the Mona Canyon, the Anegada Trough, the Muertos Trough, and the southern fault system placing the island at heightened risk for seismic events. Seismicity in the southeastern region of Puerto Rico is primarily associated with faults in the Virgin Islands and Anegada depressions. In the southwestern region, activity is influenced by the Punta Montalva fault (Roig Silva, 2010), an area that has experienced a notable increase in seismic activity in recent years (Weilert & Laó-Dávila, 2023).

Figure 13 is a screengrab sourced from a report published by the Puerto Rico Seismic Network (in Spanish). This report illustrates the epicenters of earthquakes recorded in the Puerto Rico and U.S. Virgin Islands region in 2024 (PRSN, 2025).

[6] Source: USGS, 2025

Figure 14: PRSN - 2024 Earthquakes Epicenter screengrab (PRSN, 2025)



Earthquake Chronology

The table below shows the chronological list of seismic activity in Puerto Rico for the period of 2012 to 2024 as reported by the PRSN (PRSN, n.d.).

Table 20: Puerto Ric Seismic Activity 2013-2024

Year	Description of seismic events
2024	The largest earthquake of 2024 occurred on May 14, 2024, at 8:30:11 p.m. (Puerto Rico local time). The magnitude 5.6 Ml earthquake was located 94.3 km north-northwest of Aguadilla (PR) at a depth of 7 km. This moderate earthquake was widely felt throughout Puerto Rico, with a maximum intensity of V (Modified Mercalli Intensity Scale, MMI) in Aguadilla (PR). The largest earthquake of 2024 occurred on May 14, 2024, at 8:30:11 p.m. (Puerto Rico local time). The magnitude 5.6 Ml earthquake was located 94.3 km north-northwest of Aguadilla (PR) at a depth of 7 km. This moderate earthquake was widely felt throughout Puerto Rico, with a maximum intensity of V (Modified

Year	Description of seismic events
	Mercalli Intensity Scale, MMI) in Aguadilla (PR). During 2024, aftershocks from the South-Southwest Puerto Rico seismic sequence continued. This sequence began on December 28, 2019, with a magnitude 4.7 Ml earthquake. The main event of this sequence occurred on January 7, 2020, in the southern region of Puerto Rico, 12.7 km south of Guayanilla, with a magnitude of 6.4 Mw. This strong earthquake, at a depth of 7 km, had a maximum intensity of VIII in Guánica, Puerto Rico, and caused major damage across the island. From the start of the South-Southwest Puerto Rico seismic sequence in 2019 through April 2024, 27,497 earthquakes associated with this sequence have been processed (Figure 2). More than 1,688 felt earthquakes and over 492 significant events with magnitudes greater than 3.5 have been recorded. Of these, 42 earthquakes had magnitudes greater than 4.5.
2023	The largest earthquake of 2023 occurred on December 9, 2023, at 10:27:22 a.m. (Puerto Rico local time). The magnitude 5.7 Ml earthquake was located 192.28 km east-northeast of San Juan, PR, at a depth of 7 km. This moderate earthquake was widely felt throughout Puerto Rico and the Virgin Islands, with a maximum intensity of V (Modified Mercalli Intensity Scale, MMI) in St. Thomas (USVI). During 2023, aftershocks from South-Southwest Puerto Rico seismic sequence continued. This sequence began on December 28, 2019, with a magnitude 4.7 Ml earthquake. The main event of this sequence occurred on January 7, 2020, in the southern region of Puerto Rico, 12.7 km south of Guayanilla, with a magnitude of 6.4 Mww. This strong earthquake, at a depth of 7 km, had a maximum intensity of VIII in Guánica, Puerto Rico, and caused major damage across the island.
2022	The seismic sequence in the South-Southwest region of Puerto Rico, which began on December 28, 2019, continues. From its onset until the March 2022 report by the Puerto Rico Seismic Network, a total of 19,436 earthquakes associated with this sequence had been recorded. In that report, 1,502 events were

Year	Description of seismic events
	documented for 2022, of which 30 were reported as felt. The regions with the highest seismic activity during March 2022 were in the southern area of Puerto Rico.
2021	The largest earthquake of 2021 occurred on January 24, 2021, at 7:21:41 p.m. (Puerto Rico local time). The magnitude 5.4 Ml earthquake was located 44.82 km southeast of Virgin Gorda, BVI, at a depth of 94 km. This moderate earthquake was widely felt throughout Puerto Rico and the Virgin Islands, with a maximum intensity of V (Modified Mercalli Intensity Scale, MMI) in Tortola, British Virgin Islands.
2020	The year 2020 was marked by significant seismic activity. An earthquake of magnitude 5.8 was recorded on January 6, 2020, followed by another of 6.4 on January 7, 2020, located 8 km from Indios, Puerto Rico. It is important to clarify that, starting from the 4.7 magnitude event recorded on December 28, 2019, up to October 22, 2020, approximately over 1,200 earthquakes of magnitude 2.0+ have been felt on the island. Tectonic activity in Puerto Rico is dominated by the convergence between the North American and Caribbean plates, with the island compressed between the two. To the north of Puerto Rico, the North American plate subducts beneath the Caribbean plate along the Puerto Rico Trench. To the south of the island, and south of the January 7 earthquake, the upper crust of the Caribbean plate subducts beneath Puerto Rico in the Muertos Trough. However, the January 6 earthquake and other recent events are occurring in the offshore deformation zone, connected by the Punta Montalva fault on land and the Guayanilla Canyon offshore. Between December 28, 2019, and January 23, 2020, southern Puerto Rico recorded 90 seismic events of magnitude 4.0 or greater, including the 6.5 magnitude earthquake on January 7, 2020, according to the USGS. These seismic movements led state authorities to request a disaster declaration from the President of the United States. This Disaster Declaration was issued on January 16, 2020, under number DR-4473. The Municipality of Añasco was not included among those designated to receive Individual Assistance funds from FEMA.

Year	Description of seismic events
2019	During 2019, the Puerto Rico Seismic Network (PRSN) located a total of 6,510 earthquakes in the Puerto Rico and Virgin Islands region (our seismic responsibility area, between latitudes 17°N–20°N and longitudes 63.5°W–69°W). Compared to 2018 (3,974 earthquakes), the detected and located seismicity in 2019 increased. The year 2019 ended with 2,536 more earthquakes than the previous year. In 2019, the month with the highest activity was December with 1,291 earthquakes, while August had the lowest seismicity with 303 earthquakes. The region with the highest recorded seismicity during 2019 was the Mona Canyon with 1,288 seismic events, followed by the southern region of Puerto Rico with 885 earthquakes (Table 3). Earthquake depths ranged from 1 km to 191 km, and magnitudes varied from 0.34 Md to 6.0 Mw. Of the total earthquakes in 2019, 70 were reported as felt. On December 28, 2019, an active period of seismic activity began, with a 4.7 magnitude earthquake, followed several hours later by another of 5.0 magnitude south of the island.
2018	During 2018, the Puerto Rico Seismic Network (PRSN) located a total of 3,974 earthquakes in the Puerto Rico and Virgin Islands region (our seismic responsibility area, between latitudes 17°N–20°N and longitudes 63.5°W–69°W). Compared to 2017 (3,129 earthquakes), the detected and located seismicity increased by 845 more earthquakes than the previous year. In 2018, the month with the highest activity was December with 549 earthquakes, while February had the lowest seismicity with 227 earthquakes. The region with the highest recorded seismicity during 2018 was the southern region of Puerto Rico with 412 seismic events, followed by the 19°N Fault Zone with 349 earthquakes. Earthquake depths ranged from 2 km to 185 km, and magnitudes varied from 0.63 Md to 4.67 Md. Of the total earthquakes in 2018, 29 were reported as felt within our area of responsibility.
2017	During 2017, the Puerto Rico Seismic Network (PRSN) located a total of 3,129 earthquakes in the Puerto Rico and Virgin Islands region (our seismic responsibility area, between latitudes 17°N–20°N and longitudes 63.5°W–69°W). Compared to 2016 (3,948

Year	Description of seismic events
	earthquakes), the detected and located seismicity decreased by 20%, which means 819 fewer earthquakes than the previous year. In 2017, the month with the highest activity was April with 518 earthquakes, while October had the lowest seismicity with 48 seismic events. The region with the highest recorded seismicity during 2017 was the Sombrero Seismic Zone with 856 seismic events, followed by the Virgin Islands Platform with 327 earthquakes. Earthquake depths ranged from 1 km to 180 km, and magnitudes varied from 0.85 Md to 4.8 Mb. Of the total earthquakes in 2017, 24 were reported as felt within our area of responsibility.
2016	During 2016, the Puerto Rico Seismic Network (PRSN) located a total of 3,947 earthquakes in the Puerto Rico and Virgin Islands region (our seismic responsibility area, between latitudes 17°N–20°N and longitudes 63.5°W–69°W). Compared to 2015 (3,235 earthquakes), the detected and located seismicity increased by 22.0%, or 712 more earthquakes than the previous year. In 2016, the month with the highest activity was September with 566 earthquakes, while March had the lowest seismicity with 169 earthquakes. The region with the highest recorded seismicity during 2016 was the Sombrero Seismic Zone with 973 seismic events, followed by the Virgin Islands Platform with 497 earthquakes. Earthquake depths ranged from 1 km to 177 km, and magnitudes varied from 0.76 Md to 4.6 Ml. Of the total earthquakes in 2016, 28 were reported as felt within our area of responsibility.
2015	During 2015, the Puerto Rico Seismic Network (PRSN) located a total of 3,235 earthquakes in the Puerto Rico and Virgin Islands region (our seismic responsibility area, between latitudes 17°N–20°N and longitudes 63.5°W–69°W). Compared to 2014 (3,420 earthquakes), the detected and located seismicity decreased by 5.4%, or 185 fewer earthquakes than the previous year. In 2015, the month with the highest activity was July with 473 earthquakes, while April had the lowest seismicity with 157 earthquakes. The region with the highest recorded seismicity during 2015 was the Sombrero Seismic Zone with 588 seismic events, followed by the 19°N Fault Zone with 477 earthquakes. Earthquake depths ranged from 1 km to 211 km, and magnitudes varied from 0.80 Md

Year	Description of seismic events
	to 4.80 Md (duration magnitude). Of the total earthquakes in 2015, 23 were reported as felt within the area of responsibility.
2014	During 2014, the Puerto Rico Seismic Network (PRSN) located a total of 3,420 earthquakes in the area of responsibility (AOR) known as the Puerto Rico and Virgin Islands Region (latitude 17.00˚ to 20.00˚N and longitude 63.50˚ to 69.00˚W). Compared to 2013 (2,293 earthquakes), the detected and located seismicity increased by 49%, which is 1,127 more earthquakes than the previous year. In this year, the month with the highest seismicity was January with 709 earthquakes, and the month with the lowest seismicity was November with 192 earthquakes. Of the total seismicity in 2014, 29 earthquakes (0.85%) were reported as felt, all located within our AOR. The magnitudes (Md) of the seismic events calculated for this year by PRSN ranged from 1.0 to 6.4, although for felt events they ranged from 2.53 Md to 6.4 Mwp. During 2014, depths varied between 1 km and 182 km, while for felt earthquakes they ranged from 6 km to 134 km. Earthquakes with depths of 0 to 25 km were the most frequent with 1,385 events, while those between 175 km and 200 km were the least frequent this year. The region with the highest recorded seismicity during 2014 was the 19°N Fault Zone with 905 seismic events, followed by the Sombrero Seismic Zone with 483 earthquakes.
2013	During 2013, the Puerto Rico Seismic Network (PRSN) located a total of 2,293 earthquakes in the Puerto Rico and Virgin Islands region (latitude 17.00˚ to 20.00˚N and longitude 63.50˚ to 69.00˚W). Compared to 2012 (2,852 earthquakes), the detected and located seismicity decreased by 20%, which is 559 fewer earthquakes than the previous year. In this year, the month with the highest seismicity was September with 272 earthquakes, and the month with the lowest seismicity was February with 114 earthquakes. Of the total seismicity in 2013, 44 earthquakes (1.92%) were reported as felt, all located within the Puerto Rico and Virgin Islands region. The magnitudes of the seismic events calculated for this year by PRSN ranged from 1.0 to 5.12, although for felt events they ranged from 2.36 to 5.12. During 2013, depths varied between 1 km and 182 km, while for earthquakes they ranged from 4 km to 112 km. The region with the highest recorded seismicity

Year	Description of seismic events
	during 2013 was the Sombrero Seismic Zone with 504 seismic events, followed by the Virgin Islands Platform with 246 earthquakes. Through its educational program, PRSN reached 14,099 people in Puerto Rico and the U.S. and British Virgin Islands during 2013.

2020 Seismic Sequence

In early January 2020, Puerto Rico experienced a significant seismic sequence that began with a series of foreshocks and culminated in a major earthquake on January 7. The main shock registered a magnitude of 6.4 Mw and struck along the island's southern coast, severely affecting the municipalities of Guayanilla, Ponce, and Yauco. This event was preceded by a magnitude 5.8 Mw earthquake on January 6, which had already caused widespread concern and notable structural damage (USGS, n.d.). The seismic activity was associated with the complex interaction between the Caribbean and North American tectonic plates, a region characterized by active subduction zones and fault systems. The resulting shaking was felt across the island, causing power outages, school closures, and the collapse of numerous structures, including residential and public buildings.

The aftermath of the earthquake resulted in extensive damage to homes and critical infrastructure, displacing thousands of residents and prompting a federal emergency declaration. The southern region experienced prolonged aftershocks—some exceeding magnitude 5.0, which continued for weeks, intensifying public concern and creating sustained disruption. This event underscored Puerto Rico's heightened vulnerability to seismic hazards and highlighted the importance of preparedness measures and resilient construction practices. The incident received a Presidential Disaster Declaration under the Stafford Act (DR-4473-PR) (FEMA, n.d.). Although the Municipality of Añasco was not included in the Disaster Declaration, it recognizes that Puerto Rico's location along active tectonic boundaries place all jurisdictions at risk of seismic events capable of causing millions of dollars in damage and significant disruptions to daily life.

According to the Puerto Rico Seismic Network (PRSN), from the onset of the South–Southwest Puerto Rico seismic sequence in 2019 through April 2024, a total of 27,497 earthquakes associated with this sequence were recorded and processed. Of these events, more than 1,688 were reported as felt, and over 492 registered magnitudes greater than 3.5. Additionally, 42 earthquakes reached magnitudes exceeding 4.5.

4.6.1.4 Future Event Probabilities (B1-E)

Unlike atmospheric hazards, earthquakes cannot be predicted with current scientific capabilities. However, advances in seismology allow for the development of probabilistic forecasts. Historical records indicate that Puerto Rico has experienced four major destructive earthquakes since 1670—specifically in 1670, 1787, 1867, and 1918. This sequence suggests a recurrence interval ranging from 51 to 117 years, with an average interval of approximately 83 years for significant events. It is important to note, however, that each of these earthquakes originated on different fault systems; therefore, this record alone cannot be used to establish a precise recurrence rate.

For more comprehensive analyses, geologic maps of specific zones are examined to identify active faults and other relevant structural features. These datasets are then correlated with historical earthquake intensity distributions, seismic attenuation models, and statistical records. This integrated approach produces maps of seismically active areas that delineate regions with varying potential for strong earthquake activity. Identifying these high-risk zones is essential for informed land-use planning and effective emergency preparedness.

In the case of Puerto Rico, the PRSN cites a probabilistic seismic hazard study conducted in 1987 by Dr. William McCann, which estimated a 33–50% probability of a strong earthquake (Intensity VII or higher on the Modified Mercalli Scale) occurring in various parts of the island within a 50-year period (PRSN, 2025).

Further research conducted by the U.S. Geological Survey in 2003 identified an area west–southwest of Puerto Rico as the region most likely to experience strong earthquakes on the island. This probabilistic analysis does not account for secondary hazards such as tsunamis, liquefaction, or seismic wave amplification, which predominantly affect low-lying coastal areas and high-elevation zones susceptible to landslides.

4.6.2 Risk Analysis (B2-A, B2-B)

4.6.2.1 Estimated Losses

The Federal Emergency Management Agency's HAZUS Earthquake Analysis provides estimates of Annualized Earthquake Losses defined as the long-term average annual economic impact of earthquakes on the general building stock within a given geographic area as well as annualized estimates of population loss.

The Annualized Earthquake Loss is calculated using the Riemann Sums Method, which averages the annual losses associated with multiple return periods and then multiplies each average loss by its corresponding differential probability to produce a single loss estimate for each Census tract. (FEMA, National Risk Index Data - Technical Documentation, 2025)

Table 21 presents the exposure to earthquake hazards. It is important to note that, although assigning an exact monetary value to human life is inherently complex, FEMA guidance converts population loss into an economic estimate using a "population equivalence" methodology based on the Value of Statistical Life (VSL). Under this approach, each fatality—or the equivalent of ten injuries—is assigned an economic loss value of $11.6 million, reflecting FEMA's inflation adjusted VSL estimate. All historical loss figures are subsequently adjusted to December 2024 dollars to account for inflation.

The HAZUS 6.1 analysis indicates that the municipality's total exposure to an earthquake event is $300,011,076,000. This estimate includes $3,097,476,000 in building value exposure and $296,913,600,000 in population exposure, based on the population equivalence methodology. The analysis further indicates that approximately 25,596 residents are located within the earthquake impact area, which encompasses 39.96 square miles of the municipality.

Table 21: Exposure to Earthquake Hazard

Exposure - Impacted Area (sq mi)	Exposure Building Value	Exposure Population	Exposure Population Equivalence	Exposure Total
39.958322	$3,097,476,000	25,596	$296,913,600,000	$300,011,076,000

Source FEMA NRI

The expected annual loss for each Census tract or jurisdiction represents the average yearly economic impact, expressed in dollars, anticipated from natural hazard events. Table 22 presents the expected annual earthquake-related losses for both buildings and population.

Table 22: Expected Annual Loss to Earthquake

Expected Annual Loss - Building Value	Expected Annual Loss - Population	Expected Annual Loss - Population Equivalence	Expected Annual Loss - Total
$2,939,437.8	0.2287	$ 2,653,190	$5,592,627.8

4.6.2.2 Lifelines and Critical Infrastructure

Earthquakes can affect a community's lifelines in the following ways:

- **Safety and Security** – An earthquake can cause the structural failure of critical facilities such as police stations and fire stations, generate increased demand for search-and-rescue operations, and result in population displacement requiring emergency sheltering. Such conditions may also create challenges in maintaining public order and ensuring community security.

- **Food, Hydration, and Shelter** – A seismic event can cause damage to water treatment plants and distribution systems, resulting in contamination or loss of potable water. Disruptions to transportation routes and storage facilities may also interrupt food supply chains. Widespread structural damage can increase the demand for temporary shelters. Additionally, the loss of refrigeration capacity may lead to significant spoilage of perishable goods.

- **Health and Medicine** - Hospitals and clinics may experience structural damage or a reduction in operational capacity during an earthquake. A surge in injuries requiring emergency medical attention can overwhelm existing healthcare facilities. Disruptions to pharmaceutical supply chains and medical logistics may also occur. Additionally, compromised sanitation conditions in emergency shelters can elevate the risk of disease outbreaks.

- **Energy** - Damage to power plants, substations, and transmission lines can result in widespread power outages. Ruptures in gas lines may create fire and explosion hazards. Interruptions in the fuel supply chain can also impede the operation of generators and emergency response vehicles.

- **Communications** - Damage to cell towers, fiber-optic cables, and communication hubs can result in significant loss of connectivity. Emergency call surges may overload telecommunications networks, further degrading

service availability. These disruptions can impair coordination among emergency response agencies and hinder the timely dissemination of critical information.

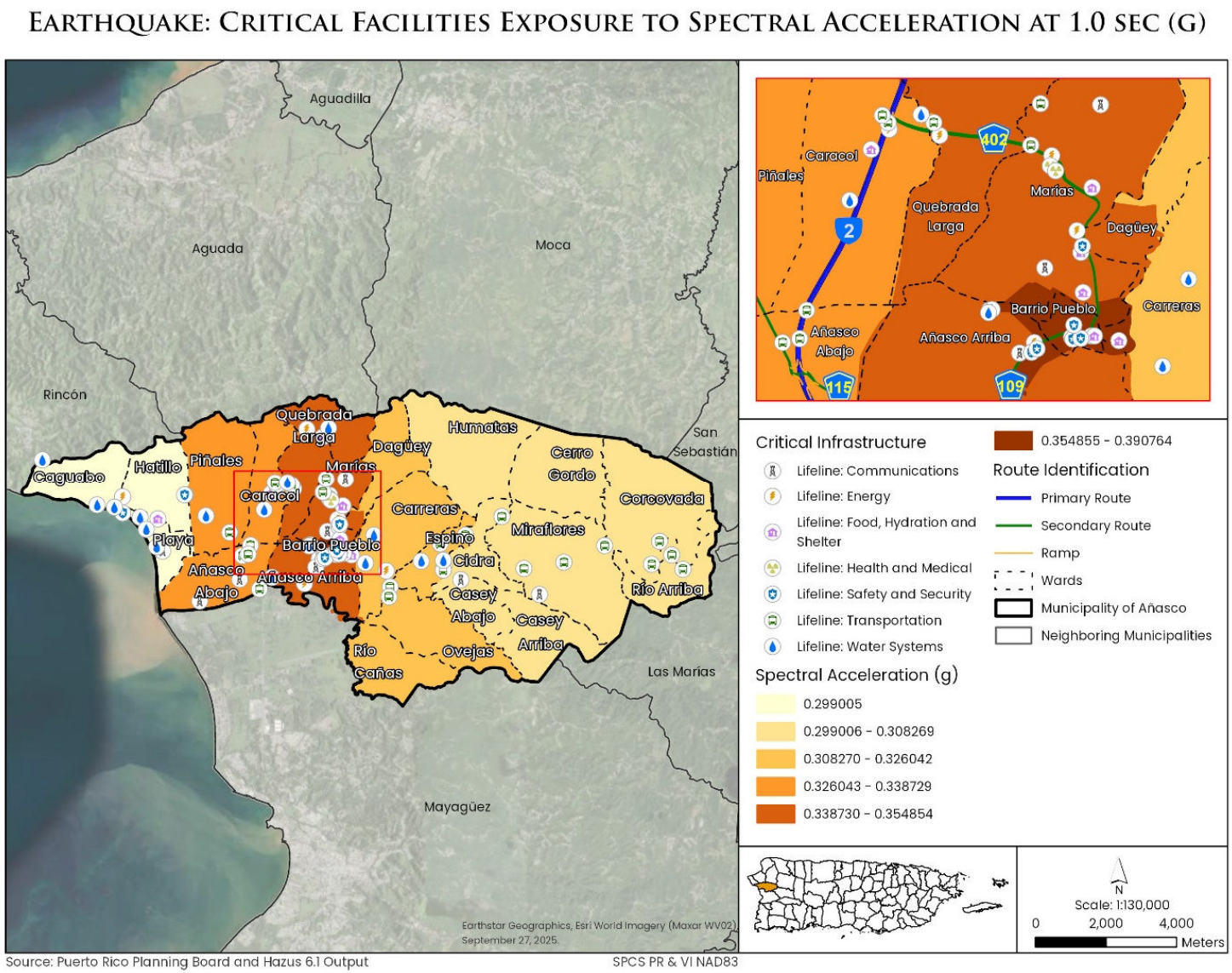
- **Transportation** - Collapse or severe damage to roads, bridges, and tunnels can significantly restrict mobility. Airports and seaports may become inoperable due to damage to runways or docks.

- **Hazardous Materials** – An earthquake may cause spills from industrial facilities, chemical plants, or storage tanks, increasing the risk of environmental contamination affecting air, soil, and water resources. Additionally, damage to sites containing hazardous materials may result in fires or explosions.

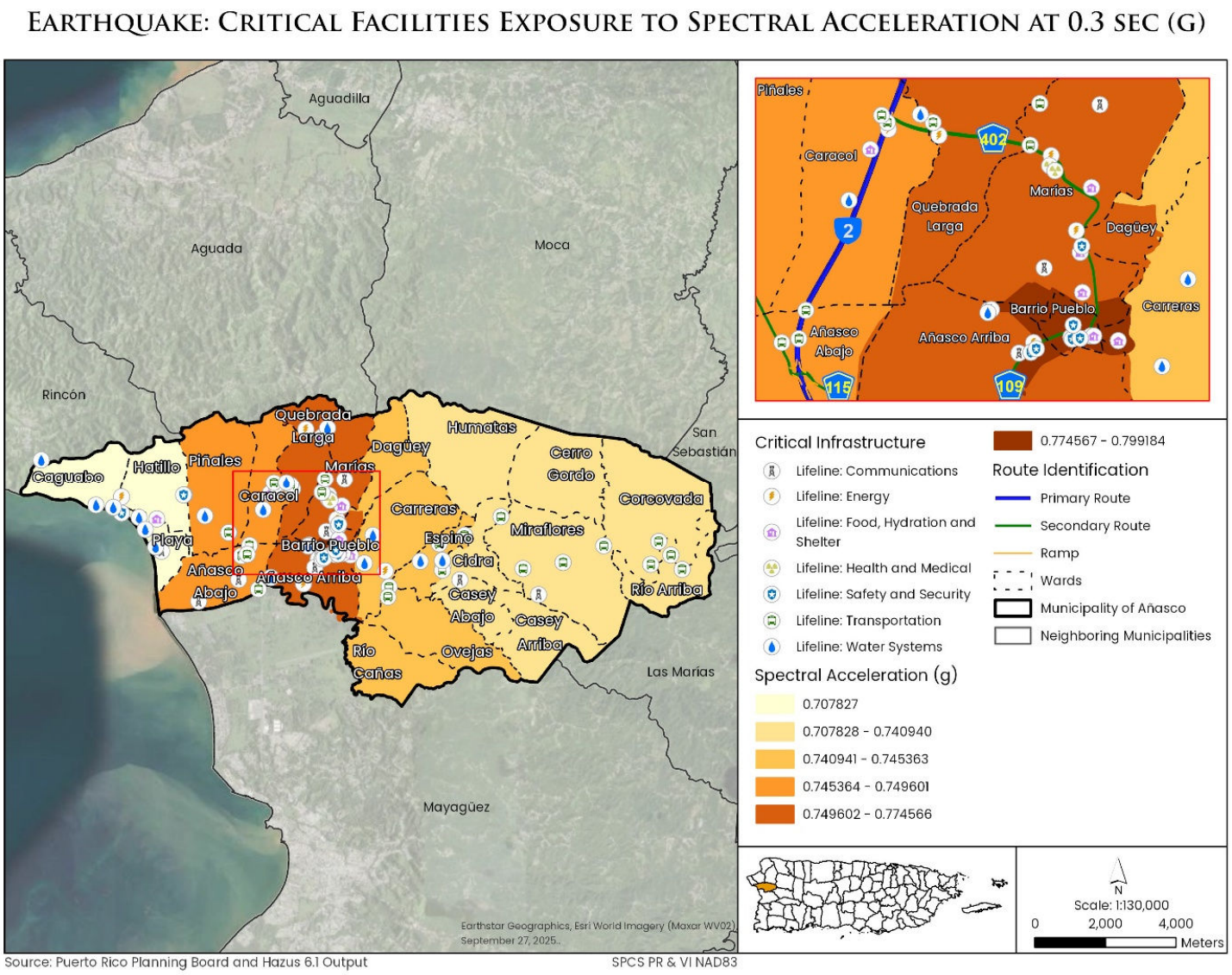
- **Water Systems** - Breakage of water mains and sewer lines can result in localized flooding and contamination. Such damage may also reduce firefighting capacity due to diminished water pressure and lead to long-term disruptions in wastewater collection and sanitation services.

Map 16 - 17 shows the exposure of critical facilities to modeled earthquake spectral acceleration within the Municipality of Añasco based on Hazus 6.1 outputs. The maps indicate that many of the municipality's critical facilities are concentrated within the central portion of Añasco, particularly in Barrio Pueblo, Añasco Arriba, Marías, Caracol, and Quebrada Larga, which correspond to the areas exhibiting the highest spectral acceleration values. Several transportation, water system, health and medical, safety and security, communications, energy, and food, hydration and shelter facilities are located within these higher acceleration zones. Additional critical facilities are distributed throughout the municipality, including the barrios of Dagüey, Espino, Cidra, Casey Abajo, Casey Arriba, Miraflores, Río Arriba, Playa, Hatillo, and Caguabo, where lower to moderate spectral acceleration values are mapped. The highest modeled spectral acceleration values are concentrated in Barrio Pueblo, Quebrada Larga, and Marías, reaching up to approximately 0.7992 g at 0.3 seconds and 0.3908 g at 1.0 second. Major transportation corridors shown within the higher acceleration zones include PR-2, PR-109, PR-115, and PR-402. These maps illustrate the geographic relationship between critical facilities and areas of varying earthquake ground-motion intensity throughout the municipality.

Map 16: Earthquake Critical Facilities Exposure to Spectral Acceleration at 1.0 sec



Map 17: Earthquake - Critical Facilities exposure to spectral acceleration at 0.3 sec



4.6.2.3 Social Vulnerabilities

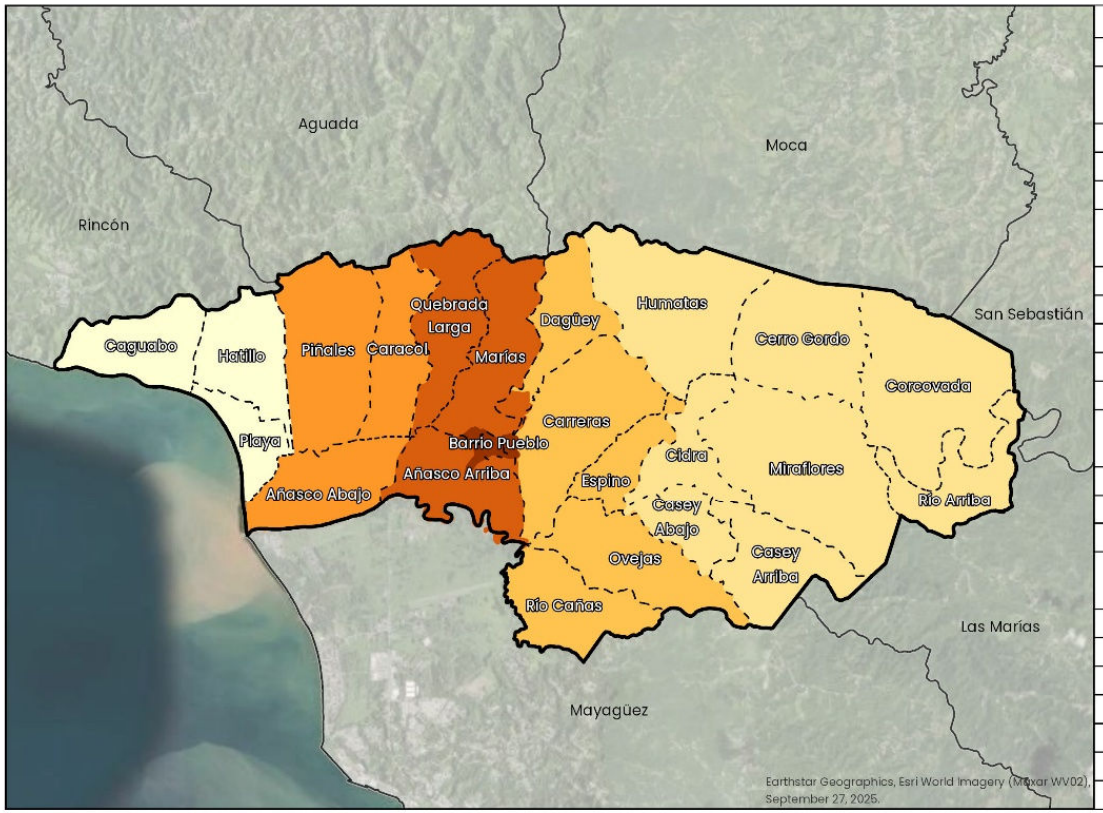
Social vulnerability to earthquakes in Puerto Rico is shaped by high levels of poverty, aging infrastructure, and limited access to essential resources, all of which disproportionately affect the ability of communities to withstand and recover from seismic events. Many residents face compounding disadvantages—such as disability, low educational attainment, and limited vehicle access—that reduce their capacity to evacuate, access information, or secure aid after a damaging earthquake. Research on disaster governance also shows that systemic governmental neglect and energy insecurity intensify the impacts of disasters, leaving communities with fewer resilience mechanisms in the aftermath of earthquakes.

Puerto Rico's disaster research literature identifies long-standing structural inequities that heighten vulnerability, including political and economic marginalization that limit long-term recovery and exacerbate risk accumulation across hazard types. Federal assessments further find that many census tracts exhibit high social vulnerability scores (US Census Bureau, 2024), (US Census Bureau, 2025), meaning that an earthquake's impacts are likely to intersect with broader socio-economic fragility. Overall, these combined factors demonstrate that earthquakes in Puerto Rico pose not only a physical hazard but also a deep social challenge tied to historical, economic, and infrastructural conditions that shape uneven disaster outcomes. For more details about Social Vulnerabilities see section 3.4.

Notwithstanding the classification of the municipal territory into areas of spectral acceleration in section 4.6.1 This version of the LHMP will be more conservative than the previous version and will consider all of the population of Añasco, equally vulnerable to the natural hazard of earthquake.

Map 18: Earthquake: Population Exposed to Spectral Acceleration at 1.0 (g) sec

Earthquake: Population Exposure to Spectral Acceleration at 1.0 sec (g)



Wards	Risk Category	Population
Añasco Abajo	High	1,195
Añasco Arriba	Extreme	310
	Very High	1,574
Barrio Pueblo	Extreme	351
Caguabo	Very Low	1,045
Caracol	High	1,040
Carreras	Extreme	110
	Medium	2,173
Casey Abajo	Low	149
Casey Arriba	Low	281
Cerro Gordo	Low	388
Cidra	Low	188
Corcovada	Low	574
Dagüey	Medium	1,036
	Very High	710
Espino	Medium	682
Hatillo	Very Low	1,085
Humatas	Low	508
Marías	Extreme	281
	Very High	2,755
Mirafiores	Low	636
Ovejas	Medium	1,662
Piñales	High	1,907
Playa	Very Low	525
Quebrada Larga	Very High	1,773
Río Arriba	Low	240
Río Cañas	Medium	1,367

Source: Puerto Rico Planning Board, Hazus 6.1 Output and Census Tract

SPCS PR & VI NAD83

Spectral Acceleration (g)
- 0.299005 (Very Low)
- 0.299006 - 0.308269 (Low)
- 0.308270 - 0.326042 (Medium)
- 0.326043 - 0.338729 (High)
- 0.338730 - 0.354854 (Very High)
- 0.354855 - 0.390764 (Extreme)
- Wards
- Municipality of Añasco
- Neighboring Municipalities

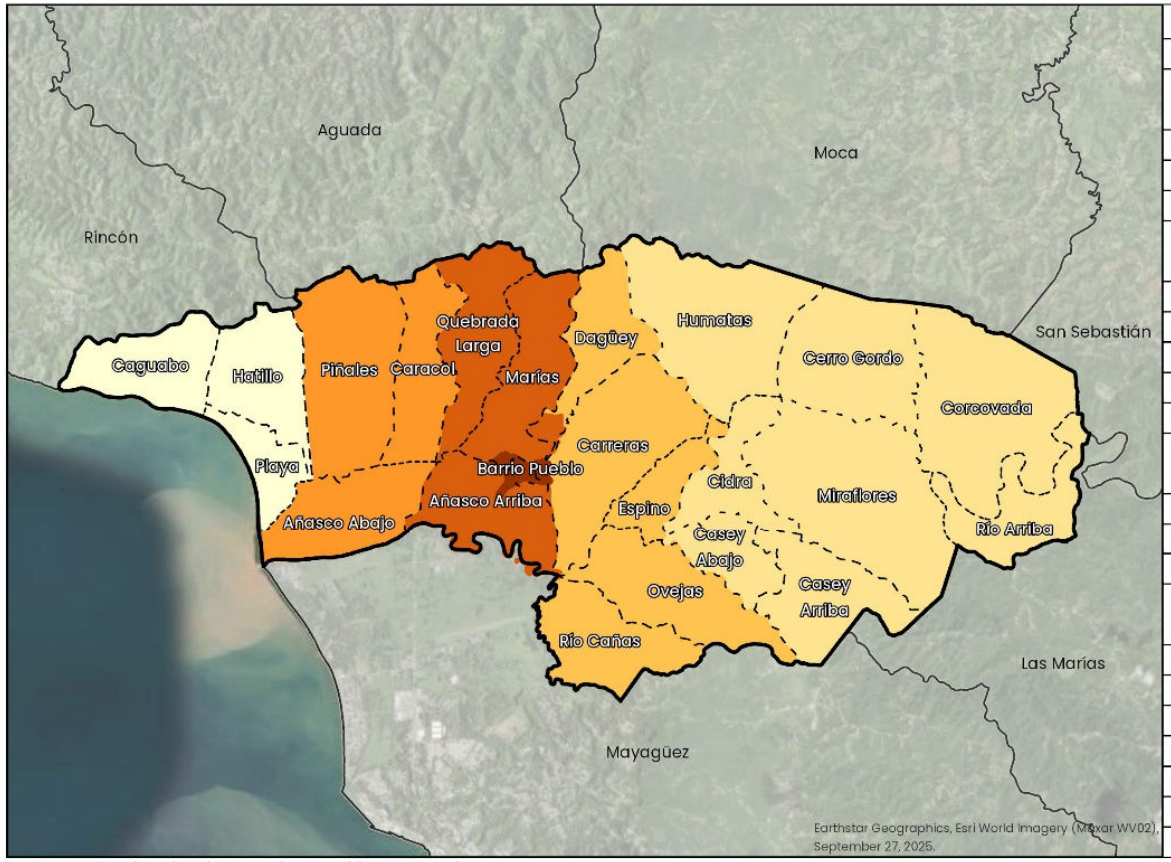


N

Scale: 1:110,000

0 1,500 3,000 Meters

Map 19: Earthquake: Population Exposure to Spectral Acceleration at 0.3 (g) sec



Wards	Risk Category	Population
Añasco Abajo	High	1,195
Añasco Arriba	Extreme	310
	Very High	1,574
Barrio Pueblo	Extreme	351
Caguabo	Very Low	1,045
Caracol	High	1,040
Carreras	Extreme	110
	Medium	2,173
Casey Abajo	Low	149
Casey Arriba	Low	281
Cerro Gordo	Low	388
Cidra	Low	188
Corcovada	Low	574
Dagüey	Medium	1,036
	Very High	710
Espino	Medium	682
Hatillo	Very Low	1,085
Humatas	Low	508
Marías	Extreme	281
	Very High	2,755
Miraflores	Low	636
Ovejas	Medium	1,662
Piñales	High	1,907
Playa	Very Low	525
Quebrada Larga	Very High	1,773
Río Arriba	Low	240
Río Cañas	Medium	1,367

Source: Puerto Rico Planning Board, Hazus 6.1 Output and Census Tract

SPCS PR & VI NAD83

Spectral Acceleration (g)
- 0.707827 (Very Low)
- 0.707828 - 0.740940 (Low)
- 0.740941 - 0.745363 (Medium)
- 0.745364 - 0.749601 (High)
- 0.749602 - 0.774566 (Very High)
- 0.774567 - 0.799184 (Extreme)
- Wards
- Municipality of Añasco
- Neighboring Municipalities



N

Scale: 1:110,000

0 1,500 3,000 Meters

4.6.2.4 Natural and Cultural Resources

Earthquakes can produce a wide range of impacts on natural and cultural resources:

- **Landslides and Soil Instability**: Seismic activity can trigger landslides, rockfalls, and soil liquefaction, altering natural landforms and damaging ecological habitats.
- **Water Quality and Hydrology**: Ground shaking may modify river pathways, impair aquifers, and increase sedimentation in water bodies, which can degrade water quality and disrupt aquatic ecosystems.
- **Vegetation and Wildlife**: Ground deformation and related secondary hazards such as flooding or fires can lead to habitat loss, fragmentation, and adverse effects on biodiversity.
- **Coastal and Marine Environments**: Submarine earthquakes may generate tsunamis, resulting in coastal erosion, coral reef degradation, and the deterioration of marine and estuarine ecosystems.

While the following damage can happen to Cultural Resources:

- Seismic forces can cause significant structural damage or the complete collapse of heritage structures, archaeological sites, and monuments.
- Museums and Archives: Earthquakes may lead to the loss, damage, or deterioration of artifacts, archival materials, and collections due to structural failures or insufficient seismic protection.
- Community Identity and Tourism: Damage to culturally important sites can undermine community identity and reduce tourism activity, thereby affecting local economic stability.

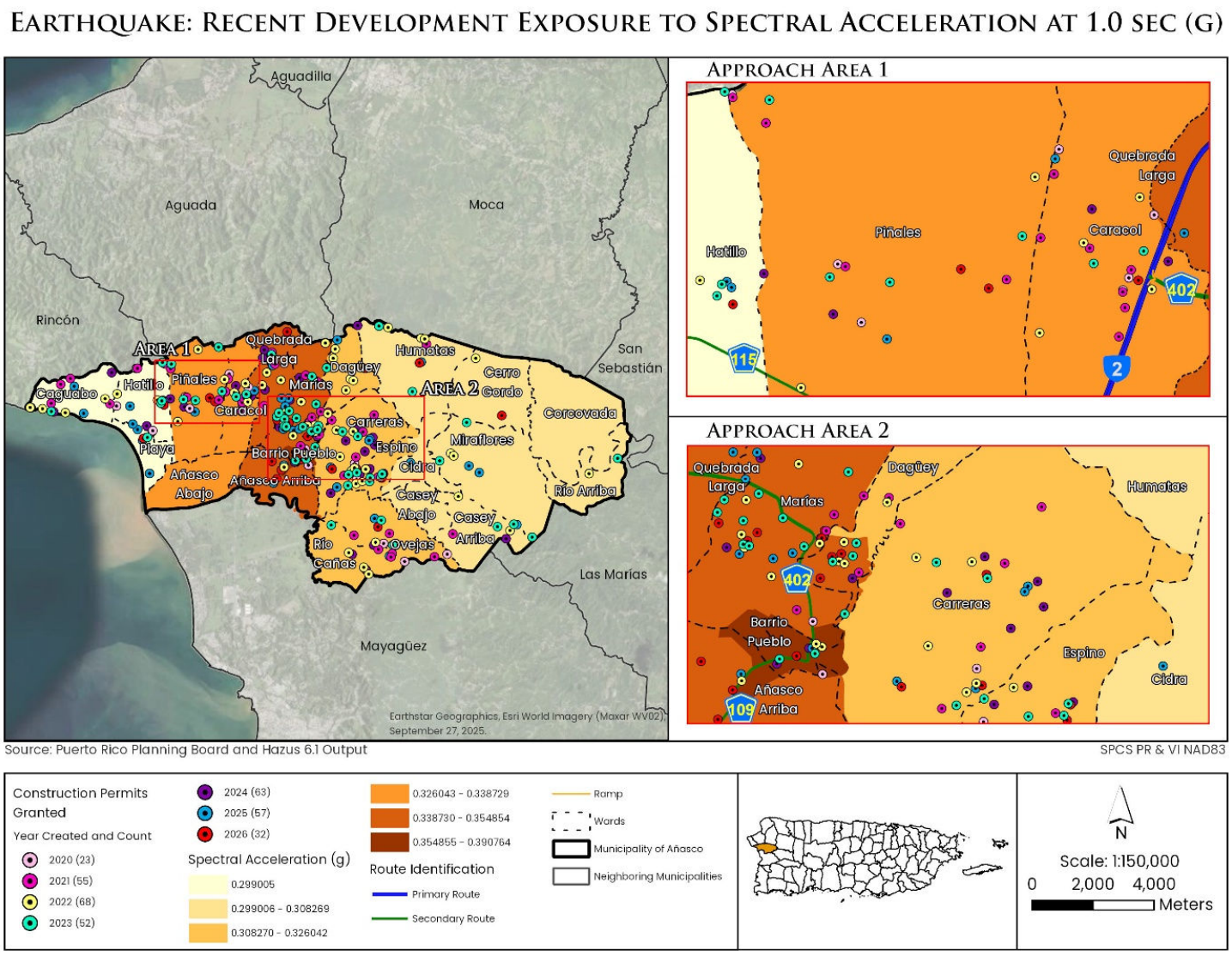
4.6.2.5 Future Conditions (E1-a)

As discussed in Section 3.5, the elevated number of constructions permits issued by the Municipality reflects a sustained level of economic activity. To further support this analysis, Maps 20 and 21 shows the exposure of recent development to modeled earthquake spectral acceleration within the Municipality of Añasco based on Hazus 6.1 outputs. Construction permits issued between 2020 and 2026 are distributed throughout the municipality; however, a notable concentration of recent development is observed within the central and western portions of Añasco, particularly in the barrios of Barrio Pueblo, Añasco Arriba, Marías, Caracol, Piñales, Quebrada Larga, and Carreras. These areas correspond to the higher spectral acceleration zones depicted

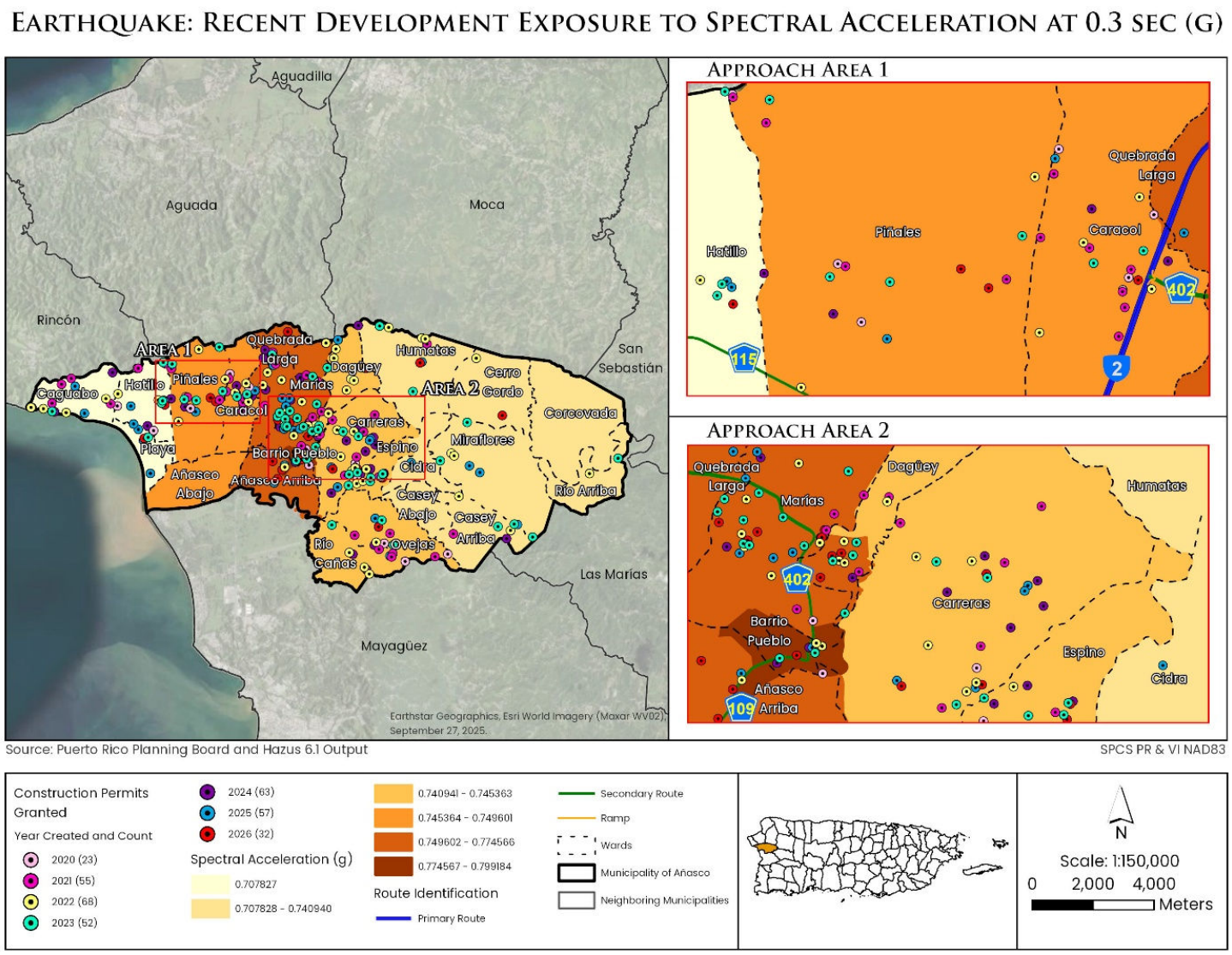
on both maps. Additional recent development is present in Dagüey, Espino, Cidra, Ovejas, Río Cañas, Casey Abajo, Casey Arriba, Miraflores, Río Arriba, Playa, Hatillo, and Caguabo, where moderate to lower spectral acceleration values are shown. The approach area insets highlight clusters of recent development along the PR-2, PR-109, PR-115, and PR-402 transportation corridors, including locations within or adjacent to the municipality's highest spectral acceleration zones. According to the Hazus 6.1 outputs, spectral acceleration values range from approximately 0.7078 g to 0.7992 g at 0.3 seconds and from approximately 0.2990 g to 0.3908 g at 1.0 second. The maps illustrate that portions of Añasco's recent development activity have occurred within areas modeled to experience comparatively higher levels of earthquake ground motion.

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Map 20: Earthquake: Recent Development Exposure to Spectral Acceleration at 1.0 sec



Map 21: Earthquake: Recent Development Exposure to Spectral Acceleration at 0.3 sec



4.7 Landslides

4.7.1 Description (B1-a)

Landslides are a natural geomorphological process characterized by the downslope movement of soil, rock, or debris due to terrain instability. These events occur when environmental conditions align such that gravitational forces acting on surface materials exceed their natural resistance. The term landslide encompasses multiple types of ground displacement including rockfalls, slope failures, and debris flows, all of which pose significant risks to life and property. Such movements can obstruct transportation routes and carry with them vegetation, homes, bridges, vehicles, and other infrastructure, causing extensive disruption and damage (FEMA, 1997).

Prolonged and intense rainfall associated with meteorological systems such as tropical waves, troughs, and tropical cyclones is one of the primary triggers of landslide events. Additionally, population growth and the expansion of informal construction increase the municipality's exposure to landslide hazards. Potable water supply and wastewater systems including sanitary pipes, septic tanks, and storm sewers whether properly authorized or informally installed, can further exacerbate slope instability. The likelihood of landslides rises significantly when these systems leak or are inadequately sited or constructed (USGS, n.d.).

Multiple factors contribute to the development of landslides, including soil type, terrain slope, degree of soil saturation, erosion processes, the presence of depressions or subsurface voids, human activities, and seismic events. The Building Performance Assessment Report (BPAR) prepared after Hurricane Georges warns that "landslides will become a major problem in the future as more houses are built and more development occurs in areas susceptible to these risks." This observation underscores the increasing vulnerability associated with continued development in high-risk zones (FEMA, 1997).

Many landslides in Puerto Rico fall into a specific subtype known as debris flows. These events typically occur in mountainous areas with steep slopes during periods of intense rainfall. As rainwater infiltrates the ground, the soil becomes saturated and the underlying subsurface layer loses its cohesion. This loss of stability causes the material to detach often at the interface where the subsurface meets the bedrock resulting in a rapid downslope flow of soil, rock, and water.

There are many types of landslides; however, those specifically linked to water-saturated soils include the following (PREMB, 2021):

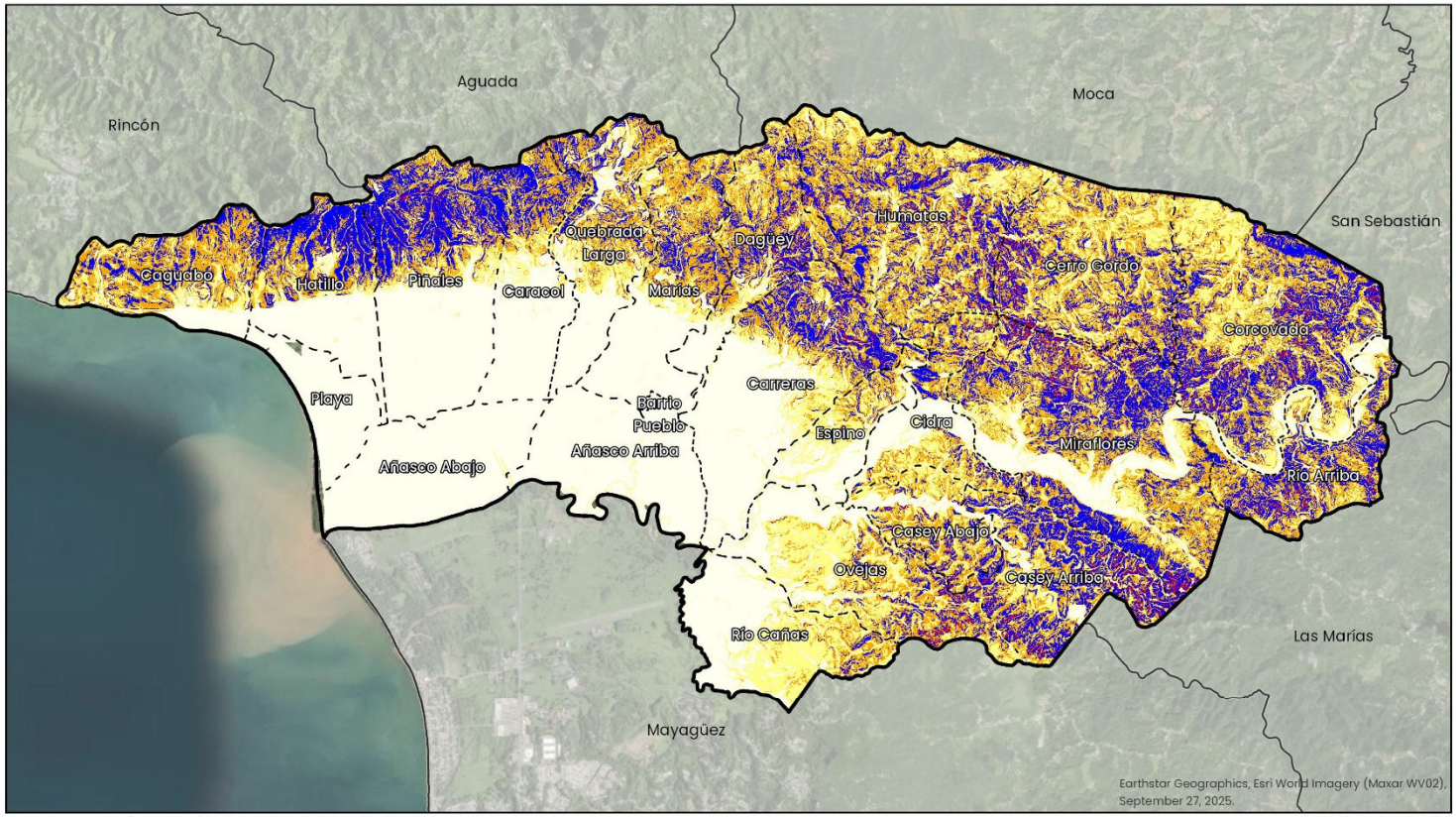
- Slow Landslide: A gradual and sustained downslope movement of soil or rock. These events are often identifiable by displaced tree trunks, distorted or twisted fences and retaining walls, and leaning posts or structures.
- Debris Flow: A rapid mass movement in which loose soil, rocks, and organic material combine with infiltrated water and air to form a dense, viscous flow that travels swiftly down a hillside.
- Debris Avalanche: An extremely rapid or very fast-moving form of debris flow, characterized by high velocity and significant destructive potential.
- Mudflow: A fast-moving mass composed of water-saturated material containing at least 50 percent sand, silt, and clay particles.

4.7.1.1 Affected Area (B1-B)

Map 22 presents the landslide susceptibility throughout the Municipality of Añasco. The map classifies susceptibility into Low, Moderate, High, Very High, and Extremely High categories. As shown, the highest concentrations of High, Very High, and localized Extremely High susceptibility areas are distributed primarily throughout the northern, northeastern, eastern, and southeastern portions of the municipality. These areas are particularly evident within the barrios of Caguabo, Hatillo, Piñales, Quebrada Larga, Marías, Dagüey, Humatas, Cerro Gordo, Corcovada, Miraflores, Río Arriba, Casey Arriba, Casey Abajo, and portions of Ovejas and Cidra. In contrast, lower susceptibility areas are concentrated in the southern and southwestern portions of the municipality, including much of Playa, Añasco Abajo, Añasco Arriba, Barrio Pueblo, and Río Cañas. The map indicates that landslide susceptibility generally increases within the more rugged upland areas of the municipality, while flatter coastal and valley areas exhibit lower susceptibility levels.

Map 22: Landslide Susceptibility

LANDSLIDE SUSCEPTIBILITY



Source: Puerto Rico Planning Board and Hazus 6.1 Output

SPCS PR & VI NAD83

Landslide Susceptibility
- Low
- Moderate
- High
- Very High
- Extremely High
- Wards
- Municipality of Añasco
- Neighboring Municipalities



N

Scale: 1:80,000

0 1,000 2,000 Meters

4.7.1.2 Risk Magnitude (B1-c)

Landslides typically occur in steep, mountainous areas during periods of intense or prolonged rainfall. As water infiltrates the ground, the soil becomes saturated, weakening natural drainage systems and reducing the structural capacity of the terrain, which can ultimately lead to slope failure. Certain areas are inherently more susceptible to landslides than others, particularly those with greater slope gradients. Vegetation plays a critical role in maintaining soil cohesion and reducing surface erosion; therefore, slopes lacking vegetation are generally more prone to instability.

Slope stability is influenced by several factors, including elevation, steepness, vegetative cover, and underlying geology. In general, increases in slope height and inclination correlate with a greater likelihood of terrain instability. Below are key factors that contribute to the occurrence of landslides:

- The base of inclined slopes
- Areas near small depressions where drainage converges
- The lower portion of slopes is composed of fill - material
- The base or crest of a very steep slope
- Locations with a history of previous landslides
- Hillsides that have been developed and where septic systems are present
- Steep slopes underlain by clay-rich soils
- Hills or slopes with inclinations greater than 12 degrees and elevations exceeding 300 meters

The hazard categories are derived from the USGS classification index, which evaluates slope and soil characteristics as defined by the agency. Table 24 outlines these categories—low, moderate, high, and very high—and describes the corresponding levels of hazard.

Table 23: Landslide Risk Categories

Category	Description
Low	Areas with minimal slopes and stable soil; landslides are unlikely except under extreme conditions.
Moderate	Areas with some susceptibility; landslides may occur during prolonged or intense rainfall.

High	Areas with significant susceptibility; landslides are likely during heavy rain or seismic activity.
Very High	Areas extremely prone to landslides; frequent events during storms or earthquakes.

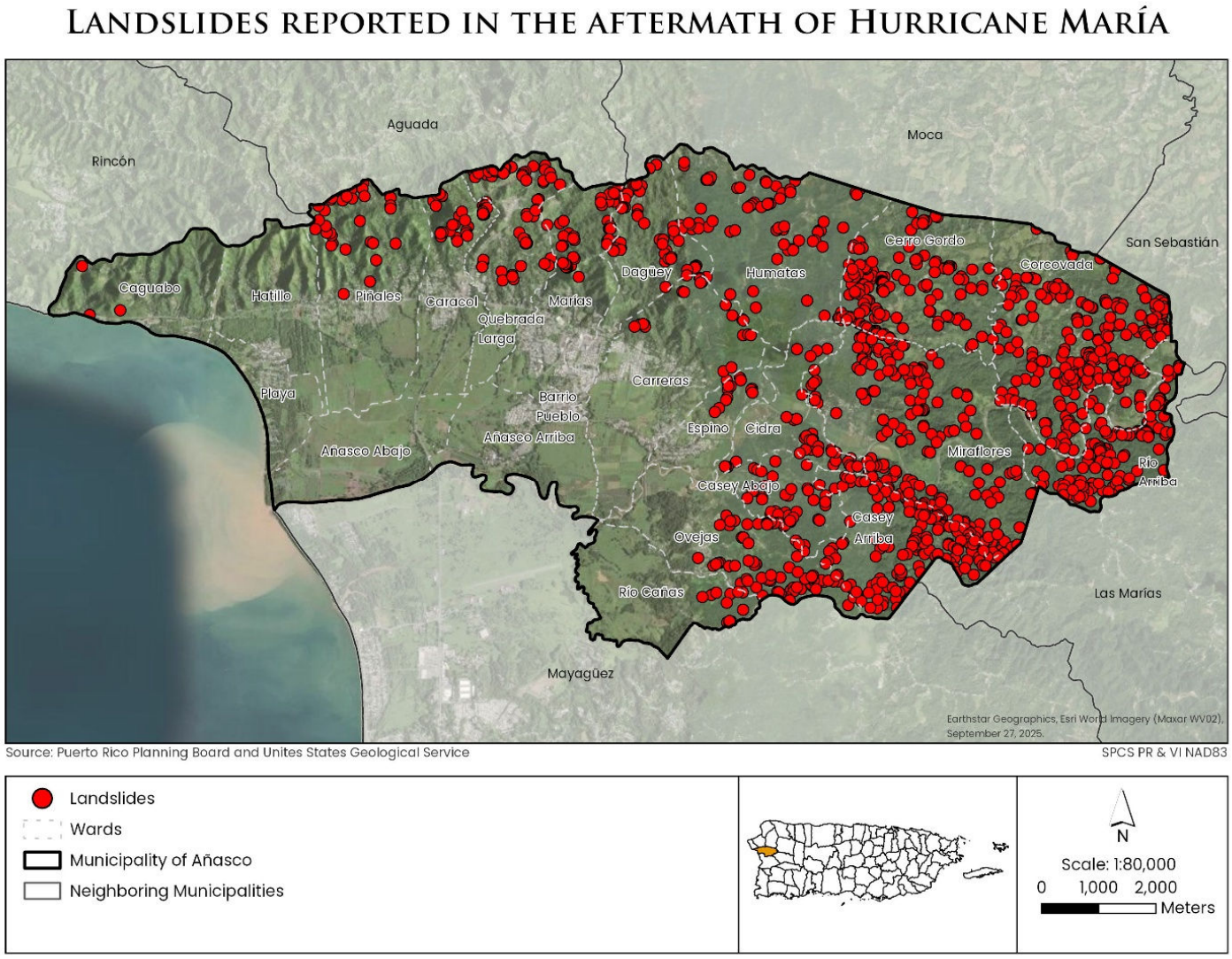
The municipality incorporates landslide prevention and mitigation measures as an integral component of its earthquake response protocol. (Municipio de Añasco, 2020)

4.7.1.3 Past Events

As noted earlier, landslides are frequently associated with heavy rainfall events. Map 23 illustrates the landslides reported following Hurricane María in 2017, which align with the areas of greatest susceptibility shown in the map. Landslides are often connected to rain events and the prevalence of roadways (Larsen & Park, 1997) (Larsen & Torres-Sanchez, 1998). According to data from the U.S. Geological Survey (USGS), more than 200 individual landslides were identified following Hurricane María (Hughes, Bayouth García, Martínez Milian, Schulz, & Baum, 2019).

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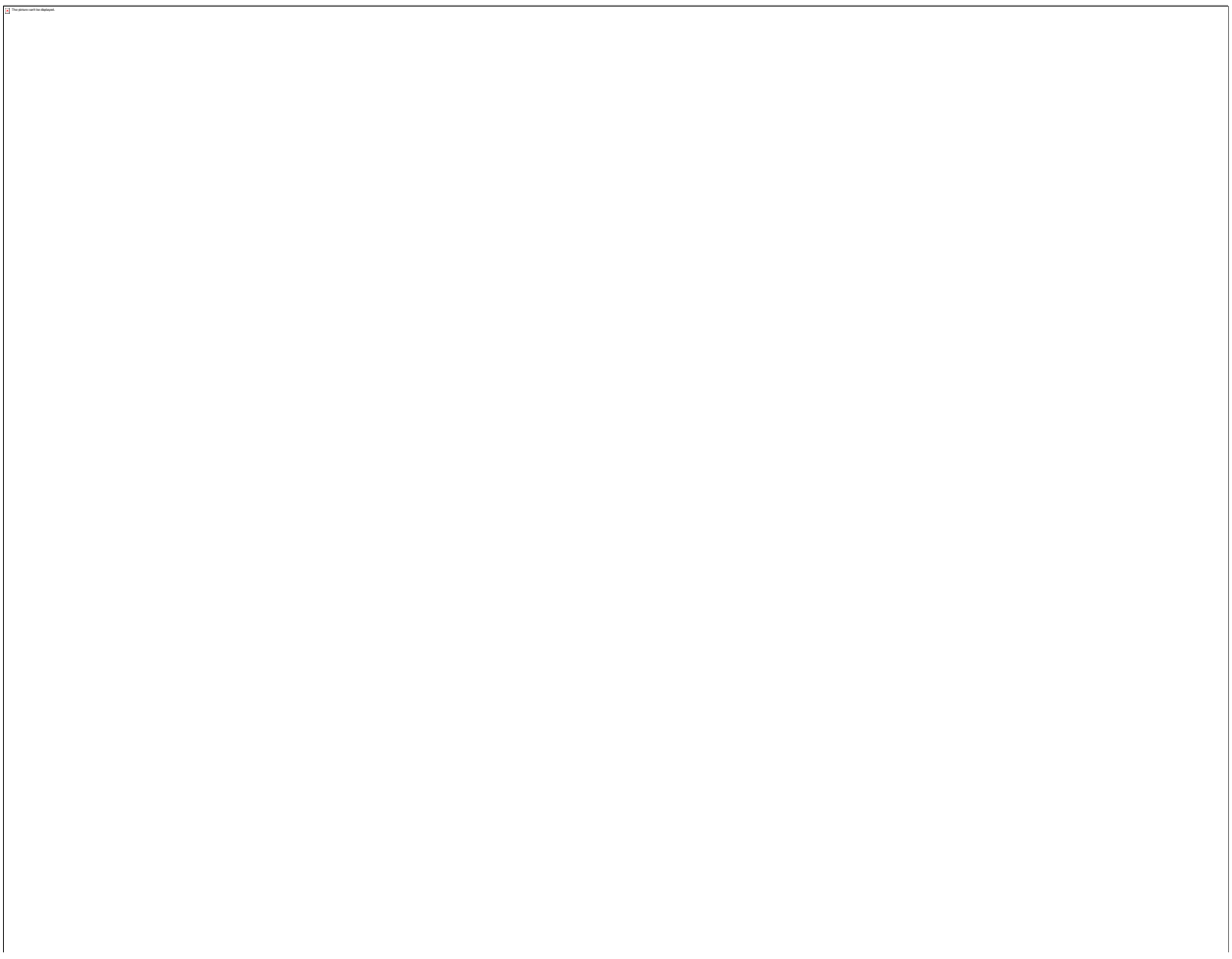
Map 23: Landslides related to Hurricane Maria



4.7.1.4 Future Event Probabilities

Although landslides can also result from earthquakes or human activities, most landslides in Puerto Rico are triggered by rainfall. As previously discussed, these events can occur during any type of rain event. The Figure below presents the Mean Annual Rainfall for Puerto Rico and the U.S. Virgin Islands from 1991 to 2020. The Municipality of Añasco lies within four (4) different zones that receive between 30 and 69.99 inches of rainfall annually. Given these precipitation levels, landslides are expected to continue occurring in some areas in the municipality.

Figure 15: Mean Annual Rainfall 1991-2020 (PR & USVI)[7]



[7] Obtained from https://www.weather.gov/sju/climo_pr_usvi_normals

4.7.2 Risk Analysis

4.7.2.1 Estimated Losses

In the Municipality of Añasco, as in many other parts of Puerto Rico, landslides most often occur during or immediately after major storms that produce intense, prolonged rainfall. Rainfall-induced landslides are closely linked to severe weather systems or consecutive rain events that saturate steep and vulnerable soils.

At present, no standardized models exist to quantify structural or content losses resulting from landslides or other mass-movement events. Consequently, USGS susceptibility indices were applied empirically using the best available data to estimate potential impacts from these hazards in Añasco . These indices classify risk into four levels: low, moderate, high, and very high. Due to data limitations, it is not currently possible to calculate monetary losses associated with building damage.

4.7.2.2 Lifelines and Critical Infrastructure

Landslides can impact FEMA Lifelines in the following ways:

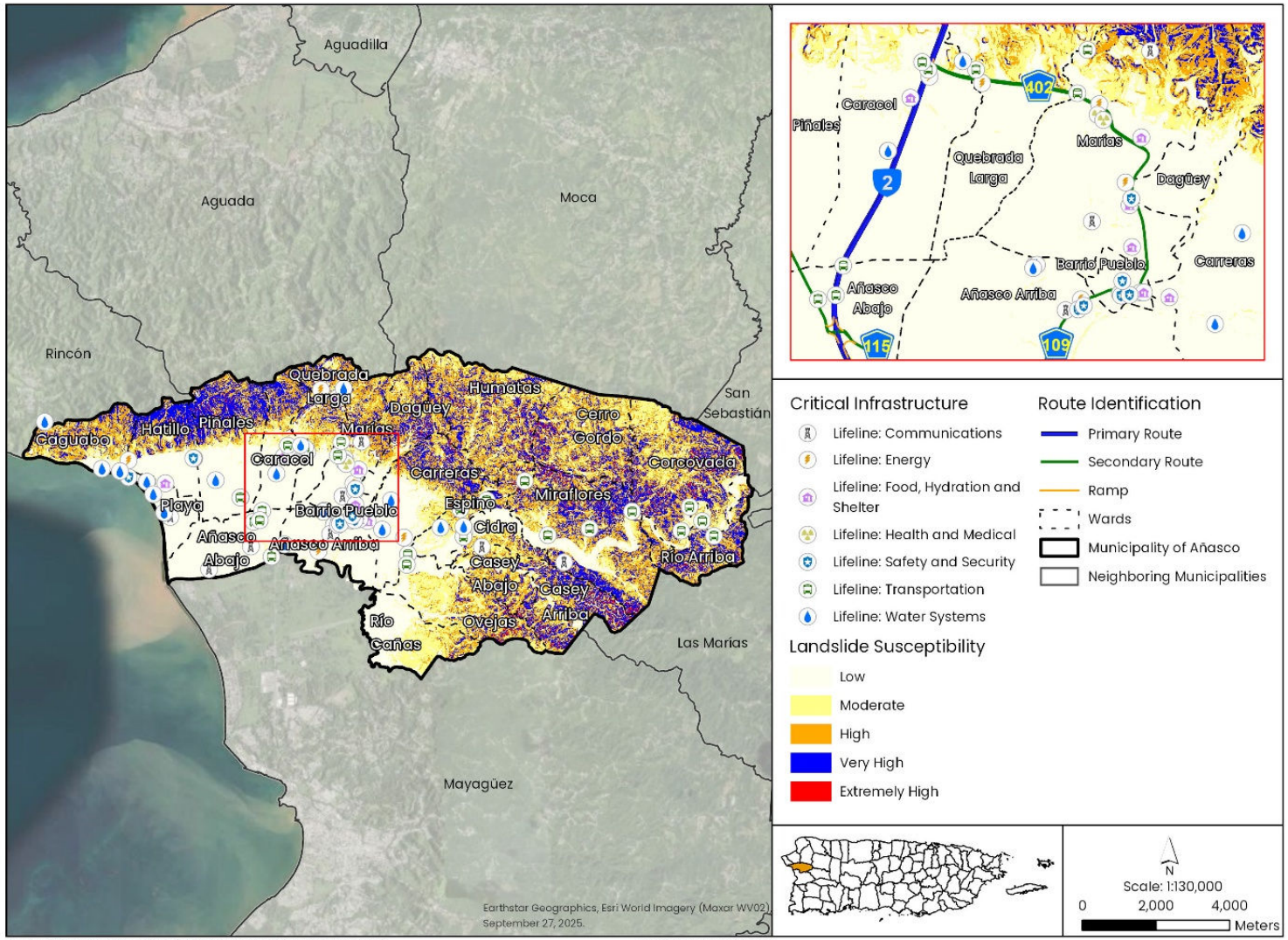
- Safety and Security: Landslides can trap and injure or kill individuals through rapidly moving debris, hinder rescue operations, and create life-safety risks when emergency services become isolated or damaged (Center for Disaster Resilient Communities, n.d.).
- Food, Hydration, and Shelter: Landslides can destroy homes and agricultural areas, resulting in displacement and increased food insecurity. They may also disrupt local water and sanitation systems, heightening contamination risks, especially within temporary shelter environments (IFRC, 2023).
- Health and Medicine: Landslides can cause direct injuries such as trauma or suffocation, while longer-term impacts may include outbreaks of waterborne and vector-borne diseases, as well as psychological distress and trauma among survivors (Center for Disaster Resilient Communities, n.d.).
- Energy: Landslides can severely damage power lines, electrical substations, and fuel supply infrastructure, resulting in widespread power outages that hinder both public services and emergency response operations.
- Communications: Damage to communication cables, fallen utility poles, and restricted access to telecommunications infrastructure can disrupt alert and warning systems, hinder coordination among emergency responders, and impair public information networks.

- Transportation: Landslides can render roads, railways, bridges, and tunnels impassable or destroy them entirely as debris obstructs critical routes, severely limiting mobility for the public and restricting access for emergency response services.
- Hazardous Materials: Landslides can rupture containment structures, pipelines, storage tanks, or industrial facilities, leading to the release of hazardous chemicals or pollutants and potentially triggering HAZMAT emergencies (FEMA, 2024).
- Water Systems: Landslides can damage water intakes, treatment plants, distribution lines, and wastewater collection and treatment facilities, leading to contamination, reduced water pressure, and significant service interruptions (IFRC, 2023).

Map 24 shows the exposure of critical infrastructure to landslide susceptibility within the Municipality of Añasco. As shown on the map, critical facilities associated with communications, energy, food, hydration and shelter, health and medical services, safety and security, transportation, and water systems are distributed throughout the municipality. Several critical facilities are located within or adjacent to areas classified as High, Very High, and localized Extremely High landslide susceptibility, particularly in the barrios of Quebrada Larga, Marías, Dagüey, Carreras, Espino, Cidra, Miraflores, Casey Abajo, Casey Arriba, Corcovada, Río Arriba, Humatas, Hatillo, Piñales, and Caguabo. In contrast, a concentration of critical facilities is also located within the lower susceptibility areas of Barrio Pueblo, Añasco Arriba, Añasco Abajo, Playa, and Río Cañas. The map further shows that portions of the municipality's transportation network, including PR-2, PR-115, PR-109, and PR-402, traverse areas exhibiting varying levels of landslide susceptibility. These results indicate that critical infrastructure is present throughout both lower- and higher-susceptibility areas of the municipality, with several facilities located in areas where landslide hazards may be more pronounced.

Map 24: Landslide: Critical Infrastructure Exposure

LANDSLIDE: CRITICAL INFRASTRUCTURE EXPOSURE



Source: Puerto Rico Planning Board and Hazus 6.1 Output

SPCS PR & VI NAD83

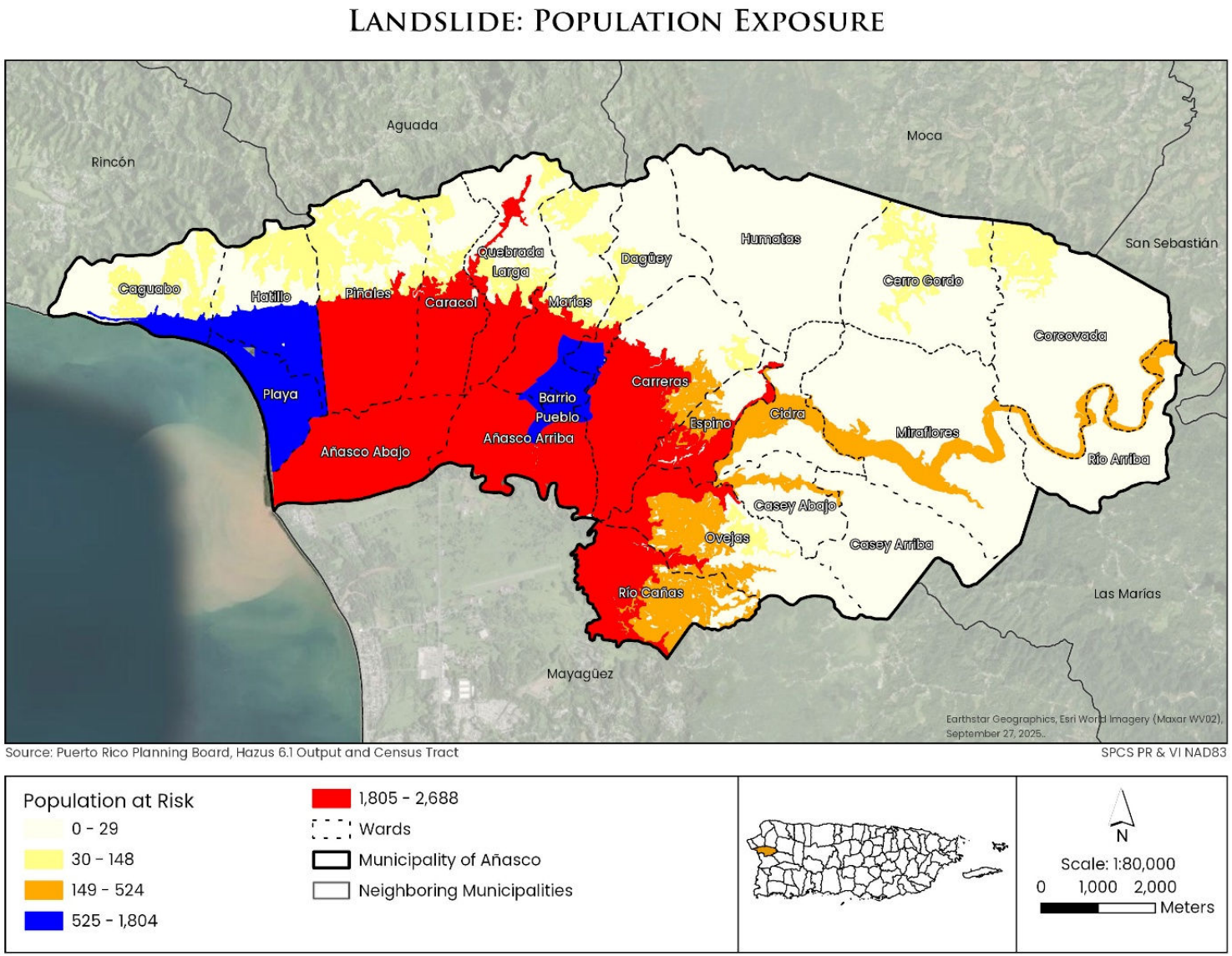
4.7.2.3 Social Vulnerabilities

Social vulnerability to landslides in Puerto Rico is the product of topography, poverty, aging populations, fragile infrastructure, and geographic isolation, all of which shape the severity of impacts after major storms or seismic events. Academic and federal analyses consistently show that landslides disproportionately burden communities that already struggle with access to transportation, healthcare, income stability, and emergency response. Addressing these vulnerabilities requires hazard mitigation strategies that integrate geospatial risk analysis, social vulnerability indicators, community-based planning, and infrastructure reinforcement tailored to rural and mountainous municipalities (West, Rodríguez Cruz, & Hughes, 2023).

As discussed earlier, a significant portion of Añasco's population is considered vulnerable. According to the 2020-2024 American Community Survey, approximately 40.83 percent of the municipality's residents are either 19 years of age or younger or 65 years of age and older. Landslide susceptibility is concentrated in the municipality's northern, eastern, and southeastern mountainous areas, including portions of Quebrada Larga, Marías, Dagüey, Humatas, Corcovada, Miraflores, Río Arriba, Casey Arriba, and Casey Abajo. Residents in these communities often depend on transportation corridors such as PR-109, PR-115, PR-402, and local rural roads to access medical facilities, schools, employment centers, and emergency services. Landslides triggered by intense rainfall can block or damage these routes, disrupting access to healthcare, emergency response, utilities, food supplies, and other essential services. Such disruptions may create particularly challenging conditions for older adults, individuals with disabilities, and residents with medical or mobility limitations who depend on timely access to critical services. Research conducted in Puerto Rico has shown that landslide-related transportation interruptions can significantly increase community vulnerability and hinder emergency response and recovery operations (West, Rodríguez Cruz, & Hughes, 2023).

Consequently, landslide events have the potential to disrupt transportation networks and access to critical services throughout Añasco, particularly where communities, infrastructure, and transportation corridors intersect areas of elevated susceptibility. Such disruptions may affect access to medical care, emergency response services, utilities, and other essential services. Therefore, maintaining roadway connectivity, implementing slope stabilization measures, and improving access to critical facilities remain important priorities for reducing landslide risk in the Municipality of Añasco.

Map 25: Landslide: Population Exposure



4.7.2.4 Natural and Cultural Resources

Landslides are among the most destructive natural hazards, producing impacts that extend far beyond the immediate physical damage they cause (Eliot, Cloyd, & Philbin, 1994). Their effects on natural resources are profound and often irreversible. When a landslide occurs, vast areas of vegetation are uprooted or buried, leading to the loss of critical habitats and a decline in biodiversity. The displacement of soil not only strips away fertile layers essential for agriculture but also introduces large volumes of sediment into rivers and reservoirs. This sedimentation degrades water quality, disrupts aquatic ecosystems, and can compromise drinking water supplies. Furthermore, landslides frequently alter hydrological systems by blocking river channels, creating temporary dams that increase flood risk and modify groundwater recharge patterns.

The cultural dimension of landslide impacts is equally significant. Archaeological sites, historic monuments, and culturally significant landscapes are highly vulnerable to burial or destruction during such events. These losses are irreplaceable, erasing tangible links to the past and diminishing cultural heritage. In many regions, landslides have damaged centuries-old structures, including churches, colonial buildings, and sacred sites, resulting in costly restoration efforts or permanent loss. Beyond physical damage, the alteration of cultural landscapes such as terraced fields or ceremonial grounds undermines community identity and traditions deeply tied to the land. Economically, these impacts ripple through local economies dependent on cultural tourism, reducing visitor numbers and income for communities that rely on heritage-based activities.

4.7.2.5 Future Conditions

As shown in Map 26, landslide susceptibility and population exposure are not uniformly distributed throughout the Municipality of Añasco. The population exposure map indicates that the highest concentrations of population at risk are located primarily within the central and southwestern portions of the municipality, including Añasco Abajo, Añasco Arriba, Barrio Pueblo, Marías, Caracol, Piñales, portions of Carreras, and Río Cañas. Several census tracts within these areas are classified within the highest population-at-risk category, ranging from approximately 1,805 to 2,688 residents. Additional concentrations of population at risk are present in Playa, where census tracts fall within the 525 to 1,804 population-at-risk categories, and in portions of

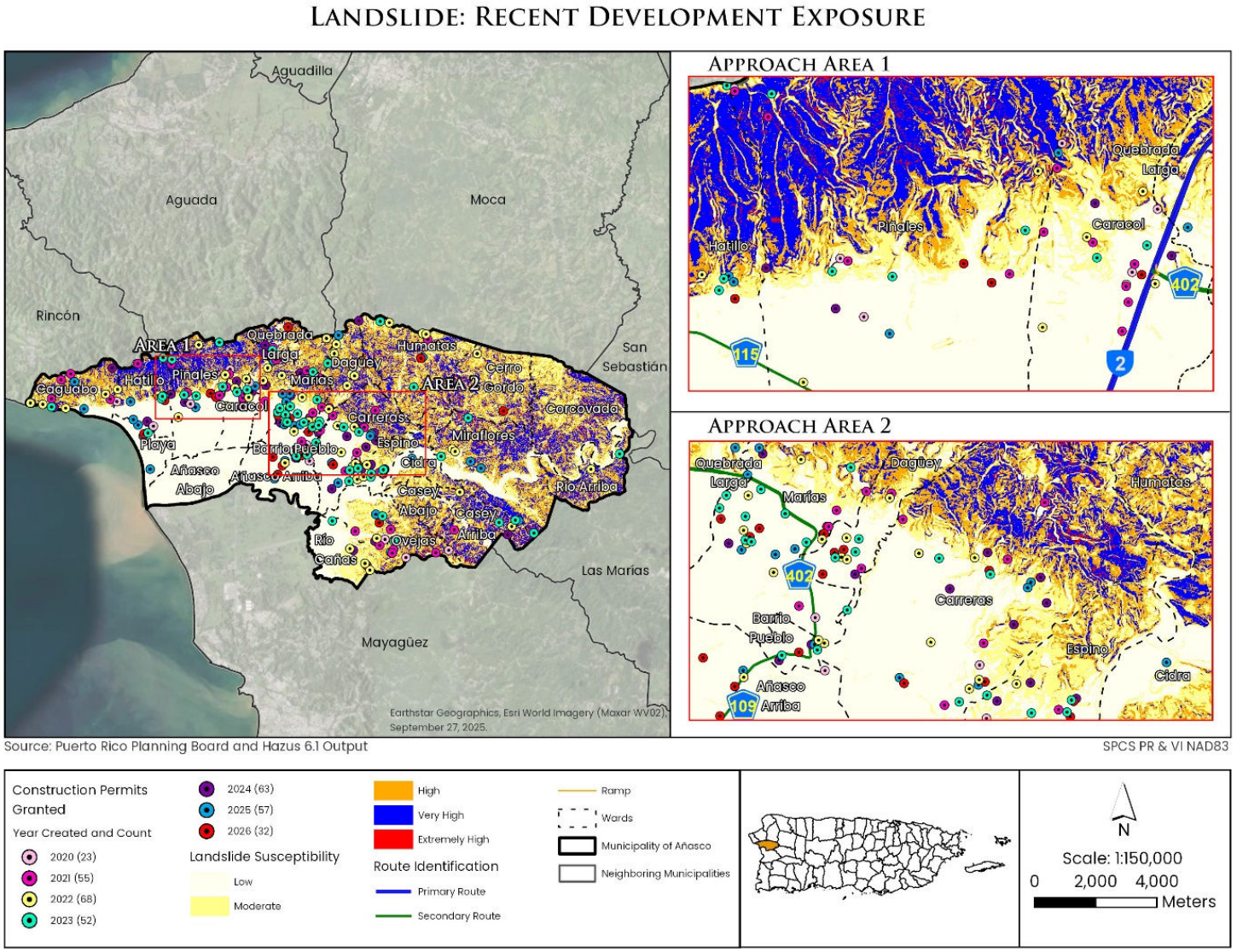
Espino, Ovejas, Cidra, and Río Arriba, where moderate population-at-risk categories are mapped.

Of particular concern, portions of the municipality's population reside near areas identified as having High, Very High, and localized Extremely High landslide susceptibility. The landslide susceptibility map indicates that these conditions are most prevalent within the northern, northeastern, eastern, and southeastern portions of the municipality, including Quebrada Larga, Marías, Dagüey, Humatas, Corcovada, Miraflores, Río Arriba, Casey Arriba, Casey Abajo, and nearby areas. Landslides triggered by intense rainfall may affect transportation corridors and limit access between these communities and the municipality's service centers.

This condition is consistent with previous research demonstrating a strong relationship between roadway infrastructure and landslide occurrence (Larsen & Park, 1997; Larsen & Torres-Sánchez, 1998). The critical infrastructure exposure map further shows that communications, energy, health and medical, safety and security, transportation, water system, and food, hydration and shelter facilities are distributed across the municipality, including locations situated within or adjacent to areas of elevated landslide susceptibility. Major transportation corridors, including PR-2, PR-115, PR-109, and PR-402, also traverse areas exhibiting varying levels of landslide susceptibility.

Consequently, landslide events have the potential to disrupt transportation networks and access to critical services throughout Añasco, particularly where communities, infrastructure, and transportation corridors intersect areas of elevated susceptibility. Such disruptions may affect access to medical care, emergency response services, utilities, and other essential services. Therefore, maintaining roadway connectivity, implementing slope stabilization measures, and improving access to critical facilities remain important priorities for reducing landslide risk in the Municipality of Añasco.

Map 26: Landslide: Recent Development Exposure



4.8 Tsunami

4.8.1 Description (B1-a)

A tsunami, or tidal wave, is a series of waves typically caused by a vertical displacement of the ocean floor resulting from an underwater earthquake. Tsunamis can also be triggered by submarine landslides or volcanic eruptions in a specific region. The characteristics of a tsunami vary depending on whether the wave is moving through deep water or approaching the shore. In deep waters, these waves can travel at speeds of up to 500 miles per hour and appear as low waves, generally less than one foot above sea level, often unnoticed by vessels at sea. The distance between wave crests is usually very wide. As the waves near coastal areas, their speed decreases significantly while their height increases dramatically because the wave frequency rises as its amplitude diminishes. This phenomenon can produce massive waves, sometimes exceeding 98 feet in height. However, tsunamis are often sudden, large surges in sea level along the coast, resembling a powerful tide rushing inland.
Additional warning signs may precede a tsunami. These include a noticeable retreat of the sea—where water recedes from the shore—or a rapid and excessive rise in coastal sea level. Typically, a loud roar from the ocean can be heard, similar to the sound of a low-flying aircraft. Other noises may occur as powerful waves crash against reefs, rocks, and objects dragged by the current.

Although tsunami hazards cannot be prevented, municipalities can implement mitigation measures through individual and collective preparedness, maintain alert systems to warn vulnerable communities, and ensure an effective response after such an event. In Puerto Rico, efforts have been coordinated under the National Tsunami Hazard Mitigation Program (NTHMP) at the University of Puerto Rico at Mayagüez (UPRM) and by UNESCO's IOCARIBE for regional areas. This program aims to reduce tsunami impacts through disaster assessment, alert messaging guidance, and mitigation strategies. NTHMP develops tsunami inundation maps, disseminates information through media for community drills, and promotes awareness of past events. Mitigation efforts include improving information dissemination, reducing risks, creating evacuation plans, producing educational materials, and implementing NOAA's Tsunami Ready Program, among other initiatives.

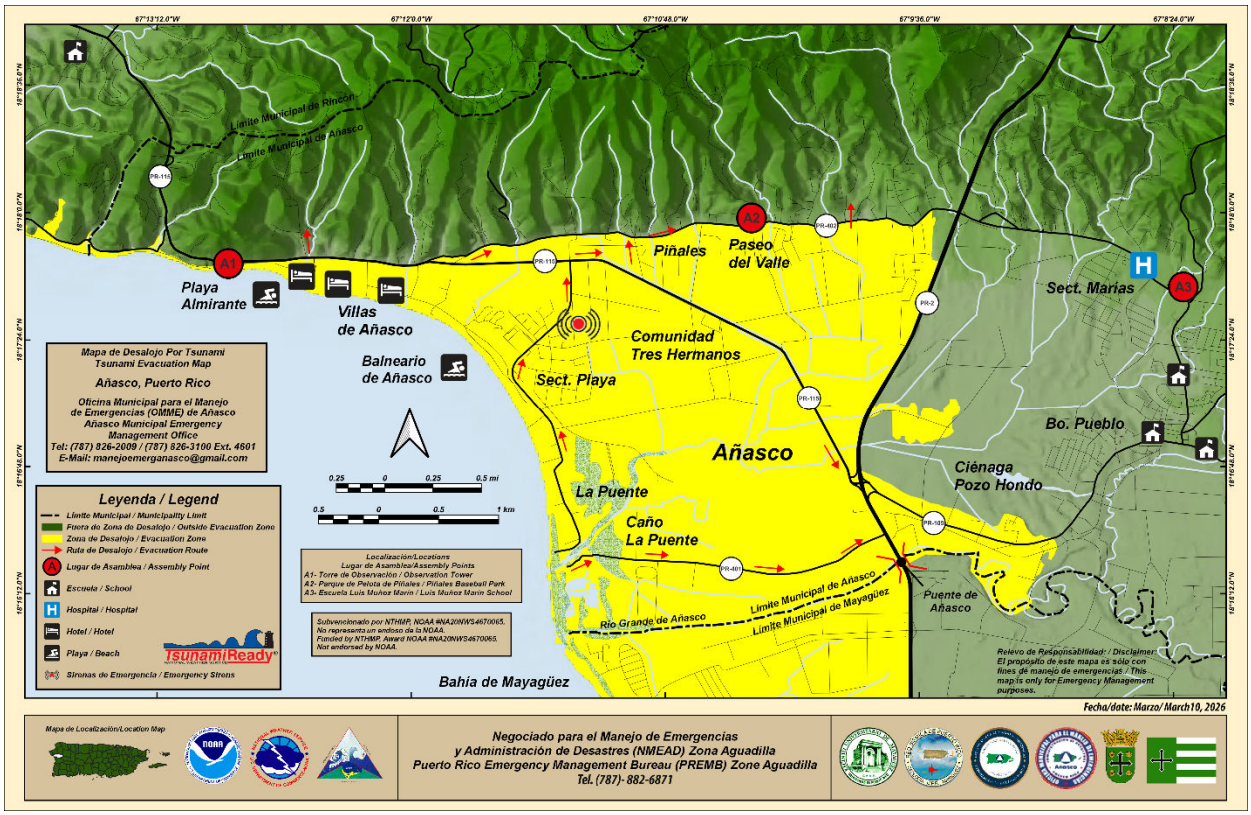
4.8.1.1 Affected Area (B1-B)

As Figure 14 below shows the Tsunami Evacuation Map for the Municipality of Añasco developed by the Puerto Rico Emergency Management Bureau (PREMB), the Municipal Office for Emergency Management (OMME), NOAA, the National Weather Service, the Puerto Rico Seismic Network (PRSN), and the University of Puerto Rico at Mayagüez. As shown on the map, the areas most vulnerable to tsunami inundation are concentrated along the municipality's northern coastal zone and lower-elevation shoreline areas identified within the designated tsunami evacuation zone. Communities and locations located within or immediately adjacent to the evacuation zone include Playa Almirante, Villas de Añasco, Balneario de Añasco, Sector Playa, Comunidad Tres Hermanos, Piñales, Paseo del Valle, Caño La Puente, and portions of the urban area of Añasco. The evacuation zone also extends eastward toward the boundary with Mayagüez and includes low-lying areas adjacent to Bahía de Mayagüez and the Río Grande de Añasco.

The map identifies designated assembly points, emergency sirens, schools, hospitals, hotels, beaches, and official evacuation routes intended to facilitate the safe and timely movement of residents and visitors to higher ground outside the tsunami hazard area. Three assembly points are identified: A1, located at the Torre de Observación (Observation Tower); A2, located at Parque de Pelota de Piñales (Piñales Baseball Park); and A3, located at Escuela Luis Muñoz Marín (Luis Muñoz Marín School). The map also identifies a hospital in Sector Marías and depicts evacuation routes directing populations inland toward areas outside the designated evacuation zone.

The evacuation map illustrates that much of the municipality's developed coastal area, including residential neighborhoods, recreational facilities, lodging establishments, and public infrastructure, is located within the tsunami evacuation zone. As a result, a tsunami generated by a local or regional seismic event could require the rapid evacuation of residents and visitors from these coastal sectors. Maintaining clearly marked evacuation routes, ensuring the functionality of emergency warning systems, promoting public awareness, and preserving access to designated assembly points remain important components of tsunami preparedness and risk reduction within the Municipality of Añasco.

Figure 16 Tsunami Evacuation Map



Source: NOAA, National Weather Service (NWS), Puerto Rico Seismic Network (PRSN), University of Puerto Rico at Mayagüez, and PREMB Tsunami Evacuation Map for Añasco.

4.8.1.2 Risk Magnitude (B1-C)

Tsunami events rank among the most severe natural disasters. Among the hazards associated with a tsunami event are the following:

- Flooding of low-lying coastal areas: This occurs when tsunami waves penetrate inland, causing property destruction and fatalities due to drowning.
- Damage to coastal properties and buildings: Homes and structures located near the shoreline can suffer severe damage, rendering them uninhabitable. Additionally, these waves cause significant coastal erosion and undermine building foundations by washing away sand and soil, increasing their reach and force.
- Floating debris and large objects: A tsunami can carry debris or even large vessels inland, creating additional hazards and potentially causing major

accidents and further tragedies.

Although this natural phenomenon moves slowly across the ocean, the force of a tsunami's waves can cause thousands of deaths and extensive property damage, including homes, critical facilities, and municipal infrastructure. If the disturbance originates near a coastal area, the tsunami can devastate the community within minutes (NOAA, n.d.). Developing and implementing an early warning system is essential to mitigate or reduce the impacts of such events. Likewise, it is critical that communities vulnerable to tsunamis are prepared to respond promptly and effectively once an alert is issued (NOAA, n.d.).

In 1995, the U.S. Congress designated NOAA to lead the National Tsunami Hazard Mitigation Program (NTHMP). This program represents a federal–state partnership that includes NOAA, FEMA, the U.S. Geological Survey, and 28 states and territories. Its primary goal is to reduce tsunami impacts on U.S. coasts through activities such as public education and awareness, community-level planning, risk assessments for specific areas, and guidance on tsunami alerts (NOAA, n.d.).

The TsunamiReady Program, created by NOAA's National Weather Service, aims to minimize loss of life and property from tsunamis and promote preparedness. In Puerto Rico, the Seismic Network (RSPR) manages funds for both the NTHMP and TsunamiReady Program, in coordination with the NWS Forecast Office in San Juan, FEMA, PREMB, Municipal Emergency Management Offices (OMMEs), and local communities.

Currently, 46 municipalities across the island participate in the TsunamiReady Program, including Añasco. The municipality of Añasco has a tsunami evacuation map and holds TsunamiReady certification.

Map 27 shows the modeled extent of the tsunami impact area in Añasco. The map further illustrates that tsunami impacts are largely confined to the western portion of the municipality, while the northern, eastern, and southeastern barrios, including Caguabo, Hatillo, Piñales, Quebrada Larga, Caracol, Marías, Dagüey, Humatas, Cerro Gordo, Corcovada, Miraflores, Río Arriba, Casey Abajo, Casey Arriba, Ovejas, Río Cañas, and much of Cidra, are located outside the modeled inundation area. The greatest exposure is concentrated within the coastal communities and developed areas situated adjacent to Bahía de Mayagüez and the shoreline corridor.

According to the map, median inundation depths within the impact area range from

near zero to approximately 6.67 feet. Although the map does not identify specific structures or population counts, it demonstrates that residential areas, transportation corridors, public facilities, and other assets located within Playa, Añasco Abajo, and portions of Añasco Arriba may be exposed to tsunami inundation. Consequently, residents and visitors within these coastal sectors may require rapid evacuation following a tsunami warning. Maintaining effective evacuation routes, public awareness programs, emergency notification systems, and coordination with the municipality's tsunami evacuation planning efforts remains critical for reducing tsunami risk in the Municipality of Añasco.

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Map 27: Tsunami Impact Area

TSUNAMI: IMPACT AREA



Source: Puerto Rico Planning Board and Hazus 6.1 Output

SPCS PR & VI NAD83

Median Inundation Depth (ft)

6.66668

0.000160853

Wards

Municipality of Añasco

Neighboring Municipalities



N

Scale: 1:80,000

0 1,000 2,000 Meters

4.8.1.3 Past Events (B1-D)

The following tables show the most recent recorded Tsunami Events in Puerto Rico.

Table 24: Tsunami events in Puerto Rico

Tsunami Event	Description
1946 Tsunami	In Puerto Rico, the sea receded at Aguadilla (24 m) and Mayagüez (76 m) before returning as destructive waves. The combined earthquake and tsunami resulted in 75 fatalities and left 20,000 people homeless. At San Juan, the tsunami was recorded on a tide gauge 35 minutes after the earthquake, following a second shock (Ms 7.9) nearly as strong as the August 4 quake but located about 100 km to the northwest. The waves were also detected at distant locations, with travel times of 2:02 hours to Bermuda, 4:02 to Daytona Beach, and 4:42 to Atlantic City (Lander, Whiteside, & Lockridge, 2002).
1918 Tsunami	On October 11, 1918, Puerto Rico experienced one of the most powerful earthquakes in its history. Official reports indicate that 116 people lost their lives, and economic losses were estimated at $4 million—twice the island's annual budget at the time. The earthquake generated a tsunami that struck the island's western coast within minutes of the initial shaking. Waves reached heights of up to 20 feet, at the island's northwestern corner, appearing almost

	immediately after the quake. Approximately 40 of the fatalities were attributed to the tsunami itself (PRSN, 2025). In all areas where the wave was observed, witnesses reported that the sea first receded, exposing reefs and sections of the seabed never seen before, even during the lowest tides. The water then surged back, reaching equally high levels. In some locations, the large wave was followed by one or two smaller ones, and in enclosed bays, the water remained turbulent for some time. At Punta Borinquen in Aguadilla, the lighthouse keeper noted that the water began to recede during the earthquake and later rose to 15 feet. Near Punta Aguejereada, the wave reached between 18 and 20 feet, arriving 4 to 7 minutes after the quake. In Aguadilla, 32 people drowned, and nearly 300 beachside huts were destroyed. The tsunami reached Mayagüez about 20 minutes after the earthquake, with a height of approximately 5 feet (PRSN, 2025).
1867 Tsunami	On November 18, an earthquake of magnitude 7.3 was felt strongly in the Virgin Islands and the eastern region of Puerto Rico. The epicenter was in the Anegada Passage, between the islands of St. Thomas, St. Croix, and Vieques. The resulting tsunami reached heights of nearly

	20 feet in St. Thomas and St. Croix. At San Juan and Arroyo, water levels increased by approximately 0.9 to 1.5 meters, accompanied by significant wave activity near the Vieques Islands. In Fajardo, only a minor wave was documented, whereas in Yabucoa, a pronounced sea withdrawal occurred prior to a return surge that penetrated approximately 137 meters inland (Lander, Whiteside, & Lockridge, 2002). No fatalities were recorded (Castro Rivera, Proyecto 1867, n.d.).

4.8.1.4 Future event probabilities (B1-e)

The occurrence of a tsunami cannot be predicted, nor can its timing be determined with precision. However, because tsunamis are closely associated with seismic events such as earthquakes, their future likelihood depends on the probability of future seismic activity. Vulnerability studies have estimated a 33% to 50% probability of experiencing strong ground shaking (Modified Mercalli Intensity VII or higher) in different parts of the island within a 50-year period (PRSN, n.d.). Consequently, given that the areas of greatest seismic activity around Puerto Rico are located underwater to the northwest southeast and southwest of the island, it is plausible that the next significant earthquake could generate a tsunami.

Earthquakes and tsunamis are relatively infrequent phenomena, and not all earthquakes generate tsunamis. Nevertheless, when a major earthquake occurs beneath the ocean floor, the likelihood of a tsunami increases substantially. This implies that the probability of a tsunami is directly correlated with the probability of a strong earthquake, particularly in coastal areas. This probability serves as a key parameter for risk classification, based on historical records and contributions from planning committees and existing studies.

4.8.2 Risk Analysis (B2-a, B2-b)

4.8.2.1 Estimated Losses

Table 25 presents the exposure to tsunamis, as registered in FEMA National Risk Index.

Table 25: Tsunami Exposure

Exposure - Impacted Area (sq mi)	Exposure - Building Value	Exposure - Population	Exposure - Population Equivalence	Exposure - Total
0.605781	$368,091,111	2781	$32,263,108,853	$32,631,199,964

The expected annual loss for each Census tract or jurisdiction represents the average yearly economic impact, expressed in dollars, anticipated from natural hazard events. **Error! Reference source not found.** presents the expected annual tsunami-related losses for both buildings and population.

Table 26 Expected Annual Loss to Tsunami

Expected Annual Loss - Building Value	Expected Annual Loss - Population	Expected Annual Loss - Population Equivalence	Expected Annual Loss -Total
$0	0	$0	$0

4.8.2.2 Lifelines and Critical Infrastructure

A tsunami event poses a severe and cascading threat to community functionality due to rapid onset, widespread inundation, strong currents, and extensive debris transport. Tsunamis can significantly disrupt all FEMA Community Lifelines, both immediately and over prolonged recovery periods. Lifeline impacts are often interdependent, creating compounding effects that hinder response, relief, and long-term recovery efforts (FEMA, 2021).

- The Safety and Security lifeline is critically compromised during tsunami events due to sudden flooding, debris, and limited evacuation time. Law enforcement, fire services, and emergency shelters may be damaged or rendered inaccessible by inundation or coastal erosion. Search and rescue operations are often required on a large scale, placing heavy strain on emergency responders while access routes are obstructed by debris, collapsed structures, or washed-out roadways. Additionally, damaged correctional facilities and

disrupted communications can elevate secondary public safety risks (NOAA, n.d.).

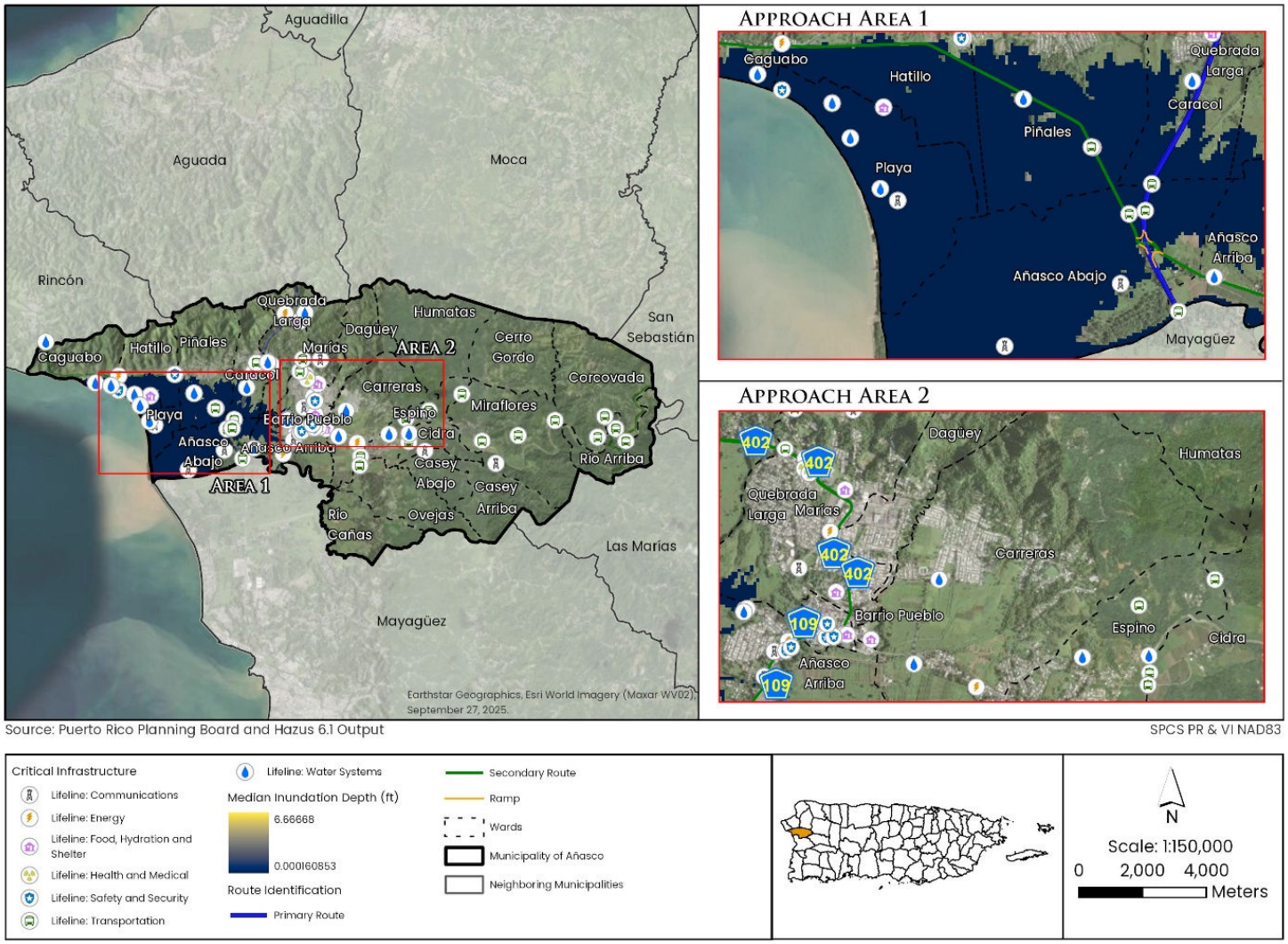
- Tsunami impacts frequently contaminate potable water systems through saltwater intrusion, chemical releases, and damage to treatment facilities. Food distribution systems may be interrupted due to flooded warehouses, damaged ports, and loss of refrigeration. Housing stock in coastal and low-lying areas is particularly vulnerable; entire neighborhoods may be destroyed or declared uninhabitable due to structural damage or mold contamination. As a result, large, displaced populations require mass care, sheltering, and long-term housing solutions, significantly stressing local and regional resources (FEMA, 2020).
- Healthcare systems face immediate challenges following a tsunami, including physical damage to hospitals and clinics, loss of power, and limited access for patients and staff. Medical surges are common due to drowning, trauma, and exposure-related injuries. Public health risks increase as standing water and debris contribute to disease transmission, while ongoing disruptions to water and sanitation systems exacerbate health vulnerabilities. Long-term mental health impacts are also common among affected populations and first responders (FEMA, 2017; World Health Organization, 2019).
- Electrical substations, fuel storage facilities, and distribution infrastructure located in coastal or low-elevation areas are at high risk of inundation and corrosion damage during tsunami events. Power outages can persist for extended periods, affecting all other lifelines such as water treatment, healthcare delivery, telecommunications, and emergency operations. Fuel supply disruptions may hinder debris removal, emergency response, and generator operations, further delaying restoration efforts (FEMA, 2017).
- Tsunami waves and associated flooding can damage fiber-optic lines, cellular towers, and switching facilities, resulting in widespread loss of voice and data communications. These disruptions impair emergency notifications, situational awareness, interagency coordination, and public information dissemination. Communication outages during evacuation and response phases can significantly increase risk to life and complicate rescue operations (FEMA, 2020).
- Transportation systems are among the most heavily impacted lifelines during tsunami events. Roads, bridges, ports, rail lines, and airports may be destroyed, undermined, or obstructed by debris and sediment. Port facilities are particularly vulnerable and may experience prolonged closures, affecting regional supply chains and economic recovery. Impaired transportation networks limit evacuation, emergency access, and delivery of critical supplies during response and recovery operations (NOAA, 2023).

- Water and wastewater infrastructure is highly susceptible to tsunami damage due to inundation, pipeline breaks, pump station failures, and contamination from saltwater and hazardous materials. Wastewater system failures can result in environmental contamination and public health hazards. Restoration of water service is often complex and time-consuming, particularly where underground infrastructure has shifted or corroded due to saltwater exposure (FEMA, 2017).

Accordingly, Map 28 shows that tsunami impacts are largely confined to the western portion of the municipality, while the northern, eastern, and southeastern barrios, including Caguabo, Hatillo, Piñales, Quebrada Larga, Caracol, Marías, Dagüey, Humatas, Cerro Gordo, Corcovada, Miraflores, Río Arriba, Casey Abajo, Casey Arriba, Ovejas, Río Cañas, and much of Cidra, are located outside the modeled inundation area. The greatest exposure is concentrated within the coastal communities and developed areas situated adjacent to Bahía de Mayagüez and the shoreline corridor. According to the map, median inundation depths within the impact area range from near zero to approximately 6.67 feet. Although the map does not identify specific structures or population counts, it demonstrates that residential areas, transportation corridors, public facilities, and other assets located within Playa, Añasco Abajo, and portions of Añasco Arriba may be exposed to tsunami inundation. Consequently, residents and visitors within these coastal sectors may require rapid evacuation following a tsunami warning. Maintaining effective evacuation routes, public awareness programs, emergency notification systems, and coordination with the municipality's tsunami evacuation planning efforts remains critical for reducing tsunami risk in the Municipality of Añasco.

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Map 28: Tsunami: Critical Infrastructure Exposure



4.8.2.3 Social Vulnerabilities

Social vulnerability during a tsunami event reflects pre-existing social, economic, and health conditions that influence how individuals and communities prepare for, respond to, and recover from rapid-onset coastal hazards. Research by U.S. scholars demonstrates that populations with lower incomes, limited access to transportation, and residence in hazard-prone coastal zones face disproportionately higher risk during tsunami evacuations (Cutter, Boruff, & Shirley, 2003). Older adults and people with disabilities are particularly vulnerable due to reduced mobility, dependence on medical and social support systems, and challenges accessing timely warnings and evacuation assistance (Peek & Stough, 2010). Studies of community resilience further show that inadequate risk communication, lack of hazard awareness, and weak institutional planning can significantly amplify disaster impacts, even when physical exposure is similar (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2007). Language barriers and social isolation may delay protective actions, increasing mortality and injury risk during time-compressed tsunami events. Collectively, these factors produce uneven disaster outcomes and underscore the importance of integrating social vulnerability considerations into tsunami preparedness and emergency planning.

Map 29 shows that population exposure is concentrated within the municipality's western coastal plain, particularly in the barrios of Playa and Añasco Abajo, with additional exposed populations located in portions of Añasco Arriba near the municipal center and coastal corridor. These areas coincide with the mapped tsunami inundation zone extending inland from Bahía de Mayagüez and the lower reaches of the Río Grande de Añasco.

The population exposure map indicates that the highest concentrations of population at risk are located within portions of Añasco Abajo, where several census tracts fall within the highest mapped category of approximately 174 to 420 persons at risk. Additional concentrations of exposed population are identified throughout Playa and adjacent portions of Añasco Arriba, where census tracts are classified within the intermediate exposure categories ranging from 42 to 173 persons at risk. Lower population exposure categories are observed along the periphery of the inundation area, where fewer residents are located within the modeled tsunami impact zone.

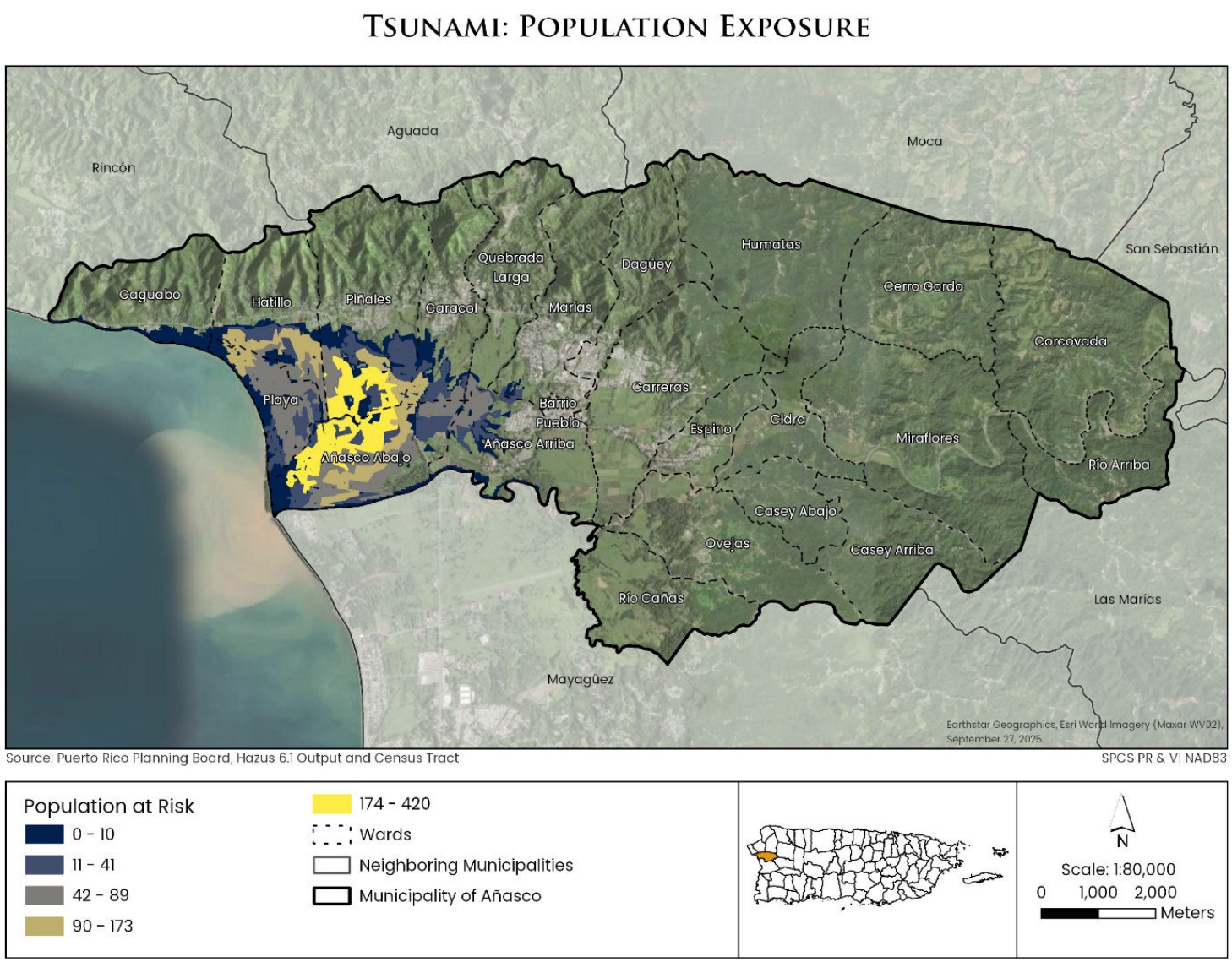
Of particular concern, many of the exposed populations are situated within the municipality's developed coastal areas, where residential neighborhoods, local businesses, public facilities, and transportation corridors are concentrated. Because tsunami waves can arrive with limited warning time following a local or regional seismic event, residents within Playa, Añasco Abajo, and portions of Añasco Arriba

may require rapid evacuation to higher ground or designated assembly areas. The tsunami evacuation map further demonstrates that these communities depend on established evacuation routes and warning systems to facilitate safe movement out of the inundation zone.

Consequently, tsunami events have the potential to create significant life-safety risks for residents located within the municipality's coastal sectors. Disruptions to transportation networks, emergency access routes, and critical services could further complicate evacuation and response efforts. Therefore, maintaining effective warning systems, preserving evacuation route accessibility, promoting public preparedness, and ensuring continued access to designated assembly areas remain important priorities for reducing tsunami risk in the Municipality of Añasco.

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Map 29: Tsunami: Population Exposure



4.8.2.4 Natural and Cultural Resources

A tsunami's waves scour coastal areas, eroding beaches, dunes, and cliffs, and reshaping geomorphology through sediment redistribution. They remove coastal vegetation, including mangroves, saltmarshes, and coastal forests, severely weakening ecological buffers against future events and disrupting habitat for wildlife. Submerged ecosystems, such as coral reefs and seagrass beds, suffer mechanical damage or smothering from debris and sediment, reducing biodiversity and undermining fisheries (Institute for Environmental Research and Education, 2025).

Saltwater intrusion contaminates freshwater ecosystems and aquifers, compromising drinking water and agriculture. Inland, fish and other aquatic organisms are often displaced or perish due to abrupt changes in salinity, wave force, and sedimentation. Studies on the 2011 Tōhoku tsunami showed changes in seafloor sediment structure that affected benthic invertebrate activity over time, highlighting lasting ecological legacies. Overall, these effects can take years or decades to recover from, especially when compounded by diminished habitat complexity and altered physical conditions (Institute for Environmental Research and Education, 2025).

Cultural heritage in coastal regions—including historic towns, monuments, and archaeological sites—is profoundly impacted. Physical destruction often occurs due to wave forces, flooding, debris impact, and prolonged inundation. Buildings and monuments can collapse or suffer structural failure, while artifacts and intangible cultural practices may be irretrievably lost. (Okamura, et al., 2013).

4.8.2.5 Future Conditions (E1-a)

Map 300 shows the exposure of recent development to the modeled tsunami impact area within the Municipality of Añasco based on Hazus 6.1 outputs and construction permit data. As shown on the map, recent development activity is distributed throughout the municipality; however, several construction permits issued between 2020 and 2026 are located within or immediately adjacent to the modeled tsunami inundation area concentrated along the western coastal plain. The areas with the greatest potential exposure are located within Playa and Añasco Abajo, where the tsunami impact zone extends inland from Bahía de Mayagüez and overlaps portions of the municipality’s developed coastal corridor.

The map further indicates that recent development has occurred near coastal and

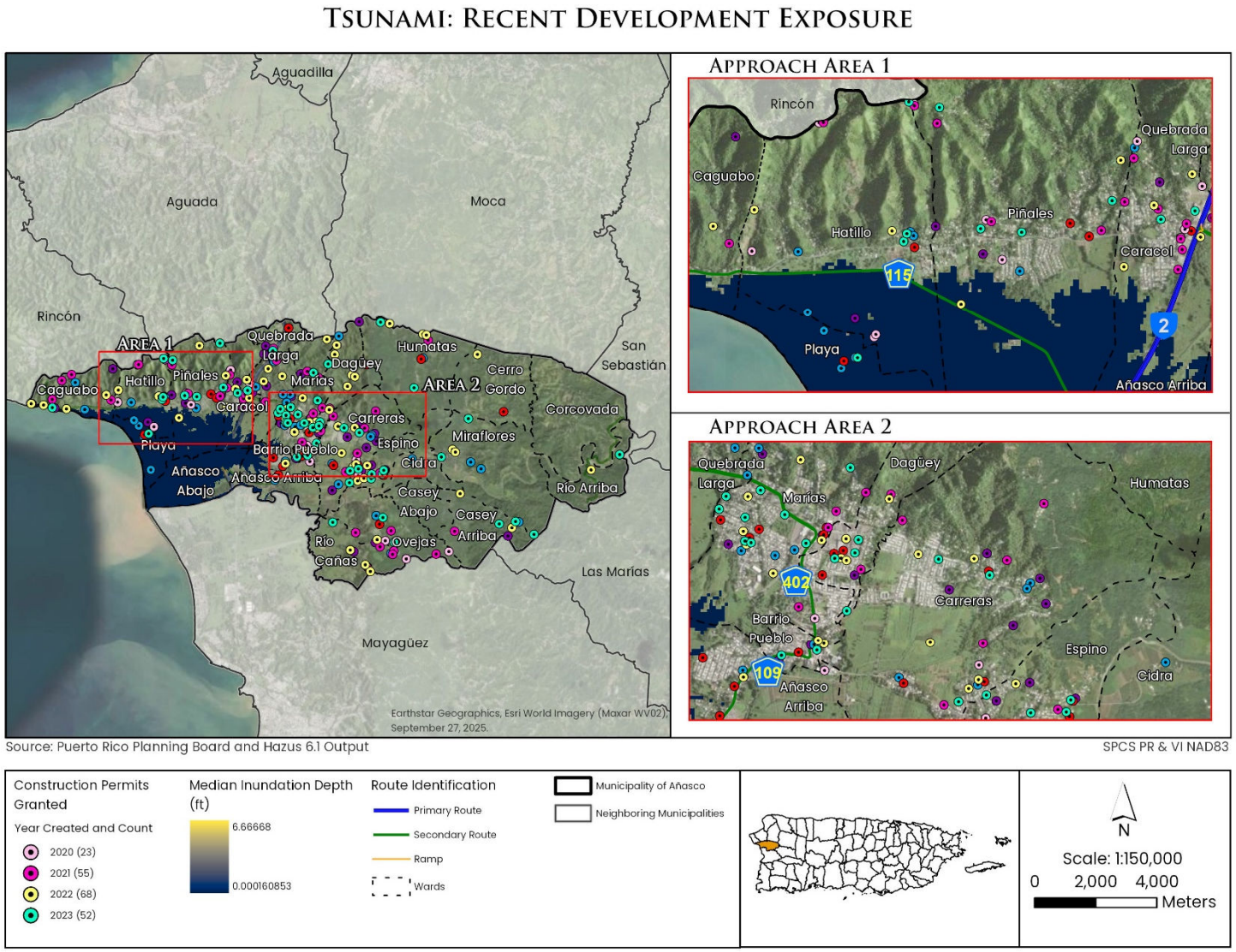
low-lying areas extending from Caguabo, Hatillo, Piñales, and Playa toward Añasco Arriba and the urban center. Approach Area 1 highlights numerous permitted developments situated near the boundary of the inundation area, particularly along the PR-115 corridor and surrounding coastal communities. Approach Area 2 illustrates additional concentrations of recent development within Barrio Pueblo, Añasco Arriba, Marías, Carreras, and Espino, areas that are generally located outside the primary tsunami impact zone but remain connected to evacuation and emergency response networks serving coastal populations.

According to the construction permit data shown on the map, a total of 350 permits were issued between 2020 and 2026, including 23 permits in 2020, 55 in 2021, 68 in 2022, 52 in 2023, 63 in 2024, 57 in 2025, and 32 in 2026. The distribution of these permits demonstrates continued development within both coastal and inland sectors of the municipality. While many recent developments are located outside the modeled inundation area, some are situated within areas that could experience tsunami flooding, particularly within the coastal portions of Playa and Añasco Abajo.

Of particular concern, future tsunami events could affect recently developed residential, commercial, and community facilities located within the inundation zone, potentially disrupting access, emergency response operations, and evacuation efforts. Because tsunami impacts are concentrated in the municipality's coastal areas, continued consideration of tsunami hazards during development review, land-use planning, emergency preparedness activities, and public outreach efforts remains important for reducing long-term risk in the Municipality of Añasco.

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Map 30: Tsunami: Recent Development Exposure



4.9 Flooding

4.9.1 Description (B1-a)

Floods, generally caused by excessive rainfall (FEMA, 1997), are classified into two main categories: general floods and flash floods.

- General floods are long-duration events that can last several days and include riverine, coastal, and urban floods. Coastal floods are associated with storm surges, waves, and heavy rains generated by hurricanes and tropical storms, while urban floods result from the alteration of natural drainage due to urban development. Riverine floods occur when rivers overflow due to excessive water runoff though rainfall or structural failures, causing water to spill into surrounding land. Flash floods often stem from stationary storms, hurricanes, or dam failures, affecting both mountainous areas and urbanized zones.

- Flash floods happen when prolonged rainfall falls over a watershed (water basin). The latter result from intense precipitation over a short period in specific areas. The magnitude of flash floods events depends on factors such as basin topography and physiography, weather patterns, soil saturation, and surface impermeability. Flash floods mainly originate from slow-moving storms over specific areas or from intense rainfall associated with hurricanes and tropical storms (NMEAD, 2021). However, they can also occur after the collapse of dams or levees within minutes or hours, due to extreme rainfall or the sudden release of water from retention basins or other stormwater control facilities. Although more frequent in mountain streams, these events can occur in urban areas where impermeable surfaces limit infiltration.

The periodic flooding of land adjacent to rivers, streams, and coasts—known as floodplains—is a predictable natural phenomenon based on recurrence intervals. These intervals represent the average time, in years, between events of equal or greater magnitude. The longer the recurrence interval, the greater the magnitude of the event, which implies a significant increase in risk and the extent of the affected area. Floodplains flood periodically according to recurrence intervals, defined as the average time between events of equal magnitude. For example, a 100-year flood has a 1% annual probability, while a 500-year flood corresponds to 0.2%. These frequencies are calculated through statistical analysis of historical flow records and extreme events.

The table below shows the different flood zone classifications for Puerto Rico adopted by the PRPB (PRPB, 2021).

Table 27: Puerto Rico Flood Zones

Flood Zone	Description
Zone A	Special Flood Hazard Area with a recurring period of one hundred (100) years determined by using approximate methodologies with no base flood elevation or Floodway determined.
Zone AE	Special Flood Hazard Areas with a recurring period of one hundred (100) years determined by detailed methodologies with base flood elevations indicated. According to the scope of the study, may include the Floodway determination.
Zone AO/AH	Shallow Special Flood Hazard Areas with a recurring period of one hundred (100) years with a base flood depth fluctuating between 0.30 meters (one (1) foot) and 0.91 meters (three (3) feet). The average flood depths are obtained from detailed hydraulic analysis.
Zone A99	areas prone to flooding from a flooding event with a one percent (1%) annual chance of occurring. These special areas are within a flood protection or control system where enough progress has been made in its construction, even though it has not been completed, but specific statutory progress has been reached to complete it. This zone does not detail base flood elevations or flooding depths, so it is recommended to use, if required, the previous flood elevation for Zone 99. Mandatory flood insurance purchase requirements apply.

Zone D	Flooding area that is not determined but is possible.
Zone VE	Coastal high flood hazard area with a recurring period of one hundred (100) years with velocity and energy (storm surge) and a determined base flood elevation.
Zone X Shaded	flooding area with 0.2% chance of occurring each year or the one hundred (100) year flood with a water depth of less than 0.3 meters, with drainage areas of less than 2.6 square kilometers or areas protected by levees against the one hundred (100) year flood.
Zone X (unshaded)	Area determined to be outside the five hundred (500) year storm flood.

4.9.1.1 Affected Area

Flood Hazard Insurance Map

Map 31 shows the FEMA Flood Hazard Zones within the Municipality of Añasco. As shown on the map, the municipality contains areas classified as the 1-percent annual chance flood hazard (100-year floodplain), the 0.2-percent annual chance flood hazard (500-year flood plain), and regulatory floodways. The most extensive flood hazard areas are concentrated within the coastal plain and along major river and drainage corridors. Flood-prone areas are particularly evident in Playa, Añasco Abajo, Añasco Arriba, Barrio Pueblo, Carreras, Cidra, Río Cañas, and portions of Espino, where flood hazard zones extend inland from the coast and along the Río Grande de Añasco and its tributaries.

The regulatory floodway, representing the channel and adjacent areas that must remain unobstructed to convey floodwaters, is concentrated primarily within Añasco Abajo, Añasco Arriba, Barrio Pueblo, and portions of Cidra and adjacent riverine corridors. The 1-percent annual chance flood hazard area extends across much of the municipality's western coastal plain and follows major watercourses through the central and eastern sectors of the municipality. Additional areas classified within the 0.2-percent annual chance flood hazard are present along the margins of the mapped floodplain, particularly in portions of Barrio Pueblo and Carreras.

The map illustrates that flood hazards in Añasco are associated with both coastal and riverine processes. Coastal flood hazards are concentrated in the low-lying western portion of the municipality, including Playa and Añasco Abajo, while riverine flood hazards extend inland along the Río Grande de Añasco and associated drainage systems affecting portions of Añasco Arriba, Barrio Pueblo, Carreras, Cidra, Río Cañas, and neighboring areas. As a result, residential, commercial, transportation, agricultural, and public service areas located within these flood hazard zones may be subject to recurring flood risks during significant rainfall events and other flood-producing conditions.

Consequently, flooding remains one of the most geographically widespread hazards affecting the Municipality of Añasco. Development within mapped flood hazard areas may be exposed to inundation, erosion, roadway disruptions, and impacts to public infrastructure and essential services. Therefore, continued implementation of floodplain management regulations, preservation of natural drainage corridors, maintenance of stormwater infrastructure, and incorporation of flood risk considerations into future development decisions remain important strategies for reducing flood risk within the Municipality of Añasco.

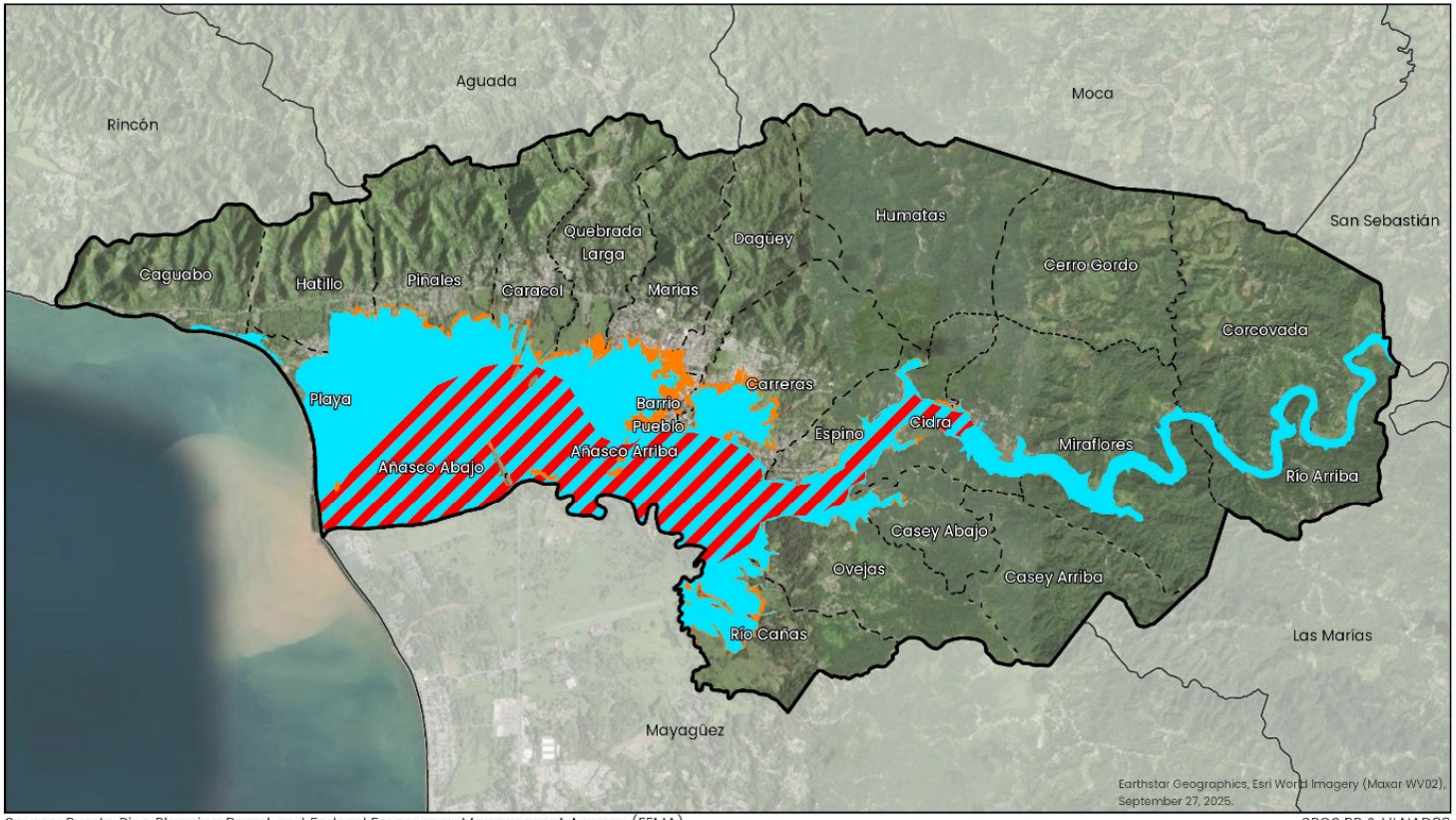
Map 31 presents a FEMA National Flood Hazard Layer (NFHL) depicting a coastal flood hazard area within the Municipality of Añasco. The map identifies coastal flood zones along the shoreline, including Zone VE and Zone AE. The mapped VE zone extends along the immediate coastline and is associated with Base Flood Elevations (BFEs) ranging from approximately 3.0 to 3.4 meters, while the adjacent AE zone is mapped with a BFE of 2.1 meters.

The flood-prone area is concentrated within the low-lying coastal corridor, whereas inland areas are predominantly classified as Zone X (Area of Minimal Flood Hazard). The presence of both VE and AE flood zones indicates exposure to coastal flooding, storm surge, wave action, and erosion during the 1-percent annual chance flood event.

This Map illustrates that development located along this section of Añasco's coastline is more vulnerable to coastal flood impacts than nearby inland areas. As a result, continued application of floodplain management regulations and consideration of coastal flood hazards in future development decisions remain important for reducing flood risk in the municipality.

Map 31 Flood Hazard Zones

Flood Hazard Zones



Source: Puerto Rico Planning Board and Federal Emergency Management Agency (FEMA)

SPCS PR & VI NAD83

FEMA Flood Hazard
- 1% Annual Chance Flood Hazard
- Regulatory Floodway
- 0.2% Annual Chance Flood Hazard

Wards
Municipality of Añasco
Neighboring Municipalities



N

Scale: 1:80,000

0 1,000 2,000 Meters

Figures 16 to 20 shows various FIRMette that shows specific areas of flooding in the Municipality.

- Figure 16 presents a FEMA National Flood Hazard Layer (NFHL) FIRMette depicting the lower Río Grande de Añasco near the municipal boundary between Añasco and Mayagüez. The map shows extensive areas classified as Zone AE and designated as a regulatory floodway, indicating areas subject to inundation during the 1-percent annual chance flood event. A Base Flood Elevation (BFE) of 2.1 meters is identified within the mapped floodplain.
- The floodway follows the Río Grande de Añasco channel and encompasses adjacent low-lying areas on both sides of the municipal boundary. A coastal Zone VE area with a BFE of 3.0 meters is also mapped near the river mouth, demonstrating the interaction of riverine and coastal flood hazards in this area. This FIRMette highlights the significant flood risk associated with development located adjacent to the Río Grande de Añasco and emphasizes the importance of continued floodplain management and development regulations within the municipality.
- Figure 17 presents a FEMA National Flood Hazard Layer (NFHL) FIRMette depicting a localized flood-prone area within the Municipality of Añasco. The map identifies an area classified as Zone AE, indicating inundation during the 1-percent annual chance flood event, with a mapped Base Flood Elevation (BFE) of 10.2 meters. The flood hazard area is concentrated along a drainage corridor and adjacent low-lying lands.
- Surrounding areas are primarily classified as Zone X, indicating minimal flood hazard. The configuration of the mapped floodplain suggests flooding associated with overbank flow and local drainage patterns. This FIRMette demonstrates that properties and infrastructure located within the AE floodplain may be exposed to flood inundation during significant rainfall events, emphasizing the importance of continued compliance with floodplain management regulations and consideration of flood risk in future development activities.
- Figure 18 presents a FEMA National Flood Hazard Layer (NFHL) FIRMette depicting flood-prone areas within the Municipality of Añasco. The map identifies extensive areas classified as Zone AE, indicating inundation during the 1-percent annual chance flood event. Base Flood Elevations (BFEs) shown on the map range from approximately 9.9 to 11.4 meters.
- A regulatory floodway is mapped within the southern portion of the figure, indicating areas necessary for the conveyance of floodwater during major flood events. The surrounding AE floodplain extends across low-lying agricultural and

developed areas adjacent to the floodway. This FIRMette illustrates the potential for riverine flooding in areas located near the mapped floodplain and highlights the importance of continuing floodplain management and development regulations to reduce flood risk within the Municipality of Añasco.

- Figure 19 presents a FEMA National Flood Hazard Layer (NFHL) FIRMette depicting a section of the Río Grande de Añasco floodplain near the municipal boundary between Añasco and Mayagüez. The map shows extensive areas classified as Zone AE and designated as a regulatory floodway, indicating areas that convey floodwaters during the 1-percent annual chance flood event.
- Base Flood Elevations (BFEs) shown on the map range approximately 3.7 to 4.6 meters. The floodway encompasses low-lying lands adjacent to the river channel and extends across portions of both municipalities. This FIRMette illustrates the significant riverine flood hazard associated with the Río Grande de Añasco and highlights the need for continued floodplain management and careful consideration of flood risks when planning future development within or adjacent to the mapped floodplain.

Figure 17: National Flood Hazard Layer FIRMette

Figure 18: National Flood Hazard Layer

Figure 19: National Flood Hazard Layer FIRMette

Advisory Base Flood Elevation (ABFE)

Likewise, FEMA uses another type of map for the purpose of developing regulations and construction permits known as the Advisory Base Flood Elevation Maps (ABFE). ABFEs are developed after the occurrence of a high-impact atmospheric event, and several factors related to the latest engineering analysis are taken into consideration to determine whether an analysis is necessary. Some of the factors considered in the analysis include the age of the analysis, the territory covered by the analysis, and the engineering models/data used in the analysis. ABFEs have been produced for states such as Mississippi (Hurricane Katrina), New York, and New Jersey (Hurricane Sandy). Following Hurricane María's passage through Puerto Rico in 2017, and due to the availability of better data, FEMA developed ABFEs for Puerto Rico. It should be noted that the Puerto Rico Planning Board adopted the ABFEs on an emergency basis in March 2018. At present, Puerto Rico has two (2) types of flood maps: the FIRMs (2009), which are used solely for flood insurance rates, and the ABFEs (2018), which are used to regulate construction on the Island.

For comparison purposes, this subsection includes the difference in the extent of land affected by flooding based on the FIRMs prior to Hurricane María in September 2017 and the ABFEs developed by FEMA for Puerto Rico. After Hurricane María in 2017, the areas designated as flood-prone throughout the Island increased by 20%. Thus, this reflected an increase of 41%.

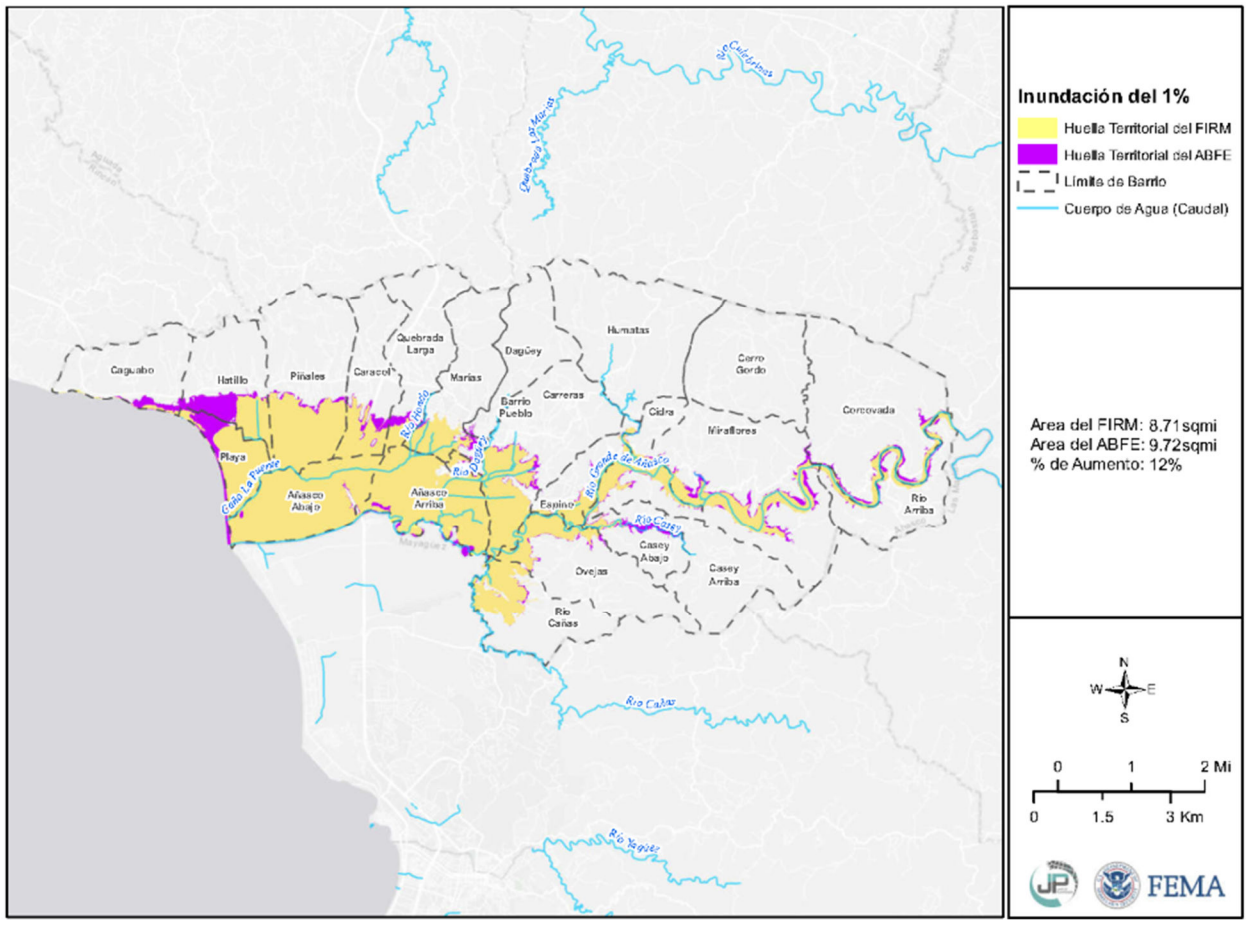
Figure 20 shows the difference between the extent of the FEMA Flood Insurance Rate Map (FIRM) floodplain and the Advisory Base Flood Elevation (ABFE) floodplain developed following Hurricane María for the 1-percent annual chance (100-year) flood event within the Municipality of Añasco. As shown on the map, the FIRM floodplain covers approximately 8.71 square miles, while the ABFE floodplain covers approximately 9.72 square miles, representing an increase of approximately 12 percent in the mapped flood hazard area. This increase indicates that flood-prone areas within the municipality may be more extensive than previously identified by the effective FEMA floodplain maps.

The most notable expansions are observed along the coastal plain encompassing Playa, Añasco Abajo, Añasco Arriba, and Barrio Pueblo, as well as along portions of the Río Grande de Añasco and its tributaries. Additional increases in the flood hazard area are evident along drainage corridors extending through Marías, Espino, Cidra, Casey Abajo, Ovejas, Río Cañas, and Río Arriba. The map shows that many of these expanded flood hazard areas are associated with riverine systems that convey runoff from the

municipality's interior areas toward the coast.

The expanded ABFE footprint highlights areas that may be subject to greater flood extents during extreme rainfall events than previously reflected in the effective FIRM mapping. Consequently, future land-use decisions, infrastructure improvements, and hazard mitigation initiatives should consider the larger flood hazard area identified by the ABFE analysis to reduce long-term flood vulnerability within the Municipality of Añasco.

Figure 22 ABFE vs FIRM 1% (100 years)



As instructed by PRPB the hazard analysis was made using the ABFE maps.

HAZUS Modeling

Flooding source identification and hazard loss estimation were performed using Federal Emergency Management Agency's (FEMA) HAZUS platform, a nationally standardized tool for multi-hazard risk assessment. The HAZUS flood module was used to delineate streams in areas where no engineering studies have been developed and

also used to estimate potential monetary losses associated with structural damage.

Input data included depth grids produced by a Base Level Engineering (BLE) study in 2018 post hurricanes Irma and Maria. This BLE study did not review all potential riverine flooding sources so additional modeling was developed with HAZUS hydrology and hydraulics to review other potential losses associated with streams with drainage areas of one square mile or more.

Topographic data used by HAZUS s for depth calculations and damage estimation was sourced from the USGS 3D Elevation Program (3DEP) seamless 1/3 arc-second Digital Elevation Model (DEM), at an approximate resolution of 10 feet. This dataset provides current coverage of Puerto Rico and its surrounding islands.

The 3DEP seamless DEM for Puerto Rico is derived from two lidar collection efforts: a 2016–2017 USGS lidar survey and a 2018 USGS post-Hurricane Maria lidar survey. The 2018 collection, conducted following the significant coastal geomorphic changes caused by Hurricane Maria, represents the most current available terrain data for the island and forms the primary basis of the 3DEP elevation layer used in this analysis.

The areas documented in the maps included within the LHMP may have streamlines represented but with no depth grids associated with them. Due to the inconsistency of available regression equations and other data necessary for computation of flood risk and losses with Hazus's hydrology and hydraulics models, some streams that were delineated were unable to be completed during modeling runs. These stream areas may need to be reviewed for future flood studies and potential flood risk identification but, due to the lack of data, they were unable to be included in the HAZUS studies.

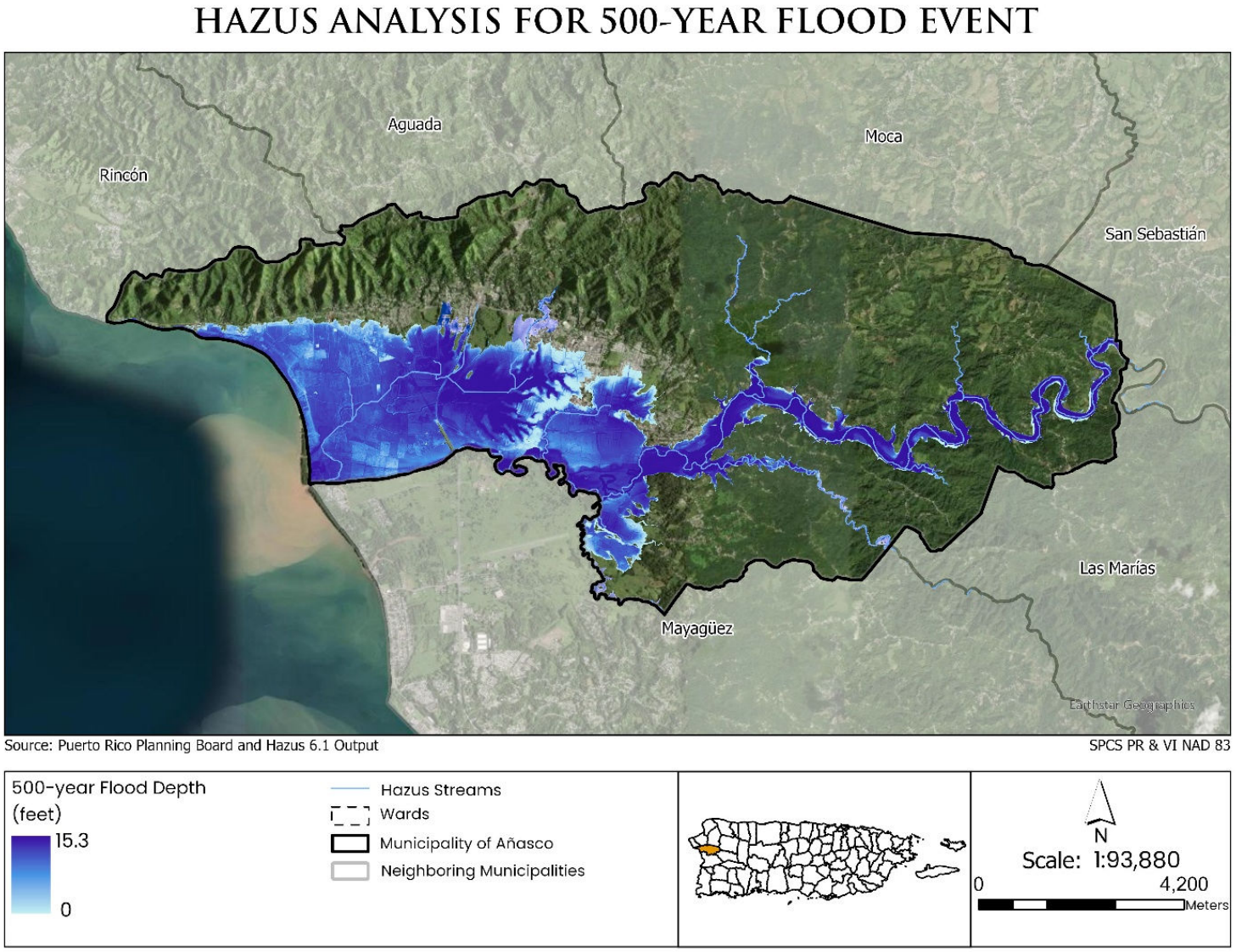
Map 32 shows the modeled flood extent associated with a 500-year flood event within the Municipality of Añasco based on Hazus 6.1 outputs. As shown on the map, flooding is concentrated throughout the coastal plain and along the Río Grande de Añasco and its tributaries. The most extensive inundation occurs within Playa, Añasco Abajo, Añasco Arriba, Barrio Pueblo, Carreras, and Espino, where floodwaters extend across broad low-lying areas.

Additional flooding is projected along river and stream corridors extending through Cidra, Casey Abajo, Casey Arriba, Ovejas, Miraflores, Río Arriba, and Corcovada. According to the Hazus analysis, modeled flood depths range from 0 to approximately 15.3 feet. The map demonstrates that a 500-year flood event could affect areas beyond the FEMA 100-year floodplain, highlighting the municipality's exposure to

extreme flooding and the importance of incorporating flood risk considerations into future planning and mitigation efforts.

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Map 32 HAZUS Analysis for 500 – Year Flood Event



4.9.1.2 Risk Magnitude (B1-C)

Flood events can represent one of the most severe atmospheric threats, as there is no other event worldwide that causes greater loss of life (FEMA, 1997). This is due to the high frequency of such events and the population's lack of awareness regarding the magnitude of the damage they can cause, whether physical harm or property damage. It should be noted that most disaster declarations in the U.S. are related to flood events. The majority of flood-related incidents involve people being swept away by fast-moving water, along with their vehicles (FEMA, 1997). Each year, the devastation caused by floods results in billions of dollars in asset losses. Highly urbanized areas with dense populations are particularly vulnerable to flash floods, as the construction of buildings, roads, and parking lots create impermeable surfaces, reducing the land's natural ability to absorb water (NSWL, n.d.).

Floods are the most common natural disaster, occurring when water overflows and submerges land that is typically dry. They are often triggered by heavy rainfall, rapid snowmelt, or storm surges from tropical cyclones or tsunamis in coastal regions.
Floods can cause extensive destruction, including loss of life and severe damage to homes, property, and critical public health infrastructure. Between 1998 and 2017, floods impacted more than 2 billion people worldwide. Those living in floodplains, in poorly constructed buildings, or without access to warning systems and hazard awareness are the most vulnerable (WHO, 2025).

Three common types of floods include:

- Flash floods: Result from sudden, intense rainfall that rapidly raises water levels, overwhelming rivers, streams, channels, or roads.
- River floods: Occur when prolonged rainfall or snowmelt causes rivers to exceed their capacity.
- Coastal floods: Caused by storm surges linked to tropical cyclones or tsunamis.

Regarding the impact on life, property, and operations, floods cause loss of life and property damage, including residences, buildings, infrastructure, agriculture, and sanitation and drainage systems. After a flooding event, the aftermath can increase the occurrence of various diseases, such as leptospirosis, and lead to rises in contaminated water (Malilay, 2000).

According to a Congressional Budget Office (CBO) report, "Over the past 10 years, damage from flooding in the United States has averaged $46 billion per year (in 2023

dollars)" (CBO, 2024). This estimate includes costs such as:

- The replacement of residential and commercial property;
- Repairs for or rebuilding of public infrastructure;
- Emergency response measures;
- Costs associated with the continued loss of property use (for example, the provision of temporary housing);
- Commercial losses resulting from business interruptions; and
- Damage to crops, livestock, and timber" (CBO, 2024).

Although the effectiveness of adaptation projects varies, estimates by the U.S. Army Corps of Engineers indicate that approximately two-thirds of its projects—excluding those in the highest and lowest sixth of benefit–cost ratios—are expected to reduce flood damages by $2 to $6 for every dollar invested over a 50-year project lifespan (CBO, 2024).

4.9.1.3 Past Events (B1-D)

For the most part, flooding events in Puerto Rico are related to tropical systems (tropical waves, tropical depressions, tropical storms and hurricanes). Consequently, flooding hazards occur most frequently during Atlantic hurricane season, which extends from June 1 through November 30.

However, flooding events can occur outside this window as shown in the case of the April- May 2024 Floods, the February 2022 floods and the Three Kings' Flooding of 1992. The following table summarizes the major flooding events in the period of 2010 – 2025.

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Table 28: Major flooding events in Puerto Rico 2010-2025

Event	Date	Disaster Declaration Number	Añasco . Included?	Description
Tropical Storm Ernesto	8/14/2025 – 8/16/2025	DR-4850- PR	Public Assistance – NO Individual Assistance NO	The storm's slow movement and moisture-rich environment contributed to prolonged precipitation, particularly in central and eastern municipalities. Parts of Central Puerto Rico recorded 12–14 inches of rainfall in localized areas. . Stormwater drainage systems in metropolitan areas, notably San Juan, were overwhelmed, leading to localized urban flooding. Emergency Response and Disruptions Evacuations were conducted in flood-prone areas such as Toa Baja to mitigate loss of life.
Puerto Rico Severe Storms, Flooding, Landslides, and Mudslides	4/29/2024 – 5/10/2024	DR-4808-PR	Public Assistance – No Individual Assistance - No	In April 2024, Puerto Rico was struck by a series of severe storms that delivered prolonged heavy rainfall—some areas received more than 10 inches—leading

				to widespread flooding and landslides. Central and western municipalities saw rivers overflow, breaching their banks and inundating highways like PR-2. Urban areas, especially in the southwest (Cabo Rojo, Mayagüez, Ponce), faced flash flood warnings as heavy afternoon downpours overwhelmed drainage systems. Floodwater turned streets into torrents, trapping residents on rooftops and prompting emergency evacuations in over 20 municipalities.
Hurricane Fiona	9/17/2025 - 9/21/2022	DR-4671-PR	Public Assistance – Yes Individual Assistance - Yes	Hurricane Fiona struck Puerto Rico in September 2022, unleashing torrential rains—up to 31.22 inches of rainfall over 72 hours in Ponce, nearly matching the accumulation from Hurricane Maria. This deluge led to catastrophic flooding, with 7 to 20 inches common across most of the island and localized spots exceeding 30 inches.
Puerto Rico	2/4/2022 –	DR-4649-PR	Public	In February 2022, Puerto

Severe Storm, Flooding and Landslide	2/6/2022		Assistance: No Individual Assistance: Yes	Rico experienced a severe storm that brought prolonged heavy rainfall, causing widespread flooding across the island. Rainfall totals ranged from 3 to 10 inches in many areas, with localized peaks reaching up to 16 inches in Toa Alta. The intense precipitation overwhelmed drainage systems, leading to urban flooding Rivers swelled beyond their banks, inundating roads and isolating communities, while landslides compounded the damage in mountainous regions. Emergency responders issued flash flood warnings and conducted evacuations as homes and businesses were submerged.
Puerto Rico Severe Storm and Flooding	9/13/2020	DR-4571-PR	Public Assistance: No Individual Assistance: No	Puerto Rico was battered by a severe storm and flooding on September 13, 2020, resulting in widespread flood damage and infrastructure disruption. Torrential rains overwhelmed drainage

				systems and caused rivers to overtop Roads and bridges were submerged or damaged, isolating communities and impeding emergency response efforts. Floodwaters inundated homes and public facilities, prompting evacuation orders and flash flood warnings across several municipalities.
Tropical Storm Isaías	7/29/2020 - 7/30/2020	DR-4560-PR	Public Assistance: No Individual Assistance; No	Although the center of Tropical Storm Isaías did not make landfall on the island, the system left a large amount of rain in its path, causing flooding throughout Puerto Rico. Rainfall accumulation of up to 10 inches was recorded around the island.
Hurricane María	9/20/2017	DR-4339-PR	Public Assistance – Yes Individual Assistance - Yes	Widespread flooding severely affected the whole Island. Survivors reported that floodwater rose 6 feet in just 30 minutes, and some areas experienced depths of up to 15 feet (4.6 m).
Hurricane Irma	9/5/2017	DR-4336-PR	Public Assistance – Yes Individual	On September 5, 2017, Hurricane Irma impacted Puerto Rico; an Emergency

			Assistance - No	Declaration was issued for the Island. On September 6, 2017, a Major Disaster Declaration was issued following Hurricane Irma's passage. Two people died due to torrential rains before the hurricane: Wave heights in Puerto Rico reached 9 meters, and sustained winds of 111 mph were recorded.
Tropical Storm María[10]	9/8/2011 – 9/114/2011	DR-4040-PR	Public Assistance: No Individual Assistance: No	Tropical Storm (later Hurricane) Maria formed in early September 2011 and passed near Puerto Rico, bringing significant heavy rainfall and tropical storm conditions to the island. The storm caused widespread flooding that inundated numerous roadways and homes; floodwaters as destroyed several homes and bridges,
Hurricane Irene	8/22/2011	DR-4017-PR	Public Assistance: Yes Individual Assistance: No	Total rainfall reached 22 inches over three days, with the eastern region being the most affected—the same area that had already received over 6 inches earlier in August during the close passage of Tropical Storm Emily.

				Flooding was severe enough to cause infrastructure stress and dangerous conditions across multiple municipalities. Tragically, there was one direct fatality attributed to Irene, due to drowning.
Puerto Rico Severe Storms, Flooding. Mudslides and Landslides	5/20/2021 – 6/8/2021	DR-4004-PR	Public Assistance: No Individual Assistance: No	In May 2021, Puerto Rico experienced a series of intense rainfall events that caused flash flooding, river overflows, mudslides, and landslides, particularly in mountainous and interior regions. Although May is normally one of the wettest months of the year, several storm systems produced short-duration but high-intensity rainfall, overwhelming local drainage systems and destabilizing steep terrain.
Sub-Tropical Storm Otto	10/3/2010 – 10/8/2010	DR-1946-PR	Public Assistance: No Individual Assistance No	An extensive rain band covered Puerto Rico while Otto moved as a distant tropical cyclone north of the Island (NOAA). This resulted in heavy and continuous rainfall that caused serious flooding. (Eco Exploratorio).

Puerto Rico Severe Storms and Flooding	5/26/2010 – 5/31/2010	DR-1919-PR	Public Assistance: No Individual Assistance: No	In May 2010, Puerto Rico was hit by a series of severe storms that produced torrential rainfall and widespread flooding across the island. Rainfall exceeded 12 inches in some areas, overwhelming drainage systems and causing rivers to overflow their banks. Low-lying communities and urban centers experienced significant inundation, with roads submerged and bridges damaged, isolating several municipalities. Flash floods swept through residential areas, forcing evacuations and leaving homes and businesses underwater. Landslides triggered by saturated soil compounded the crisis, blocking access routes and delaying emergency response efforts. The event resulted in extensive infrastructure damage and highlighted the island's vulnerability to prolonged heavy rain events during the wet season.

In summary, between 2010 and 2025 there were a total of 13 major disaster

declarations caused by flooding or events that had flood related damage. Of those, the municipality of Añasco was declared eligible for either Public Assistance or Individual Assistance in five instances.

4.9.1.4 Special Consideration: Floods by Stormwater Management Deficiencies

Urban drainage systems — whether natural or constructed — are designed to convey surface water runoff to receive water bodies. When storm drains, channels, or swales become obstructed, insufficient or overwhelmed by heavy rainfall and expanding urbanization, they can overflow and flood surrounding areas. As a result, floodwaters may spread beyond FEMA's mapped floodplains, even entering zones typically considered low or moderate risk (e.g., Zones B, C, or X) (FEMA, Reducing Damage from Localized Flooding, 2025).

Puerto Rico's stormwater runoff is conditioned by the island's climate, topography and land cover. Annual rainfall varies from less than 1,000 millimeters (mm) to over 4,000 mm (40 to 157 inches). The island's watersheds are largely mountainous, with steep slopes, and stream valleys are typically narrow and well-incised. Intense but short-duration storms are common, leading to rapid flooding with peak discharges that can be several orders of magnitude higher than base flows. All of Puerto Rico's watersheds have experienced significant alterations. It is estimated that more than 11% of the island is covered by developed surfaces, within areas reaching up to 40% in regions such as the San Juan Metropolitan Area. These changes have significantly modified stormwater drainage patterns and downstream floodwater levels (FEMA, 2024).

Paved surfaces severely limit the infiltration of rainwater, increasing both the volume and velocity of surface runoff. As a result, storm drains can easily become overwhelmed. In addition, runoff from paved surfaces reaches streams and rivers much faster, exceeding their capacity to convey water and causing higher and more frequent flood levels in adjacent areas. Moreover, contaminants from both point and non-point pollution sources are more likely to reach surface water bodies when transported by runoff over paved surfaces instead of being partially or totally degraded by vegetated soils. Higher flows also have a greater capacity to remove and transport soil and other loose materials from streambanks and riverbeds, facilitating erosion and scouring (FEMA, 2024).

Paradoxically, river flow between rain events tend to decrease after urbanization. Paved surfaces act as a barrier that isolates the soil, preventing the infiltration of

rainwater that otherwise would have gradually discharged from the ground and into streams days later, a process that is critical for maintaining base flows for riparian fish and wildlife species, but also to sustain public water supply. In response, various hard infrastructure measures (hard infrastructure measures such as flood-control pump stations, concrete trapezoidal channels, and curved side gutters have been widely implemented across Puerto Rico. While effective at quickly conveying runoff, these structures often neglect ecological, social, cultural, and aesthetic considerations. These practices often involve significant operation and maintenance costs and, in many instances, can exacerbate downstream erosion, scouring and water quality problems.

A more sustainable approach would be to take advantage of the ecological services that green areas and other nature-based solutions to manage runoff flows and improve water quality. Such strategies are increasingly critical to protect communities from the growing water-related impacts of climate change in Puerto Rico (FEMA, 2024).

4.9.1.5 Future Event Probabilities (B1-e)

A sustained increase in the frequency of extreme rainfall events has been identified in recent decades. As stated above, the Island of Puerto Rico has had 13 flood – related flood major disaster declaration in the last fifteen years. This means that the average frequency of a flooding event is approximately every 14 months.

Any mitigation action adopted to reduce the effects of flooding in the Municipality of Añasco must consider, for example, that 100-year return events or those with a 1% annual probability could become 50-year return events or have a 2% annual probability in the future. This means that flood events of a certain magnitude and impact on the municipality may increase, particularly in high-risk areas. Though there are many floods control projects in Añasco, the probability of future events is considered high.

4.9.2 Risk Analysis (B2-a, B2-b)

4.9.2.1 Estimated Losses

Maps 33 and 34 show the estimated building losses resulting from 100-year (1% annual chance) and 500-year (0.2% annual chance) flood events in Añasco, distributed by census block. It is important to note that these maps do not represent the geographic

extent of flooding, but rather the estimated economic losses to structures resulting from flood exposure.

For the 500-year flood scenario, the highest estimated building losses are concentrated within the municipality's central and western sectors, particularly in portions of Barrio Pueblo, Añasco Arriba, Marías, Caracol, Playa, and areas adjacent to the Río Grande de Añasco floodplain. Several census blocks within these areas are estimated to experience losses exceeding $5 million, reflecting the concentration of residential, commercial, and community assets within flood-prone areas. Elevated losses are also observed throughout Añasco Abajo, Cidra, Espino, Miraflores, Casey Abajo, Casey Arriba, and Río Arriba, primarily along major drainage corridors and river systems.

The spatial distribution of losses generally follows the municipality's principal floodplains, including the Río Grande de Añasco and its tributaries, which convey runoff from the northern and eastern upland areas toward the coastal plain. Although the mountainous barrios contain fewer developed areas overall, localized building losses are evident in portions of Quebrada Larga, Caracol, Marías, Dagüey, and the eastern river valleys where structures are located near stream channels and flood-prone corridors.

The 100-year flood loss map exhibits a similar spatial pattern but generally lower estimated losses than the 500-year flood scenario. The highest losses remain concentrated within Playa, Añasco Abajo, Añasco Arriba, Barrio Pueblo, Caracol, and Marías, demonstrating that these areas represent the municipality's most economically vulnerable locations during flood events. The primary difference between the two scenarios is the magnitude and geographic extent of losses, with the 500-year event affecting a larger number of developed areas and generating substantially higher economic impacts.

As a reminder, these maps estimate potential monetary losses to buildings resulting from flood exposure rather than the extent of inundation. The concentration of losses within the western coastal plain and central developed sectors is largely associated with the presence of residential, commercial, institutional, and community assets located within or adjacent to major flood hazard areas. During extreme rainfall events, flooding along the Río Grande de Añasco and associated tributaries can affect nearby structures and contribute to significant economic damages throughout the municipality.

The following table shows the municipality exposure to flood.

Table 29 Flood Exposure

Exposure - Impacted Area (sq mi)	Exposure - Building Value	Exposure - Population	Exposure - Population Equivalence	Exposure - Total
3.03	$439,659,427	3639	$42,216,679,927	$42,656,339,354

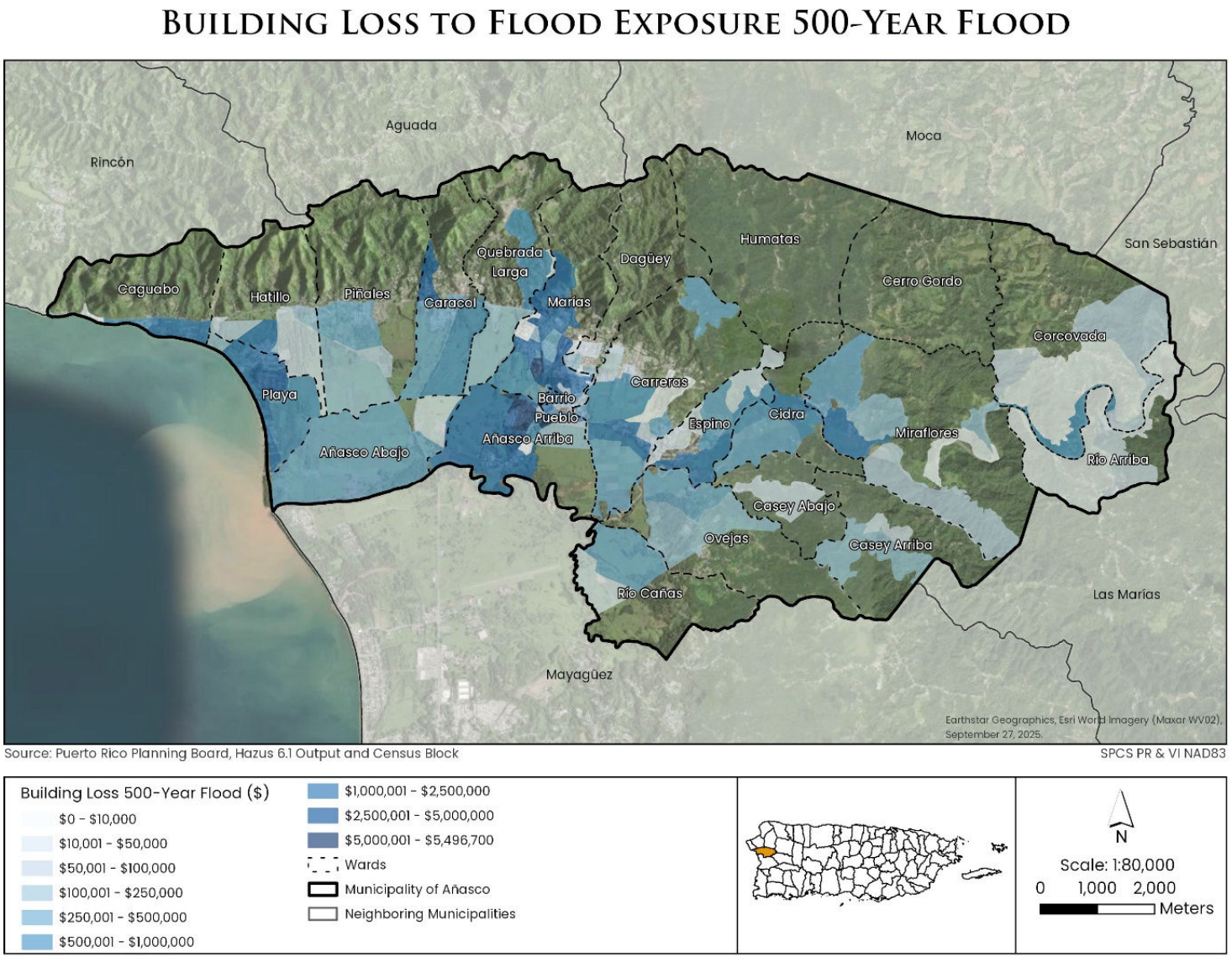
Source: FEMA NRI

While Table 30 presents the expected annual flood related losses for both buildings and population.

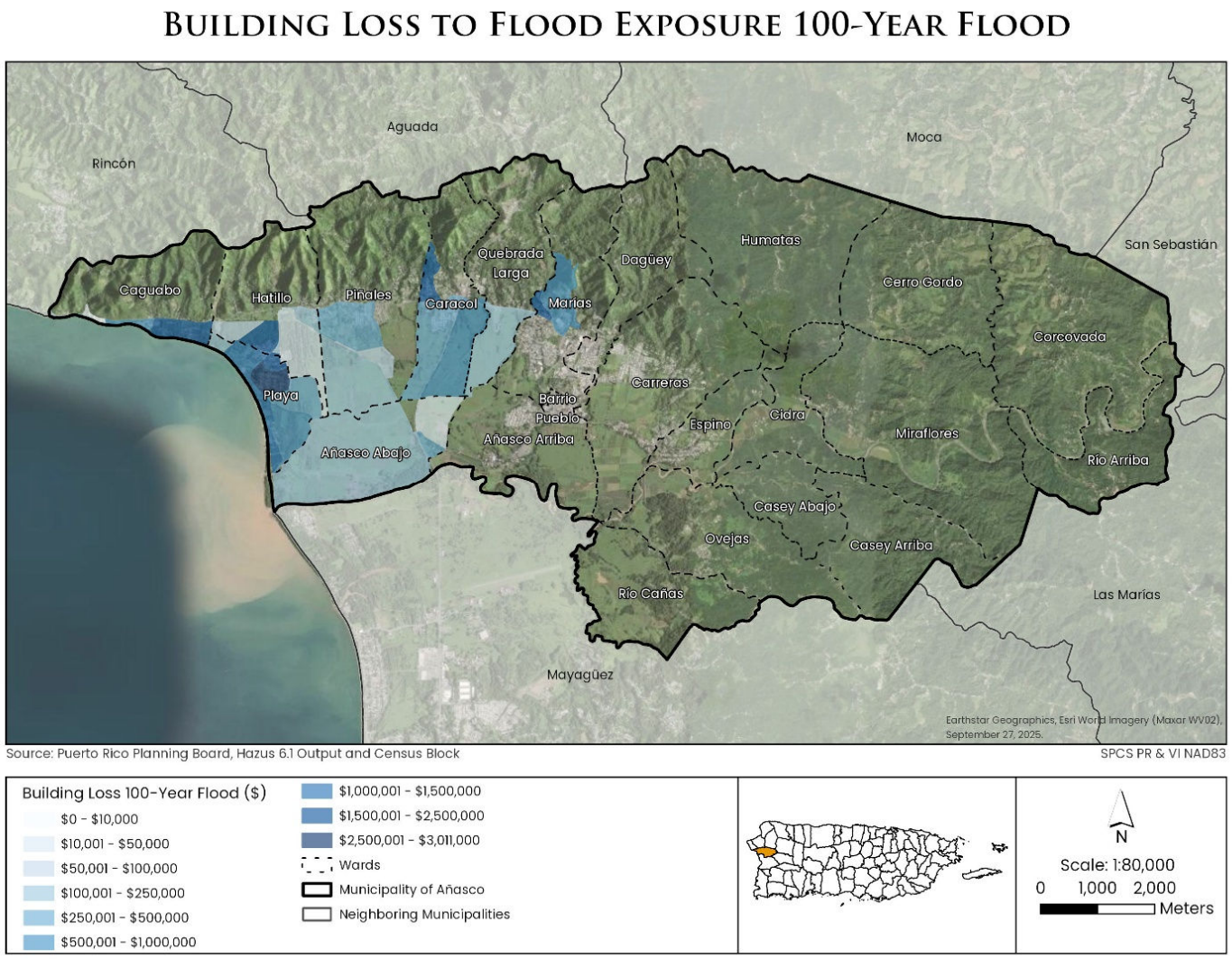
Table 30 Expected Annual Loss to Flood

Expected Annual Loss - Building Value	Expected Annual Loss - Population	Expected Annual Loss - Population Equivalence	Expected Annual Loss - Total
$4,224,605	0.027	$312,769	$4,537,374

Map 33 Building Loss to Flood Exposure 500 – year flood



Map 34: Building Loss to Flood Exposure 100 – year flood



After running the HAZUS 6.1 model, the following flood-related losses and exposure levels were estimated for Añasco:

- The modeled 500-year flood event affects extensive portions of the municipality's western coastal plain and major river corridors.
- According to the HAZUS flood-depth model, inundation is concentrated within Playa, Añasco Abajo, Añasco Arriba, Barrio Pueblo, Carreras, Espino, and portions of Río Cañas, where floodwaters extend across broad low-lying areas adjacent to the coast and the Río Grande de Añasco.
- Additional flooding is projected along river and stream corridors extending through Cidra, Casey Abajo, Casey Arriba, Ovejas, Miraflores, Río Arriba, Corcovada, and eastern portions of the municipality. The inundation pattern follows the Río Grande de Añasco and its tributaries as they convey runoff from the interior mountainous areas toward the coastal plain.
- Flood depths shown in the model range from 0 to approximately 15.3 feet, with the greatest depths generally occurring along major waterways, floodplain areas, and low-lying portions of the coastal plain.
- The most extensive exposure occurs where developed areas overlap the municipality's principal flood corridors, particularly near the Río Grande de Añasco floodplain and adjacent low-elevation lands. These areas contain residential, commercial, transportation, agricultural, and community assets that may be vulnerable during extreme flood events.

Overall, the HAZUS analysis demonstrates that flood risk in Añasco is driven primarily by the interaction of the Río Grande de Añasco watershed, its tributary drainage network, and the municipality's low-lying coastal plain. The areas of greatest potential impact are concentrated within the western and central portions of the municipality, where flood-prone lands coincide with many of Añasco's developed residential, commercial, agricultural, and infrastructure corridors. Consequently, future flood mitigation efforts should continue to focus on floodplain management, watershed protection, drainage improvements, infrastructure resilience, and land-use planning within these vulnerable areas.

Table 31: Total Structures at Risk

Structures	
Non-Residential	34
Residential	13,046
Total	13,080

Table 32: Aggregated Loss of dollars for 1% (100-year) and 0.2% (500 - year) events

Occupancy Type	Losses in Dollars. 1% Event	Losses in Dollars. 0.2% Event
Non-Residential	$0	$ 7,000
Residential	$ 13,531,000	$ 23,919,000
Total	$ 13,531,000	$23,926,000

Table 33: Detailed Loss for Non-Residential Buildings

Occupancy	Losses in Dollars, 1% Event	Losses in Dollars, 0.2% Event
Commercial	$0	$0
Education	$0	$7,000
Government	$0	$0
Religious	$0	$0
Agriculture	$0	$0
Industrial	$0	$7,000
Total	$0	$0

Table 34: Detailed Loss for Residential Buildings

Residential, Detailed Losses	Losses in Dollars, 1% Event	Losses in Dollars, 0.2% Event
Structure	$35,654,000	$41,001,000
Contents	$19,670,000	$22,693,000
Relocation	$29,320,000	$33,698,000
Rental Income	$12,535,000	$14,247,000
Total	$97,179,000	$111,639,000

4.9.2.2 Lifelines and Critical Infrastructure

Flooding is among the most disruptive natural hazards, affecting all eight FEMA Community Lifelines. These lifelines represent essential services that support public health, safety, and economic stability. Below is an analysis of some of the impacts that flooding can have on lifelines:

- **Safety and Security** - Flooding can damage emergency services infrastructure such as police stations, fire departments, and emergency operations centers. Blocked evacuation routes and submerged roads hinder rescue efforts, while prolonged outages increase vulnerability to crime and civil unrest.

- **Food, Water, Shelter** - Floodwaters can contaminate drinking water supplies and damage water treatment facilities. Food supply chains may be severely disrupted when warehouses and grocery stores are flooded. Damage to residential structures can result in displacement, creating urgent demand for temporary shelters.

- **Health and Medical** - Hospitals and clinics may become inaccessible or experience power outages during flood events. Flood conditions can contribute to increased incidence of waterborne diseases and mold-related illnesses increase significantly. Disruptions to medical supply chains may delay both emergency care and routine treatments.

- **Energy** (Power and Fuel) - Flooding can submerge electrical substations and transformers, causing widespread outages. Fuel distribution networks may be disrupted due to impassable roads and damaged transportation routes. Prolonged power loss can significantly affect critical facilities such as hospitals and water treatment plants.

- **Communications** – Flooding can damage cell towers, fiber-optic cables, and emergency communication systems, reducing the capacity to coordinate rescue and recovery operations. This disruption can delay the dissemination of critical information.

- **Transportation**- Flooding can wash out or undermine roads, bridges, and rail lines, rendering them impassable. Airports and seaports may be forced to suspend operations, delay evacuation and the delivery of emergency supplies. Also, transportation disruptions amplify the overall impact of the disaster.

- **Hazardous Materials** - Floodwaters can mobilize and disperse hazardous substances from industrial sites, sewage systems, and fuel storage tanks, increasing the risk of environmental contamination. Cleanup efforts can become complex, costly and time-consuming, potentially resulting in long-term public and environmental impacts.

- **Water Systems** - Floodwaters can contaminate drinking water supplies and damage water treatment facilities. Excessive inflow from floodwaters may overwhelm sewer systems, causing untreated sewage to backflow into streets and homes. Flood conditions can exceed the design capacity of storm drains and retention basins, resulting in urban flooding and infrastructure damage. The accumulation of sediment and debris clog drainage systems, reducing effectiveness and increasing flood risk during subsequent storms events.

Map 35 illustrates the location of critical infrastructure facilities in relation to FEMA-mapped flood hazard areas within the Municipality of Añasco. The map shows that several critical facilities are located within or adjacent to the 1-percent annual chance flood hazard area (100-year floodplain), the 0.2-percent annual chance flood hazard area (500-year floodplain), and the regulatory floodway.

The highest concentration of potentially exposed critical infrastructure is located within the municipality's western and central sectors, particularly in Playa, Añasco Abajo, Añasco Arriba, Barrio Pueblo, Marías, Caracol, and Espino. The approach areas highlight locations where multiple critical facilities coincide with mapped flood hazard areas, especially within the developed portions of the coastal plain and along major drainage corridors associated with the Río Grande de Añasco.

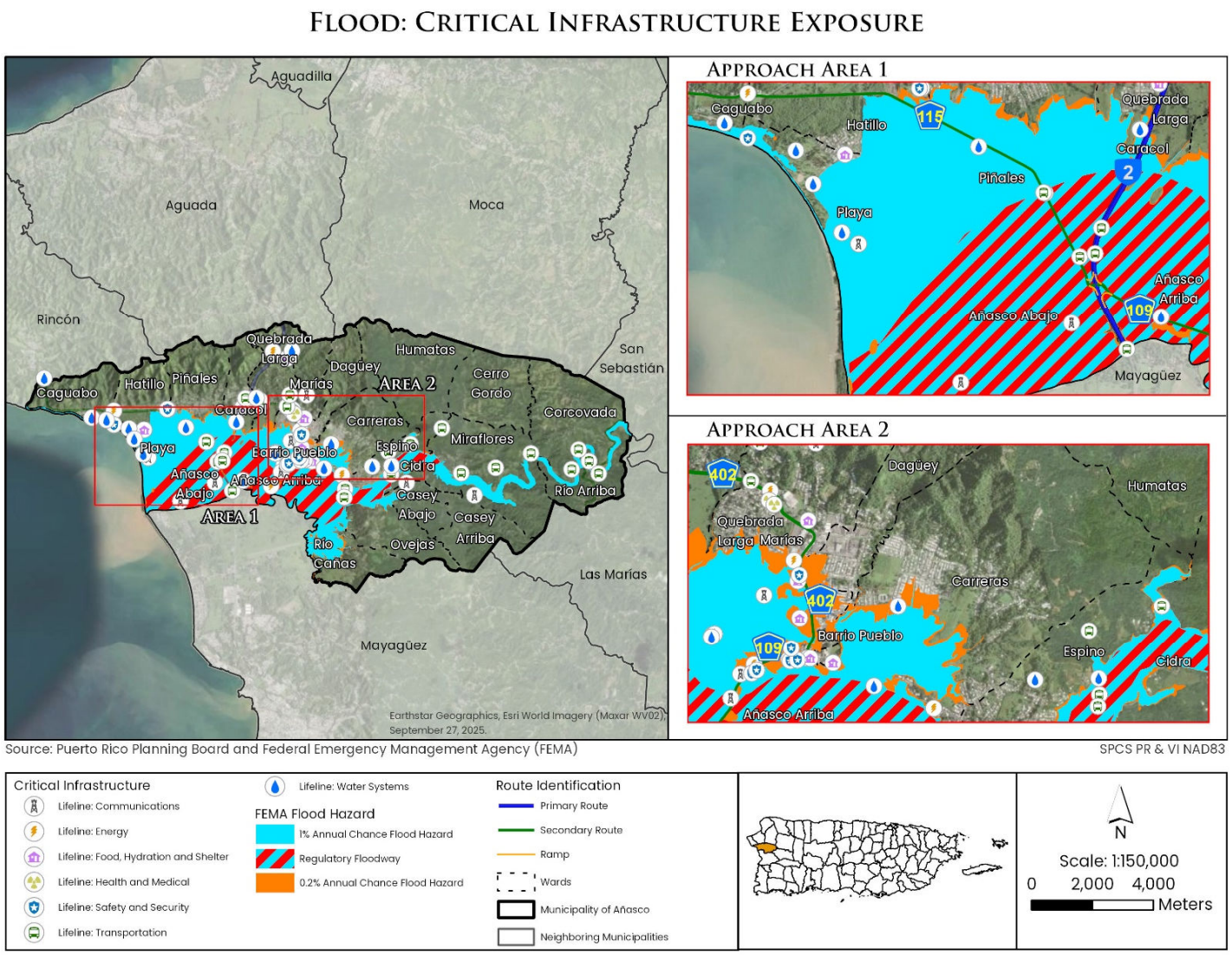
The mapped facilities include assets associated with several community lifelines, including transportation, water systems, communications, energy, safety and security, health and medical services, food, hydration and shelter facilities, educational institutions, economic facilities, community assets, and recreational facilities. The map indicates that flood hazard areas overlap portions of the municipality where numerous critical facilities are concentrated, particularly within the urbanized and low-lying western areas of Añasco.

The regulatory floodway is primarily associated with the Río Grande de Añasco and adjacent river corridors, where several critical facilities are located within or near mapped flood hazard areas. Additional concentrations of potentially exposed

infrastructure are present near Barrio Pueblo, Añasco Arriba, Añasco Abajo, Playa, Marías, Caracol, and Espino. These findings suggest that flooding could affect essential services and municipal operations during significant flood events, underscoring the importance of protecting critical facilities and maintaining continuity of operations throughout the Municipality of Añasco.

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Map 35: Flood Critical Exposure



4.9.2.3 Social Vulnerabilities

Social vulnerability to flood hazards is influenced not only by the physical extent of flooding but also by the location and concentration of the population within flood-prone areas. Communities with larger exposed populations are generally more likely to experience disruptions to housing, transportation, access to services, and daily activities during flood events. Higher population concentrations within hazard areas may also increase the demand for emergency response, evacuation assistance, temporary sheltering, and post-disaster recovery resources.

Map 366 shows the population at risk from flooding within the Municipality of Añasco based on Hazus 6.1 outputs and Census Block data. The highest concentrations of exposed population are located within the municipality's western and central developed areas, particularly in Playa, Añasco Abajo, Añasco Arriba, Barrio Pueblo, Caracol, Marías, and portions of Piñales. These areas correspond closely with the municipality's primary flood-prone corridors and contain many of the residential and commercial areas most susceptible to flood impacts.

Additional populations at risk are present along the Río Grande de Añasco floodplain and associated drainage networks extending through Espino, Cidra, Casey Abajo, Casey Arriba, Miraflores, Río Arriba, Ovejas, and Río Cañas. The distribution of exposed population generally follows major river and stream corridors that convey runoff from the municipality's interior upland areas toward the coastal plain.

As discussed previously, a substantial portion of Añasco's exposed population is concentrated within developed areas where flood hazards overlap with residential neighborhoods, community facilities, and transportation infrastructure. Of particular concern, residents living within the coastal plain and riverine flood-prone areas depend on major transportation routes to access employment centers, schools, medical services, and emergency response facilities. Flooding along these corridors may reduce mobility, delay emergency response operations, and restrict access to critical services during significant rainfall events.

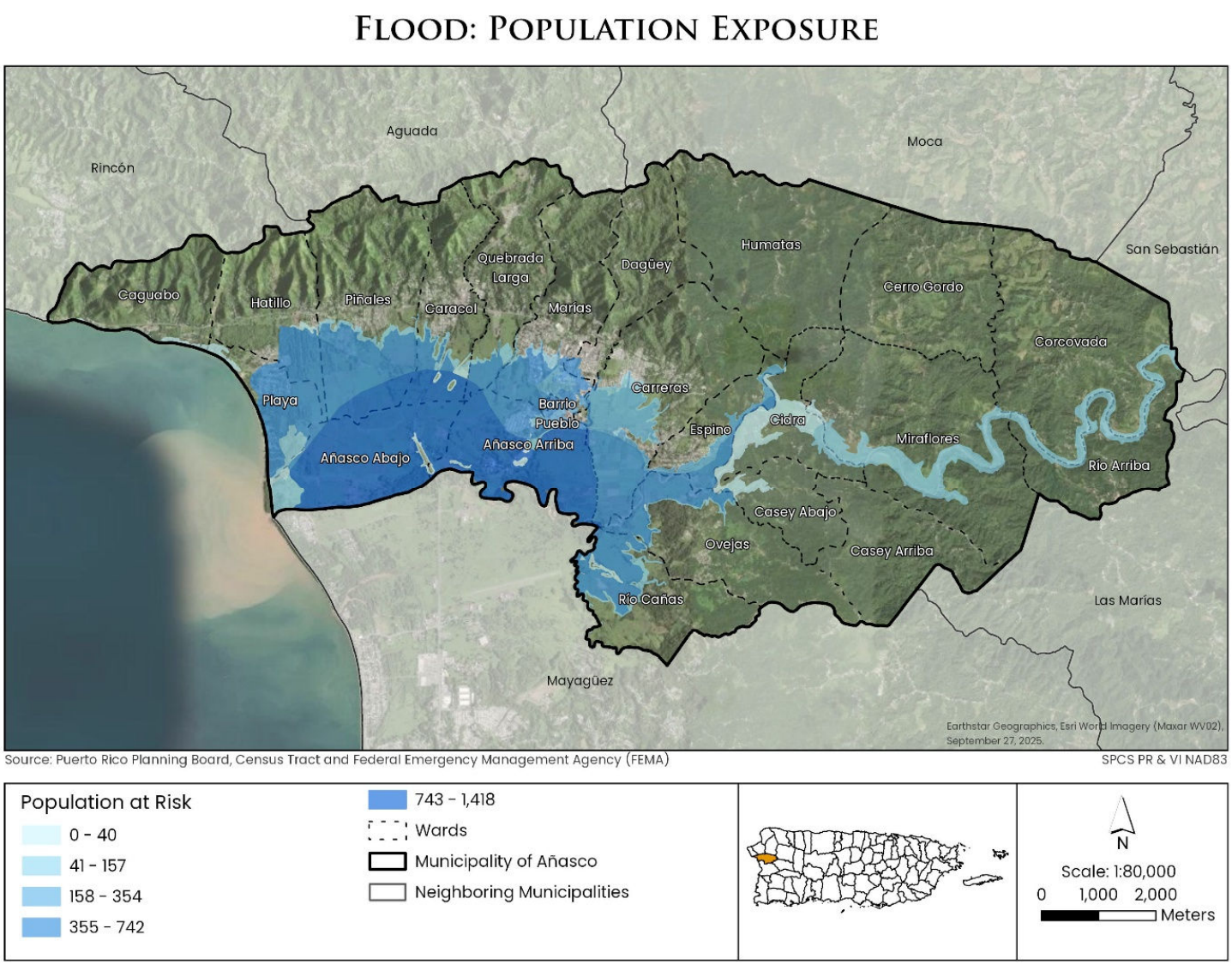
The population exposure analysis demonstrates that flood risk is concentrated not only within the coastal portions of Playa, Añasco Abajo, and Añasco Arriba, but also along inland river corridors extending through several central and eastern barrios. Consequently, maintaining transportation connectivity, improving drainage infrastructure, preserving floodplain functions, and incorporating flood risk

considerations into land-use and emergency management planning remain important components of flood risk reduction in the Municipality of Añasco.

Research in flood-prone Puerto Rican communities shows that access to economic, material, and social resources strongly influences adaptive capacity, with low-income residents facing significant barriers to elevating homes, purchasing insurance, or relocating away from high-risk zones. These same communities frequently experience "false security" due to structural flood-control measures that reduce perceived risk but do not eliminate underlying exposure, which can worsen long-term vulnerability when residents underestimate future flood potential. Flood impacts also disproportionately affect individuals with limited mobility—including older adults, disabled residents, and those with chronic medical conditions—who may be unable to evacuate rapidly or access emergency shelters during rising waters. The Census Bureau's Community Resilience Estimates indicate that vehicle access, caregiver support, health insurance gaps, and disability prevalence are among the most widespread vulnerability components in the commonwealth, factors that directly shape whether individuals can flee or recover from flooding (US Census Bureau, 2024), (López Marrero, 2010) .

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Map 36: Flood Population Exposure



4.9.2.4 Natural and Cultural Resources

In most flood events, water resources are exposed to high levels of contaminants associated with rising water, sewage accumulation, and other hazardous or toxic substances left behind by flooding (Malilay, 2000). This contamination can facilitate the spread of diseases in municipal water bodies and adversely affect local flora and fauna, including humans. For example, prolonged stagnant water after a flood can promote diseases such as dengue and leptospirosis. Following Hurricane María, stagnant water contributed to leptospirosis outbreaks and mosquito proliferation. Leptospirosis is a bacterial disease that affects both humans and animals and can spread through urine from infected animals. These contaminated residues often remain in stagnant water after flooding events.

Floods also lead to the accumulation of debris, including structural remnants, soil, sediments, organic waste, and personal belongings. If not properly managed, this debris can contaminate land and water when burned, abandoned, buried, or dumped into water bodies.

4.9.2.5 Special Consideration: Repetitive Losses and Severe Repetitive Losses

In Añasco there are properties insured under the National Flood Insurance Program (NFIP). These properties participate in the NFIP covered by the PRPB. Section 6.5 provides further details on how the municipality can use the NFIP as a mechanism for mitigation planning.

The Municipality has included properties that have experienced repetitive losses and/or severe repetitive losses located in identified flood hazard areas. These properties currently lack descriptions of the type of structures (residential, commercial, institutional, among others). Including this information helps to understand the vulnerability of properties affected by flooding within the jurisdiction and increases the likelihood of qualifying for flood control or prevention grants through programs such as Flood Mitigation Assistance (FMA), Hazard Mitigation Grant Program (HMGP), Housing and Urban Development (HUD), CDBG-DR, and others.

As of May 29, 2026, the information regarding NFIP coverage for Repetitive Losses (RL) and Severe Repetitive Losses (SRL) for the Municipality of Añasco are as follow:

Table 35: NFIP Policies in force and coverage

Amount of NFIP Policies	Total Disbursement for both RL and SRL Losses
46	$ 5,726,824

Accordingly, the registered RL are as follows

Table 36: NFIP Repetitive Losses

Structures with Repetitive Losses (RL)	Insured structures (RL)	Total Repetitive Losses (RL)
2	2	4

While the data provided show the following information regarding SRL

Table 37: NFIP Severe Repetitive Losses

Structures with Severe Repetitive Losses (SRL)	Insured structures S(RL)	Total Repetitive Losses (SRL)
0	0	0

4.9.2.6 Future Conditions (E1-A)

Map 37 shows the location of recent construction permits in Añasco in relation to FEMA flood hazard areas. The map indicates that a portion of recent development has occurred within or immediately adjacent to mapped flood hazard areas, particularly within the municipality's western and central sectors. The greatest concentration of permits is located in Playa, Añasco Abajo, Añasco Arriba, Barrio Pueblo, Marías, Caracol, and portions of Piñales, where residential and commercial development overlaps with areas identified as susceptible to riverine and coastal flooding.

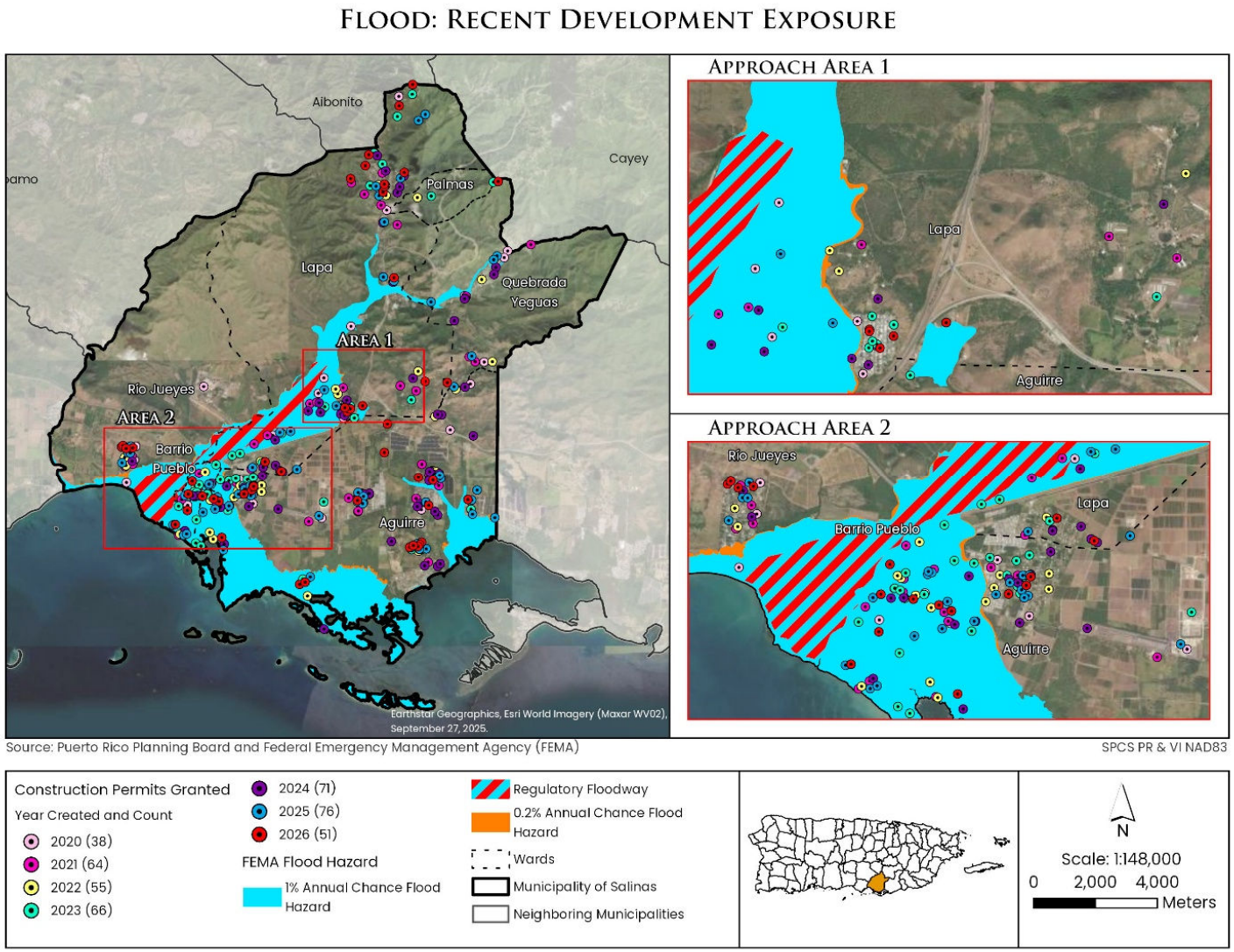
The detailed approach areas further illustrate this pattern. Recent construction permits are concentrated near the Río Grande de Añasco floodplain and associated drainage corridors that extend through the municipality's developed areas. Several permits are located in close proximity to FEMA Special Flood Hazard Areas, including portions of the 1-percent annual chance floodplain and regulatory floodway. These areas correspond to some of the municipality's most developed sectors and contain important residential, commercial, and community assets.

The map also demonstrates that development activity continues within areas previously identified as vulnerable to flooding, particularly along the coastal plain encompassing Playa, Añasco Abajo, Añasco Arriba, and Barrio Pueblo. Additional permit activity is evident near drainage corridors extending through Marías, Caracol, Espino, Cidra, and neighboring barrios. At the same time, numerous permits are located outside the mapped flood hazard areas, particularly within higher-elevation portions of the municipality where flood exposure is generally lower.

Overall, the map suggests that future flood exposure in Añasco may continue as development occurs within portions of the municipality already identified as flood-prone. The presence of recent construction within or near flood hazard areas indicates that additional structures and economic assets may be exposed to future flood events. Consequently, continued integration of flood hazard information into land-use planning, permitting decisions, infrastructure improvements, and hazard mitigation strategies remains important for reducing long-term flood risk in the Municipality of Añasco.

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Map 37: Recent Development Exposure



4.10 Tropical Cyclones and Extreme Wind Events

4.10.1 Description (B1-a)

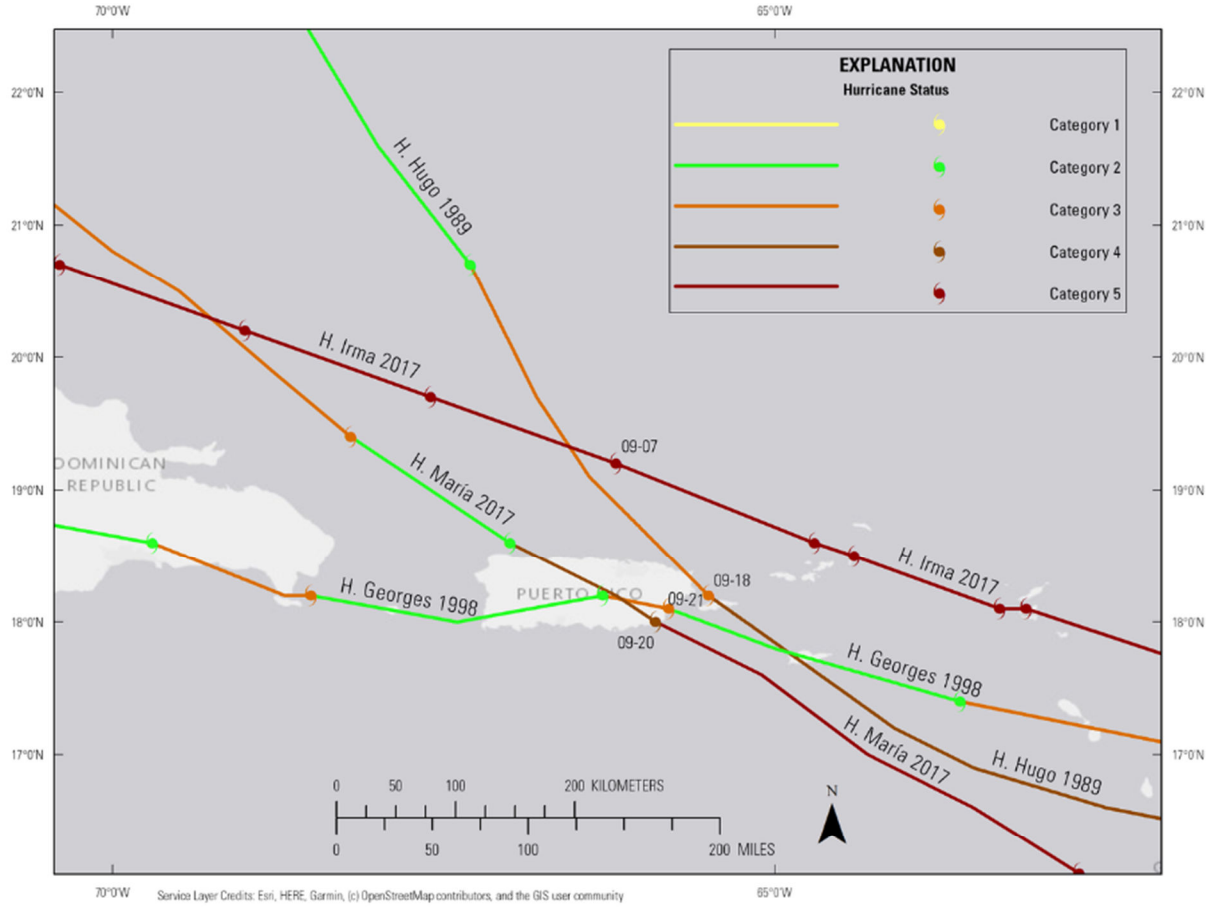
Winds consist of air currents generated in the atmosphere due to variations in pressure. Although these currents are constantly present, when their intensity increases, they can become a high-level hazard. For the purposes of this Plan, we will focus on events severe wind events associated with tropical cyclones and their extreme force (Castro Rivera & López Marrero, Cartilla de los Ciclones, 2018).

This sub-chapter is titled Tropical Cyclones in order to include phenomena such as tropical storms and tropical depressions. However, hurricanes pose the greatest threat due to their high destructive potential, wide geographic impact, rapid development, and sometimes unpredictable paths. In addition, hurricanes are often accompanied by high tides, storm surges, and heavy rainfall, which may result in landslides and riverine flooding. Since these accompanying hazards are addressed in separate sections, this section will focus specifically on the impact of wind within the municipality.

Figure 22 shows the path of category 2 – 5 hurricanes that have affected Puerto Rico since 1989.[8]

[8] Hortense (1996) and Fiona (2022) are not shown since they were category 1 hurricanes when they hit Puerto Rico.

Figure 23: Hurricane Tracks 1989-2017 (only Cat 2-5) [9]



Sources/Usage: Public Domain. View Media Details

Figure 1. *Hurricane tracks for Hugo (1898), Georges (1998), Irma (2017) and Maria (2017). Data provided by NOAA. Base image is intellectual property of Esri and is used herein under license. Copyright Esri and its creator.*

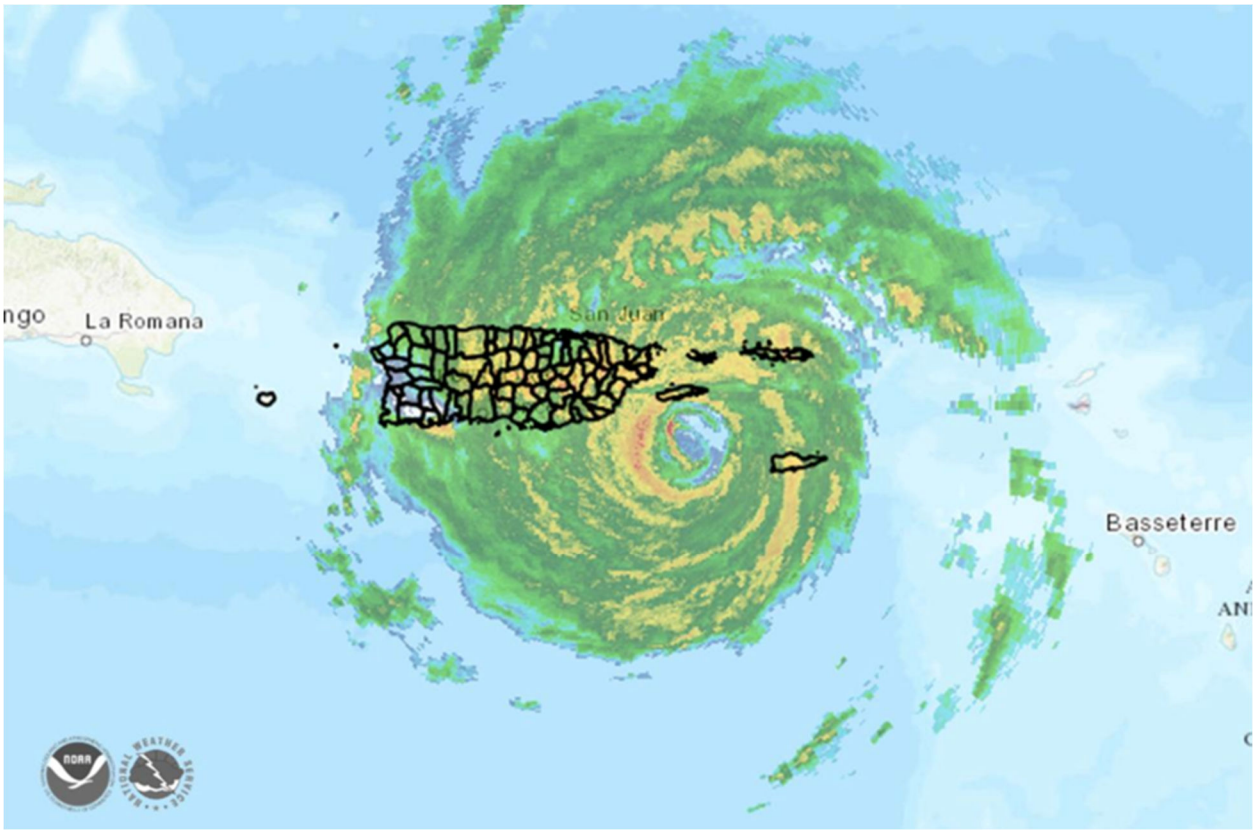
Figura 1: *Trayectorias de los huracanes Hugo (1989), Georges (1998), Irma (2017) y María (2017). Datos provistos por la NOAA. La imagen de base es propiedad intelectual de Esri y se usa aquí bajo licencia. Los derechos de autor y reproducción son propiedad de Esri y sus licenciatarios.*

4.10.1.1 Affected Area (B1-b)

Tropical Cyclones are atmospheric systems that can affect the whole island. For example, Figure 23 shows the size of hurricane María (2017) as it approached Puerto Rico.

[9]htt.s://www.usgs/gov/mission-areas/natural-hazards/science/Puerto-rico-natural-hazards-hurricanes-peligros-naturales-de

Figure 24: Hurricane María (2017) as it approaches Puerto Rico[10]



4.10.1.2 Risk Magnitude (B1-C)

Tropical cyclones are the most frequent natural hazard in Puerto Rico, with hurricanes being the most dangerous. Hurricanes are tropical atmospheric systems characterized by sustained wind speeds exceeding seventy-four (74) miles per hour. They develop over warm ocean waters and result from instability caused by the interaction of warm and cool air masses. Tropical cyclones are classified according to sustained wind intensity as follows:

- Tropical Depression: An organized system of clouds with a defined circulation and maximum sustained winds below 39 mph. This represents the formative stage of a tropical cyclone.
- Tropical Storm: An organized system of clouds with a defined circulation and maximum sustained winds ranging from 39 to 73 mph.
- Hurricane: The most intense form of a tropical cyclone, with sustained winds of

[10] Obtained from https://www.researchgate.net/figure/Hurricane-Maria-approaching-Puerto-Rico-NWS-2017_fig1_371340603.

74 mph or greater. Hurricanes have a well-defined center with very low barometric pressure. They are categorized from one (I) to five (V), and the strongest can reach wind speeds exceeding 155 mph (Castro Rivera & López Marrero, 2018).

Table 38 shows the Saffir - Simpson Scale of hurricanes and gives historical examples of those passing through or near Puerto Rico.

Table 38: Saffir-Simpson Hurricane Scale

Category	Wind Speed	Description	Historical Example
Tropical Storm	39 – 73 mph	Strong enough to cause tree damage, power outages, and localized flooding, but generally less destructive than a hurricane.	Eloise (1975) Claudette (1979) Frederic (1979) Jeanne (2004) Irene (2011) Isaias (2020) Ernesto (2024)
1	74–95 mph	Winds can cause minor damage to roofs, siding, and trees, with potential for power outages.	Santa Clara[16] (1956) Hortense (1996) Fiona (2022)
2	96–110 mph	Strong winds can cause extensive damage to roofs and trees, leading to widespread power loss.	Marilyn (1995)
3	111–129 mph	Devastating winds can destroy roofs and walls of homes, uproot trees, and cause prolonged outages.	Hugo (1989) Georges (1998)
4	130–156 mph	Catastrophic winds can cause severe	San Ciriaco (1899) San Ciprian (1932)

		structural damage, most trees snapped or uprooted, and power outages lasting weeks.	Donna (1960) David (1979) María (2017)
5	157 mph or higher	Catastrophic winds can result in total roof failure and building collapse, rendering areas uninhabitable for weeks or months.	San Felipe II (1928) Irma (2017)

To assess the vulnerability posed by hurricanes, this LHMP utilizes the 100 – year wind event and 500-year wind event as benchmark design standards. A 100-year wind event refers to a wind speed that has a 1% chance of being equaled or exceeded in any given year. Similarly, a 500-year wind event has a 0.2% annual probability of being equaled or exceeded. These terms describe statistical return periods and do not imply that such events occur only once every 100 or 500 years. Rather, they express the likelihood of occurrence in any single year. Wind returns period values are derived through statistical analysis of historical wind speed records using extreme value probability models. These analyses estimate wind intensities associated with specific recurrence intervals and are widely applied in engineering, insurance modeling, and hazard mitigation planning.

These values are critical for structural design standards like the American Society of Civil Engineers Standard 7 (ASCE 7), which specify wind loads for different risk categories, and for insurance companies assessing potential storm damage. For example, typical 3-second gust wind speeds at 33 ft above ground (Exposure Category C) are about 100 mph for a 100-year event and approximately 110–115 mph for a 500-year event. These design speeds ensure safety for buildings, bridges, and critical infrastructure, and help guide emergency planning and financial risk management.

4.10.1.3 Past Events (B1-D)

The following table shows the extreme wind events that received a declaration of

disaster in since 2000. One column identifies whether the Municipality of Añasco was designated for Public Assistance (PA), Individual Assistance (IA), or both under each declaration. Table 39 provides a list of tropical cyclones that have affected Puerto Rico during the first quarter of the twenty-first (21st) century, throughout the twentieth (20th) century, and selected notable storms from earlier centuries that had significant historical impact.

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Table 39: Tropical Cyclone Disaster Declarations since 2025

Event	Date	Disaster Declaration Number	Añasco	Description
Tropical Storm Ernesto	8/14/2024 – 8/16/2024	DR-4850- PR	Public Assistance – No Individual Assistance No	The storm's slow movement and moisture-rich environment contributed to prolonged precipitation, particularly in central and eastern municipalities. Parts of Central Puerto Rico recorded 12–14 inches of rainfall in localized areas. The municipality of Flash flooding occurred in urban and rural areas, rendering primary and secondary roads impassable. Floodwater caused structural failures in bridges and washed-out critical road

Event	Date	Disaster Declaration Number	Añasco	Description
				segments, isolating several communities. Stormwater drainage systems in metropolitan areas, notably San Juan, were overwhelmed, leading to localized urban flooding. Emergency Response and Disruptions Evacuations were conducted in flood-prone areas to mitigate loss of life.
Hurricane Fiona	9/17/2022 - 9/21/2022	DR-4671-PR	Public Assistance – Yes Individual Assistance - Yes	Hurricane Fiona struck Puerto Rico in September 2022, unleashing torrential rains. This deluge led to catastrophic flooding, with 7 to 20 inches common across most of the island and localized spots exceeding 30 inches.

Event	Date	Disaster Declaration Number	Añasco	Description
Tropical Storm Isaías	07/29/2020 – 07/31/2020	DR-4560-PR	Public Assistance: No Individual Assistance; No	Although the center of Tropical Storm Isaías did not make landfall on the island, the system left a large amount of rain in its path, causing flooding throughout Puerto Rico. Rainfall accumulation of up to 10 inches was recorded around the island.
Hurricane María	9/17/2017 – 11/15/2017	DR-4339-PR	Public Assistance – Yes Individual Assistance - Yes	Widespread flooding severely affected the whole Island. For example, in San Juan, water levels reached up to 6 feet in some areas and numerous structures losing their roofs. Survivors reported that floodwater rose 6 feet in just 30 minutes, and some areas

Event	Date	Disaster Declaration Number	Añasco	Description
				experienced depths of up to 15 feet (4.6 m).
Hurricane Irma	9/5/2017 – 9/7/2017	DR-4336-PR	Public Assistance – Yes Individual Assistance - No	On September 5, 2017, Hurricane Irma impacted Puerto Rico; an Emergency Declaration was issued for the Island. On September 6, 2017, a Major Disaster Declaration was issued following Hurricane Irma's passage. Two people died due to torrential rains. Wave heights in Puerto Rico reached 9 meters, and sustained winds of 111 mph were recorded in Culebra.
Tropical Storm María[17]	9/8/2011 – 9/14/2011	DR-4040-PR	Public Assistance: No Individual Assistance: No	Tropical Storm (later Hurricane) Maria formed in early September 2011 and passed near Puerto Rico, bringing

Event	Date	Disaster Declaration Number	Añasco	Description
				significant heavy rainfall and tropical storm conditions to the island. The storm caused widespread flooding that inundated numerous roadways and homes; floodwaters near Patillas destroyed several homes and bridges.
Hurricane Irene	8/22/2011	DR-4017-PR	Public Assistance: Yes Individual Assistance: No	Total rainfall reached 22 inches over three days, with the eastern region being the most affected—the same area that had already received over 6 inches earlier in August during the close passage of Tropical Storm Emily. Flooding was severe enough to cause infrastructure stress and dangerous

Event	Date	Disaster Declaration Number	Añasco	Description
				conditions across multiple municipalities. Tragically, there was one direct fatality attributed to Irene, due to drowning.

4.10.1.4 Future event probabilities (B1-e)

According to the Colorado State University Tropical Cyclones, Rada, Atmospheric Modeling and Software Team, the following average annual probabilities apply for storms coming ashore or passing within 50 miles of Puerto Rico: (Colorado State University, 2026)

- Average probability of a named storm coming ashore or within 50 miles of Puerto Rico: 40%
- Average probability of a hurricane coming ashore or within 50 miles of Puerto Rico: 24%
- Average probability of a major hurricane coming ashore or within 50 miles of Puerto Rico: 9%

4.10.2 Risk Analysis (B2-a, B2-b)

4.10.2.1 Estimated Losses

Table 40 presents the exposure to tropical cyclones as registered in FEMA National Risk Index.

Table 40 Tropical Cyclone Exposure

Exposure - Impacted Area (sq mi)	Exposure - Building Value	Exposure - Population	Exposure - Population Equivalence	Exposure - Total
39.958322	$ 3,096,363,104	25,533	$ 296,188,492,222	$ 299,284,855,326

The expected annual loss for each Census tract or jurisdiction represents the average yearly economic impact, expressed in dollars, anticipated from natural hazard events.

Table 41 presents the expected annual tsunami-related losses for both buildings and population.

Table 41 Expected Annual Loss to Tropical Cyclones

Expected Annual Loss - Building Value	Expected Annual Loss - Population	Expected Annual Loss - Population Equivalence	Expected Annual Loss - Total
$ 1,321,741	0.0439	$ 508,687	$1,372,609

Map 38 and Map 39 show the expected number of damaged buildings resulting from 100-year and 500-year tropical cyclone wind events in Añasco.

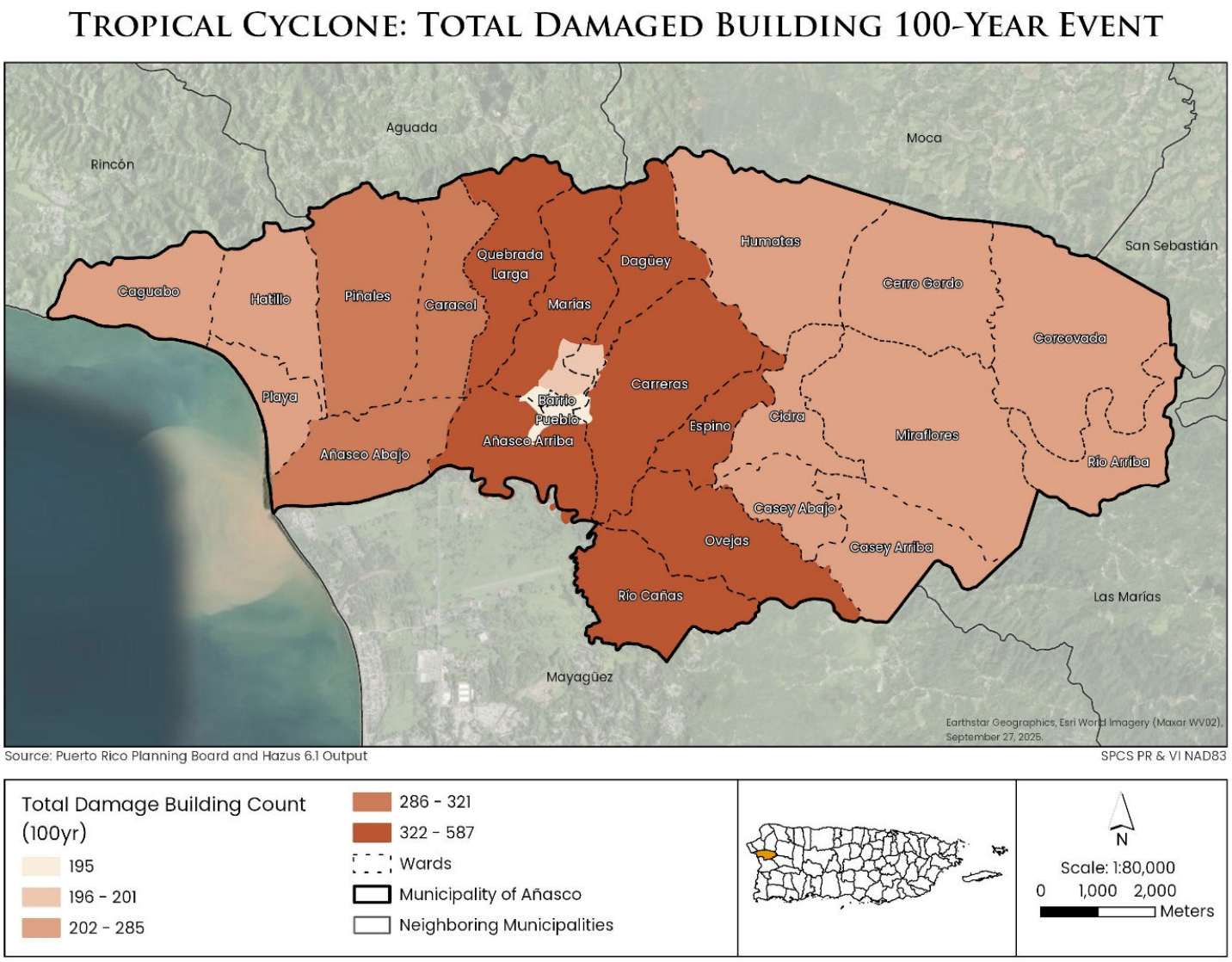
The 100-year event indicates that the highest concentration of damaged buildings is expected within Carreras, Espino, Río Cañas, Añasco Arriba, Marías, Dagüey, and Quebrada Larga, where projected damage ranges from 322 to 587 buildings. Moderate damage levels are also projected in Caguabo, Piñales, Caracol, Playa, and Añasco Abajo.

The 500-year event exhibits a similar spatial pattern but with substantially higher losses. The highest damage category, ranging from 537 to 1,110 damaged buildings, remains concentrated in Quebrada Larga, Marías, Dagüey, Carreras, Espino, Río Cañas, and Añasco Arriba. Additional elevated losses, ranging from 443 to 536 damaged buildings, are projected in Caguabo, Piñales, Caracol, Playa, and Añasco Abajo.

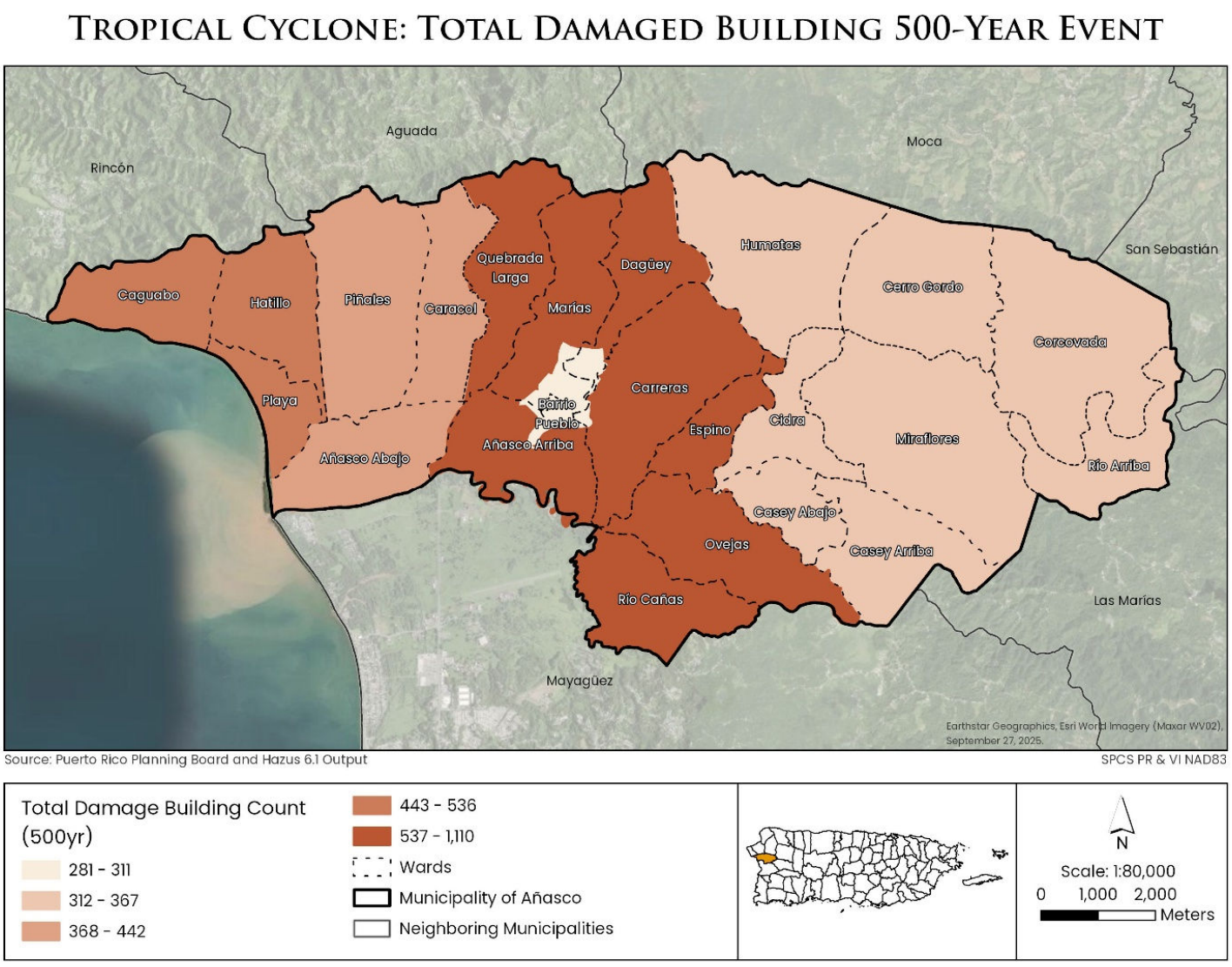
Overall, the maps indicate that the greatest wind-related building losses are expected within Añasco's central and most developed barrios, where higher concentrations of residential, commercial, and community assets are located. Consequently, efforts to strengthen structures and improve building resilience in these areas could significantly reduce future tropical cyclone damage.

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Map 38: Total Damaged Buildings 100 – Year Event



Map 39: Total Damaged Building 500 - Year Event



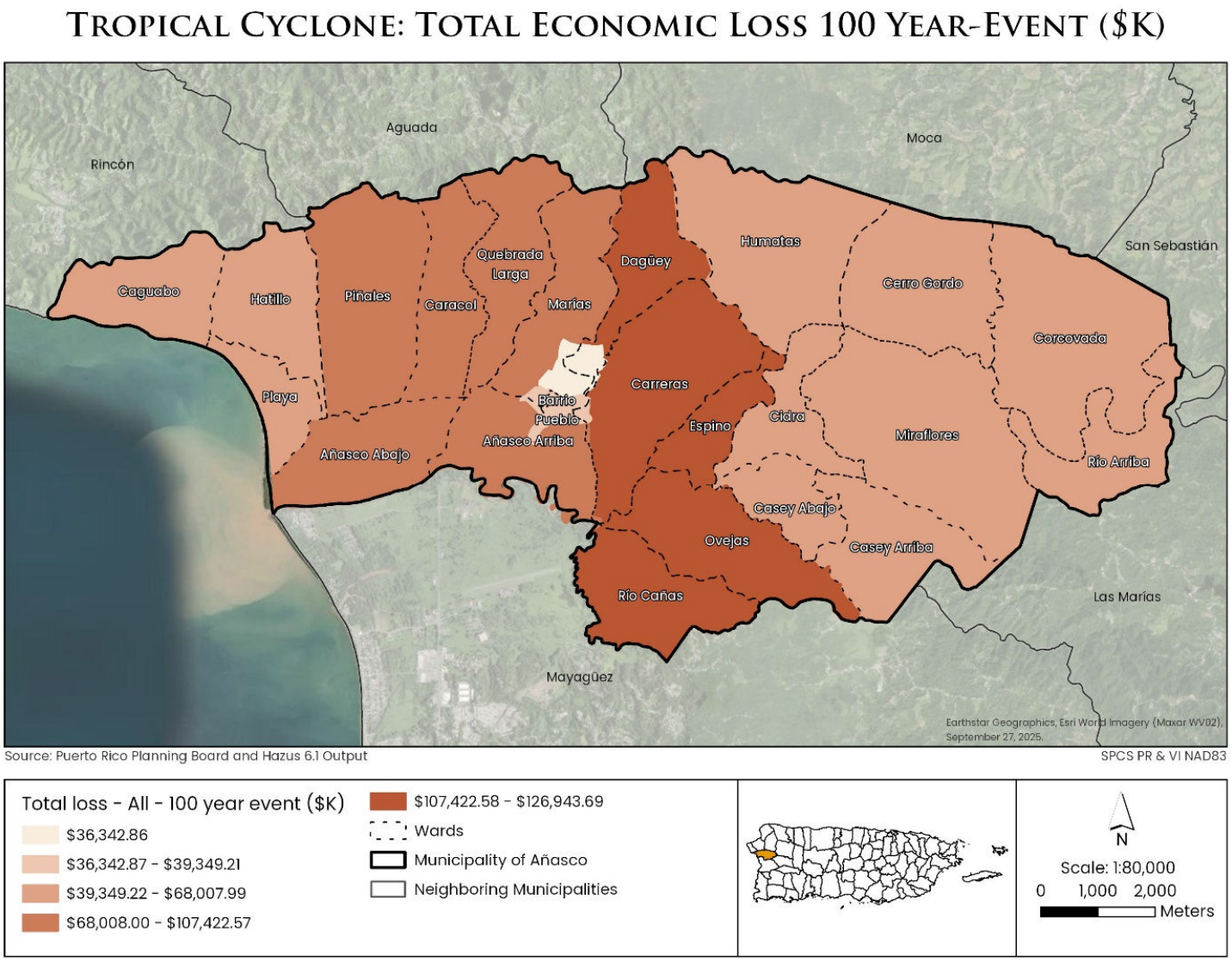
Map 40 and Map 41 show the projected economic losses resulting from tropical cyclone wind impacts associated with 100-year and 500-year wind events in the Municipality of Añasco. Map 39 presents the estimated economic losses for the 100-year event, while Map 40 presents the results for the 500-year event.

The 100-year event indicates that the highest economic losses are concentrated within Carreras, Espino, Río Cañas, Añasco Arriba, Marías, Dagüey, and Quebrada Larga. The highest loss category ranges from approximately $107.4 million to $126.9 million, reflecting the concentration of residential, commercial, public, and community assets within these barrios. Moderate losses are projected in Caguabo, Piñales, Caracol, Playa, and Añasco Abajo, while lower losses are observed in Humatas, Cerro Gordo, Corcovada, Miraflores, Río Arriba, Casey Arriba, Casey Abajo, and portions of Cidra.

The 500-year event exhibits a similar spatial distribution but substantially higher loss values. The highest economic loss category, ranging from approximately $270.9 million to $323.4 million, remains concentrated within Carreras, Espino, Río Cañas, Añasco Arriba, Marías, Dagüey, and Quebrada Larga. Elevated losses are also projected in Caguabo, Piñales, Caracol, Playa, and Añasco Abajo, while the lowest losses continue to occur in the municipality's less developed eastern and northeastern barrios.

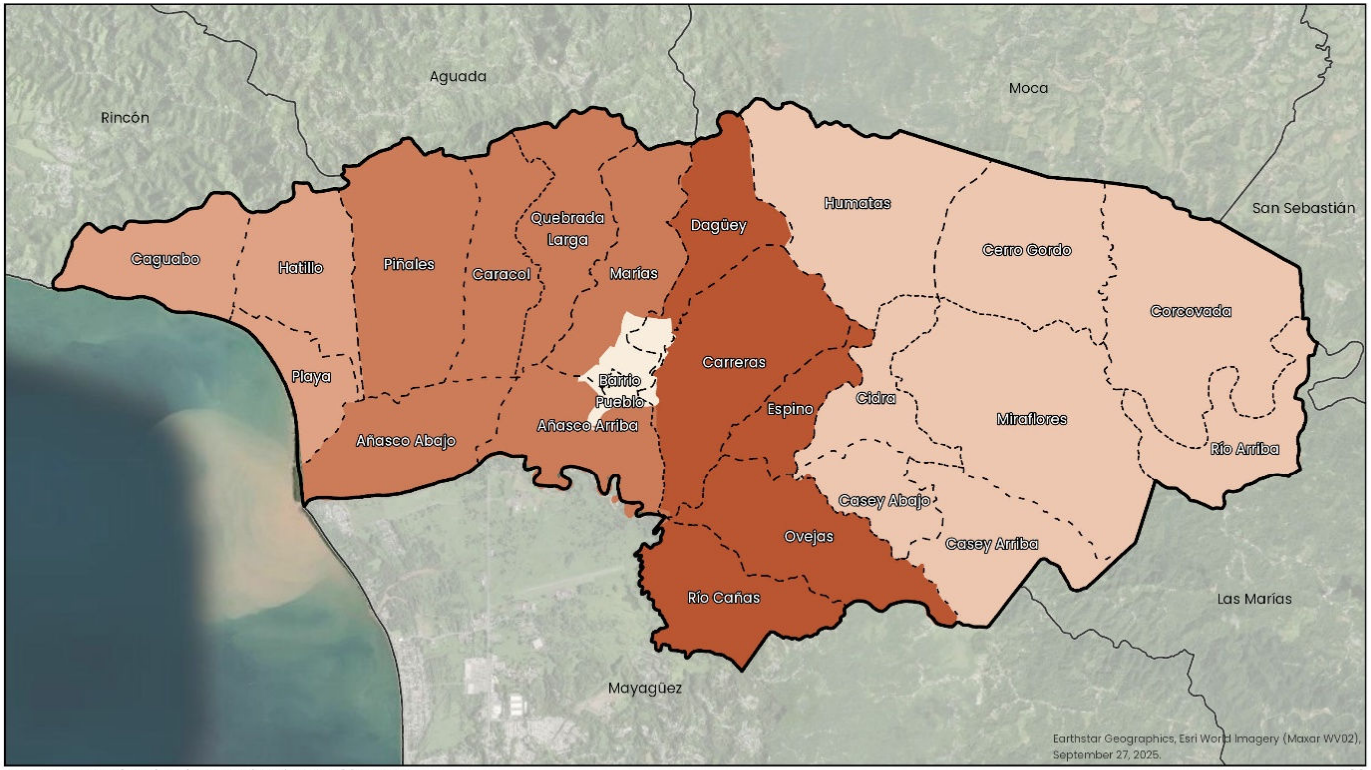
The pattern shown in both maps indicates that economic losses are driven primarily by the distribution and value of developed assets rather than by location alone. Consequently, the central portion of Añasco, particularly Carreras, Espino, Río Cañas, Añasco Arriba, Marías, Dagüey, and Quebrada Larga, represents the area with the greatest potential economic impact from future tropical cyclone events.

Map 40: Total Economic Loss 100 Year



Map 41: Total Economic Loss 500 Year

Tropical Cyclone: Total Economic Loss 500 Year-Event ($K)



Source: Puerto Rico Planning Board and Hazus 6.1 Output

SPCS PR & VI NAD83

Total loss - All - 500 year event ($K)

- $95,285.16 - $103,173.44
- $103,173.45 - $127,999.95
- $127,999.96 - $169,524.42
- $169,524.43 - $270,923.21
- $270,923.22 - $323,446.56

Wards

Municipality of Añasco

Neighboring Municipalities



N

Scale: 1:80,000

0 1,000 2,000 Meters

4.10.2.2 Lifelines and Critical Infrastructure

Hurricane winds have profound effects on all eight FEMA Community Lifelines, disrupting essential services and infrastructure.

- Safety and Security systems are compromised when high winds damage police stations, fire departments, and emergency operations centers, while debris and fallen power lines obstruct emergency routes, delaying rescue efforts.
- Food, Hydration, and Shelter lifelines suffer as winds destroy agricultural fields, damage food storage facilities, and tear roofs off homes and shelters, leaving communities vulnerable and displacing thousands.
- In the Health and Medicine sector, hospitals and clinics experience roof failures and structural damage, forcing evacuations and interrupting critical care, while pharmacies and supply chains face severe disruptions.
- The Energy lifeline is particularly vulnerable, as hurricane winds topple transmission towers, snap utility poles, and damage substations, causing widespread power outages that cascade into other lifelines.
- Communications systems fail when telecommunication towers and antennas are blown down, severing cellular and internet connectivity and hindering emergency coordination.
- Transportation networks are crippled by blocked roads, damaged bridges, and wind-related destruction at airports and seaports, delaying relief efforts and supply deliveries.
- Facilities handling Hazardous Materials face increased risks when wind-driven debris ruptures tanks or pipelines, creating environmental hazards and complicating cleanup operations.
- Finally, Water Systems are disrupted as treatment plants and pumping stations sustain roof and equipment damage, while elevated storage tanks and distribution infrastructure collapse, interrupting access to clean water for drinking and sanitation. These cascading failures underscore the critical need for wind-resistant design standards and proactive planning to protect lifelines and maintain community resilience during hurricane events.

For planning purposes this LHMP shall assume that all critical infrastructure is equally exposed to this hazard.

4.10.2.3 Social Vulnerabilities

As discussed before in Section 4.6.1.1 a tropical cyclone can impact the whole island. For this LHMP we are going to assume that all the population of Añasco is vulnerable to this hazard. For further details on the Municipality's social vulnerability see section 3.4.4.

4.10.2.4 Natural and Cultural Resources

Hurricane winds caused extensive damage to both natural and cultural resources by exerting extreme mechanical forces on landscapes and built environments. In natural settings, strong winds uproot trees, strip foliage, and break branches, leading to deforestation and habitat loss. This disruption affects biodiversity and can alter ecosystem functions for years. Coastal vegetation such as mangroves is particularly vulnerable, as wind-driven forces weaken root systems and reduce their ability to protect shorelines. Agricultural areas also suffer severe losses, with crops flattened or destroyed, impacting food supply and local economies.

Cultural resources, including historic buildings, monuments, and archaeological sites, are equally at risk from hurricane winds. High wind speeds can dislodge roofing materials, collapse walls, and damage structural integrity, especially in older or unreinforced constructions. Museums, archives, and heritage sites may experience irreparable harm if protective measures are inadequate. The loss of these cultural assets not only affects community identity but also has economic implications for tourism and preservation efforts. Understanding wind speed thresholds and incorporating them into design standards and conservation planning is essential to mitigate these risks and safeguard both natural and cultural heritage.

4.10.2.5 Future Conditions (E1-A)

The risk of hurricane is a municipal – wide risk. Every part of the recent development approved by the municipality is equally in risk of being affected by a tropical cyclone.

4.11 Storm Surge

4.11.1 Description

A storm surge is the inland movement of seawater that occurs when a hurricane makes a direct impact on the coast. These storm surges occur due to an atypical increase in the water levels of water bodies. Primarily, storm surges are produced by

an excessive rise in water along coastlines as a consequence of a massive low-pressure system, rainfall, and strong winds, characteristic of a hurricane or tropical storm (Castro Rivera & López Marrero, 2018).

These factors, inherent to a storm surge, create dangerous conditions at sea and cause extensive devastation after passing through coastal areas. Consequently, this type of natural hazard results in loss of life and severe damage to infrastructure and structures located in the affected areas. They are particularly dangerous when they occur during high tide, combined with the effects of swells and wave action. These factors make it difficult to predict this type of event because they depend on the diversity of tropical systems, the geological formations of the impacted area, and meteorological forecasts (FEMA, 1997).

The maximum potential storm surge for a particular location depends on a series of different factors. Storm surge is a very complex phenomenon because it is sensitive to even slight changes in storm intensity, forward speed, size (radius of maximum winds—RMW), angle of approach to the coast, central pressure (which contributes minimally compared to wind), and the shape of coastal features such as bays and estuaries.

Coastal areas are usually prone to storm surge impacts when an imminent hurricane threat is present. The behavior, magnitude, and impact of storm surge over land vary depending on the hurricane's trajectory. Likewise, the topography and coastal bathymetry of the municipality play an important role in relation to the impact of the surge on affected areas (FEMA, 1997).

4.11.1.1 Affected Area

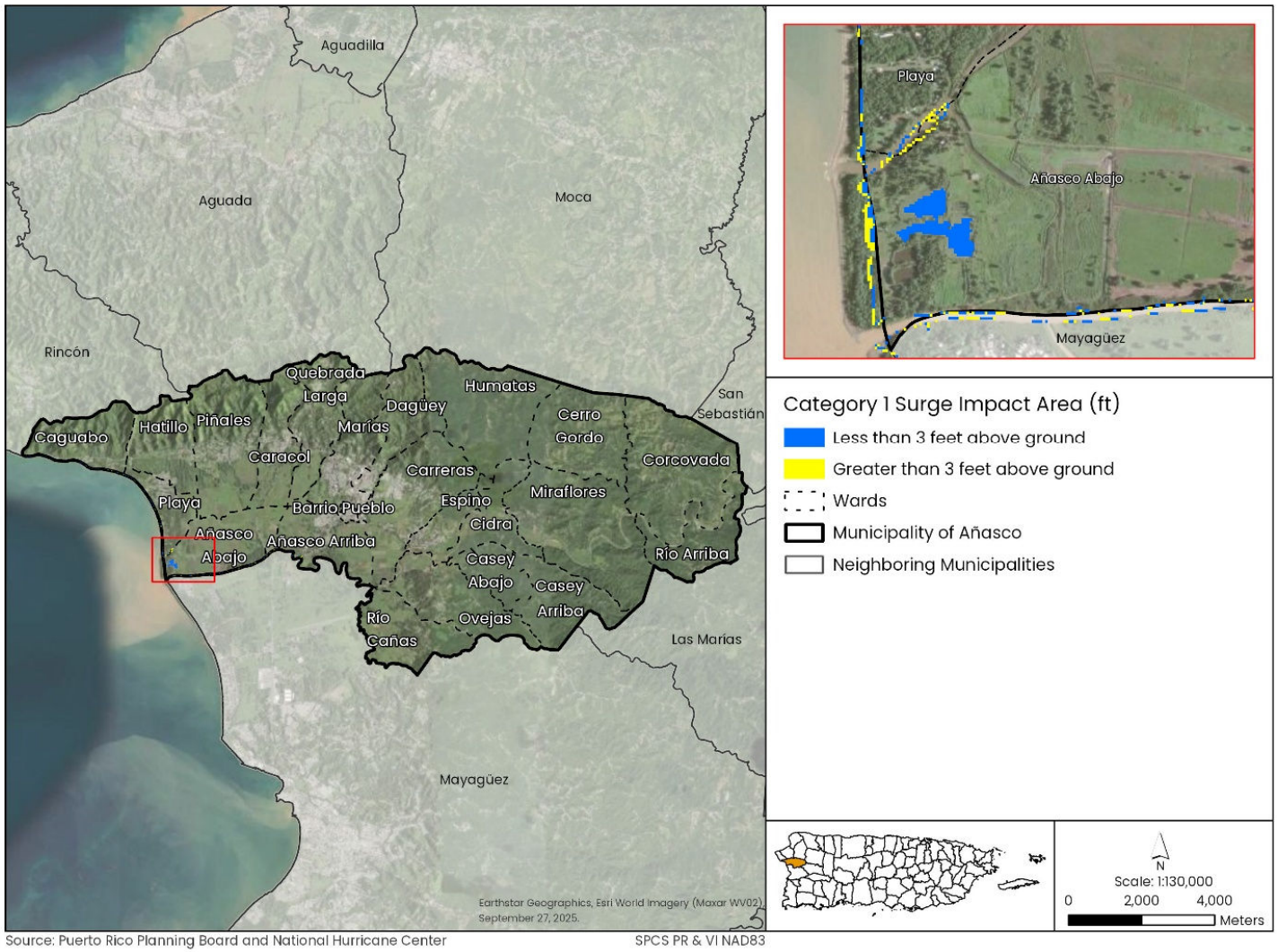
Map 42 and Map 43 illustrate the location of critical infrastructure facilities in relation to FEMA-mapped flood hazard areas within the Municipality of Añasco. The map shows that several critical facilities are located within or adjacent to the 1-percent annual chance flood hazard area (100-year floodplain), the 0.2-percent annual chance flood hazard area (500-year floodplain), and the regulatory floodway.
The highest concentration of potentially exposed critical infrastructure is located within the municipality's western and central sectors, particularly in Playa, Añasco Abajo, Añasco Arriba, Barrio Pueblo, Marías, Caracol, and Espino. The approach areas highlight locations where multiple critical facilities coincide with mapped flood hazard areas, especially within the developed portions of the coastal plain and along major drainage corridors associated with the Río Grande de Añasco.

The mapped facilities include assets associated with several community lifelines, including transportation, water systems, communications, energy, safety and security, health and medical services, food, hydration and shelter facilities, educational institutions, economic facilities, community assets, and recreational facilities. The map indicates that flood hazard areas overlap portions of the municipality where numerous critical facilities are concentrated, particularly within the urbanized and low-lying western areas of Añasco.

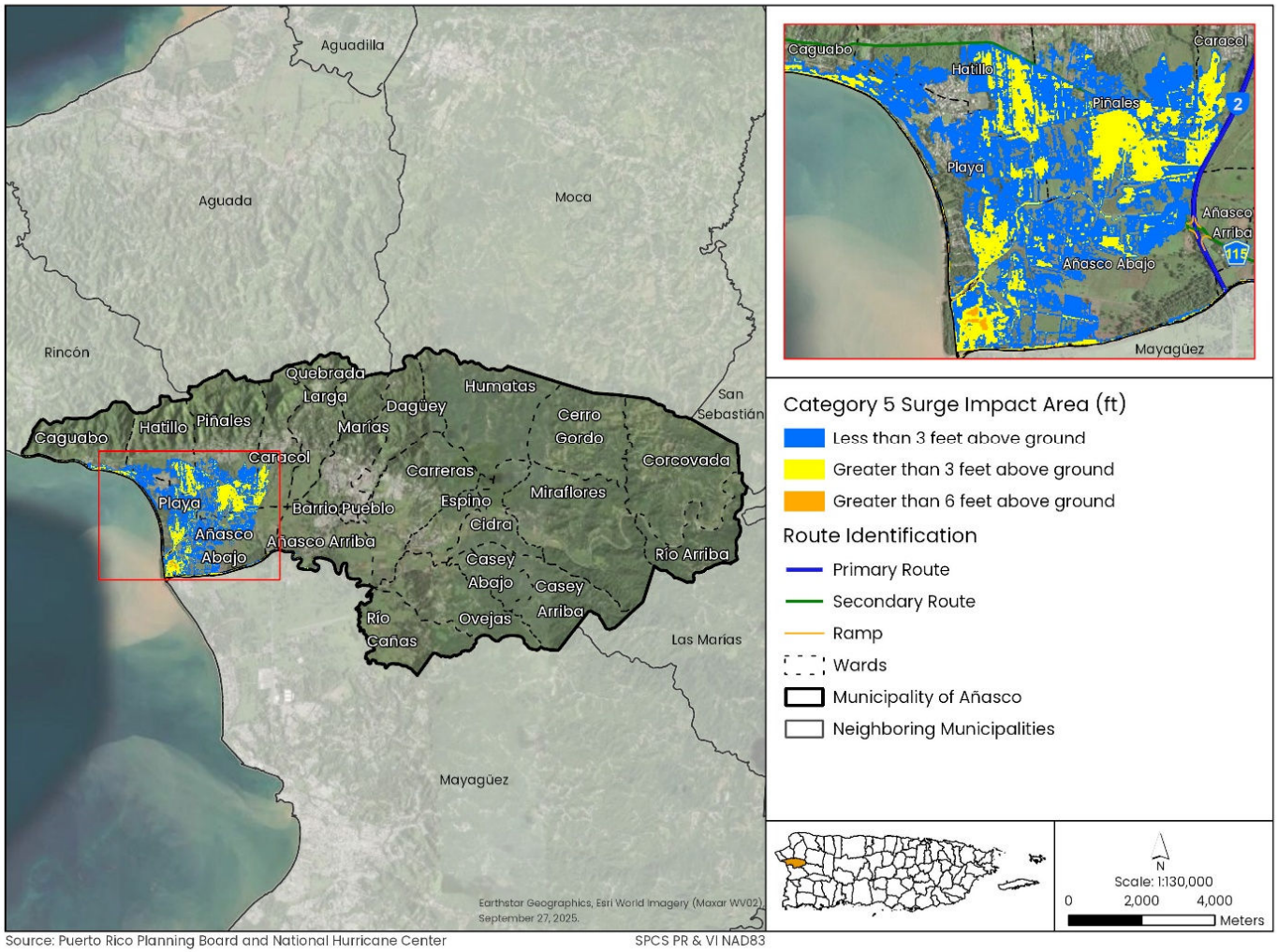
The regulatory floodway is primarily associated with the Río Grande de Añasco and adjacent river corridors, where several critical facilities are located within or near mapped flood hazard areas. Additional concentrations of potentially exposed infrastructure are present near Barrio Pueblo, Añasco Arriba, Añasco Abajo, Playa, Marías, Caracol, and Espino. These findings suggest that flooding could affect essential services and municipal operations during significant flood events, underscoring the importance of protecting critical facilities and maintaining continuity of operations throughout the Municipality of Añasco.

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Map 42: Category 1 Storm Surge Impact Area



Map 43: Category 5 Storm Surge Impact Area



4.11.1.2 Risk Magnitude

Each of the storm surge maps shows the depth of flooding that would be expected at a given location based on the category of the storm. Flood depth represents the severity/magnitude of the storm surge risk; therefore, when describing this severity/magnitude, it could be expressed in a manner such as, "the greatest flood depth that communities Playa, Añasco Abajo, and portions of Piñales and Hatillo could experience as a result of storm surge is six (6) feet." The building table can be used to determine a rough estimate of the maximum potential flood depth.

The maps included in the storm surge section of the risk assessment, with reference to the geographic areas affected by this natural hazard, show the impact of this event based on flood depth and according to the occurrence of Category 1 and Category 5 hurricane events. In summary, flood depth represents the severity or magnitude of the storm surge risk, and likewise, there is a correlation between the magnitude of the storm event and the depth of flooding and the extent of land area that will be affected. That is, in most instances, as a storm escalates to higher-magnitude categories, a greater number of neighborhoods and sectors may be impacted by flooding events of greater depth.

Similar to other coastal hazards, storm surges have the potential to expose the population and infrastructure supporting lifelines. Likewise, areas within the municipality that are already prone to flooding may be more severely affected by flooding resulting from storm surge events.

4.11.1.3 Past Events

Hurricane Maria (2017) generated measurable storm surge and storm tide impacts along Puerto Rico's southeastern and eastern coasts. Post-storm field investigations conducted by the U.S. Geological Survey (USGS) documented storm-tide inundation heights generally ranging from approximately 6 to 9 feet above ground level in coastal municipalities including Humacao, Naguabo, and Ceiba (Byrne, 2019). Lower storm surge levels, typically between 1 and 4 feet, were observed along portions of the northern and western coasts. Although the most catastrophic impacts of Hurricane Maria were driven by extreme rainfall and inland flooding, storm surge contributed to coastal flooding, shoreline erosion, and damage to marinas and port facilities, particularly along exposed eastern shorelines (Byrne, 2019) (Pasch, Penny, & Berg, Hurricane Maria, 2023).

Hurricane Georges (1998) generated storm surge impacts along the southern and eastern coasts, exacerbating coastal inundation and contributing to damage in low-lying coastal communities (Guiney, 1999). More recently, Hurricane Fiona (2022) caused storm surge and wave-driven coastal flooding along Puerto Rico's southern coast, particularly in municipalities facing the Caribbean Sea, despite making landfall as a hurricane of relatively lower wind intensity (Pasch, Reinhart, & Alaka, Hurricane Fiona, 2023).

4.11.1.4 Future Events Probability

The NOAA defines the term storm surge as the rise in ocean level resulting from the effects of wind and the drop in atmospheric pressure associated with hurricanes and other storms. In other words, storm surge is caused primarily by the strong winds of a hurricane or tropical storm; therefore, the probability of occurrence of a storm surge event in the municipality is directly associated with—and increases following—events of strong winds such as hurricanes and will increase or may intensify as such events occur.

To this end, the Sea, Lake, and Overland Surges from Hurricanes model (known as SLOSH, by its English acronym) is a computerized model used by NOAA for the assessment of coastal flooding risk and the operational prediction of storm surge.

According to FEMA, coastal flood risk areas are determined through a statistical analysis of records of riverine flow or currents, storm tides, and rainfall; information obtained through consultations with the community; and a hydrologic and hydraulic analysis. Coastal flood risk areas are delineated or defined in the Flood Insurance Rate Maps (FIRM). These maps also communicate two regulatory flood mapping elements: the extent of land at risk of base flooding (1% annual probability) and the related flood levels in these areas, known as Base Flood Elevations (BFE).

4.11.2 Risk Analysis

4.11.2.1 Estimated Losses

For the FEMA National Risk Index (NRI), storm surge losses are generally represented under the Coastal Flooding hazard category. FEMA does not report a separate "storm surge" Expected Annual Loss (EAL) value for Añasco (FEMA, 2026). To prevent duplication of the data presented in the flood risk analysis, this LHMP will not consider it, as it cannot separate damages created by storm surge or other types of coastal

floods.

4.11.2.2 Lifelines and Critical Infrastructure

Storm surges pose a significant threat to FEMA-defined community lifelines by inundating critical infrastructure located in coastal and low-lying areas. Transportation lifelines are frequently disrupted when roads, bridges, ports, and evacuation routes are flooded or damaged, restricting evacuation, emergency response, and supply chain movement. Energy lifelines, including power plants, substations, and fuel distribution systems, are highly vulnerable to saltwater intrusion and flooding, which can result in equipment failure and prolonged power outages. Communications lifelines may also be compromised when cell towers, fiber-optic networks, 911 systems, and backup power supplies are damaged or inaccessible due to storm surge flooding. These cascading failures reduce situational awareness and hinder coordination among emergency responders and government agencies. Collectively, impacts on these lifelines significantly reduce a community's ability to protect lives and property during storm surge events. (NOAA, n.d)

Map 44 and 45 show the critical infrastructure exposed to storm surge associated with Category 1 and Category 5 hurricane events within the Municipality of Añasco. Several facilities associated with transportation, water systems, communications, energy, health and medical services, safety and security, food and shelter, and recreational lifelines are located within the municipality's coastal storm surge impact area. The highest concentration of exposed facilities is located within Playa, Añasco Abajo, and portions of Añasco Arriba adjacent to Bahía de Mayagüez and the lower Río Grande de Añasco corridor.

Under the Category 1 scenario, exposure is primarily limited to facilities located immediately adjacent to the coastline and low-lying coastal areas. Under the Category 5 scenario, both the extent and depth of inundation increase substantially, exposing a greater number of facilities to surge levels exceeding 6 feet and, in some coastal locations, 9 feet above ground. As a result, additional transportation, utility, community, and public service facilities become vulnerable to direct storm surge impacts.

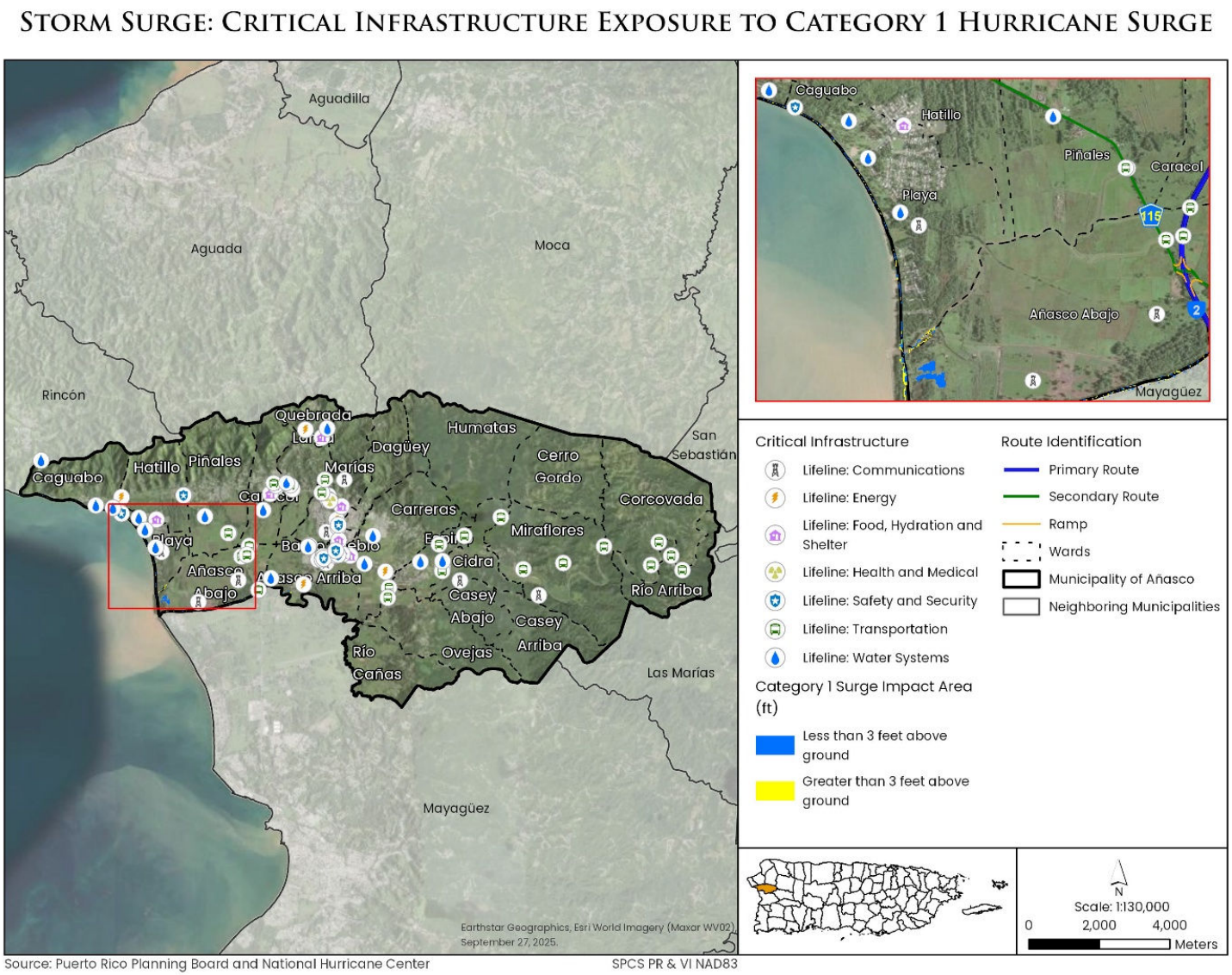
The maps also identify potential vulnerabilities within the transportation network serving the municipality's coastal communities. Roadways connecting Playa and Añasco Abajo with Añasco Arriba and Barrio Pueblo traverse areas projected to experience storm surge inundation and may become impassable during major

hurricane events, potentially affecting evacuation, emergency response, and access to critical services.

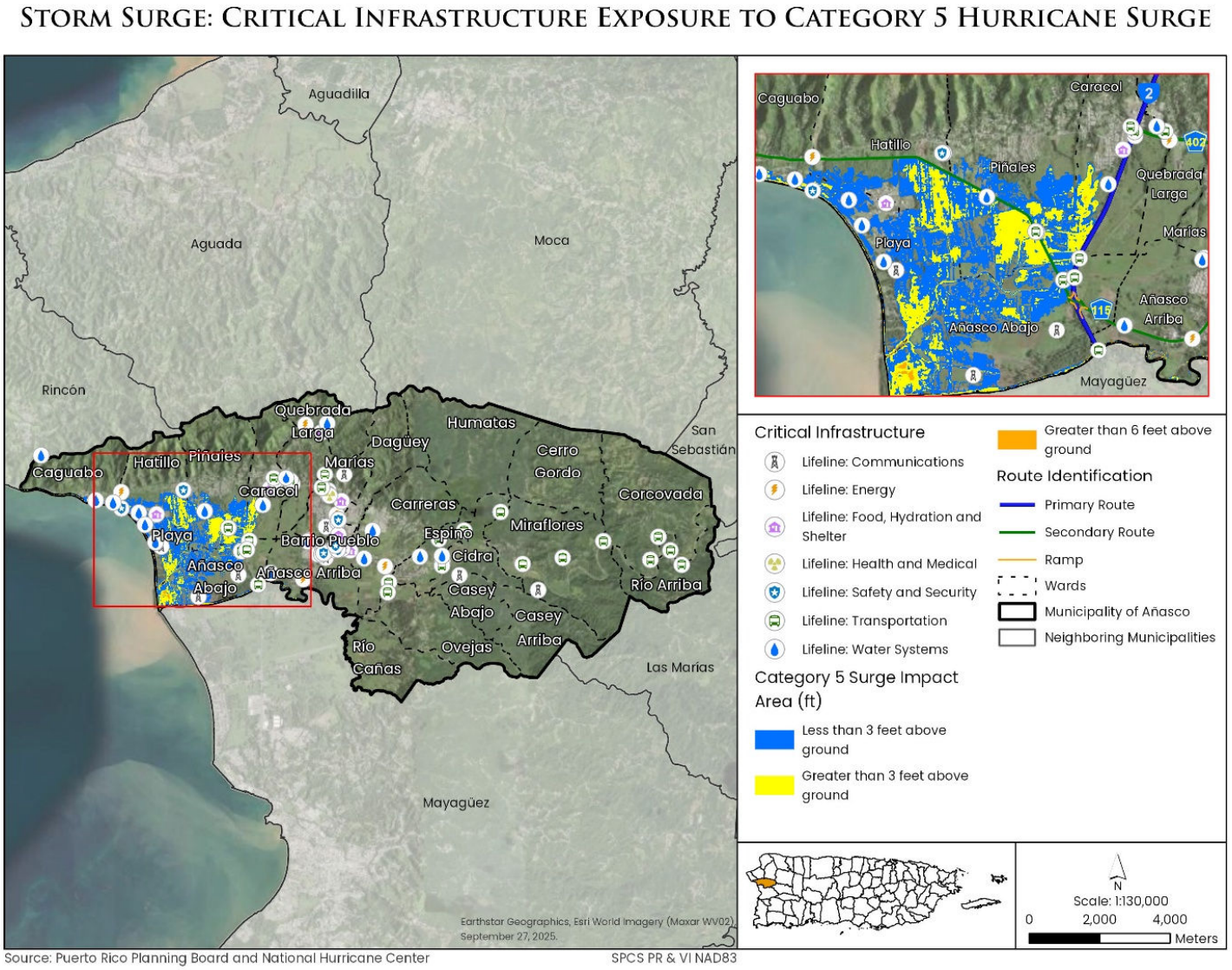
Overall, the maps indicate that the critical infrastructure most vulnerable to storm surge is concentrated within the municipality's western coastal plain. While the interior and higher-elevation barrios remain outside the projected surge areas, several facilities that support essential municipal functions are located within low-lying coastal sectors and could experience direct impacts during severe hurricanes. Consequently, these facilities should remain priorities for resilience planning, continuity-of-operations planning, and future storm surge mitigation efforts.

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Map 44: Critical Infrastructure exposure to Category 1 Hurricane Surge



Map 45: Critical Infrastructure exposure to Category 5 Hurricane Surge



4.11.2.3 Social Vulnerabilities

Storm surge events represent a significant social hazard for Puerto Rico due to the Island's extensive coastline, high population density in coastal municipalities, and legacy socioeconomic vulnerabilities. Storm surge–related flooding frequently results in displacement, housing damage, and prolonged interruption of essential services, particularly in low-lying coastal communities and estuarine areas. Studies of hurricanes impacting Puerto Rico, including Hurricane Maria, have shown that flood exposure and displacement are disproportionately concentrated among low-income households, older adults, and communities with limited access to transportation, healthcare, and economic resources, which delays recovery and increases long-term vulnerability. FEMA and NOAA analyses further indicate that socially vulnerable populations are more likely to reside in surge-prone areas and experience compounded impacts when storm surge coincides with power outages, roadway flooding, and disruptions to water and medical services. (Chowdhury, et al., 2025)

Storm surge flooding also poses serious public health, economic, and equity challenges for Puerto Rico. Flooding of homes, healthcare facilities, and water and wastewater systems increases risks of injury, water contamination, and adverse mental health outcomes, particularly in communities that experience extended power outages and limited access to medical care. Economic impacts are often prolonged, as small businesses, informal workers, and coastal livelihoods face income losses and slower recovery due to limited insurance coverage and financial capacity. Research and federal reviews of disaster recovery programs highlight that inequities in disaster assistance and rebuilding resources can exacerbate social and wealth disparities on the Island, reinforcing the need for mitigation actions that integrate social vulnerability, equitable recovery, and community resilience into storm surge planning. (Chowdhury, et al., 2025)

Storm surge impacts in Añasco would disproportionately affect vulnerable populations residing within the municipality's low-lying coastal areas, particularly in Playa, Añasco Abajo, and portions of Añasco Arriba. Residents in these areas may be more susceptible to displacement, service disruptions, and health-related impacts resulting from storm surge flooding. Damage to transportation, water systems, communications, energy infrastructure, and other critical facilities located within the storm surge impact area could restrict access to essential services, delay recovery efforts, and exacerbate existing social and economic challenges.

Attention should be given to older adults, who represent an increasing share of the

municipality's population. As discussed in Section 3.3.1, the proportion of residents aged 65 years and older increased from approximately 19.9 percent in 2019 to 23.4 percent in 2024. This population may be especially vulnerable during storm surge events due to mobility limitations, medical needs, and dependence on critical services and transportation networks. Consequently, evacuation planning, emergency communications, and continuity of essential services remain important considerations for reducing storm surge risk in the Municipality of Añasco. Map 46 shows the population exposition to a Storm Surge induced by a Category 1 Hurricane, while Map 47 shows the same for a Category 5 induced Storm Surge.

Map 46: Storm Surge Population Exposure to Category 1 Surge

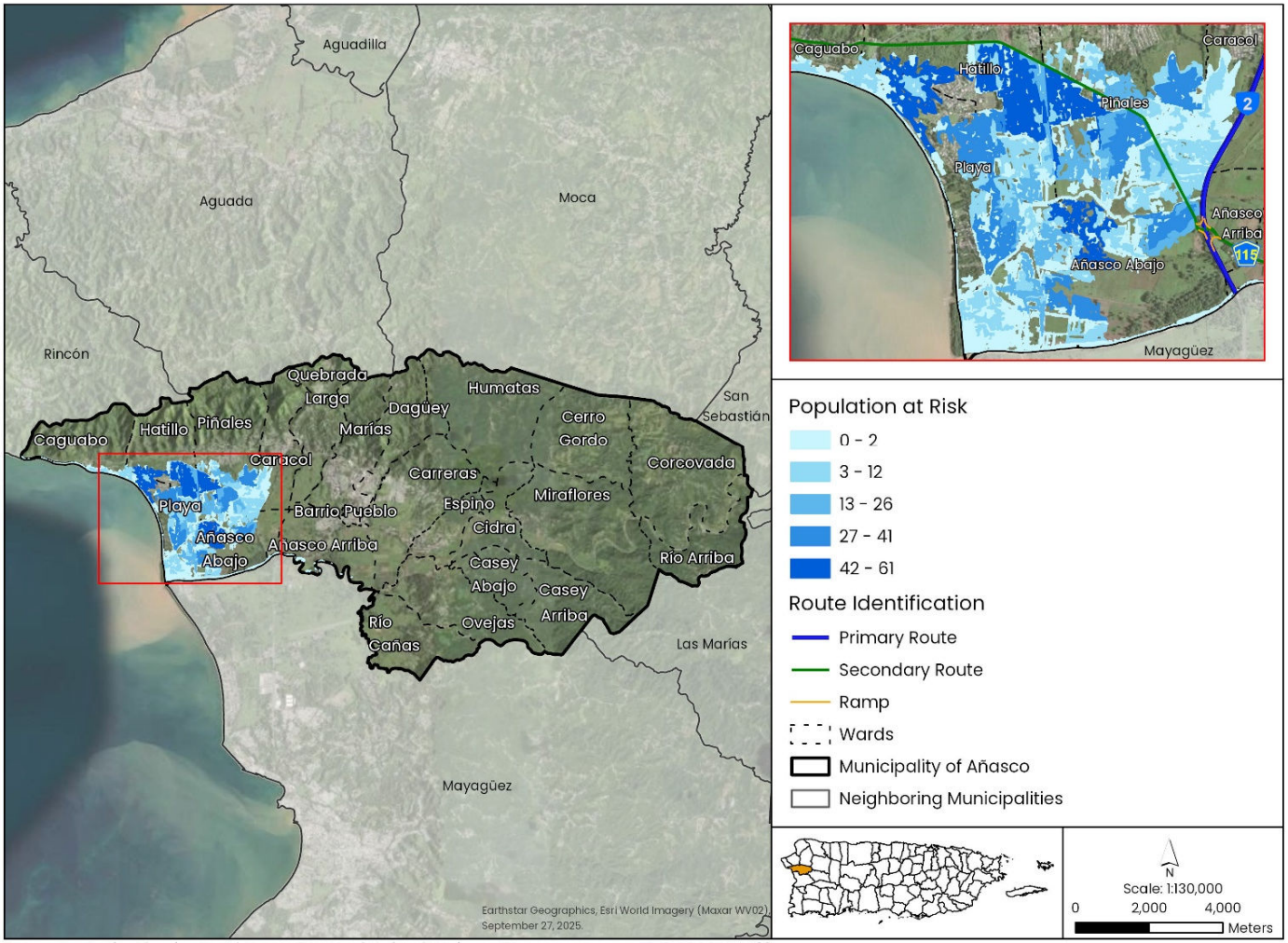
Storm Surge: Population Exposure to Category 1 Surge



Source: Puerto Rico Planning Board, Census Tract and National Hurricane Center SPCS PR & VI NAD83

Map 47: Strom Surge Population Exposure to Category 5 Surge

Storm Surge: Population Exposure to Category 5 Surge



Source: Puerto Rico Planning Board, Census Tract and National Hurricane Center SPCS PR & VI NAD83

4.11.2.4 Natural and Cultural Resources

Storm surge poses a significant natural hazard to Puerto Rico's coastal and near-coastal environments due to the Island's extensive shoreline, low-lying coastal plains, and concentration of sensitive ecosystems. Surge-driven flooding and wave action can cause severe erosion, saltwater intrusion, and habitat degradation in mangroves, coastal wetlands, estuaries, seagrass beds, and coral reef systems that are critical to biodiversity, fisheries, and natural coastal protection. These ecosystems can experience vegetation die-off, sediment redistribution, and long-term loss of ecological functions such as flood attenuation and water filtration following storm surge events. Repeated storm surge exposure can permanently alter coastal geomorphology and reduce the buffering capacity of natural systems, increasing vulnerability of inland areas and amplifying future flood risk across Puerto Rico's coastal municipalities (Ganz, Duan, & Ji, 2023).

Storm surge also presents substantial risks to Puerto Rico's cultural and historic resources, many of which are concentrated in coastal zones and historic town centers. Flooding and erosion associated with storm surge events can damage or destroy historic buildings, archaeological sites, cemeteries, and cultural landscapes, including Spanish-era structures and Indigenous archaeological resources located near the coast. In addition to physical damage, storm surge–related displacement can disrupt traditional cultural practices and undermine community identity tied to historic places and coastal livelihoods. FEMA and its federal partners recognize the vulnerability of cultural resources to coastal flooding and support mitigation, documentation, and recovery efforts through programs such as the Heritage Emergency National Task Force, emphasizing the importance of incorporating cultural resource protection into hazard mitigation planning for Puerto Rico.

4.11.2.5 Future Conditions

Maps 48 and 49 show the construction permits approved between 2020 and 2026 in relation to the storm surge impact areas associated with Category 1 and Category 5 hurricanes within the Municipality of Añasco.

The Category 1 storm surge map indicates that relatively few recent development projects are located within the projected surge area. Most construction permits are

concentrated within Barrio Pueblo, Añasco Arriba, Marías, Caracol, Espino, and other inland portions of the municipality that remain outside the Category 1 storm surge zone. Only a limited number of permits are located within or immediately adjacent to the projected surge area, primarily within Playa and Añasco Abajo near the municipality's western coastline. This suggests that most recent development has occurred outside the areas expected to experience direct storm surge impacts during lower-intensity hurricane events.

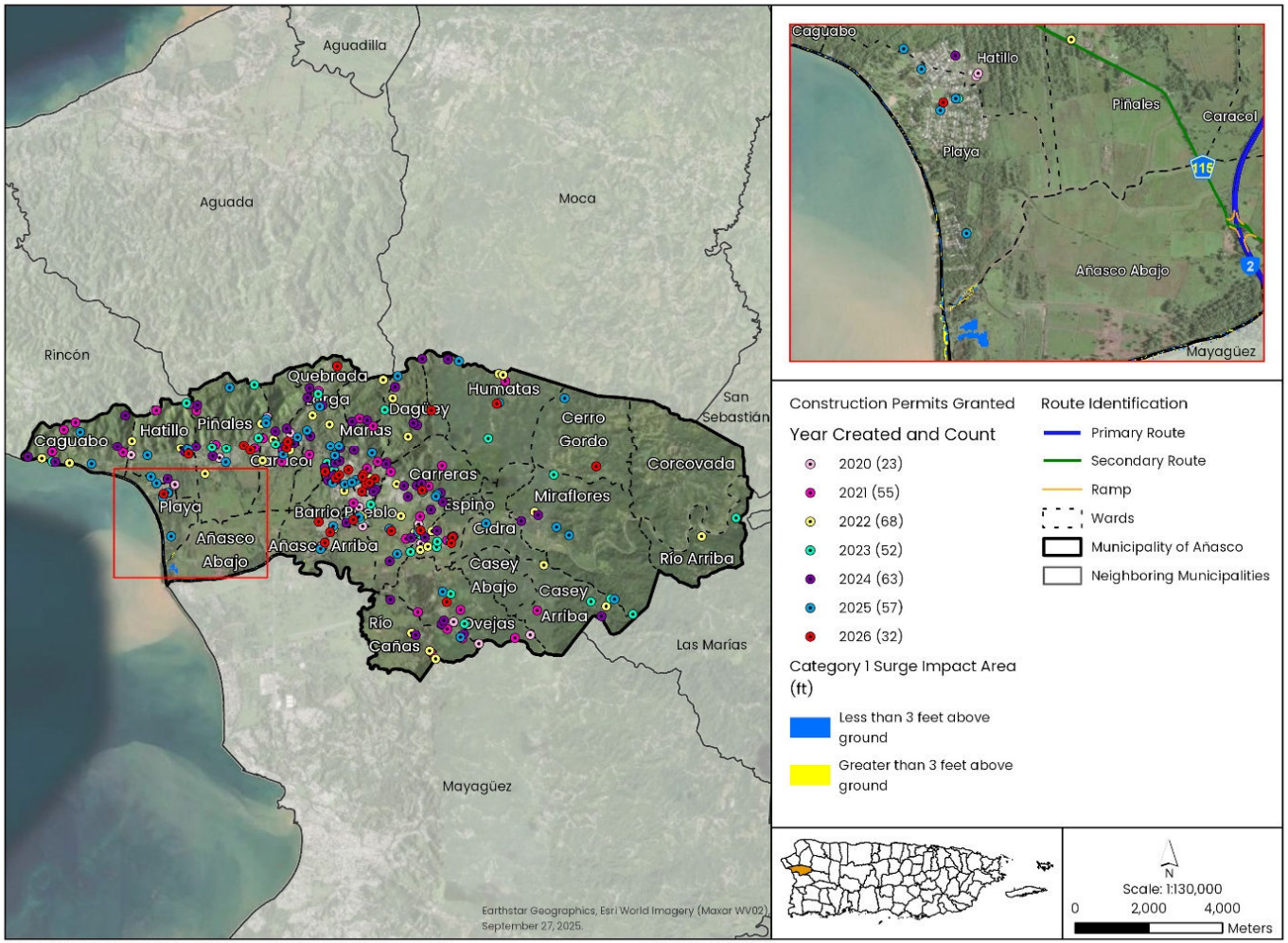
The Category 5 storm surge scenario presents a substantially different pattern. Under this event, the storm surge extent expands farther inland across the coastal plain, exposing a greater number of recent development projects to potential inundation. This is particularly evident within Playa, Añasco Abajo, and portions of Añasco Arriba, where several construction permits overlap with the projected Category 5 storm surge impact area. Additional development located near the shoreline and within low-lying coastal sectors becomes exposed under this more severe hurricane scenario.

Together, these maps indicate that recent development exposure to storm surge remains relatively limited under Category 1 hurricane conditions but increases significantly under Category 5 conditions. While much of the municipality's recent development has occurred outside the Category 1 surge zone, a portion of the newer development located within the coastal plain would be exposed to inundation during an extreme hurricane event. Consequently, continued consideration of storm surge hazards in land-use planning, permitting decisions, building design, and evacuation planning remains important for reducing long-term coastal risk within the Municipality of Añasco.

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Map 48: Storm Surge Recent Development Exposure Category 1

Storm Surge: Recent Development Exposure Category 1 Surge

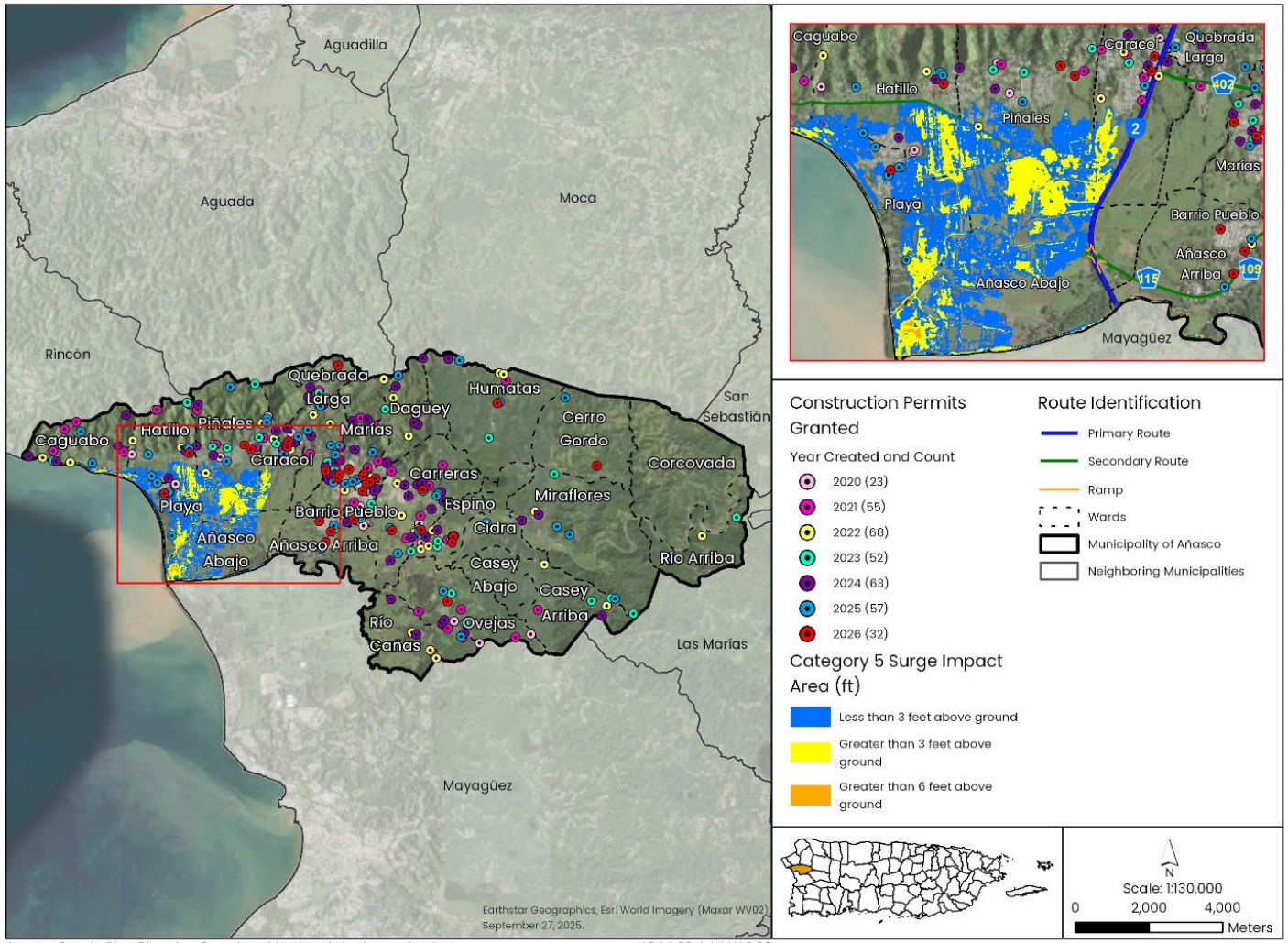


Source: Puerto Rico Planning Board and National Hurricane Center

SPCS PR & VI NAD83

Map 49: Storm Surge Recent Development Exposure Category 5

Storm Surge: Recent Development Exposure Category 5 Surge



Source: Puerto Rico Planning Board and National Hurricane Center SPCS PR & VI NAD83

4.12 Extreme Heat

4.12.1 Description (B1-a)

There is no universally accepted definition for extreme heat or heat waves. For the purposes of this Plan, the definition adopted by the Department of Homeland Security (DHS) is used. It is defined as a prolonged period of 48 to 72 hours of intense heat and humidity, with temperatures above 90 ºF. Under these conditions, evaporation is reduced and the body is forced to make a significant effort to maintain its normal temperature, which has caused the death of many people in attempts to stabilize physically. In general, extreme heat represents the highest rate of deaths among weather-related hazards.

A study titled Heat Risk Perception and Vulnerability in Puerto Rico: Insights for Climate Adaptation in the Caribbean, published in the academic journal International Journal of Environmental Research and Public Health, analyzes how Puerto Rico residents perceive health risks associated with extreme heat and how these perceptions relate to vulnerability and protective behaviors during extreme heat events that occurred in the summer of 2020 (Guzmán-Colon, Guido, Amaya-Ardilla, Cabrera-Rivera, & Méndez-Lázaro, 2025). The research was conducted through a cross-sectional telephone survey of 500 adults in metropolitan and non-metropolitan areas. This study defined the metropolitan area as the municipalities of Carolina, Cataño, Toa Baja, and Trujillo Alto. The non-metropolitan zone consists of the remaining municipalities of Puerto Rico.

The questionnaire included sociodemographic variables, health status, prior heat exposure, risk perception, and mitigation strategies. Statistical analysis employed chi-square tests and multinomial and logistic regression models.

The results reveal that, although most participants expressed concern about climate change and high temperatures, less than half perceived heat as a high health risk, and only one-fourth considered it likely to suffer a heat-related illness in the next five years. Risk perception was significantly higher among men, people aged 50 to 64, the unemployed, individuals with fair health, multiple chronic conditions, and those who had experienced heat-related symptoms. In contrast, older adults (65+) reported low levels of risk perception despite their high vulnerability.

Forty-four percent (44%) of respondents indicated having suffered heat-related symptoms during the summer, and 68% reported nighttime thermal discomfort, a

factor closely linked to health problems. The most common strategies to mitigate heat were the use of fans (84%) and air conditioning (64%), although economic limitations and instability of the electrical system reduced their effectiveness. Regional differences were also notable: residents in non-metropolitan areas showed greater risk perception than those in metropolitan zones.

The study concludes that there is a significant gap between actual vulnerability and risk perception, especially among older adults. It recommends strengthening risk communication targeted at vulnerable groups, addressing nighttime heat exposure, and improving electrical infrastructure to ensure equitable access to cooling systems. Proposed solutions include decentralized energy systems, cooling centers with backup power, and passive designs that reduce electrical dependence, thus contributing to community resilience in the face of increasing extreme heat events.

4.12.1.1 Affected Area (B1-B)

Extreme heat events can impact the entire municipality, particularly in urbanized areas where the heat island effect may occur. Based on previously presented information, adverse climate effects have been observed, including severe droughts, increased frequency of strong wind events and flooding, higher heat index levels, among others. Due to the municipality's geography and location, the entire region is highly susceptible to extreme heat conditions.

Urban heat islands refer to urbanized areas where structures such as buildings, roads, and other infrastructure absorb and emit the sun's heat more than natural landscapes such as forests and water bodies. Daytime temperatures in urban areas are about 1–7 °F higher than temperatures in outlying areas; nighttime temperatures are about 2–5 °F higher (EPA, 2025).

Heat islands develop due to a combination of factors:

- Loss of Natural Landscapes – Urban areas often replace trees, vegetation, and water bodies—natural elements that cool the air through shade, transpiration, and evaporation—with hard, dry surfaces like roads, rooftops, and parking lots. These surfaces provide little shade or moisture, leading to higher temperatures.
- Properties of Urban Materials – Common construction materials such as asphalt and concrete absorb and retain more heat than natural surfaces. They reflect less solar energy and release heat slowly, causing temperatures to remain elevated, especially after sunset.

- Urban Design and Geometry – The layout of buildings affects airflow and heat retention. Dense developments with narrow streets and tall structures create "urban canyons" that trap heat and block cooling winds, turning buildings into thermal masses that release heat gradually.
- Human-Generated Heat – Activities such as transportation, industrial operations, and air conditioning add waste heat to the environment, intensifying the heat island effect.
- Weather and Geographic Conditions – Clear, calm weather amplifies heat islands by maximizing solar energy absorption and limiting heat dispersion. Conversely, wind and cloud cover help reduce the effect. Geographic features like mountains can also influence wind patterns, either blocking cooling breezes or channeling heat through urban areas (EPA, 2025).

According to the Añasco Territorial Plan and municipal profile, development within the municipality is concentrated primarily in Barrio Pueblo, Añasco Arriba, Añasco Abajo, Playa, Marías, and Carreras, while much of the remaining territory consists of agricultural, forested, and open-space lands. As a result, the potential for urban heat island effects is generally limited to the more developed portions of the municipality. However, older adults, children, and other vulnerable populations residing in these developed areas may experience increased exposure to extreme heat conditions. Given the interaction of land use, vegetation cover, development intensity, and local climatic conditions, detailed urban-scale analyses would be necessary to better understand the distribution and severity of extreme heat impacts within Añasco

4.12.1.2 Risk Magnitude (B1-C)

Local NWS offices often work with community agencies to decide when heat alerts should be issued. Because the United States is so geographically and culturally diverse, heat tolerance varies by region. For example, residents of Puerto Rico are generally more accustomed to temperatures above 90°F than those living in Alaska.

Nevertheless, the NWS uses the following standard alerts (NWS, n.d.):

- Excessive Heat Warning – Issued 12 hours before dangerous heat conditions are expected. This occurs when the heat index is forecast to reach 105°F or higher for more than three hours over two consecutive days, or 115°F or higher for any period of time.
- Excessive Heat Watch – Issued when an extreme heat event is possible within

the next 24 to 72 hours.

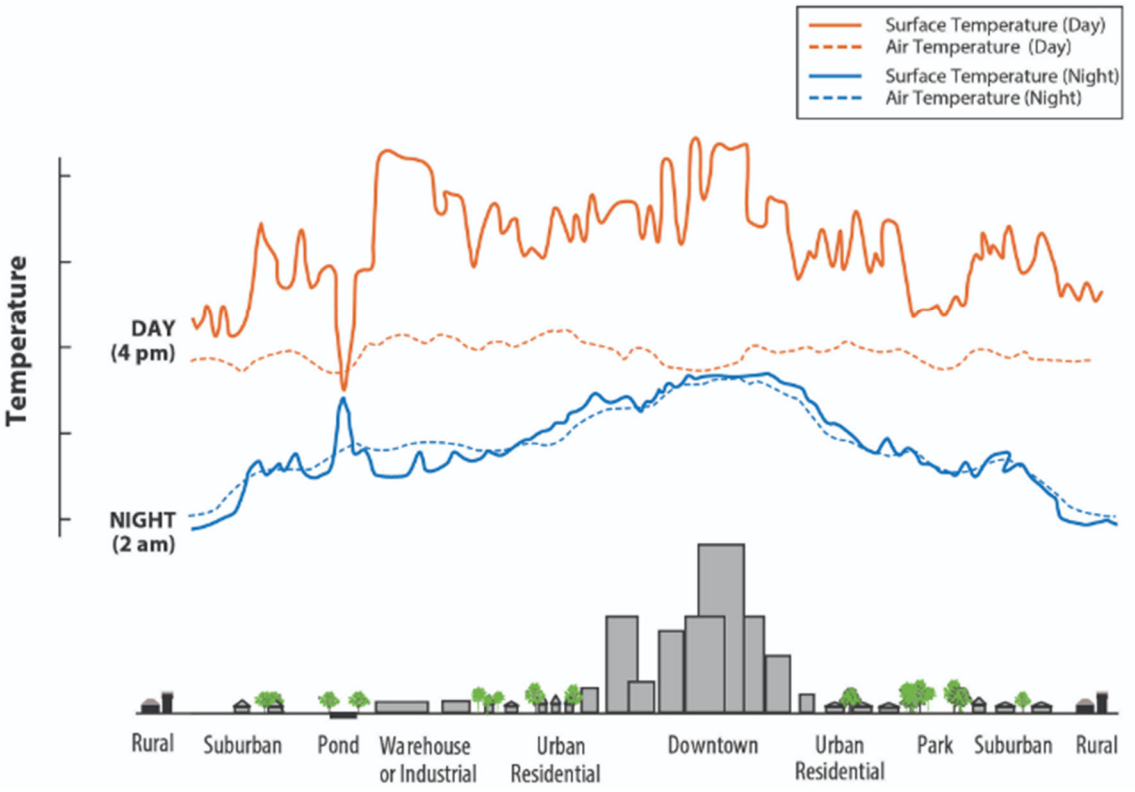
- Heat Advisory – Issued 12 hours before conditions where the heat index is at least 105°F but less than 115°F for three consecutive days.
- Extreme Heat Outlook – Issued when there is potential for extreme heat within the next three to seven days, providing advance notice for those who need extra time to prepare.

It must be emphasized that Urban Heat islands (UHI) phenomena can occur regardless of whether there is an extreme heat warning event. UHI is a relative temperature difference between urban and surrounding rural areas caused by factors like heat-absorbing surfaces, lack of vegetation, and human activities. It exists year-round, even during mild or cool weather, because cities consistently retain more heat than natural landscapes. Extreme heat events can amplify UHI, making UHI effects more dangerous, but UHI does not require extreme heat to form—it simply means urban areas are warmer than their surroundings under similar conditions.

UHIs are typically assessed by comparing temperatures in urban areas to those in surrounding regions. Even within a city, temperatures can vary significantly. Some neighborhoods are hotter due to dense concentrations of heat-absorbing surfaces like buildings and pavements, while areas with trees and greenery remain cooler. These variations create what are known as intra-urban heat islands. In diagrams illustrating this effect, urban parks, ponds, and residential zones generally appear cooler than central downtown districts.

The following diagram, taken from an EPA website, shows a diagram of how a heat island effect behaves in temperature.

Figure 25: Heat Island Effect Diagram (EPA, 2025)



Surface temperatures vary more than atmospheric air temperatures during the day, but they are generally similar at night. The dips and spikes in surface temperatures over the pond area show how water maintains a nearly constant temperature day and night because it does not absorb the sun's energy the same way as buildings and paved surfaces. Parks, open land, and bodies of water can create cooler areas within a city. Temperatures are typically lower at suburban-rural borders than in downtown areas.

4.12.1.3 Past Events (B1-D)

Méndez Lázaro et al. (2015) identified several years in which extreme heat temperatures were recorded in the San Juan metropolitan area. According to their findings, periods of extreme heat occurred in 1983, 1995, 2012, and 2013. Notably, the summer of 2012 was the hottest in a century, with 42 days of extreme temperature values. During June, July, and August, the maximum heat index reached 98.06° F, 98.96° F, and 102.02° F, respectively (Méndez Lázaro et al., 2015).

4.12.1.4 Future event probabilities (B1-E)

Official NOAA assessments in the 2018 Puerto Rico and U.S. Virgin Islands State Climate Summary report an increase in both average temperature (≈1.5°F since 1950) and the frequency of extreme heat events (NOAA, 2022). Additionally, climate projections from CMIP6 (via the World Bank's Climate Change Knowledge Portal) show steady rises in summer and annual maximum temperatures for Puerto Rico, further indicating elevated future risk for heat waves (World Bank, n.d.).

4.12.2 Risk Analysis (B2-a, B2-b)

4.12.2.1 Estimated Losses

Extreme Heat primarily causes material and system stress rather than immediate structural failure. For example:

- Roads and Pavements: Asphalt can soften and deform under prolonged high temperatures, leading to rutting and surface damage (Highways Industry, n.d.) (EPA, 2012).
- Rail Systems: Steel tracks expand in extreme heat, which can cause buckling and derailment risks (USDOT - FRA, 2013).
- Power Infrastructure: Electrical grids experience higher loads from air conditioning demand, and transformers or cables can overheat, reducing efficiency or causing outages.
- Building Materials: Expansion and contraction of concrete, steel, and glass can lead to cracks or joint failures over time. Roofing materials may degrade faster under intense heat.
- Cooling Systems: HVAC systems work harder, increasing energy consumption and risk of failure, which can compromise indoor comfort and safety.

While heat waves rarely cause buildings to collapse, they accelerate wear and tear, increase maintenance costs, and can lead to system failures that disrupt essential services. As of now the municipality does not have a method to calculate losses from extreme heat events.

4.12.2.2 Lifelines and Critical Infrastructure

Extreme heat poses systemic risks across energy, transportation, and communications systems, creating compound failures precisely when demand for services peaks. In Energy Lifeline, high temperatures drive sharp increases in electricity demand for cooling while simultaneously decreasing generation and delivery

efficiency. Thermoelectric plants may be forced to curtail output when cooling water is too warm, solar panels produce less electricity at elevated module temperatures, and transmission lines lose carrying capacity as conductors heat and sag—conditions that heighten the likelihood of voltage drops and blackouts during heat waves (Jessen, 2025). The combination of record cooling loads and diminished supply underscores a growing "peak risk" problem for grids that were not designed for today's heat extremes (Jessen, 2025) (American Society of Civil Engineers, 2024).

Similarly, the Transportation Lifeline is similarly vulnerable. Prolonged high surface temperatures soften asphalt, accelerating rutting and deformation; steel rails thermally expand and can buckle, prompting heat-related slow orders that disrupt service; and catenary or other overhead lines can sag in the heat, further constraining operations. Airports face dual constraints: runway pavements can deform under extreme heat, and reduced air density on hot days impairs aircraft performance, affecting takeoff weight and scheduling. These effects are now commonly observed across U.S. systems during sustained heat events, requiring operational restrictions and emergency maintenance that ripple through supply chains and passenger mobility (American Society of Civil Engineers, 2024)

Communication Lifeline also faces mounting heat stress. Data centers, switching facilities, and network nodes rely on continuous cooling; overheating elevates outage risks and can degrade equipment lifespans. Heat-related disruptions to power supply and localized microclimate conditions compound these risks, with cascading impacts across other lifeline sectors that depend on connectivity for operations and emergency response. Federal assessments underscore that extreme weather—including extreme heat—can interrupt fiber networks, degrade wireless performance, and limit access to data centers, affecting each of the other critical infrastructure sectors and complicating disaster response coordination (Public-Private Analytic Exchange Program, 2025).

Overall, extreme heat acts as a stress multiplier: it pushes materials beyond design thresholds, reduces equipment efficiency, and narrows operational safety margins, all while increasing demand for services. The evidence from engineering organizations and energy market observers indicates that without targeted adaptation—such as heat-resilient design standards, strategic grid reinforcement, enhanced thermal management for digital infrastructure, and heat-aware operations—systems will face more frequent service disruptions and higher lifecycle costs as heat events intensify (American Society of Civil Engineers, 2024).

4.12.2.3 Social Vulnerabilities

A recent academic study examines the relationship between heat stress and mortality in Puerto Rico (Méndez - Lázaro, et al., 2025). Researchers analyzed hourly 2-meter air temperature data from ERA5 reanalysis for 2015–2020 and derived daily minimum, maximum, and mean values to calculate two heat stress indices: the Heat Index (HI) and the Universal Thermal Climate Index (UTCI). Findings show that extreme heat conditions are common for eight months of the year, with August and September being the hottest months, and that urban heat island effects exacerbate exposure in metropolitan areas. (Méndez - Lázaro, et al., 2025) Mortality risk increased significantly on days with high heat stress: deaths were 23% higher in the highest HI tertile and 47% higher in the highest UTCI tertile compared to the lowest. Cardiovascular and cerebrovascular diseases, heart failure, and respiratory conditions were among the leading causes of death associated with heat stress. The study highlights Puerto Rico's socio-economic vulnerabilities, aging population, and limited infrastructure amplifying health risks during extreme heat events (Méndez - Lázaro, et al., 2025).

Further information about social vulnerabilities can be found in section 3.4.4.

4.12.2.4 Natural and Cultural Resources

Extreme heat, specifically Urban Heat Islands can pose the following impacts on the natural resources:

- Increased Energy Consumption – Heat islands increase electricity demand for air conditioning and peak energy demand. Increased electricity demand for air conditioning ranges from 1–9% for each 2°F increase in temperature, with the highest increase in countries where most buildings have air conditioning, such as the United States.[3] This increased demand contributes to higher electricity expenses. Peak demand generally occurs on exceptionally hot afternoons, when offices and homes are running air-conditioning systems, lights, and appliances. This increased demand can overload systems and require a utility to institute controlled brownouts or blackouts to avoid power outages.
- Elevated Emissions of Air Pollutants – To meet electricity needs, utility companies typically rely on fossil fuel power plants as a power source. Increased use of fossil fuels increases emissions of air-borne pollutants, such as carbon dioxide, which can have health concerns, especially in people living

with respiratory diseases.

- Compromised Human Health and Comfort – Hot weather events contribute to heat-related deaths and heat-related illnesses. Areas experiencing heat islands further contribute to higher daytime temperatures and reduced nighttime cooling. Heat is of greatest concern for groups such as older adults, young children, populations with low-income, people who work outdoors, and people with chronic health conditions, disabilities, mobility constraints, or taking certain medications. From 2004 to 2018 the Centers for Disease Control and Prevention recorded an average of 702 heat deaths per year.

- Impaired Water Quality – High temperatures of pavement and rooftop surfaces can heat stormwater runoff, which drains into storm sewers. This runoff raises water temperatures as it is released into streams, rivers, ponds, and lakes. Water temperature affects the metabolism and reproduction of many aquatic species.

Rapid temperature changes can also be stressful, and even fatal, to aquatic life. One study found that urban streams have more frequent temperature surges than streams in forested areas. Temperature surges in urban streams were as much as 18°F higher due to heated runoff from urban areas, higher discharge volumes due to impervious surfaces, and warmer baseline stream temperatures (EPA, 2025).

4.12.2.5 Future Conditions

Most of Añasco settlements, being a predominantly rural municipality, are spread-out throughout existing, or past, agrarian communities. While the potential for UHI is relatively low when compared to larger, denser, urban developments, design decisions regarding the materials, design, placement and orientation of buildings can create or exacerbate extreme heat conditions in individual buildings.

4.13 Drought

4.13.1 Description (B1-a)

Drought is described as a temporary irregularity in rainfall or natural water flow, where a prolonged lack of precipitation leads to a significant hydrological imbalance. This condition may or may not result in interruptions to regular drinking water service, crop failures, and adverse effects on wildlife and vegetation. The severity of a drought is determined by the level of moisture deficiency, its duration, and the geographic extent

of the affected area (Colón, 2009).

Drought represents one of the most complex climatological risks and one of the most severe events (DRNA, 2016). Drought is the result of a natural reduction in the expected amount of precipitation over a prolonged period, usually a season or longer. High temperatures, strong winds, and low humidity levels can exacerbate the effects of drought in areas where they are already prevalent. Likewise, drought can lead to severe wildfires (FEMA, 1997). Human actions and the demands they place on water resources can accelerate drought-related impacts. Droughts occur in different forms across the island, meaning that some regions may experience greater impact while others remain normal.

According to FEMA there are three types of droughts (FEMA, 1997):

Table 42: Types of Droughts

Meteorological Drought	A period characterized by a significant deficiency in precipitation compared to normal conditions over a specific timeframe (e.g., monthly, seasonal, yearly)
Agricultural Drought	Occurs when soil moisture becomes insufficient to support crops or livestock needs, typically following meteorological drought.
Hydrological Drought	Defined by reduced water levels in streams, rivers, reservoirs, and groundwater systems, often lagging behind meteorological drought
Socioeconomic Drought	Reflects the impact on human systems and the economy, arising when water supply shortages—due to any form of drought—fail to meet societal demand for water and other resources

In 1999, the Federal Drought Monitor program was implemented. This program is a tool that publishes data and maps on drought conditions in the United States, including Puerto Rico and Hawaii. This system integrates information from various agencies, such as NOAA, the United States Department of Agriculture (USDA), and the National Drought Mitigation Center at the University of Nebraska-Lincoln. In addition, the monitor has developed standardized indicators that allow drought categories to be classified at the national level, providing a uniform reference for risk assessment and management.

The short-term drought indicator focuses on precipitation over 1–3 months. The long-term drought indicator focuses on a period of 6–60 months. Additional indices used, especially during the growing season, include the "USDA/NASS Topsoil Moisture," the Keetch-Byram Drought Index (KBDI), and NOAA/NESDIS satellite vegetation health indices. Other indicators include groundwater levels, reservoir capacity, and pasture conditions.

In Puerto Rico, the Puerto Rico Aqueduct and Sewer Authority (PRASA), the Puerto Rico Electric Power Authority (PREPA), and the Department of Natural and Environmental Resources (DNER) are responsible for constantly monitoring the dams and reservoirs used for potable water supply. Once critical levels are reached, the first strategy adopted at the supply system level is reducing water pressure. If adequate levels are not restored, water rationing begins. This is implemented in phases lasting 12 hours and, in extreme cases, up to 48 hours. The affected area is divided into sectors, and the different rationing phases of a given duration are initially implemented locally, usually in municipalities with the highest consumption. In extreme circumstances, several municipalities and entire regions may be affected.

4.13.1.1 Affected Area

Droughts are not limited by municipal boundaries. For example, prolonged periods of below-normal rainfall within the Río Grande de Añasco watershed could affect potable water availability in Añasco because the municipality depends on surface water resources associated with the Río Grande de Añasco raw water system and the regional Miradero water supply system. Reduced streamflows within the watershed may decrease water availability for treatment and distribution, potentially affecting residents and businesses throughout the municipality. For this analysis, it is assumed that the entire Municipality of Añasco may be affected by drought conditions, either through local reductions in rainfall or through water supply impacts occurring elsewhere within the watershed that supports the municipal water system.

4.13.1.2 Risk Magnitude (B1-C)

Drought is a slow-onset hazard, but over time, it can have highly detrimental effects on crops, municipal water supplies, recreational uses, and wildlife. If drought conditions persist for several years, the direct and indirect economic impact can be significant. Drought can also potentially provide favorable conditions for another

hazard to occur, wildfire.

The National Drought Monitoring Center uses the following categories to describe the magnitude of drought conditions (US Drought Monitor, 2025).

Table 43: US Drought Monitor Categories

Category	Description	Typical Impacts
None	Normal/Wet Conditions	No drought impacts
D0 - Abnormally Dry	Early signs of dryness may slow planting, affect surface water	Short-term dryness; minor stress
D1 - Moderate Drought	Noticeable soil moisture depletion; low water; voluntary restrictions	Crop stress; reduced streamflow
D2 - Severe Drought	Common water shortages; likely crop/pasture losses	Mandatory restrictions possible
D3 - Extreme Drought	Major crop/pasture losses; widespread restrictions	Fire bans; severe water stress
D4 - Exceptional Drought	Exceptional and widespread losses; water emergencies	Emergency measures; critical impacts

4.13.1.3 Past Events (B1-D)

Puerto Rico has a humid tropical climate characterized by two well-defined seasons: a rainy season, which extends from May to November, and a dry season, which runs from December to April. The eastern and western interior regions record the highest annual rainfall, while the northern zone receives significantly more rain than the south.

USGS identified that major drought conditions have occur in 1967 – 1969, 1974, 1994, 1997, 2001-2002 and 2013 -2016 (USGS, 2014), (DNER, 2016). According to historical records the federal government has activated its resources to deal with drought conditions;

- Puerto Rico Extreme Drought Conditions (DR-170-PR) – Date of Declaration May

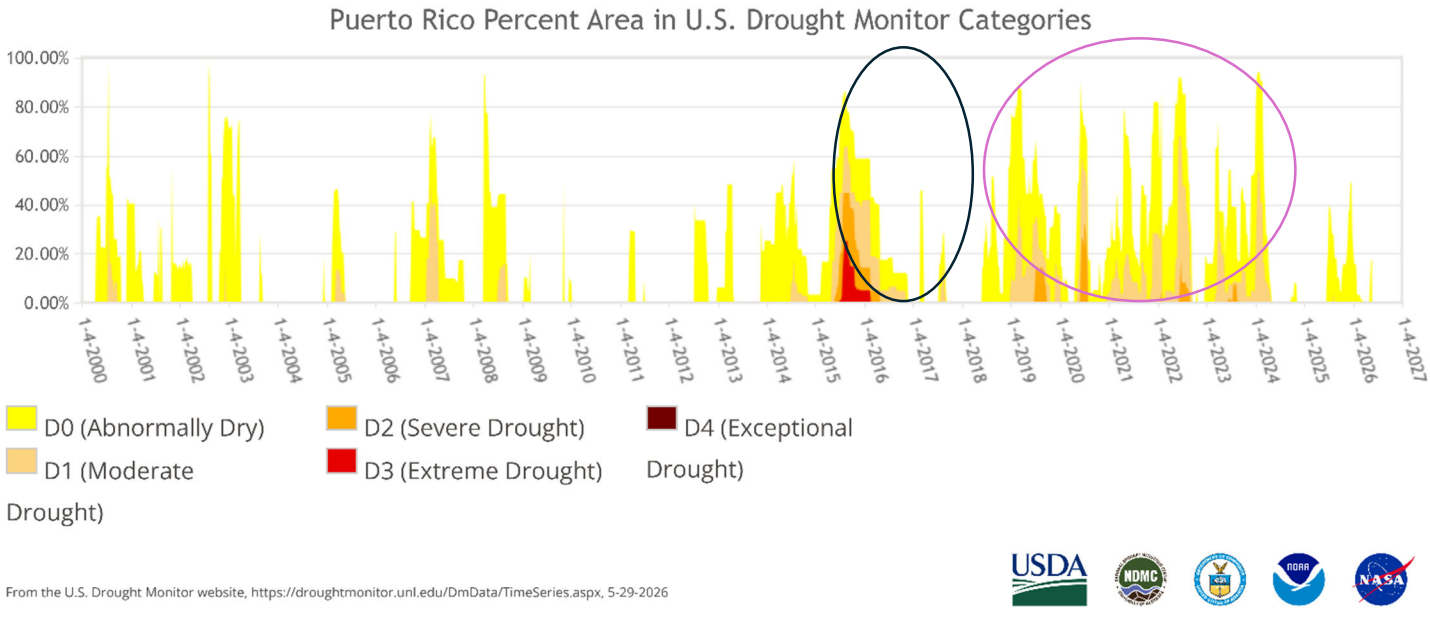
26, 1964

- Puerto Rico Impact of Drought (EM-3002-PR) - Date of Declaration August 29, 1974

During the rainy season, precipitation mainly comes from local convection processes, orographic effects, tropical waves, and cyclones. In contrast, rainfall during the dry season is mostly associated with the influence of cold fronts and troughs (CEACC, 2024).

Figure 26 shows the data captured by US Drought Monitor Categories for the period of January 2020 to January 2026 (US Drought Monitor, 2025) for Puerto Rico's entire territory. The graph measures the occurrence, duration, territorial extent and intensity of droughts in Puerto Rico. Intensity is measured with a color gradient ranging between yellow (D0 (abnormally Dry in the legend) as being the lowest intensity and the dark red (D4 Exceptional Drought) representing the highest level of drought. Duration is measured through the width of the data, expressed along the lower axis of the graph. Territorial extent is represented on the horizontal axis of the graph, the higher an event reaches the more Puerto Rico's territory it covers. Occurrence is measured by combining all of the other variables and locating them within the graph.

Figure 26: Puerto Rico's Percent Area in U.S. Drought Monitor Categories[11]

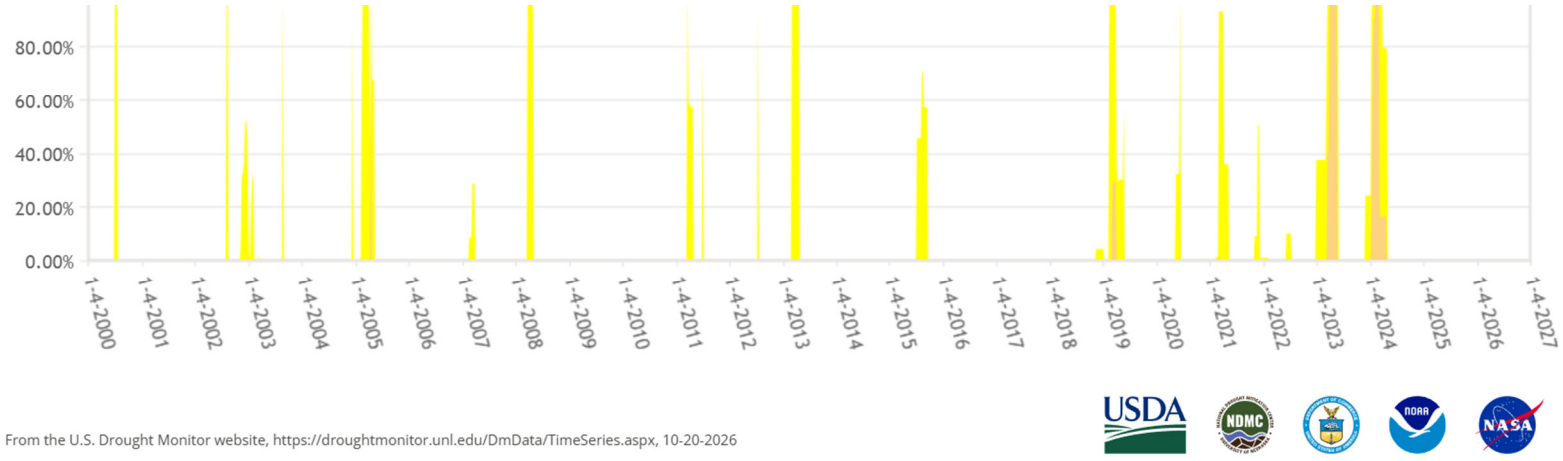


[11] Source US Drought Monitor

From the graph we may appreciate a sustained trend of increased occurrence, duration and intensity of droughts in Puerto Rico that began as early as 2010 and solidified by 2014. Between 2015-2017, Puerto Rico experienced the most intense period of drought in recent years, with more than 80% of the Island's territory experiencing at least Abnormally Dry levels while at least 20% of the territory experienced Extreme Drought. The 2017 Hurricane season brough historic volume of precipitation, which explains the brief reduction in drought between 2017-2019. From 2017-2024, Puerto Rico experienced an extended period of drought in the vast majority of its territory.

Figure 27 shows the drought conditions for Vega Alta doe the period of January 2000 to January 2027. Thia graph shows that since contrary to the island- wide metric the frequency of drought in Añasco has not significantly increased.

Figure 27: Municipality's Percentage Area in US Drought Monitor Categories



4.13.1.4 Future Event Probabilities (B1-E)

USGS reports that in Puerto Rico, drought has an occurrence of 15 of 18 years (USGS, 2016), (USGS, 2014). Recent scientific data shows that the Caribbean region faces increased vulnerability to drought hazards. (USGCRP, 2018). The probability of drought occurrence is difficult to forecast or foresee in a long-term perspective. Though as figure 25 shows, moderate droughts periods have become more prevalent since 2018.

4.13.2 Risk Analysis (B2-A, B2-B)

If drought results in potable water rationing, the municipality could experience

economic losses to the extent that services are immediately affected by the partial or total closure of schools, businesses, industrial areas, and public and private offices.

The potential economic impact of a prolonged drought would arise from the need to mobilize the municipality to meet the basic needs of its population during the emergency period. This cost is associated with mobilizing resources such as personnel and equipment for the distribution of water to communities and municipal facilities. However, the municipality has not been able to quantify the economic impact of this expense, nor the impact on agriculture, due to a lack of information. Since drought is a hazard that does not directly affect structures, no dollar estimate of structural losses is generated.

Among other effects, it results in increased food prices, loss of agricultural production, impacts on the industrial, commercial, and service sectors, losses in hydroelectric energy, and losses in the tourism industry, whether domestic tourism or foreign visitors.

4.13.2.1 Estimated Losses

Documenting the fiscal impact of a drought is a complex process due to the wide range of ways this climate event affects society (DNER, 2015). Loses on account of drought can be documented the losses caused by drought period is by looking at the impact on the agricultural sector. The Puerto Rico Department of Agriculture reported that the 2015 drought had a net cost of $14,000,000.00 impact on the agricultural sectors.

4.13.2.2 Lifelines and Critical Infrastructure

Drought can place significant strain on critical infrastructure by reducing water availability for municipal systems, often leading to rationing measures and service interruptions. Extended water shortages can disrupt essential operations in schools, hospitals, and businesses, resulting in economic losses and reduced access to public services. Energy infrastructure may also be affected, particularly where hydroelectric generation declines due to low reservoir levels, increasing reliance on more expensive or less sustainable energy sources. Transportation systems can experience indirect impacts, such as road damage caused by soil shrinkage and heightened wildfire risk along highways. Emergency response and communication services may face additional challenges when limited water supplies constrain cooling systems and firefighting capabilities. Collectively, drought conditions can trigger cascading

impacts across interconnected infrastructure systems, increasing vulnerabilities and underscoring the need for coordinated mitigation and response strategies.

As noted above, drought events that require potable water rationing can lead to economic losses for the municipality by disrupting normal government operations. Partial or complete closures of schools, businesses, industrial zones, and public or private offices may occur when water availability is reduced. These impacts primarily affect the day-to-day functioning of municipal assets, as the services they provide are directly limited by water shortages or service interruptions. As droughts become more frequent or prolonged, their cumulative effects on operations are likely to intensify. However, while drought significantly affects service delivery and operational capacity, it does not directly damage the municipality's critical facilities and physical assets.

4.13.2.3 Social Vulnerabilities

As discussed in Section 3.3.1, vulnerable populations within the Municipality of Añasco may be disproportionately affected by drought conditions. Prolonged drought can reduce water availability for residential, commercial, industrial, and agricultural uses, potentially affecting public health, economic activity, and community well-being. Reduced water supplies may contribute to decreased quality of life, physical and mental stress, and increased challenges for populations that already face social or economic constraints. Because drought impacts may affect the municipal water supply system regardless of whether rainfall deficits occur directly within Añasco, it is prudent to consider the entire municipal population as potentially exposed to this hazard.

4.13.2.4 Natural and Cultural Resources

When a region experiences prolonged and cumulative periods of little or no rainfall, a drought begins. This natural hazard has adverse effects on biodiversity and water supplies. For instance, a precipitation deficit lowers water levels in bodies of water, including mangroves, impacting the region's flora and fauna. Damage to vegetation directly affects animal habitats, creating an imbalance in food availability for wildlife.

Agriculture in the area is also severely affected due to the lack of water. When rainfall is significantly below normal levels, it causes severe hydrological imbalances that negatively affect land productivity systems. Similarly, crop growth and harvests

decline, along with the availability and quality of drinking water. Drought can also lead to ecosystem degradation, loss of biodiversity and species, wind erosion, and increased wildfire risk.

4.13.2.5 Future Conditions

Over the long term, drought-related challenges are expected to intensify as rainfall patterns continue to vary. These variations may result in droughts that are more severe, longer in duration, and wider in geographic extent than those experienced historically, thereby increasing vulnerability among affected populations.

Overall population trends in the Municipality of Añasco indicate a general population decline between 2019 and 2024. However, the proportion of residents aged 65 years and older increased from approximately 19.9 percent to 23.4 percent during the same period, representing a growing vulnerable segment of the community (see Section 3.4.1). Older adults require special consideration in drought planning due to their heightened sensitivity to water shortages, public health impacts, extreme heat, and disruptions to essential services. Prolonged drought conditions may disproportionately affect this population by increasing challenges related to hydration, health care needs, mobility, and access to critical resources. As a result, the municipality's aging population may face greater difficulty adapting to water supply interruptions and other drought-related impacts.

Future land development also plays a critical role in drought vulnerability. Approving projects near sinkholes or developments that rely on septic systems increases the risk of groundwater contamination, which becomes especially problematic during drought conditions when alternative water sources are limited. Additionally, soil surface impermeabilization and the obstruction or filling of sinkholes reduce natural aquifer recharge by increasing surface runoff. These factors further diminish groundwater availability, limiting its viability as a supplemental water source during drought events.

4.14 Wildfire (E1-a)

4.14.1 Description (B1-a)

Wildfires are uncontrolled fires that spread through vegetation, posing serious threats to structures, human health, and natural ecosystems. These events often begin

unnoticed and can spread rapidly, producing dense smoke that affects nearby communities. While wildfires may occur at any time of year, they are most common during periods of low rainfall, when grasses, leaves, and other fine fuels become dry and highly combustible.

In 2021, the Puerto Rico Department of Natural and Environmental Resources published its Forest Action Plan (DNER, 2021). The Plan discusses overall trends, issues and objectives for the management of forest resources. Wildfires are among the challenges discussed in the document. The Plan argues that wildfire management is a pressing issue at both local and global levels due to the complex interactions among human activity, fire dynamics, and natural landscapes. While research has established that fire influences ecosystem structure and function, its effects on ecosystem services remain uncertain because of interrelated factors such as land cover changes, invasive species, and climate change (Gould, 2008).

A clear understanding of the ecological and social impacts of wildfire in Puerto Rico's natural ecosystems is essential for guiding effective conservation and management strategies. Prevention efforts must extend to private forest owners and the general public, as most fires on the island are human caused (Gould, 2008). Historically, fire monitoring and research in the region have received limited attention. Currently, fires occur predominantly in dry forest zones, where the risk is highest. However, climate change, prolonged droughts, and human-induced landscape fragmentation could expand fire-prone conditions into moist and wet tropical forests, as well as into areas traditionally unaffected by fire (Gould, 2008).

Increasing temperatures, more frequent droughts, and the spread of invasive species are making forests more susceptible to wildfires. This shift is already evident in Puerto Rico, where fires are becoming more frequent and occurring in areas with no prior history of such events (Robbins, Eckelmann, & Quiñones, 2009).

4.14.1.1 Risk Magnitude

The United States Forest Service main classification for fire types (USFS, n.d.) are;

- **Ground Fire** - Fire that burns within the organic material below the litter layer, mostly by smoldering combustion. It typically occurs in duff, peat, dead moss and lichens, and punky wood are typically ground fire. Ground fires mainly growing vegetation such as grasslands, shrubs, and tree bases. Depending on environmental factors (vegetation composition and density, slope orientation

and steepness, wind speed, among others), these fires can vary in intensity but generally release less thermal energy than fires that spread through tree canopies.

- **Crown Fires** – A fire that burnt in the crowns of trees and shrubs usually ignited by a surface fire. Crown fires are common in coniferous forests and chaparral-type shrublands. In these types of fires, flames climb through lower branches until reaching the tree canopy. However, in some cases, its spread remains primarily surface-based, often because trees are sparse and their canopies are too far apart.
- **Surface Fire** – A fire that burnt through leaf litter and other live or dead fuels located at or just above the ground, mostly by flaming combustion.

While FEMA follows a four-classification typology (FEMA, 1997):

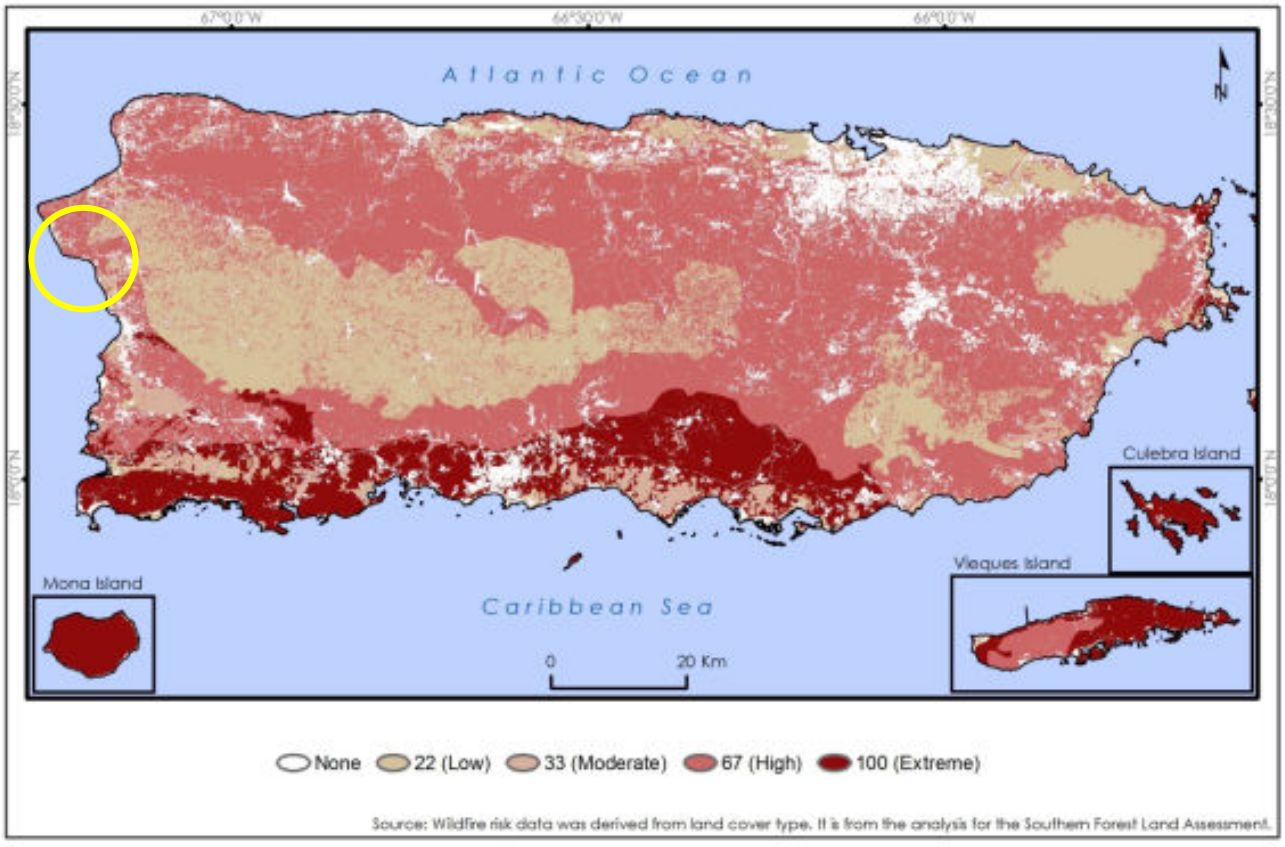
- **Wildfires** – Fueled almost exclusively by natural vegetation. They typically occur in forests and national parks, where federal agencies are responsible for fire management and suppression.
- **Interface or Intermixed Fires** – Fires that occur in urban and/or wildland areas where vegetation and integrated surroundings provide the fuel.
- **Firestorms** – Events of such extreme intensity that effective suppression is virtually impossible. Firestorms occur under severe weather conditions and generally burn until conditions change, or available fuel is exhausted.
- **Intentional and Prescribed Burns** – Fires caused by human intervention and natural fires intentionally allowed to burn vegetation for management purposes.

Another typology is the distinction between wildfires and wildland-urban interface (WUI) fires. Wildfires occur in areas with minimal development, except for infrastructure such as roads or power lines. WUI fires, on the other hand, involve situations when fire spreads into areas with structures or other human developments. In WUI fires, flames feed on both vegetation and structural elements of urban areas. The US Fire Administration defines WUI as the zone or area where human structures and developments meet or intermingle with wildland vegetation and fuels (US Fire Administation, 2025).

4.14.1.2 Affected Area (B1-B)

Figure 26 (DNER, 2021) provides an overview of areas in Puerto Rico, Vieques, and Culebra under varying levels of wildfire incidence, as defined by Southern Federal Land Assessment (SFLA). This information provides the state of knowledge of what is known as fire-prone landscapes. The combination of human presence, dry fuels, and climatic conditions accounts for the high number of fires in the southern coastal plain. Añasco's territory (yellow circle) is characterized by High risk in the mountainous area and a moderate risk in the valleys to wildfires.

Figure 28: Overview of areas of Puerto Rico, Vieques and Culebra under different levels of wildlife incidence



4.14.1.3 Risk Magnitude (B1-c)

Wildfires tend to be associated with template climate areas, like California or Canada. However, the recent experience in the State of Hawai'i showed that rapid and deadly wildfire can occur even in tropical humid locations. The catastrophic Lahaina Fire of August 2023 sent swift, devastating flames through densely built neighborhoods, revealing severe vulnerabilities in early warning systems, evacuation planning, and

community preparedness. Fueled by dry vegetation, strong winds, and record-setting drought conditions, the blaze rapidly ignited structures and overwhelmed emergency response efforts. Independent investigation by the Fire Safety Research Institute highlights that inadequate infrastructure resilience, insufficient communication networks, and a lack of coordinated interagency planning significantly amplified the disaster's impact.

As Puerto Rico faces similar wildfire threats, especially in southern coastal plains, this tragedy underscores the need to strengthen detection systems, bolster community evacuation routes, and elevate public education about fire safety. Building codes that emphasize fire-resistant materials and defensible space strategies around homes and critical facilities can reduce structural losses under extreme wildfire conditions.

The importance of integrated land management also emerges, encouraging Puerto Rico to limit development in WUI zones and maintain vegetation buffers. The Lahaina lessons highlight that rapid, well-coordinated suppression and resilient communications systems are vital to curbing wildfire escalation. Investing in cross-agency collaboration and emergency training at the local level will help Puerto Rican municipalities respond more effectively. Ultimately, Lahaina serves as a stark wake-up call, emphasizing that proactive planning, robust infrastructure, and community resilience are essential to preventing a similar wildfire catastrophe in Puerto Rico.

4.14.1.4 Past Events (B1-D)

Citing data from the Puerto Rico Firefighters Bureau (PRFB), The Puerto Rico Forest Action Plan states that a total of 7,099 wildland fires were reported across Puerto Rico between 2018 and 2020. The highest number of incidents occurred in 2020, with 5,077 recorded fires. The regions most affected were Ponce, Guayama, and Mayagüez (DNER, 2021).

Within the Department of Natural and Environmental Resources (DNER) Protected Natural Areas, fire incidence increased in 2019 compared to 2018. Notable affected sites included Guánica State Forest, Boquerón Wildlife Refuge, Punta Cuchara Natural Reserve, Caño Tiburones Natural Reserve, and Tortuguero Lagoon Natural Reserve. Most of these fires were linked to human activities, such as unattended campfires, discarded cigarettes, intentional burning, improper waste burning, and poorly managed prescribed burns in pasturelands (DNER, 2021).

The high frequency of wildfires in Puerto Rico highlights the urgent need for targeted education and public outreach efforts to raise awareness. When combined with active land management and a landscape-scale conservation approach, these initiatives can help reduce the occurrence of fires and mitigate additional pressures on forest ecosystems.

During 2024 a total of 44 wildfires were reported by the Puerto Rico Fire Bureau. The following table shows the details of the wildfires reported in that year.

Table 44: Registered Wildfires

Case Number	Discovery Date	Containment Date	Incident Coordinates[17]
PR040524-742	2024-04-05 15:20:29.175000	2024-04-05 19:16:55.332000	-67.13334, 18.2813
BPR030524-457	2024-03-05 11:31:07.598000	2024-03-05 14:19:18.064000	-67.136, 18.2883
PR030524-563	2024-03-05 12:58:48.431000	2024-03-05 15:19:40.654000	-67.06829, 18.2592
BPR033024-569	2024-03-30 14:32:22.623000	2024-03-30 16:50:40.842000	-67.136, 18.2883
BPR010824-826	2024-01-08 15:36:43.094000	2024-01-08 16:21:49.171000	-67.136, 18.2883
PR030424-929	2024-03-04 16:47:51.499000	2024-03-04 17:50:34.324000	-67.21494, 18.3023
BPR031424-391	2024-03-14 10:39:10.200000	2024-03-14 12:06:50.120000	-67.136, 18.2883
PR032624-774	2024-03-26 14:44:57.852000	2024-03-26 15:46:57.313000	-67.20568, 18.2964
PR032624-1013	2024-03-26 18:32:53.502000	2024-03-26 22:23:44.311000	-67.21622, 18.2957
PR032924-708	2024-03-29 16:09:58.300000	2024-03-29 22:06:39.198000	-67.19879, 18.2961
BPR040524-630	2024-04-05 13:56:08.149000	2024-04-05 17:24:39.858000	-67.136, 18.2883
BPR112224-744	2024-11-22 15:07:14.506000	2024-11-22 16:01:16.341000	-67.136, 18.2883
BPR123123-620	2023-12-31 16:10:49.082000	2023-12-31 18:53:20.059000	-67.136, 18.2883
PR123123-787	2023-12-31 19:33:02.758000	2023-12-31 20:23:03.171000	-67.13252, 18.2808
BPR010224-1055	2024-01-02 19:38:59.237000	2024-01-02 20:37:23.224000	-67.136, 18.2883

Case Number	Discovery Date	Containment Date	Incident Coordinates[17]
BPR010324-566	2024-01-03 13:06:35.636000	2024-01-03 14:22:21.143000	-67.136, 18.2883
PR010424-510	2024-01-04 11:46:24.557000	2024-01-04 13:23:44.566000	0.0, 0.0
PR010624-614	2024-01-06 15:28:59.733000	2024-01-06 16:35:33.144000	-67.1213, 18.3007
BPR010724-832	2024-01-07 18:06:06.662000	2024-01-07 19:42:13.101000	-67.136, 18.2883
BPR010824-736	2024-01-08 14:25:24.602000	2024-01-08 15:24:16.723000	-67.136, 18.2883
BPR011124-828	2024-01-11 16:33:36.186000	2024-01-11 18:17:34.695000	-67.136, 18.2883
PR011324-567	2024-01-13 13:33:05.961000	2024-01-13 14:53:04.195000	-67.20921, 18.2961
BPR011424-1032	2024-01-14 21:05:23.692000	2024-01-14 21:42:28.958000	-67.136, 18.2883
BPR011824-600	2024-01-18 13:23:40.845000	2024-01-18 16:31:44.400000	-67.136, 18.2883
PR012024-548	2024-01-20 12:30:36.375000	2024-01-20 14:07:59.467000	-67.1488, 18.314
PR012024-834	2024-01-20 16:14:42.276000	2024-01-20 17:17:43.140000	0.0, 0.0
PR012124-519	2024-01-21 13:06:57.435000	2024-01-21 14:35:30.805000	-67.18797, 18.2829
BPR012124-737	2024-01-21 16:18:40.733000	2024-01-21 17:09:10.040000	-67.136, 18.2883
BPR012124-1092	2024-01-21 21:27:52.040000	2024-01-21 22:01:42.607000	-67.136, 18.2883
BPR012224-511	2024-01-22 11:18:08.854000	2024-01-22 11:51:01.753000	-67.136, 18.2883
BPR012324-716	2024-01-23 13:56:48.223000	2024-01-23 15:05:30.878000	-67.136, 18.2883
BPR012324-1035	2024-01-23 17:22:12.174000	2024-01-23 19:32:05.008000	-67.136, 18.2883
BPR012324-1263	2024-01-23 20:34:30.154000	2024-01-23 21:32:12.623000	-67.136, 18.2883
BPR012624-789	2024-01-26 15:40:58.769000	2024-01-26 17:28:37.614000	-67.136, 18.2883
PR012724-920	2024-01-27 18:22:00.532000	2024-01-27 20:20:51.202000	-67.19311, 18.2895
BPR012824-130	2024-01-28 04:01:21.767000	2024-01-28 06:33:44.599000	-67.136, 18.2883
PR012824-453	2024-01-28 12:04:13.697000	2024-01-28 15:41:30.433000	-67.05458, 18.2931

Case Number	Discovery Date	Containment Date	Incident Coordinates[17]
BPR012924-386	2024-01-29 10:26:08.598000	2024-01-29 11:06:25.953000	-67.136, 18.2883
BPR012924-870	2024-01-29 16:31:24.513000	2024-01-29 18:06:15.162000	-67.136, 18.2883
PR013024-893	2024-01-30 16:54:49.591000	2024-01-30 18:31:36.832000	-67.21423, 18.2961
BPR020124-1071	2024-02-01 19:10:06.970000	2024-02-01 20:29:50.206000	-67.136, 18.2883
BPR020224-1012	2024-02-02 19:35:23.671000	2024-02-02 21:05:23.629000	-67.136, 18.2883
PR020524-542	2024-02-05 11:11:47.080000	2024-02-05 12:28:32.580000	-67.16233, 18.2765
BPR021424-600	2024-02-14 13:27:02.419000	2024-02-14 13:57:56.238000	-67.136, 18.2883
PR021424-948	2024-02-14 18:09:11.370000	2024-02-14 18:53:45.361000	-67.21254, 18.2962
BPR021524-469	2024-02-15 10:42:11.895000	2024-02-15 14:18:39.880000	-67.136, 18.2883
BPR021524-938	2024-02-15 17:03:20.477000	2024-02-15 18:07:47.024000	-67.136, 18.2883
BPR021524-1009	2024-02-15 18:01:21.521000	2024-02-15 19:55:04.851000	-67.136, 18.2883
BPR021724-919	2024-02-17 18:19:33.443000	2024-02-17 18:59:40.627000	-67.136, 18.2883
BPR021824-485	2024-02-18 12:31:12.683000	2024-02-18 13:32:21.173000	-67.136, 18.2883
BPR021924-610	2024-02-19 14:20:53.083000	2024-02-19 14:49:32.614000	-67.136, 18.2883
BPR021924-949	2024-02-19 18:54:12.222000	2024-02-19 19:38:34.498000	-67.136, 18.2883
BPR022024-911	2024-02-20 17:19:11.764000	2024-02-20 17:56:48.542000	-67.136, 18.2883
PR022624-940	2024-02-26 18:38:36.014000	2024-02-26 19:12:33.237000	-67.13473, 18.2895
BPR022824-952	2024-02-28 17:48:03.629000	2024-02-28 18:13:55.519000	-67.136, 18.2883
PR030524-343	2024-03-05 10:06:57.138000	2024-03-05 11:27:23.204000	-67.06065, 18.2556
PR030924-1022	2024-03-09 21:25:03.652000	2024-03-09 22:16:54.066000	-67.19548, 18.2912
BPR031124-1074	2024-03-11 17:36:41.757000	2024-03-11 18:31:59.461000	-67.136, 18.2883
BPR031324-623	2024-03-13 13:14:41.109000	2024-03-13 21:31:58.982000	-67.136, 18.2883

Case Number	Discovery Date	Containment Date	Incident Coordinates[17]
PR031324-757	2024-03-13 15:06:23.379000	2024-03-13 18:03:43.682000	0.0, 0.0
PR031324-1235	2024-03-13 23:50:50.974000	2024-03-14 00:54:03.917000	-67.12527, 18.2888
PR031424-824	2024-03-14 16:12:16.417000	2024-03-14 17:33:22.852000	0.0, 0.0
BPR031624-1053	2024-03-16 20:35:50.147000	2024-03-16 22:22:12.008000	-67.136, 18.2883
BPR031724-540	2024-03-17 13:29:51.925000	2024-03-17 14:27:04.184000	-67.136, 18.2883
BPR031724-585	2024-03-17 14:18:36.887000	2024-03-17 14:57:38.623000	-67.136, 18.2883
BPR031924-301	2024-03-19 09:05:52.875000	2024-03-19 09:37:54.422000	-67.136, 18.2883
PR031924-584	2024-03-19 12:29:01.550000	2024-03-19 13:55:51.386000	-67.136, 18.2883
BPR031924-755	2024-03-19 14:56:09.904000	2024-03-19 17:35:12.467000	-67.136, 18.2883
PR032024-739	2024-03-20 14:18:26.518000	2024-03-20 16:16:17.564000	-67.08918, 18.2967
PR032124-821	2024-03-21 16:08:13.716000	2024-03-21 16:10:24.344000	-67.19209, 18.2974
PR032424-741	2024-03-24 16:07:24.454000	2024-03-24 17:42:17.387000	-67.08183, 18.3023
PR032924-966	2024-03-29 19:51:55.641000	2024-03-29 22:06:07.818000	-67.09634, 18.2569
PR032924-1061	2024-03-29 21:53:24.061000	2024-03-29 23:32:35.594000	-67.09699, 18.2576
BPR040224-797	2024-04-02 16:39:10.199000	2024-04-02 17:11:05.684000	-67.136, 18.2883
PR040324-636	2024-04-03 14:00:44.645000	2024-04-03 14:49:24.844000	0.0, 0.0
PR040324-897	2024-04-03 17:50:04.768000	2024-04-03 18:35:44.409000	-67.13935, 18.2102
BPR040324-1150	2024-04-03 22:47:14.669000	2024-04-03 23:43:26.046000	-67.136, 18.2883
BPR040424-713	2024-04-04 15:40:35.014000	2024-04-04 16:42:14.335000	-67.136, 18.2883
BPR040424-929	2024-04-04 19:14:28.626000	2024-04-04 22:30:31.101000	-67.136, 18.2883
BPR040524-1095	2024-04-05 20:39:58.880000	2024-04-05 21:55:51.297000	-67.136, 18.2883
BPR040524-1210	2024-04-05 22:19:15.235000	2024-04-05 23:05:19.220000	-67.136, 18.2883

Case Number	Discovery Date	Containment Date	Incident Coordinates[17]
PR040624-446	2024-04-06 11:09:24.295000	2024-04-06 12:08:49.401000	0.0, 0.0
PR040624-887	2024-04-06 17:52:55.518000	2024-04-06 19:31:10.432000	0.0, 0.0
BPR040724-497	2024-04-07 12:54:38.679000	2024-04-07 13:26:04.392000	-67.136, 18.2883
BPR040724-766	2024-04-07 16:57:38.775000	2024-04-07 18:04:30.545000	-67.136, 18.2883
BPR040724-933	2024-04-07 19:48:38.482000	2024-04-07 20:41:30.884000	-67.136, 18.2883
BPR040824-674	2024-04-08 13:47:19.181000	2024-04-09 07:04:40.623000	-67.136, 18.2883
PR040824-714	2024-04-08 14:08:47.243000	2024-04-09 07:04:57.085000	-67.08995, 18.2953
BPR041024-532	2024-04-10 11:49:31.938000	2024-04-10 14:37:48.287000	-67.136, 18.2883
BPR041024-922	2024-04-10 17:22:39.924000	2024-04-10 20:28:20.544000	-67.136, 18.2883
BPR041124-427	2024-04-11 10:34:35.082000	2024-04-11 11:49:27.927000	-67.136, 18.2883
BPR041124-611	2024-04-11 13:10:48.469000	2024-04-11 14:09:41.582000	-67.136, 18.2883
BPR042124-521	2024-04-21 13:06:05.763000	2024-04-21 14:23:22.963000	-67.136, 18.2883
PR051224-474	2024-05-12 13:50:54.142000	2024-05-12 14:06:58.584000	-67.16209, 18.295
PR081524-1383	2024-08-15 19:35:49.791000	2024-08-15 19:37:14.785000	-67.14814, 18.2807
BPR082224-797	2024-08-22 15:47:22.086000	2024-08-22 17:16:25.282000	-67.136, 18.2883
BPR101624-522	2024-10-16 11:56:00.280000	2024-10-16 14:39:29.778000	-67.136, 18.2883
BPR122824-768	2024-12-28 16:05:44.915000	2024-12-28 18:02:47.270000	-67.136, 18.2883
BPR010124-935	2024-01-01 17:40:33.311000	2024-01-01 20:47:56.112000	-67.136, 18.2883
BPR010824-588	2024-01-08 12:40:38.965000	2024-01-08 15:24:10.408000	-67.136, 18.2883
PR011424-447	2024-01-14 12:03:21.483000	2024-01-14 15:34:38.733000	-67.1264, 18.2769
BPR011424-703	2024-01-14 15:44:55.683000	2024-01-14 16:35:14.905000	-67.136, 18.2883
PR011824-1172	2024-01-18 22:00:33.551000	2024-01-18 22:06:32.170000	-67.16602, 18.2804

Case Number	Discovery Date	Containment Date	Incident Coordinates[17]
BPR011924-950	2024-01-19 17:51:46.214000	2024-01-19 18:22:12.855000	-67.136, 18.2883
PR011924-1083	2024-01-19 19:51:58.919000	2024-01-19 20:00:10.105000	-67.17125, 18.2653
PR012024-250	2024-01-20 07:12:17.883000	2024-01-20 07:52:31.560000	-67.14909, 18.3128
BPR012624-1041	2024-01-26 19:17:21.060000	2024-01-26 20:07:02.968000	-67.136, 18.2883
PR012724-799	2024-01-27 16:43:41.514000	2024-01-27 18:12:50.403000	-67.20466, 18.2964
BPR012724-1070	2024-01-27 21:30:36.899000	2024-01-27 22:33:54.393000	-67.136, 18.2883
PR012824-548	2024-01-28 13:26:25.334000	2024-01-29 08:03:12.653000	-67.13956, 18.3012
BPR012824-561	2024-01-28 13:34:57.548000	2024-01-28 19:59:06.690000	-67.136, 18.2883
PR012824-584	2024-01-28 13:48:55.595000	2024-01-29 07:03:36.148000	-67.13381, 18.3061
BPR012824-679	2024-01-28 15:04:14.782000	2024-01-28 17:04:27.902000	-67.136, 18.2883
PR012924-917	2024-01-29 17:07:13.598000	2024-01-29 17:45:49.154000	-67.15666, 18.2984
BPR013024-427	2024-01-30 11:01:25.627000	2024-01-30 11:40:28.356000	-67.136, 18.2883
PR020124-659	2024-02-01 13:40:32.843000	2024-02-01 14:32:00.402000	-67.16389, 18.3041
BPR021224-596	2024-02-12 12:31:31.805000	2024-02-12 13:48:50.454000	-67.136, 18.2883
BPR021224-740	2024-02-12 14:14:41.195000	2024-02-12 15:01:16.809000	-67.136, 18.2883
BPR021324-779	2024-02-13 15:48:06.595000	2024-02-13 18:33:24.193000	-67.136, 18.2883
PR021424-969	2024-02-14 18:29:46.900000	2024-02-14 19:51:07.633000	-67.20262, 18.2961
BPR031324-670	2024-03-13 13:53:44.294000	2024-03-13 14:32:33.341000	-67.136, 18.2883
BPR031324-932	2024-03-13 17:28:11.889000	2024-03-13 18:36:43.728000	-67.136, 18.2883
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BPR031324-1123	2024-03-13 20:47:35.524000	2024-03-13 22:45:24.511000	-67.136, 18.2883
BPR031424-432	2024-03-14 11:07:28.123000	2024-03-14 13:06:38.669000	-67.136, 18.2883

Case Number	Discovery Date	Containment Date	Incident Coordinates[17]
BPR032024-774	2024-03-20 14:39:32.202000	2024-03-20 15:17:20.931000	-67.136, 18.2883
BPR032724-1045	2024-03-27 21:33:22.786000	2024-03-27 22:47:33.151000	-67.136, 18.2883
BPR032824-922	2024-03-28 18:35:27.935000	2024-03-28 19:48:27.746000	-67.136, 18.2883
BPR032924-476	2024-03-29 12:29:36.734000	2024-03-29 14:42:08.035000	-67.136, 18.2883
BPR032924-582	2024-03-29 14:13:58.461000	2024-03-29 16:38:50.603000	-67.136, 18.2883
PR033024-734	2024-03-30 17:00:32.798000	2024-03-30 18:59:53.756000	-67.21346, 18.2961
BPR040424-979	2024-04-04 20:03:53.759000	2024-04-04 21:51:56.078000	-67.136, 18.2883
BPR040524-1129	2024-04-05 20:59:23.281000	2024-04-05 22:11:06.976000	-67.136, 18.2883
BPR040824-925	2024-04-08 16:47:55.402000	2024-04-08 18:59:29.097000	-67.136, 18.2883
PR040824-1047	2024-04-08 18:30:30.795000	2024-04-08 19:40:42.636000	-67.21531, 18.3039
PR042024-578	2024-04-20 14:26:46.810000	2024-04-20 17:01:34.214000	-67.19522, 18.2969
PR011424-448	2024-01-14 12:03:44.257000	2024-01-14 12:10:23.761000	-67.1264, 18.2769
BPR012724-905	2024-01-27 18:11:45.694000	2024-01-27 19:13:27.539000	-67.136, 18.2883
BPR031324-1231	2024-03-13 23:42:44.085000	2024-03-14 00:53:45.060000	-67.136, 18.2883
BPR032124-808	2024-03-21 16:01:19.712000	2024-03-21 16:53:41.053000	-67.136, 18.2883
PR032924-1128	2024-03-29 23:15:39.993000	2024-03-29 23:31:28.854000	-67.09626, 18.2584

Source: Puerto Rico Fire Bureau

4.14.1.5 Future Event Probability (B1-E)

Long-term trends in rain patterns, such as those caused by fluctuations in the El Niño–Southern Oscillation (ENSO), may lead to extended dry periods (CCOF, 2026), reduced soil moisture, and increased vegetation stress. When combined with rising temperatures, these conditions accelerate evapotranspiration and further dry out fuels, significantly increasing the likelihood of ignition and fire spread. As a result, areas

that have not historically been prone to wildfires may become increasingly susceptible under these changing climate conditions.

4.14.2 Risk Analysis (B2-a, B2-b)

4.14.2.1 Estimated Losses

Wildfires can result from both natural conditions, such as the presence of flammable vegetation, and human activities, including the intentional use of fire. These factors strongly influence the potential scale and intensity of wildfire events. The level of potential loss increases with higher population concentrations, greater numbers of structures, and sensitive ecosystems located within the affected area. Climatic conditions, combined with patterns of human activity, largely determine the extent and severity of wildfire impacts.

At present, there is insufficient information to quantify monetary losses related to building damage from this hazard. Additionally, at the time of this Plan update, no official damage estimates were available for the municipality. To address this gap, the municipality will take a proactive approach by incorporating updated damage information in future revisions as data become available.

4.14.2.2 Critical Infrastructure

Wildfires pose a significant threat to critical infrastructure, creating cascading impacts across power systems, communications, water supply, transportation, and the built environment. The electric grid is particularly vulnerable. Research from Sandia National Laboratories (Sandia National Laboratories, n.d.) and other institutions shows that wildfire can both damage grid components and be ignited by them, as seen in the 2018 Camp Fire, which caused $9.3 billion in damages. To address this, the U.S. Department of Energy has invested $3.46 billion through its Grid Resilience and Innovation Partnerships program (DOE, 2023), funding projects that include undergrounding power lines, installing fire-resistant poles, and deploying advanced sensors.

Communications infrastructure faces similar risks. A study by the University of Wisconsin – Madison faculty found that while cell towers often survive fires physically, power outages lead to widespread service disruptions (Anderson, Barford, & Barford, 2020). Water systems and watersheds are also heavily impacted. Post-fire conditions—such as vegetation loss and soil hydrophobicity—can trigger flooding and

debris flows, introducing sediment, nutrients, and metals into water supplies.

Transportation networks suffer both direct and indirect damage. Roads, bridges, and drainage systems are often compromised by post-fire floods and debris flows buildings and other structures in the wildland–urban interface is increasingly at risk due to climate change and urban expansion.

In summary, wildfire creates complex, interconnected risks for critical infrastructure, requiring a combination of engineering solutions, advanced modeling, policy reforms, and community engagement. Official and academic sources consistently call for proactive measures—such as infrastructure hardening, improved land management, and resilience planning—to reduce exposure and enhance recovery.

Wildfire occurs regularly during periods of drought, primarily in the southern region of Puerto Rico. These events have significant social and economic impacts, mainly due to structural and property damage or loss caused by the fires. If the affected area served as an employment or industrial hub, many individuals could face unemployment. Additionally, insurance premiums tend to rise because of increased demand for coverage to mitigate economic losses associated with wildfire hazards. Collectively, these factors negatively affect the region's economy, wildlife, vegetation, and contribute to broader social decline.

4.14.2.3 Social Vulnerability

Social vulnerability plays a critical role in shaping how communities experience and recover from wildfire events. Research consistently shows that populations with higher levels of poverty, older adults, individuals with disabilities, limited English proficiency, and households without reliable transportation face greater challenges preparing for, evacuating from, and recovering after wildfires. The CDC/ATSDR Social Vulnerability Index (SVI) identifies these demographic and socioeconomic conditions as key factors that increase susceptibility to disaster impacts, including wildfires, by constraining a community's adaptive and coping capacity before, during, and after an event. National-scale studies further demonstrate that U.S. communities experiencing wildfire occurrence or exposure tend to have systematically higher levels of social vulnerability, including higher unemployment, lower educational attainment, and greater concentrations of medically or socially dependent populations (Schumann, III, et al., 2024).

Wildfires also exacerbate existing inequalities through indirect impacts such as

prolonged displacement, loss of livelihoods, and health effects from smoke exposure. Peer-reviewed studies show that socially vulnerable populations experience disproportionate health burdens from wildfire smoke, including higher rates of respiratory and cardiovascular illness and increased mortality risk, due to pre-existing health conditions and limited access to medical care. FEMA and the U.S. Fire Administration emphasize that older adults, low-income households, people living in mobile homes, and individuals without access to private vehicles face heightened risk of injury or death during wildfire evacuations, underscoring the importance of incorporating social vulnerability into wildfire mitigation, evacuation planning, and recovery strategies (Dennin, Nock, Muller, Akindele, & Adams, 2025).

4.14.2.4 Natural and Cultural Resources

The severity, scale, and consequences of wildfire can be grouped into the following categories:

- **Impact on Landscape** - The most visible effect after a wildfire is the loss of scenic quality caused by the destruction of vegetation cover and its regression to earlier ecological stages.
- **Impact on Wildlife** - Wildfires have both immediate and long-term effects on fauna. In the short term, fires can cause direct mortality, particularly among invertebrates, small vertebrates, and young animals with limited mobility, as well as larger herbivores and carnivores that may be trapped by flames or barriers such as fencing. In the longer term, habitat loss, reduction of forage, and ecosystem disruption can force wildlife migration and threaten vulnerable or endangered species.
- **Impact on Soil** - Wildfires significantly alter soil structure and increase its susceptibility to erosion. The combustion of organic matter destabilizes soil aggregates, causing progressive disintegration. As a result, solid particles are then removed by rain or wind erosion. Fire often creates hydrophobic (water-repellent) layers to the deposition of organic compounds and changes in mineral composition, which reduce water infiltration and further accelerate surface runoff and erosion. Significant losses of soil and organic matter reduce nutrient levels, lowering fertility. In addition, heat also kills many organisms, reducing biological activity and disrupting biogeochemical cycles. However, not all effects are negative. Naturally occurring fires (now increasingly rare) can benefit forest health by mobilizing nutrients and controlling pests. Low-intensity fires help retain carbon in the soil, preventing its release as carbon dioxide.

- **Alteration of the Water Cycle** - Wildfire-induced soil degradation can significantly disrupt the hydrological cycle. Reduced infiltration lowers groundwater reserves that feed aquifers essential for agriculture and urban use. At the same time, increased surface runoff accelerates soil erosion, transports sediment into water bodies, and heightens the risk of flash flooding following intense rainfall events.
- **Increase in Carbon Emissions** – The combustion of biomass during wildfires releases substantial quantities of carbon dioxide (CO_2), methane (CH_4), and suspended particles. These emissions cause significant environmental damage and negatively affect people with respiratory illness (Asthma, COPD, etc.).

Wildfires can lead to numerous environmental consequences, including the destruction of vegetation cover, the death or displacement of wildlife, the loss of fertile soil, and an increase in erosion events. They can also cause significant loss of life and property, resulting in substantial economic costs associated with firefighting and recovery efforts.

As for cultural resources, wildfires pose a serious threat to cultural resources, including historic buildings, and archaeological sites. Intense heat and flames can destroy irreplaceable structures, artifacts, and archives, erasing centuries of heritage in a matter of hours. In addition, smoke, soot, and water used during firefighting operations can further damage delicate materials. Post-fire effects such as erosion and flooding after fires may expose or wash away archaeological remains.

Beyond physical damage, the loss of cultural landmarks disrupts can community identity and traditions, while also affecting tourism and local economies. Protecting these resources requires proactive planning, fire-resistant measures, and collaboration between emergency agencies and cultural preservation experts.

4.14.2.5 Future Conditions (E1-a)

Puerto Rico already experiences a high annual probability of wildfire-supporting conditions. According to the World Bank–supported ThinkHazard! platform, Puerto Rico's wildfire hazard is classified as High, meaning there is a greater than 50% probability in any given year of weather conditions capable of supporting a significant wildfire that could cause impacts to life or property. This assessment incorporates historical fire occurrence, climate variables, vegetation type, and drought conditions and is widely used in infrastructure and hazard mitigation planning worldwide (World

Bank, n.d.).

Taken together, the best available scientific evidence indicates that Puerto Rico currently faces a probability exceeding 50% annually of wildfire-supportive weather conditions, with future probability and severity expected to increase due to rising temperatures, expanded drylands, and longer seasonal droughts. While precise ignition probability percentages cannot be reliably projected at the municipal scale, confidence is high that wildfire occurrence, fire weather days, and burned area will increase by mid-century, particularly in southern, western, and interior regions of the island (World Bank, n.d.).

4.15 Long-Term Coastal Dynamics

4.15.1 Description

Long-term coastal dynamics refer to the gradual, persistent processes that shape coastlines over extended periods of time, including shoreline movement, sediment transport, erosion, accretion, and changes in coastal water levels, which together influence coastal form, stability, and hazard exposure (USGS, 2018) (Mentaschi, Vousdoukas, Pekel, Voukouvalas, & Feyen, 2018). These dynamics differ from short-term storm impacts in that they reflect persistent, incremental change rather than episodic disturbance. For Local Hazard Mitigation Plans, understanding long-term coastal dynamics is critical because such changes influence shoreline position, coastal stability, and long-term exposure to coastal hazards (USGS, 2018).

Long-term coastal dynamics are primarily driven by the interaction of coastal erosion, coastal accretion, and changes in the mean (base) sea level, all of which influence sediment distribution, natural protective features, and flood exposure along coastal areas (Bird, 2008; Davidson-Arnott, 2010).

Coastal Erosion

Coastal erosion is the long-term landward movement of the shoreline resulting from a net loss of sediment from beaches, dunes, bluffs, or nearshore environments. While erosion may occur rapidly during storm events, long-term erosion reflects sustained sediment imbalance operating over decades (Komar, 1998).

From a hazard mitigation perspective, chronic coastal erosion is important because it gradually reduces beach width and elevation, weakens dune systems, and exposes

inland areas to increased wave action and flooding. Long-term erosion is commonly measured as average annual shoreline retreat, integrating multiple historical shoreline positions and providing an indicator of sustained vulnerability rather than isolated event-driven damage (Allan et al., 2003; USGS, 2018).

Coastal Accretion

Coastal accretion refers to the long-term accumulation of sediment that results in shoreline advancement or increases in beach width and elevation. Accretion can enhance coastal resilience by reinforcing natural protective features; however, it is often spatially variable and dependent on sediment availability and transport pathways (Davidson-Arnott, 2010).

In many coastal systems, accretion in one location corresponds to erosion elsewhere, reflecting sediment redistribution rather than net sediment gain. As a result, accretion may be temporary and insufficient to offset long-term erosional trends at a regional scale (Bird, 2008; Mentaschi et al., 2018).

Variations in Mean (Base) Sea Level

Mean sea level, often referenced using tidal datums such as mean sea level (MSL) or mean higher high water (MHHW), serves as a controlling baseline for coastal processes. Long-term changes in mean sea level influence the elevation at which waves interact with the shoreline, the frequency of tidal inundation, and the position of the coastal profile (USGS, 2018).

Gradual changes in mean sea level contribute to long-term coastal dynamics by promoting landward adjustment of beaches and dunes, increasing inundation during routine tides, and enhancing erosion during moderate storm conditions. These impacts occur incrementally and contribute to persistent shoreline retreat over time (Bird, 2008; Mentaschi et al., 2018).

Long-term coastal dynamics emerge from the interaction of erosion, accretion, and mean sea-level position rather than from any single process acting independently. Coastal systems tend to adjust toward equilibrium conditions, which may involve shoreline migration, redistribution of sediment, and progressive loss of natural buffering capacity (Davidson-Arnott, 2010).

As a result, localized accretion may slow erosion but may not reverse long-term

shoreline retreat where underlying sediment deficits or water-level changes persist. These interactions explain why many coastlines experience sustained landward movement despite episodic periods of beach recovery (Komar, 1998; Allan et al., 2003).

For Local Hazard Mitigation Plans, long-term coastal dynamics are a key consideration because they contribute to the gradual expansion of coastal hazard exposure beyond areas affected by single storm events. Persistent erosion, shifting shorelines, and changing base water levels can increase the vulnerability of infrastructure, reduce the effectiveness of fixed shoreline protection measures, and influence long-term land-use suitability (USGS, 2018).

Incorporating long-term coastal dynamics into hazard mitigation planning supports proactive decision-making related to land use, infrastructure siting, and mitigation strategy development by addressing the underlying physical processes shaping coastal risk.

Long-term coastal dynamics, including ongoing erosion, accretion, and changes in mean sea level, contribute to gradual shoreline adjustment and increased exposure to coastal hazards over time. These processes represent a persistent source of coastal risk that should be considered in land-use planning, infrastructure investment, and hazard mitigation strategies (Bird, 2008; USGS, 2018).

4.15.1.1 Affected Area

Under HMGP FEMA-4339-DR-PR Subgrantee Number 4339-0007P, a comprehensive post-event coastal assessment was conducted to evaluate the geomorphic condition of Puerto Rico's beaches following Hurricane María (September 2017) and their subsequent recovery. This study was conducted by the University of Puerto Rico, Río Piedras' Coastal Research and Planning Institute of Puerto Rico (COREPI-PR).

The assessment analyzed beach conditions immediately after the hurricane and approximately ten months later (July 2018), covering a representative group of coastal municipalities across the north, west, east, and south coasts including Aguada, Aguadilla, Añasco, Arecibo, Arroyo, Barceloneta, Humacao, Loíza, Rincón, and San Juan (COREPI-PR, 2020).

The Añasco coastline exhibits a dynamic pattern of coastal change influenced by sediment transport, wave action, storms, riverine processes, and sea-level rise. Areas along the municipality's western coastline, particularly within Playa, Caguabo, and

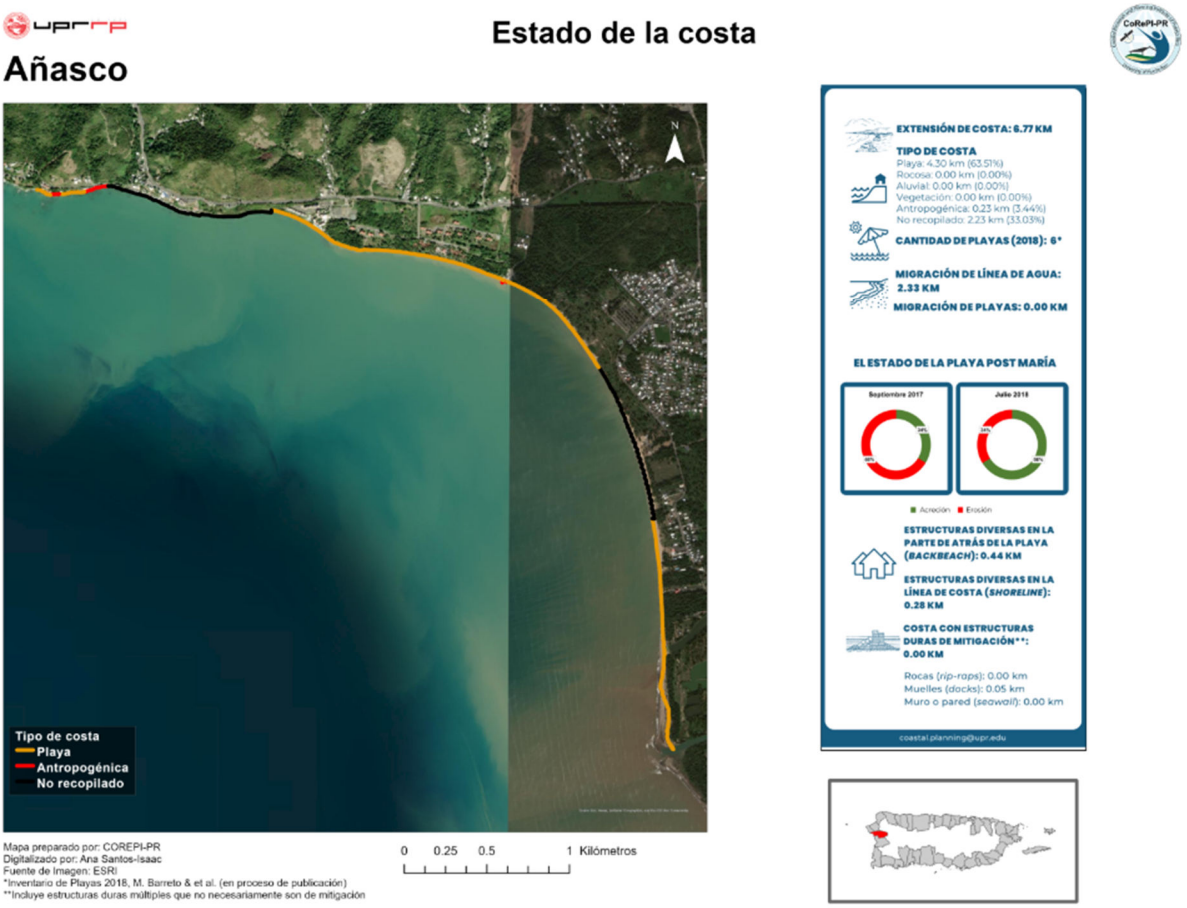
Hatillo, are subject to ongoing shoreline change processes. The historical shoreline data available through the USGS Coastal Change Hazards Portal indicate that portions of the coastline exhibit relatively stable conditions, while other segments show evidence of shoreline erosion and localized accretion.

The greatest erosional trends are observed along portions of the northern coastal sectors near Caguabo and Hatillo, where shoreline change rates indicate gradual landward retreat. In contrast, sections of the coastline near Playa and the mouth of the Río Grande de Añasco exhibit positive shoreline change rates, indicating localized shoreline advancement associated with sediment deposition processes. These coastal areas contain beaches, low-lying coastal lands, natural habitats, and developed areas that may be affected by long-term shoreline migration and storm-related erosion.

Overall, the historical shoreline record indicates that coastal change remains an active process along the Añasco coastline. Although much of the shoreline appears relatively stable, localized erosion and accretion continue to influence coastal conditions. As a result, future shoreline change may affect nearby residential areas, transportation infrastructure, recreational resources, natural habitats, and other assets located along the municipality's coastal zone.

CoRePI-PR's post-María assessment highlights the importance of monitoring shoreline conditions and coastal migration patterns to support planning and mitigation efforts. The information generated by this project assists in identifying areas where erosion may affect natural resources, infrastructure, and coastal communities and supports the development of future coastal resilience and hazard mitigation strategies.

Figure 29 State of the Beach Study



The Añasco coastline is approximately 6.7 kilometers long. According to CoRePI-PR (2020), approximately 63.5% (4.30 km) of the coastline is composed of beaches, 3.4% (0.23 km) is classified as anthropogenic coastline, and 33.0% (2.23 km) was not classified in the coastal assessment. No hard coastal mitigation structures were identified along the assessed shoreline.

By September 2017, approximately 36% of the municipality's beach segments exhibited accretion, while 64% exhibited erosion following the passage of Hurricane María. By July 2018, shoreline conditions had changed considerably, with approximately 69% of the assessed beach segments exhibiting accretion and 31% exhibiting erosion. These results indicate a substantial recovery of several beach segments during the months following the hurricane. Changes in the extent of coastal vegetation were not included in this assessment (CoRePI-PR, 2020).

Approximately 2.33 kilometers of the coastline exhibited inland waterline migration by July 2018. However, no measurable beach migration was identified during the assessment period. The assessment also identified approximately 0.44 kilometers of backshore structures and 0.28 kilometers of shoreline structures along the municipality's coast (CoRePI-PR, 2020).

Figure 30(available only in Spanish) shows the beach segments along the coastline of Añasco that experienced erosion or accretion during the period between September 2017 and July 2018 following the passage of Hurricane María. The figure compares shoreline conditions immediately after the hurricane with those observed approximately ten months later and highlights the dynamic nature of the municipality's coastal system.

The figure indicates that shoreline change was not uniform throughout the municipality. Several coastal segments experienced erosion immediately following Hurricane María, particularly along portions of Playa and adjacent beach areas. By July 2018, many of these same shoreline segments exhibited accretion, indicating localized sediment deposition and beach recovery following the storm. Nevertheless, some sections of the coastline continued to exhibit erosion, demonstrating the variable response of individual beach segments to post-storm coastal processes.

The distribution of erosional and accretional segments demonstrates that sediment movement along the Añasco coastline is highly variable and influenced by local coastal processes, wave conditions, sediment availability, and storm impacts. While several shoreline segments exhibited significant recovery through sediment accumulation, adjacent areas continued to experience erosion, highlighting the complex response of the coastline following Hurricane María.

Overall, the coast of Añasco experienced a combination of erosion and accretion during the period from September 2017 to July 2018, reflecting the ongoing adjustment of the shoreline after a major hurricane event. The observed changes underscore the importance of continued monitoring of coastal conditions, particularly along the municipality's beach systems and developed coastal areas, where future shoreline change may affect natural resources, recreational areas, infrastructure, and coastal development.

Figure 30: State of the Beach (Erosion vs. Accretion)

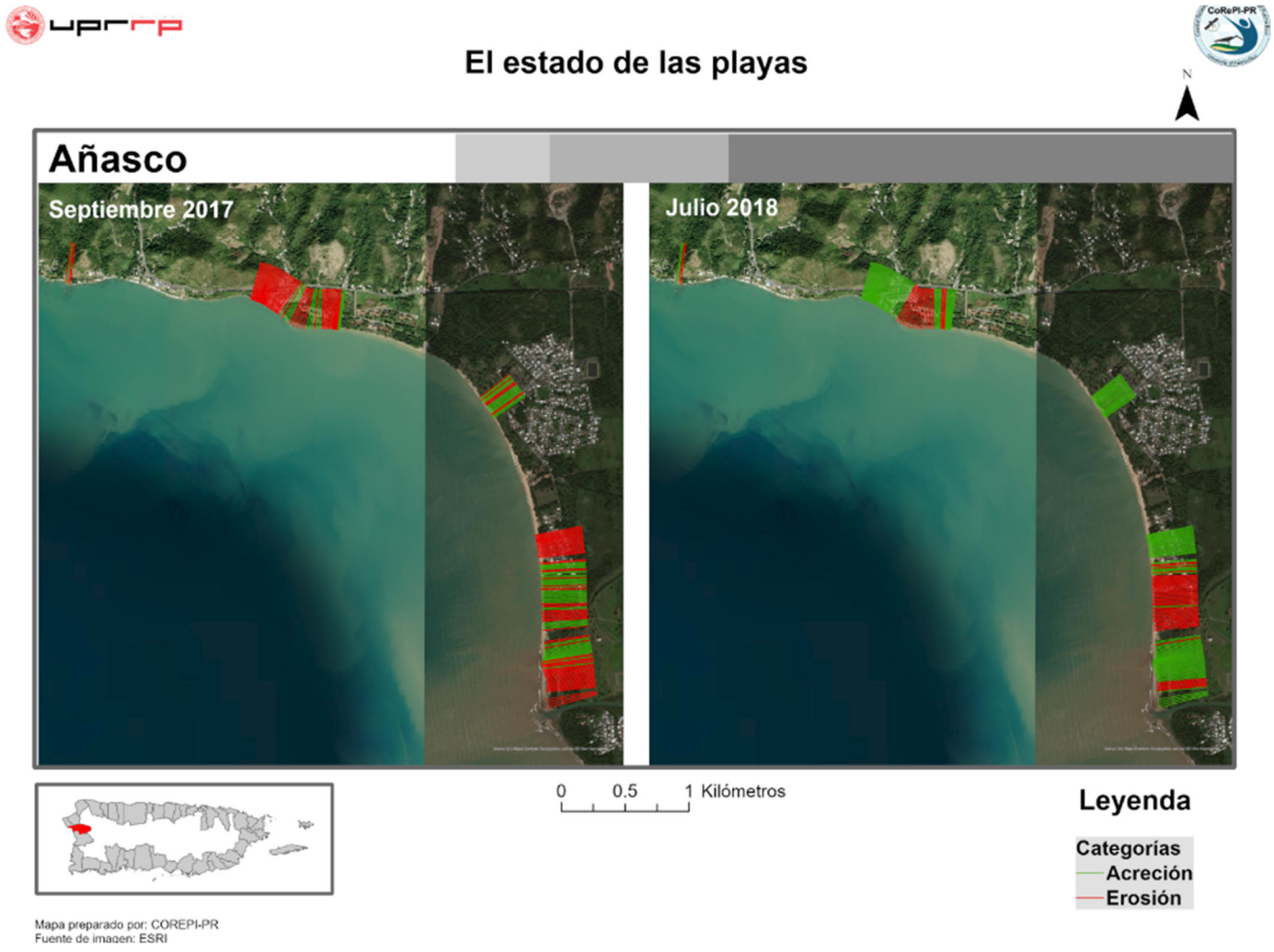


Figure 31 shows the changes in beach width observed along the coastline of Añasco between September 2017 and July 2018 following Hurricane María. The figure illustrates substantial spatial variability in shoreline response, with both erosion and accretion occurring along different sections of the coast.

The most significant increases in beach width were observed near the mouth of the Río Grande de Añasco and Caño La Puente (transects 3-50), where accretion reached approximately 37.07 meters. Additional notable accretion occurred along Playa Tres Hermanos (transects 57-135), where beach widening reached approximately 26.01 meters and 33.91 meters at several locations. Significant accretion was also identified near Balneario Tres Hermanos (transects 247-268), where beach width increased by

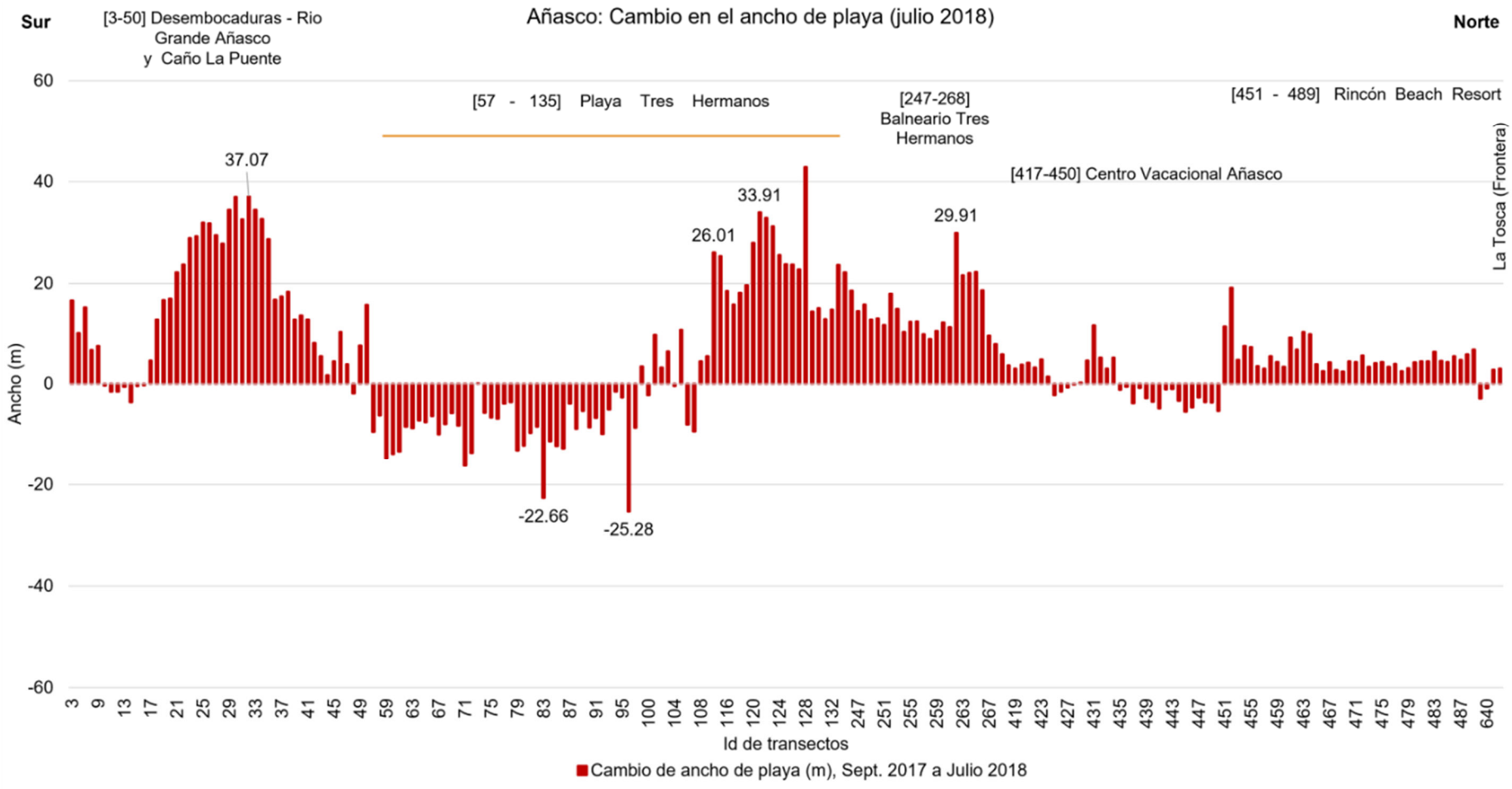
approximately 29.91 meters. These results indicate substantial sediment deposition and beach recovery in portions of the coastline during the post-María period.

Conversely, several shoreline segments exhibited erosion, particularly along portions of Playa Tres Hermanos and adjacent beach sectors, where beach width losses reached approximately -25.28 meters and -22.66 meters. Additional localized erosional trends were observed throughout the coastline, indicating that sediment redistribution following Hurricane María was uneven and highly site-specific.

The figure also demonstrates that shoreline behavior varied considerably among coastal sectors, including the areas surrounding the Río Grande de Añasco, Playa Tres Hermanos, Balneario Tres Hermanos, Centro Vacacional Añasco, and Rincón Beach Resort. While some shoreline segments experienced substantial beach widening, others underwent measurable shoreline retreat. This pattern reflects the dynamic interaction of storm impacts, wave energy, sediment transport, riverine sediment supply, and local coastal morphology. Changes in beach width are further detail in figure 31.

Overall, Añasco coastline experienced both erosion and accretion during the period immediately following Hurricane María. The magnitude and direction of shoreline change varied considerably along the coast, highlighting the importance of continued monitoring and management of coastal resources, particularly along Playa Tres Hermanos, Balneario Tres Hermanos, the Río Grande de Añasco mouth, Centro Vacacional Añasco, and other developed coastal sectors where future shoreline change may affect infrastructure, natural resources, recreational areas, and coastal development.

Figure 31: Change in Width of Beach (July 2018)



4.15.1.2 Risk Magnitude

Coastal Erosion

Erosion is the process by which major storms, flooding, strong wave action, rising sea levels, and human activities wear away beaches and cliffs along coastlines (FEMA, 1997). Beaches are affected by storms and other natural events that cause coastal erosion; however, the extent and severity of the problem are not uniform, as they vary by location. Consequently, there is no single solution for mitigating erosion. Erosion processes and their impacts may be episodic or long-term. These two (2) descriptors assign an important temporal component to erosion processes and their consequences.

Episodic erosion, also known as storm-induced erosion, primarily consists of the cross-shore movement of sand and sediments resulting from high-intensity weather events and ocean storms. This type of response leads to coastal adjustment and occurs during a single storm or a sequence of storm events within a season. Changes in beach and shoreline profiles during intense storms may result in dramatic erosion of beaches and dunes, including the reduction or removal of coastal dunes, as well as the retreat and collapse of coastal cliff formations. The consequences of this type of erosion may include increased inland wave penetration and ocean flooding in areas that were previously not exposed to water inundation.

Long-term or chronic erosion, on the other hand, is associated with slower processes such as gradual shoreline change linked to:

- Increases in sea level,
- Land subsidence,
- Changes in sediment supply due to watershed modifications,
- Impacts on coral reefs resulting from rising water temperatures and ocean acidification,
- Coastal structures and development, and
- Decadal adjustments in rainfall, wind, and climate associated with global warming.

Erosion may also be caused by anthropogenic forces (Romeu-Cotchett, 2012), including:

- Removal of coastal sediments, resulting in area erosion and the loss of dunes and beaches;

- Construction of developments, roadways, or agricultural activities, which increase sediment deposition and contamination in coastal waters, causing adverse effects on coral reefs. It should be noted that reefs function as natural barriers that protect beaches from wave impacts and, consequently, from erosion;
- Dam systems constructed to reduce the normal flow of sand delivered to the ocean by rivers; and
- Construction close to beaches, which allows the sea to advance further inland, thereby increasing erosion processes.

Coastal Accretion

Coastal accretion is a fundamental component of long-term coastal dynamics and represents the process by which sediment is deposited along the shoreline, resulting in the widening, elevation, or seaward movement of beaches, dunes, and other coastal landforms. Accretion occurs when sediment inputs exceed sediment losses over time and plays a critical role in shaping shoreline configuration and influencing coastal hazard exposure (USGS, 2018).

For Mitigation planning coastal accretion is significant because it affects the capacity of beaches and dunes to function as natural protective features that reduce wave energy, coastal flooding, and erosion impacts. However, accretion is neither uniform nor permanent and must be evaluated in terms of its duration, spatial extent, and relationship to broader coastal processes (Bird, 2008).

Episodic coastal accretion refers to short-term sediment deposition that occurs following discrete events or over limited periods, such as between storm seasons. This form of accretion is typically associated with the return of sediment from offshore bars or adjacent shoreline segments to the beach through cross-shore or alongshore transport processes (Davidson-Arnott, 2010).

Episodic accretion may result in temporary increases in:

- Beach width,
- Beach elevation, and
- Dune volume following storm-related erosion.

These changes may occur rapidly, sometimes within weeks or months; however, episodic accretion represents temporary profile adjustment rather than sustained

shoreline stabilization. Subsequent storms or shifts in hydrodynamic conditions may quickly redistribute or remove accreted sediments (Komar, 1998).
From a hazard mitigation perspective, episodic accretion may reduce short-term exposure to wave action or tidal inundation but should not be assumed to provide long-term protection unless supported by evidence of persistent sediment supply.

Long-term coastal accretion occurs when sediment deposition persists over years to decades, resulting in stable or progressively advancing shorelines. This form of accretion reflects a positive sediment budget within the coastal system, often supported by consistent sediment delivery and favorable transport conditions (USGS, 2018).

Long-term accretion is commonly associated with:

- Sustained sediment input from rivers or coastal ecosystems,
- Alongshore sediment transport that concentrates material in specific shoreline segments,
- Nearshore bathymetry that favors sediment retention, and
- Relatively stable mean sea-level conditions relative to land elevation (Bird, 2008).

While long-term accretion can enhance coastal resilience by reinforcing beaches and dunes, it is often spatially limited and may occur concurrently with erosion in adjacent areas. In many cases, accretion reflects sediment redistribution rather than net sediment gain across a regional coastline (Mentaschi et al., 2018).

Human activities can influence coastal accretion both directly and indirectly. In some cases, engineered interventions such as beach nourishment or coastal structures may promote localized sediment accumulation. In other cases, development and infrastructure interfere with natural sediment pathways, limiting accretion potential elsewhere (Komar, 1998).

Anthropogenic factors affecting accretion include:

- Beach nourishment and sediment placement projects,
- Coastal structures that trap sediment locally,
- Alterations to river systems that modify sediment delivery, and
- Shoreline development that restricts natural shoreline adjustment (NOAA, 2020).

While engineered accretion may provide short- to medium-term protective benefits, it typically requires long-term maintenance and should be evaluated within the context of sustained coastal dynamics.

Change in Base Sea Level Mean

Changes in the mean (base) sea level, commonly referenced using tidal datums such as mean sea level (MSL) or mean higher high water (MHHW), represent an important component of long-term coastal dynamics and influence the frequency and extent of coastal inundation. Mean sea level serves as a baseline against which shoreline position, wave interaction, and tidal flooding are measured, and gradual shifts in this baseline affect how coastal systems respond over time (NOAA, 2026). Sustained increases in mean sea level relative to the land surface allow wave energy to act on higher portions of the coastal profile, increasing the frequency of tidal flooding and accelerating shoreline adjustment processes. These incremental changes can lead to landward migration of beaches and dunes, greater exposure of low-lying areas to coastal flooding, and reduced effectiveness of natural and engineered protective features, even in the absence of major storm events. From a hazard mitigation planning perspective, changes in mean sea level contribute to long-term increases in coastal hazard exposure and should be considered when evaluating future risk, land-use suitability, and infrastructure resilience along the coast (USGS, 2018) (NOAA, 2026).

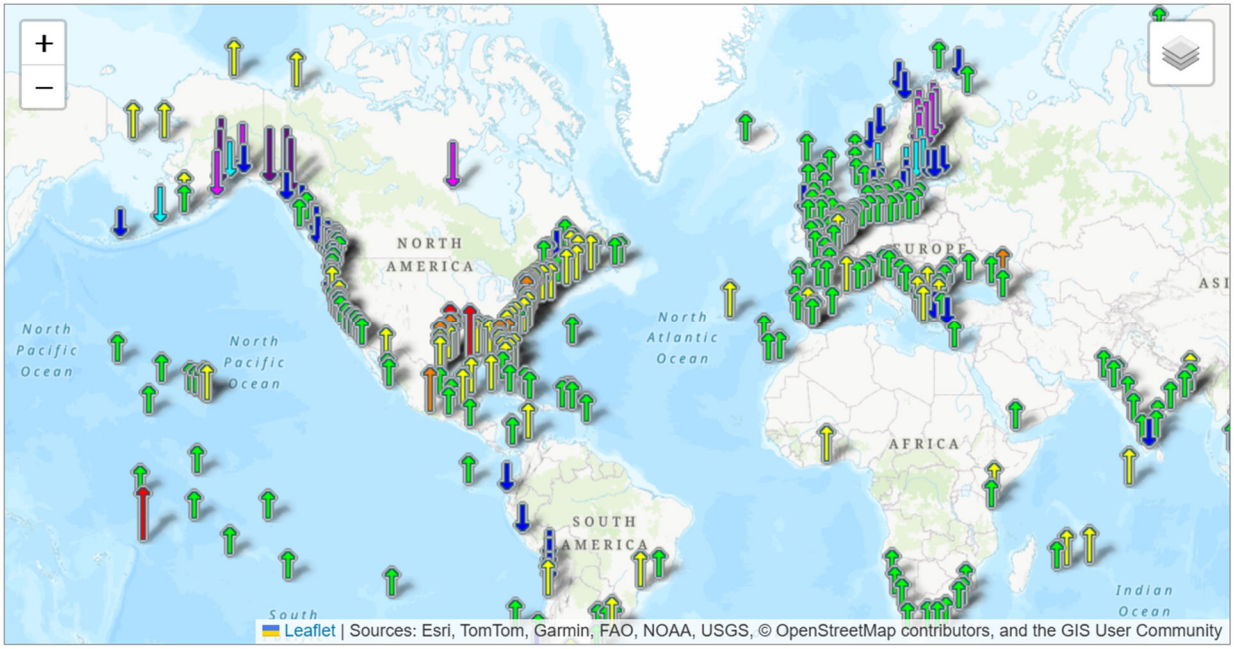
Sea level fluctuates over both short- and long-term timeframes as a result of multiple interacting factors. Short-term variations typically occur on daily to event-based timescales and are influenced by processes such as waves, tides, and discrete flooding events, including those associated with seasonal snowmelt, hurricanes, or other coastal storms. In contrast, long-term sea-level variations occur over extended periods ranging from months to multiple years and may manifest as recurring cycles, gradual trends, or episodic departures from typical conditions. These longer-term changes are influenced by a combination of factors, including seasonal atmospheric patterns, variations in the Earth's declination, changes in coastal and ocean circulation, human activities such as dredging, vertical land motion, and large-scale climate–ocean oscillations such as the El Niño–Southern Oscillation.

When evaluating long-term sea-level trends, a minimum observational record of 30 years is commonly used to capture these underlying variations and minimize uncertainty associated with shorter-term fluctuations in monthly mean sea level.

Accounting for predictable and repeatable processes—such as tidal cycles, seasonal variability, and interannual oscillations—allows for a more accurate representation of long-term sea-level behavior (NOAA, 2026).

NOAA's Relative Sea Level Trends website provides the up-to-date trends for sea levels at a global scale. The global sea-level trend has been measured using satellite altimetry since 1992, and the most recent global estimates, along with maps showing regional variations, are available from NOAA's Laboratory for Satellite Altimetry. The screen shot below shows the map provided by NOAA as of 4/29/2026 (NOAA, 2026).
As Figure 29 show, although there are various places where the sea level has decreased (specially to the south of Alaska, the west of British Columbia, Hudson Bay, the Nordic countries and among some parts of the South American western coast (Ecuador, Peru and northern Chile) the general trend is for an increasing sea level in varying degrees.

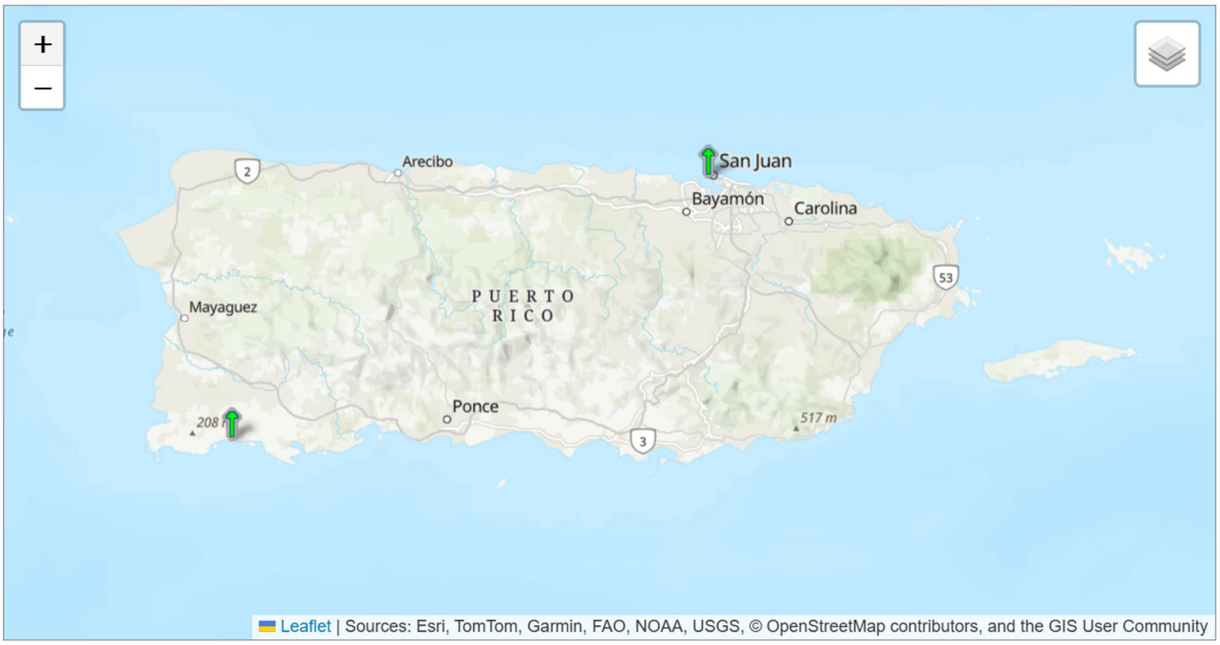
Figure 32: NOAA's Relative Sea Level Trend Map



As figure 32 show, although there are various places where the sea level has decreased (specially to the south of Alaska, the west of British Columbia, Hudson Bay, the Nordic countries and among some parts of the South American western coast (Ecuador, Peru and northern Chile) the general trend is for an increasing sea level in varying degrees.

In the case of Puerto Rico, according to this map there has been observed an increase in base sea levels.

Figure 33: NOAA's Relative Sea Level Trend Map (Zoom to Puerto Rico)



The gauges shown in the map present the following data:

Table 45: Puerto Rico Sea Level Observations

Gauge Name	*Trend*	*Period*	*Commentary*
Magueyes Island, PR 9759110	+ 2.06/year	1955 - 2025	The relative sea level trend is 2.06 mm/year with a 95% confidence interval of +/- 0.27 mm/year based on monthly mean sea level data from 1955 to 2025 which is equivalent to a change of 0.68 feet in 100 years.
San Juan, PR 9755371	+2.16/year	1962 - 2025	The relative sea level trend is 2.16 mm/year with a 95% confidence interval of +/- 0.32 mm/year based on monthly mean sea level data from 1962 to 2025 which is equivalent to

			a change of 0.71 feet in 100 years.

Figures 34and 35 are screen grabs from the Relative Sea Level Website and shows the trend for the Magueyes Island gauge.

Figure 34: Relative Sea Level Trend 9759110 Magueyes Island, PR

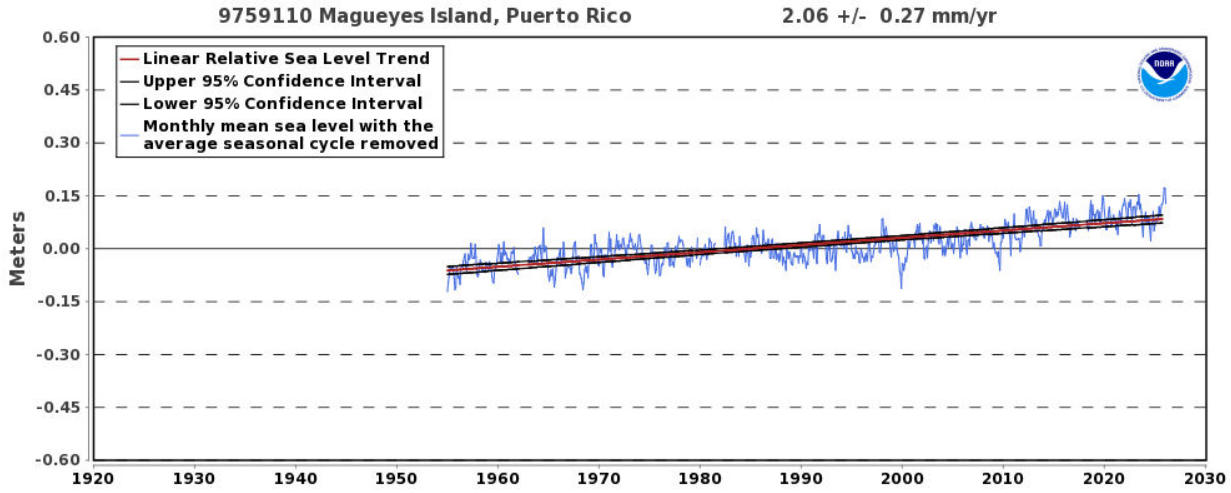
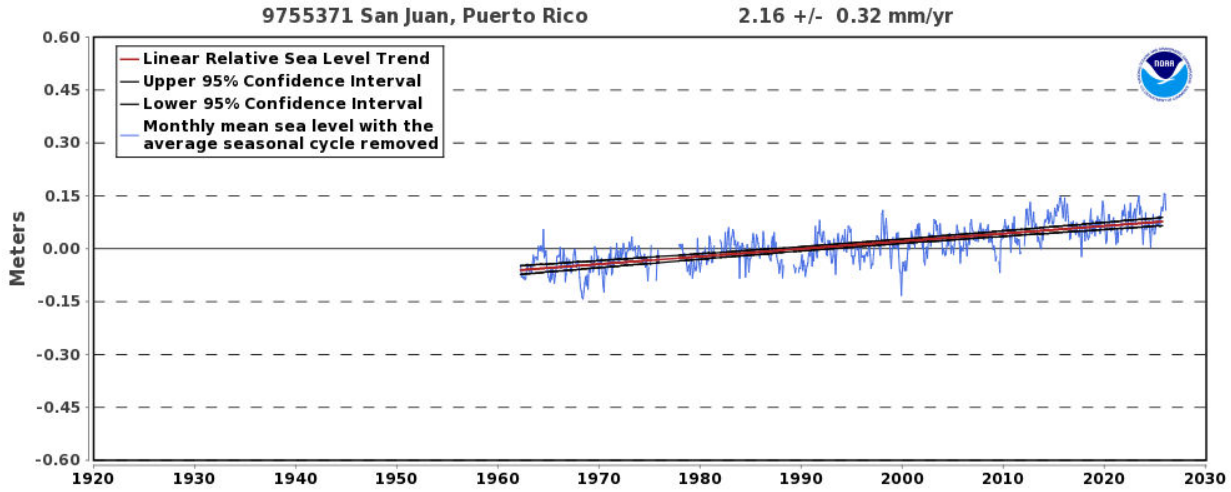


Figure 35: Relative Sea Level Trend 9755371 San Juan, PR



4.15.1.3 Past Events

Section 4.11.1.1 above details the changes in beach erosion or accretion for the beaches in Añasco in the aftermath of Hurricane Maria as detailed in the COREPI-PR study.

This study brought forth the following key findings (COREPI-PR, 2020):

- Widespread Coastal Erosion: Significant erosion occurred along multiple beach segments following Hurricane María, particularly in Arroyo, Humacao, and Barceloneta, reducing beach width and elevation and increasing exposure to storm surge and flooding. https://storymaps.arcgis.com/stories/ac6e366a14d840e88a266d23b440ab0c
- Partial Natural Recovery: Ten months after the hurricane, many beaches exhibited sediment accretion and partial recovery; however, recovery was uneven and site-specific, with some areas remaining highly vulnerable to future events.
- Beach Migration: The study documented permanent inland migration of beaches in several municipalities, including Añasco, Humacao, Arecibo, Aguada, and Rincón. This indicates a long-term shift of the shoreline landward, increasing risk to inland infrastructure and properties.
- Influence of Built Infrastructure: Erosion was frequently observed adjacent to rigid shoreline structures (e.g., seawalls, rip-rap, coastal development), suggesting that hardened shorelines may exacerbate erosion processes and reduce natural beach resilience.
- Loss of Protective Function: In several locations, the reduction of beach width and loss of sandbars diminished the beach's capacity to function as a natural protective barrier, resulting in greater susceptibility to storm surge damage during subsequent events (e.g., 2018 extra-tropical storms).

The findings of this study are important for hazard mitigation planning since beaches are a critical natural infrastructure that provide coastal protection by dissipating wave energy, reducing flooding extent, and protecting inland development. The documented erosion, beach migration, and reduced protective capacity highlight increased vulnerability to; coastal flooding, storm surge, wave action and progressive shoreline retreat.

These findings support the integration of coastal erosion monitoring, nature-based solutions, land-use planning controls, and adaptive shoreline management strategies into local and regional hazard mitigation efforts. The assessment also provides a

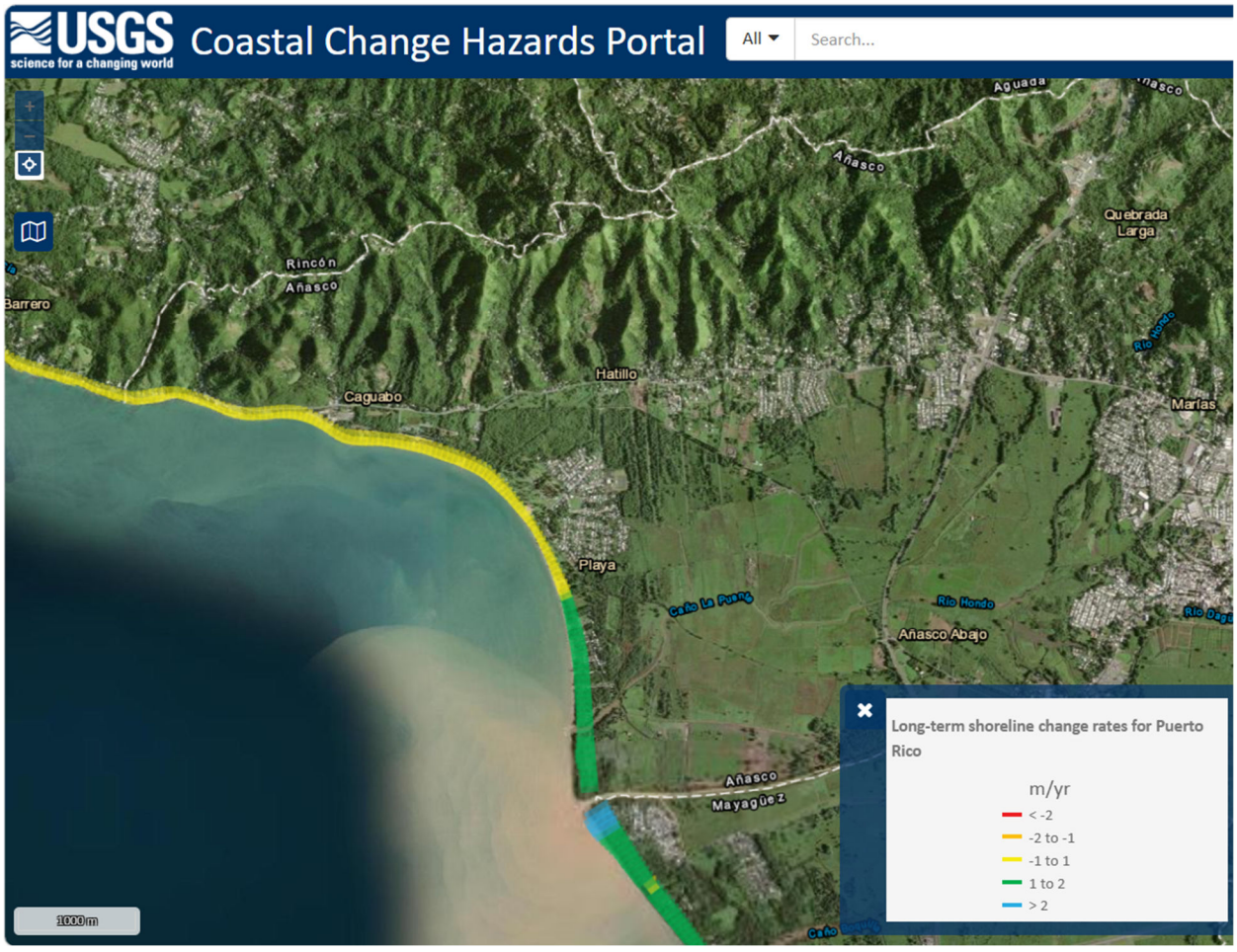
baseline for prioritizing mitigation projects and for validating requests for local, state, and federal mitigation funding.

In the case of Añasco, there is qualitative evidence of ongoing coastal change along portions of the municipality's western coastline. The historical shoreline dataset available through the USGS Coastal Change Hazards Portal indicates that shoreline change rates vary along the coast, reflecting the influence of coastal processes such as wave action, storms, sediment transport, and sea-level rise. As shown on the map, much of the coastline extending through the coastal sectors of Caguabo, Hatillo, and Playa is classified within the -1 to 1 meter per year range, indicating relatively stable shoreline conditions, while other segments exhibit moderate erosion rates between -2 and -1 meters per year.

The most notable erosional trends are observed along portions of the northern coastal sectors near Caguabo and Hatillo, where shoreline change rates indicate gradual shoreline retreat. In contrast, segments of the coastline near the southern portion of Playa and the municipal boundary with Mayagüez show positive shoreline change rates ranging from 1 to 2 meters per year, with localized sections exceeding 2 meters per year, indicating shoreline advancement or accretion. These patterns suggest that sediment deposition and shoreline growth occur in some portions of the coast, while erosional processes predominate in others.

Overall, the historical shoreline record indicates that coastal change remains an active process along the Añasco coastline. While much of the shoreline appears relatively stable, several coastal segments exhibit measurable erosion, and localized areas show significant accretion. The spatial variability of shoreline change highlights the dynamic nature of the municipality's coastal environment and suggests that future coastal management efforts should continue to consider the potential effects of erosion, sediment redistribution, storms, and sea-level rise on coastal communities, infrastructure, natural resources, and shoreline ecosystems.

Figure 36 - Historical Shoreline Changes



4.15.1.4 Future Events Probability

According to the USGS, the coastline of Añasco displays long-term shoreline change rates that allow for the evaluation of historical coastal change patterns along the municipality's western shoreline. The available shoreline change data indicate that coastal conditions vary considerably along the coast extending through the coastal sectors of Caguabo, Hatillo, Playa, and the municipal boundary with Mayagüez.

The shoreline changes rates shown on the map indicate that much of the coastline exhibits relatively stable conditions, with shoreline change rates generally ranging between -1 and 1 meter per year. However, several shoreline segments display moderate erosion, with rates ranging from -2 to -1 meters per year, particularly along portions of the coastline near Caguabo and Hatillo. In contrast, portions of the southern coastline near Playa and the municipal boundary with Mayagüez exhibit

positive shoreline change rates ranging from 1 to 2 meters per year, with localized areas exceeding 2 meters per year, indicating shoreline accretion and seaward advancement. These patterns reflect the influence of coastal processes such as sediment transport, wave action, storm impacts, riverine sediment inputs, and changes in coastal morphology.

Unlike municipalities where shoreline retreat is the dominant trend, the Añasco coastline exhibits both erosional and accretional processes. The shoreline adjacent to Playa and the mouth of the Río Grande de Añasco appears to be particularly influenced by sediment deposition processes, while portions of the northern coastline exhibit evidence of gradual shoreline retreat. This spatial variability highlights the dynamic nature of the municipality's coastal environment and the interaction between marine and fluvial processes.

Overall, the historical shoreline record indicates that coastal change remains an active process along the Añasco coastline. Although large portions of the shoreline appear relatively stable, localized erosion and accretion continue to shape the coast. As a result, future coastal change could affect nearby residential areas, transportation infrastructure, recreational resources, natural habitats, and other assets located along the municipality's shoreline. Continued monitoring of shoreline trends and incorporation of coastal change information into planning and mitigation efforts remain important for enhancing the long-term resilience of the Municipality of Añasco.

4.15.2 Risk Analysis

4.15.2.1 Estimated Losses

Currently there is no standard way to estimate losses due to long-term coastal erosion. This is due to the unpredictability of this hazard.

4.15.2.2 Lifelines and Critical Infrastructure

Coastal Erosion

Coastal erosion is a long-term, progressive hazard that results in the loss of shoreline, land instability, and the degradation of natural protective features such as beaches, dunes, and wetlands. This hazard is driven by wave action, coastal storms, flooding,

and long-term shoreline change processes, and it poses increasing risks to developed coastal areas and supporting infrastructure. In coastal communities, erosion directly affects the Community Lifelines that are essential to public safety, economic stability, and effective emergency response (FEMA, 2024).

- Safety and Security Lifeline is particularly vulnerable to coastal erosion. Law enforcement facilities, fire stations, emergency operations centers, and evacuation routes located near the shoreline may experience increasing exposure as erosion undermines foundations, access roads, and protective buffers. Roadway narrowing or collapse caused by shoreline retreat can reduce emergency response times and limit evacuation capacity during hazard events, placing residents and responders at greater risk (FEMA, 2021)

- The Food, Water, and Shelter Lifeline is also impacted as erosion threatens utility infrastructure and housing stock. Water distribution lines, wastewater systems, and stormwater infrastructure may become exposed or damaged as coastal land erodes, increasing the risk of service disruptions and water quality concerns. In areas where erosion leads to the loss of residential structures, displaced households may require emergency shelter and housing assistance. Additionally, erosion affecting ports, coastal roads, and access points can disrupt food supply chains and the delivery of essential goods, particularly in geographically isolated or island communities (FEMA, 2024).

- Coastal erosion can adversely affect the Health and Medical Lifeline by limiting access to healthcare facilities and emergency medical services. Hospitals, clinics, and pharmacies located in erosion-prone areas may face increased structural risk or reduced accessibility. Transportation disruptions caused by erosion can delay emergency medical response and impede the delivery of medical supplies. Secondary public health concerns may arise when erosion damages water and wastewater infrastructure, potentially increasing exposure to contaminants or unsanitary conditions (USGS, 2025); (FEMA, 2021).

- The Energy Lifeline, including power generation, transmission, and fuel systems, is highly susceptible to erosion-related impacts. As shorelines retreat, erosion can expose underground electrical lines, pipelines, substations, and fuel storage facilities that were previously protected by coastal landforms. Damage to this infrastructure can result in power outages or fuel shortages, affecting residents, critical facilities, and emergency response operations that rely on consistent energy supply (USACE, 2013); (FEMA, 2021)

- Erosion also threatens the Communications Lifeline by damaging or destabilizing physical infrastructure such as cell towers, fiber-optic cables, and communications hubs located in coastal areas. Loss of communications systems can impair emergency notification, 911 services, and coordination among response agencies. Reduced system redundancy along eroding shorelines increases the likelihood that communications outages will occur during coastal hazard events (FEMA, 2024).

- The Transportation Lifeline experiences direct and cascading impacts from coastal erosion. Roads, bridges, ports, ferry terminals, and coastal airports may be undermined or rendered inoperable as erosion progresses. Transportation disruptions limit evacuation routes, restrict access for emergency responders, slow the delivery of supplies, and delay recovery operations. These impacts can have significant economic consequences and prolong community recovery following disaster events (USGS, 2023).

- Finally, coastal erosion may affect the Hazardous Materials Lifeline by exposing buried fuel tanks, contaminated soils, or legacy industrial sites located near the coast. Erosion can increase the risk of hazardous material releases, threatening environmental quality and public health, and complicating emergency response and cleanup efforts. Facilities handling hazardous materials lose natural protective buffers as shorelines retreat, increasing the likelihood of cascading impacts during severe weather events (USGS, 2023); (FEMA, 2021).

Variations in Mean Base Sea-Level

Sea level rise is a chronic and progressive coastal hazard that increases the frequency, depth, and duration of coastal flooding while accelerating erosion and shoreline instability. As relative sea levels rise, coastal communities experience more frequent high-tide flooding, expanded floodplains, and greater storm surge impacts. These changes place increasing stress on the y Lifelines that support public safety, economic stability, and emergency response, even in the absence of major storm events (FEMA, 2024).

- The Safety and Security Lifeline is affected as sea level rise increases the exposure of emergency facilities and evacuation routes to recurrent flooding. Police stations, fire stations, and emergency operations centers located in low-lying coastal areas may experience reduced functionality or loss of access

due to chronic inundation. Rising seas can also compromise evacuation routes, bridges, and ingress/egress corridors, limiting the ability to conduct timely evacuations and delaying emergency response during hazard events (FEMA, 2021); (USGS, 2025).

- Sea level rise presents significant challenges to the Food, Water, and Shelter Lifeline. Potable water systems, wastewater treatment plants, and stormwater infrastructure are increasingly vulnerable to tidal flooding and saltwater intrusion as sea levels rise. These impacts can disrupt service delivery, degrade water quality, and increase maintenance and operational costs. In addition, repetitive flooding can damage residential structures, reduce housing availability, and increase demand for emergency shelter and long-term housing assistance, particularly in socially vulnerable communities (USGS, 2025).

- The Health and Medical Lifeline is impacted through both direct and indirect effects. Healthcare facilities located in flood-prone coastal zones may experience operational disruptions, equipment damage, or access constraints due to flood-impacted transportation networks. Frequent flooding can hinder patient movement, delay emergency medical services, and disrupt supply chains for pharmaceuticals and medical equipment. Public health concerns may also increase as rising groundwater and flooded sanitation systems elevate the risk of contamination and disease exposure (USGS, 2025; FEMA, 2024).

- Sea level rise also threatens the Energy Lifeline by increasing flood risk to power generation facilities, substations, fuel terminals, and transmission infrastructure located near the coast. Even minor but repeated flooding events can degrade electrical components and reduce system reliability, leading to power outages that affect residences, businesses, and critical facilities. Fuel distribution systems and ports may also experience operational interruptions, limiting fuel availability for generators, emergency vehicles, and recovery operations (FEMA, 2024).

- Communications Lifeline is vulnerable as increase in base sea level potentiates exposure of communications infrastructure, including cell towers, fiber-optic networks, and data facilities, to chronic flooding and corrosion. Disruptions to communications systems can impair emergency notification, 911 services, and interagency coordination. Repeated flood exposure without permanent

mitigation measures may result in cumulative damage and decreased system reliability over time (FEMA, 2024).

- Transportation systems associated with Transportation Lifeline are particularly sensitive to increase in base sea levels. Roads, bridges, ports, ferries, and coastal airports may experience more frequent closures or long-term service reductions due to flooding and infrastructure degradation. Transportation disruptions can isolate communities, delay emergency response, limit evacuation options, and impede the movement of goods, services, and recovery resources (USGS, 2025).

- Finally, increase in the mean base sea level can affect the Hazardous Materials Lifeline by increasing exposure of industrial sites, fuel storage areas, landfills, and wastewater facilities to flooding. Inundation of these sites raises the potential for releases of hazardous substances, posing risks to human health, ecosystems, and drinking water supplies. Managing these risks becomes more complex as flood frequencies increase and protective buffers are lost (FEMA, 2021); (USGS, 2025).

4.15.2.3 Social Vulnerabilities

Long-term coastal dynamics can be not only a physical hazard but also a social stressor that disproportionately affects certain populations due to preexisting social, economic, and environmental conditions.

Low-income households are among the most socially vulnerable to long-term coastal dynamics. These populations are more likely to reside in older or lower-cost housing located in high-risk coastal areas and may lack the financial resources needed to invest in mitigation measures, such as structural reinforcement or relocation. As erosion or inward changes in shoreline progresses, declining property values can further reduce household wealth and limit access to insurance, credit, and recovery assistance, thereby prolonging vulnerability and recovery timelines (FEMA, 2023).

Housing insecurity is a significant concern associated with long-term coastal dynamics. Gradual land loss can render homes unsafe or uninhabitable, leading to chronic displacement rather than sudden disaster-related relocation. Renters are particularly vulnerable, as they often have limited control over mitigation decisions and may be displaced without sufficient notice or long-term relocation support. In communities with limited affordable housing options, erosion-related housing loss

can increase overcrowding, homelessness, or permanent out-migration (FEMA, 2023).

Elderly individuals, people with disabilities, and those with chronic health conditions face heightened risks as coastal erosion disrupts access to essential services and infrastructure. Eroded or flooded roadways and transportation networks can isolate neighborhoods from healthcare facilities, pharmacies, grocery stores, and social services. These populations may also experience limited mobility or depend on in-home medical equipment, increasing their sensitivity to infrastructure disruptions associated with erosion (FEMA, 2023).

Communities that rely on coastal and marine resources for their livelihoods are also socially vulnerable to erosion. Fishing communities, small tourism-dependent businesses, and subsistence users may experience economic losses as shorelines retreat, beaches narrow, and access to coastal infrastructure is reduced. These impacts can lead to job loss, reduced household income, and community-wide economic stress, particularly in rural and island settings where economic diversification is limited (USGS, 2023).

4.15.2.4 Natural and Cultural Resources

Long-term coastal dynamics can significantly impact natural resources by altering shorelines, degrading habitats, and disrupting ecological processes. As beaches, dunes, wetlands, and mangroves erode or become permanently inundated, the natural systems that provide storm protection, water filtration, and wildlife habitats are reduced or lost. These changes can lead to declines in biodiversity as plant and animal species lose critical breeding, feeding, and nesting areas. Saltwater intrusion caused by rising sea levels can also degrade freshwater ecosystems, affecting groundwater, estuaries, and coastal forests. Increased erosion can mobilize sediments and pollutants, diminish water quality and harm coral reefs and seagrass beds. Over time, the loss of natural coastal features reduces ecosystem resilience and increases inland exposure to flooding and storm impacts. (USGS, 2023)

Long-term coastal dynamics can also pose serious threats to cultural resources, particularly those located near shorelines. Historic buildings, archaeological sites, cemeteries, and cultural landscapes may be damaged or permanently lost as shorelines retreat and soils are destabilized. Gradual erosion can undermine foundations and expose artifacts, making sites vulnerable to destruction, looting, or environmental decay. As these resources are often irreplaceable, coastal erosion and

sea level rise represent not only physical loss but also the loss of cultural memory and heritage passed through generations (USGS, 2023).

4.15.2.5 Future Conditions

As discussed in section 4.14.1 long-term coastal dynamics are understood to contribute to loss of shoreline, either due to coastal erosion or increases in mean base sea level. Specific mitigation actions to deal with expected future conditions will be included as part of Section 6.5.

4.16 High Hazard Potential Dams

The Robert T. Stafford Act, as amended by the Disaster Mitigation Act of 2000 (DMA2K), established mitigation planning as the cornerstone for reducing disaster risk. Local governments with a mitigation plan that identifies natural hazards, assesses risks and vulnerabilities, and outlines strategies for implementing mitigation actions are eligible for FEMA mitigation grants. Specific requirements for these plans are detailed in the Code of Federal Regulations[12] and further supported by FEMA policies and guidance (FEMA, 2024).

The National Dam Safety Act, as amended, created the Rehabilitation of High Hazard Potential Dams (HHPD) Grant Program. Funding for HHPD projects first became available in Fiscal Year 2020 (FY20) and has increased since then. Eligibility criteria for these grants, as they relate to mitigation planning, are outlined in FEMA's Local Mitigation Planning Policy Guide (FEMA, 2024).

It is important to emphasize that a dam with HHPD status does not mean necessarily that a dam breach is eminent. The Association of State Dam Safety Officials (ASDSO), provided the following classification of dam hazard (ASDSO, 2022):

- **High Hazard Potential** – "Typically defined as a dam whose failure or mis-operation will cause loss of human life and significant property destruction".
- **Significant Hazard Potential** – "Typically defined as a dam whose failure or mis-operation will cause significant property destruction".
- **Low Hazard Potential** – "Typically defined as a dam whose failure or mis-operation will cause minimal property destruction".

[12] 44 CFR § 201.6

According to ASDSO, out of the 37 dams reported in Puerto Rico, 36 are considered HHPD.

4.16.1 Description

Act 133-1986 as amended defines a dam as an artificial barrier, together with its accessory works, built for the purpose of retaining, storing, or diverting water or any other liquid or semi-liquid, and whose height exceeds twenty-five (25) feet from the natural bed of the water body or the natural ground level. While a reservoir is defined as an artificial basin where the waters of a river or stream, or stormwater runoff, are collected and that exceeds a volume of fifty (50) acre-feet. 13 Dams can represent a potential hazard in cases of dam failure (breach) or mis-operation (such as unscheduled or uncontrolled releases (FEMA, 2024).

4.16.1.1 Affected areas (HHPD2-a)

As stated in Section 3.2.3, the Municipality of Añasco is influenced by the Río Grande de Añasco Watershed, where the Ajíes Dam (PR00072) and Dagüey Dam (PR00073) are located. These dam structures have the potential to generate downstream flooding impacts within the municipality if a breach were to occur. The following tables provide available information from the National Inventory of Dams (NID) regarding these structures and their associated hazard characteristics (USACE, 2022).

Table 46: Ajíes Dam NID Data

Ajies Dam	
Watershed	Ajies Creek
Purposes	Flood Risk Reduction
Main Body of Water	Ajies Creek
Municipality	Añasco
Date of Completed Construction	1984
Dam Type	Earth
Hazard Potential Classification	High
NID ID	PR00072

[13] 22 L.P.R.A. § 401

Coordinates as per NID	18.2967332, -67.1370974
Height as per NID	52 Ft.
Storage as per NID	95 Acre Ft.
Emergency Action Plan	Yes
Last Recorded NID Inspection	04/16/2021
Existing Condition Assessment	Poor
Operator	Puerto Rico Department of Natural and Environmental Resources (DNER/DRNA)

Table 47 Dagüey Dam NID Data

Dagüey Dam	
Watershed	Daguey Creek
Purposes	Flood Risk Reduction
Main Body of Water	Daguey Creek
Municipality	Añasco
Date of Completed Construction	1978
Dam Type	Earth
Hazard Potential Classification	High
NID ID	PR00073
Coordinates as per NID	18.298252, -67.1289576
Height as per NID	50 Ft.
Storage as per NID	334 Acre Ft.
Emergency Action Plan	Yes
Last Recorded NID Inspection	04/16/2021
Existing Condition Assessment	Poor
Operator	Puerto Rico Department of Natural

	and Environmental Resources (DRNA)

Although the Guayo Dam (PR00005) and Prieto Dam (PR00002) are located outside the Municipality of Añasco, they were evaluated as part of the dam hazard assessment due to their location within regional watershed systems that ultimately contribute flow to western Puerto Rico. Dam failures have the potential to produce downstream impacts that extend beyond municipal boundaries, particularly where interconnected river systems and drainage networks exist. Therefore, these structures were included in the assessment to identify potential regional risks and to ensure that all significant upstream sources of dam-related flooding were considered. However, the dam breach modeling indicates that the most direct dam-related flood risk to Añasco is associated with the Ajíes Dam (PR00072) and Dagüey Dam (PR00073), whose inundation areas extend into populated and developed portions of the municipality.

Table 48: Prieto Dam NID Data

Prieto Dam	
Watershed	Prieto River
Purposes	Hydroelectric, Irrigation
Main Body of Water	Prieto River
Ward and Municipality Location	Maricao
Date of Completed Construction	1955
Dam Type	Gravity
Hazard Potential Classification	High
NID ID	PR00002
Coordinates as per NID	18.1858258, -66.8638102
Height as per NID	98 Ft.
Storage as per NID	880 Acre Ft.
Emergency Action Plan	Yes
Last Recorded NID Inspection	12/11/2021
Condition Assessment	Satisfactory
Operator	Puerto Rico Electric Power Authority (PREPA)

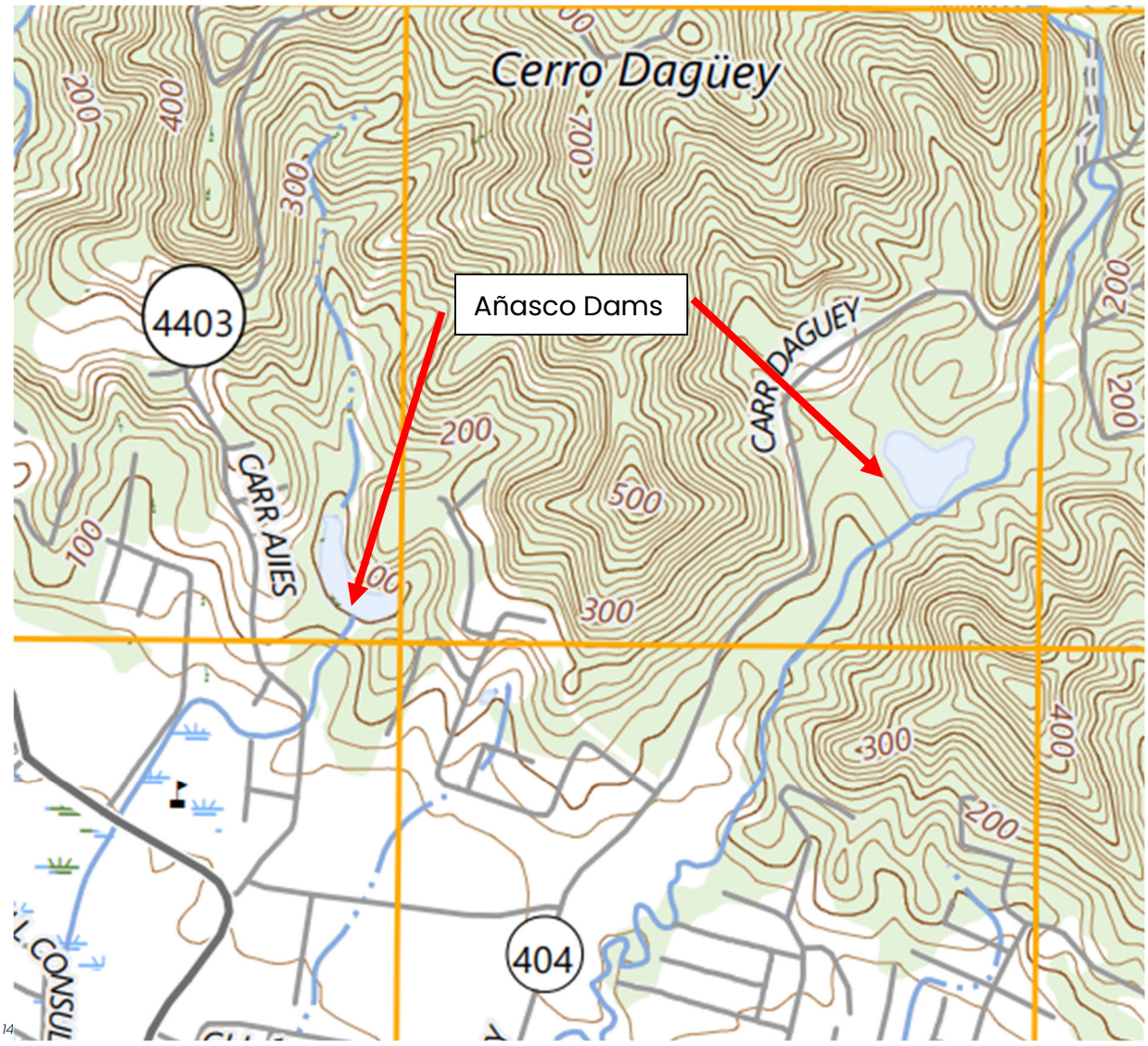
Table 49: Guayo Dam NID Data

Guayo Dam	
Watershed	Guayo River
Purposes	Hydroelectric, Irrigation, Water Supply
Main Body of Water	Guayo River
Ward and Municipality Location	Espino Ward, Adjuntas
Date of Completed Construction	1943
Dam Type	Earth (Earth Core)
Hazard Potential Classification	High
NID ID	PR00005
Coordinates as per NID	18.2104748, -66.8347974
Height as per NID	190 Ft.
Storage as per NID	19,000 Acre Ft.
Emergency Action Plan	Yes
Last Recorded NID Inspection	12/11/2021
Condition Assessment	Poor
Operator	Puerto Rico Electric Power Authority (PREPA)

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Figure 37 shows the Ajíes and Dagüey Reservoir as it appears in the latest USGS Topographic map.

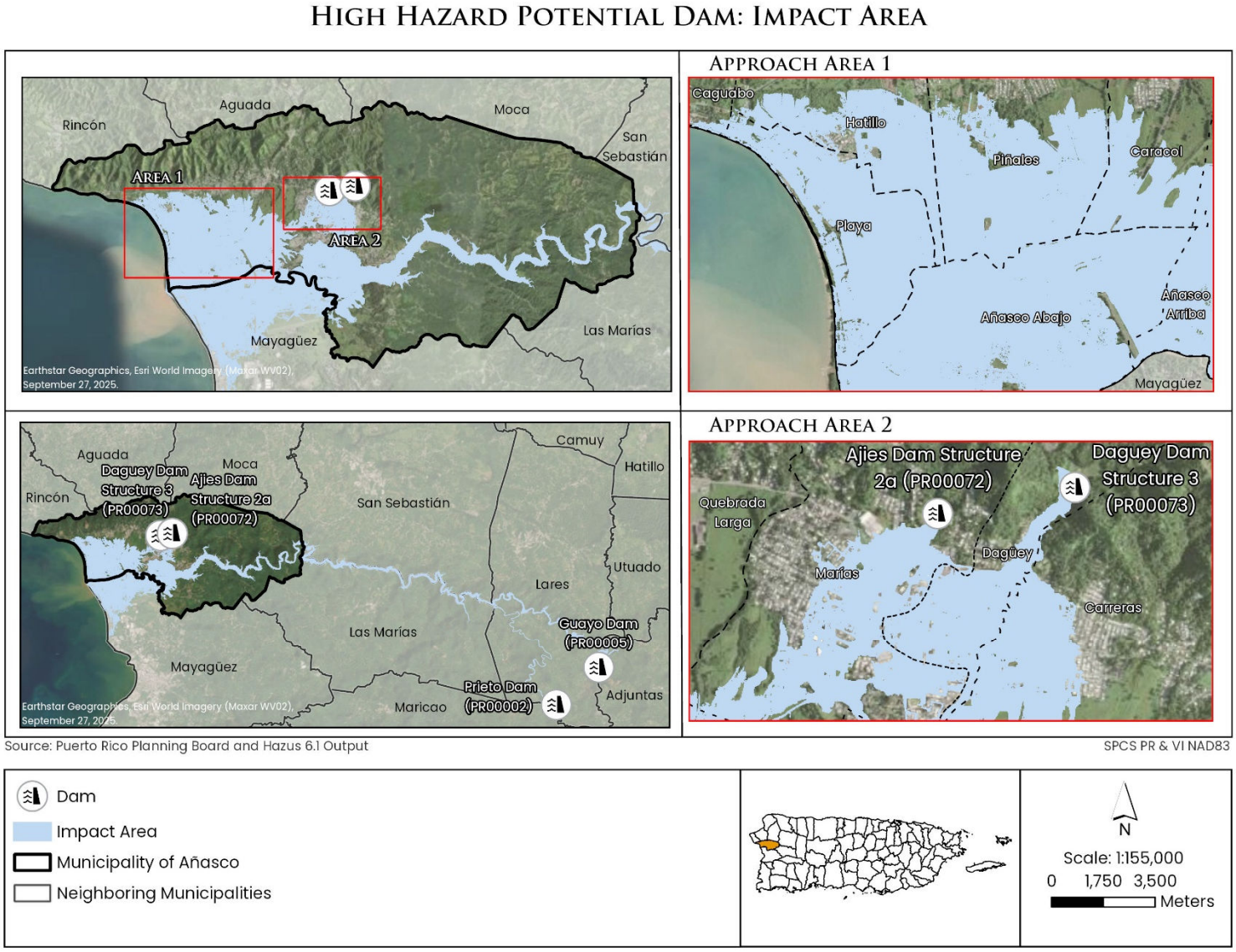
Figure 37: Rincón-Añasco Topographic Quadrangle USGS



Map 51 shows the Sunny Day Dam Breach scenario developed for the Ajíes and Dagüey Dams in Añasco. The areas of the Municipality that could be inundated by a dam breach are Añasco Abajo, Playa, and Hatillo barrios. The inundation area extends from the vicinity of the Dams structures toward the coastal plain, affecting low-lying areas within the Río Grande de Añasco floodplain.

[14] Not to scale

Map 50: High Hazard Potential Dam Impact Area



4.16.1.2 Risk Magnitude

Multiple factors influence both the exposure to and the overall impact of dam-related risks. Each dam is unique and requires an individual assessment to understand the risks it poses and those it faces. Dams may also operate in series, where water released from an upstream dam affects the performance of a downstream dam. In such cases, modeling the dams together is recommended (AtkinsRéalis, 2024).

Risk exposure can result from hazard creep, upstream flooding, large reservoir releases, controlled or partial breaches, design or construction flaws, cascading storm impacts, seismic activity, landslides, wildfires, and deferred maintenance or rehabilitation. These risks can affect populations, infrastructure, critical facilities, economic stability, environmental and social resources, and may lead to multi-jurisdictional consequences (AtkinsRéalis, 2024).

Dam risk consists of three primary components: incremental risk, non-breach risk, and residual risk.

- Incremental risk refers to the likelihood and consequences for the reservoir area and downstream floodplain that result from the presence of the dam if it fails—whether due to overtopping, structural malfunction, or mis-operation. These consequences go beyond what would occur without a dam breach and typically involve downstream flooding, though loss of the reservoir can also significantly impact upstream areas.
- Non-breach risk is the risk associated with normal dam operations or scenarios where the dam overtops without failing. For example, a gated dam may release water ahead of a storm to manage inflows, which could lead to downstream flooding if releases exceed channel capacity.
- Residual risk is the remaining risk after all mitigation and risk-reduction measures have been implemented. FEMA defines this as “risk remaining at any time,” meaning the remote risk tied to conditions judged not to be credible dam safety issues after prudent actions have been taken (AtkinsRéalis, 2024).

Although dams are not natural hazards themselves, they can be affected by natural hazard events. Under extreme conditions, a dam may fail, causing flooding in the downstream inundation zone. Hazards such as flooding, landslides, wildfires, earthquakes, high winds, and drought can all compromise dam safety. Each hazard introduces risks that may lead to cascading impacts associated with dam incidents.

- **Flooding:** Puerto Rico's dams have historically been vulnerable to flooding. Heavy rainfall from tropical cyclones, severe thunderstorms, or stalled systems can affect multiple dams simultaneously, creating hydrologic emergencies. When several dams are impacted at once, resources are strained, and prioritizing response becomes difficult without clear information on dam conditions and potential consequences. Many dams in Puerto Rico are arranged in series, meaning releases from an upstream dam can affect downstream dams, requiring coordinated emergency actions.
- **Landslides:** Landslides can alter stream channels upstream or downstream, affecting reservoir inflows and outflows. Slides near a dam can undermine its stability, potentially leading to failure. Landslides within the reservoir can also generate overtopping waves that damage or breach the dam.
- **Wildfires:** Fires can change watershed characteristics by removing vegetation, reducing water absorption, and increasing runoff speed and volume. Post-fire conditions heighten risks of flash floods, mudslides, and debris flows, all of which can threaten dam operations and structural integrity.
- **Seismic Events:** Earthquakes can compromise dam stability and, like floods, may impact multiple dams across a wide area.
- **Wind:** Hurricanes and tornadoes can uproot trees, weaken dam structures and increase seepage or erosion risks. Combined with heavy rainfall, wind damage can significantly threaten dam safety.
- **Drought:** Extended droughts lower reservoir levels, potentially rendering water supply dams inoperable. Drought also reduces vegetation cover, increasing susceptibility to flash flooding and debris flows when rains return—similar to post-wildfire conditions.
- **Dam Deficiencies:** Beyond natural hazards, structural deficiencies pose serious risks. Aging dams require increased maintenance; otherwise, they may develop cracks, seepage, or erosion issues. Malfunctioning gates can prevent controlled releases before floods or remain open, causing low reservoir levels and downstream flooding. Mis-operation can also compromise structural integrity or trigger downstream impacts.

Failure Modes

Failure modes are plausible physical processes that can lead to dam failure due to an existing weakness or defect. These may stem from natural foundation conditions, design flaws, construction issues, material deficiencies, operational or maintenance problems, or aging, and can result in an uncontrolled release of the reservoir. For example, a crack in the dam may worsen under extreme rainfall, ultimately causing

failure. While failure mode analysis is highly technical and requires detailed investigation, for hazard mitigation planning purposes, failure modes are generally grouped into three categories: static, hydrologic, and seismic.
Static failure modes include (but are not limited to):

- Internal erosion
- Slope stability issues such as sinkholes, landslides, and cracks
- Gate or equipment malfunction
- Scour or erosion

Hydrologic failure modes include (but are not limited to):

- Overtopping
- Elevated reservoir levels exceeding structural capacity
- Rapid drawdown
- Spillway failure
- Impact loads during flooding

Seismic failure modes include (but are not limited to):

- Liquefaction
- Slope failures

4.16.1.3 Past Events

Built in 1928, the Guajataca Dam is 984 feet long, 120 feet tall earthen dam, located in the island's northwestern region between the municipalities of San Sebastián, Camuy, Quebradillas and Isabela.

On September 20, 2017, Hurricane Maria caused failure of the spillway structure and damaged both the water supply line and the dam's outlet works. On October 3, 2017, FEMA assigned the U.S. Army Corps of Engineers (USACE) a Stafford Act mission to prevent catastrophic dam failure, which posed an immediate threat to approximately 1,000 downstream residents and risked interrupting water service to more than 250,000 people. The Stafford Act provided USACE with the authority and funding to execute these measures (USACE, 2023).

USACE addressed the situation at Guajataca Dam in three risk-based stages:

- Stage 1: Threat of Imminent Flooding
- Stage 2: Implementation of Interim Risk Reduction Measures (IRRMs)
- Stage 3: Permanent Repairs

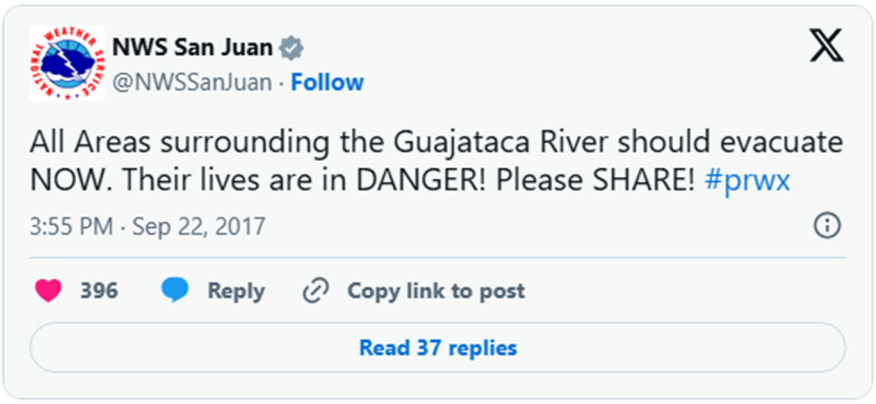
During Stage 1, USACE performed limited emergency stabilization to prevent dam

failure. However, the spillway remained at an unacceptable risk of failure during future flooding events. Consequently, six critical IRRMs were implemented in Stage 2:

- Grouting voids beneath the concrete spillway
- Installing anchors to stabilize the spillway
- Repairing outlet gates
- Reconnecting the water-supply line
- Reinforcing the spillway and channel
- Stabilizing slopes near the inlet tower

By the end of 2018, four IRRMs were completed, achieving approximately a 100-year level of flood protection. The remaining two were finalized in September 2019, increasing protection to about a 1,000-year level and further reducing public risk. The estimated cost of these works was between $900 million and $1.1 billion (USACE, 2023).

Figure 38: Social Media Post from NWS warning about the Guajataca Dam Breach[15]



[15] Taken from 'Imminent' Dam Failure Threatens Thousands Of People In Puerto Rico : The Two-Way : NPR

Figure 39: Guajataca Dam Breach 9/23/2017[16]



4.16.1.4 Future Event Probabilities

Puerto Rico faces significant risks of future dam failures due to aging infrastructure, environmental hazards, and operational challenges. The island has 36 dams, all classified as high-hazard potential, meaning that any failure could result in severe loss of life and property (National Inventory of Dams, 2022). Many of these structures are decades old and have been rated in poor or unsatisfactory condition, indicating critical deficiencies that require immediate attention (Puerto Rico Dam Safety Program, 2022).

Climate-related threats further exacerbate these risks. Hurricanes and extreme rainfall events, such as those experienced during Hurricanes Maria (2017) and Fiona (2022), have placed immense stress on dam systems. Although no failures occurred during these storms, emergency water releases were necessary to prevent overtopping. Future projections of more intense precipitation events will increase the

[16] Image taken from Puerto Rico's Failing Guajataca Dam Endangers Thousands

likelihood of flash floods, challenging spillway capacity and structural resilience (Argonne National Laboratory & FEMA, 2023; Torres-Alavez et al., 2023).

Seismic activity adds another layer of vulnerability. Puerto Rico lies in a seismically active zone with an estimated 5–10% annual probability of a magnitude 7.0 earthquake. Such events could compromise dam foundations and structural integrity (FEMA, 2022). Additionally, satellite-based studies have detected subsidence and differential settlement in some dams, signaling gradual instability that could lead to failure over time (De la Paz-Bonilla et al., 2021; Virginia Tech, 2022).

Monitoring and early-warning systems have improved since Hurricane Maria, with FEMA supporting the installation of sensors, communication upgrades, and sirens for high-risk dams. However, coverage remains incomplete, leaving gaps in real-time monitoring and emergency preparedness. Budget constraints and limited staffing further hinder consistent inspections and maintenance, increasing operational risk (FEMA, 2022; USACE, 2023).

In summary, Puerto Rico's dams face converging hazards: aging infrastructure, climate-driven flooding, seismic threats, and geotechnical instability. While modernization efforts, structural repairs, and risk management programs are underway, comprehensive upgrades and robust emergency planning are essential to safeguard communities and ensure the long-term reliability of these critical water and energy assets.

4.16.2 Risk Analysis

The following section discusses an analysis of sunny day – scenario breach for the mentioned Dams. The risk analysis for this hazard differs from the other hazards because it is following a different recommended format developed for Puerto Rico.

4.16.2.1 Risk Assessment Methodology and Limitations (HHPD2-A & HHPD-B)

On the aftermath of Hurricanes Irma and María a sunny-day scenario executed between September 23, 2017, and September 25, 2017, to quantify the effects of possible dam breaches in Puerto Rico due to effects of those two hurricanes. STARR II engineers and GIS specialists prepared these files, reports, and graphics at the request of the FEMA Region. II under Contract Number HSFE60-15-D-0005, Task Order Number HSFE60-17-J-0008.

For this LHMP, it was decided to update the modeling of sunny-day scenarios using the decision support system for water infrastructure security parentheses (DSS-WISE). DSS-WISE is a FEMA funded, web-based system for automatic dam break and levy failure flood modeling mapping and human consequence analysis to support emergency planning and infrastructure resiliency. Developed by the National Center for Computational Hydroscience and Engineering (NCCHE) at the University of Mississippi, DS-wise provide 2-dimensional flood modeling and mapping without requiring advanced numerical modeling expertise from users. It is funded and supported by FEMA to enhance emergency preparedness hazard assessment, and risk informed decision making.

DSS-WISE models dam-break events using a scenario-based decision support framework rather than acting as a stand-alone hydraulic flood model. First, users define dam-failure scenarios (such as overtopping, structural failure, or earthquake-induced collapse) along with dam characteristics, reservoir levels, and triggering conditions. DSS-WISE then incorporates dam-break outputs from external hydraulic models (for example, flood extent, depth, velocity, and arrival time generated by specialized flood modeling software) as input datasets. These results are evaluated within DSS-WISE using risk and consequence metrics, including impacts to population, critical infrastructure, environmental resources, and economic assets. The tool applies multi-criteria decision analysis to compare dam-break scenarios, mitigation options, and emergency response strategies under uncertainty. By integrating modeling results with expert judgment and stakeholder priorities, DSS-WISE helps decision-makers understand relative risks and trade-offs associated with dam-break hazards. In essence, DSS-WISE translates technical dam-break modeling outputs into actionable planning and safety decisions.

In the case of the 2017 modeling exercise, input data for the simulations was obtained from 2013 United States Geologic Survey (USGS) LIDAR for Puerto Rico, with a 10-meter cell spacing, and from the databases contained within DSS-WISE for dam sizes, bridge sizes, and terrain. There were occasional conflicts between these two sources of information. However, all were able to be successfully resolved to generate dam breach simulations. The most frequent conflict was differences in the top elevation of the dam from the LIDAR data versus the DSS-WISE reservoir elevation data. This was resolved by computing a hydrograph using the following spreadsheet from the U.S. Natural Resources Conservation Service (NRCS).

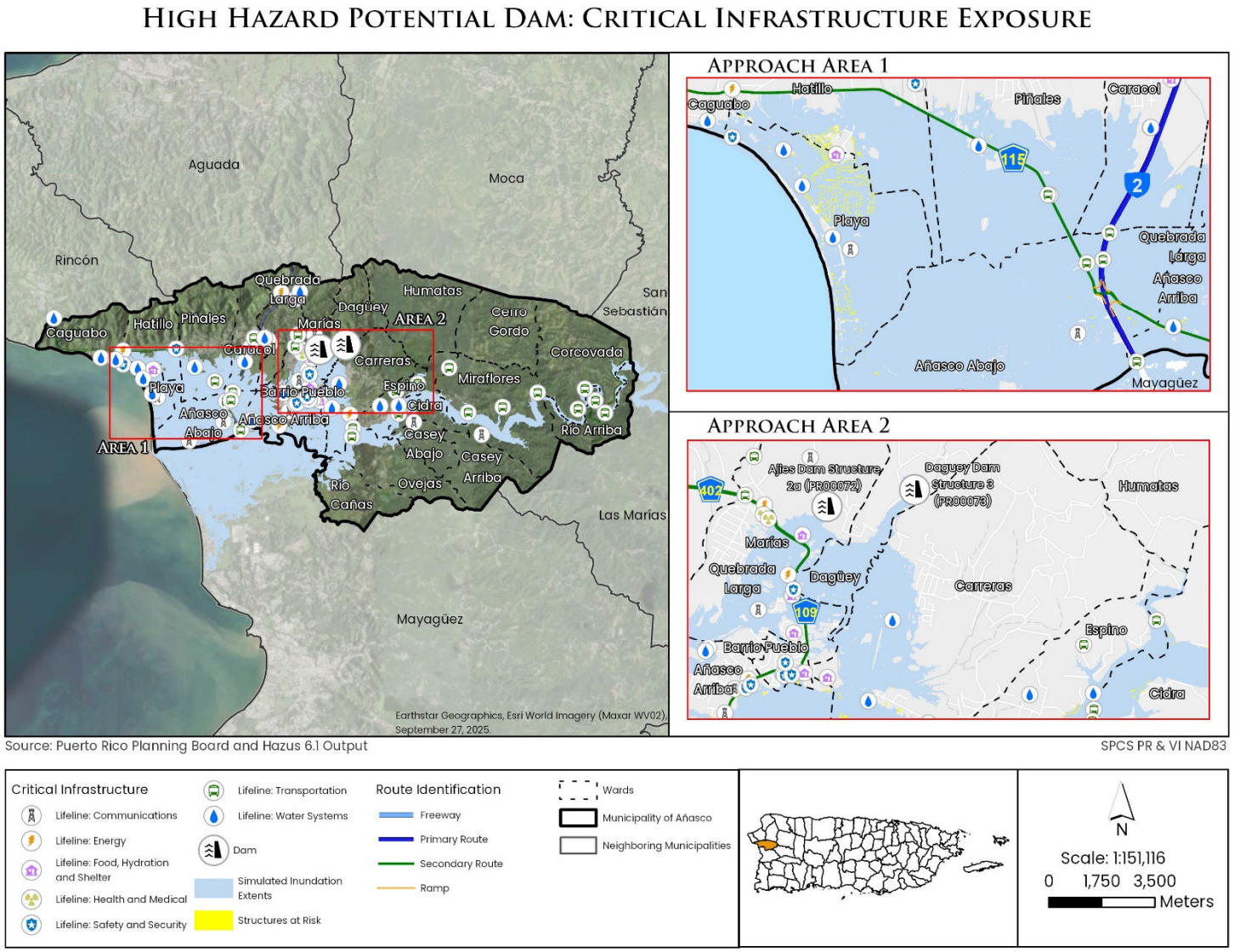
4.16.2.2 Estimated Losses (HHPD2-a)

The sunny – day scenario ran in 2026 does not include an estimation of losses. It is recommended that this be done in a future project for this municipality in particular.

4.16.2.3 Critical Infrastructure (HHPD2-a)

According to Map 51, several categories of critical infrastructure could be impacted by flooding associated with a high-hazard potential dam failure. The simulated inundation area overlaps transportation, water system, communications, energy, safety and security, health and medical, and food, hydration, and shelter facilities located primarily within the northern and central portions of Añasco. The areas of greatest exposure are highlighted in Approach Areas 1 and 2, where the projected inundation extent affects portions of Playa, Hatillo, Piñales, Añasco Abajo, Añasco Arriba, Barrio Pueblo, Marías, Quebrada Larga, Carreras, Espino, and Cidra. The map also indicates that segments of PR-115, PR-109, and other local transportation corridors intersect the inundation area, potentially affecting access to critical services during a dam failure event. These findings suggest that flooding resulting from a high-hazard potential dam failure could disrupt essential community lifelines, transportation connectivity, emergency response operations, utility services, and access to public facilities within the Municipality of Añasco.

Map 51: HHPD Critical Infrastructure Exposure



4.16.2.4 Social Vulnerability

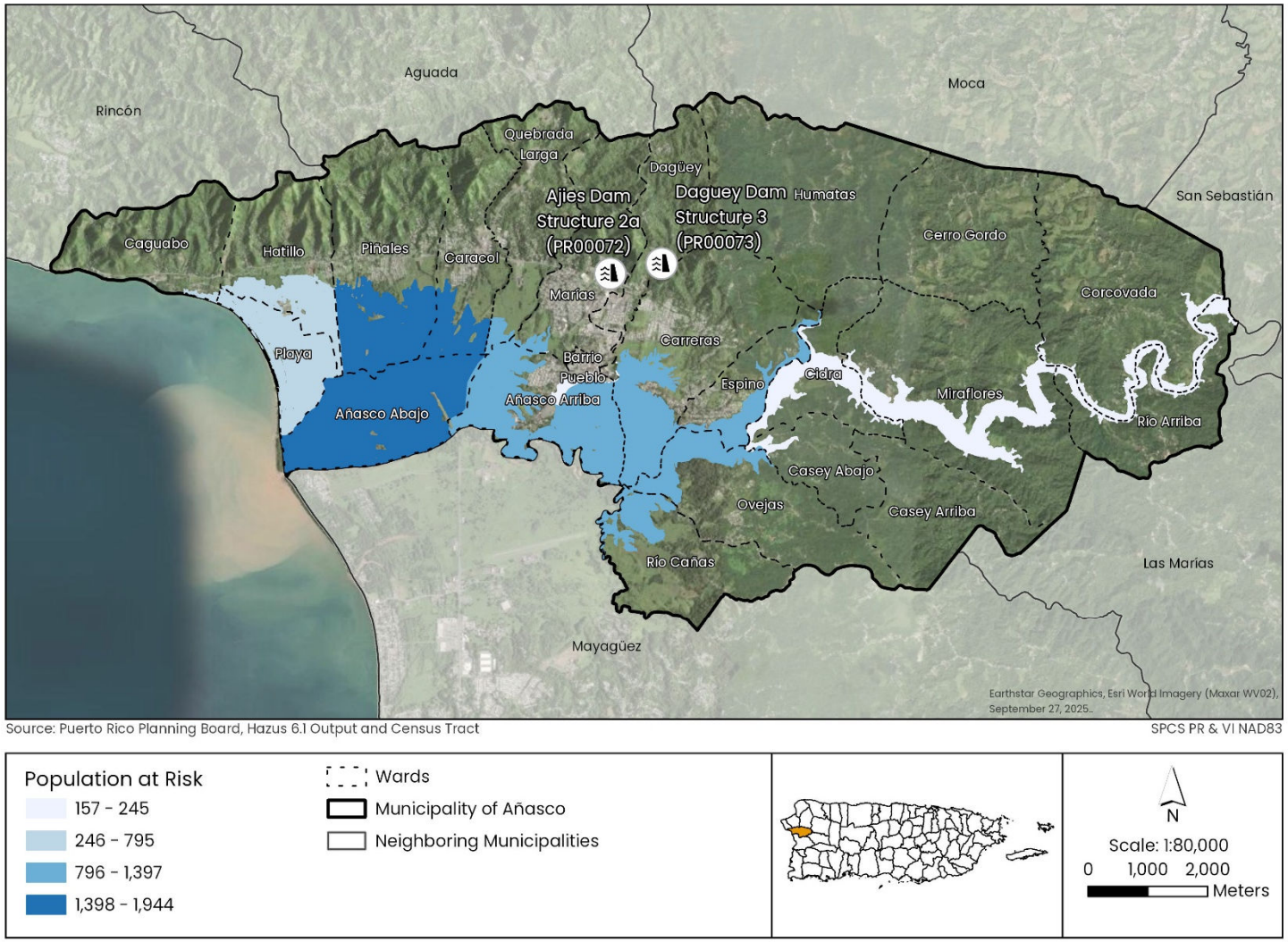
Social vulnerability strongly influences how communities experience flooding resulting from a dam breach, often determining who is most at risk of injury or loss of life. Research shows that low-income households, elderly populations, and people with disabilities are more likely to live in high-hazard areas and face greater challenges in receiving warnings and evacuating quickly (Cutter, Boruff, & Shirley, 2003). Language barriers and limited access to transportation further reduce the effectiveness of emergency communications during rapidly developing dam-break floods (Baker, Cohen, Coulson, Durden, & Rossman, n.d.). The Social Vulnerability Index (SoVI), developed by Cutter and colleagues, highlights how socioeconomic status, age, and housing conditions increase susceptibility to flood impacts (Cutter, Boruff, & Shirley, 2003). FEMA and USACE guidance emphasize that socially vulnerable populations often have less capacity to respond during the short warning times typical of dam-failure events. As a result, dam-breach risk is not only a hydraulic issue but also a significant social and equity concern (Cutter, Emrich, Morath, & Dunning, 2013).

Following a dam-breach flood, socially vulnerable communities often experience disproportionate and prolonged recovery challenges. Studies show that low-income and rented households face greater difficulties accessing disaster assistance, replacing lost housing, and returning to normal economic activity. Disruptions to healthcare, education, and critical infrastructure tend to have lasting effects in communities that already lack robust social support systems. Academic research demonstrates that flood losses compound existing social inequalities by increasing poverty and reducing long-term resilience. USACE guidance stresses the importance of identifying and engaging socially vulnerable populations during dam safety planning to reduce inequitable outcomes. Incorporating social vulnerability into dam-breach risk assessments helps decision-makers design more effective emergency planning, mitigation, and recovery strategies.

Map 52 shows the population density and the modeled dam breach impact area for the Municipality of Añasco. The map indicates that portions of the inundation area overlap with some of the municipality's more densely populated areas, particularly within Añasco Abajo, where the highest population exposure category is identified. Additional populated areas within the modeled impact area include portions of Piñales, Playa, Añasco Arriba, Barrio Pueblo, Espino, and Carreras. These results suggest that a dam breach could affect residential populations located along the lower Río Grande de Añasco floodplain and adjacent developed areas.

Map 52: HHPD: Population Exposure

High Hazard Potential Dam: Population Exposure

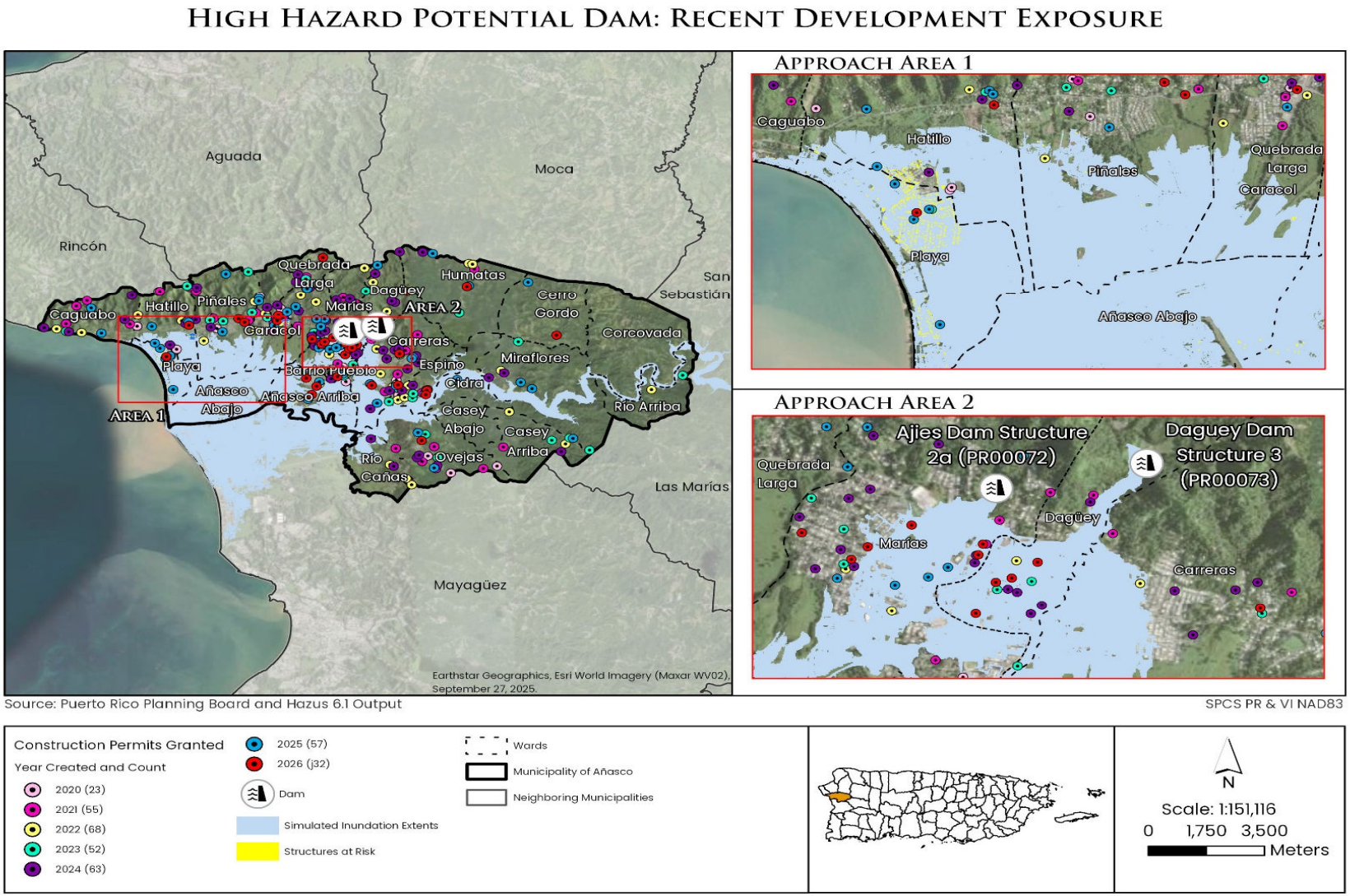


4.16.2.5 Recent Development

The following map shows the recent development exposure for a sunny day dam breach scenario. It shows that several recently developed properties and permitted construction projects are located within the modeled inundation area associated with the Ajíes and Dagüey Dams. Recent development exposure is concentrated in portions of Añasco Abajo, Playa, Barrio Pueblo, Añasco Arriba, Marías, Espino, and Carreras, indicating that future dam breach flooding could affect new residential, commercial, and other developed areas within the municipality. The presence of recent development within the impact area highlights the importance of considering dam-related flood hazards in future planning, land use, and emergency management efforts.

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Map 54: HHPD - Recent Development Exposure



4.16.2.6 Special Considerations: Coordination with local dam owners and state dam safety agencies (HHPD1-a & HHPD1-b)

Effective interagency coordination is widely recognized as essential for preventing, mitigating, and managing dam breaks and levee breaches, because these events involve rapid onset, cascading impacts, and shared responsibilities across jurisdictions. Federal guidance emphasizes that dam and levee risks cannot be managed by a single entity and instead require collaboration among dam owners, state dam safety offices, emergency management agencies, hydrologic forecasting organizations, and local governments (FEMA, 2025) (USACE, n.d.). Best practices begin during preparedness, when agencies establish clear roles and responsibilities through Emergency Action Plans (EAPs), memoranda of understanding, and formal communication protocols (FEMA, 2013). Research has shown that jurisdictions with predefined coordination frameworks experience faster decision-making and fewer communication breakdowns during flood emergencies (Cutter, Emrich, Morath, & Dunning, 2013). Regular joint training, tabletop exercises, and scenario simulations help agencies build shared understanding and operational trust. These preparatory actions form the foundation for effective prevention, response, and recovery.

Prevention and mitigation activities benefit from coordinated, risk-informed planning across agencies. The USACE Dam Safety Program promotes the use of shared risk assessment frameworks that integrate structural condition, hydrologic loading, and downstream consequences, with life safety identified as the highest priority (USACE, 2016; USACE, 2020). Academic literature indicates that using common analytical tools—such as inundation mapping and consequence analysis—improves transparency and consistency in prioritizing mitigation investments (Cutter et al., 2015). Coordination with land-use planners and transportation agencies reduces future exposure by discouraging development in high-hazard inundation zones (FEMA, Reducing Damage from Localized Flooding, 2025). Joint risk communication by technical and emergency management agencies improves public understanding and trust, particularly for low-probability, high-consequence events such as dam failures. When mitigation strategies are developed collaboratively, they are more likely to address both physical risk and social vulnerability.

During imminent failure threats or actual dam breaks and levee breaches, interagency coordination must transition rapidly to operational alignment. FEMA guidance identifies the Incident Command System (ICS) as the standard framework for managing multi-agency flood emergencies, enabling unified objectives, shared situational awareness, and coordinated resource deployment (FEMA, National Incident Management System, 2021). USACE dam safety guidance stresses the

importance of timely information sharing between technical experts and emergency managers, particularly regarding breach development, flood arrival times, and risk to downstream populations (USACE, 2016). Studies of flood disasters consistently show that unclear command structures and fragmented communication are major contributors to increased loss of life during rapidly developing events (Cutter et al., 2017). Coordinated evacuation planning involving law enforcement, transportation, and public works agencies is critical to ensuring safe and timely movement of at-risk populations. Consistent public messaging across agencies further reduces confusion and increases compliance with emergency directives.

Recovery and long-term learning are equally important components of interagency coordination. FEMA and USACE both recommend structured after-action reviews following dam- or levee-related incidents to document lessons learned and update EAPs, mapping products, and communication procedures (FEMA, 2013); (USACE, 2020). Research indicates that coordinated recovery efforts accelerate infrastructure repair and reduce long-term social and economic impacts, particularly for socially vulnerable communities (Fox, Agyemang, Hawker, & Neal, 2024). Integrating post-event findings into training and planning supports adaptive risk management and continuous improvement. Transparency and interagency collaboration during recovery also help rebuild public trust. Ultimately, best practice treats dam and levee safety as a shared, continuous responsibility rather than a sequence of isolated agency actions.

4.17 Pandemic/Epidemic

4.17.1 Description (B1-a)

An epidemic occurs when the incidence of a disease or health-related event rises suddenly and significantly above what is expected in a specific community or region. According to the CDC, an epidemic represents a sudden increase in cases over the normal baseline in a population, and outbreaks—often used interchangeably—refer to such events in more limited geographic areas (CDC, 2012).

A pandemic is essentially an epidemic that has expanded to span multiple countries or continents, affecting a large portion of the global population. The CDC describes it as an epidemic with broad geographic spread, while the World Health Organization defines it as the worldwide transmission of a new disease to which people generally have little or no immunity (CDC, 2012).

These terms emphasize both the magnitude of cases and their geographical distribution: an epidemic is localized, but a pandemic reaches across international borders and impacts global public health systems. Consequently, emergency response strategies must escalate accordingly—from targeted regional interventions during epidemics to coordinated global action in pandemics.

4.17.1.1 Affected Area (B1-b)

This LHMP considers that all areas of the municipality are equally vulnerable to the Epidemic/Pandemic Hazard.

4.17.1.2 Risk Magnitude (B1-c)

Although all these events can result in loss of life and economic disruption, to distinguish between the following terms:

- Epidemic: refers to a sudden increase in the number of disease cases beyond what is normally expected within a specific population and geographic area.
- Outbreak: shares the same definition as epidemic but is typically used for a more localized area.
- Cluster: describes a grouping of cases in a particular place and time that appears to exceed the expected number, even if that expected number is unknown.
- Pandemic: refers to an epidemic that has spread across multiple countries or continents, usually affecting a large population (CDC, 2012).

4.17.1.3 Past Events (B1-d)

The following table listing epidemics and pandemics in Puerto Rico has been collected from various sources. This list does not intend to be exhaustive:

Table 50: Pandemics and Epidemic in Puerto Rico 1855 - 2020

Disease	Date	Classification	Description
Cholera Epidemic	1855 - 1856	Epidemic	Between 1855 and 1856, Puerto Rico suffered a major cholera outbreak that claimed over 25,820

Disease	Date	Classification	Description
			lives, representing approximately 4–10% of the island's population at the time. (Vega Lugo, 2021)
Measles and Malnutrition	1917 - 1918	Epidemic	A severe measles outbreak occurred between 1917 and 1918, resulting in nearly 9,000 cases and approximately 2,000 deaths. High infant mortality—59% of deaths within six months were in children under two—was driven by malnutrition and poor living conditions (Rigau-Pérez & Vallejo - Calzada, 2020).
Spanish Flu (A/H1N1 influenza pandemic)	1918 - 1919	Pandemic	Puerto Rico was affected by the global A/H1N1 influenza pandemic, also known as the Spanish flu. Beginning around June 1918, community spread produced as many as 1,000 cases in four days in areas like Puerta de Tierra. Misdiagnosis as dengue initially obscured the true impact (Rosario Urrutia, 2021).
Poliomyelitis	1960	Epidemic	The 1960 polio epidemic in Puerto Rico was the most severe paralytic polio outbreak in the

Disease	Date	Classification	Description
			Western Hemisphere at the time. It impacted 68 of 76 municipalities, causing 495 cases of paralysis, predominantly among school-age children (Timothee, Morris, Filiberti, & Mainardi, 1963).
Dengue	2013, 2024	Outbreak	Dengue is endemic in Puerto Rico, with significant outbreaks occurring in 2013 and again in 2024. The 2024 outbreak triggered a public health emergency, with 6,291 confirmed cases, a 4.2% rate of severe dengue, and 11 deaths reported (Rodríguez, et al., 2024) (Ware-Gilmore, et al., 2025)
Chikungunya	2014	Epidemic	The first locally acquired chikungunya case in Puerto Rico was confirmed on May 5, 2014, triggering expanded surveillance efforts using Puerto Rico's dengue infrastructure. Between May 5 and August 12 of that year, 10,201 suspected cases (approximately 282 per 100,000 residents) were reported, of which 1,975

Disease	Date	Classification	Description
			(68%) were laboratory-confirmed. During this period, four deaths were also recorded. (Sharp, et al., 2014)
Zika	2015 - 2016	Epidemic	The first locally transmitted Zika case in Puerto Rico was reported in December 2015. By April 2016, over 6,000 suspected cases had been evaluated, with 683 confirmed cases. Pregnant women and related neurological issues (e.g., Guillain-Barré syndrome) were of particular concern. (Thomas, et al., 2016) (Dirlikov, et al., 2016)
COVID - 19	2020 - 2022	Pandemic	See narrative below

COVID – 19 Pandemic

Puerto Rico confirmed its first COVID-19 case—a European tourist—on March 8, 2020, leading the governor to declare an emergency on March 12 and implement early measures including airport screening and mandatory isolation, as outlined in the Puerto Rico Department of Health's epidemic situation reports (PRDH, 2022), (COR3, n.d.). By April 6, 2022, official data reported 270,485 confirmed cases and 4,171 deaths due to COVID-19 in Puerto Rico, according to detailed government spreadsheets and dashboards maintained by the Puerto Rico Health Department (PRDH, 2022), (COR3, n.d.).

The municipality experienced significant economic and social disruptions. A Bayesian analysis revealed a clear causal relationship between rising COVID-19 infections and increased unemployment, and engineering studies from the University of Puerto Rico–

Mayagüez estimated that unemployment soared above 17%, also noting elevated operating costs for businesses due to personal protective equipment (PPE) and safety measures (Hernández - Padilla & Méndez-Piñero, 2020).

Subsequent public health research revealed widespread mental health consequences. One study found that 31% of healthcare workers scored in the range of depressive symptomatology following combined stress from prior disasters (e.g., hurricanes) and the pandemic; another identified high levels of anxiety (26.9%) and stress (69.9%) among physicians during the second COVID-19 wave (Hernández - Torres, et al., 2023), (Sánchez - Plazas, García - De Jesús, Martínez - González, Amaya - Ardila, & Almodóvar - Rivera, 2024).

4.17.1.4 Future Events Probability (B1-e)

Puerto Rico's susceptibility to future pandemics or epidemics is underscored by its subtropical climate, population distribution, and healthcare infrastructure. A university-developed emergency preparedness model—commissioned by Puerto Rico's Department of Health—simulated influenza pandemics and demonstrated how variations in disease transmissibility, healthcare capacity, and mitigation efforts can significantly influence outbreak trajectories and the likelihood of healthcare system overload. Furthermore, the U.S. Department of Health and Human Services' Hospital Preparedness Program (HPP) in Puerto Rico operates under the Assistant Secretary for Preparedness and Response, with coordinated health care coalitions and special pathogen systems explicitly designed to reduce pandemic risk by strengthening surge capacity and infection-control readiness. These combined efforts reflect a data-driven recognition that, without sustained investment in public health infrastructure and preparedness modeling, Puerto Rico remains at an elevated probability for experiencing another epidemic or pandemic (Hirsh & Centeno - Marín, 2015), (ASPR, n.d.)

4.17.2 Risk Assessment (B2-a, B2-b)

4.17.2.1 Estimated Losses

The COVID-19 pandemic resulted in significant mortality across Puerto Rico, underscoring the importance of public health hazards in local mitigation planning. Official data from the Puerto Rico Department of Health indicate that COVID-19 mortality is tracked through an epidemiological surveillance system that compiles

death certificate data and case investigations and is made publicly available through government data portals. At the territorial level, thousands of deaths have been attributed to COVID-19 since 2020, as reported in official datasets and federal summaries. However, cumulative mortality totals for individual municipalities, including Añasco, revision are not consistently published as single static figures in official reports. Instead, municipality-level death counts must be obtained by querying downloadable datasets provided by the Puerto Rico Department of Health, which allow users to filter results by municipality.

These datasets are considered provisional and subject to due to reporting delays and ongoing validation of death records, as acknowledged by public health authorities. Consequently, while Añasco-specific COVID-19 mortality was not recorded as fixed published figure. Based on the currently available data, the total number of COVID-19-related deaths in Añasco cannot be reliably determined.

4.17.2.2 Lifelines and Critical Infrastructure

In the event of a pandemic or epidemic, the most significantly affected lifeline is typically the healthcare and medicine lifeline. During widespread disease outbreaks, hospitals, clinics, and other healthcare facilities often face overwhelming demand for services. Surges in patient volume can exceed system capacity, leading to shortages of personal protective equipment (PPE), critical medical devices (such as ventilators during COVID-19), hospital beds, and qualified medical personnel. As resources are redirected to address the immediate public health emergency, non-urgent and even some essential non-related medical services may be postponed or delayed. Additionally, mortality management systems—including morgues, funeral services, and vital records processing—may experience severe strain during periods of elevated death rates.

However other lifelines can be affected such as the Food, Hydration and Shelter Lifeline, due to increase food insecurity from unemployment and economic shutdowns ort closed or reduced shelters due to infection control requirements. The Safety and Security Lifelines can be affected by high absenteeism due to illness, quarantine or caregiving responsibilities and increase levels of stress and burnout among first responders and law enforcement officers.

Other lifelines and critical infrastructures can be affected by increased demand, like increased residential water demand) or the lack of trained personnel to maintain existing operations.

4.17.2.3 Social Vulnerability

For this hazard, the whole population of Añasco is considered equally vulnerable. Nonetheless besides factors of age and poverty, the 2020 - 2024 ACS shows that a total of 1,407 people in Añasco did not have health insurance coverage (US Census Bureau, 2025). This means that 17.75% of the total population of Añasco is uninsured.

Of those most of the uninsured group belonged to the 26-to-34-year cohort (391 persons) followed by the cohort of 19 to 25 years (285 persons).[17] The results given by the ACS show that the young adult population is the most vulnerable in terms of uninsured in the face of a pandemic or epidemic.

The table below shows the breakdown of uninsured people in Añasco according to the 2020 - 2024 ACS.

Table 51: Number of People in Añasco without Healthcare Coverage

Age Cohort	Number of people uninsured
Under 6 years	28
6 to 18 years	168
19 to 25 years	285
26 to 34 years	391
35 to 44 years	233
45 to 54 years	135
55 to 64 years	158
65 to 75 years	0
75 years or older	9
Total	1,407

Further information regarding social vulnerability can be found in Section 3.4.

4.17.2.4 Natural and Cultural Resources

The scientific literature shows that the COVID-19 Pandemic produced mixed environmental outcomes. While temporary lockdowns initially led to short-term improvements in air quality and reductions in greenhouse gas emissions in many

[17] US Census 2019 - 2023 ACS Table S2701

regions, broader evidence suggests that the pandemic also generated significant negative environmental impacts.

These impacts included increased pollution from the widespread use of personal protective equipment, deforestation, illegal poaching and logging, overfishing, and disruptions to conservation programs and projects. The findings also note that the spread of pandemics may be intensified by environmental pollution and rapid global population growth (Muche, Yemata, Molla, Muasya, & Tsegay, 2022) (Guo & Lee, 2021).

At the same time, despite these adverse impacts, the period of reduced human activity—often referred to as the *anthropause*—also produced several positive effects on natural resources. These included short-term reductions in indoor and outdoor air pollutants including $PM_{2.5}$, PM_{10}, NO_2, SO_2, CO, and CO_2, as well as a decrease in noise pollution from ships, boats, vehicles, and aircraft. Collectively, these changes benefited aquatic ecosystems and water quality, influenced bird behavior, supported wildlife biodiversity, and contributed to temporary ecosystem recovery (Muche, Yemata, Molla, Muasya, & Tsegay, 2022).

When it comes to cultural and heritage sites, a report from UNESCO notes that the crisis has produced both negative and positive effects across different types of World Heritage properties (UNESCO, 2021). The sudden cessation of travel and tourism disrupted visitor flows and eliminated a critical source of revenue for many sites, where tourism income is essential to supporting conservation activities, routine maintenance, and staff salaries. Local communities surrounding these properties were similarly affected, with widespread loss of employment and income.

Conversely, in some cases, the reduced level of human activity enabled rehabilitation and restoration efforts to proceed more efficiently, while anthropogenic pressures were temporarily reduced across many natural areas. This contrast highlights the diverse and uneven impacts of the crisis on World Heritage properties. At the same time, it highlights opportunities to build upon the environmental benefits observed during reduced activity periods, while advancing targeted research, sustainable tourism strategies, and long-term recovery planning (Guo & Lee, 2021) (Guibert & Hyde, 2021), (UNESCO, 2021).

4.17.2.5 Future Conditions (E1-a)

Puerto Rico faces structural and environmental conditions that elevate its exposure and vulnerability to future pandemics relative to many mainland U.S. locations. As a

tropical island with high population density in urban corridors, frequent international travel, and climatic conditions favorable to vectors and pathogens, Puerto Rico is particularly susceptible to emerging and re-emerging infectious diseases, especially those with zoonotic or vector-borne origins. The CDC and peer-reviewed research document ongoing transmission of diseases such as dengue and previous outbreaks of Zika and Chikungunya, demonstrating the island's continued exposure to pathogens with outbreak and epidemic potential. This exposure holds regardless of the development pattern of the municipality.

4.18 Hazard Prioritization

After receiving feedback from the public and stakeholders (see Section 2.3) along with their own expertise the planning committee has determined that the following is the prioritization for the hazard discussed in this LHMP.

Table 52 Hazard Prioritization

Hazard	Priority
Earthquake	High Priority
Landslide	High Priority
Tsunami	Mid Priority
Flooding	High Priority
Tropical Cyclone/Extreme Winds	High Priority
Storm Surge	Mid Priority
Extreme Heat	Low Priority
Drought	Mid Priority
Wildfire	Low Priority
Long-Term Coastal Dynamics	Low Priority
Pandemics	Low Priority

(further development od this section will occur after the second public meeting)

4.19 Planning Mechanism

Understanding and recognizing regulatory and planning capacities enables more effective management of land use and economic growth. These capacities consist of the legal frameworks and public policy provisions that influence land use to guide sustainable development, while also supporting actions that mitigate the vulnerability of communities and their resources to natural hazards.

Besides the Public Policies already discussed in Section 1.1, what follows is a list in chronological order of the regulatory and planning mechanisms available to the municipality for the implementation of this LHMP.

4.19.1 Joint Regulation for the Evaluation and Issuance of Permits Related to Development, Land Use, and Business Operations (2023)

Figure 40: Joint Regulation Cover



The Joint Regulation for the Evaluation and Issuance of Permits Related to Development, Land Use, and Business Operations (*Reglamento Conjunto* in Spanish) is a regulatory instrument created by the Planning Board in compliance with Law No. 161, as amended. Its main purpose is to regulate land use, territorial planning, and the granting of permits related to development, construction, and business operations within a uniform and centralized framework. The Joint Regulation aims to harmonize public policy on land use planning with the principles of sustainable development, seeking a balance between economic growth, environmental protection, and social well-being. This regulation establishes the rules to classify land, define zoning districts, regulate zoning, and determine the permitted uses in each category. Additionally, it sets the procedures to evaluate projects, issue permits, and monitor compliance with the applicable provisions. Its purpose is to provide a uniform regulatory framework for the evaluation and issuance of permits, ensure the proper use of land, protect natural resources, and facilitate economic development under

criteria of competitiveness and sustainability, integrating planning with permit management.

Of particular importance in the Joint Regulation is the zoning district *Distrito de Riesgo para Espacios Abiertos* – Open Space (RE-A).[18] The RE-A zoning district is established to identify lands designated as open space in accordance with federal regulations (44 CFR Part 80) or another federal program, due to the presence of a risk condition resulting from a natural event. These spaces may include, but are not limited to, severe flooding and landslides. There are conditions in these areas that are unfavorable or harmful to health, safety, or general welfare, and there may be a risk of loss of life and property. Land within this district may be susceptible to one or more of the identified hazards.

The purpose of the district is to preserve the open space condition established in perpetuity by federal regulation, which the government or the community must uphold, with the objective of protecting health, life, and property; preventing severe losses and repetitive use of affected properties; reducing the investment of public and federal funds in mitigation; and limiting rescue efforts, among other goals.

4.19.2 Special Flood Hazards Areas Regulation (2021)

The 2021 regulation was adopted by the Puerto Rico Planning Board under its authority from Public Law No. 75 of 1975 and Public Law No. 3 of 1961 to control development in flood-prone zones. It aligns Puerto Rico's floodplain management requirements with the minimum standards of the National Flood Insurance Program (NFIP), administered by FEMA. The regulation establishes updated criteria for construction, land use, and development within Special Flood Hazard Areas (SFHAs), including requirements such as elevating structures above Base Flood Elevation and submitting technical certifications. It applies to new construction, substantial improvements, and land-use changes across designated flood zones such as AE and VE, using FEMA Flood Insurance Rate Maps (FIRMs) and Flood Insurance Studies (FIS) for zone identification. The revision clarifies and expands regulatory provisions to enhance public safety and prevent harmful development in high-risk areas.

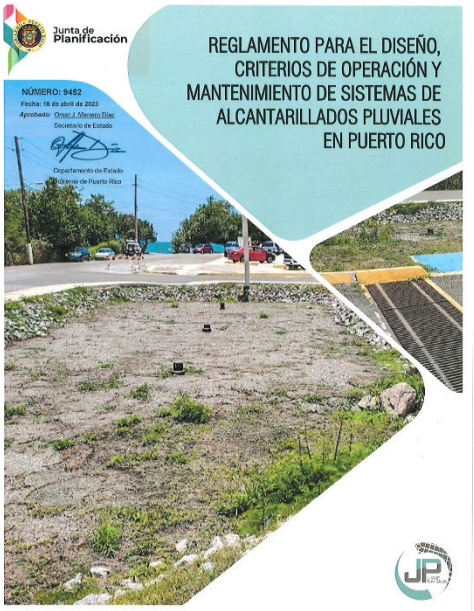
[18] Joint Regulation Rule 6.1.30

4.19.3 Puerto Rico Building Code

The Puerto Rico Building Code sets minimum requirements for the design, construction, modification, and upkeep of buildings to ensure the safety, health, and well-being of the public. It is derived from nationally and internationally recognized model codes and is updated periodically to incorporate improvements in construction practices and lessons learned from past hazard events. The code includes provisions addressing structural safety, fire protection, accessibility, energy conservation, and resistance to natural hazards such as earthquakes, hurricanes, floods, and strong winds. Adherence to the Building Code is mandatory for all new construction and substantial renovations throughout Puerto Rico. Enforcement is carried out through local permitting, planning review, and inspection processes to verify compliance with established standards. Overall, the Puerto Rico Building Code is a key instrument for advancing resilient, safe, and sustainable development across the island.

4.19.4 Regulation for the Design, Operation Criteria and Maintenance of Stormwater Systems in Puerto Rico

Figure 41: Regulation 40 Cover



Adopted in 2023 as Planning Regulation No. 40, this regulation updates and replaces the island's outdated 1975 standards to address current engineering practices, environmental considerations, and increased flood risk. The regulation is designed to provide developers, engineers, contractors, and municipalities with modern technical criteria for designing, operating, and maintaining public and private stormwater systems, incorporating updated scientific knowledge and methodologies necessary for managing stormwater infrastructure under present-day conditions. Its objectives include minimizing flood-related damage, improving the capture and management of runoff, reducing impacts to water resources and ecosystems, and supporting safer, more resilient community development. The regulation integrates risk management principles and aligns with Puerto Rico's climate adaptation policies, requiring consideration of urban flooding, karst hydrology, low-impact development practices, and stormwater control structures such as retention and detention systems. It also establishes minimum design considerations for all land development projects

and provides a comprehensive framework for planning, monitoring, and maintaining stormwater systems across the island.

4.19.5 Añasco land Use Plan (2026)

The Territorial Planning Plan was approved through a protocol event on September 10, 2026. However, it is still under the State Department carrying out the corresponding processes.

The Territorial Plan was carried out under Chapter XIII of Law No. 81 of 1991, as amended, known as the Autonomous Municipalities Law. It authorizes municipalities to adopt Zoning Plans (Territorial Plans, Expansion Plans, and Area Plans) to organize land use within their territorial limits and promote the social and economic well-being of the population. The Territorial Plan consists of three documents: the Memorial, the Program, and the Regulations. Its preparation involved four stages that were submitted to public hearings: Statement of Objectives and Work Plan, Memorial, Plan Progress, and Final Territorial Plan. The latter, in turn, is made up of three narrative documents: the Memorial, the Program, and the Regulations. This document, the Memorial, essentially consists of the Plan's Report, which summarizes its general content; an inventory that describes Añasco' role in its region, its natural resources, infrastructure and their socioeconomic condition; as well as a situational analysis, which is accompanied by objectives and general recommendations. The Program presents the projects that the Municipality aims to carry out in line with its objectives, the analyzed information, and the municipal capacity. The Regulation of Planning, for its part, is the key document for regulating land use and construction in the Municipality.

4.19.6 National Flood Insurance Program

The National Flood Insurance Program falls within the category of planning mechanisms, as it imposes certain floodplain management requirements. FEMA provides flood insurance to communities that are following the NFIP criteria. This includes adopting and enforcing floodplain management practices that promote appropriate development in these flood-prone areas.

The National Flood Insurance Program of the Federal Emergency Management Agency allows homeowners, business owners, and renters in participating NFIP communities to purchase federally backed flood insurance. This insurance provides assistance to

help cover the costs of repairing damage caused by flooding to buildings and their contents. This is an insurance program established to help property owners, renters, and businesses recover more easily and at a lower cost. Likewise, the program aims to reduce the impact of flooding on both public and private structures. These efforts help mitigate the effects of flooding on new and improved structures within each community.

The NFIP has several components, including:

- Floodplain management — for which the community must adopt and enforce measures for managing flood-prone lands in accordance with NFIP regulations;
- The preparation of Flood Insurance Rate Maps (FIRMs); and
- Flood insurance.

The Puerto Rico Planning Board has a collection of FIRM maps that can be consulted to determine whether your property is in a high-risk area or in a low- to moderate-risk zone. FIRMs refer to the official map developed and approved by FEMA and adopted by the Puerto Rico Planning Board to designate areas at risk of a 100-year flood (or a 1% annual chance of occurrence). In addition, these maps serve as a tool for managing special areas due to their susceptibility to flooding events.

While the Write Your Own Program (WYO) began in 1983 as a partnership between insurance companies and FEMA. This arrangement allows property and casualty insurance companies to underwrite and service federal flood insurance policies in their own company name. A key feature of this type of policy is that all companies participating in the WYO program provide the same coverage, and their rates must comply with NFIP rules and regulations.

Communities, for their part, adopt and require compliance with the NFIP's minimum standards for construction and development in designated Special Flood Hazard Areas. However, many communities seek to achieve a higher level of safety and protection for their residents beyond the NFIP minimum standards. For this purpose, communities have the option of participating in the NFIP's Community Rating System (CRS), which allows them to obtain reductions in flood insurance premiums.

This is because the CRS recognizes additional community efforts to: 1) Reduce flood damage to insurable property; 2) strengthen and support NFIP insurance provisions; and 3) encourage a comprehensive approach to floodplain management. These additional efforts provide residents with greater safety, reduce property damage,

enhance community resilience, and promote a better quality of life. The municipality's participation in the NFIP will be discussed in Section 6.6

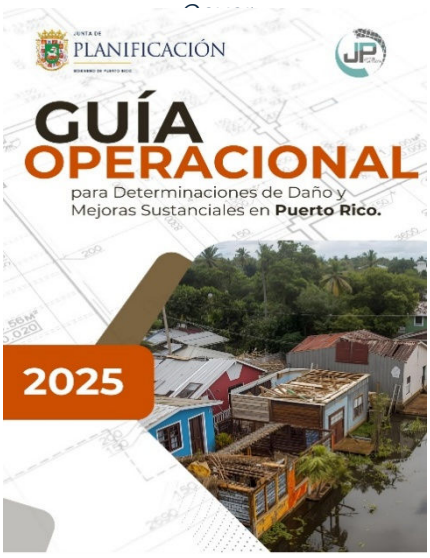
4.19.7 National Pollutant Discharge Elimination System (NPDES)

The NPDES is a program authorized under the United States Clean Water Act and administered by the Environmental Protection Agency (EPA). This program requires Municipal Separate Storm Sewer Systems (MS4s) to obtain a permit for the discharge of stormwater into water bodies. In the case of Puerto Rico, the EPA issued a general permit in 2016, under which municipalities can obtain coverage by submitting a Notice of Intent (NOI) and adopting a Stormwater Management Program (SWMP). If any of the mitigation measures listed in Section 6.5 modify the NOI or the SWMP, they will be properly amended.

4.19.8 Operational Guidelines for Determining Damages and Substantial Improvements in Puerto Rico (2025)

The Floodplain Administrator or the Participating Community may review, require, and audit permits in accordance with the provisions of Act No. 3 of September 27, 1961, known as the "Floodplain Building Control Act"; Act No. 75, the "Puerto Rico Planning Board Organic Act"; Act No. 161 of December 1, 2009, as amended, the "Puerto Rico Permit Process Reform Act"; and Act No. 38 of June 30, 2017, the "Uniform Administrative Procedure Act of the Government," as amended, and in compliance with the regulations of the National Flood Insurance Program (NFIP) of the Federal Emergency Management Agency (FEMA), Title 44 of the Code of Federal Regulations (CFR), Part 60.3 [d, e, and Subpart B], and its related sections.

Figure 42: Operational Guidelines



As of the effective date of this guidance, an evaluation of substantial damage or substantial improvement will be required as part of the permitting requirements in Special Flood Hazard Areas. The Floodplain Administrator will require that both new structures and substantial improvements be constructed in a manner that minimizes or prevents damage during a regulatory flood.

4.19.9 Green Infrastructure and Nature Based Solutions

Section 502 of the United States Clean Water Act defines green infrastructure as the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvesting and reuse, or landscaping to store, infiltrate, or evapotranspiration stormwater and reduce flows to sewer systems or surface waters.

Green infrastructure is a cost-effective and resilient approach to managing wet weather impacts that provide many benefits to the community. While conventional single-purpose gray stormwater infrastructure (such as pipe drainage and water treatment systems) is designed to move urban stormwater away from the built environment, green infrastructure reduces and treats stormwater at its source while providing environmental, social, and economic benefits.

Stormwater runoff is a major cause of water pollution in urban areas. When it rains on rooftops, streets, and parking lots in cities and suburbs, the water cannot soak into the ground as naturally would. Instead, stormwater drains through gutters, storm sewers, and other collection systems and is discharged into nearby water bodies. This runoff carries trash, bacteria, heavy metals, and other pollutants from the urban landscape. Higher flows resulting from heavy rainfall can also cause erosion and flooding in urban streams, damaging the environment, property, and infrastructure.

When rain falls in undeveloped natural areas, the water is absorbed and filtered by soil and vegetation. Stormwater runoff is cleaner and less problematic. Green infrastructure uses vegetation, soil, and other elements and practices to restore some of the natural processes needed to manage water and create healthier urban environments. At the municipal scale, green infrastructure is a network of natural areas that provide habitat, flood protection, cleaner air, and cleaner water. At the neighborhood, development, or sector scale, managing stormwater systems in a way that mimics natural processes help absorb and store runoff that can otherwise cause localized flooding (EPA, 2019).

Some green infrastructure measures that may be considered to mitigate flooding problems include:

- Rainwater harvesting
- Rain gardens (bio-retention/bio-infiltration)
- Urban rain gardens (“planter boxes”)
- Bioswales

- Porous pavements
- Green streets
- Green parking lots
- Green roofs
- Land conservation
- Creation or maintenance of urban tree canopy
- Wetland restoration
- Riparian area rehabilitation
- Sand dune restoration, among others.

The Municipality will consider green infrastructures measures when developing or championing flood control measures with the state or the federal government. In addition to flood control, green infrastructure provides benefits such as improved water quality, enhanced water supply, reduced stormwater management costs (public and private), improved habitat quality, increased spaces for recreation and physical activity, job creation in the maintenance of natural areas, and increased property values (EPA, 2019).

4.19.10 Four – Year Investment Program

The Four-Year Investment Program 2026–2027 to 2029–2030 (hereinafter, the PICA) is a short- and medium-term planning instrument designed to guide, coordinate, and direct public investments during the period it covers. Through this instrument, the Planning Board integrates the efforts of various government entities aimed at improving the quality of life of the people of Puerto Rico, in line with established public policies.

The Framework of Reference PICA guides agencies and public corporations in preparing their investment and capital improvement programs. The framework includes a demographic and socioeconomic profile of Puerto Rico as a whole and by regional organization, a diagnosis of the recent performance of the economy, and information on development patterns and priority projects for the competitive Puerto Rico to which all aspire.

The full PICA document for the 2022–2023 to 2025–2026 period incorporates all information on capital improvement projects to be carried out by government entities. It includes a detailed analysis of the distribution of recommended resources by program areas and the origin of those resources. This analysis is the result of an integration process designed to guide budget recommendations formulated by the

Office of Management and Budget regarding the Annual Capital Improvements Program included in Puerto Rico's budget.

This program serves as a short- and medium-term planning tool to guide, coordinate, and direct public investments during its period of effectiveness. It uses Puerto Rico's demographic and socioeconomic profile, along with a regional analysis as established by the Planning Board (JP, 2022).

With respect to the municipality's Hazard Mitigation Plan, the PICA is used to integrate information on the current performance of Puerto Rico's economy, including data on public debt and development trends, as well as projects designated as priorities for implementation on the Island. Within this framework, the PICA provides municipalities with information from government entities regarding funding allocations and investments in improvements they are responsible for implementing, which contribute to municipal efforts to mitigate natural hazards.

As part of the projects influencing all Functional Areas of Puerto Rico, the review of municipal Mitigation Plans is included. The Planning Board was designated by the Government Authorized Representative (GAR) as the agency responsible for reviewing and developing Hazard Mitigation Plans in coordination with the 78 municipalities[19].

5. Municipal Capacities

5.1 Regulatory and Planning Mechanism (C1-a)

These capabilities refer to the legal provisions that influence land used to manage economic growth and that could support the municipality in its efforts to mitigate the vulnerability of its communities and resources to natural hazards. The municipality identified existing regulations and planning documents that could support its actions, as well as opportunities to promote the development of studies or plans for the same purpose of advancing its mitigation goals. These regulatory and planning tools are described in Section 4.18.

Esta tabla no se si está actualizada. [19] GAR function is currently held by COR3

5.2 Technical and Administrative Capacities (C1-a)

The Municipality has enough staff to implement this LHMP. Any additional resources will be procured through existing or future external resources.

Table 53 shows the Municipality's Technical and Administrative Capacity

Table 53: Hazard Prioritization Municipal Technical and Administrative Human Resources

Personnel Team / Resources	Yes	No	Future Positions	Department or Agency	Opportunities to Integrate into LHMP	Comments
Planners with experience in land use and mitigation		X	Through contract services if needed	N/A	N/A	Currently the municipality does not have a planning department. Any planning related issue is worked through the mayor's office, or subcontracted staff.
Engineers or professionals trained in construction practices related to buildings and infrastructure		X	Through contract services if needed	N/A	N/A	Currently the municipality does not have this staff. If the need arises this position will be procured by external professional services.
Planners or engineers with a broad understanding of natural hazards		X	Through contract services if needed	N/A	N/A	Currently the municipality does not have this staff. If the need arises this position will be procured by external professional services.

Personnel Team / Resources	Yes	No	Future Positions	Department or Agency	Opportunities to Integrate into LHMP	Comments
Emergency Manager	X		Director of the Municipal Emergency Management Office	Municipal Emergency Management Office, Department of Public Safety	The LHMP may be used to update the EOP	None
Scientists familiar with natural hazards		X	Through contract services if needed	University of Puerto Rico, Puerto Rico Seismic Network, other universities in Puerto Rico		Currently the municipality does not have this staff. If the need arises this position will be procured by external professional services.
Personnel with expertise or education regarding the vulnerabilities and natural hazards affecting the community		X	Community Representative	N/A	N/A	Currently the municipality does not have this staff. If the need arises this position will be procured by external professional services.
Resource development staff or grant writers		X	Director of Municipal Federal Programs	Municipal Federal Programs Office	This staff may write and administer grants to cover the mitigation strategies mentioned below.	N/A

5.3 Financial Capacity (C1-a)

The Municipality has experience administering federal funds from various streams and maintains a dedicated office responsible for the administration and oversight of federally funded programs.

5.3.1 FEMA Funding Streams

For hazard mitigation projects the municipality has identified the following FEMA – administered possible funding streams which it could draw from.

Stafford Act - Section 404

Section 404 refers to Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, which authorizes the Hazard Mitigation Grant Program (HMGP), administered by FEMA. Its primary purpose is to reduce future disaster losses by funding long-term mitigation projects after a major disaster is declared.

Under Section 404, funding is made available to states, territories, tribes, and local governments to implement mitigation measures that lessen the impacts of future hazards such as floods, earthquakes, hurricanes, wildfires, and droughts. Unlike Section 406, Section 404 projects do not have to be tied to facilities that were damaged by the declared disaster. This allows communities to take a proactive approach by investing in mitigation actions that address known risks before damage occurs.

Eligible projects under Section 404 may include activities such as elevation or acquisition of flood-prone structures, drainage improvements, seismic retrofits, safe rooms, wildfire mitigation measures, and hazard mitigation planning. Projects must be cost-effective, technically feasible, and consistent with an approved Hazard Mitigation Plan. The program typically provides up to 75 percent federal funding, with the remaining share provided by non-federal sources.

Under Section 404 is also the Hazard Mitigation Grant Program (HMGP) that can support plan development, data collection, risk assessments, and engagement activities required to maintain FEMA approval following a presidential disaster declaration.

Stafford Act – Section 406

Section 406 of the Stafford Act supports mitigation projects by allowing hazard-mitigation measures to be incorporated directly into the repair or replacement of public facilities damaged during a declared disaster. This provision enables communities to strengthen damaged infrastructure against future hazards, such as elevating flood-damaged buildings, reinforcing structures to withstand high

winds, or improving drainage systems during repairs. Mitigation measures funded under Section 406 must be cost-effective and directly related to the damaged facility. By integrating mitigation into recovery activities, Section 406 helps reduce the likelihood of repetitive damage and future repair costs. Overall, it ensures that rebuilding efforts contribute to long-term resilience rather than simply restoring pre-disaster conditions.

Stafford Act - Section 428

Section 428 of the Stafford Act can support mitigation projects by allowing communities to integrate hazard-resilient and risk-reduction measures directly into disaster recovery projects funded through FEMA's Public Assistance Program. Through its alternative procedures, Section 428 enables flexible project design, fixed-cost funding, and consolidation of damaged facilities, making it easier to incorporate mitigation improvements such as relocation, elevation, floodproofing, or structural hardening. Applicants may also reinvest cost savings from efficiently managed projects into additional mitigation features, as long as project objectives are met. By emphasizing outcomes rather than strict cost reimbursement, Section 428 encourages rebuilding that reduces future risk rather than simply restoring pre-disaster conditions. This approach allows mitigation to become an integral part of recovery, strengthening resilience and reducing the likelihood of repetitive losses.

Flood Mitigation Assistance Program

The Flood Mitigation Assistance (FMA) Program reduces flood hazards by providing funding to help communities identify and implement measures that lessen long-term flood risk to National Flood Insurance Program (NFIP)insured properties. The program focuses on projects such as elevating, acquiring, relocating, or floodproofing flood-prone structures, with particular priority given to repetitive loss and severe repetitive loss properties. By mitigating flood damage before disasters occur, FMA helps protect lives and property, reduces future flood insurance claims, and lowers the overall cost of disaster assistance. The program encourages proactive risk reduction by aligning mitigation investments with floodplain management and local hazard mitigation planning.

Stafford Act – Section 203 (BRIC)

The Building Resilient Infrastructure and Communities (BRIC) program supports mitigation projects by providing pre-disaster funding to help communities reduce

risks from natural hazards before disasters occur. Administered by FEMA, BRIC focuses on long-term, cost-effective investments that enhance the resilience of critical infrastructure, lifelines, and communities. The program funds activities such as infrastructure retrofits, flood control projects, seismic upgrades, and nature-based solutions, as well as hazard mitigation planning and capacity building. BRIC emphasizes innovative, large-scale projects that address multiple hazards and provide measurable community benefits. By investing in mitigation prior to disasters, the BRIC program helps protect lives and property, reduce future disaster costs, and support more resilient and sustainable development.

5.3.2 Non-FEMA Federal Funding Streams

Non-FEMA federal Funding Streams can include:[20]

CDBG-DR

The Department of Housing and Urban Development's Community Development Block Grant–Disaster Recovery (CDBG-DR) program can fund hazard mitigation planning and projects by supporting activities that reduce long-term disaster risk and address unmet recovery needs following a major disaster. CDBG-DR funds may be used to develop or update hazard mitigation plans, conduct risk assessments, and support resilience and mitigation planning efforts that guide future investments. In addition, the program can finance mitigation projects such as drainage improvements, flood control infrastructure, elevation or acquisition of flood-prone properties, utility hardening, and other measures that reduce vulnerability to natural hazards. Unlike some recovery programs, CDBG-DR allows communities to target mitigation actions even if facilities were not damaged in the most recent disaster, as long as the activities address identified risks.

CDBG-MIT

The Department of Housing and Urban Development's Community Development Block Grant–Mitigation (CDBG-MIT) program supports hazard mitigation planning and projects by providing federal funding specifically dedicated to reducing future disaster risks in communities that have experienced major disasters. CDBG-MIT funds can be used for mitigation planning activities such as risk assessments, data analysis, and development of strategies that guide long-term resilience investments. The

[20] Please note that the following list is not intended to be exhaustive.

program also finances a wide range of mitigation projects, including flood risk reduction, stormwater management, wildfire mitigation, resilient infrastructure upgrades, and nature-based solutions. CDBG-MIT emphasizes addressing identified vulnerabilities and repetitive loss areas, even if they were not directly damaged in a recent disaster. By focusing on forward-looking risk reduction, the program helps communities proactively adapt to climate impacts and future hazards. Overall, CDBG-MIT integrates mitigation into long-term recovery and development efforts, strengthening community resilience and reducing future disaster losses.

It should be noted that CDBG-DR and CDBG-MIT differ primarily in their purpose and how they support hazard mitigation planning and projects. CDBG-DR focuses on post-disaster recovery, with mitigation activities integrated into rebuilding efforts to address unmet needs and reduce future risk as communities recover. Under CDBG-DR, mitigation planning and projects must be closely tied to disaster recovery goals and justified by disaster impacts or recovery assessments. In contrast, CDBG-MIT is specifically dedicated to hazard mitigation and long-term risk reduction, allowing communities to fund mitigation planning and projects even if areas or facilities were not damaged in the most recent disaster.

Resilience and Emergency Relief Programs

The Federal Highway Administration (FHWA) Resilience and Emergency Relief Programs support Hazard Mitigation Plans by promoting the identification and reduction of risks to transportation infrastructure from natural hazards. Through the Emergency Relief Program, FHWA allows mitigation and resilience measures—such as improved drainage, roadway elevation, and bridge reinforcement—to be incorporated into post-disaster repairs. FHWA resilience initiatives also encourage vulnerability assessments and risk-based planning that align with the risk assessment and mitigation strategy components of FEMA-approved HMPs. By integrating hazard mitigation and climate resilience into transportation planning, these programs help ensure that roads and bridges are addressed as critical lifelines. Overall, FHWA programs complement Hazard Mitigation Plans by supporting transportation-focused mitigation actions that reduce future disruption and repair costs.

National Resource Conservation Service

The Environmental Quality Incentives Program (EQIP) and the Watershed and Flood Prevention Operations (WFPO) program support hazard mitigation projects by addressing risks at the landscape and watershed scale through conservation and infrastructure improvements. EQIP, administered by the USDA Natural Resources

Conservation Service (NRCS), provides financial and technical assistance to landowners to implement conservation practices that reduce erosion, manage runoff, improve soil health, and mitigate risks from flooding, drought, and wildfires. These practices—such as vegetation management, streambank stabilization, and water retention—help lessen downstream flood impacts and enhance resilience to climate variability. The Watershed and Flood Prevention Operations program support larger-scale mitigation through structural and non-structural measures, including small dams, floodwater retarding structures, channel improvements, and watershed planning. Together, these programs reduce hazard exposure upstream, protect communities and infrastructure downstream, and integrating natural resource management into long-term flood and drought mitigation strategies.

5.3.3 Local Funds

Añasco, like other municipalities in Puerto Rico, receives revenue from the Municipal Revenue Collection Center (MRCC). Other funding sources include revenue from the Sales and Use Tax (IVU, by its Spanish acronym), legislative funds that might be assigned from time to time and other sources. Depending on the state of municipal finances, the municipality might determine that there are some funds that can be used to pay for or cover local funds match for mitigation projects.

However, most major capital improvement projects depend on federal funds transfers. The use of federal funds varies widely from year to year. In some cases, these funds are used to cover costs associated with the creation and monitoring of specific programs (for example, Section 8 or housing programs). In other cases, the funds are used to finance major capital improvement projects.

5.4 Outreach and Communications Capacity (C1-a)

Building robust outreach and communication capacity is essential to the successful implementation of a Hazard Mitigation Plan, as effective risk communication enables residents to recognize their risks, actively participate in planning processes, and make informed decisions to reduce potential impacts. FEMA guidance underscores the importance of early and thoughtfully designed engagement strategies to ensure that key stakeholders exchange information at the right time, promoting shared awareness of hazards and broad support for mitigation actions. Communication is a fundamental preparedness capability because it provides timely, practical information that helps individuals and communities act to limit harm. Research further

demonstrates that outreach efforts are most successful when messages are clearly defined, customized for specific audiences, and conveyed through trusted sources. Communities that prioritize outreach—by collaborating with local leaders, leveraging a variety of communication channels, and tailoring messages to different population groups—tend to achieve higher public involvement and more effectively incorporate community feedback into hazard mitigation planning. These practices ultimately contribute to more effective plans and more resilient communities (FEMA, 2025).

The Municipality demonstrates adequate capacity to conduct effective outreach and communication activities. The Recovery Office is responsible for coordinating these efforts, and an organizational chart for this office is provided in Appendix E. The Municipality utilizes both social media platforms for real-time communication and traditional methods to disseminate information to the public. In addition, the Planning Office administers the Community Board responsible for land-use decisions, which is largely composed of municipal residents. This board serves as an important forum for public engagement and provides an opportunity to further expand and strengthen the Municipality's outreach and communication capacity.

Table 54 details the communication tools available to the municipality.

Table 54: Outreach and Communications Tools

Tool or resource	Present or not present	Description	Agency in Charge
Municipal Social Media	Yes	Facebook Page @anasmunicipio	Mayor's Office
Planning Board Print Material	Yes	Print Material regarding hazard mitigation, focused on flood hazard	Puerto Rico Planning Board
Community Meetings	Yes	Community Outreach Meeting to reach people that do not have access to social media	Various

5.5 Capacity Development (C1-b)

Strengthening institutional and technical capacity is vital to the successful implementation of a Hazard Mitigation Plan, as communities must have the expertise, resources, and organizational frameworks needed to move from planning to sustained risk-reduction actions. FEMA guidance stresses that effective mitigation planning relies on well-coordinated teams, access to reliable technical data, and the ability to collaborate across agencies and stakeholders—all of which directly affect the execution of mitigation strategies. National evaluations have shown that local and state governments often face challenges in implementing mitigation projects not due to a lack of commitment, but because of limited technical assistance, constrained administrative capacity, and insufficient engagement with federal support programs. Studies focused on low-capacity communities further demonstrate that gaps in technical knowledge, training, and leadership involvement can significantly hinder mitigation outcomes. These findings highlight the importance of strengthening workforce skills, enhancing guidance and tools, and reinforcing institutional support to achieve long-term resilience.

The Municipality continues to enhance its mitigation capacity by retaining qualified professionals as staff or contractors as needs arise. It also actively participates in training and continuing education opportunities offered through Commonwealth agencies and academic institutions to build and maintain the technical and institutional expertise necessary to support hazard mitigation efforts.

6. Mitigation Action Plan

The goals, objectives, and mitigation actions outlined in this Plan are based on discussions held by the designated Mitigation Plan Committee, as well as the public-participation activities conducted to date.

6.1 Mitigation Goals (C3-a)

6.1.1 Municipal Goals and Objectives

The Municipality of Añasco, through its Planning Committee and after having carried out on-site inspections and having citizen participation during the development of this document, determined that they are in a position to develop the local goals for natural hazard mitigation. The Committee had the opportunity to reassess the goals and objectives included in the original Plan and later in the 2014 Plan and decided to keep them in this revision, since most of the goals and objectives could not be completed. That said, the Committee will make every effort to achieve the goals and objectives over the next five (5) years. Likewise, the Committee prioritized and arranged the local goals according to levels of risk, recurrence, and affected communities in areas susceptible to natural hazards. (Municipio de Añasco, 2020)

- Goal # 1 - Promote community training about mitigation against natural hazards.
- Goal # 2 - Encourage prevention
- Goal # 3 - Protect human life
- Goal # 4 - Techniques to protect natural resources
- Goal # 5 - Community emergency services
- Goal # 6 - Techniques for mitigating natural hazards in businesses, industries, institutions, among others

6.1.2 National Mitigation Investment Strategy

The Municipality also adopts the National Mitigation Investment Strategy and the following goals.

- Goal 1: Show How Mitigation Investments Reduce Risk - The whole community

will build a shared understanding of mitigation investment and its value. Specifically, the whole community will understand how effective mitigation investments can protect people, homes, neighborhoods, cultural and historic resources, ecosystems and lifelines (for example, communications, energy, transportation and water). The federal government and its non-federal partners will create a shared vocabulary and common measures to communicate information about risk and find opportunities to educate, hire, train and develop a base of qualified mitigation professionals.

- Goal 2: Coordinate Mitigation Investments to Reduce Risk - The whole community will coordinate mitigation investments through shared risk information, reinforced strategies for risk reduction, and easier access to existing funding. Such coordination will help the whole community justify mitigation investments and choose the most cost-effective and reasonable actions.
- Goal 3: Make Mitigation Investment Standard Practice The whole community will factor mitigation into investment decisions, especially for buildings and infrastructure. The federal government and its non-federal partners will use and expand financial products and approaches for mitigation investment, including funding, incentives and financial risk transfer opportunities. The federal government and its non-federal partners also will make mitigation standard professional practice critical to safeguarding lifelines, services, and national safety and security.

6.2 Mitigation Strategy Selection Criteria

The following methodologies were used to select the mitigation actions:

- The Planning Committee reviewed mitigation actions from the previous Mitigation Plan.
- The Committee evaluated those actions and determined which ones were appropriate to include in the current Plan. Actions were excluded if:
    - The measure had already been implemented during the previous plan's period and was not a recurring or ongoing action.
    - The measure was no longer necessary or useful based on new information. This applies to mitigation actions linked to identified hazards, risks, and vulnerabilities.
- The Committee considered the Letters of Intent (LOIs) submitted by the municipality to COR3 in 2019 to participate in the Hazard Mitigation Grant

Program. These projects were incorporated into the current Plan, ensuring no duplication of projects included in the previous Plan.
- Committee members evaluated and added new measures. These new actions were proposed based on the Committee members' professional experience and suggestions received from community members.

The mitigation strategies of the Municipality of Añasco were evaluated by the Committee using the STAPLEE methodology. This methodology was considered in the selection of the strategies included in Section 6.5. This methodology has seven evaluation criteria:

- S – Social: The proposed action must be socially acceptable.
- T – Technical: The proposed action must be technically feasible.
- A – Administrative: The community must have the capacity to implement the action (for example, determining whether the responsible agency is capable of supervising the mitigation project).
- P – Political: Mitigation actions must be politically acceptable.
- L – Legal: The community must have the authority to implement the proposed action.
- E – Economic: Economic considerations must include the current economic base, projected growth, and opportunity costs.
- E – Environmental: The environmental impact must be considered, given statutory requirements and the public's interest in maintaining sustainable and environmentally healthy communities.

6.3 Mitigation Strategy Categorization

The 2025 Local Hazard Mitigation Planning Handbook established the following categorization:

Local Planning and Regulations (LP)- These activities aim to keep hazards from creating or worsening problems. These actions are typically carried out through government programs or regulatory measures that guide land-use development and building practices. Prevention is especially effective for reducing future vulnerability in areas that have not yet been developed. Examples include:

- Planning and zoning
- Building codes

- Open-space preservation
- Floodplain regulations
- Stormwater management regulations
- Maintenance of drainage systems
- Capital improvement programming
- Riverbank realignment
- Projects addressing fault zones

Structure and Infrastructure Projects – These actions involve modifying existing structures and infrastructures to protect them from a hazard or remove them from a hazard area. This could also apply to public or private structures as well as critical facilities and infrastructure. Since these are the bulk of the strategies presented in this LHMP, the municipality has made the decision to subdivide these types of projects into two subcategories:

- **Property Protection (PP)** – measures involve modifying existing buildings and structures so they can withstand natural hazards, or removing structures located in high-risk areas. Examples include:
  - Acquisition of properties
  - Relocation
  - Elevating structures
  - Protection of critical facilities
  - Structural retrofits (wind protection, floodproofing, seismic techniques)
  - Safe rooms, shutters, impact-resistant windows
  - Insurance policies
- **Structural Improvements (SI)** – Projects aim to reduce the impact of disasters by controlling or altering the natural flow of hazard events through engineered construction. These projects are usually designed by engineers and maintained by public works teams. Examples include:
  - Reservoirs
  - Dams, levees, and retaining walls
  - Diversion, detention, and retention systems
  - Channel modifications
  - Stormwater drainage systems
  - Installation of storm drains and related infrastructure

Natural Resource Protection (NR) – activities reduce the impact of natural disasters by preserving or restoring natural areas that offer protective benefits. These areas include flood plains, wetlands, steep slopes, and sand dunes. Parks, recreational agencies, and conservation organizations commonly implement measures such as:

- Flood protection
- Watershed management
- Riparian buffers
- Forest and vegetation management (including wildfire and fuel-load control)
- Erosion and sediment control
- Wetland preservation and restoration
- Habitat preservation
- Slope stabilization

Emergency Services (ES) - Although not typically classified as mitigation, emergency management measures reduce the human and property impacts of natural hazards. These actions occur immediately before, during, or after a disaster. Examples include:

- Warning systems
- Evacuation management and planning
- Emergency response drills and training
- Flood-fighting measures
- Installation of shutters

Education and Awareness Programs (EA) - Efforts to help inform residents, elected officials, business owners, homebuyers, and visitors about hazard-prone areas and mitigation techniques they can use to protect themselves and their property. Examples include:

- Outreach projects
- Demonstration events and guest presentations
- Hazard information materials
- Property-specific risk information
- Library materials
- Educational programs for children
- Exposure to risk-related information

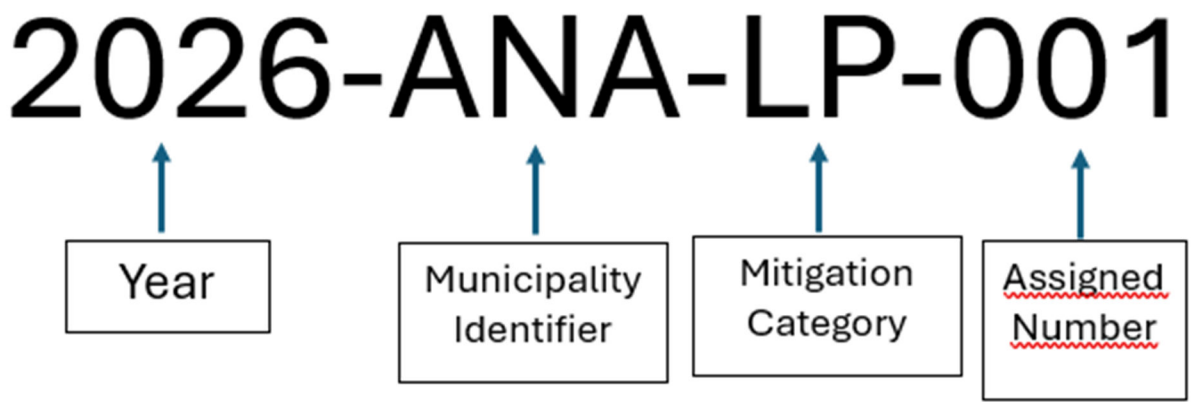
Although these are not considered hazard mitigation actions, the municipality deems it necessary to also document projects related to emergency services in this LHMP. In this sense, the interaction between the LHMP and the annually updated EOP is streamlined and cross-referenced.

6.4 Mitigation Strategies (C4-a, C4-b, C5-a, C5-b, E2.b)

To improve tracking and updating, each mitigation strategy has been giving a unique

identification number. The following figure shows the meaning of the nomenclature.

Figure 43: Unique Id Nomenclature



Each identified mitigation strategy shall include:

- New 2026 Mitigation ID
- Old 2020 ID if applicable
- Description
- Mitigated hazard(s): If a mitigation action is applicable to all hazards, it will be identified by the word "all"
- Priority of the strategy according to the planning committee
- Assigned FEMA Lifelines
- Municipal Office in charge of execution
- Possible funding sources
- Implementation Horizon: For this LHMP horizon time frames are as follows:
    - Immediate: Any action that will be executed in a period of one year or less.
    - Short – Term: Any action that will be executed in a period of two to three years.
    - Mid – Term: Any action that will be executed in a period of four to five years.
    - Long – Term: Any action that will be executed in a period beyond five years.

    - Note: Should funding for a specific strategy become available, the municipality may execute it even if it is not in the assigned time horizon.
- Current status and expected benefits

Strategies from the 2020 LHMP that are no longer needed will be identified as "Suppressed from this LHMP" to indicate that they should not be carried forward into the 2031 LHMP update. Tables 48-53 have the details of the mitigation strategies adopted by this LHMP.

Table 55: Mitigation Strategies - Prevention

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-ANA-LP-001	P –1	Implement the Mitigation Plan for the Municipality of Añasco through the Planning Committee.	All	High	All	Leader: Emergency Management (OMME) Support: Recovery	Municipal	Medium Term	Current Status: Under Construction – This strategy is being worked on with the help of AtkinsRéalis contracted by the Planning Board to assist municipalities with this task. This strategy will strengthen the municipality's capacity to identify, prioritize, and implement mitigation measures that reduce vulnerability to natural hazards and protect the community.
2026-ANA-LP-002	P –2	Acquisition and relocation of 40 housing units with repetitive losses distributed in: Urb. Brisas de Añasco Maria Plots Bo. Espino Bo. Añasco Arriba Sector Pagán Bo. Playa Bo. Añasco Abajo	Flooding	Medium	Safety & Security	Leader: Federal Programs Support: Administration and Citizen Assistance	Municipal, HMGP, CDBG, or USDA	Long Term	Current Status: Funding – The amount of funds needed to carry it out is estimated to exceed millions of dollars, which the Municipality of Añasco does not have available, and no funding sources have been identified to complete it. This strategy will reduce residents' exposure to recurrent flooding, increase the safety of affected families, and decrease future property losses.

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-ANA-LP-003	P –3	Implement a flood prevention program for critical facilities Government Center Police Headquarters Mayor's Office Senior Center	Flooding	High	Safety & Security	Leader: Public Works Support: Emergency Management (OMME)	Municipal, State or Federal	Long Term	Current Status: Funding – For this strategy, the Municipality of Añasco has not yet identified funding sources to complete it. This strategy will reduce the risk of flood damage, protect critical facilities, and ensure continuity of essential services to the community.
2026-ANA-LP-004	P –4	Conduct a study to identify mitigation measures and evaluation of structures that includes an inventory in Special Communities that are vulnerable to structural damage from winds in order to make improvements. La Choza in Bo. Pinales Parcelas Ajíes in Bo. María Bo. Playa	Tropical Cyclone	Low	Safety & Security	Leader: Public Works Support: Emergency Management (OMME)	Municipal, Special Communities or Federal Program	Long Term	Current Status: The Design – Project includes gutters and gabions for rainwater runoff control and soil stabilization in La Choza en Bo. Pinales This strategy will provide the following qualitative benefits: reduction of the risk of landslides, protection of vulnerable structures and better management of rainwater. Under Construction – Development of gutters for rainwater runoff control in Bo. Beach. This strategy will provide the following qualitative benefits: flood mitigation, housing protection, and improvement of drainage infrastructure
2026-ANA-LP-005	P –5	Designate funds to establish the Office of City Planning, including employees and equipment	All	High	All	Leader: Administration Support: Finance	Municipal	Long Term	Current Status: Funding – Currently in resource identification, physical location, equipment procurement, and staffing. This strategy will provide the following qualitative benefits: institutional strengthening, better territorial planning, and greater capacity to manage external projects and funds.

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-ANA-LP-006	P –6	Ground Stabilization Project in Sector Ajíes. Bo. María Install gabion walls and concrete cladding.	Landslides	N/A	N/A	N/A	N/A	N/A	Current Status: Reclassified – Will be removed from this table at the next Mitigation Plan review and will be assigned the new ID 2026-ANA-SI-006 under Structural Improvements.
2026-ANA-LP-007	P –7	Slope stabilization in the Bo. Corcovada PR – 420. With this project, it is possible to stabilize the land and protect a family's cement residence.	Landslides	N/A	N/A	N/A	N/A	N/A	Current Status: Withdrawn – Ambiguity in the definition of the scope of the strategy so that the project could not be clearly identified for its development. It will be eliminated in the next revision of the Mitigation Plan. This strategy will be eliminated in the next LHMP revision.

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-ANA-LP-008	P –8	Inspection of the Municipality's shelters to make non-structural improvements, i.e., fixing cupboards, shelves, etc. Esc. Carmen Casasus Esc. Isabel Suárez Esc. Luis Muñoz Marín	Earthquake	N/A	N/A	N/A	N/A	N/A	Status: Withdrawn – Consolidated with the 2026 strategy –ANA –PP –005. It will be removed in the next revision of the Mitigation Plan. This strategy will be eliminated in the next LHMP revision.
2026-ANA-LP-009	P –9	Enforce the requirements of Planning Regulation No. 13 on flood risk areas; promote the purchase of insurance provided by the NFIP; cleaning streams, ditches, rivers, roads, among others.	Flooding	High	Safety & Security	Leader: Emergency Management (OMME) Support: Public Works	Municipal, State or Federal	Short Term	Current Status: Ongoing Execution – This strategy is completed annually in preparation for hurricane season. This strategy reduces flood risk, protects lives and property, improves storm drainage, and strengthens community resilience to extreme events.

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-ANA-LP-010	P –10	Incorporate the data obtained and the recommendations of this Natural Hazard Mitigation Plan into the municipality's preparedness, response, and recovery plans.	All	High	All	Leader: Emergency Management (OMME) Support: Recovery	Municipal, State or Federal	Short Term	Current Status: Ongoing Execution – This strategy is worked on annually and plans are reviewed in preparation for hurricane season. This strategy strengthens municipal planning, improves interagency coordination, and increases response and recovery capacity in the face of adverse events.
2026-ANA-LP-011	P –11	Incorporate the findings of the risk assessment of this Plan into the Territorial Plan of the municipality, limiting the development of areas susceptible to natural hazards, promoting construction based on current building codes, relocation of critical facilities in areas prone to natural hazards, among others.	All	High	All	Leader: Emergency Management (OMME) Support: Recovery	Municipal, State or Federal	Short Term	Current Status: In Design – This strategy is in the evaluation phase for its integration into the Territorial Plan of the municipality. This strategy will promote orderly and safe development, reduce exposure to natural hazards, and encourage compliance with current building codes.

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-ANA-LP-012	P –12	Review and update municipal codes or ordinances related to the development of the municipality so that they are tempered with the mitigation strategies and risk assessment presented in this document.	All	High	All	Leader: Emergency Management (OMME) Support: Municipal Legislature	Municipal, State or Federal	Short Term	Current Status: In Design – This strategy is under evaluation for the revision and updating of municipal codes and ordinances. This strategy will strengthen development regulation, reduce risks associated with natural hazards, and align regulations with existing mitigation strategies.
2026-ANA-LP-013	P –13	Establish the Planning Committee.	All	High	All	Leader: Administration Support: Federal Programs	Municipal, State or Federal	Immediate	Current Status: In Design – This strategy is under evaluation for the establishment of the Planning Committee. This strategy will improve municipal coordination, strengthen decision-making, and support the implementation of mitigation strategies.
2026-ANA-LP-014	P –14	Complete the approval of the Land Use Plan for the municipality of Añasco	All	High	All	Leader: Ownership Support: Administration	Municipal, State or Federal	Medium Term	Current Status: In Continuous Execution – The plan was submitted, public hearings were held and is in the process of final approval. This strategy will provide qualitative benefits by fostering orderly and sustainable urban development, reducing vulnerability to natural hazards, improving land-use decision-making, and strengthening the resilience and planning of the municipality.

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-ANA-LP-015	P –15	Reinforce, through municipal ordinances, the imposition of fines for the illegal disposal of materials such as garbage, debris, landfill and other materials that tend to reduce the natural flow and quality of water. The illegal practice of disposing of these materials near bodies of water, protected natural resource areas, sewers and drains, to name a few, increases or causes severe flooding in urban areas.	Storm Surge and Flooding	High	Hazardous Materials	Leader: Municipal Legislature Support: Administration, Emergency Management (OMME)	Municipal, State or Federal	Medium Term	Current Status: In Design – This strategy is being worked on in collaboration with the City legislature awaiting session to strengthen ordinances that address illegal disposal. This strategy will provide qualitative benefits by reducing illegal waste disposal, improving stormwater flow, reducing flood risk, and protecting the quality of the municipality's water bodies and natural resources.
2026-ANA-LP-016	P –16	Implement measures within the Territorial Plan of the municipality and grant interagency agreements aimed at protecting water supplies such as watersheds, geological micro-basins, among others.	Drought	Medium	Water Systems	Leader: Federal Programs Support: Administration	Municipal, State or Federal	Long Term	Current Status: Under Design – This strategy is under evaluation for incorporation into the Territorial Plan and interagency agreements. This strategy will protect water resources, strengthen environmental management, and reduce risks associated with natural events.

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-ANA-LP-017	P –17	Through the granting of inter-agency agreements, an inventory of critical facilities in the municipality vulnerable to structural and non-structural damage will be carried out in order to proceed with their structural reinforcement. Ensuring that facilities and new buildings comply with current building codes.	All	N/A	N/A	N/A	N/A	N/A	Current Status: Withdrawn– This strategy is eliminated from the plan as an action at the municipal level since the mitigation committee identified that it is not financially viable; however, the municipality will continue to meet the needs of structural reinforcement in a timely manner to critical and non-critical facilities as warranted, in those cases where risks to life and property are identified. Likewise, the commitment to ensure that new constructions comply with current building codes, as established in other strategies of the plan, thus promoting safer and more resilient development, is maintained. This strategy will be eliminated in the next revision of the Mitigation Plan.
2026-ANA-LP-018	P –18	The municipality, its agencies and dependencies will be custodians of land use controls to prohibit the development of illegal structures in flood-prone areas in accordance with Regulation 13 of the Puerto Rico Planning Board and applicable federal and state laws.	Storm Surge and Flooding	High	Safety & Security	Leader: Administration Support: Municipal Police	Municipal, State or Federal	Long Term	Current Status: Continuous Execution – This strategy is carried out regularly in the municipality. This action has been institutionalized as part of the operational functions of the municipality, ensuring compliance with Regulation 13 of the Planning Board and other applicable laws. Through these controls, land use is regulated and the development of structures in areas prone to flooding and storm surge is prevented. The continuation of this practice reduces exposure to risk, protects lives and property, and ensures that urban development is carried out safely and in accordance with current regulations.

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-ANA-LP-019	P –19	The municipality will maintain a direct liaison with the Office of Management and Permitting and the Planning Board of Puerto Rico in order to ensure the implementation of runoff control in new developments.	Storm Surge and Flooding	High	Water Systems	Leader: Emergency Management (OMME) Support: Administration	Municipal, State or Federal	Short Term	Current Status: Continuously Running – This Strategy The mitigation plan is currently being worked on through the Planning Board with the purpose of ensuring mitigation strategies in the planning of our municipality and aligning efforts and vision with the Planning Board and in this way and in an interagency manner, ensure the implementation of runoff controls and other mitigation strategies in the development of new projects. The municipality has been verbal when granting permits to actively avoid giving municipal recommendations to projects that affect the municipality by creating floods in vulnerable areas. These municipal recommendations are given directly to the OGPe. This strategy will strengthen interagency coordination, improve land-use planning, reduce flood risk in vulnerable communities, and promote sustainable development through the effective implementation of runoff controls in new projects.

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-ANA-LP-020	P –20	Prohibit the construction or rehabilitation of structures in areas identified as high risk for storm surge and coastal erosion. Those structures that due to their structural condition are highly vulnerable to storm surge hazards and aggravate the problem of coastal erosion will be removed.	Coastal Modification, Storm Surge	High	Safety & Security	Leader: Administration Support: Municipal Legislature, OMME	Municipal, State or Federal	Medium Term	Current Status: Ongoing Implementation – As part of the strategy, the relocation of residents has been promoted through R3 and mitigation programs, as well as the demolition of existing structures that contribute to coastal erosion. The municipality continues to identify and manage sources of financing for the relocation of infrastructure in areas highly vulnerable to coastal erosion. This strategy will reduce the exposure of the population and property to risks associated with storm surge and coastal erosion, reduce the potential loss of life and property, mitigate the environmental impact on coastal areas and strengthen the resilience of the municipality through safer and more planned management of the territory.
2026-ANA-LP-021	P –21	Prohibit or restrict construction in areas identified as storm surge, EVs, and areas identified as susceptible to tsunamis.	Tsunami	Medium	Safety & Security	Leader: Administration Support: Municipal Legislature OMME	Municipal, State or Federal	Medium Term	Current Status: Ongoing Execution – The municipality continues to actively evaluate development proposals in areas identified as vulnerable to storm surge and tsunamis, and to deny municipal recommendations for projects that drive development in high-risk areas without proper implementation of effective mitigation measures. This strategy will reduce the exposure of lives and property to coastal risks, minimize economic losses in the event of storm surge and tsunamis, strengthen the resilience of the municipality and promote safer and more responsible development in coastal areas.

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-ANA-LP-022	P –22	Promote the preparation of a scientific study by the Department of Natural and Environmental Resources, through the Coastal Zone Management Program, to obtain scientific information on coastal erosion in Puerto Rico. Thus, the municipality is in a better position to develop and implement effective mitigation strategies.	Coastal Modification	High	Safety & Security	Leader: Emergency Management (OMME) Support: Recovery	Municipal, State or Federal	Medium Term	Current Status: In Continuous Execution – Although communication with DNER has been hindered by the agency, the municipality has adopted the study The State of Puerto Rico's Post-Maria Beaches previously conducted by the Puerto Rico Coastal Research and Planning Institute using them as a basis for planning and developing mitigation strategies such as the 2026 strategy –ANA–NR–006 added in this review. This strategy will strengthen the scientific basis for decision-making related to coastal management, allow for more accurate identification of areas vulnerable to erosion, support the development of more effective mitigation measures, promote the protection of natural resources and critical infrastructure, and increase the municipality's resilience to the effects of climate change and coastal degradation.
2026-ANA-LP-023	P –23	Encourage the Puerto Rico Planning Board and the Office of Permit Management to incorporate, as part of their regulations, the limitation of construction in areas with high population density and susceptible to tsunamis.	Tsunami	High	Safety & Security	Leader: Administration Support: Emergency Management (OMME)	Municipal, State or Federal	Medium Term	Current Status: Running – This strategy is carried out regularly because OGPE regulations already limit construction in areas susceptible to tsunamis and flooding. This strategy will contribute to reducing the exposure of the population and infrastructure to the risks associated with tsunamis, promote safer and more orderly urban development, minimize human and economic losses during coastal emergencies, strengthen compliance with territorial planning and increase the resilience of the municipality to extreme natural events.

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-ANA-LP-024	P –24	Promote the regulation of development and construction in areas at risk of liquefaction and seismic wave expansion, integrating these limitations into the Land Use Plan.	Earthquake	Medium	Safety & Security	Leader: Emergency Management (OMME) Support: Administration	Municipal, State or Federal	Medium Term	Current Status: In Design – This strategy is under evaluation for its integration into the Land Use Plan. This strategy will reduce seismic risks, promote safer development, and protect lives and property in vulnerable areas.
2026-ANA-LP-025	P –25	Promote a study on climate change and its impact on the municipality with the purpose of implementing strategies to mitigate its effects.	Coastal Modification, Tropical Cyclone, Extreme Heat, Drought, Tsunami, Wildfire, Earthquake	High	All	Leader: Emergency Management (OMME) Support: Administration	Municipal, State or Federal	Medium Term	Current Status: In Continuous Execution – Post-event data continues to be collected to identify vulnerable areas and update strategies, in coordination with the Land Use Plan, whose related action has been completed and is awaiting final approval. This strategy will provide qualitative benefits by strengthening the continuous identification of areas vulnerable to climatic events and improving decision-making based on updated information. In addition, it allows the findings to be linked to formal planning instruments such as the Land Use Plan (see p. 110), facilitating the implementation of more effective mitigation measures. This contributes to a better integration of climate change into municipal management, supports long-term planning and increases the resilience of the municipality to extreme events.

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-ANA-LP-026	P –26	Promote, through the implementation of municipal public policy, the use of technologies that reduce the emission of greenhouse gases and the consumption of fossil fuels.	Coastal Modification, Tropical Cyclone, Extreme Heat, Drought, Tsunami, Wildfire, Earthquake	Medium	Energy	Leader: Emergency Management (OMME) Support: Administration	Municipal, State or Federal	Medium Term	Current Status: Continuous Execution – Initiated with installation of 32 solar batteries in vulnerable homes; it will continue to be expanded with various technologies according to funds. This strategy will provide qualitative benefits by promoting the reduction of greenhouse gas emissions through the adoption of various clean technologies, building on initiatives already implemented, such as the installation of solar systems in vulnerable communities. In addition, it strengthens the municipality's energy resilience, reduces dependence on fossil fuels, and promotes the diversification of energy sources. Its flexible approach allows for continued incorporation of new sustainable solutions as financing opportunities are identified, benefiting both residents and municipal infrastructure and aligning the municipality with modern mitigation and sustainability practices.
2026-ANA-LP-027	P –27	Develop an inter-agency liaison between the municipality and the Puerto Rico Planning Board with the purpose of including regulations that regulate and control construction in areas that present significant risks to the coasts such as erosion.	Coastal Modification	Medium	Safety & Security	Leader: Administration Support: Emergency Management (OMME).	Municipal, State or Federal	Medium Term	Current Status: In Continuous Execution – Regulations incorporated through the revision of the POT to control construction in coastal zones in continuous interagency coordination. This strategy will provide qualitative benefits by evidencing concrete progress through the integration of coastal erosion control policies within the Land Use Plan (see p. 124, Section 3.1.8.9 and public policy on p. 221), which allows for the regulation of new construction in high-risk areas.

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-ANA-LP-028	P –28	Implement a liaison between the municipality's Planning Committee and organizations, community groups, faith-based entities, and others, by creating a Community committee to encourage the development and implementation of mitigation strategies at the municipal, community, and individual levels.	All	High	All	Leader: OMME Support: Administration Citizen Assistance	Municipal, State or Federal	Medium Term	Current Status: Ongoing Implementation – Community participation was integrated during the plan update; its continuity is promoted as support to the Planning Committee. This strategy recognizes that the participation of community leaders, organizations, and entities was carried out as part of the mitigation plan review process, in compliance with public participation requirements. From this base, the continuity of these links is promoted as a component of support to the Planning Committee, facilitating communication between the municipality and the communities. This approach strengthens risk identification, improves the implementation of mitigation strategies, and fosters a more inclusive and resilient process at the municipal, community, and individual levels.

Table 56: Mitigation Strategies – Natural Resources Protection

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026 – ANA –NR –001	PRN-1	Plant Vetiver (Chrysopogon zizanioides) to stabilize slopes and prevent landslides and sedimentation of water bodies and install nets, nets or safety fences that assist with the retention of landslide susceptible to landslides	Landslides	High	Transportation	Leader: Public Works Support: Emergency Management (OMME)	Municipal, State and Federal	Medium Term	Current Status: In Continuous Execution – This strategy is constantly carried out as the need arises. *Rephrased to clarify scope due to ambiguity in the previous version, incorporating additional technical information. The use of vetiver (Chrysopogon zizanioides), a technique commonly used in bioengineering for short-term slope stabilization, is specified in order to improve the accuracy and effectiveness of the strategy. This strategy strengthens soil stability in a cost-effective and sustainable way, reduces risks to infrastructure and nearby communities, and protects the quality of water resources by reducing sediment load.

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026 –ANA –NR –002	PRN –2	The municipality will maintain a commitment to be a faithful custodian and guardian, together with the corresponding state agencies, of the protected natural areas, including rustic land, through the acquisition of land, restriction of use and protection of areas susceptible to natural hazards.	All	High	Safety & Security	Leader: Administration Support: Municipal Police, Public Works	Municipal, State and Federal	Long Term	Current Status: In Continuous Execution – This strategy is performed constantly. The Municipality of Añasco continues to protect natural areas and restrict the use of areas susceptible to natural hazards. This strategy contributes to conserving the municipality's natural resources, reducing exposure to natural hazards, and protecting areas of environmental value for present and future generations.
2026 –ANA –NR –003	New	Protect natural bodies of water (streams, lagoons, ponds) and their riparian areas, in order to contribute to the thermal regulation of the environment through evaporation and natural cooling processes.	Drought, Extreme Heat, Wildfire	High	Water Systems	Leader: Administration Support: Public Works	Municipal, State and Federal	Medium Term	Current Status: New – This strategy improves environmental resilience by restoring natural water bodies and their riparian zones, which help regulate local temperatures through natural cooling processes. In addition, it improves water quality, supports ecosystems, and reduces the impacts of heat, drought, and flooding on surrounding communities.

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026 – ANA –NR –004	New	Implement vegetation management programs in high-risk areas through controlled fuel reduction (dry material, grass, dense shrubs) and the establishment of firebreaks around communities, critical infrastructure, and access corridors, with the goal of reducing the likelihood of ignition and limiting the spread of wildfires. These actions must be carried out in accordance with technical plans that define the frequency, handling methods and proper disposal of the removed material, avoiding inappropriate practices such as the uncontrolled accumulation or burning of plant waste.	Forest Fire	High	Safety & Security	Leader: Public Works Support: Emergency Management (OMME)	Municipal, State and Federal	Medium Term	Current Status: New – This strategy reduces the risk of wildfires by decreasing the buildup of vegetative fuels and limiting the spread of fire near communities and critical infrastructure.
2026 – ANA –NR –005	New	Restoration of complete coastal wetland systems (mangrove-marsh-beach transition) to increase sediment retention, buffer wave energy or hydraulic impact, allow natural migration of ecosystems in the face of sea level rise and also to function as a buffer zone to capture and filter pollutants transported by the flooding of the event.	Storm Surge, Flood, Tropical Cyclone, Coastal Modification	High	Safety, Security, Hazardous Materials	Leader: Public Works Support: Emergency Management (OMME)	Municipal, State and Federal	Short Term	Current Status: New – This strategy strengthens coastal resilience by reducing the impact of waves and flooding, improving sediment retention, and supporting natural protection from sea level rise and pollution associated with coastal events.

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2023 – ANA –NR –006	New	Implementation of "living shoreline" solutions using a combination of native coastal vegetation, preferably salinity-tolerant species (halophytes), as well as oyster reefs, anchored logs and biodegradable elements, strategically designed and installed to stabilize the coastline, reduce erosion and maintain natural ecological processes in the face of waves and sea level rise. Species tolerant to adverse conditions, such as vetiver (Chrysopogon zizanioides), which have demonstrated resistance to temporary wave or flood events, may be used in transition zones.	Coastal Modification, Tsunami	High	Safety & Security	Leader: Public Works Support: Emergency Management (OMME)	Municipal, State and Federal	Short Term	Current status: New – This strategy strengthens coastal resilience by reducing erosion, conserving coastal ecosystems, and increasing natural protection from waves and sea level rise.
2026 – ANA –NR –007	New	Protect ecological corridors and open spaces that facilitate natural ventilation and airflow in urban areas, avoiding their fragmentation by development, in order to mitigate heat accumulation.	Extreme Heat	High	Safety, Security, Food, Hydration and Shelter	Leader: Management Support: Public Works, Recovery, Municipal Police	Municipal	Short Term	Current Status: New – The City will promote coordination with state and federal agencies to identify and protect ecological corridors and open spaces that favor natural ventilation and contribute to reducing heat accumulation in urban areas.

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026 – ANA –NR –008	New	Create shade corridors, strategic reforestation projects with drought-resistant and native species, rain gardens, infiltrating soils, and vegetative firebreak strips to reduce urban temperatures, increase moisture retention, and decrease fire spread.	Drought, Extreme heat, Wildfire	High	Safety, Security, Food, Hydration and Shelter	Leader: Management Support: Public Works, Recovery	Municipal, State and Federal	Medium Term	Current Status: New – This strategy encourages reforestation, the creation of rain gardens, and fire strips which will provide less heat, humidity and fewer fires.

Table 57 Mitigation Strategies Property Protection *2026 ID*	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026 –ANA –PP –001	PP –1	Design and implement runoff water management system improvements to eliminate existing and future local flooding in: • New Street • San Antonio Urb.	Flooding	Medium	Water Systems	Leader: Recovery Support: Administration	Municipal, FEMA, CDBG	Medium Term	Current Status: In Execution – In the procurement phase, with requests for proposals in progress prior to award. This strategy will improve runoff water management in areas identified with recurring flooding problems, reducing property risks and facilitating safe access for residents. In addition, it will contribute to the protection of existing infrastructure and the strengthening of the resilience of the municipality to heavy rain events in sectors such as Calle Nueva and Urb. San Antonio.
2026 –ANA –PP –002	PP –2	Make repairs to existing stormwater drainage infrastructure to facilitate the entry and exit of neighbors in the PR-109, Bo. Cañas and Bo. Miraflores	Flooding	High	Water Systems	Leader: Emergency Management (OMME) Support: Public Works	Municipal, DTOP, CDBG	Long Term	Current Status: In Funding – In the process of identifying and securing funding for project implementation. This strategy will provide qualitative benefits by improving stormwater management and reducing flood risks in vulnerable areas. In addition, it will facilitate safe access for residents during rain events, protect existing

Table 57 Mitigation Strategies Property Protection *2026 ID*	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
									infrastructure, and increase the municipality's resilience to extreme events.
2026 –ANA –PP –003	PP –3	Designate funds to establish the Office of City Planning, including employees and equipment	All	High	All	Leader: Administration Support: Finance	Municipal	Long Term	Current Status: In Continuous Execution – Planning functions are performed with existing personnel and resources within the municipal structure. The municipality has not yet established an independent planning office, but continues to perform these functions through its current agencies. The creation of a formal office remains a future alternative, subject to the availability of resources and institutional needs. This strategy strengthens the municipality's institutional capacity for long-term

Table 57 Mitigation Strategies Property Protection *2026 ID*	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
									planning, risk management, and the effective implementation of mitigation projects and measures.
2026 –ANA –PP –004	PP –4	Set slope to Bo. Casey to prevent the collapse of a cement residence	Landslides	High	Safety & Security	Leader: Public Works Support: Administration	Local, State, and Federal	Short Term	Current Status: At Procurement – Project in Progress; stabilization works are being carried out by means of gabions on several slopes in the area. This strategy will provide qualitative benefits by reducing the risk of landslides in the Bo. Casey, stabilizing the ground and protecting vulnerable structures. In addition, it contributes to safeguarding the lives and property of residents, improving the safety of the environment and strengthening the resilience of the municipality to heavy rain

Table 57 Mitigation Strategies Property Protection *2026 ID*	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
									events that can cause soil instability.
2026 –ANA –PP –005	PP –5	Inspection of the Municipality's shelters to make non-structural improvements, i.e., fixing cupboards, shelves, etc. • Carmen Casasus School • Isabel Suárez School • Luis Muñoz Marín School	Earthquake	Medium	Food, Hydration and Shelter	Leader: Emergency Management (OMME) Support: Recovery	Municipal	Short Term	Current Status: Ongoing Implementation – This strategy is carried out annually to ensure that refugees are in the best conditions for the safety of refugees. This strategy improves the safety and functionality of municipal shelters, reduces the risk of damage and injury during seismic events, and contributes to providing safer spaces for refugees.

Table 57 Mitigation Strategies Property Protection *2026 ID*	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026 –ANA –PP –005	PP –6	Conduct a study in a tsunami-prone area to determine mitigation measures including ordinances, regulations, building codes, vertical evacuation, etc.	Tsunami	N/A	N/A	N/A	N/A	N/A	Current Status: Reclassified – Will be removed from this table at the next revision of the Mitigation Plan and will be assigned the new xxx ID under Local Planning and Regulations. This strategy will be eliminated in the next LHMP revision.
2026 –ANA –PP –005	PP –7	Acquire the Geographic Information System (GIS) tool to obtain a georeferenced inventory (GPS) of critical municipal facilities that need to be rehabilitated, reinforced or demolished. This information makes it easier to process claims for funds after a disaster. It also improves the statistical base of the municipality, helping to optimize the quality and accuracy of the risk	All	N/A	N/A	N/A	N/A	N/A	Current Status: Withdrane– Removed from this plan; although ArcGIS is used for projects, it will not be deployed for critical facility inventory. The Mitigation Committee has determined that this action is no longer viable. It will be eliminated in the next revision of the Mitigation Plan." This strategy is eliminated as a specific action, since the municipality does not contemplate expanding the use of GIS systems for the inventory of critical facilities

Table 57 Mitigation Strategies Property Protection *2026 ID*	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
		profile of natural hazards and people and structures located in areas of high vulnerability.							due to the financial viability of maintaining that license versus the benefit. ArcGIS is currently used for project location and management, while the identification and evaluation of critical structures continues to be done through other municipal mechanisms. This approach allows operational functions to be maintained without requiring the adoption of new systems or additional investments.
2026 –ANA –PP –005	PP –8	Implement, maintain, and update a detailed inventory of structures and infrastructure found in tsunami-susceptible areas for the purpose of developing mitigation strategies tailored to the particular needs of these hazard zones.	Tsunami	High	Safety & Security	Leader: Emergency Management (OMME) Support: Recovery	Municipal, State or Federal	Medium Term	Current Status: Ongoing Implementation – New tsunami strategies have been added considering vulnerable areas and infrastructure inventory that could be affected. This strategy strengthens tsunami planning and preparedness, facilitates the identification of vulnerable infrastructure, and supports the development of mitigation measures to reduce risks to the community.

Table 57 Mitigation Strategies Property Protection *2026 ID*	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026 –ANA –PP –005	PP –9	Through inter-agency agreements, the municipality will create a plan for the reinforcement of housing and/or remove structures unsuitable for natural hazards. Consequently, the municipality will promote, through surveillance committees, the development of structures in accordance with the current building codes and the prohibition of illegal constructions.	Storm Surge, Flood, Tropical Cyclone, Coastal Modification	High	Safety & Security	Leader: Administration Support: Municipal Legislature	Municipal, State or Federal	Medium Term	Current Status: Ongoing Execution – Removal of structures exceeds municipal jurisdiction and requires state support. However, the municipality continues to encourage and monitor the development of code-compliant structures. This strategy contributes to reducing the vulnerability of homes and structures to natural hazards, promotes compliance with building codes and encourages safer and more resilient development.
2026 –ANA –PP –005	PP –10	Create inter-agency agreements for the acquisition of land and properties located in areas susceptible to liquefaction and/or seismic waves, preventing the development of new structures and maintaining these areas as open spaces (EAs)	Earthquake	N/A	N/A	N/A	N/A	N/A	Current Status: Withdrawn– Will be eliminated in the next revision of the Mitigation Plan as it goes beyond the responsibilities and powers delegated to the municipality. The acquisition is not justified due to the risk of liquefaction.

Table 57 Mitigation Strategies Property Protection *2026 ID*	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026 –ANA –PP –005	PP –11	Create interagency agreements for the purpose of determining the earthquake-resistant capacity of public schools in the municipality in order to reinforce those schools built before 1987, in accordance with current building codes. Likewise, identify schools that need non-structural reinforcement.	Earthquake	High	Safety & Security	Leader: Administration Support: Emergency Management (OMME)	Municipal, State or Federal	Long Term	Current Status: In Execution: This strategy is developed through interagency efforts and partial reinforcement of identified schools. This strategy will improve structural safety, reduce earthquake risks, and protect students and school staff.
2026 –ANA –PP –005	PP –12	Implement non-structural mitigation measures to protect the movable property of critical facilities and reduce injuries caused by the sudden and violent movement of these assets.	Earthquake	High	Safety & Security	Leader: Emergency Management (OMME) Support: Citizen Assistance	Municipal, State or Federal	Short Term	Current Status: In Continuous Execution – Measures are implemented as needed to secure furniture and protect property in critical facilities. This strategy reduces personnel injuries, minimizes damage to critical equipment, and improves operational continuity after seismic events.

Table 57 Mitigation Strategies Property Protection *2026 ID*	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026 –ANA –PP –005	PP –13	Conduct periodic inspections to examine the structural and non-structural conditions of the municipality's critical facilities. Once the municipal assets that need structural or non-structural modifications are identified, joint mitigation measures will be implemented to reduce loss of life and property. Likewise, this strategy will allow the continuity of the facility's operations after the event occurs.	All	High	Safety & Security	Leader: Emergency Management (OMME) Support: Recovery	Municipal, State or Federal	Short Term	Current Status: In Continuous Execution – This strategy is carried out annually with the intention of maintaining optimal conditions to protect integrity and security. This strategy helps identify and address vulnerabilities in critical facilities, reduces the risk of damage from natural hazards, and helps ensure the continuity of the municipality's essential services before, during, and after an emergency.
2026 –ANA –PP –005	PP –14	Implement a georeferenced system to inventory the occurrence of landslides in the municipality, including information on the damage, profile, magnitude, and frequency of the event.	Landslides	High	Communication	Leader: Emergency Management (OMME) Support: Recovery	Municipal, State or Federal	Medium Term	Current Status: Running Continuously – "My Coordinates" and "GPS Coordinates" are used to georeference landslides and update inventory. This strategy improves event log accuracy, supports planning, and strengthens landslide response.

Table 58: Mitigation Strategies - Structural Improvements

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-ANA-SI-001	SP –1	Proyecto de estabilización de terreno Bo. María Sector Ajíes. Instalar muros de gaviones y recubrimiento en hormigón.	Landslides	High	Safety & Security	Leader: Recovery Support: Public Works	Federal Funds	Long Term	Current Status: In Design – This strategy is being worked on through a FEMA-funded project. The design phase has been completed, and we will soon request proposals to move on to the construction phase. This strategy will reduce the risk of landslides, protect the safety of residents and nearby infrastructure, and increase ground stability in vulnerable areas.
2026-ANA-SI-002	SP –2	Desarrollar un programa de manejo de reservas de agua mediante la implementación de un sistema de colección y conservación de agua por lluvia en cisternas u otras herramientas de almacenamiento de aguas alternas.	Drought, Tropical Cyclone	Medium	Water Systems	Leader: Emergency Management (OMME) Support: Administration	Municipal, State or Federal	Medium Term	Current Status: Funding – Funding and grant opportunities are identified to implement water collection and storage systems. This strategy will increase resilience to droughts, ensure water availability in emergencies, and reduce dependence on the aqueduct system.

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-ANA-SI-003	SP –3	Soterrar el sistema eléctrico y de comunicaciones en el municipio. Asimismo, el municipio supervisará que los trabajos de desganche y poda de árboles próximo a infraestructura eléctrica se lleven a cabo por parte de las agencias correspondientes y sin reducir las áreas de sombra.	Tropical Cyclone, Extreme Heat	High	Energy	Leader: Public Works Support: Administration	Municipal, State or Federal	Long Term	Current Status: Funding – This strategy requires interagency coordination and the identification of external funding sources for its progressive implementation, particularly for the burying of electrical and communications infrastructure, as well as to strengthen vegetation maintenance programs near them. it will minimize interruptions of essential services, improve public safety through the proper management of vegetation and contribute to a more resilient and reliable infrastructure in the municipality.
2026-ANA-SI-004	SP –4	Actualizar los sistemas de alcantarillados pluviales.	Storm Surge and Flooding	High	Water Systems	Leader: Public Works Support: Emergency Management (OMME)	Municipal, State or Federal	Long Term	Current Status: In Design – This strategy is in the initial phase of evaluation for the modernization and updating of the municipality's storm sewer systems. This strategy will improve drainage capacity,

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
									reduce the frequency and intensity of urban flooding, protect critical infrastructure and property, and strengthen the municipality's resilience to heavy rainfall and storm events.
2026-ANA-SI-005	SP –5	Estudios de vulnerabilidad y posible rehabilitación estructural de las represas y vasijas de retención ubicada en Añasco.	Flood, Earthquakes	High	Water Systems	Leader: Public Works Support: Emergency Management (OMME), Administration	Municipal, State or Federal	Medium Term	Current Status: In Design – This strategy is in the initial phase of evaluation for the performance of vulnerability studies of dams and retention vessels in the municipality of Añasco. This strategy will identify structural risk conditions, prioritize rehabilitation interventions, reduce the possibility of failures in the face of extreme events, and strengthen the safety of communities and infrastructure downstream.

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-ANA-SI-007	New	Proyecto de estabilización de terreno Bo. María Sector Ajíes. Instalar muros de gaviones y recubrimiento en hormigón.	Extreme Heat	High	Safety & Security	Leader: Emergency Management (OMME) Support: Administration	Municipal	Medium Term	Current Status: New – This strategy strengthens the City's capacity to protect the population during extreme heat events, providing safe cooling spaces and reducing the health risks associated with high temperatures.
2026-ANA-SI-008	New	Designar y preparar instalaciones municipales en todo el municipio para servir como centros de enfriamiento durante olas de calor.	Extreme Heat	High	Food, Hydration and Shelter	Leader: Public Works Support: FTA Public Transport, Recovery	Municipal, State or Federal	Medium Term	Current Status: New – This strategy improves the comfort and safety of pedestrians and transit users by increasing the availability of shade and reducing exposure to extreme heat.
2026-ANA-SI-009	New	Reacondicionar (cuando sea necesario) las paradas de transporte para proveer sombra a peatones y usuarios del transporte público.	Forest Fire	High	Safety, Water Systems	Leader: Public Works Support: Emergency Management (OMME)	Municipal	Short Term	Current Status: New – Strategy identified during the plan update to strengthen wildfire response capacity. Priority locations and possible sources of financing for its implementation will be evaluated.

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-ANA-SI-010	New	Diseñar e instalar puntos fijos de abastecimiento de agua en zonas estratégicas de alto riesgo (tanques, hidrantes rurales, cisternas o estanques artificiales) para facilitar la respuesta rápida de brigadas contra incendios forestales, reduciendo tiempos de operación y aumentando la capacidad de supresión.	Landslides, Floods, Drought and Extreme Heat	High	Water Systems	Leader: Public Works Support: Recovery	Municipal, State or Federal	Short Term	Current Status: New – Incorporated strategy to promote sustainable runoff management and risk reduction associated with floods, landslides, drought and extreme heat. It requires evaluation of potential areas for implementation.
2026-ANA-SI-011	New	Construcción de sistemas de manejo de escorrentias como bioswales o zanjas de infiltración, jardines de lluvia (rain gardens) y áreas de retención natural, diseñadas para capturar escorrentía superficial y permitir su infiltración al suelo, favoreciendo la recarga de acuíferos mientras a su vez reduce la escorrentía superficial que al acumularse puede ocasionar inundaciones y deslizamientos.	Landslides	High	Transportation	Leader: Public Works Support: Recovery	Municipal, State or Federal	Short Term	Current Status: New – Municipal roads with greater susceptibility to landslides will be identified to evaluate slope stabilization alternatives and priorities for intervention.

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-ANA-SI-012	New	Implementación de sistemas de estabilización de taludes mediante muros de contención, soil nailing y/o mallas geosinteticas para reducir el riesgo de desprendimientos en carreteras municipales expuestas a altas pendientes y lluvias intensas	Dam Failure	High	Transportation	Leader: Public Works Support: Recovery	Municipal, State or Federal	Short Term	Current Status: New – This strategy allows for rapid response to hazardous situations and facilitates the timely implementation of mitigation measures. Maintaining access roads is critical to effective risk management and the protection of public safety.
2026-ANA-SI-013	New	Desarrollar y mantener caminos de acceso transitables en todo tipo de clima para garantizar un acceso confiable a la represa para inspección, operación, mantenimiento y respuesta a emergencias en cualquier condición.	Dam Failure	High	Water Systems	Leader: Public Works Support: Recovery	Municipal, State or Federal	Short Term	Current Status: New – This strategy should establish criteria and procedures for sediment removal in order to ensure proper operation of the dam and reduce potential hazards. Preventative maintenance helps avoid unsafe hydraulic or structural conditions.

Table 59: Mitigation Strategies - Emergency Services

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026 – ANA – ES–001	ES –1	Installation of storm shutters in the following shelters and hospital: • Carmen Casasus School • Isabel Suárez School • Añasco CDT	Tropical Cyclone	N/A	N/A	N/A	N/A	N/A	Current Status: Reclassified – Will be removed from this table at the next revision of the Mitigation Plan and will be assigned the new identification 2026 – ANA –PP –012 under Property Protection.
2026 – ANA – ES–002	ES –2	Implement a flood prevention program for critical facilities: • Government Center • Police Headquarters • Mayor's Office • Center for the Elderly	Flooding	Medium	Safety & Security	Leader: Public Works Support: Emergency Management (OMME), Administration	Municipal, State and Federal	Medium Term	Current Status: In Design – This strategy is in the early planning phase for the development of a flood prevention program at critical facilities in the municipality, including the Government Center, Police Headquarters, City Hall, and Senior Center. This strategy will reduce the exposure of essential facilities to flood events, reduce damage to infrastructure and equipment, and ensure the operational continuity of critical services for citizens during emergencies.

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026 – ANA – ES–003	ES –3	Construct structures or identify existing structures that serve as vertical tsunami evacuation shelters. These structures must be raised above tsunami flood levels and built to withstand the onslaught of an earthquake, waves, or other loads associated with a tsunami.	Tsunami	Medium	Safety & Security	Leader: Emergency Management (OMME) Support: Public Works Administration	Municipal, State and Federal	Long Term	Current Status: In Execution – This strategy is in the phase of identification and evaluation of existing structures with the potential to be used as vertical tsunami evacuation shelters, having identified some preliminary alternatives, without any new construction having been carried out so far. This strategy will improve the ability to respond to tsunami events, allow safer evacuation in vulnerable areas, and reduce the risk of loss of life by providing elevated and structurally safe shelter alternatives during emergencies.
2026 – ANA – ES–004	ES –4	After the passage of hurricanes Irma and Maria in September 2017, Puerto Rico recognized the vulnerability of critical infrastructure and the continuity of operations of essential services and/or essential services in the face of a natural event. For this reason, the municipality is committed to adopting alternative electricity generation tools through the installation of solar panels and energy storage batteries in critical facilities.	Tropical Cyclone	High	Energy	Leader: Federal Programs Support: Administration	Municipal, State and Federal	Short Term	Current Status: Up for Procurement – This strategy is being developed through a FEMA project from HMGP. We are currently soliciting proposals to complete the procurement and installation of the generators. This strategy strengthens the municipality's energy resilience by ensuring the continuity of essential services during and after tropical cyclone events through backup power generation systems. It reduces the impact of interruptions in the power grid and allows critical facilities to be kept operational during emergencies. In turn, it lays the foundation for a possible future transition to renewable energy systems, such as solar panels with batteries, increasing energy self-sufficiency in the long term.

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026 – ANA – ES–005	ES –5	Implement a planned municipal communication program that can be used after the occurrence of a hurricane. Puerto Rico's experience in the face of a natural event has demonstrated the vulnerability of communications infrastructure to the onslaught of a natural hazard, for this reason the municipality will acquire radio frequency equipment, satellite radios from NOAA, among others.	All	High	Communication	Leader: Emergency Management (OMME) Support: Works Publication Administration	Municipal, State and Federal	Medium Term	Current Status: In Execution – This strategy is in the partial implementation phase, since the municipality currently has radio frequency equipment, satellite systems and computerized tracking tools for emergency management, which are part of the planned municipal communication program. This strategy will strengthen communication capacity during and after atmospheric events, allow for more effective coordination of emergency operations, and ensure the continuity of the flow of critical information even when conventional telecommunications infrastructure is affected.
2026 – ANA – ES–006	ES –6	Carry out an inventory of critical municipal facilities, vulnerable to damage due to hurricane winds, for the installation of storm shutters in these assets.	All	N/A	N/A	N/A	N/A	N/A	Current Status: Reclassified – Will be removed from this table in the next revision of the Mitigation Plan and will be assigned the new identification 2026 – ANA –PP –013 under Property Protection.
2026 – ANA – ES–007	ES –7	Maintain approved Tsunami Ready Plan certification, including maintenance or acquisition of the warning siren system. This mitigation strategy will be implemented in coordination with the Puerto Rico Seismic Network.	Tsunami	High	All	Leader: Emergency Management (OMME) Support: Administration	Municipal, State and Federal	Immediate	Current Status: In Continuous Execution – This strategy is in active implementation, as the municipality maintains the Tsunami Ready Plan certification and is currently working on the acquisition of a new tsunami warning system through a project funded by FEMA, in coordination with the Puerto Rico Seismic Network. This strategy ensures timely preparedness and response to tsunami events, strengthens early warning

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
									systems, improves the evacuation capacity of the population, and significantly reduces the risk of human loss through more effective and reliable emergency communication.
2026 – ANA – ES–008	ES –8	Design, construct, and/or designate structures to implement collection centers and/or safe rooms and/or Emergency Operations Centers (ECC/EOCs), through appropriate municipal agencies or dependencies, to store non-perishable supplies, including, but not limited to: food, basic necessities, long-term and short-term medical items (including medications), communication equipment, among others.	All	High	Food, Hydration and Shelter	Leader: Public Works Support: Emergency Management (OMME)	Municipal, State and Federal	Long Term	Current Status: In Execution – This strategy is in the implementation phase, as the municipality has identified and established several collection centers in different neighborhoods of Añasco, and is currently developing a FEMA-funded project for the construction of a centralized Emergency Operations Center with shelter and supply storage capabilities. This strategy strengthens emergency response and coordination capacity, improves the availability and distribution of essential supplies in different communities, and centralizes critical emergency management operations, reducing response times and increasing the municipality's operational efficiency
2026 – ANA – ES–009	New	Improve or develop integrated communication and early warning systems capable of issuing warnings through multiple channels, including alarms, visual signals, and digital platforms, to inform the community about natural hazards, expected risks, protective measures, evacuation routes, shelter locations, road	All	High	Communication	Leader: Emergency Management (OMME) Support: Administration	Municipal, State and Federal	Medium Term	Current Status: New - The municipality will evaluate alert and notification alternatives to strengthen emergency communication and improve the dissemination of warnings to the community. This strategy will strengthen resilience, streamline response, improve coordination, and reduce critical risks.

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
		conditions, and other critical information before, during, and after an event, supporting a timely response and a more effective recovery.							
2026 – ANA – ES–010	New	Develop and implement educational workshops and orientation campaigns on wildfire prevention, including the risks associated with illegal burning, the safe handling of combustible materials, the identification of high-risk conditions, and preventive measures that residents can adopt to reduce the likelihood of fires.	Forest Fire	Medium	Safety & Security	Leader: Emergency Management (OMME) Support: Administration	Municipal	Medium Term	Current Status: New – This strategy promotes changes in community behavior by educating and raising awareness about safe practices, reducing the incidence of forest fires caused by human activities, such as illegal burning. In addition, it contributes to the protection of lives, property, critical infrastructure, natural resources and air quality.

Table 60: Mitigation Strategies: Education and Awareness

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-ANA-EA-001	EA –1	Develop an education campaign to warn about hazards, vulnerability and promotion of mitigation measures. • Educate property owners on safety techniques during and after an earthquake. • Provide information on structural and non-structural improvements to property owners vulnerable to different hazards • Provide NFIP information and encourage the community to obtain flood insurance.	All	High	Food, Hydration and Shelter	Leader: Emergency Management (OMME) Support: Public Works Administration	Municipal	Medium Term	Current Status: In Execution – This strategy is in partial implementation, as the municipality develops ongoing educational campaigns through social media to guide citizens about natural hazards, safety measures during earthquakes, and general mitigation actions, although specific outreach on the NFIP has not yet been implemented. This strategy strengthens community preparedness for seismic and hydrometeorological events, promotes safety practices in the population, improves awareness of risk reduction, and fosters a culture of prevention that contributes to reducing human and material losses.
2026-ANA-EA-002	EA –2	Develop an education campaign to warn about hazards, vulnerability and promotion of mitigation measures. • Educate property owners on safety techniques during and after an earthquake. • Provide information on structural and non-structural improvements to property owners vulnerable to different hazards. • Provide NFIP information	Flood, Earthquakes, Tropical Cyclone	N/A	N/A	N/A	N/A	N/A	Current Status: Withdrawn– Consolidated with strategy 2026-ANA-EA-002. It will be removed in the next revision of the Mitigation Plan.

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
		and encourage the community to obtain flood insurance.							
2026-ANA-EA-003	EA –3	Promote education about natural hazards and risk mitigation in the municipality's public schools through interagency agreements with the Department of Education. In this way, it is hoped to develop a generation that is more informed about the importance of prevention, planning, mitigation of natural hazards and resilience.	All	High	All	Leader: Emergency Management (OMME) Support: Administration	Municipal, State and Federal	Medium Term	Current Status: In Continuous Execution – This strategy is in active implementation through coordination between the municipality and the Department of Education, through educational talks offered by the Municipal Office for Emergency Management in the municipality's schools on natural hazards and mitigation measures. This strategy strengthens the culture of prevention in the student population, promotes early awareness of natural hazards, and improves the preparedness and resilience of future generations to emergency events.
2026-ANA-EA-004	EA –4	Develop an awareness and education program, through workshops, talks and/or publications, for merchants, stakeholders and the general public about the importance of water and alternatives for its conservation, rainwater	Drought, Tropical Cyclone, Earthquake	Medium	Water Systems	Leader: Emergency Management (OMME) Support: Administration	Municipal, State and Federal	Medium Term	Current Status: In Design – This strategy is in the initial planning phase for the development of an awareness and education program aimed at merchants, stakeholders and the general public on the importance of the water resource and its conservation alternatives. This strategy will promote the

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
		harvesting, storage and protection.							responsible use of water resources, encourage conservation practices such as rainwater harvesting and storage, and contribute to the protection of the municipality's water resources through greater education and community participation.
2026-ANA-EA-005	EA –5	Educate businesses, stakeholders and the general public, through workshops, talks, publications, external resources, about the importance of preventing fires due to spontaneous combustion of pastures or others wildfire incidents in the municipality.	Forest Fire	Medium	Safety & Security	Leader: Emergency Management (OMME) Support: Municipal Police Administration	Municipal, State and Federal	Medium Term	Current Status: In Design – This strategy is in the initial planning phase for the development of educational activities aimed at merchants, stakeholders and the general public on the prevention of spontaneous combustion fires of pastures in the municipality. This strategy will reduce the risk of fires in areas of dry vegetation, protect lives and property, and promote preventive practices that contribute to public safety and environmental damage reduction.
2026-ANA-EA-006	EA –6	Inform the public, through workshops, talks and/or publications, about the importance and benefits of the National Flood Insurance Program (NFIP).	Flooding	N/A	N/A	N/A	N/A	N/A	Current Status: Retired – Consolidated with strategy 2026-ANA-EA-002. It will be removed in the next revision of the Mitigation Plan.

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-ANA-EA-007	EA –7	Develop an educational portal on the Internet to keep the population informed about natural hazards and the importance of implementing mitigation measures to develop safe and resilient communities.	All	Medium	Safety & Security	Leader: Administration Support: Finance, Emergency Management (OMME)	Municipal, State and Federal	Medium Term	Current Status: In Execution – This strategy is in the development and implementation phase, using the municipal portal municipiodeanasco.com (in the process of improvements) and the official Facebook page of the Municipal Government of Añasco for the dissemination of educational information on natural hazards and mitigation measures. This strategy expands the reach of preventive education to the population, facilitates timely access to information on natural hazards, and strengthens community awareness through multiple digital communication channels, promoting more informed and resilient communities.
2026-ANA-EA-008	EA –8	Implement an educational program through workshops, talks, and/or publications to inform homeowners, businesses, and the general public about the dangers of building or acquiring property in areas susceptible to coastal erosion.	Coastal Modification	High	Safety & Security	Leader: Emergency Management (OMME) Support: Municipal Police, Administration	Municipal, State and Federal	Medium Term	Current Status: Ongoing Implementation – This strategy is being implemented through the municipality's general educational efforts, including guidance to citizens on the risks associated with coastal erosion, although it has not been formalized as a specific structured program. This strategy strengthens public awareness of development risks in vulnerable coastal areas, promotes informed decisions in property acquisition and construction, and contributes to the reduction of

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
									economic losses and damage to life and property through prevention and ongoing education. This strategy helps reduce future economic losses, property damage and risks to life and promotes safer and more sustainable urban development, reduces pressure on municipal resources for response and recovery, and contributes to the protection of coastal ecosystems.
2026-ANA-EA-009	EA –9	Develop, in collaboration with central agencies and non-profit organizations, information campaigns (educational materials, talks, announcements) on the risks of extreme heat and the preventive measures applicable at home and in outdoor spaces.	Extreme Heat	High	Safety & Security	Leader: Emergency Management (OMME)	Municipal	Medium Term	Current Status: New – This strategy will reduce unnecessary exposure to extreme heat events, minimize all costs related to medical emergencies associated with extreme heat, and promote sustainable and resilient practices during extreme heat events.
2026-ANA-EA-010	New	Develop an educational program for residents and contractors on safe slope management practices, including prohibiting cuts without technical design, proper runoff management, and the importance of maintaining vegetation cover. The program should emphasize the negative impacts of indiscriminate herbicide use and	Extreme Heat, Landslides, Tropical Cyclone	High	Safety & Security	Leader: Public Works Support: Administration	Municipal	Short Term	Current Status: New – This strategy will promote proper slope management practices, reduce soil erosion and landslide risk, and encourage the protection of vegetation cover as a mitigation measure.

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
		vegetation removal, which can increase erosion and lead to landslides.							

6.5 Participation in the NFIP

Covered under the PRPB, the Municipality maintains continuous participation in the National Flood Insurance Program (NFIP) and remains committed to meeting all program requirements to reduce flood risk and protect life and property. Ongoing participation in the NFIP enables residents and businesses to access federally backed flood insurance while promoting sound floodplain management practices. The PRPB, on the municipality's behalf, enforces floodplain management regulations consistent with FEMA requirements, including the adoption and use of Flood Insurance Rate Maps (FIRMs) and Flood Insurance Studies (FIS) for development decisions. Local permitting, inspection, and enforcement activities help ensure that new construction and substantial improvements in Special Flood Hazard Areas comply with applicable elevation and floodproofing standards. The Municipality also supports public awareness and education activities related to flood risk, insurance requirements, and mitigation measures. Continued compliance with the NFIP strengthens eligibility for federal hazard mitigation funding and supports the long-term reduction of flood-related damages.

7. Plan Maintenance

This chapter describes the procedures and actions necessary to ensure that the Plan is effectively implemented, regularly reviewed, and maintained in alignment with the established mitigation goals and objectives. In some instances, Plan updates may require adjustments to proposed mitigation actions to reflect changes in on-site conditions that could either increase or reduce the level of risk affecting certain areas.

In accordance with federal requirements, the Local Hazard Mitigation Plan (LHMP) review process must include the following elements:

- A description of the methods and schedule for monitoring, evaluating, and updating the Mitigation Plan within a five-year period.
- A process for integrating the Mitigation Plan's requirements into other applicable local planning mechanisms, such as comprehensive plans or capital improvement plans.
- A description of how the community will continue to participate in the Plan's review and maintenance process.

7.1 Point of Contact

The designated point of contact is responsible for the monitoring, revision, and update of the Añasco. LHMP is as follows:

Name:	Adalberto Sagardía
Position:	Director
Office:	Oficina de Recuperación
Telephone:	787-826-3100 Ext. 2014
Email:	asagardia@anasco.gobierno.pr

7.2 Continuous Public Participation (D1-a)

The Municipality of Añasco is committed to ensuring ongoing public participation by implementing the following engagement methods:

- Public education and awareness initiatives
- Surveys
- Community workshops and meetings held throughout the municipality

Consistent with this commitment, public participation and community education are integral components of several mitigation strategies included in this Plan. Residents are encouraged to submit comments and participate in LHMP updates at any time, including requesting copies of the Plan during its development, monitoring, and maintenance phases.

Each time a progress report is completed, it will be made available for public review. Plan progress will also be discussed periodically during public meetings and shared through social media and other communication platforms. Public participation notices will be distributed throughout all monitoring and oversight stages of the Plan. Additionally, the Municipality will continue providing presentations to community groups regarding the LHMP and the status of mitigation strategy implementation. These groups may include elected officials, schools, and other community organizations. The Municipality will also promote civic engagement and preparedness education by offering training courses and workshops—such as Community Emergency Response Team (CERT) programs—and by informing residents about the National Flood Insurance Program (NFIP) and other relevant initiatives.

Mitigation efforts will be tailored to address the specific vulnerabilities and needs of individual communities, supporting the development of a more informed, prepared, and resilient population. This approach underlines the Municipality's commitment to sustained community engagement throughout the Plan's effective period, updating cycles, and post-adoption activities.

7.3 LHMP Oversight (D2-a)

The Municipality's strategy for Plan implementation, monitoring, and evaluation establishes a framework that promotes collaboration, information sharing, and innovation. Through its Planning Committee, composed of representatives from various municipal agencies and departments, the Municipality will work with partners and residents to apply a localized and coordinated approach to hazard mitigation. This collaborative strategy is intended to reduce losses, address community needs, and strengthen the Municipality's capacity to withstand future hazard events.
The Plan will be monitored to assure:

- Maintain current and accurate hazard and risk information
- Ensure mitigation strategies reflect community and stakeholder priorities

- Comply with federal and Commonwealth LHMP requirements
- Maintain eligibility for mitigation funding
- Ensure consistency with other local and regional planning efforts

To support effective implementation, the Municipality will leverage existing resources and infrastructure planning processes. Mitigation actions identified as immediate or short-term will be pursued over the next five (5) years, subject to available funding and resources.

7.4 LHMP Evaluation and Monitoring

Evaluation of the LHMP will be an ongoing process. In addition to FEMA's required five-year review, the Municipality will conduct annual evaluations, or more frequently if conditions warrant. Following each annual review, the Planning Committee will meet to approve a yearly progress report documenting updates, accomplishments, and progress toward mitigation goals and objectives. This report will be submitted to the Office of the Mayor and made available to the public.

A preliminary schedule for Planning Committee meetings is outlined below:

Table 61: Preliminary Planning Committee Meeting Schedule

Time Period	Participants	Purpose of the Meeting
Annual Meeting (2027)	Planning Committee (Can be open to the public if deemed necessary)	The Committee will identify funding needs, reassess hazard priorities, develop strategies for grant applications, and conduct site visits to high-risk areas to monitor progress and engage directly with communities.
Annual Meeting (2028)	Planning Committee (Can be open to the public if deemed necessary)	The Committee will review mitigation implementation status, identify emerging risks, and evaluate community needs. Site visits

		will be conducted as necessary.
Annual Meeting (2029)	Planning Committee (Can be open to the public if deemed necessary)	The Committee will confirm progress on mitigation actions and assess the need for additional funding.
Annual Meeting (2030)	Planning Committee (Can be open to the public if deemed necessary)	The Committee will hold its final meeting prior to the next LHMP update to verify mitigation implementation status, which will be documented in the updated Plan.

7.5 LHMP Update and Revision (D2-c, D3-a)

7.5.1 Revision Following a Major Disaster

If a major emergency or disaster declaration affecting the Municipality occurs during the Plan's five-year term, the Planning Committee—along with stakeholders, community representatives, and nonprofit organizations—will convene to identify newly affected areas, revise mitigation priorities, and incorporate lessons learned. This meeting will replace the annual review scheduled for that year.

7.5.2 Five-Year Comprehensive Update

In accordance with federal guidance, the LHMP will be comprehensively updated five (5) years after approval and submitted to the State Hazard Mitigation Officer and FEMA for review and approval. Approximately eighteen (18) months prior to the Plan's expiration, the review process will begin, including a full evaluation of the municipal profile, risk assessment, and mitigation strategies, with attention to updated guidance and requirements.

7.6 Integration with Other Planning Mechanisms (D3-a)

The following public policies and planning documents were considered in the development of this LHMP:

Commonwealth Level:

- Puerto Rico Land Use Plan (PUT-PR)
- Añasco Territorial Plan (PT)
- Joint Regulation for the Evaluation and Issuance of Permits
- Special Flood Hazard Areas Regulation (2021)
- Stormwater System Design, Operation, and Maintenance Regulation
- Añasco Emergency Operations Plan

Following adoption, the LHMP will guide updates to the Territorial Plan, special area plans, and urban expansion plans, and will inform municipal budget priorities. Once FEMA approval is received, a digital copy of the Plan will be submitted to the Puerto Rico Planning Board to support updates to the PUT-PR and other relevant Commonwealth planning documents.

8. DOPTION AND APPROVAL (F1-A, F1-B)

8.1 LHMP ADOPTION

Federal policy establishes LHMPs must include "Documentation that the LHMP has been formally adopted by the governing body of the jurisdiction requesting approval of the Plan. The municipality has one (1) year to adopt the Plan once it receives an *Approval Pending Adoption (APA).*"[27]

This LHMP was adopted by the Municipality of Añasco on **XXXXXX**. A copy of **Resolution**, titled *"To Adopt the 2026 Natural Hazard Mitigation Plan of the Municipality of Añasco, and for Other Related Purposes,"* is included as part of **Appendix A**.

8.2 LHMP APPROVAL

This LHMP was approved by FEMA and the SHMO on **XXXXX**. A copy of the Approval Letter, titled *"Approval of the Local Hazard Mitigation Plan, Municipality of Añasco,"* is included in **Appendix A**. FEMA's approval of the Plan is valid for a period of **five (5) years**, through **XXXXXX**

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Appendix A: Adoption and Approval

Adoption

To be included in the FEMA approved document.

Approval by FEMA

To be included in the FEMA approved document.

FEMA APA Letter

To be included in the FEMA approved document.

Review Tool Sheet

To be included in the Final Draft

Appendix B: Planning Committee

Letter of Agreement Municipality and Puerto Rico Planning Board

To be included in the final draft

JUNTA DE
PLANIFICACIÓN
GOBIERNO DE PUERTO RICO

FORMULARIO PARA DESIGNAR PERSONA(S) CONTACTO(S)
PLAN DE Mitigación CONTRA PELIGROS NATURALES

Municipio: **Añasco**

	Nombre	Teléfono	Correo electrónico
Personal Designado	Jennifer Rosario Rivera		
Personal Alterno	Daniel Feliciano Claudio		
Consultora	Brenda Torrellas		
Director OMME	Hector Soto		

Khabir B. Solares García
Nombre (letra de molde)
Alcalde

Firma
Alcalde

Fecha: 31 de diciembre de 2025

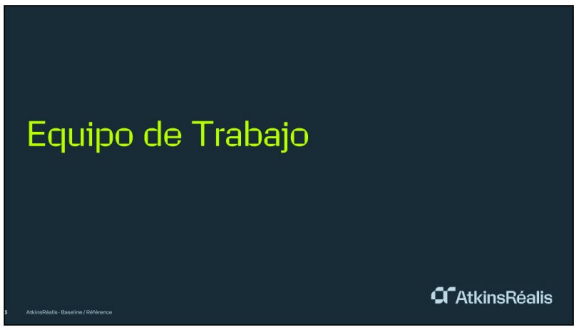
First Planning Committee Meeting

Presentation

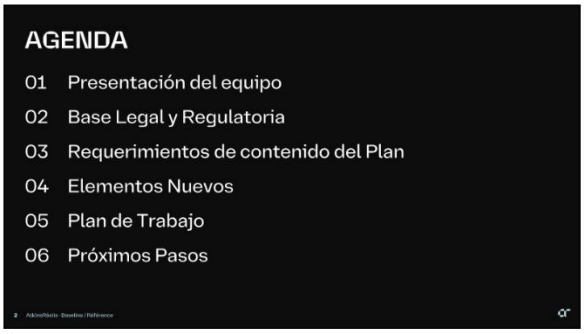
February 5, 2026



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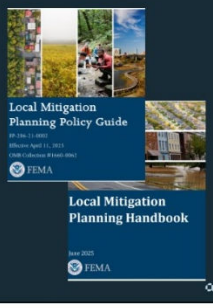
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8

Requerimientos del Plan de Mitigación

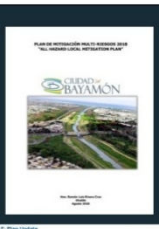
- Elemento A: Proceso de Planificación
- Elemento B: Identificación de Peligros y Evaluación de riesgos
- Elemento C: Estrategias de Mitigación
- Elemento D: Plan de Seguimiento e Implementación
- Elemento E: Actualización del Plan
- Elemento F: Adopción del Plan
- Elemento G: Peligros Potenciales ante fallos en Represas (opcional)
- Elemento H: Requisitos Estatales Adicionales



9

Elementos nuevos del Plan

- **Actualización del Plan: "Review Tool" especifica los elementos que se deben documentar para reflejar los cambios**
  - El Plan describe los cambios en las áreas propensas a peligros (ha incrementado o disminuido la vulnerabilidad o peligro)
  - Deberá reflejar los cambios en prioridades y progreso de los esfuerzos locales de mitigación.





11

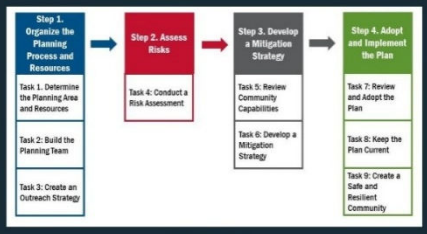
Elementos nuevos del Plan

1. **Identificación y evaluación de riesgos**
   - Se clasifica la infraestructura crítica por servicio vital o línea de vida
   - Se analiza su exposición y vulnerabilidad
   - Se prioriza por línea de vida
2. **Evaluación de capacidades**
   - Se evalúa la capacidad local para proteger servicios vitales
   - Se identifican brechas y se proponen acciones
3. **Estrategia de Mitigación**
   - Se incluyen acciones específicas para proteger, estabilizar y restaurar servicios vitales
4. **Participación de Partes Interesadas**
   - Se invita a agencias responsables o representantes de servicios vitales y se documenta su participación
   - Se comunica al público y recopila retroalimentación sobre los servicios vitales



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Proceso del Plan de Mitigación



12

Riesgos a Evaluar

13

Represas





Aguas Buenas



Comerío

15

Peligros a considerar


Terremoto


Modificaciones costeras


Marejada Ciclónica


Fuego Forestal


Deslizamientos


Inundaciones


Calor Extremo


Pandemia/ Epidemia


Tsunami


Ciclones Tropicales


Sequías

14

¿Qué necesitamos del Municipio?

- Designación del Comité de Planificación
- Apoyo en la actualización de las estrategias de mitigación del plan anterior.
- Incorporación de nuevas estrategias de mitigación.
- Actualizacion de capacidades

16

Evaluación de Capacidades

17

Participación Ciudadana

19

Capacidades

- Planificación y Reglamentación
- Técnica
- Financiera
- Alcance Comunitario
- Desarrollo de Capacidades

18

Participación Ciudadana

- Dos reuniones de participación ciudadana.
- Notificación sera publicada por Junta de Planificación.
- Publicar 15 días antes de la reunion
- Se otorga 15 días para comentarios
- Para la Segunda reunion se discute el primer borrador.
- El primer borrador sera comentado por el publico, el municipio y la Junta de Planificación



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Ventana para la primera actividad de participacion ciudadana

2 de marzo al 13 de marzo

Debe informar su fecha de reunion antes del lunes 9 de febrero.

Favor proveer varias fechas para que su analista de Planificación pueda estar.

De no recibir las fechas en o antes del lunes 9, su reunión será calendarizada después de las de otros municipios.

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PLANIFICACION

Información de Contacto

Programa	Junta de Planificación	prpb.lhmp@atkinsrealis.com
Plan. Ivette Colón	Junta de Planificación	colon_i@jp.pr.gov
Plan. William Pitre	AtkinsRéalis Caribe	William.Pitre@atkinsrealis.com /+19392051336

Pedimos que el título de todo correo comience únicamente con el nombre del municipio.
Ej.: "San Germán – Tablas de Mitigación Actualizadas"

Solicitamos que en todo correo electrónico relacionado con el programa se copie siempre al correo oficial: **prpb.lhmp@atkinsrealis.com**

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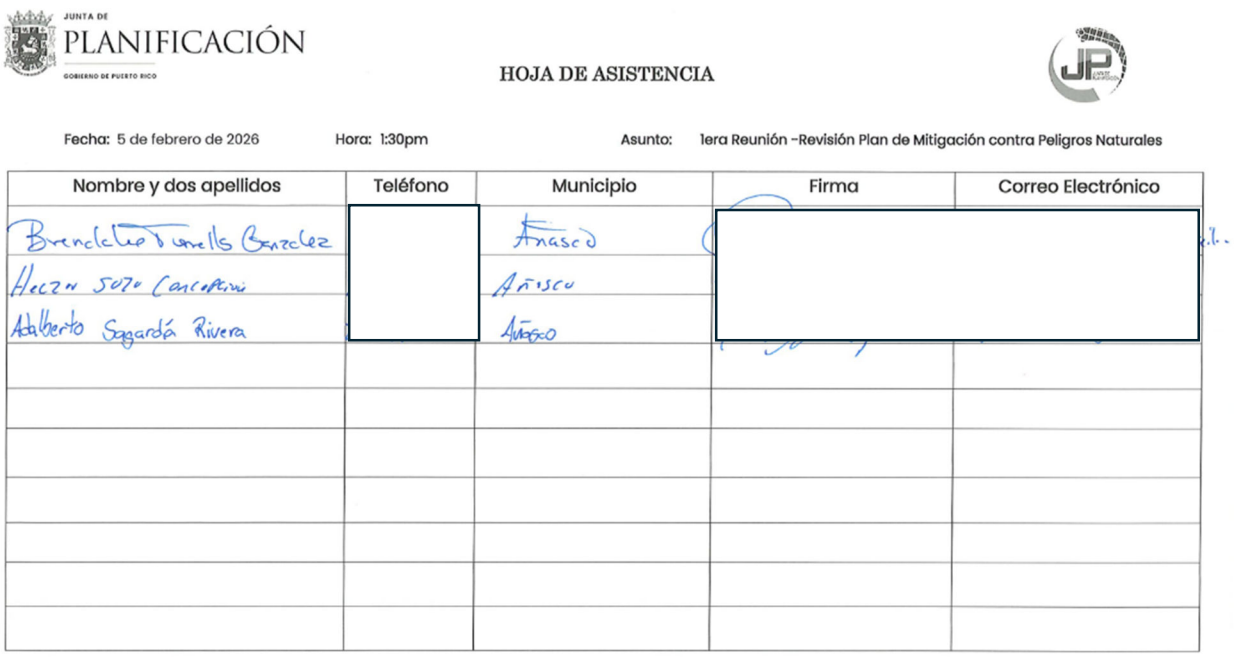
Comunicación

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Grupos de Trabajo

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Documentation



JUNTA DE PLANIFICACIÓN
GOBIERNO DE PUERTO RICO

HOJA DE ASISTENCIA

Fecha: 5 de febrero de 2026 **Hora:** 1:30pm **Asunto:** 1era Reunión -Revisión Plan de Mitigación contra Peligros Naturales

Nombre y dos apellidos	Teléfono	Municipio	Firma	Correo Electrónico
Brenclette Torres Gonzalez		Anasco		
Hector Soto Concepcion		Añasco		
Adalberto Sagardía Rivera		Añasco		

MINUTA

PROYECTO:	PRPB 25 LHMP Update		
TITULO:	LHMP First Planning Committee Meeting		
LUGAR DE LA REUNIÓN:	Junta de Planificación, Salón B	**# REUNIÓN:**	01
FECHA Y HORA:	02/05/2026 a las 1:30 pm	**MINUTA POR:**	Yashira Santos

Lista de Asistencia:

NOMBRE	INICIALES	COMPAÑÍA
Adalberto Sagardía - Oficina de Manejo de Emergencia	AS	Municipio de Añasco
Héctor Soto - Oficina de Recuperación	HS	Municipio de Añasco
Brendalee T. González- Fondos Federales	BT	Municipio de Añasco
Yashira Santos - Analista de Planificación	YS	AtkinsRéalis

Asuntos Discutidos:

ID	ASUNTOS DISCUTIDOS
AD-1	Aprobación de Minuta Reunión Anterior: • N/A
AD-2	Asunto Relacionado con Alcance de Servicio Contratado y Entregables • N/A
AD-3	Plan de Trabajo Propuesta (Two Weeks Ahead / Four Week Ahead) • N/A
AD-4	Asuntos Nuevos • Y. Santos procedió a presentarse y abundar sobre su experiencia en mitigación y los municipios, y pasó la palabra para que los participantes indicaran su nombre y dependencia municipal. Y. Santos explicó la asistencia que estará recibiendo el municipio a través de estas ayudas para el desarrollo del Plan de Mitigación.

NOTA A LOS DESTINATARIOS:
Estas notas de la reunión reflejan la interpretación de AtkinsRéalis sobre la reunión y las acciones previstas que se derivan de la misma. Se asumirá su conformidad en que estas notas constituyen un registro fiel de lo discutido, a menos que se reciban comentarios adversos por escrito dentro de los cinco (5) días posteriores a su recepción.

ID	ASUNTOS DISCUTIDOS
	• El municipio no tenía definido quién sería POC (Point of Contact) del municipio por lo que acordaron enviar la información durante la misma semana. También se solicitó que enviaran la fecha de la reunión comunitaria, el logo oficial, el Single Audit y la carta identificando al Comité. • Se identificó que la persona encargada de desarrollar el plan la ocasión previa no estaba presente en la reunión. • Y. Santos explicó en qué consiste el programa de mitigación y se procedió a discutir las tablas de estrategias del municipio de Añasco incluidas en la versión del Plan de Mitigación bajo revisión. Se destacó la importancia de que los municipios provean información sobre si las medidas de mitigación han sido trabajadas o, de no haberlo sido, que expliquen el estado de progreso. En caso de no haberse trabajado, deberán proveer una justificación válida dentro del marco de responsabilidad que conlleva cada medida adoptada previamente por el municipio. • Se discutieron los tipos de actividad en los que están clasificados los proyectos: Prevención, Protección a la Propiedad, Protección a los Recursos Naturales, Proyectos Estructurales, Servicios de Emergencia y Educación y Concientización Pública. • Referente a la acción SE-3, se discutió la escuela en el barrio Parcelas Marías, carretera 402, km 0.9, donde se está ubicando un refugio y para el cual los fondos han sido obligados bajo el Programa de Asistencia Pública. • Referente a la acción SE-5, A.Sagardía describió un Sistema de Alerta Masiva (SAM) para comunicación de emergencia establecido como respuesta a esta acción. • Referente a la acción ECP-1 se identificó que la misma pudiera ser reclasificada, ya que aparenta estar ubicada bajo una sección incorrecta. • Referente a la acción ECP-2, A.Sagardía indicó que el municipio ha estado activo mediante Facebook y charlas educativas para propósitos concienciación pública. • Se trabajó con el municipio una dinámica para identificar el proyecto de mitigación de mayor prioridad en caso de no existir límites de fondos. Surgieron los siguientes proyectos: o Proyecto: Nuevas facilidades en la OMME (oficinas operacionales, centro de acopio, refugio municipal, centro de recreación, comedor y almacén de suministro) Razón: Atender emergencias o Proyecto: Canalización de aguas y sistema de aguas pluviales para Pueblo, San Antonio, Daguey, Brisas y Pozo Hondo. o Razón: El sistema pluvial no atiende la cantidad actual de escorrentías. Proyecto: Sistema de drenaje en Pozo Hondo. Razón: Es una de las principales entradas de Añasco.

NOTA A LOS DESTINATARIOS:
Estas notas de la reunión reflejan la interpretación de AtkinsRéalis sobre la reunión y las acciones previstas que se derivan de la misma. Se asumirá su conformidad en que estas notas constituyen un registro fiel de lo discutido, a menos que se reciban comentarios adversos por escrito dentro de los cinco (5) días posteriores a su recepción.

ID	ASUNTOS DISCUTIDOS
	• Se repitió la dinámica para establecer proyectos adicionales de prioridad: o Proyecto: Mantenimiento del Río Grande y Río Hondo. Razón: Mitigar inundaciones y evitar pérdida de vidas. o Proyecto: Soterrado de Energía Razón: Los postes que energizan el pueblo sufren inundaciones; tras el huracán María el municipio permaneció seis (6) meses sin servicio eléctrico. El soterrado ya existe. • Se realizó una dinámica para identificar los tres (3) peligros prioritarios para el equipo, siendo el tres (3) el más crítico. Las respuestas fueron las siguientes: o 1. Terremoto 2. Inundaciones 3. Ciclones Tropicales o 1. Deslizamientos 2. Inundaciones 3. Ciclones Tropicales o 1. - 2. Falta de electricidad 3. Deslizamientos, falta de agua, vientos fuertes e inundaciones.
AD-5	Discusión de Acciones por Tomar • Tabla Inferior
AD-6	Coordinación Próxima Reunión • TBD

Acciones Por Tomar:

ID	ACCIONES POR TOMAR	FECHA LÍMITE	ENTIDAD RESPONSABLE
AT-1	Enviar logo del Municipio.	Lo antes posible	Mun. Añasco
AT-2	Enviar fecha, hora y lugar de reunión comunitaria.	Lo antes posible	Mun. Añasco
AT-3	Continuar con la identificación de estado de proyectos propuestos en su plan de mitigación a revisar.	Lo antes posible	Mun. Añasco

NOTA A LOS DESTINATARIOS:
Estas notas de la reunión reflejan la interpretación de AtkinsRéalis sobre la reunión y las acciones previstas que se derivan de la misma. Se asumirá su conformidad en que estas notas constituyen un registro fiel de lo discutido, a menos que se reciban comentarios adversos por escrito dentro de los cinco (5) días posteriores a su recepción.

Acuerdos/Aclaraciones:

ID	DESCRIPCIÓN
AC-1	N/A

Anejos:

ID	DESCRIPCIÓN ANEJO	NÚMERO DE PÁGINAS
AN-1	N/A	

PRÓXIMA REUNIÓN:	TBD		
MEDIO DE DISTRIBUCIÓN:	Email		
FECHA DISTRIBUCIÓN:	02/18/2026	**ARCHIVO DE REFERENCIA:**	First Planning Committee Meeting

NOTA A LOS DESTINATARIOS:
Estas notas de la reunión reflejan la interpretación de AtkinsRéalis sobre la reunión y las acciones previstas que se derivan de la misma. Se asumirá su conformidad en que estas notas constituyen un registro fiel de lo discutido, a menos que se reciban comentarios adversos por escrito dentro de los cinco (5) días posteriores a su recepción.

Appendix C – Public Participation and Outreach

First Public Meeting Notification



Documentation

JUNTA DE PLANIFICACIÓN
GOBIERNO DE PUERTO RICO

PLANES DE MITIGACIÓN CONTRA PELIGROS NATURALES
Planificar para proteger

HOJA DE ASISTENCIA

Asunto: 1era Reunión de Planificación con la Comunidad- Municipio de Añasco — Fecha: 10 de marzo de 2026

Lugar: Legislatura Municipal en la Casa Alcaldía de Añasco — Hora: 10:00 am

Nombre completo (en letra de molde)	Municipio/Barrio/ Comunidad	Teléfono	Correo electrónico	Firma
Rosa H. Pérez Moreno	Municipio de Añasco	[redacted]		
Omar F. Carcaño	Junta de Planificación.			
Luis J. Valentín	Barrio Marías, Añasco			
Brendalee Tanelle				
Arlene M. Figueroa				
RAYMOND F. WATERS				
Rosa L. Ramirez	Bo. Playa			
Juan I. Collado	Bo. Playa			
Marilyn Mendoza	Bo. Playa			
Mirta E. Santiago	Bo. Miraflores			

JUNTA DE PLANIFICACIÓN
GOBIERNO DE PUERTO RICO

PLANES DE MITIGACIÓN CONTRA PELIGROS NATURALES
Planificar para proteger

HOJA DE ASISTENCIA

Asunto: 1era Reunión de Planificación con la Comunidad- Municipio de Añasco — Fecha: 10 de marzo de 2026

Lugar: Legislatura Municipal en la Casa Alcaldía de Añasco — Hora: 10:00 am

Nombre completo (en letra de molde)	Municipio/Barrio/ Comunidad	Teléfono	Correo electrónico	Firma
Hector Soto	Añasco	[redacted]		
Luis A Rivera	Espino			
Joel Babilonia	Añasco carreras			
Thaiana Rosario	Añasco			
Alexys Moreno	Añasco			
Anacelia Gutiérrez	Añasco			
Robin Santiago	Caguabo/Añasco			
Maria Teresa Ramirez	Caguabo/Añasco			
Andya Aponte	SP			
Steven Gracia Martinez	Cidra — Casey			

JUNTA DE PLANIFICACIÓN
GOBIERNO DE PUERTO RICO

PLANES DE MITIGACIÓN
CONTRA PELIGROS NATURALES
Planificar para proteger

HOJA DE ASISTENCIA

Asunto: 1era Reunión de Planificación con la Comunidad- Municipio de Añasco

Fecha: 10 de marzo de 2026

Lugar: Legislatura Municipal en la Casa Alcaldía de Añasco

Hora: 10:00 am

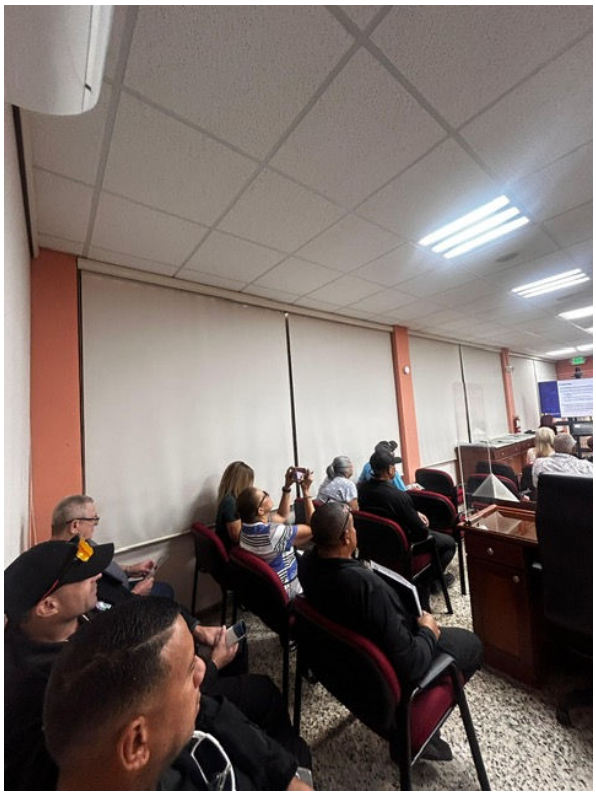
Nombre completo (en letra de molde)	Municipio/Barrio/ Comunidad	Teléfono	Correo electrónico	Firma
[illegible]	Miraflores Añasco			
[illegible]	Bo. Dagüey			
[illegible]	Mayuco			

Photographic Evidence





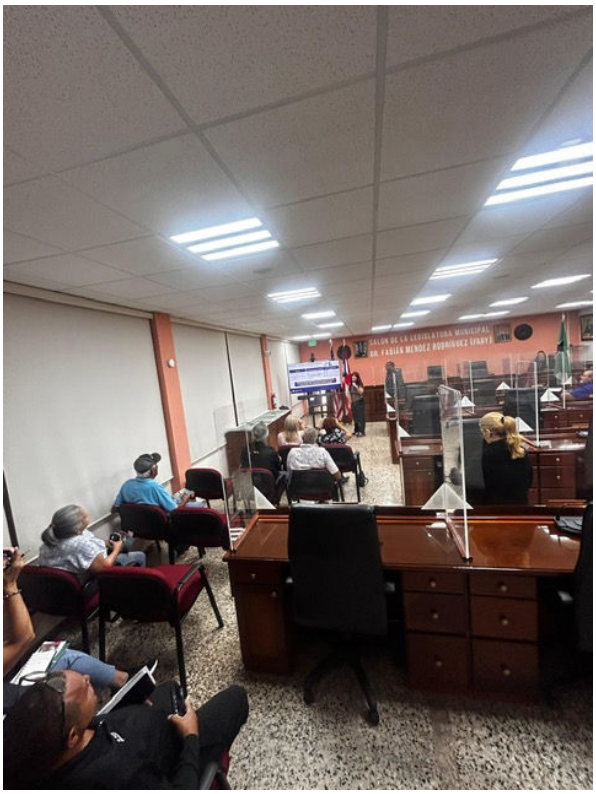


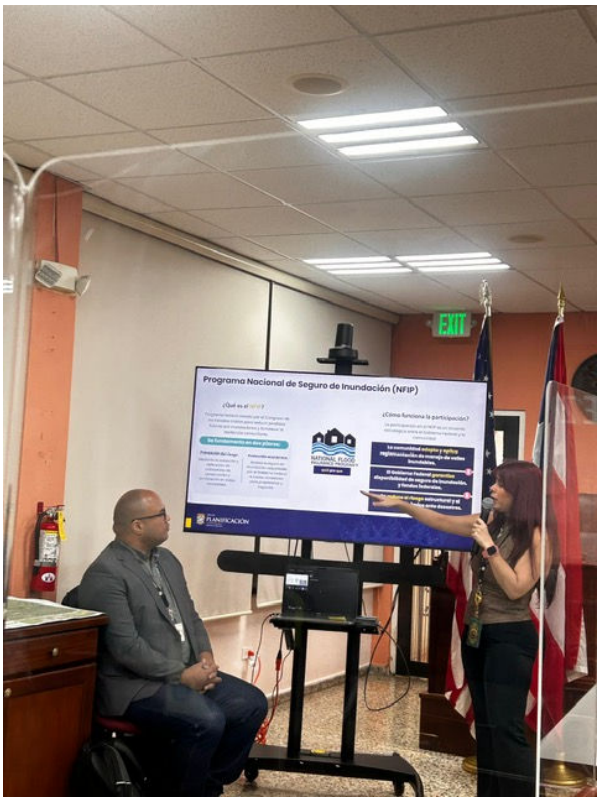


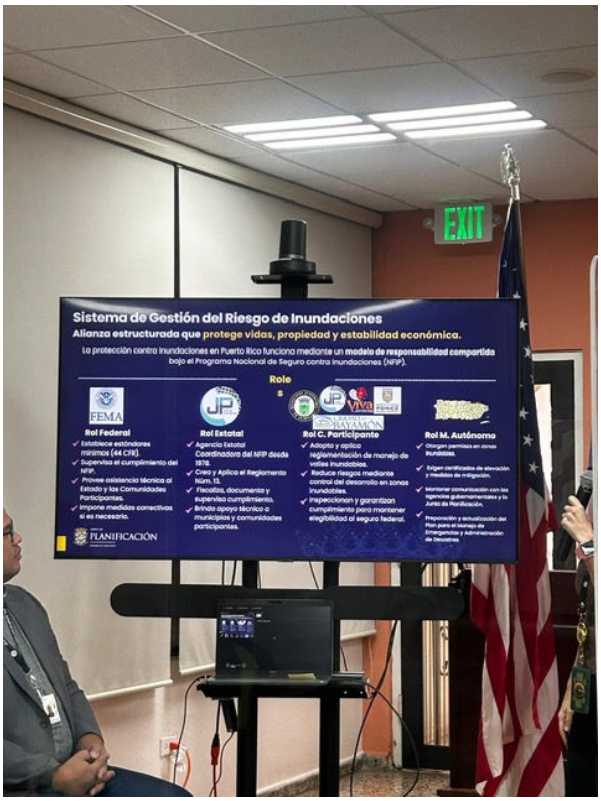




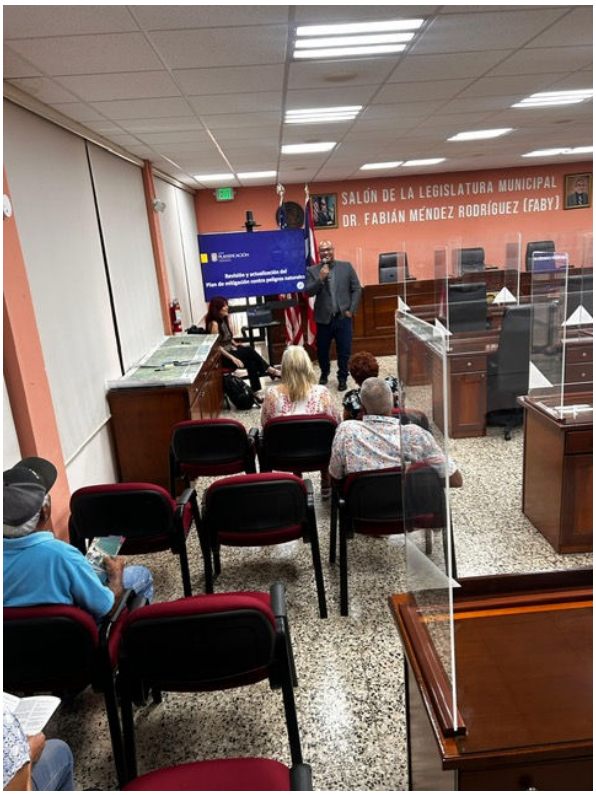





EXIT
Programa Nacional de Seguro de Inundación (NFIP)
PLANIFICACIÓN


EXIT
Sistema de Gestión del Riesgo de Inundaciones
Alianza estructurada que protege vidas, propiedad y estabilidad económica.
La protección contra inundaciones en Puerto Rico funciona mediante un modelo de responsabilidad compartida bajo el Programa Nacional de Seguro contra Inundaciones (NFIP).
Roles
FEMA
Rol Federal
Establece estándares mínimos (44 CFR).
Supervisa el cumplimiento del NFIP.
Provee asistencia técnica al Estado y las Comunidades Participantes.
Impone medidas correctivas si es necesario.
Rol Estatal
Agencia Estatal Coordinadora del NFIP desde 1978.
Crea y Aplica el Reglamento Núm. 13.
Fiscaliza, documenta y supervisa cumplimiento.
Brinda apoyo técnico a municipios y comunidades participantes.
Rol C. Participante
Adopta y aplica reglamentación de manejo de valles inundables.
Reduce riesgos mediante control del desarrollo en zonas inundables.
Inspeccionan y garantizan cumplimiento para mantener elegibilidad al seguro federal.
Rol M. Autónomo
Otorgan permisos en zonas inundables.
Exigen certificados de elevación y medidas de mitigación.
Mantener comunicación con las agencias gubernamentales y la Junta de Planificación.
Preparación y actualización del Plan para el manejo de Emergencias y Administración de Desastres
PLANIFICACIÓN


Formulario para Determinación de Zonas Inundables
SALÓN DE LA LEGISLATURA MUNICI
DR. FABIÁN MÉNDEZ RODRÍGUEZ (FA
PLANIFICACIÓN


SALÓN DE LA LEGISLATURA MUNICIPAL
DR. FABIÁN MÉNDEZ RODRÍGUEZ (FABY)

Second Public Meeting Notification

To be included in Final Draft

Appendix D: Stakeholder Involvement

To be included in the final draft

Appendix E – Municipality Org-Chart

To be included in the final draft

Appendix F – List of Critical Infrastructure

To be included in the final draft